UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REGIONS BANK,

Petitioner,

v.

UNITED SERVICES AUTOMOBILE ASSOCIATION,
Patent Owner.

Case IPR2025-01356

U.S. Patent No. 12,211,095

DECLARATION OF DR. DANIEL LOPRESTI IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW

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I. INTRODUCTION

1. My name is Daniel Lopresti. I am currently a Full Professor in the Department of Computer Science & Engineering ("CSE") at Lehigh University.

2. I have been retained by Regions Bank, ("Regions"). I have been asked for opinions regarding the validity of claims 1-30 of U.S. Patent No. 12,211,095 ("'095 patent"). For the reasons set forth below, it is my conclusion that claims 1-30 are invalid.

II. QUALIFICATIONS AND EXPERIENCE

3. My curriculum vitae, which describes my education, experience, professional activities, and which lists, *inter alia,* my publications and patents, is attached as **Appendix B**. Below is a summary of my education, work experience and other qualifications.

4. I received a B.A. in Mathematics and Engineering Science from Dartmouth College in 1982, an M.S.E. in Electrical Engineering and Computer Science from Princeton University in 1983, an M.A. in Electrical Engineering and Computer Science from Princeton University in 1984, and a Ph.D. in Computer Science from Princeton University in 1987.

5. I am currently a Full Professor in the Department of Computer Science & Engineering ("CSE") at Lehigh University in Bethlehem, PA, and have been since May 2009. From July 2009 through June 2019, I also served as Chair of

the CSE Department, except for a period from July 2014 to June 2015 when I served as the Interim Dean of the P. C. Rossin College of Engineering and Applied Science at Lehigh. In July 2015, I was named Director of the Lehigh Data X strategic initiative focused on interdisciplinary data science, a role I held until June 2020. From 2003 to 2009, I was an Associate Professor in the CSE Department.

6. The courses that I have taught at Lehigh include Big Data Analytics, Artificial Intelligence Theory and Practice, AI for Social Good, Software Product Management, Issues in Cybersecurity, Data Mining, Research Methods, Operating System Design, and Breadth of Computing. In my Big Data Analytics, AI, and Data Mining courses I have covered a range of computer vision and machine learning techniques for object recognition. The Breadth of Computing course was an introductory course which covered the operation of computer hardware, software, networks, and systems. Topics covered in this course included introductions to designing websites, writing computer programs, computer architecture, operating systems, computer networks, databases, security, privacy, and social, ethical, and professional issues. As a part of this class, I taught the students HTML and JavaScript programming running in a standard web browser.

7. From December 2002 to June 2003, I held a courtesy appointment as a Visiting Research Scientist at the Palo Alto Research Center, and from February

2003 to June 2003 I also held courtesy appointments as a Research Fellow in the Information Security Institute at Johns Hopkins University, and as a Visiting Research Associate Professor at Rensselaer Polytechnic Institute.

8. From October 1997 to December 2002, I was a Member of Technical Staff at Bell Labs/Lucent Technologies, conducting research in the areas of document image analysis, optical character recognition, pen-based computing[1] using portable tablet computers and PDAs, and computer security. During this time, I developed code to run on tablet computers to collect handwriting data, which supported research that led to multiple publications and, later, after I had left Bell Labs to work at Lehigh, an NSF grant. I also worked on the development of text-to-speech ("TTS") technologies, audio CAPTCHAs, speech biometrics, and handwriting biometrics.

9. From June 1991 to October 1997, I was a Principal Scientist at the

[1] Pen computing refers to the computerized analysis of characters or other forms of handwriting (e.g., signatures) or hand-drawn sketches entered by a finger, pen, or stylus using a trackpad or graphics tablet, or other device with a touch-sensitive screen such as a tablet computer or a personal digital assistant (PDA).

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Matsushita Information Technology Laboratory in Princeton, NJ, conducting research in the areas of optical character recognition, document analysis, document processing systems, and pen computing. As part of my work in pen computing, I utilized a range of devices for research, including tablet computers and PDAs.

10. From September 1986 to May 1991, I was an Assistant Professor of Computer Science at Brown University, conducting research in parallel computing and computer-aided design of VLSI. During this time, I also taught courses related to VLSI design, parallel computing, discrete math, and computational molecular biology.

11. From 2009 through 2013, I served as Chair of Technical Committee 11 of the International Association for Pattern Recognition ("IAPR"). Technical Committee 11 is known as the "Reading Systems" committee, and its goal is to understand and develop systems that can analyze media containing character symbols and return an encoded representation of the text content and structure. TC-11 focuses specifically on document analysis, whether captured from scanners or cameras, and sponsors the CBDAR ("Camera-Based Document Analysis and Recognition") workshop series, which began in 2005 and continues biennially. I served as Chair of TC-11 during the 2009, 2011, and 2013 CBDAR workshops, and I have also served as a Program Chair and Executive Chair for ICDAR

("International Conference on Document Analysis and Recognition"), the parent conference of CBDAR, in multiple years.

12. From 2018 through 2021, I served as Treasurer of IAPR, and in 2021, I was elected President of IAPR. In 2022, I transitioned to the role of Past-President. I served as a member of the IAPR Executive Committee from 2018 through 2024. During my tenure with IAPR, I have engaged in a wide range of technical, organization, and leadership activities. I have reviewed hundreds of papers across dozens of conferences, including papers directly related to the technologies at issue in this case. I have helped decide the technical programs for a number of conferences in the field of document analysis, including making acceptance decisions and organizing papers into scientific sessions along specific themes. I have helped develop new conferences and new activities within existing conferences.

13. From 2015 through 2025, I served as an appointed member on the Council for the Computing Community Consortium ("CCC") of the Computing Research Association ("CRA"). I assumed the role of Vice Chair of CCC effective July 2020 and became Chair of CCC in July 2022. I served in the position of Chair Emeritus of CCC from July 2024 through June 2025 and remain involved in some ongoing CCC and CRA activities. The role of the CCC is to catalyze the United

States computing research community to pursue high-impact research, conduct activities that strengthen the research community, articulate compelling research visions, and align those visions with key national and global challenges. While on the CCC Council, I have served on, and also co-chaired, a number of Task Forces, including: Intelligent Infrastructure; Cybersecurity and Cybercrime; Technology for a Connected and Distributed Life; Security, Integrity, and Trust; NextGen AI; and Grand Challenges in Computing. I helped organize the recent CCC Workshop on the Future of Information Retrieval Research in the Age of Generative AI, which was held in Washington, DC in July 2024.

14. Since 2014, I have served as an Editor-in-Chief of the International Journal of Document Analysis and Recognition, a scholarly journal published by Springer-Nature that addresses all areas related to document analysis and recognition. This includes research on computer recognition of characters, symbols, text, lines, graphics, images, handwriting, signatures, and the physical and logical structures of documents, with the objective of advancing high-level semantic understanding. The journal has also published numerous papers on mobile device-based document analysis, and in my role as Editor-in-Chief, I have been involved in reviewing and making editorial decisions on such submissions. Over a period of more than 20 years, I have served as a scientific program co-chair for many major

international conferences in the fields of document analysis and pattern recognition, including the Workshop on Document Analysis Systems (DAS). Across these conferences, I have participated in reviewing and organizing sessions that addressed technologies applicable to mobile device-based document analysis, such as handwriting recognition, image-based document processing, and check image analysis. Since 2011, I have also served as an Area Editor for Computer Vision and Image Understanding (CVIU), which is a scholarly journal published by Elsevier. The focus of CVIU is the computer analysis of pictorial information, including all aspects of image analysis from the low-level, iconic processes of early vision to the high-level, symbolic processes of recognition and interpretation of objects and other imaged elements. Many of the papers in CVIU are aimed at problems arising from camera-captured images.

15. My areas of expertise encompass the fields of document analysis techniques, optical character recognition technology, computer and mobile software development, artificial intelligence techniques (e.g., machine learning and computer vision), computer and biometric security techniques, electronic voting systems, and research reproducibility.

16. I have authored over 175 publications in peer-reviewed academic journals, transactions and books. I have authored or co-authored publications

involving document image analysis, tabular data processing, techniques for handling noisy text, handwriting recognition, analyzing camera-captured images, user authentication, and machine learning. While they are fully set forth in my CV, some examples include:

17. "Finding Text in Color Images," J. Zhou, D. Lopresti, and T. Tasdizen, Proceedings of Document Recognition V (IS&T/SPIE International Symposium on Electronic Imaging), February 1998, San Jose, CA, pp. 130-140.

18. "Mobile Interactive Support System for Time-Critical Document Exploitation," G. Nagy and D. Lopresti, Symposium on Document Image Understanding Technology, November 2005, College Park, MD, pp. 111-119.

19. "Document Photography in Vitro," G. Nagy, B. Clifford, A. Berg, G. Saunders, E. Barney Smith, and D. Lopresti, Proceedings of the Third International Workshop on Camera-Based Document Analysis and Recognition, July 2009, Barcelona, Spain, pp. 26-33.

20. "Camera-based Ballot Counter," G. Nagy, B. Clifford, A. Berg, G. Saunders, D. Lopresti, and E. Barney Smith, Proceedings of the Tenth International Conference on Document Analysis and Recognition, July 2009, Barcelona, Spain, pp. 151-155.

21. "A New Common Points Detection-Based Method for

Classification of 2D and 3D Texts in Video/Scene Images," L. Nandanwar, P. Shivakumara, A. Kumar, T. Lu, U. Pal, and D. Lopresti, Proceedings of the Fourteenth International Workshop on Document Analysis Systems (DAS 2020), July 2020, Wuhan, China (virtual), Springer LNCS Vol. 12116, pp. 512-528.

22. "A New Context-Based Method for Restoring Occluded Text in Natural Scene Images," A. Mittal, P. Shivakumara, U. Pal, T. Lu, M. Blumenstein, and D. Lopresti, Proceedings of the Fourteenth International Workshop on Document Analysis Systems (DAS 2020), July 2020, Wuhan, China (virtual), Springer LNCS Vol. 12116, pp. 466-480.

23. "Local Gradient Difference Features for Classification of 2D-3D Natural Scene Text Images," L. Nandanwar, S. Palaiahnakote, R. Ramachandra, T. Lu, U. Pal, D. Lopresti, N. B. Anuar, Proceedings of the Twenty-Fifth International Conference on Pattern Recognition (ICPR 2020), January 2021, Milan, Italy (virtual), IEEE Computer Society Press, pp. 1,112-1,119.

24. "Arbitrarily-Oriented Text Detection in Low Light Natural Scene Images," M. Xue, P. Shivakumara, C. Zhang, Y. Xiao, T. Lu, U. Pal and D. Lopresti, IEEE Transactions on Multimedia, vol. 23, pp. 2706-2720, early access August 2020, DOI: https://ieeexplore.ieee.org/document/9162503.

25. "Graph Attention Network for Detecting License Plates in Crowded

Street Scenes," P. N. Chowdhury, P. Shivakumara, S. Kanchan, R. Raghavendra, U. Pal, T. Lu, and D. Lopresti, Pattern Recognition Letters, vol. 140, December 2020, pp. 18-25.

26. "An Episodic Learning Network for Text Detection on Human Bodies in Sports Images," P. N. Chowdhury, P. Shivakumara, R. Raghavendra, S. Nag, U. Pal, T. Lu, and D. Lopresti, IEEE Transactions on Circuits and Systems for Video Technology, vol 32, no. 4, April 2022, pp. 2279-2289, online access June 2021, DOI: https://doi.org/10.1109/TCSVT.2021.3092713.

27. I am a named inventor in 24 United States patents, including:

28. "Method of Locating a Machine-Readable Two-Dimensional Barcode Within an Image," J. Zhou and D. Lopresti, U.S. Patent No. 5,974,200, issued October 1999.

29. "Identification of Logos from Document Images," J. Zhou, D. Lopresti, and P. Sarkar, U.S. Patent No. 6,327,388, issued December 2001.

30. I have also been a member of the Institute of Electrical and Electronics Engineers ("IEEE") since 1982. I became an IEEE Senior Member in 2003, and an IEEE Life Member in 2024. During my career, I have authored or coauthored approximately 18 refereed papers or proceedings that were published in IEEE technical publications.

31. I have also been active in other IEEE activities. For example, I served as program co-chair for the Eleventh International Conference on Document Analysis and Recognition in 2011, whose proceedings were published on the IEEE Explore website. I have received two awards from IEEE organizations. I was an Associate Editor of IEEE Transactions on Pattern Analysis and Machine Intelligence between 2005 and 2010. I have been a member of conference program committees for several IEEE conferences, I have served as an invited reviewer for a number of different IEEE journals and several IEEE conferences, all as listed in my CV.

32. I am also a member of several other scientific and research associations, and have conducted various activities for them, attended their conferences, and published papers and proceedings in their technical publications. These include the Association for Computing Machinery ("ACM"), and the Association for the Advancement of Artificial Intelligence ("AAAI").

33. In formulating my opinions, I have relied upon my training, knowledge, and experience in the relevant art.

III. LEGAL PRINCIPLES

34. I am not an attorney. For purposes of this declaration, I have been informed about and understand certain aspects of the law that are relevant to my analysis and opinions.

A. Scope of Opinion

35. I have been informed and understand that the petitioner in an *inter partes review* may request cancellation of claims as unpatentable only on grounds that such claims are anticipated or would have been obvious to a person of ordinary skill in the art at the time of the purported invention and only on the basis of prior art consisting of patents or printed publications. My opinions in this declaration are limited to this scope.

B. Anticipation

36. I understand that to anticipate a claim of a patent, a prior art refence must disclose, either expressly or inherently, all limitations of a claim as those limitations are arranged in the claim.

C. Obviousness

37. I understand that a claim is unpatentable if it would have been obvious to a person of ordinary skill in the art at the time the alleged invention was made. I understand that a claim could have been obvious based on the teachings or suggestions of a single prior art reference or from a combination of two or more prior art references. I understand that an obviousness analysis requires an understanding of the scope and content of the prior art, any differences between the alleged invention and the prior art, and the level of ordinary skill in evaluating the pertinent art.

38. I further understand that a claim would have been obvious if it unites old elements with no change to their respective functions or alters prior art by mere substitution of one element for another known in the field, and that combination yields predictable results. Also, I understand that obviousness does not require physical combination or bodily incorporation, but rather consideration of what the combined teachings would have suggested to persons of ordinary skill in the art at the time of the alleged invention.

39. In connection with obviousness, I have been informed that there must have been some reason or motivation that would have led a person of ordinary skill in the art to combine or modify the relevant teachings in the prior art to obtain the claimed invention, and one of ordinary skill in the art must have had a reasonable expectation of success in doing so. I understand that obviousness does not require a particular combination or modification to be the best or preferred approach, and instead need only be desirable in view of the prior art.

40. While it may be helpful to identify a reason for this combination, I understand that there is no rigid requirement of finding an express teaching, suggestion, or motivation to combine within the references. If a person of ordinary skill in the art can implement a predictable variation, obviousness likely bars its patentability. For the same reason, if a technique has been used to improve one

device and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique would have been obvious. I understand that a claim would have been obvious if a person of ordinary skill in the art would have had reason to combine multiple prior art references or add missing features to reproduce the alleged invention recited in the claims.

41. I understand that a determination of whether a claim would have been obvious is based on a variety of considerations, including, among others:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, which, when combined, would yield predictable results;
- whether a person having ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent;
- whether the alleged invention uses a known technique to improve a

similar device or method in the same way; and

- whether the alleged invention applies a known technique to a known device or method that was ready for improvement to yield predictable results.

42. I also understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered. I also understand that one of ordinary skill in the art has ordinary creativity and is not an automaton. However, I understand that silence in the patent itself can indicate that persons of ordinary skill in the art would have been able to choose among known ways to implement a relevant feature.

43. I have been informed and understand that for a patent's claims to receive the benefit of priority of an earlier-filed application, every application in the priority chain leading to the application in question must support every limitation of the claim. This means every parent application must describe every limitation of every claim and that it is not enough for the parent application to simply render obvious the claims of the child patent.

44. I have been informed and understand that whether an application describes a patent's claim limitations is known as the "written description requirement." I have been informed and understand that to satisfy the written

description requirement, the patent's specification must describe the claimed invention in sufficient detail that a person of ordinary skill in the art could reasonably conclude that the inventor had possession of the claimed invention at the time of filing.

45. I have been informed and understand that if a child patent includes claims that are greater in scope than the subject matter that the inventor chose to disclose to the public in the written description of the parent application, the parent application does not provide written description support for the claims of the child patent.

46. I further understand that certain factors, commonly referred to as secondary considerations, may support or rebut the obviousness of a claim. I also understand that secondary considerations cannot be used to overcome anticipation. I understand that such secondary considerations include, among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus, that is, a connection, between any

such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

47. I have been informed and understand that in an obviousness analysis, prior art can be relied upon if it qualifies as analogous art. Prior art is considered analogous if it is either (a) from the same field of endeavor as the claimed invention, or (b) from a different field but is reasonably pertinent to the problem the inventor was trying to solve.

48. I have been informed and understand that determining whether a reference is reasonably pertinent depends on whether a person of ordinary skill in the art would have considered the reference when attempting to solve the problem addressed by the patent. This inquiry focuses on the relationship between the reference and the problem, rather than the specific field from which the reference originates.

49. I have been informed and understand that if a reference is outside the field of endeavor and not reasonably pertinent to the problem addressed by the claimed invention, it is generally not considered analogous art and therefore cannot be used in the obviousness analysis. This ensures that the assessment of obviousness reflects what a person of ordinary skill in the art would have reasonably considered

at the time of the invention.

50. I reserve the right to respond to any allegations that may be put forth by Patent Owner in this proceeding that any secondary considerations tend to rebut the obviousness of any claim of the '095 patent discussed in this Declaration.

D. Claim Construction

51. I was informed and I understand that, in my analysis, I should give claim terms their ordinary and customary meaning, as understood by a person of skill in the art at the time of the invention. I was informed and I understand that the words of the patent's claims and the context in which the term is used in the claims can be highly instructive in ascertaining the term's meaning. I further understand that the terms of a claim are to be interpreted in the context of the entire patent, including the patent's claims, its specification and its figures. I have been further instructed that a patent's "prosecution history" may often provide helpful evidence about how the Patent Office and the applicant understood the patent and its claims. Therefore, I have been instructed that claim terms should also be interpreted in light of the patent's prosecution history.

E. Claim Dependency

52. I understand that a patent may include two types of claims, independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an

independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to all of the limitations recited in the claim or claims from which it depends.

53. The analysis in this declaration is in accordance with the above-stated legal principles.

IV. SUMMARY OF OPINION

54. In my opinion, claims 1-30 of U.S. Patent No. 12,211,095 are not patentable. In reaching my opinion I have considered, among other things, the following specific references as prior art:

- International Patent Application Publication No. WO 2005/043857 ("Garcia") (EX1003)[2]
- Chinese Patent Application Publication No. CN 1897644A ("Luo") (EX1004)[3]

[2] Garcia was originally published in Spanish. Exhibit A of EX1003 includes the original Spanish publication, and Exhibit B of EX1003 includes a certified translation of the Spanish publication. This Declaration's citations to "EX1003" refer specifically to Exhibit B of EX1003.

[3] Luo was originally published in Chinese. Exhibit A of EX1004 includes the

- Reto Meier, Professional Android Application Development, Wiley Publishing (June 25, 2008) ("Meier") (EX1005)
- U.S. Patent Application Publication No. 2007/0194102 ("Cohen") (EX1006)
- U.S. Patent Application Publication No. 2007/0262148 ("Yoon") (EX1007)
- Vikram Goyal, Pro JAVA ME MMAPI: Mobile Media API for Java Micro Edition, Apress (June 14, 2006) ("Goyal") (EX1008)
- U.S. Patent Application Publication No. 2006/0106717 ("Randle") (EX10048)
- U.S. Patent No. 7,156,311 ("Attia") (EX1043)

55. The table below lists the combination of references based on which a person of ordinary skill in the art would have found the challenged claims obvious.

original Chinese publication, and Exhibit B of EX1004 includes a certified translation of the Chinese publication. This Declaration's citations to "EX1004" refer specifically to Exhibit B of EX1004.

Ground	References	Basis	Claims Challenged
I	Garcia, Luo, Meier, Cohen	§103	1-4, 6-12, 14-21, 23-30
II	Garcia, Luo, Meier, Cohen, Yoon	§103	5, 13, 22
III	Garcia, Luo, Meier, Cohen, Randle	§103	7, 24
IV	Garcia, Luo, Meier, Cohen, Attia	§103	11, 16
V	Garcia, Luo, Goyal, Cohen	§103	1-4, 6-12, 14-21, 23-30
VI	Garcia, Luo, Goyal, Cohen, Yoon	§103	5, 13, 22
VII	Garcia, Luo, Goyal, Cohen, Randle	§103	7, 24
VIII	Garcia, Luo, Goyal, Cohen, Attia	§103	11, 16

V. DESCRIPTION OF THE RELEVANT FIELD

56. I have reviewed and understand the specification, claims, and file history of the ’095 patent. I have also reviewed the exhibits listed in the Table of Exhibits attached hereto. Based on my review of these materials, I believe that the relevant field for purposes of my analysis is computer science, including the areas of computer engineering, or electrical engineering, including relevant experience

with image processing or scanning technology involving transferring and processing of image data to and at a server. As I describe above, I have extensive experience in the relevant technology.

VI. TECHNICAL BACKGROUND

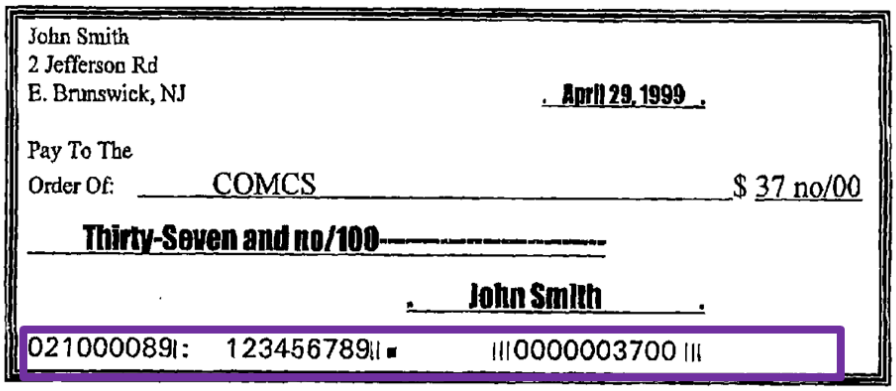
57. In this section, I discuss the state of the art with respect to certain technologies relevant to the subject matter of the '095 patent.

A. Checks

58. The use of checks to transfer funds from one entity to another "is well known in the art, and has been in use in one form or another for hundreds of years." EX1012-Richardson, [0005]. Checks are pieces of paper prepared by a payor that wishes to pay a certain sum of money to a payee. More specifically, checks are a type of financial instrument that requests the payor's bank to pay the designated amount of money to the payee listed on the check. Checks can either be cashed or deposited. Depositing a check requires obtaining certain information from the check, including the amount to be paid, the payee's account number, and the identity of the payee. *See* EX1003-Garcia, 7:1-14, 10:12-13; EX1006-Cohen, [0008], [0022]. Checks typically contain other information, such as a date and the payor's signature. The payee also typically signs the back or reverse side of a check before cashing or depositing.

59. To identify the payer's account from which payment will be drawn,

checks typically include information known as the **magnetic-ink character-recognition ("MICR") line**, which is a line of numbers near the bottom of a front side of the check. *See* EX1006-Cohen, [0008], [0022]. The **MICR line** typically includes three pieces of information: (1) the payor's bank routing number (which identifies the payor's bank), the payor's account number with that bank (which identifies the account from which the check will be drawn), and the check number (a unique number assigned to each check that can be used for keeping track of particular checks and for security purposes):



EX1014-Slater, Fig.11.

60. **MICR lines** have been used on checks for decades. **MICR lines** are printed in a standardized font that is intended to make them readable. EX1061-Xerox, 1-1, 1-3, 1-5. As the name suggests, **MICR lines** are typically printed in magnetic font that allows the check to be read by a magnetic reader. However, the **MICR line** font is "often printed according to the 'E13B' font specification

developed by the American Bankers Association", which is "designed to be easily recognized by…optical character recognition systems…." EX1011-Clarke, 1:22-32, 5:61-65. The uniquely stylized **MICR** font makes it easier to read using OCR than other typefaces. Moreover, OCR of the **MICR** is made more accurate by the fact that the **MICR line** contains only numbers, meaning that the OCR matches a smaller set of characters than a full alphanumeric set, which reduces the likelihood of errors.

B. Electronic Check Processing

61. Before the advent of OCR and magnetic check readers, checks were typically processed by transferring physical checks between banks. However, "[o]ver time, the process has become gradually more and more automated with the advent of high speed check processing machines, computer-readable check numbers, and…computer handwriting recognition." EX1012-Richardson, [0005]-[0006]; EX1013-FDIC.

62. This technology had matured significantly by the early 2000s. For example, by that time banks were already implementing automated technology that processed check deposits using only images of the checks and without transferring a paper copy of the check between banks. EX1012-Richardson, [0005]. As I mentioned above, banks had "***well known***" OCR technology for automatically

recognizing information on a check image. EX1006-Cohen, [0007]; EX1003-Garcia, 11:7-15; EX1014-Slater, [0023]. Indeed, by the early 2000s OCR technology had made significant strides. As I discussed above in Section II regarding my qualifications and experience, I began working on OCR technology in the 1990s. By the early 2000s, OCR had improved such that it could accurately read most handwriting and read typeset text from lower quality images.

63. In order to standardize the digital processing of checks, the Federal Reserve adopted certain standards for check images. As an example, the Federal Reserve began requiring a standardized file format that included requirements to compress check images to a bi-tonal format. EX1006-Cohen, [0010]; EX1015-DSTU. A bi-tonal image uses only two colors to represent data: black and white. When converting to a bi-tonal format, pixels are converted from color or grayscale data to black or white depending on how dark they are. By this time, it was well known that converting images to bi-tonal formats can make them easier to read using OCR (and even to recognize other important components like document edges) in many ways. For example, a bitonal image has increased contrast, reduced noise, and consistent output between images. This helps reduce the amount of processing required for OCR, including by making segmentation easier and by reducing the overall size of data required to be processed.

64. Electronic processing of checks went a step further in 2004, when Congress passed the Check Clearing for the 21st Century Act ("Check 21 Act"). The Check 21 Act imposed certain requirements on banks, including that they accept a digital image of a check for deposit instead of the physical paper version. EX1006-Cohen, [0010]; EX1012-Richardson, [0007]-[0008]; EX1013-FDIC.

65. The Check 21 Act enables a process called check "truncation." A check is truncated when the original check is replaced with a digitized version. EX1006-Cohen, [0004]; EX1012-Richardson, [0008]. Truncation occurs at the moment when the check is removed from the deposit process. EX1012-Richarson, [0009]. The original paper check can be destroyed. *Id.* As I discussed above, the digitized version of the check includes the relevant deposit information, including an image of the check. The truncated version of the check is processed just like a paper check to extract and process such deposit information. This simplifies the processing of checks by allowing information to be transmitted electronically, rather than in physical form. EX1006-Cohen, [0005].

66. A truncated check is different from a "substitute check," which is a physical copy of a check that is to be treated as the original. EX1006-Cohen, [0004]; EX1012-Richardson, [0008]. A truncated check can be used to print a substitute check. EX1006-Cohen, [0005]; EX1012-Richardson, [0010]. However, banks are

free to simply use the truncated version of the check for completing the deposit without printing a substitute check. EX1006-Cohen, [0004].

C. Use of Camera Phones for Image-Based Document Processing

67. The late 1990s and early 2000s saw an explosion in the prevalence of **cellular phones**. **Camera phones** in particular became popular in the early 2000s. By the mid-2000s, hundreds of millions of **camera phones** were already in circulation globally. While the first **camera phones** produced relatively low-resolution images, by the mid-2000s resolution and performance of these devices had improved, and was continuing to improve rapidly. By that time there were many phones on the market that had **cameras** that produced pictures sized at 1 megapixel or greater. Processing power increased as well, which meant that phones were capable of capturing images suitable for text recognition and **document** processing, and performing that processing locally on the **phone**. This shift enabled new applications for **camera** -based **document** analysis and recognition, which leveraged the portability, simplicity and contactless nature of **mobile phone cameras**. Example uses for **phone cameras** and increasing processing power include:

- Reading text on a **document** image, including OCR in real-time. *See, e.g.*, EX1050-Pilu, [0050]; EX1004-Luo, 4; EX1007-Yoon, [0022]-[0023];

EX1016-MotoRokr-Manual, 95-96.

- Real time recognition of bar codes. EX1043-Attia, 6:19-27, 4:13-18.
- Detecting human faces and smiles as well as determining location of a face within a capture guide overlayed upon a screen. EX1051-Jeong, [0036], [0031]-[0032]; EX1052-VX-11000, 5.
- Detecting movement. EX1053-Landschaft, [0014].
- Detecting other objects, like screens of other electronic devices. EX1054-Gejdos, [0022].

68. The advancements in **mobile phone cameras** and processing power significantly increased the reliability of OCR. Higher resolution reduces the impact of image defects like lighting, angle, and focus conditions on OCR by providing more detailed images to analyze, whether the OCR is run on the **mobile device** or a server. Moreover, increased processing power of **mobile devices** and improved adaptive OCR technologies increases the accuracy of OCR output from **document** images captured by **mobile devices** when the OCR is run on the **mobile device**.

69. With the increasing prevalence of **camera phones** and **document** processing applications came other improvements designed to produce better images at the point of capture. For example, **alignment guides** were developed to help users **align documents** in **camera preview windows**. EX1004-Luo, 1, 4-6; EX1007-

Yoon, [0022]-[0023]; EX1016-MotoRokr-Manual, 95-96. More specifically, the **mobile phone** would display one or more lines in the **preview window** that a user would use to **align** the **document** being imaged. This helps reduce distortions like warp and skew. Warp can refer to an image of a rectangular **document** like a check or a piece of paper that is not lying flat on a solid surface so that its edges are not perfectly straight but rather have a curved "bend." Skew can refer to an image of a rectangular **document** like a check or a piece of paper where its edges are rotated by some angle and not perfectly vertical and horizontal. A related distortion is projective distortion, which can refer to a keystoning effect where one part of the **document** is further away from the **camera** than another part and hence the **document** text will appear to be smaller or larger depending on its location even though all the text was printed at the same size. Reducing these unwanted effects helps to produce better OCR results by providing more consistent and focused characters in the image of the **document**. These issues can also be detected and corrected by algorithms developed over the years, although having a higher quality input image further improves results. The use of **alignment guides** gives the user an easy visual clue as to whether the **document** they are trying to photograph is flat and squared-up in the image frame.

70. Another improvement was the automatic capture of images. To

manually capture a picture of a document, a user must ensure the document appears in the **camera preview window** and then cause the **camera** to capture the image. This can be done by pressing a physical or on-screen button. The act of pressing the button can cause slight movement of the **camera**, however, which can blur the image or cause the document to move out of view. To avoid potential drawbacks of manual image capture (including user error and the aforementioned defects resulting from pressing a button), automatic capture systems were developed to allow the phone itself to make the determination when to capture an image. Automatic capture systems function by monitoring one or more monitoring criteria, such as detecting **document** edges and the image brightness, and capturing the image automatically when those criteria are satisfied. EX1004-Luo, 6 ("[W]hen the **straight edge** 205 displayed on the **preview window** 125 is substantially parallel to the corresponding **reference line** 135, the system 100 can automatically capture the selected image and provide the user"); EX1007-Yoon, [0019] ("In particular, in order to photograph a business card, the controller 100 receives brightness data from the **camera** unit 102, checks a brightness environment under which the business card is to be photographed, and controls whether to perform automatic photographing on the business card. Also, the controller 100 displays on the display unit 106 reference boundary lines, for presenting a size and location, of a business card, which are

appropriate for recognizing the business card; and determines whether the boundary lines of the business card received from the image processor 104 coincide with the reference boundary lines. If they coincide with one another, the controller 100 controls automatic photographing to be performed."), [0025]-[0026]; EX1016-MotoRokr-Manual, 95-97 ("Your phone automatically captures a business card image when the card is properly framed in the OCR viewfinder."). Most systems—like **camera phones** recording video—capture image frames continuously in real time. In those cases, no additional hardware or software is needed; the system simply selects the frame that best represents the image based on the desired criteria.

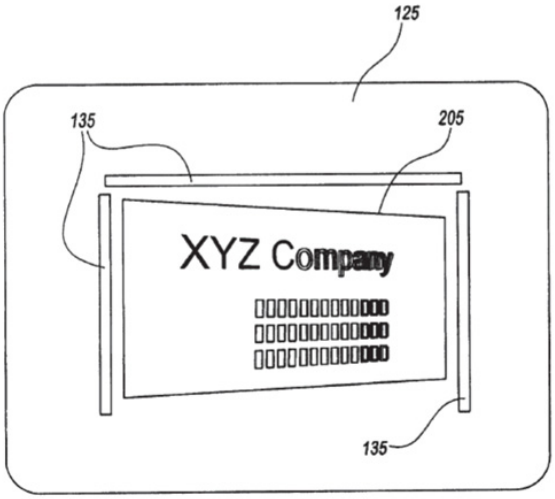


Fig. 5

EX1004-Luo, FIG.5. Known monitoring criteria included, but was not limited to:

- Edge detection (EX1045-Zhu,[4] 8; EX1004-Luo, 5; EX1007-Yoon, Abstract, [0019])
- Corner Detection (EX1045-Zhu, 8)
- Brightness detection (EX1007-Yoon, [0025]-[0026])
- Text recognition (EX1050-Pilu, [0050]; EX1004-Luo, 4; EX1007-Yoon, [0022]-[0023]; EX1016-MotoRokr-Manual, 95-96)
- Bar code recognition (EX1043-Attia, 6:19-27, 4:13-18)
- Face and smile detection (EX1051-Jeong, [0036]; EX1052-VX-11000, 5)
- Movement Detection (EX1053-Landschaft, [0014])
- Detecting the screen of another computerized device (EX1054-Gejdos, [0022])

71. By the early to mid-2000s, persons of skill in the art recognized that these advanced **mobile device** imaging techniques would lead to using **mobile devices** to capture images of checks and transmit those images to a bank for deposit.

[4] Zhu was originally published in Chinese. Exhibit A of EX10045 includes the original Chinese publication, and Exhibit B of EX1045 includes a certified translation of the Chinese publication. This Declaration's citations to "EX1045" refer specifically to Exhibit B of EX1045.

For example, Garcia (EX1003) disclosed:

> The present invention applies to the acceptance of documents, for example, banking or financial documents and preferably to the validation and deposit into the existing account at a banking institution of checks by a user using a mobile device that incorporates a camera, capable of capturing and transmitting digital images, as well as performing the usual telephony operations.

EX1003-Garcia, 4:11-18.

Similarly, Acharya (EX1017) disclosed:

> A system and method for initiating a deposit transaction, where the depositor is a banking customer located at a remote location, and where the item to be deposited is a financial instrument, such as a paper check from a third party, payable to the depositor. The enabling system features a Remote Customer Terminal (RCT) with certain input devices, connected to a bank system. An image and/or other data of the financial instrument are transmitted from the RCT to the Bank of First Deposit (BOFD) where the data may be processed by conversion to Electronic Funds Transfer (EFT), via Electronic Check Presentment

> (ECP), or via check reconstruction. The deposit transaction can be accomplished without physical transfer of the financial instrument to or through the bank system. The system and method provide convenience and improved transaction processing speed compared to other deposit transactions of financial instruments.

EX1017-Acharya, Abstract.

72. In Acharya, the RCT can be a **PDA** or **cell phone**. *Id.*, 4:18-22. Similarly, Burks (EX1018) discloses:

> A user (not shown) uses the integrated digital camera in cellular phone 704 to capture a digital image of check 714.
>
> The user causes cellular phone 704 to transmit the digital image to bank 730 via cellular transceiver 706, cellular network application provider 710, and communication pathway 740. Prior to depositing check 714 into account 760, bank 730 may verify the digital image received, determining if the information extracted from the digital image is valid. Bank 730 may use application server 750 to perform the image validation and image correction. By processing the digital image at server 750, the user may not need access to the computing resources that may otherwise be required to verify the digital image.

> To possibly reduce the amount of skew and to increase image quality, a user may use an apparatus to help align the negotiable instrument with the digital camera.

EX1018-Burks, 14:15-31. As another example, a 2005 paper describes a working example that used a **camera phone** to capture and process checks. EX1019-Parikh, 80 ("We're working on SHG-Checkbook as a way to enable secure, human-mediated electronic transactions in remote rural areas. SHGs would conduct transactions with a registered banking proxy equipped with a **mobile phone** running CamBrowser.… The proxy banker then scans the check, which provides the remaining information for the transaction…with the proxy in exchange for a predetermined service fee."). Two companies—Mitek and West Virginia United Federal Credit Union—introduced mobile deposit applications in quick succession. EX1020-Bruno-Britz; EX1021-Mitek, 37. *See also* EX1022-Bruene.

D. Mobile Applications

73. Small form factor devices, like **PDAs** and **cellphones**, increased in popularity throughout the 2000s. *See, e.g.*, EX1023-Edwards. Such devices were well known for including basic capabilities like notetaking and calendar applications. As technology developed further, **PDA** developers began introducing new features like handwriting recognition as a means of inputting information and

high-quality **cameras**. EX1024-Rajeswari, 1863; EX1025-Slocombe, 1-4. As I discussed in Section II regarding my qualifications and experience, I worked on pen computing interfaces throughout the 1990s and early 2000s, including technologies for devices where keyboard input was inconvenient.

74. **Cellphone** technology advanced in similar ways. By the mid-2000s nearly all **cellphones** had an integrated **camera**. More advanced **phones** had significantly improved features. For example, the iPhone was launched in 2007 and had a 2-megapixel **camera** and a nearly-half-a-gigahertz processor. EX1026-Apple; EX1027-EveryiPhone. As another example, the Nokia N93 (introduced in April 2006 / released July 2006) had a 3.2-megapixel **camera**. EX1028-Nokia.

75. One additional development in the field of **mobile devices** was the advent of downloaded applications. Mobile applications are the **mobile device** analog to computer applications, which became prevalent as early as the 1980s with programs like VisiCalc and MS Word, and continued to explode through the 1990s and early 2000s. Like with computer applications, mobile applications could be provided on the device in a limited number of ways. First, "native" applications are loaded onto the device by the manufacturer. Second, applications can be loaded onto the device after purchase via some external storage element, such as a compact disc ("CD-ROM") or a memory stick. Finally, an application can be loaded onto the

device after purchase by downloading the application package over the internet. The third option became increasingly more common for third party software developers, as it allowed third parties to provide end users with applications without needing to convince the device manufacturer to load it on the device before sale or to manufacture a hardware medium (CD-ROM, memory stick) to distribute the software. Capitalizing on that trend, the Apple App Store opened in July 2008 with 500 downloadable applications. EX1029-Graham. The Apple App store was by no means the first or only storefront for downloaded applications. Others included the Android Market (EX1005-Meier, 5), Nokia's Ovi (which launched in May 2009 with more than 20,000 items including applications (EX1063-Ovi)), Ovi's predecessor—the Nokia Software Market (EX1064-Software-Market), GetJar for Java Mobile Edition applications (EX1065-GetJar), and Handango for Windows Mobile applications (EX1066-Handango). These application storefronts were incredibly popular—by August 2008, GetJar "ha[d] surpassed 300 million [app] downloads." EX1065-GetJar. Even in 2006—long before the '095 patent—Handango was adding more than 11,000 software titles in a year that were available to millions of consumers. EX1066-Handango.

76. To develop these applications, **mobile device** manufacturers created and distributed free kits called "software development kits" (SDKs). These SDKs

included the basic syntax and format for designing an application for a particular **mobile device** platform, and also included more advanced features like standard libraries and application programming interfaces (APIs) to allow app developers to easily take advantage of device features like the **camera**, GPS, and/or accelerometer. In this context, APIs are simply software calls that allow the developer's application to access hardware resources like a **camera** without having to learn low level hardware details and write all the code to make the **camera** operate. EX1005-Meier, 5-6; EX1008-Goyal, 1, 127, 174; EX1030-Aiello, 3, 10; EX1031-Raento, 51, 53, 58. Instead, the developer's app would interact with the API, which acts as an interface to the hardware. There were many known APIs for accessing **camera** hardware for different software platforms, some of which are summarized below:

- Android: `Camera`, including `startPreview()` and `takePicture()` (EX1005-Meier, 319-21)
- Windows Mobile: `CameraCaptureDialog` (EX1067-Windows), `SHCameraCapture` (EX1040-CodeGuru)
- Symbian: `CCamera`, `MCameraObserver` (EX1068-Symbian)
- IOS: `UIImagePickerController` (available on iOS 2.0, 3.0) (EX1069-AppleDevelopers)
- Palm: Camera Manager API for PalmOne (EX1070-PalmOne, 71, 73-74)

- BlackBerry: `VideoControl` and `GetSnapshot` from Java MMAPI (EX1008-Goyal, 163-69, 174)

77. App developers took full advantage of these advanced features, including access to **camera** hardware. For example, device manufacturers and app developers began releasing applications that could read text from **documents**. EX1005-Meier, 320; EX1016-MotoRokr-Manual, 95-96; EX1032-Patrick, 2; EX1071-Haritaoglu, 55-62; EX1072-Bae, 539-44; EX1073-Zhang, 273-92; EX1074-Koga, 635-39; EX1075-Ferreira, 133-39; EX1076-Laine, 1-5; EX1077-Zhou, 1-6; EX1035-Siegemund, 1-8.

VII. DISCUSSION OF THE '095 PATENT

A. Brief Description

78. As I show in Figure 2 (reproduced below), the '095 patent relates to remote deposit of checks. During remote check deposit, "the payee may capture a digital image of a check using a [**camera** on a] **mobile device**. The **financial institution** [e.g., **depository**] may then receive from the payee the digital image of the check. The **financial institution** may then use the digital image to credit funds to the payee" via a **clearinghouse**. EX1001-USP095, 1:29-34. This practice is consistent with the Check 21 procedures I discussed in Section VI.B with reference to the technical background to the '095 patent.

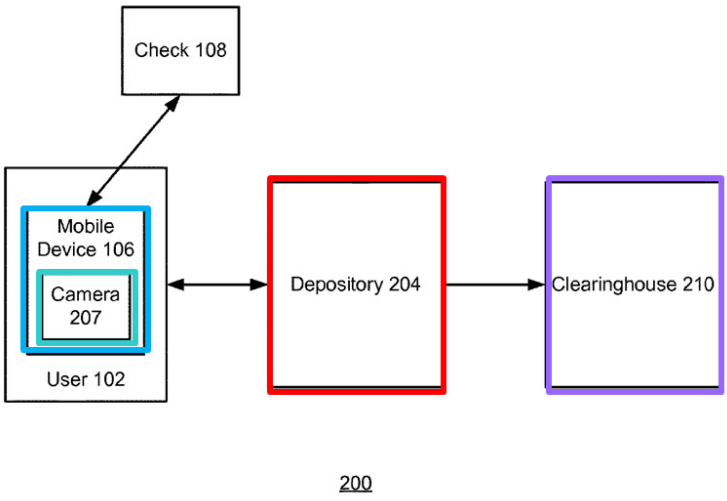


FIG. 2

Id., FIG.2.[5]

79. As I also discussed in Section VI.B with respect to the technical background of the '095 patent, using a **mobile phone** to take an image of a check was already known. Therefore, the '095 patent purports provide improvements to the process of capturing an image with a **mobile phone**. Specifically, the patent discusses (1) "monitoring" using the **mobile device** "[a]n image of a check that is in the field of view of [the **mobile device's**] **camera**," (2) providing the user with "feedback" "regarding the image of the check," and (3) "[w]hen the image of the check in the field of view passes ***monitoring criteria***, [taking] an image…by the

[5] All annotations added unless otherwise noted.

camera and provid[ing] [the image] to a **financial institution**." EX1001-USP095, Abstract; *see also id.*, 1:45-50. These steps are shown in 830-860 in I have reproduced Figure 8 below, which is a flow diagram that shows these steps in steps 830-860. More specifically, the image is monitored in step 830 with respect to a monitoring criterion, feedback is provided in step 840, the image is captured in step 850 when the monitoring criterion is satisfied, and the image is transmitted in step 860.

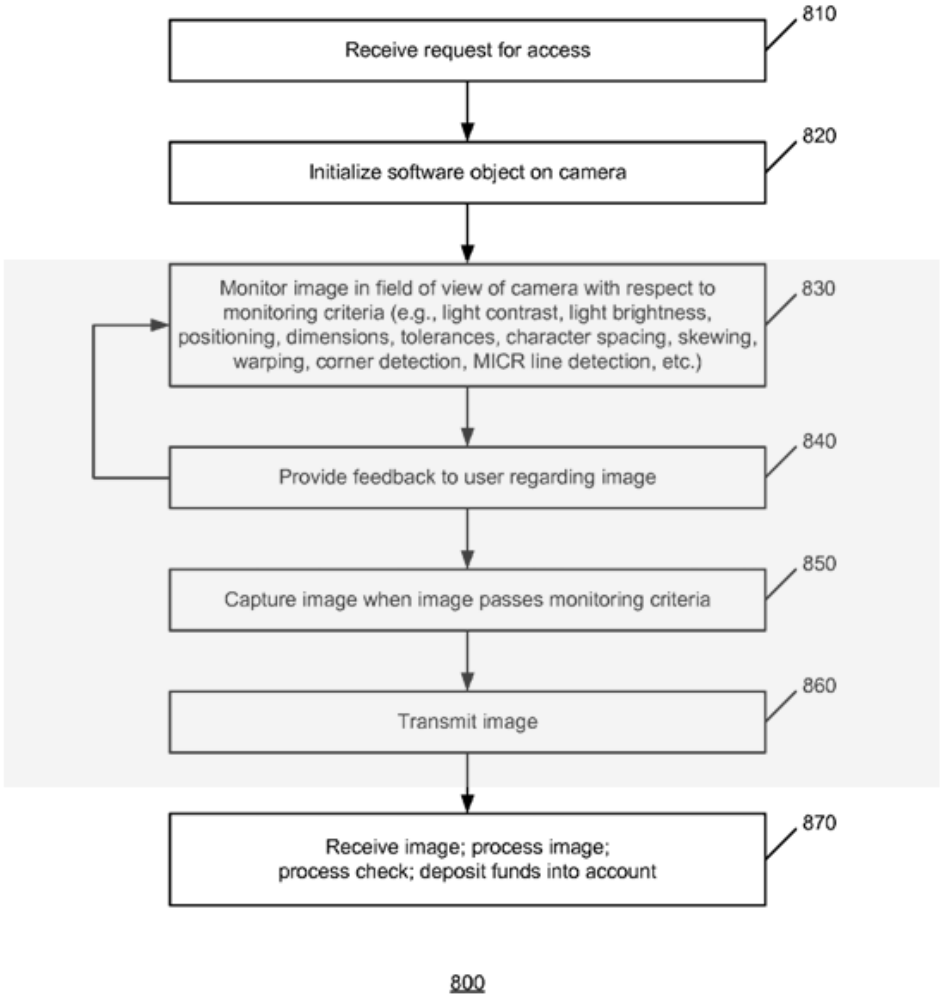


FIG. 8

Id., FIG.8.

80. The patent includes various example monitoring criteria. The provided examples include "light contrast on the image, light brightness of the image, positioning of the image, dimensions, tolerances, character spacing, skewing, warping, corner detection, and **MICR (magnetic ink character recognition) line**

detection…." EX1001-USP095, 4:15-19.

81. As I discussed above in VI.C with reference to the technology background, many of these techniques were already known. My review of the '095 patent confirms this—instead of providing experimental data or particular implementation details about how to track these criteria and determine if any are met, the patent simply relies on these "known" techniques. *Id.*, 7:17-18 ("The edge 257 may be detected using any known technique(s)."); *id.*, 7:66-67 ("Any known technique(s) for edge detection and/or corner detection may be used."); *id.*, 8:59-63 ("Any known **MICR line** detection technique(s) may be used…."); *id.*, 9:10-12 ("[T]he spacing between the numbers in the **MICR line** may be determined using any known measuring and/or image processing technique(s)"); *id.*, 9:47-49 ("A histogram is a well known graph and may be used to display where all of the brightness levels contained in an image are found…."); *id.*, 10:17-19 ("Any known technique for generating a histogram for an image (such as a grayscale image of the image 230) may be used."). The patent similarly relies on what was already known at the time with regard to feedback to the user. The '095 patent provides high level examples of what the feedback might entail, such as visual feedback "such as by text (e.g., 'go closer', 'go farther', 'move the check to the right', 'put the check on a darker background', 'tilt the **camera** down', 'take the picture now', etc.),arrows, or

other visual indicators or cues (e.g., green lights, red lights, etc.) overlaid on the image 230, shown as feedback indicator 235" or audio feedback "advis[ing] the user 102 to move the **camera** 207 or the check 108 or adjust the lighting or the background…." However, the '095 patent does not explain how to determine what feedback is appropriate to provide based on the current image. *Id.*, 7:28-43.

82. As I discussed in section VI.D with reference to the technology background, **mobile phones** and associated software architectures had advanced significantly in the early and mid-2000s. The '095 patent refers to the well-known software components available at the time for implementing the '095 patent claims. As an example, the patent describes "operat[ing] [the **mobile device camera**] through a software abstraction layer, such as an application programming interface (API)." EX1001-USP095, 11:26-28. As with monitoring criteria and consistent with the state of the art I discussed in Section VI, the '095 patent refers the reader to known APIs in mobile operating systems like Windows Mobile, Symbian OS, iPhone OS, Palm OS, BlackBerry OS, and Android. *Id.*, 11:39-41. I identified various known **camera** control APIs for these operating systems in Section VI.

B. Prosecution History

83. I have read the prosecution history of U.S. Patent Application No. 18/593,854 (the "'854 Application"), filed March 1, 2024, that resulted in the '095

patent. EX1001-USP095, cover; EX1033-FH095, 10-11. I have been informed and understand that the '854 application was originally filed without a priority claim, and was therefore rejected over U.S. Patent No. 8,977,571, which has an identical specification to the '095 patent. EX1033-FH095, 84-93. I have also been informed and understand that USAA then added a priority claim to the '571 patent. *Id.*, 96-98. The examiner issued a Notice of Allowance on September 25, 2024. *Id.*, 550-57. As I discuss below, the issued claims would have been obvious in view of the prior art that I discuss in this Declaration.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

84. It is my understanding that when considering the claims of the '095 patent and the prior art, I must do so based on the perspective of one of ordinary skill in the art at the relevant effective filing date.

85. I understand that several factors are to be considered in determining who would be a person of ordinary skill in the art. These factors include: (1) the types of problems encountered in the art; (2) the prior art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of the technology; and (5) the educational level of active workers in the field.

86. I have been informed and understand that a person of ordinary skill in the art means a hypothetical person to whom an expert in the field could assign a

routine task with reasonable confidence that the person could successfully carry it out. I have also been informed and understand that prior art references evidence the appropriate level of ordinary skill in the art. A person of ordinary skill in the relevant field of art at relevant times (August 2009 and July 2008[6]) of the '095 patent would have had a bachelor's degree in electrical engineering, computer science, computer engineering, or equivalent field, and at least two years of prior experience with (1) image capture/scanning technology, involving transferring and processing of image data to and at a server and (2) software application development. Less work experience may be compensated by a higher level of education and vice versa. A person with additional education or additional industrial experience could still be of ordinary skill in the art if that additional aspect compensates for a deficit in one of the other aspects of the requirements stated above.

IX. CLAIM CONSTRUCTION

87. I have been informed and understand that in an *inter partes* review, claims are construed using the standard of claim construction a District Court would use to construe the claim in a civil litigation action. That is, I have been informed

[6] I have been informed that the owner of the '095 patent has argued that the '095 patent was conceived by July 2008. My opinions regarding the level of ordinary skill in the art are the same regardless of whether the 2008 or 2009 date applies.

and understand that the ordinary and customary meaning, as understood by a person of ordinary skill in the art at the time of the alleged invention in light of the patent's prosecution history and specification, must be given to the claim terms.

88. For purposes of my analysis presented in this declaration, I did not identify any terms that required construction. I therefore applied the ordinary and customary meaning, as understood by a person of ordinary skill in the art at the time of the alleged invention in light of the patent's prosecution history and specification, to all claim terms in my analysis.

X. OVERVIEW OF PRIOR ART REFERENCES

A. Garcia (EX1003)

89. I understand that International Patent Application Publication No. WO2005/043857 ("Garcia") (EX1003) was published on May 12, 2005, i.e., before U.S. Patent Application No. 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

90. Garcia's "Field of Invention" is as follows:

> The present invention, as its title implies, relates to a method for processing and accepting documents, such as, for example, bank checks, with guarantee of authentication of the issuer and the document itself, using electronic media for its implementation through a mobile

> device capable of capturing and sending images via an Internet connection.

EX1003-Garcia, 1:5-13; *see also id.*, 4:10-18. That is, like the '095 patent, Garcia is directed to remotely depositing a check using an image captured by a **mobile device**. *Id.*; *see also id.*, 6:12-18.

91. Garcia's system is shown in Figure 2, which depicts a "**mobile terminal**"[7] connected to a "**financial institution**" via a "communications network." Garcia further explains that the **mobile device** is used by the user to access a "**computer equipment** at the **financial institution**," which provides the user a service. EX1003-Garcia, 9:11-18.

[7] Garcia appears to use **mobile terminal**, **mobile telephone**, and **mobile device** interchangeably, consistent with the use of such terms in the art.

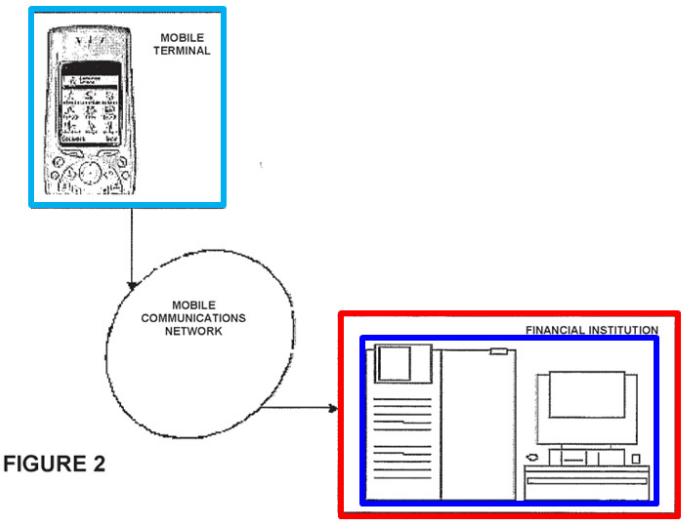


FIGURE 2

EX1003-Garcia, FIG.2.

92. During operation, the **mobile device** proceeds by "[c]apturing the digital image of the obverse and the reverse side of the **document**" and "[c]apturing the data associated with the **document**, such as the amount and the check number," both of which are then sent to a **financial institution** for deposit. EX1003-Garcia, 10:10-13; 10:16-18 ("Transmitting the digital image and the recognition data, once encrypted, to the **institution** that must accept the **document**."); 12:9-13 ("Via the keypad the user enters the aforementioned identification data, as well as the amount of the check and all the information and codes necessary for the operability of the system, proceeding with sending it."). Garcia explains that the **mobile device** sends this information via a wireless network. *Id.*, 11:20-12:3 ("The communication link between each user and the institution consists of a **mobile telephone**

communications network, for example a GSM/GPRS network or any future technology with the technological capabilities adapted to the present and future demands of the method of reference.").

93. The **financial institution** receives the image and associated information from the **mobile device** and performs various steps to "automatically process" the check and complete deposit. EX1003-Garcia, 12:17-22 ("The institution that receives the message proceeds to validate and encrypt it, ultimately obtaining a digital photograph of the check and a data set that allows it to automatically process the deposit of the check in question into the service user's account."). For example, the **financial institution** "[has] certain electronic means of recognizing, verifying and processing the information sent by the user," which includes "**computer equipment** connected to the Internet that has an optical character recognition (OCR) system." EX1003-Garcia, 11:7-15.

94. As shown below, in Garcia's Figure 1, the check "photo" is used throughout the process, including by the **financial institution** for "financial processing."

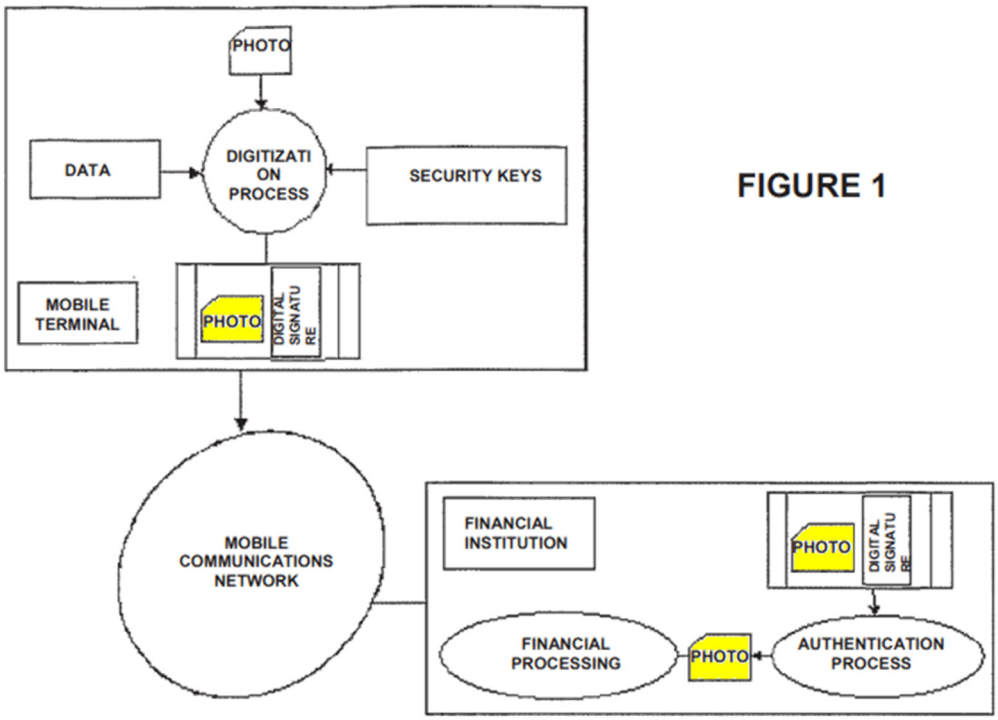


FIGURE 1

EX1003-Garcia, FIG.1.

95. Garcia discloses that such processing is performed "by the usual means (truncation systems)," which as I explained in Section VI.B with respect to the technical background, were already well known. EX1003-Garcia, 11:15-19 ("The **receiving institution** makes available to the user a digital image of the **document** in its bank account and processes the **document** in question by the usual means (truncation systems)."

B. Luo (EX1004)

96. I understand that Chinese Patent Application Publication No. CN 1897644A ("Luo") (EX1004) was published on January 17, 2007, i.e., before U.S.

Patent Application No. 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

97. Luo's "Field of the Invention" is as follows:

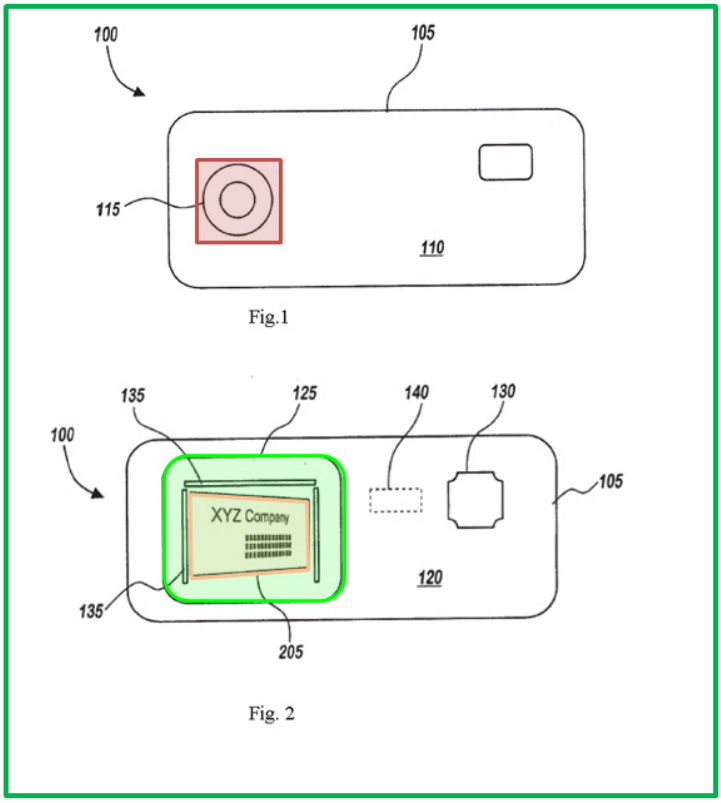
> The present invention relates generally to a method and system for capturing images using a digital camera, especially (but not exclusively) a method and system for capturing images of documents such as business cards.

EX1004-Luo, 1.

98. Luo is not limited to standalone digital **cameras**, but rather describes "digital **cameras** in a variety of **handheld** electronic **devices**," such as those "integrated into **mobile phones**, **personal digital assistants (PDAs)**, and laptops." EX1004-Luo, 1. Luo explains that information can then be extracted from the image. EX1004-Luo, 1 ("Then, they can perform optical character recognition (OCR) on the digital images, and save the name, address, and other information printed on the business cards automatically in the contact file of their **phones**."). Therefore, like the '095 patent and Garcia, Luo is directed to imaging and optically reading special case paper **documents** using a **mobile device**.

99. Luo's system is shown, for example in Figure 2, reproduced below. Specifically, Luo shows an example **handheld camera system** 100, which as

discussed above could be a **PDA** or **mobile phone**. The **handheld camera system** 100 has an "**image sensor** 115 adapted to receive an image." EX1004-Luo, 3. On the other side of the **handheld camera system** 100 is a "**preview window** 125 [that] can function as a viewfinder" to "display in real time any moving **image** of the scene in front of the **image sensor** 115." *Id.*, 3.



Id., FIGs.1-2.

100. Luo is directed to improving the quality of images captured by

mobile devices. For example, Luo identifies the problem of projective distortion (also known in the art as perspective distortion), which I discussed above in Section VI.C with regard to the technical background. Luo teaches the following:

> [M]any environments today for using digital cameras are not ideal for capturing high-quality images. For example, a user of a digital camera trying to capture a business card image simply holds the business card in front of the camera lens with one hand, while holding the camera with the other hand when taking pictures. But this makes unideal variable factors such as the distance from the lens to the business card, and the angle of the camera's image plane relative to the front of the business card. Therefore, the image resulted may contain defects such as projective distortion.

EX1004-Luo, 1.

101. Luo therefore discloses techniques "to capture well-focused and clear **document** images, with an appropriate resolution to make the optical character recognition of any text printed in the **document** effective and reliable." *Id.*, 4. Like the '095 patent, Luo discloses techniques to improve image capture using such

handheld devices to obtain "well-focused and clear **document** images" to "make the optical character recognition of any text printed in the **document** effective and reliable." EX1004-Luo, 4.

102. Luo further explains "the principle of image projective deformation, as understood by those skilled in the art," with reference to Figure 3. EX1004-Luo, 4. In Figure 3:

> The illustrated light 305 propagates through the lens 315 from the object plane 310 onto the image plane 320. With respect to the present invention, the object plane 310 is equivalent to the surface of the object to be imaged, such as the surface of a business card, while the lens 315 is equivalent to the component of the image sensor 115 of the camera system 100, and the image plane 320 is equivalent to the received image, such as in the preview image displayed in window 125 of the system 100. In a case where the object plane 310 and the image plane 320 cannot be substantially parallel, the lens 315 causes the image printed on the object plane 310 to be deformed on the image plane 320 according to a known projective

deformation method. For example, the shape in the region "p" on the object plane can be enlarged by the lens 315 and distorted into a region "Q" of a different shape on the image plane by projective deformation.

Id. Figure 3 is reproduced below:

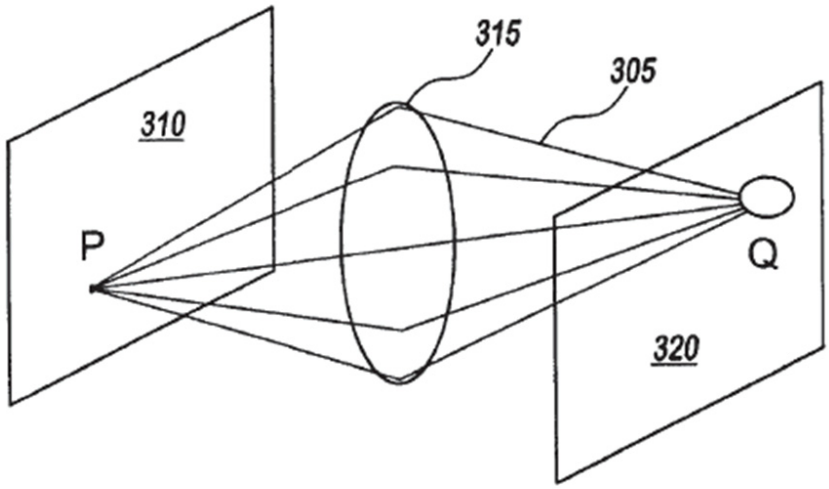


Fig. 3

Id., FIG.3.

103. When projective distortion is significant, for example as shown in Figures 4 and 5, the resulting image can be blurred. *Id.*, 5 ("As known to those skilled in the art, the limited depth of field and projective distortion of the **camera system** 100 make the right side of the image blurry."). Figure 4 is reproduced below, which shows such blurring on the right side of the image:

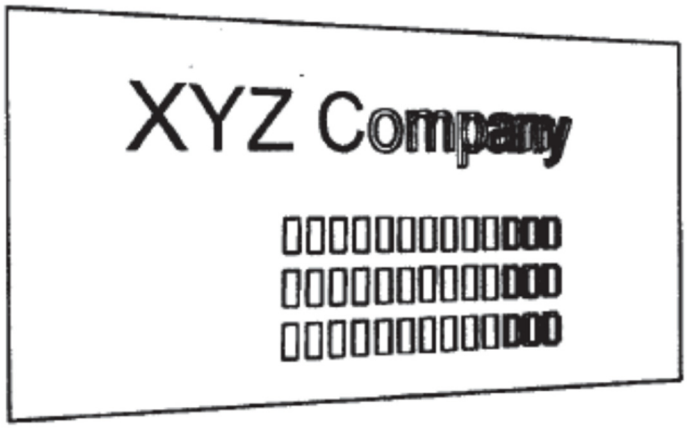


Fig. 4

Id., FIG.4.

104. As was known in the art, and like the '095 patent's "**alignment guide**," Luo teaches reducing these unwanted effects by displaying "**reference lines**" 135/235 in the "**preview window**" 125. EX1004-Luo, 3 ("When the mode selection switch 130 is set to the **document** capture mode, the **reference line** 135 is displayed in the **preview window** 125."). Luo describes the **reference lines** as follows:

> According to different embodiments of the present invention, the reference line 135 may be in various sizes, shapes, colors, and formats, and may be translucent or opaque. The reference line 135 is used to guide the user of the system 100 to position the image sensor 115 in an appropriate orientation with respect to, for example, a

> business card object. Therefore, when using the reference line 135 for positioning, it is usually fixed relative to the thousand preview window 125. According to another embodiment of the present invention, the reference line 135 may be printed on the preview window 125 or may be permanently superimposed on the preview window 125 in another way.

EX1004-Luo, 4.

105. During use, Luo explains that the user attempts to **align** the **document** edge with **reference lines** such that the two are parallel, which improves the quality of the image (and therefore OCR) by "reduc[ing] the projective distortion of the image":

> As shown in FIG.2, when implementing an embodiment of the present invention, the user often attempts to determine the frame of the document by determining the position of the reference line 135 as follows: the reference line 135 is made substantially parallel and adjacent to the straight edge 205 represented by the document displayed in the display window 125 or substantially parallel to and

above the straight edge 205. In such positioning, the system 100 is designed to capture well-focused and clear document images, with an appropriate resolution to make the optical character recognition of any text printed in the document effective and reliable.

…

The present invention ensures that the front of the object being imaged is substantially parallel to the image plane 320 of the camera system 100 to reduce the projective distortion of the image. For example, when the system 100 is in the document capture mode, the system 100 provides the user with an image of a captured object, such as a business card, only when the straight edge 205 of the business card is substantially parallel to the corresponding reference line 135 displayed in the preview window 125.

…

Therefore, additional sensitivity is added to the embodiment of the present invention, wherein only when two parallel straight edges 205 of the object displayed in

the preview window 125 have substantially the same length and are substantially parallel to the corresponding reference line 135 can the image be captured.

EX1004-Luo, 4, 5, 7.

106. Luo's **reference lines** in Figures 5 are shown below along with the similar **alignment guide** in Figure 3 of the '095 patent:

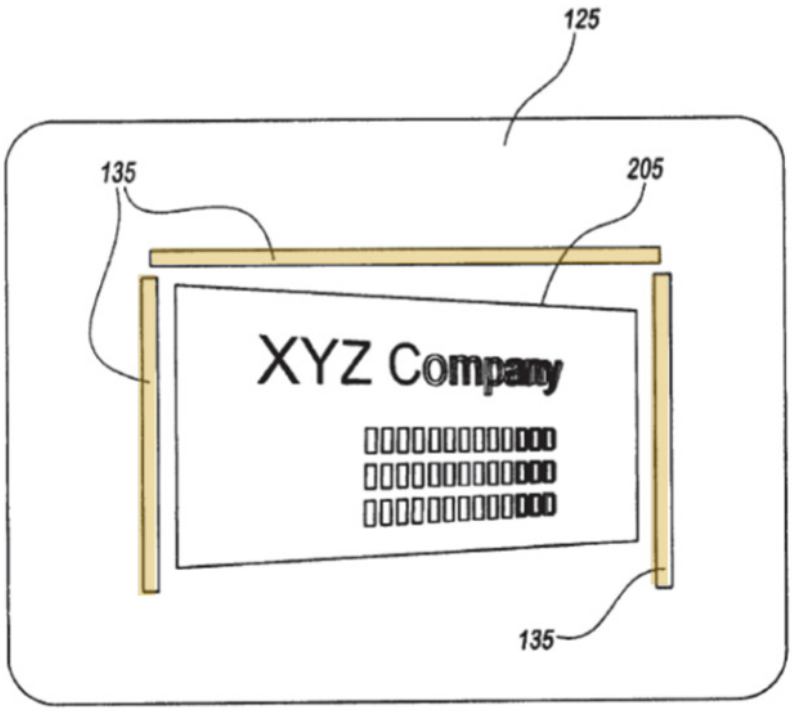


Fig. 5

EX1004-Luo, FIG.5

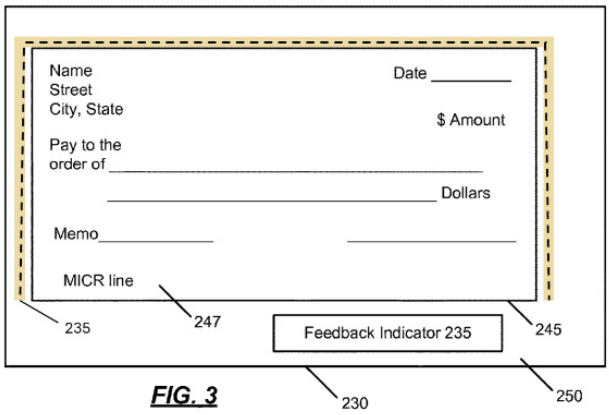


FIG. 3

EX1001-USP095, FIG.3.

107. Rather than just rely on the user to confirm that the **document** edges are parallel with the displayed **reference lines**, Luo provides the user with instructions and feedback throughout the image capture process, for example, by changing the color or flicker of the **reference lines** and other indications when, for example, the system determines an edge of the **document** in the **preview window** is parallel to one of the **reference lines**:

> Various techniques may be used to indicate to the user that an appropriate number of reference lines 135 are substantially parallel to the respective straight edges 205 of the object depicted in the preview window 125. For example, an alarm composed of sounds, such as a clicking sound output from the camera system 100, may be

> provided. In the same way, it may be the light illuminated in the preview window 125 or the light illuminated elsewhere in the camera system 100. In addition, an image indicator may be displayed on the preview window 125, for example, when each reference line 135 is substantially parallel to a corresponding straight edge 205, the reference line 135 may change color or flicker individually.

1004-Luo, 4, 6, FIG.6, claim 5.

108. Luo also teaches that "when the straight edge205 displayed on the preview window 125 is substantially parallel to the corresponding reference line 135, the system 100 can automatically capture the selected image and provide the user with or without instructions." *Id.*, 6.

C. Meier (EX1005)

109. I understand that Reto Meier, Professional Android Application Development, Wiley Publishing (June 25, 2008) ("Meier") (EX1005) was publicly available by June 25, 2008, i.e., before U.S. Patent Application Number 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

110. Meier is a guide for developing mobile applications. EX1005-Meier, xvii. As its title suggests, Meier is specifically directed to writing

applications for Android-based devices, which is one of the well-known prior art mobile operating systems that the '095 patent identifies as having appropriate **camera** control APIs for use with the purported invention. EX1005-Meier, xvii; EX1001-USP095, 11:32-41 ("In the context of a Windows **Mobile device**, the Windows Mobile operating system (OS) has one or more APIs exposed to application developers that will translate instructions from applications into instructions operable by the **camera** 207 on the **mobile device** 106. A mobile operating system, also known as a mobile platform or a handheld operating system, is the operating system that controls a **mobile device**. Other mobiles OSs include Symbian OS, iPhone OS, Palm OS, BlackBerry OS, and Android."). Android is an open source framework that is available and free to anybody wishing to use it. EX1005-Meier, xvii. To do so, Android offers a "software development kit" (SDK) that includes software libraries and developer tools (including APIs) that can be used to write a mobile application. *Id.*, xvii, xix, 12.

111. As was known in the art, Meier explains that "Android developers are free to write applications that take full advantage of increasingly powerful mobile hardware." *Id.*, xvii, 1. Like in the '095 patent, Android provides "APIs" that allow both native (i.e., Android's own) and third-party applications to access the hardware of the **mobile device** like the **camera**. For example, Meier explains:

> In Android, native and third-party applications are written using the same APIs and executed on the same run time. These APIs feature hardware access, location-based services, support for background services, map-based activities, relational databases, interdevice peer-to-peer messaging, and 2D and 3D graphics.

EX1005-Meier, 1.

> Android offers new possibilities for mobile applications by offering an open development environment built on an open source Linux kernel. Hardware access is available to all applications through a series of API libraries, and application interaction, while carefully controlled, is fully supported.
>
> In Android, all applications have equal standing. Third-party and native Android applications are written using the same APIs and are executed on the same run time. Users can remove and replace any native application with a third-party developer alternative; even the dialer and home screens can be replaced.

Id., 3.

> The true appeal of Android as a development environment lies in the APIs it provides.
>
> As an application-neutral platform, Android gives you the opportunity to create applications that are as much a part of the phone as anything provided out of the box. The following list highlights some of the most noteworthy Android features:
>
> - No licensing, distribution, or development fees
>
> …
>
> - Full multimedia hardware control including playback and recording using the camera and microphone

Id., 5, 6.

> The Android software development kit (SDK) includes everything you need to start developing, testing, and debugging Android applications. Included in the SDK download are:
>
> - **The Android APIs** The core of the SDK is the Android API libraries that provide developer access to

> the Android stack. These are the same libraries used at Google to create native Android applications.

Id., 12.

> The core libraries provide all the functionality you need to start creating applications for Android, but it won't be long before you're ready to delve into the advanced APIs that offer the really exciting functionality.
>
> Android hopes to target a wide range of mobile hardware, so be aware that the suitability and implementation of the following APIs will vary depending on the device upon which they are implemented.
>
> …
>
> - **android.hardware** Where available, the hardware API exposes sensor hardware including the camera, accelerometer, and compass sensors as shown in Chapter 10.

Id., 16.

112. As one example pertinent to the '095 patent, Meier teaches that Android Camera APIs can be used to "capture images and preview and capture live

video" from within a mobile application. *Id.*, 315. Meier discusses specific APIs, such as `camera.startPreview()` for previewing a live video stream from the **camera** and `camera.takePicture()` for capturing an image, as well as example code on pages 319-21.

113. Meier also discusses various considerations for developers seeking to deploy their mobile application. In particular, Meier teaches that the "Android Marketplace client [can be used] for downloading thied-party [*sic*] Android applications." *Id.*, 5. The Marketplace is included on any Android phone, which therefore provides any Android user with access to a wide range of third-party downloadable applications. *Id.*

D. Cohen (EX1006)

114. I understand that U.S. Patent Application Publication No. 2007/0194102 ("Cohen") (EX1006) was published on August 23, 2007, i.e., before U.S. Patent Application No. 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

115. Cohen's "Field of the Invention" is as follows:

> The present invention relates generally to financial institution document processing. More specifically, the invention relates to a non-centralized, or decentralized,

> system and method that facilitates the capture, processing and archiving of checks and related financial institution document information at a remote merchant site, and enables direct transmission of the information to a U.S. Federal Reserve Bank, circumventing intermediate transmission to the Bank of First Deposit, all in compliance with the Check Clearing for the 21st Century Act.

EX1006-Cohen, [0002].

116. Cohen explains that "Technology for check image capturing, performing optical character recognition (OCR) and image assessment, is well known in the art." EX1006-Cohen, [0002]. Taking advantage of this technology, Cohen discloses that a merchant can deposit checks using "remote computer 108, equipped with scanner 106" and "a software scanning module which allows checks to be scanned front and back, the magnetic **MICR line** to be read…." *Id.*, [0021]. The user then reviews the image and data, before submitting the check image to a clearing system for deposit. EX1006-Cohen, [0022]. Therefore, like Garcia and the '095 patent, Cohen is directed to depositing a check using its image. EX1006-Cohen, [0008], [0022].

117. Cohen's system is shown, for example, in Figure 1 reproduced below: Cohen discloses that a merchant can deposit checks using "remote computer 108, equipped with scanner 106" and "a software scanning module which allows checks to be scanned front and back, the magnetic **MICR line** to be read…." *Id.*, [0021].

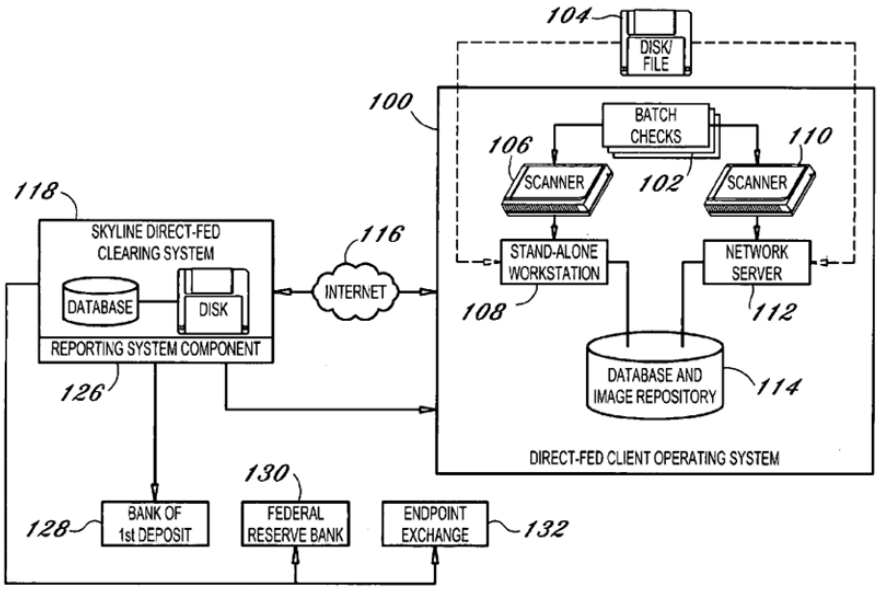


FIG. 1

Id., FIG.1.

118. Like Luo and the '095 patent, Cohen recognizes that images of checks may not be readable and that some information may be missing. Therefore, Cohen explains that the merchant's computer runs an "OCR and parsing processes [that] return[s] value data, including: (1) check amount; (2) bank routing number; (3) bank account number; and (4) check number" and performs "quantitative

measurements, or values, representing the confidence level of the accuracy of the OCR results pertaining to each of the respective pieces of data." *Id.*, [0022], FIG.2. To confirm the data parsed from the check image, the user at the "merchant site 100 reviews the images and data for each check," which is shown as steps 208 and 210 in Figure 2 below. *Id.* This includes reviewing the accuracy confidence levels to validate the images and information read therefrom and confirm there are no errors. *Id.*, [0022], [0042]. The user is free to make changes and correct items, if needed. *Id.*, [0044]. After completing review, the system transmits the check images and associated data to a clearing system 118 for deposit. *Id.*, [0016], [0022]-[0023]. This is shown as step 214 in Figure 2.

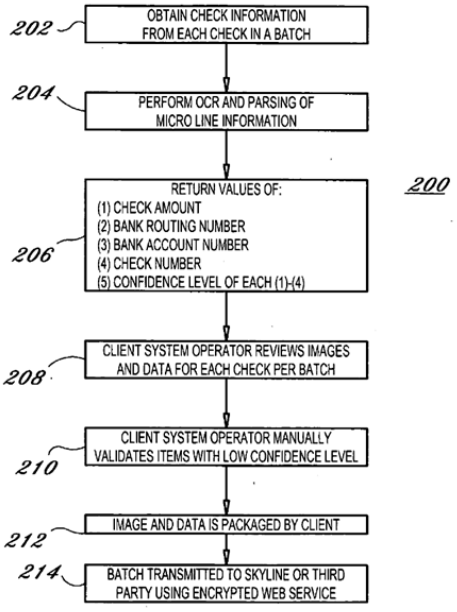


FIG. 2

Id., FIG.2.

E. Yoon (EX1007)

119. I understand that U.S. Patent Application Publication No. 2007/0262148 ("Yoon") (EX1007) was published on November 15, 2007, i.e., before U.S. Patent Application No. 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

120. Yoon's "Field of the Invention" is as follows:

> The present invention relates generally to a portable terminal, and in particular, to an apparatus and method for allowing a business card to be automatically photographed by detecting the boundary lines of the business card.

EX1007-Yoon, [0003]; *see also id.*, [0032].

121. Specifically, Yoon describes techniques for "improv[ing] the probability of satisfactorily recognizing the business card" from an automatically captured image "by achieving a business card image having a size, location, and brightness that are appropriate for recognizing the business card." *Id.*, [0032]. Therefore, like Luo and the '095 patent, Yoon is directed to capturing better images of **documents** using a **camera** (e.g., a **mobile device**) by automatically capturing an image when certain criteria are satisfied. *Id.*, Abstract, [0019], [0032], claim 1.

122. Yoon's system includes a **camera** unit 102 and a display unit 106 for displaying images of a **document** to a user. *Id.*, [0019]. Yoon, like Luo and the '095 patent, describes various criteria that can be used for automatically capturing an image of a **document**. For example, like Luo and the '095 patent, Yoon teaches that one criterion includes **aligning** the edge of a **document** with a **guide** or **reference line**:

> [T]he controller 100 displays on the display unit 106 reference boundary lines, for presenting a size and location, of a business card, which are appropriate for recognizing the business card; and determines whether the boundary lines of the business card received from the image processor 104 coincide with the reference boundary lines. If they coincide with one another, the controller 100 controls automatic photographing to be performed.

Id., [0019].

> The display unit 106 displays status information and characters (which consist of limited numbers) generated during the operation of the portable terminal. In particular the display unit 106 outputs an image received from the

> image processor 104, displays the reference boundary lines for the business card under control of the controller 100, and changes and displays the color, shape or thickness of each of the reference boundary lines.

Id., [0022].

> If it is determined that the business card recognition and photographing mode has been selected, the portable terminal outputs an image received from the camera sensor to the display unit 106, and displays on the display unit 106 reference boundary lines for appropriately fixing the size and location of the business card that is to be photographed in step 203. For example, as illustrated in FIG.3A, boundary lines for presenting a size and location of a business card, which are appropriate for recognizing the business card, are displayed as a rectangular frame in the center of the display unit 106. Here, the reference boundary lines present a location and size, of a business card, for achieving the highest probability of satisfactorily recognizing the business card; and may be obtained

through an experiment.

Id., [0024]; *see also* FIGs.1-2, 3A, claims 2-7, 9, 12-17. Yoon provides more detail on the use of its reference lines in paragraphs [0026]-[0030].

123. Yoon teaches further criteria that can be used for automatically capturing an image of a **document**, including brightness. *Id*., [0007], [0032]. For example, Yoon teaches that "in order to photograph a business card, the controller 100 receives brightness data from the **camera** unit 102, checks a brightness environment under which the business card is to be photographed, and controls whether to perform automatic photographing on the business card." *Id*., [0019]; *see also id.*, [0020] ("Also, the **camera** unit 102 converts the brightness of an image received from the **camera** sensor into measurable brightness data, and transmits the brightness data to the controller 100."). Yoon provides more detail on detecting and confirming sufficient brightness in paragraphs [0025]-[0026]. *See also id.*, FIG.2.

F. Goyal (EX1008)

124. I understand that Vikram Goyal, Pro JAVA ME MMAPI: Mobile Media API for Java Micro Edition, Apress (June 14, 2006) ("Goyal") (EX1008) was published by June 14, 2006, i.e., before U.S. Patent Application Number 12/545,127 was filed on August 21, 2009, and is therefore prior art to the '095 patent.

125. Like Meier, Goyal is a guide for developing mobile applications. As

its title suggests, Goyal is specifically directed to writing applications for Java-enabled devices. EX1008-Goyal, 5, 15, back cover. Java was well-known at the time, and includes an extensive set of capabilities and features. Therefore, Goyal focuses specially on the Java Mobile Media API (MMAPI), which extends Java's features by including multimedia capabilities. *Id.*, 1, 3-4, 127. Specifically, Goyal teaches that "MMAPI [Multi Media API] allows you to create applications for Java-enabled devices that can discover and use the multimedia capabilities of the device that they are running on." *Id.*, 1, 3. Goyal further explains that these applications are referred to "MIDlets," which are "applications for Java-enabled **mobile devices**, such as **mobile phones** and **PDAs**" that are developed using MIDP ("Mobile Information Device Profile (MIDP) 2.0"). *Id.*, 3, 1. Goyal summarizes example devices that supported MMAPI in 2006—well before the '095 patent:

Table 1-1. *Devices That Support MMAPI As an Optional Package*

Device Manufacturer	Supported Devices	Wireless Toolkit
Alcatel	One Touch 756	*http://www.my-onetouch.com*
BenQ	AX75 (MIDP 1.0), C70, C75, CF75/76, CL75, CX70/EMOTY, CX75, M75, S75, SL75, SXG75	*http://www.benq.com/developer*
Motorola	C975, E1000, A1000, A630, A780, A845, C380, C650, E398, E680, SLVR, T725, V180, V220, V3, V300, V303, V360, V400, V500, V525, V550, V551, V600, V620, V635, V8, V80, V980, i730	*http://www.motocoder.com*
Nokia	All Series 40, Series 60, and Series 80 based devices	*http://forum.nokia.com/main.html*
Samsung	E310, E380, E710, D400, P705, D410, 176X192 Series, E810, E310	*http://uk.samsungmobile.com/club/developers_club/cl_de_sdk_01.jsp*
Sony-Ericsson	W900, Z600, T610, T616, T618, V600, W800, K608, W550, W600, z520, D750, Z800, K600, K750, K300, K500, K700, J300, V800, Z500, S700, Z1010	*http://developer.sonyericsson.com*

Id., 6.

126. As one example pertinent to the '095 patent, Goyal teaches that MMAPIs can be used to "capture snapshots or full videos" from within a mobile application. *Id.*, 127; *see also id.*, 16, 253. Goyal explains first how to determine whether a device is capable of capturing images and/or video, and what formats are supported. *Id.*, 128-31. Goyal also explains how to use the `VideoControl` API to "look through [a **camera's**] viewfinder and display this video to the user." *Id.*, 174-78. In order to obtain a snapshot from the video, Goyal teaches using `getSnapshot`. *Id.*, 178-79.

127. Goyal also discusses various considerations for developers seeking

to deploy their mobile application. For example, users can download applications via the well-known "over the air" ("OTA") interface. *Id.*, 66-67. "[OTA] is the most common way in which MIDlets are downloaded to **cell phones** and similar **wireless devices**, although it is also applicable to network-connected **PDAs**. The process of deploying MIDlet suites over a network is referred to as over-the-air provisioning, or OTA provisioning for short." EX1059-Topley, 75.

G. Randle (EX1048)

128. Like Garcia and the '095 patent, Randle teaches using a check image to perform deposit. EX1048-Randle, [0002], [0006]-[0007]. More specifically, Randle's teaches techniques for providing "quality assurance" or "QA" to check images. *Id.*, Abstract, [0021], [0042]. Randle's system is source-agnostic—the check image can come from a number of sources, including: "101 teller, 102 point of sale, 103 image ATM/kiosk, 104 commercial and corporate, 105 branch back counter, 106 image POD (sorter farm), 107 remittance (sorter farm), 108 inclearing (sorter farm), and 109 inbound image exchange." *Id.*, [0014], [0016], [0020]. These are shown in Figure 1B, reproduced below:

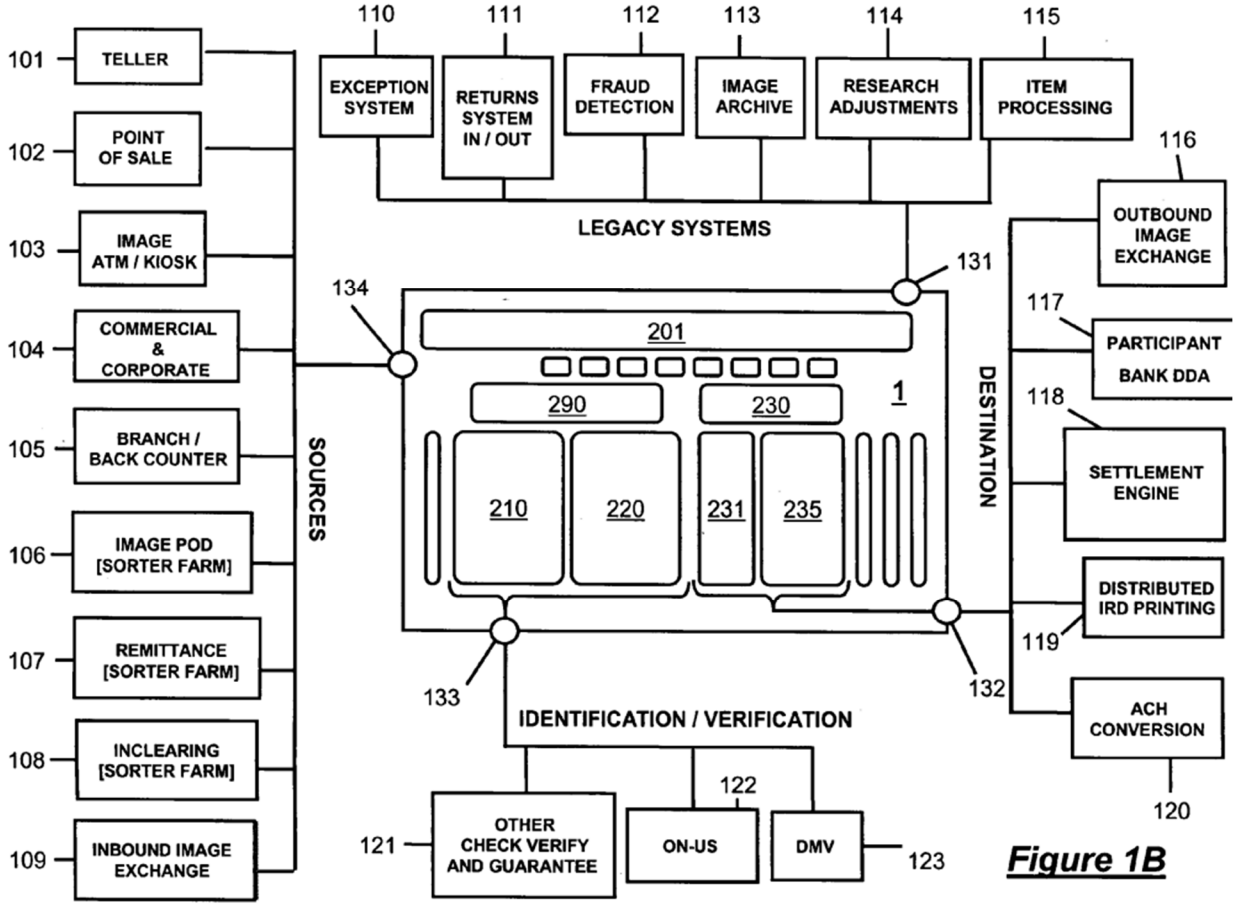
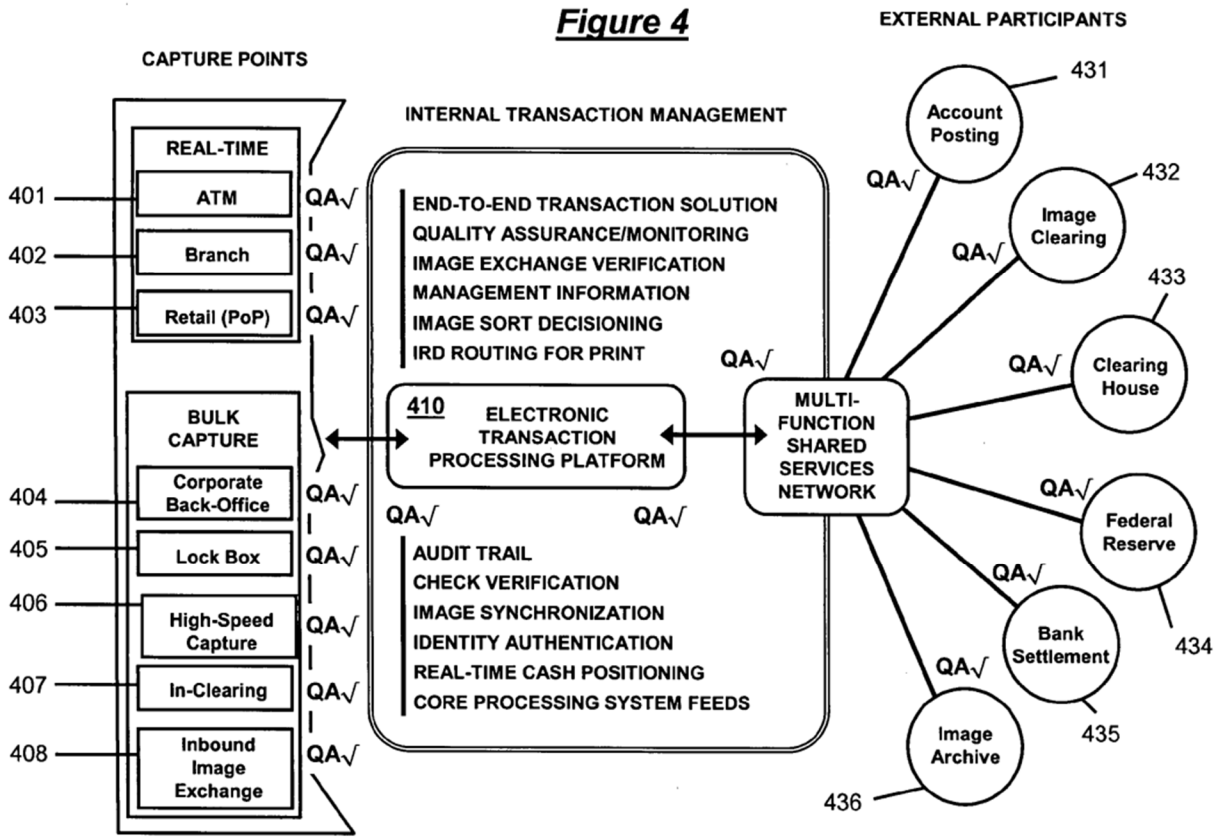


Figure 1B

Id., Fig.1B.

129. With reference to Figure 4, Randle teaches that "[q]uality assurance performed at any of the QA identification points shown (designated 'QA' with a check mark, QA√) allow an agreed to QA value to be accepted at any point in processing." *Id.*, [0014]. This includes at ATMs, retail locations, corporate offices, etc.



Id., FIG.4. Randle emphasizes the flexibility of the disclosed QA approach:

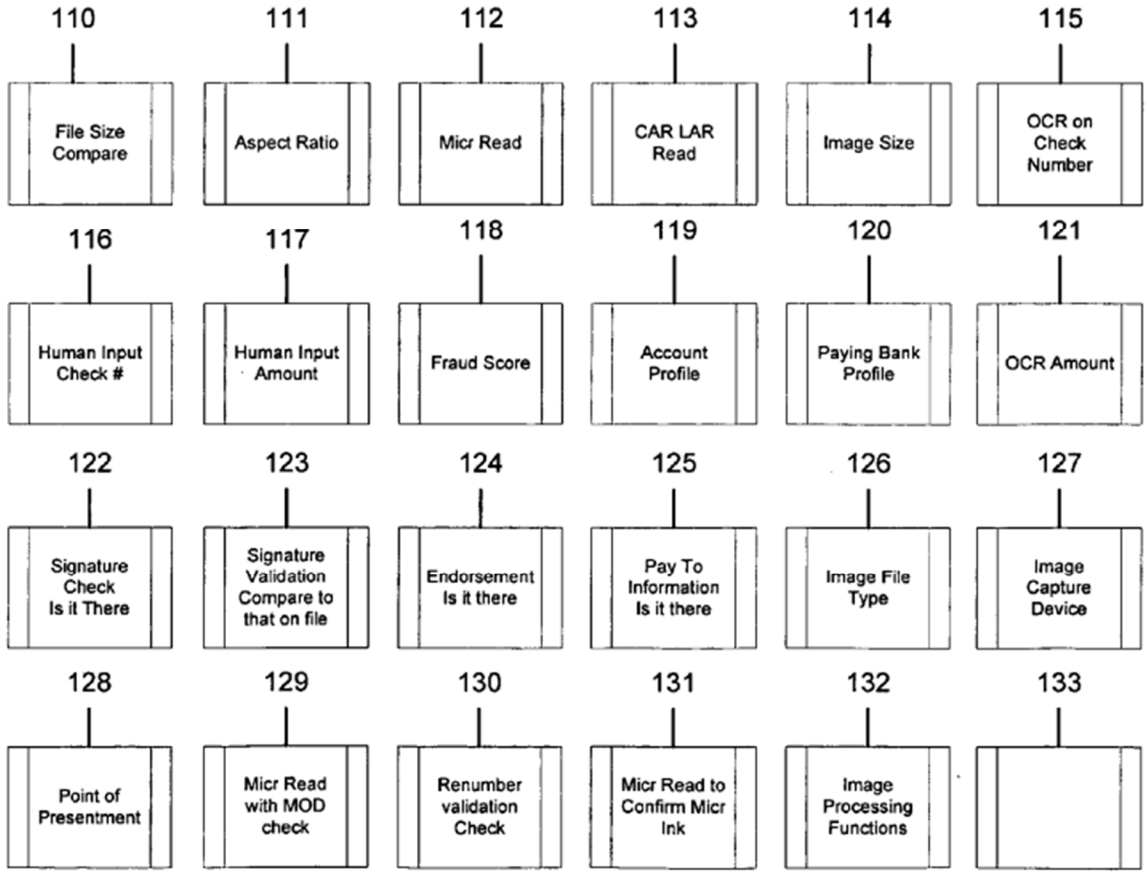
> The ability to establish virtual electronic processing bins and flows as depicted in the figures allows for an infinite range of QA processes, sorting routines, and exception routing and workflow processes to be established and managed within the system. This supports a broad range of custom QA sorting and routing offerings that are completely user defined. Some examples include: time of day routing for quickest settlement path, multiple levels of

> QA based on capture artifacts, presenter profile, risk score, transaction value, settlement method, presentment method, presentment location, etc., and multiple exception handling paths based on the results of QA paths.

Id., [0016].

130. Randle's QA process includes numerous aspects to QA processing. Figure 9B, reproduced below, "lists functions or pre-stored information criteria that are elements of QA." *Id.*, [0074].

Figure 9B



131. As one example, Randle teaches "132 image processing functions…." EX10048-Randle, [0074]. Randle teaches that the check image size can be reduced:

> Image data reduction options with QA are supported with QA being available before and after data reduction. The capture of a check in an 8 bit gray scale (or color) high dpi format (100 dpi or 200 dpi) may be needed to assure a high

level of quality for a QA process. Once that QA process is completed on the high resolution image (stamped with a QA√ signature; for example, as shown by the "QA√" check marks in the drawings) then the image is converted to a less size intensive format for transmission and use in the check processing chain. The QA signature provides an audit trail for this process and assures QA is not lost as part of the data reduction process. Examples of data reduction include: 1) 8 bit gray scale to bi-tonal (black and white); 2) 200 dpi color to 100 dpi bi-tonal; 3) 100 dpi to 50 dpi bi-tonal, 4) 24 bit color to 8 bit gray scale; 5) 8 bit gray scale to 4 bit gray scale, 6) color (grey scale or full color) to bi-tonal (black and white), and 7) equivalent or similar reductions in tone, color, contrast, resolution or other parameters. Thus the image is captured, QA'd, and then data reduction is performed (keeping the unique digital signature and transitive QA) as a method to reduce file size which increases transmission speed and reduces storage requirements. Data reduction may also include variations

> in pixel resolution and/or color depth.

Id., [0043]; *see also id.*, [0042], [0044].

132. Randle further teaches a segmentation process that keeps important parts of the check image at a higher level of quality:

> Data reduction and image segmentation with QA may also be accomplished. Segmentation of the check image where areas of interest are kept at the higher resolution and the irrelevant or blank areas are converted to a lesser resolution and/or color depth may also be done. Examples of critical information include the signature line, endorsement, amount, payee, and MICR data compared with other areas of the check.

EX1048-Randle, [0044].

H. Attia (EX1043)

133. Attia, like Garcia and the '095 patent, is directed to capturing and processing **document** images, in particular to decode a printed barcode. EX1043-Attia, Abstract, 1:12-16, 3:24-27, FIGs.2A-C, 4B, 5A. Attia discloses a system that uses a **mobile device** to capture, enhance, and decode a barcode image. *Id*., 3:45-52, 5:58-63, 11:30-47, claim 1, 3-6, 8-12, 14.

134. Attia teaches monitoring images of a barcode in real-time and capturing the image when the barcode can be decoded. EX1043-Attia, 4:8-18. Attai teaches "[t]he location of the decoding depends entirely upon the processing capabilities of the **mobile device** utilized" and that "if the…software is operating on a **mobile device** with lower system capabilities…the mobile device will automatically send the digital image of the barcode to a server for decoding." *Id.*, 4:1-7.

XI. SPECIFIC GROUNDS FOR UNPATENTABILITY

135. In my opinion, claims 1-30 of the '095 patent are unpatentable because they are obvious in view of the prior art. In the sections that follow, I provide a detailed explanation of my opinion of how those prior art references show that the claims are obvious. I rely on the following combinations of prior art references:

Ground	References	Basis	Claims Challenged
I	Garcia, Luo, Meier, Cohen	§103	1-4, 6-12, 14-21, 23-30
II	Garcia, Luo, Meier, Cohen, Yoon	§103	5, 13, 22
III	Garcia, Luo, Meier, Cohen, Randle	§103	7, 24
IV	Garcia, Luo, Meier, Cohen, Attia	§103	11, 16

Ground	References	Basis	Claims Challenged
V	Garcia, Luo, Goyal, Cohen	§103	1-4, 6-12, 14-21, 23-30
VI	Garcia, Luo, Goyal, Cohen, Yoon	§103	5, 13, 22
VII	Garcia, Luo, Goyal, Cohen, Randle	§103	7, 24
VIII	Garcia, Luo, Goyal, Cohen, Attia	§103	11, 16

A. Ground I: 1-4, 6-12, 14-21, 23-30 are Obvious Over Garcia in Combination with Luo, Meier, and Cohen ("Garcia/Luo/Meier/Cohen")

136. In my opinion, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen. First, I explain why a person of ordinary skill in the art would have been motivated to combine the Garcia with the Luo, Meier, and Cohen references (Section XI.A.1). Next, I explain why that combination of prior art references would have rendered claims 1-4, 6-12, 14-21, 23-30 obvious (Sections XI.A.2 and XI.A.3).

1. Combination of Garcia, Luo, Meier, and Cohen ("Garcia/Luo/Meier/Cohen")

137. I have reviewed the Garcia, Luo, Meier, and Cohen references. It is my opinion that each is analogous art to the '095 patent claims. It is also my opinion that a person of ordinary skill in the art would have been motivated to combine them

with a reasonable expectation of success.

138. In Section XI.A.1.a, I explain why a person of ordinary skill in the art would have been motivated to modify Garcia with Luo's teachings of displaying an **alignment guide**, providing feedback and other instructions to the user, and automatically capture an image of a **document**, and further why a person of ordinary skill in the art would have been motivated to implement those teachings using Meier's software architecture, including a downloaded application and **camera** control APIs.

139. In Section XI.A.1.b, I explain why a person of ordinary skill in the art would have been motivated to modify Garcia with Cohen's teachings regarding various remote check deposit steps.

a. Garcia in view of Luo and Meier ("Garcia/Luo/Meier")

140. **Analogous Art**: In my opinion, Garcia, Luo, and Meier are analogous art to the '095 patent claims. The '095 patent claims are in the field of capturing and processing **document** images. For example, claim 1 is "[a] system enabling mobile check deposit auto-capture functionality via video frame processing" that includes "a **mobile device** of a user, the user's **mobile device** including a **camera**, a processor, and a memory coupled to the processor" and "a downloaded app," to "control check deposit by controlling the **camera**" to facilitate

"auto-capture" of a check image via "the video frame of the live video of the check…." EX1001-USP095, claim 1. Claim 1 further describes additional processes on the **document** image, including "processing the digital image of the check including performing optical character recognition on the check in the digital image and verifying that the digital image of the check is acceptable for mobile check deposit…." *Id.* The other claims recite similar limitations. Thus, the '095 patent is directed to capturing and processing images of a **document** (i.e., a check).

141. Garcia, Luo, and Meier are also in the field of processing **document** images. For example, Garcia discloses methods and systems "for processing and accepting **documents**, such as, for example, bank checks, with guarantee of authentication of the issuer and the **document** itself, using electronic media for its implementation through a **mobile device** capable of capturing and sending images via an Internet connection." EX1003-Garcia, 1:7-13.

142. Luo discloses systems and methods for capturing better images of a rectangular **document** (e.g., a business card) for OCR. EX1004-Luo, 1 ("For example, people in business can use digital **cameras** incorporated into **mobile phones** to quickly and easily capture digital images of their business cards. Then, they can perform optical character recognition (OCR) on the digital images, and save the name, address, and other information printed on the business cards automatically

in the contact file of their phones."). Luo describes various techniques for improving image capture, and therefore the readability of the captured image, including ensuring that the edges of the rectangular **document** are parallel with **reference lines** and automatically capturing the image of the **document**. *Id.*, 6, 7. Thus, Luo is directed to capturing and processing an image of a **document**, just like the '095 patent claims.

143. Finally, Meier discloses a software development kit and example mobile application computer code for capturing images using Android devices. For example, Meier teaches that the disclosed SDK can "[a]ccess to the **[mobile] device camera** for taking pictures and previewing video." EX1005-Meier, 315. A person of ordinary skill in the art would have understood that such techniques could have been used to capture images of a wide variety of things, including a **document**). Thus, Meier is directed to techniques for capturing an image, including an image of a **document**, just like the '095 patent claims.

144. **Motivation to Combine**: In my opinion, a person of ordinary skill in the art would have been motivated to combine Garcia's disclosure of performing remote check deposit with an image captured by a **mobile device** with Luo's well-known **mobile device** image capture techniques, including providing **reference lines** to help a user **align** a **document** in a **camera preview window**, feedback and

other instructions to the user, and autocapture. In my opinion, a person of ordinary skill in the art would have also been motivated to combine Garcia's disclosure of performing remote check deposit with an image captured by a **mobile device** with Meier's software architecture, including a downloaded application and APIs for controlling **mobile device cameras**.

145. As I explained in Section X.A, Garcia discloses a remote check deposit system that extracts deposit information from images captured by a **mobile device**. EX1003-Garcia, 1:6-13 ("The present invention, as its title implies, relates to a method for processing and accepting **documents**, such as, for example, bank checks, with guarantee of authentication of the issuer and the **document** itself, using electronic media for its implementation through a **mobile device** capable of capturing and sending images via an Internet connection."), 11:7-15 ("For its part, the institution that renders the service must have certain electronic means of recognizing, verifying and processing the information sent by the user. These means consist basically of **computer equipment** connected to the Internet that has an optical character recognition (OCR) system, a code authentication system and means of transmitting data to the institution's **document** processing system."). More specifically, Garcia teaches that the "**mobile equipment** that performs the initial processes of capturing, digitizing and processing the image consists of a **mobile**

telephone equipped with the features and functions necessary for said purpose, particularly a **mobile telephone** with [a]**camera** and processing capacity." *Id.*, 11:1-6. Garcia further explains that the device includes a "computer application." *Id.*, 9:21-10:3. A person of ordinary skill in the art, when faced with Garcia's disclosure to capture images of a check with a **mobile device**, would have been motivated to look to other teachings from the prior art like Luo and Meier to supply implementation details. For example, a person of ordinary skill in the art would have been motivated to look to references like Luo for additional teachings regarding how capture the image of the check and also how to ascertain whether such image is sufficient for completing the deposit. Moreover, a person of ordinary skill in the art would have been motivated to look to references like Meier regarding the particular software implementation on Garcia's **mobile device**.

146. Luo provides these additional teachings with respect to capturing check images on a **mobile device**. For example, Luo teaches techniques for improving images of **documents** captured by a **mobile device**, which are then used for OCR. EX1004-Luo, Abstract ("A method and system for capturing the frontal image of an object having at least two substantially **straight edges** (205), which helps reduce projective distortion in the image."), 1 ("This ubiquitous availability of digital **cameras** has produced many novel commercial applications for digital

images. For example, people in business can use digital **cameras** incorporated into **mobile phones** to quickly and easily capture digital images of their business cards. Then, they can perform optical character recognition (OCR) on the digital images, and save the name, address, and other information printed on the business cards automatically in the contact file of their phones."), 5 ("The present invention ensures that the front of the object being imaged is substantially parallel to the image plane 320 of the **camera system** 100 to reduce the projective distortion of the image."), 7 ("In summary, the present invention is an improved method and system for capturing the frontal image of an object having at least two substantially **straight edges** 205."). Specifically, Luo teaches providing instructions and feedback to the user so as to help the user **align** the edge of a **document** such that it is parallel with **reference lines** displayed in a **camera preview window**:

> A method and system for capturing the frontal image of an object having at least two substantially straight edges (205), which helps reduce projective distortion in the image. The method includes receiving a preview image on an image sensor (115) related to a camera (100), and the preview image depicts a straight edge (205). Then, a preview image depicting a straight edge (205) and at least

> two reference lines (135) simultaneously present is displayed in a preview window (125) of the camera system (100), where each reference line (135) corresponds to a straight edge (205). The image of the object is captured only when the straight edge (205) shown in the preview window (125) is substantially parallel to the corresponding reference line (135).

EX1004-Luo, Abstract.

> The present invention ensures that the front of the object being imaged is substantially parallel to the image plane 320 of the camera system 100 to reduce the projective distortion of the image. For example, when the system 100 is in the document capture mode, the system 100 provides the user with an image of a captured object, such as a business card, only when the straight edge 205 of the business card is substantially parallel to the corresponding reference line 135 displayed in the preview window 125.

Id., 5.

> As is well known in the art, image edge detection

techniques can be used to reliably calculate the angle between a specific reference line 135 and the corresponding straight edge 205 in the document preview image. In FIG.5, three reference lines 135 are shown; however, according to the disclosure of the present invention, those skilled in the art should recognize that different numbers of reference lines 135 may be used according to different embodiments of the present invention, such as two, three, four or more baselines 135.

Id., 5.

Various techniques may be used to indicate to the user that an appropriate number of reference lines 135 are substantially parallel to the respective straight edges 205 of the object depicted in the preview window 125. For example, an alarm composed of sounds, such as a clicking sound output from the camera system 100, may be provided. In the same way, it may be the light illuminated in the preview window 125 or the light illuminated elsewhere in the camera system 100. In addition, an image

> indicator may be displayed on the preview window 125, for example, when each reference line 135 is substantially parallel to a corresponding straight edge 205, the reference line 135 may change color or flicker individually. As an alternative, when the straight edge 205 displayed on the preview window 125 is substantially parallel to the corresponding reference line 135, the system 100 can automatically capture the selected image and provide the user with or without instructions.

Id., 6.

> In summary, the present invention is an improved method and system for capturing the frontal image of an object having at least two substantially straight edges 205. Embodiments of the present invention employ common features of the camera system 100 such as the mode selection switch 130 and the preview window 125 to make it user friendly and intuitive in use. Therefore, the present invention helps users to accurately and reliably capture an image of the front of an object, where the object plane 310

> is substantially parallel to the image plane 320. Therefore, the projective distortion in the image is reduced, and the image is clearer and more accurate. With reduced projective distortion, it is more likely to perform an accelerated image capture process, such as an optical character recognition process performed on a text image, with high accuracy.

Id., 7; *see also id.*, 7 (describing steps in Figure 6); claims. 5, 11, 13, FIG.6.

147. In addition to helping the user **align** the **document** with **reference lines**, Luo also teaches that the image of the **document** is automatically captured when the **document** is properly **aligned** in the **preview window**. EX1004-Luo, 6 ("As an alternative, when the **straight edge** 205 displayed on the **preview window** 125 is substantially parallel to the corresponding **reference line** 135, the system 100 can automatically capture the selected image and provide the user with or without instructions."). As was well known in the art, Luo teaches that applying the disclosed **alignment** and automatic techniques provides "improved method and system for capturing the…image," are "user friendly and intuitive in use," ensure the "image is clearer and more accurate," and reduce projective distortion, which "accelerate[the] image capture process" and "optical character recognition…with

high accuracy." *Id.*, 7.

148. In my opinion, a person of ordinary skill in the art would have been motivated to incorporate Luo's teachings described above into Garcia mobile check deposit system. It was well known that **mobile device** images of **documents** can suffer from problems such as projective distortion and blur. Consistent with the knowledge of a person of ordinary skill in the art, Luo teaches that providing instructions and feedback, including with the use of parallel **reference lines**, can produce higher quality images that reduce the impact of these well known "projective distortion" and "blur" problems, and that doing so improves the accuracy of OCR by making the text more readable:

> [P]eople in business can use digital cameras incorporated into mobile phones to quickly and easily capture digital images of their business cards. Then, they can perform optical character recognition (OCR) on the digital images, and save the name, address, and other information printed on the business cards automatically in the contact file of their phones.
>
> …
>
> [I]n order to convert an image into a special character

> code, the OCR process requires images of single characters in relatively high quality.
>
> [M]any environments today for using digital cameras are not ideal for capturing high-quality images. For example, a user of a digital camera trying to capture a business card image simply holds the business card in front of the camera lens with one hand, while holding the camera with the other hand when taking pictures. But this makes unideal variable factors such as the distance from the lens to the business card, and the angle of the camera's image plane relative to the front of the business card. Therefore, the image resulted may contain defects such as projective distortion.

EX1004-Luo, 1.

> The present invention ensures that the front of the object being imaged is substantially parallel to the image plane 320 of the camera system 100 to reduce the projective distortion of the image. For example, when the system 100 is in the document capture mode, the system 100 provides

> the user with an image of a captured object, such as a business card, only when the straight edge 205 of the business card is substantially parallel to the corresponding reference line 135 displayed in the preview window 125.

Id., 5.

> In summary, the present invention is an improved method and system for capturing the frontal image of an object having at least two substantially straight edges 205. Embodiments of the present invention employ common features of the camera system 100 such as the mode selection switch 130 and the preview window 125 to make it user friendly and intuitive in use. Therefore, the present invention helps users to accurately and reliably capture an image of the front of an object, where the object plane 310 is substantially parallel to the image plane 320. Therefore, the projective distortion in the image is reduced, and the image is clearer and more accurate. With reduced projective distortion, it is more likely to perform an accelerated image capture process, such as an optical

character recognition process performed on a text image,

with high accuracy.

Id., 7.

149. A person of ordinary skill in the art would have therefore been motivated to use Luo's teachings, including displaying images in a **preview window**, instructions/feedback to the user, **reference lines**, and automatic image capture responsive to determining sufficient **alignment** to improve captured images for use in Garcia's check deposit system. In light of Garcia's teachings (1) to capture an image of a **document** (i.e., a check) with a **mobile device** and (2) to perform OCR on the **document** in the image. EX1003-Garcia, 11:1-15. A person of ordinary skill in the art would have recognized that Luo's teachings for improving mobile image capture of **documents** such as business cards would have similarly improved Garcia's image capture for checks. For example, applying Luo's teachings to Garcia's system would have predictably increased the likelihood of obtaining images suitable for "[r]ecognizing, verifying, and electronically treating and processing," as disclosed by Garcia. EX1003-Garcia, 6:8-10.

150. As I explained in Section III.C, one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. Another consideration is whether the alleged invention

applies a known technique to a known device or method that was ready for improvement to yield predictable results. In my opinion, this describes the combination of Garcia with Luo. For example, implementing Garcia's mobile check deposit method and system using Luo's **camera** method and system would have involved using and applying known techniques—here, Luo's **preview window**, instructions, feedback, **document alignment**, and automatic capture techniques—to a known or similar device or method—here, Garcia's use of a **mobile phone camera** to capture a check image—ready for improvement—here, to improve OCR of Garcia's images–in the same way—here, by reducing projective distortion and blur in the image—to yield predictable results—here, a better check image.

151. In my analysis, I have also considered Garcia's teaching to use "a computer application in the **mobile telephone**" and "features and functions necessary" to carry out check image capture. EX1003-Garcia, 9:21-10:1, 11:4. Luo provides similar teachings, including "stored program instructions that control the operation of one or more processor" and "software" such as "that [which] enables the [**camera**] **preview window**" and "software stored in **camera system** 100" for performing optical character recognition. EX1004-Luo, 3, 7, 8. A person of ordinary skill in the art, when faced with Garcia's and Luo's teachings regarding **mobile devices** and associated software, would have been motivated to look to other

teachings from the prior art like Meier to supply implementation details. For example, Meier supplies the software architecture (and how such software is loaded onto the **mobile device**) required to implement Garcia's and Luo's teachings.

152. Meier supplies such implementation details in the form of well-known and readily available software components. In the field of software development, persons of skill in the art frequently consult guides or other reference materials to understand how to write computer code a particular computing environment. I have used these types of resources many times in my career. Meier is one such guide in the field of mobile application development. Specifically, Meier describes itself as a "hands-on guide to building mobile applications" that helps application developers understand how "to get the most out of Android." EX1005-Meier, xvii; *see also id.*, 12 ("The Android software development kit (SDK) includes everything you need to start developing, testing, and debugging Android applications."). This includes helping developers take advantage of the device **camera**. *Id.*, xviii ("Hardware is then covered, starting with media recording and playback, before introducing the **camera**, accelerometers, and compass sensors."), 5 ("As an application-neutral platform, Android gives you the opportunity to create applications that are as much a part of the phone as anything provided out of the box. The following list highlights some of the most noteworthy Android features:…Full

multimedia hardware control including playback and recording using the **camera** and microphone…."), 6 ("The Android SDK includes APIs for location-based hardware (such as GPS), **camera**, network connections, Wi-Fi, Bluetooth, accelerometers, touch screen, and power management. You can explore the possibilities of some of Android's hardware APIs in more detail in Chapter 10."), 315 ("In this chapter, you'll take a closer look at some of these hardware APIs. In particular, you'll learn how to play and record multimedia content including audio, video, and still images, as well as use the **camera** to capture images and preview and capture live video.").

153. Meier describes many software features relevant to Garcia and Luo. For example, Meier provides techniques for loading application software on a **mobile device**. Specifically, Meier teaches downloading mobile applications onto the device. *Id.*, 5 ("The Android Marketplace client for downloading thied-party [*sic*] Android applications."). Meier also teaches that such downloaded applications can "[a]ccess to the device **camera** for taking pictures and previewing video." *Id.*, 315; *see also id.*, xviii,, 5, 6, 12. In order to access the **mobile device camera**, Meier teaches the use of well known "application-neutral APIs [to] provide low-level access to the increasingly diverse hardware commonly available on **mobile device**," such as the **camera**. *Id.*, 315; *see also id.*, 319-21 (discussing **camera** preview and

capture APIs), 325 (discussing "Camera APIs").

154. A person of ordinary skill in the art would have therefore been motivated to implement the Garcia/Luo combination with Meier's teachings of a downloaded application and APIs that access the **mobile device camera** hardware. As I outlined in Sections VI.C and VI.D, mobile applications were becoming increasingly popular in the early and mid-2000s. *See, supra*, §§VI.C, VI.D; EX1005-Meier, 315, 319-20. These included, for example, mobile applications that accessed **camera** functionality to preview images in a viewfinder and capture pictures. I outlined numerous examples in Sections VI.C and VI.D above. *Id.*

155. Downloaded applications were also becoming increasingly popular, and therefore would have been an attractive architecture with which to build mobile functionality like Garcia's mobile check deposit and Luo's image capture techniques. EX1034-Yuan, 24, 25, 55; *supra*, §VI.D. These downloaded applications provide useful functionality for third parties wishing to take advantage of **mobile devices**. As an example, a bank or other third-party enterprise (e.g., as disclosed by Garcia) can deploy applications to their customers with customized functionality with added sophistication above that offered by other solutions, such as webpages hosting thin-clients. EX1034-Yuan, 52 (discussing benefits of "smart-clients" which a person of ordinary skill in the art would have understood to be

enabled by downloaded applications, over "thin-clients," which a person of ordinary skill in the art would have understood to be a browser-based application, including "richer and more pervasive user interfaces," "[e]xtreme personalization," "leverage[ing] device extensions," "more powerful and flexible security schemes," and "advanced integration technologies"). Unlike webpages and thin-clients, which are downloaded every time a user navigates to the webpage, downloaded applications are installed once, stored in memory, and then maintained for use later on. *Id.*, 52 ("On-device data storage reduces network traffic, especially unnecessary round trips. It enables transactions; supports the 'offline' mode when the network is temporarily unavailable; and hence improves overall performance, reliability, and availability of mobile applications."), 44 ("a crucial disadvantage of the thin-client paradigm is that it requires the **mobile device** to be always connected. Today's wireless data networks are slow, unreliable, and expensive. They cover only limited areas. Those limitations have severely hindered the adoption of thin-client applications. To get around the network problem, we have to rely on the other two pillars in the Nokia Developer Platforms: J2ME and Symbian C++."). Downloaded applications also support increased security over then-existing web protocols. *Id.*, 52 ("Smart clients support more powerful and flexible security schemes. They enable content-based security and distributed single sign-on."), 45 ("Secure: The

Java runtime provides advanced security features through domain-based security manager and standard security APIs."). The popularity and functionality of downloaded applications would have led a person of ordinary skill in the art to teachings like those in Meier, and would have motivated a person of ordinary skill in the art to implement the Garcia/Luo combination with a downloaded application.

156. A person of ordinary skill in the art would have recognized additional benefits to downloaded applications. For example, downloaded applications also provide third parties with access to device hardware like accelerometers and GPS systems. In the case of the Garcia/Luo/Meier combination, a downloaded application can provide access to the **camera** with pre-written, and readily accessible software APIs. EX1005-Meier, 1, 3, 5, 6, 12, 16, 315, 319-21. Thus, a third party wishing to use a device **camera** could simply use those APIs and would not need to write new **mobile device** software from the ground up. Without such APIs, a third party would likely need access to proprietary hardware and software features typically known only to the device manufacturer. Rewriting code to access hardware features would have been duplicative and inefficient, especially given that APIs for performing the same functionality were already known.

157. Implementing the Garcia/Luo combination with a downloaded application and APIs for controlling image capture would have also involved the

application of techniques that were already being used for remote desktop deposit to the field of **mobile devices**. Desktop check deposit systems were already using downloaded applications. *See, e.g.*, EX1036-Westerman; EX1037-EasCorp; EX1038-eServices. Thus, when extending remote deposit capabilities to a **mobile device**, a person of ordinary skill in the art would have been motivated and found it obvious to use the equivalent software architecture for **mobile devices**. *See generally* EX1039-Hariharan.

158. A person of ordinary skill in the art would have been motivated to look to how-to guides like Meier—which explain available software features for **mobile devices**, for example using the Android platform—to implement the Garcia/Luo combination on a **mobile device**. When implementing the combination of Garcia/Luo with Meier's teachings, a person of ordinary skill in the art would have recognized that Meier's downloadable application and Camera APIs provide the software features needed to implement for Garcia's/Luo's teachings. As a few non-limiting examples, Meier's teaching to use a downloaded application would have been used to implement Luo's **preview window** and image capture using, for example, the Camera API that provides third-party mobile applications access to video preview from a device **camera**. In the Android SDK, the relevant APIs include `setPreviewDisplay`, which allows a developer to add a **camera**

preview window to their mobile applications. As another example, Meier's teaching to use a downloaded application would have also been used to implement Luo's and Garcia's teachings to capture a picture or a single frame from a video feed. In the Android SDK, the relevant APIs include `takePicture`, which allows a developer to add image capture from a **preview window** to their mobile applications. EX1004-Luo, Abstract, 5-7, claims 5, 11, 13, FIG.6; EX1005-Meier, xviii, 5, 12, 315, 318-20. Meier's teachings are not limited to these features—Meier also provides additional implementation details, such as explanations regarding how to initialize the **camera** and how to control additional **camera** settings. *See, e.g.*, EX1005-Meier, 319-20.

159. As I explained in Section III.C, one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. Another consideration is whether the alleged invention applies a known technique to a known device or method that was ready for improvement to yield predictable results. In my opinion, this describes the combination of Garcia with Luo. For example, implementing Garcia's/Luo's software with Meier's teaching to use a downloaded application and **camera** control API would have involved applying a known technique or method—here, Meier's well-known software architecture that includes downloaded applications and

APIs—to a known or similar device or method—here, Garcia/Luo's mobile check capture and processing software—ready for improvement—here, by facilitating Garcia/Luo's deposit and image capture teachings without the need to download software for each deposit and without the need for a developer to write **camera** control software—in the same way—here, by using well-known software components and software deployment techniques—to yield predictable results—here, capturing and processing a check image with a **mobile device**, as contemplated by Garcia and Lu.

160. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing the combination of Garcia's mobile check deposit method and system using the teachings of Luo's capture method and system and Meier's software architecture. For example, the similarity between the references themselves would have led a person of ordinary skill in the art to reasonably expect success. Garcia, Luo, and Meier each teach the use of **mobile devices** with **cameras** and software for capturing images. For example, Garcia discloses:

> The present invention, as its title implies, relates to a method for processing and accepting documents, such as, for example, bank checks, with guarantee of

> authentication of the issuer and the document itself, using electronic media for its implementation through a mobile device capable of capturing and sending images via an Internet connection.

EX1003-Garcia, 1:7-13.

> The mobile equipment that performs the initial processes of capturing, digitizing, and processing the image consists of a mobile telephone equipped with the features and functions necessary for said purpose, particularly a mobile telephone with camera and processing capacity.

Id., 11:1-6.

161. A person of ordinary skill in the art would have understood "the features and functions necessary for" "the initial processes of capturing, digitizing, and processing the image" to include a processor, storage, and software. Luo discloses:

> In addition, it is hoped that technicians will be able to easily generate such software instructions and programs and ICs with minimal experimentation under the guidance of the principles and principles disclosed herein, although

> it may take a lot of effort, and based on considerations such as time and current technology available and economic considerations, a number of design choices can be inspired.

EX1004-Luo, 8; *see also id.*, 6 (describing use of **camera** to capture images), 3, 7 (describing "software"). Meier discloses:

> In this chapter, you'll take a closer look at some of these hardware APIs. In particular, you'll learn how to play and record multimedia content including audio, video, and still images, as well as use the camera to capture images and preview and capture live video.

EX1005-Meier, 315.

162. These similar teachings would have suggested to a person of ordinary skill in the art that the teaching from one disclosure could have easily been applied to the teachings of others.

163. A person of ordinary skill in the art would have also expected success in the combination because Garcia and Luo each teach capturing an image of the same item. For example, Luo teaches broadly taking images of small rectangular **documents** with **straight edges** like business cards, which a person of

ordinary skill in the art would recognized would have included Garcia's "bank checks." EX1003-Garcia, 12:4-9; EX1004-Luo, 1, 4, 6.

164. A person of ordinary skill in the art would have also expected success in the combination based on the references' own teachings. For example, Garcia discloses a "computer application in the **mobile telephone** in which an interactive session is established with the **receiving institution** through the mobile communications operator" without describing any challenges that a person of skill in the art would have faced implementing such features. EX1003-Garcia, 9:19-10:18. Consistent with the level of ordinary skill in the art and the readily available solutions for image capture and mobile software architecture (*see, supra*, Sections VI.C and VI.D), a person of ordinary skill in the art would have understood Garcia to teach that implementing known details like Luo's image capture process or Meier's software architecture would have been within the capability set and knowledge of a person of ordinary skill in the art. EX1004-Luo, 1, 3, 7, 8; EX1005-Meier, 315, 319-20. Moreover, implementing the Garcia/Luo/Meier combination would have simply involved writing computer code using readily accessible software development kits, like the Android SDK taught by Meier. Consistent with my understanding of the level of skill in the art and the disclosure of the references themselves, other prior art disclosures teach that it was "trivial for a mobile

application developer to access a **camera**…." EX1040-CodeGuru, 1. This too is consistent with Meier's teachings. Meier identifies itself as a handbook directed to "***anyone*** interested in creating applications for…**mobile phone[s]**" without any regard for app develop experience and further explains that only "some experience in software development and [familiarity] with basic development practices" is required. EX1005-Meier, xvii.

165. Finally, my opinion that a person of ordinary skill in the art would have reasonably expected success in the Garcia/Luo/Meier combination is consistent with the '095 patent's disclosure. Like Garcia, the '095 patent presumes that a person of ordinary skill in the art would have understood how to implement the claimed image capture process (e.g., like that of Luo) and software architecture (e.g., like that of Meier). EX1001-USP095, 7:54-60, 8:7-19, 24-30, 10:42-51, 11:26-51, 16:19-39, 21:1-27, claims 1, 9, 18, 26. The '095 patent lacks various implementation details disclosed by Luo and Meier, such as specific APIs, example code, or particular monitoring criterion parameters.

166. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia with Luo to incorporate Luo's teaching to monitor an image of a **document** for **alignment** with displayed **reference lines**, automatically capture the image when the **document** in

the image is sufficiently parallel with the **reference lines**, and provide feedback to a user throughout the process. Similarly, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia/Luo with Meier to incorporate Meier's teaching to use a software application for download for Garcia's mobile check deposit system and Luo's capture process, and to control the **camera** with an API.

b. Garcia in view of Cohen ("Garcia/Cohen")

167. **Analogous Art**: In my opinion, similar to Garcia, Cohen is also analogous art to the '095 patent claims. As I explained in Section XI.A.1, the '095 patent claims are in the field of capturing and processing **document** images. Cohen is also in the same field of capturing and processing **document** images. For example, Cohen discloses methods and systems "captur[ing], processing, and archiving of checks…." EX1006-Cohen, [0002]. Thus, Cohen is directed to capturing and processing an image of a **document** (i.e., a check), just like the '095 patent claims.

168. **Motivation to Combine**: In my opinion, a person of ordinary skill in the art would have been motivated to incorporate Cohen's teachings regarding check processing steps into Garcia's mobile check deposit system.

169. Garcia discloses "[r]ecognizing, verifying, and electronically

treating and processing the information received by [a **financial**] **institution**." EX1003-Garcia, 6:8-10. Garcia also teaches that the **financial institution** has "**computer equipment**…that has an optical character recognition (OCR) system…." *Id.*; 11:10-15. A person of ordinary skill in the art, when faced with Garcia's disclosure to capture images of a check with a **mobile device**, and processing, verifying, and OCRing such images would have been motivated to look to other teachings from the prior art like Cohen to supply implementation details.

170. For example, Cohen discloses techniques for verifying and processing of check images using OCR, reading the **MICR line**, and validating the accuracy of various information items read from the check image with the use of confidence levels. More specifically, Cohen discloses:

> [A] system and method [that] facilitates the capture and processing of checks and related bank document information at a remote client subsystem and locally processing the checks and information at the remote client site, for transmission to a main subsystem, for direct routing of the bank document information to the U.S. Federal Reserve Bank, circumventing intermediate transmission to the Bank of First Deposit (BOFD), all in

compliance with the Check Clearing for the 21st Century

Act.

EX1006-Cohen, Abstract. Cohen's system and method are shown in Figures 1 and 2 below.

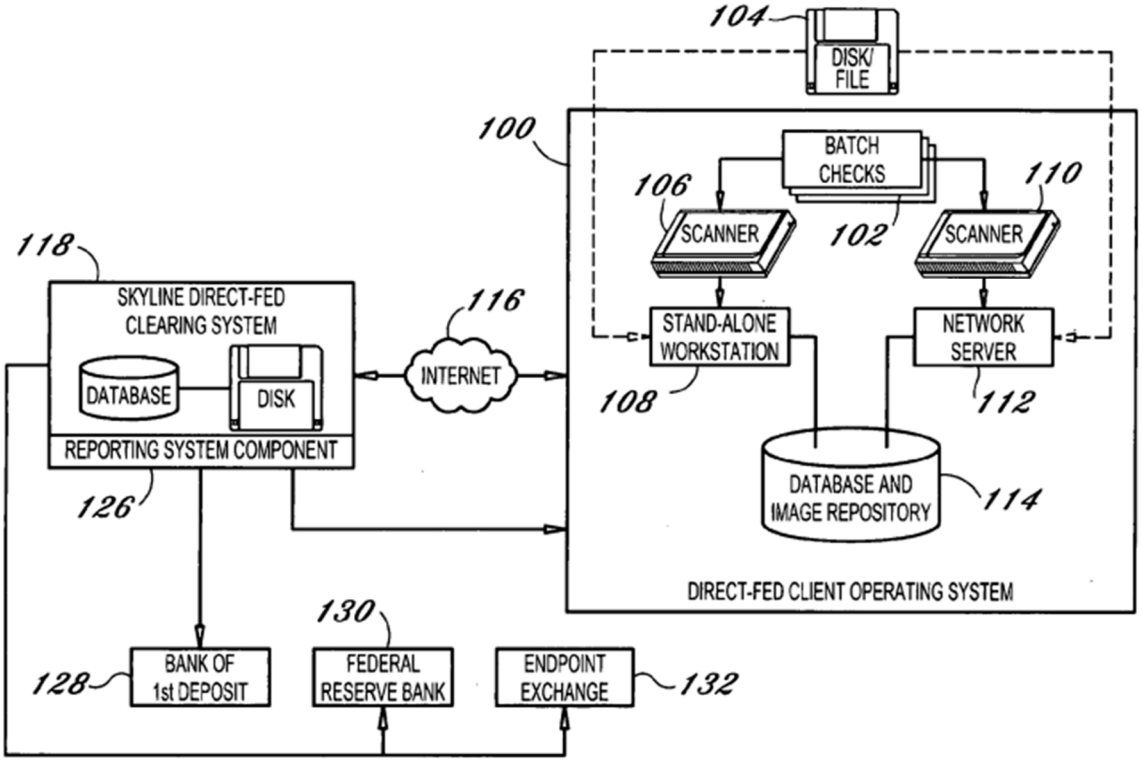


FIG. 1

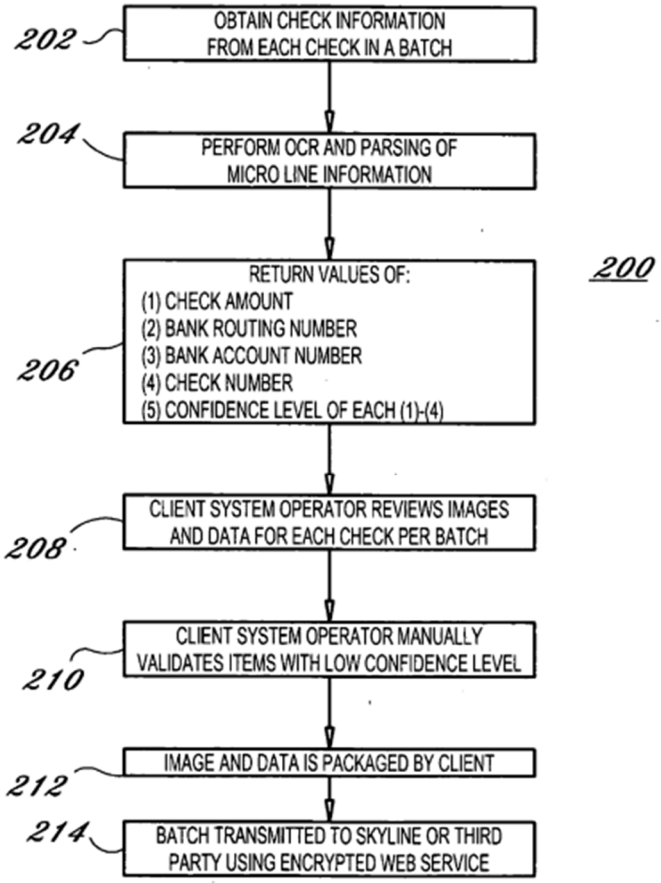


FIG. 2

Id., FIGs.1, 2.

171. Cohen teaches that the disclosed system and method allow for a merchant to scan and deposit checks locally at their own location in a batch process. *Id.*, [0017], [0019]-[0022]. More specifically, the user scans checks into their client system 100, which consists of a PC 108 or 112. *Id.*, [0020]. "The remote computer 108, equipped with scanner 106, includes a software scanning module which allows checks to be scanned front and back, the magnetic **MICR line** to be read, and a

customized physical endorsement to be printed upon the back of each check." *Id.*, [0021]; *see also id.*, [0042], [0071]-[0072]. Cohen teaches the following processing steps, which occur "at the local merchant site…: (1) OCR; (2) Scanning or Image Capture; (3) OCR and Scanning; or (4) OCR, Scanning and **MICR** Parsing." *Id.* Cohen further discloses the use of confidence levels to determine whether information read from the check, such as the **MICR** or the amount, are accurate:

> Referring now to FIGS. 1 and 2, at the conclusion of either the scanning or data importation process step 202, in step 204 another process is triggered which performs OCR as well as parsing of the MICR Line information. In a subsequent step 206, the OCR and parsing processes return value data, including: (1) check amount; (2) bank routing number; (3) bank account number; and (4) check number. Significantly, these processes also return quantitative measurements, or values, representing the confidence level of the accuracy of the OCR results pertaining to each of the respective pieces of data. Subsequently, in step 208, a remote operator at the local merchant site 100 reviews the images and data for each

check in the batch. Significantly, the efficacy of this process is greatly enhanced by assigning color-coding in accordance with the respective confidence levels. Preferably, green, yellow and red colors are utilized to provide easy visual indication to the operator as to the confidence level attached to each data item. Subsequently, in step 210, and based upon a configuration setting in the profile that governs the particular batch, the operator is required to manually validate only those data items with a certain confidence level. Termed "Examination Rigor", this profile configuration value may be set to require that only low confidence data (i.e. marked red) need be inspected, or that both low and moderate confidence level data (i.e marked red or yellow) must be inspected, or that all data (i.e. even items marked green) must be inspected for errors. Upon completion of the review, the batch is ready for transmission to the DirectFed™ clearing system 118, or a like third party system. For convenience, all further description herein will refer to transmission to the

> DirectFed™ clearing system 118. In step 212, the image and data information is packaged at the client 100 for subsequent transmission, in step 214, to the DirectFed™ clearing system 118 via the Internet utilizing an encrypted web service.

Id., [0022]; *see also id.*, [0042]-[0044], [0059], [0076]-[0088], [0093], FIGs.1, 2, claims 8, 14. Rather than simply rely on the computer-read information, Cohen further teaches that the user should review and confirm/validate the image of the check and information—such as the **MICR** and amount payable—read from the check:

> Subsequently, in step 208, a remote operator at the local merchant site 100 reviews the images and data for each check in the batch. Significantly, the efficacy of this process is greatly enhanced by assigning color-coding in accordance with the respective confidence levels. Preferably, green, yellow and red colors are utilized to provide easy visual indication to the operator as to the confidence level attached to each data item. Subsequently, in step 210, and based upon a configuration setting in the

> profile that governs the particular batch, the operator is required to manually validate only those data items with a certain confidence level. Termed "Examination Rigor", this profile configuration value may be set to require that only low confidence data (i.e. marked red) need be inspected, or that both low and moderate confidence level data (i.e marked red or yellow) must be inspected, or that all data (i.e. even items marked green) must be inspected for errors. Upon completion of the review, the batch is ready for transmission to the DirectFed™ clearing system 118, or a like third party system.

EX1006-Cohen, [0022]; *see also id.*, [0032] ("The DirectFed™ merchant client provides for alternate methods of scanning, recognition, and verification of batches. This allows for the integration of the DirectFed™ client with other programs which can provide check images and data. Specifications are provided for generation of import data. The following steps can be replaced by the import of images and data from outside programs."), [0078] ("Based upon the confidence levels for each item, and values defined within the profile, a Correct and Verify program module displays various items on screen and allows the user to view and override values provided by

the Recognition program module."), [0091], [0093], FIG.2.

172. The user's review occurs after processing but before transmitting the batch of checks deposit. *Id.*, [0022] ("Upon completion of the review, the batch is ready for transmission to the DirectFed™ clearing system 118, or a like third party system."), [0045], ("Step 6: Upon conclusion of the verification process, the batch is ready to be uploaded to the Skyline Data clearing system, or a system at an alternate third party location. The operator can choose when to upload a batch. When the operator initiates the upload of a batch, the images, data from the check, data from the profile, and data from the bank account are packaged and transmitted to Skyline Data (or the third party) via a secure, encrypted web file transfer service."), [0094].

173. In my opinion, a person of ordinary skill in the art would have been motivated to combine Garcia's mobile check deposit system with Cohen's teachings described above, including Cohen's check image processing teachings, such as OCR, validation, and confirmation techniques. A person of ordinary skill in the art would have been motivated to do so to improve the reliability and automation of remote check deposit process. Moreover, incorporating confidence levels—particularly in the OCR and validation steps—would allow for more nuanced decision-making and error handling, further improving the robustness of the system.

Garcia itself teaches toward the combination.

174. Garcia itself teaches that its mobile remote check deposit system requires OCR and additional steps such as data processing/verification. EX1003-Garcia, 1:6-13, 2:7-14, 4:11-18, 5:1-10, 6:8-10, 11:1-15, 12:17-22, claims 1, 4, FIG.1. Garcia teaches persons of ordinary skill in the art that "**receiving institution** makes available to the user a digital image of the **document** in its bank account and processes the **document** in question by the usual means (truncation systems)." EX1003-Garcia, 11:15-19. This would have led a person of ordinary skill in the art to truncation systems such as Cohen, which disclose additional check processing steps like those identified by Garcia, which were assumed to be within the skill and discretion of a person of ordinary skill in the art. For example, Cohen teaches that its system takes advantage of "check truncation" enabled by Check 21. EX1006-Cohen, [0004]-[0010], [0018], [0025], [0036] (describing check truncation, substitute checks). A person of ordinary skill in the art would have been particularly interested in Cohen because Cohen specifically teaches techniques for helping to confirm that an image captured by a user's device (i.e., not an ATM or bank system) has all the information needed to complete the deposit. A person of ordinary skill in the art would have recognized that Cohen's teachings for improving remote check deposit using a computer and scanner would have similarly improved Garcia's

mobile check deposit system. For example, by combining Garcia's mobile check deposit system with Cohen's teachings to provide users with the option to review a captured check image and the **MICR line** and amount payable information read from the image would have ensured that only higher quality check images are submitted. *Id.*, [0022], [0072], [0078], [0092]. In addition, incorporating confidence levels into the image analysis—along with enabling human review when confidence is too low—would further enhance the reliability of the submission process. This would have made it less likely that the check image would be rejected later on, for example by Garcia's **receiving institution**.

175. In addition to teaching various processing steps, the combination of Garcia and Cohen also discloses certain tradeoffs regarding where such processing steps occur. More specifically, both Garcia and Cohen teach two equally obvious implementations. Garcia teaches performing processing steps at a remote location, such as a receiving **financial institution**, whereas Cohen teaches performing processing steps on a user's device itself. For example, Garcia teaches that the recognizing, processing, and verifying steps are performed by a **remote institution's computer equipment**. EX1003-Garcia, 1:6-13, 2:7-14, 4:11-18, 5:1-10, 6:8-10, 11:1-15, 12:17-22, claims 1, 4, FIG.1. In contrast, Cohen teaches that at least some of those steps (e.g., OCR and various other verification and processing steps) are

performed on a user's electronic device remote from a **financial institution**. EX1006-Cohen, Abstract, [0017], [0019]-[0022], [0043]-[0044], [0059], [0076]-[0088], [0093], FIG.2, claims 8, 14. A person of ordinary skill in the art would have therefore been faced with two alternatives approaches: one involving performing processing steps on the **mobile device** and another performing such steps on the remote server. In light of these teachings, a person of ordinary skill in the art would have recognized the benefits of each approach and found each implementation to be obvious.

176. Regarding processing check images on the **mobile device**, a person of ordinary skill in the art would have been motivated to save bandwidth and delay by first determining readability and accuracy of some or all deposit information (e.g., the **MICR** and amount payable) before proceeding to send the check image to a **remote institution** for deposit over a network, which would have been bandwidth-constrained network.

177. Regarding processing check images at a remote location, a person of ordinary skill in the art would have also been motivated to perform some or all of the processing on the **remote institution's** computer where the rest of the deposit process takes place so as to avoid processing burden on the **mobile device**. A person of ordinary skill in the art would have understood that neither approach is inherently

superior in all cases, and that the decision could be made on a case-by-case basis. The system could be designed to support both options, with the choice determined by the consumer, the bank, or a software developer implementing the bank's preferences.

178. When faced with the decision as to where to process **mobile device**-captured images, persons of skill in the art have solved the same problem in both ways. As one example, the Nepomniachtchi patent (EX1044) discloses "systems for **document** image capture and processing using **mobile devices**," including producing "a color image of a check taken by a **mobile device** and convert it into a bi-tonal image of the check that is substantially equivalent in its resolution, size, and quality to check images produced by 'standard' scanners." EX1044-Nepomniachtchi, Abstract, 5:3-7. Nepomniachtchi explains whether to determine the quality of the captured image on the **mobile device** or a remote server can be impacted by timing considerations:

> In some embodiments, the quality of the image is determined at the mobile device. In this way the number of requests from the server for additional images might be reduced. The request may come directly from the mobile device. This may allow for the request to be more quickly

> determined and may allow a user to take an additional image within a shorter time from the earlier image. This may mean, for example, that the user is still physically close to the document and is still holding the communication device. This might make it easier to retake an image. If the image quality processing occurs at a server it might take longer to determine that the image quality is acceptable and communicate that information back to a user. This may mean the user is no longer near the document or has started performing another task. It will be understood, however, that in some embodiments, a server based implementation might be employed to off-load processing demands from the mobile device. Additionally, in some cases it might be quick as or quicker than a system that uses the mobile communication device to process an image to determine image quality.

Id., 10:29-48.

179. As another example, the Attia patent (EX1043) describes a **downloaded cellphone** or **PDA** bar code scanner application. EX1043-Attia, 3:24-

52. Attia explains that whether the barcode in the image is decoded locally or on the remote server depends on the processing capabilities of the **mobile device**:

> The location of the decoding depends entirely upon the processing capabilities of the mobile device utilized. For example, if the ScanZoom software is operating on a mobile device with lower system capabilities, such as a first generation camera phone, the mobile device will automatically send the digital image of the barcode to a server for decoding.

EX1043-Attia, 4:1-7. Randle too discloses a remote deposit system that performs "image quality assurance" processing or "QA" processes either at the client's site, a centralized location, or both:

> Commercial and corporate capture 104 is a cash management product that the bank can offer to its customers. This involves implementation of an image-scanning device at the customer's location. Scanned, corrected, and balanced work is transmitted to the system of the invention for verification, posting, and clearing purposes as well as for inclusion in the image archive. In

> this case QA may be performed at the remote capture site, at the receiving side of the system, or at both, depending on the nature of the transaction profile.

EX1048-Randle, [0028]; *see also id.*, Abstract, [0021], FIG.1B. Randle's QA processing includes things like OCR, reading the **MICR**, and recognizing information like the "CAR LAR" (courtesy and legal amount). *Id.*, [0074]. Thus, other prior art references confirm that performing Cohen's image processing steps would have been obvious both on Garcia's **mobile device** or at the **remote institution**.

180. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing the combination of Garcia's mobile check deposit method and system using the teachings of Cohen's additional check image processing steps. For example, the similarity between Garcia and Cohen would have led a person of ordinary skill in the art to reasonably expect success. For example, Garcia is directed to depositing checks using images captured from a user's device:

> The present invention, as its title implies, relates to a method for processing and accepting documents, such as, for example, bank checks, with guarantee of

> authentication of the issuer and the document itself, using electronic media for its implementation through a mobile device capable of capturing and sending images via an Internet connection.

EX1003-Garcia, 1:6-13. Garcia further teaches processing that image, for example using OCR software:

> For its part, the institution that renders the service must have certain electronic means of recognizing, verifying and processing the information sent by the user. These means consist basically of computer equipment connected to the Internet that has an optical character recognition (OCR) system, a code authentication system and means of transmitting data to the institution's document processing system. The receiving institution makes available to the user a digital image of the document in its bank account and processes the document in question by the usual means (truncation systems).

Id., 11:7-19; *see also id.*, 2:7-14, 4:11-18, 5:1-10, 6:8-10, 12:17-22, claims 1, 4, FIG.1.

Similarly, Cohen discloses:

> The present invention relates generally to financial institution document processing. More specifically, the invention relates to a non-centralized, or decentralized, system and method that facilitates the capture, processing and archiving of checks and related financial institution document information at a remote merchant site, and enables direct transmission of the information to a U.S. Federal Reserve Bank, circumventing intermediate transmission to the Bank of First Deposit, all in compliance with the Check Clearing for the 21st Century Act.

EX1006-Cohen, [0002].

181. Cohen further teaches processing that image, for example using OCR software:

> Consequently, remote processing at the local merchant site may comprise any of the following operations: (1) OCR; (2) Scanning or Image Capture; (3) OCR and Scanning; or (4) OCR, Scanning and MICR Parsing.

> Referring now to FIGS. 1 and 2, at the conclusion of either the scanning or data importation process step 202, in step 204 another process is triggered which performs OCR as well as parsing of the MICR Line information. In a subsequent step 206, the OCR and parsing processes return value data, including: (1) check amount; (2) bank routing number; (3) bank account number; and (4) check number. Significantly, these processes also return quantitative measurements, or values, representing the confidence level of the accuracy of the OCR results pertaining to each of the respective pieces of data.

Id., [0021]-[0022]; *see also id.*, [0017], [0019]-[0020], [0043]-[0044], [0059], [0076]-[0088], [0093], FIG.2, claims 8, 14. These similar teachings would have suggested to a person of ordinary skill in the art that the teaching from Cohen's regarding check image processing steps could have easily been applied to Garcia's images as well.

182. A person of ordinary skill in the art would have also expected success in the combination based on the references' own teachings. For example, Garcia's broader disclosure of "[r]ecognizing, verifying, and electronically treating

and processing the information received by [a **financial**] **institution**" and other processing steps identified above would have encompassed Cohen's complementary teaching to pursue more detailed processes including performing OCR on the **MICR** and amount, and obtaining confidence levels for deposit information, and permitting the user to verify or confirm the results before submitting for deposit. Moreover, Garcia expressly teaches that the "**receiving institution**…processes the **document** in question by the usual means (truncation systems)." EX1003-Garcia, 11:15-19. A person of ordinary skill in the art would have therefore expected success in the combination with Cohen because Cohen is one example of a truncation system. EX1006-Cohen, [0004] (describing check truncation). Finally, implementing the Garcia/Cohen combination would have simply involved writing computer code for the user's **device** and **remote institution's** system, which would have been well within the level of ordinary skill.

183. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia with Cohen to incorporate into Garcia Cohen's teachings regarding performing OCR, reading the **MICR line**, user validation/confirmation steps, and the image processing location.

2. Independent Claims 1, 9, 18, 26

a. Claims 1[pre], 9[pre], 18[pre], 26[pre]

184. The combination of Garcia/Meier/Luo teaches "a system enabling

mobile check deposit auto-capture functionality via video frame processing."

185. Garcia discloses a method and system for mobile check deposit in which a **mobile device** captures an image of a check and transmits the image over a communications network to a remote **banking institution** for processing and deposit. EX1003-Garcia, 1:6-13, 3:13-14, 4:11-18, 9:11-18, 12:4-9, FIG.2 (reproduced below).

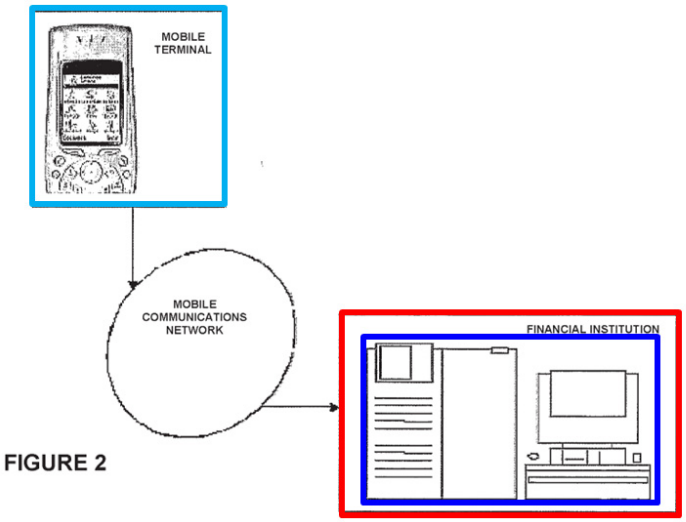
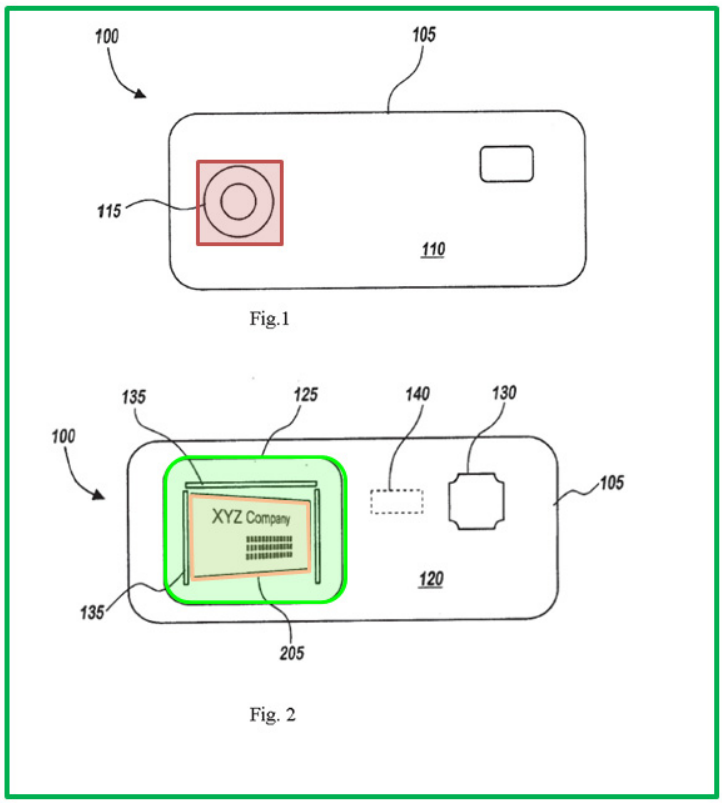


FIGURE 2

EX1003-Garcia, FIG.2.

Thus, Garcia discloses "a system enabling mobile check deposit."

186. As shown in Figures 1 and 2 below, Luo discloses a method and system for automatically capturing an image of a **document** 205 using a **handheld device** 105. EX1004-Luo, 3, 6.



Id., FIGs.1, 2.

187. Luo teaches techniques for obtaining **document** images suitable for optical character recognition. *Id.*, 1, 4, 7. Specifically, Luo teaches automatically capturing an image of the **document** when the **straight edges** of the **document** in a **preview window** are parallel to **reference lines** displayed within the **preview window**. *Id.*, 1, 4-7, FIGs.3, 5, claims 3, 10. A person of ordinary skill in the art would have understood that the **preview window** displays a live video feed composed of successive frames (i.e., "video mode"), and that the image capture

occurs while operating in that mode. See EX1004-Luo, 3 (discussing video mode with respect to FIG.2). Thus, Luo discloses "auto-capture functionality via video frame processing."

188. Meier discloses software for use on Android-based **mobile devices**. *See, e.g.*, EX1005-Meier, xviii. As one example, Meier teaches methods and systems that allow a **mobile device** to display and process video frames from a **camera** using APIs from the Android software development kit. *Id.*, xviii, 6, ("The Android SDK includes APIs for location-based hardware (such as GPS), **camera**…."), 8, 315 ("In this chapter, you'll take a closer look at some of these hardware APIs. In particular, you'll learn how to play and record multimedia content including audio, video, and still images, as well as use the **camera** to capture images and preview and capture live video."). Using Android's Camera Preview API, a user can "[a]ccess to the [device's] **camera's** streaming video [, which] means that you can incorporate live video into your applications…." EX1005-Meier, 320. The "**camera** preview can be displayed in real time onto a `Surface`…." *Id.*

```
camera.setPreviewDisplay(mySurface);
camera.startPreview();
[ … ]
camera.stopPreview();
```

EX1005-Meier, 320.

189. Consistent with what was known in the art, Meier explains that "early Android applications have used this functionality as the basis for augmenting reality." EX1005-Meier, 320. A person of ordinary skill in the art would have understood this discussion of augmented reality to disclose live processing of images/frames from the captured video, because augmenting reality requires live processing of the **camera** feed to add augmented features to the video stream on a frame-by-frame basis before presenting it to the user. Without such real-time frame-by-frame processing, augmented features would lag or appear disconnected from the user's environment, defeating the purpose of augmented reality. Thus, Meier discloses "video frame processing" by performing further processing on live images generated from the **mobile device camera**.

190. The combination of Garcia, Luo, and Meier discloses "a system enabling mobile check deposit auto-capture functionality via video frame processing." As I explained in Section XI.A.1.a, the combination of Garcia, Luo, and Meier would have been obvious.

b. Claims 1[a], 9[a] (first half), 18[a], 26[a]

191. The combination of Garcia teaches "a **mobile device** of a user, the user's **mobile device** including a **camera**, a processor, and a memory coupled to the processor."

192. Garcia discloses a user's **mobile device** (which Garcia uses interchangeably with "**mobile equipment**" and other similar terms) having a "computer application" that facilitates taking image of a check using a ***camera***. EX1003-Garcia, 9:19-10:18. More particularly, Garcia teaches "mobile telephone with **camera** and processing capacity," which a person ordinary skill in the art would have understood to be a processor. *Id.*, 11:1-6, 4:11-18. 6:12-20, 12:4-11. This is consistent with Garcia's disclosure that the user's **mobile device** "performs the [] processes of capturing, digitizing, and processing the image consists of a **mobile telephone** equipped with the ***features and functions necessary for said purpose, particularly a mobile telephone with camera and processing capacity***." EX1003-Garcia, 11:1-6. A person of ordinary skill in the art would have understood Garcia thus discloses a "a **mobile device** of a user, the user's **mobile device** including a **camera** [and] a processor."

193. Further, a person of ordinary skill in the art would have understood a device such as the **mobile device** disclosed in Garcia would have included a *memory* coupled to the processor to store software to perform the "features and functions" of Garcia's system. Such memory, which was well known in the art of **mobile devices**, would have included, for example, storage for Garcia's application and other accompanying software.

c. Claims 1[b], 18[b], 26[b]

194. The combination of Garcia/Meier teach "a software abstraction layer [for controlling the **camera**], the software abstraction layer comprising Instructions that, when executed by the processor, control the **camera**."

195. As I explained in Section XI.A.2.b, Garcia is directed to a system for depositing a check using an image captured by a **camera** of a **mobile device**. Meier discloses a downloadable application for a **mobile device** that can implement the "features and functions" described in Garcia, which would have included capturing an image of a check from a **mobile device**. EX1005-Meier, 20, 315, 320. For example, Meier teaches that the "Android Marketplace client" resident on any Android **mobile device** can be used "for downloading thied-party [*sic*] Android applications." *Id.*, 5.

196. In addition, Meier teaches that APIs of the **mobile device** can be used to "access **camera** hardware," for example to "capture images and preview and capture live video." *Id.,* 20, 315, 319. Consistent with the knowledge of a person of ordinary skill in the art and the '095 patent's disclosure,[8] a person of ordinary skill

[8] EX1001-USP095 11:26-28 ("In an alternate example, the software object may operate through a software abstraction layer, such as an application programming interface (API).").

in the art would have recognized an API to be an example of "a software abstraction layer" and that such API would run on the device processor.

197. As I explained in Section XI.A.1.a, Meier's API and associated software, such as the computer application disclosed in Garcia, can be used to "adjust **camera** settings, take pictures, and manipulate streaming **camera** previews." EX1005-Meier, 319. Therefore, the combination of Garcia/Meier refers obvious "a software abstraction layer [for controlling the **camera**], the software abstraction layer comprising Instructions that, when executed by the processor, control the **camera**."

198. Meier, in combination with Garcia, therefore renders obvious the "app associated with a bank to control check deposit by controlling the **camera** through the software abstraction layer," wherein the app, when downloaded to the user's **mobile device** and executed by the user's **mobile device**, is configured to "cause the user's **mobile device** to perform operations." The software operations disclosed by Garcia, Luo, and Cohen would be performed by software associated with Meier's APIs. *See* §§XI.A.2.e-XI.A.2.l, XI.A.1.a, XI.A.1.b.

199. As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Meier's downloaded application and Camera APIs would have been obvious. As I explained in Section XI.A.1.b, implementing

Garcia's mobile check deposit system and method with Cohen's check processing steps would have been obvious.

d. Claims 1[c], 9[a] (second half), 18[c], 26[c]

200. The combination of Garcia/Meier teach "a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the **camera** [through the software abstraction layer, the downloaded app comprising Instructions that, when executed by the processor, cause the user's **mobile device**][9] to perform operations."

201. As I explained above in Section XI.A.2.c, the combination of Garcia/Meier teaches depositing a check with a **mobile device** having a **camera** to capture images of the check. As I also explained, the **camera** is controlled by an API accessed by a downloaded app. As was well known in the art, a person of ordinary skill in the art would have understood the downloaded app to include "Instructions" to be executed on a processor, as this is how any mobile application—downloaded or native—would have been run on a **mobile device**. Therefore, the combination of Garcia/Meier teaches "a downloaded app, the downloaded app…to control check deposit by controlling the **camera** [through the software abstraction

[9] Limitation 9[a] instead recites "the system being configured." This limitation is obvious for at least the same reasons as the bracketed text.

layer, the downloaded app comprising Instructions that, when executed by the processor, cause the user's **mobile device**] to perform operations."

202. A person of ordinary skill in the art would have been motivated to implement Garcia's "computer application" with Meier's downloaded application and **camera** control API for the reasons I discussed in Section XI.A.1.a. In the Garcia/Meier combination, the app would be "associated with a bank" because Garcia discloses that the check images are sent to a computer at the **financial/remote institution** for processing and deposit. *Id.*; *see also* EX1003-Garcia, 4:1-8, 4:11-18. A person of ordinary skill in the art would have understood the **financial/remote institution** to be a bank. *Id.*, 1:15-19 ("Electronic banking processes involve the use of digital data transmission techniques via electronic means and their processing by the **financial institution**."). Moreover, because Garcia discloses replacing an in-person deposit with a remote one (EX1003-Garcia, 1:15-2:14, 7:18-8:14), a person of ordinary skill in the art would have found it obvious for the depositor's bank to provide the application to the user's **mobile device**. The '095 patent claims require that further steps be performed by the downloaded application, including those, for example, in limitations 1[d]-1[k]. In the combination of Garcia with Luo, Meier, and Cohen, these steps would have been performed by the downloaded application.

e. Claims 1[d], 9[b], 18[d], 26[d]

203. The combination of Garcia/Lu teach "providing Instructions to the user for capturing [an image of] a check."

204. Garcia teaches "[c]apturing the digital image of the obverse and the reverse side of the **document**." EX1003-Garcia, 10:10-11, 12:4-9. Garcia further explains that the disclosed system and method involves "an interactive session…with the **receiving institution** through the mobile communications operator." *Id.*, 10:1-3. In the context of such a real-time interactive session, and consistent with what was known in the art, a person of ordinary skill in the art would have understood that Garcia's system and method would have needed instructions or prompts in order to tell the user how to properly position the check to capture an image, including at least by telling the user which side of the check to capture an image of. These types of instructions were standard in mobile imaging applications at the time. *See, e.g.*, EX1016-MotoRokr, 95 ("Tip: Tap Help to see instructions on how to position and frame the business card that you want to capture."). The art abounds with other examples. EX1045-Zhu, 9 ("The technical solution of the present invention is further characterized in that said **camera** system displays instructional text on said screen to guide the **mobile phone** user to perform correct operations during the execution of each step."); EX1046-Lin, [0154]; EX1017-Acharya, 7:5–13; EX1004-Luo, 6; EX1007-Yoon, [0022], [0026], [0028]. Thus, a

person of ordinary skill in the art would have understood Garcia's description of real-time validation and feedback to imply such instructions. EX1003-Garcia, 4:11-18, 5:1-9, 12:17-22-13:5, claim 4. Moreover, such instructions would have been well within the level of ordinary creativity in the art such that persons of ordinary skill in the art would not have considered any particular instructions, much less generically providing any instructions to have been inventive. Thus, Garcia teaches or renders obvious "providing instructions to the user for capturing an image of a check."

205. Luo also teaches providing "**instructions** to the user when the **straight edge** displayed in the **preview window** is substantially parallel to the corresponding **reference line** **before capturing the image of the object**." EX1004-Luo, 6, claim 5; *see also id.*, Abstract, claims 11, 13, FIG.6. A person of ordinary skill in the art, exercising normal creativity, would have found a number of different types of instructions to be obvious, including, for example, instructions to capture an image of the entire check or to capture the front and then the back side of the check, as contemplated by Garcia.

206. Garcia and Luo therefore render obvious "providing instructions to the user for capturing [an image of] a check." As I explained in Section XI.A.1.a, a person of ordinary skill in the art would have been motivated to combine Garcia's

check image capture system and method with Luo's teachings to provide instructions to the user.

f. Claims 1[e], 9[c], 18[e], 26[e]

207. The combination of Garcia/Luo/Meier teach "generating a live video of the check in a field of view of the **camera**, the downloaded app causing the live video to be generated by controlling the **camera** [through the software abstraction layer]."

208. As I explained in Section XI.A.1.a, the **document** to be captured by Luo's method and system in the Garcia/Luo/Meier combination would have been a check. EX1003-Garcia, 1:6-13, 4:11-18.

209. As I explained in Section XI.A.2.a, Luo discloses "auto-capture functionality via video frame processing." Luo also teaches a **preview window** that "is suitable for **displaying the image** received by the **image sensor** 115" and "can function as a viewfinder of a conventional **camera** and display in real time any **moving image of the scene in front of the image sensor 115**." EX1004-Luo, 3. In light of this disclosure, a person of ordinary skill in the art would have understood Luo's "viewfinder" or "**preview window**" to disclose showing (and therefore "generating") live video from **camera** output. In addition, a person of ordinary skill in the art would have considered "the scene in front of the **image sensor**115" in

Luo's viewfinder to be the claimed "the field of view of the **camera**." EX1004-Luo, 3. As I explained in Section XI.A.1.a, the **document** being imaged in the Garcia/Luo combination would have been a check. Luo therefore teaches "generating a live video of the [**document**] in a field of view of the **camera**," which in the combination with Garcia would have been a check.

210. Meier also teaches "generating a live video of the check in a field of view of the **camera**." Meier discloses "hardware APIs" that provide "[a]ccess to the device **camera** for taking pictures and **previewing video**." EX1005-Meier, 315; *id.*, ("In this chapter, you'll take a closer look at some of these hardware APIs. In particular, you'll learn how to play and record mul[t]imedia content including audio, video, and still images, as well as use the **camera** to capture images and preview and capture **live video**."). "Access to the **camera's** streaming video means that you can incorporate live video into your applications." *Id.*, 319. For example, the "`Camera` class lets you adjust **camera** settings, take pictures, and manipulate streaming **camera** **previews**." *Id.*. A person of ordinary skill in the art would have understood "previewing video" and "**camera** previews" to be live video. *Id.*, 315 (disclosing "preview and capture **live video**"). Thus, Meier teaches "generating a live video of the check in a field of view of the **camera**."

211. In addition, as explained above in Sections XI.A.2.c-XI.A.2.d,

Meier's Camera APIs are "software abstraction layer[s]." Because Meier's Camera APIs control "access" to the **camera** hardware, for example, by providing an application with the ability to preview live video and capture images, the downloaded application in the Garcia/Luo/Meier combination is configured to "caus[e] the live video to be generated by controlling the **camera** [through the software abstraction layer]." *See* EX1005-Meier, 315, 319; *supra* §§XI.A.2.c-XI.A.2.d.

212. Therefore, Garcia/Luo/Meier render obvious "generating a live video of the check in a field of view of the **camera**, the downloaded app causing the live video to be generated by controlling the **camera** through the software abstraction layer." As I explained in Section XI.A.1.a, a person of ordinary skill in the art would have been motivated to implement Garcia's check image capture with Luo's **preview window** using Meier's downloaded application and **camera** control API.

g. Claims 1[f], 9[d]

213. The combination of Garcia/Luo/Meier teach "overlaying an alignment guide on the live video of the check in the field of view of the **camera**."

214. As I explained in Section XI.A.1.a, when combining Garcia with Luo and Meier, the **document** being imaged would have been a check, as taught by

Garcia. EX1003-Garcia, 1:6-13, 4:11-18. Moreover, as I explained in Section XI.A.2.f, Luo/Meier renders obvious previewing the check in the field of view of the **camera**.

215. In addition, Luo discloses displaying "a preview image depicting a **straight edge** (205) and at least two **reference lines** (135) simultaneously…in a **preview window** (125) of the **camera system** (100), where each **reference line** (135) corresponds to a **straight edge** (205)." EX1004-Luo, Abstract; *see also id.*, 3 ("When the mode selection switch 130 is set to the **document** capture mode the **reference line** 135 is displayed in the **preview window** 125."), FIG.5:

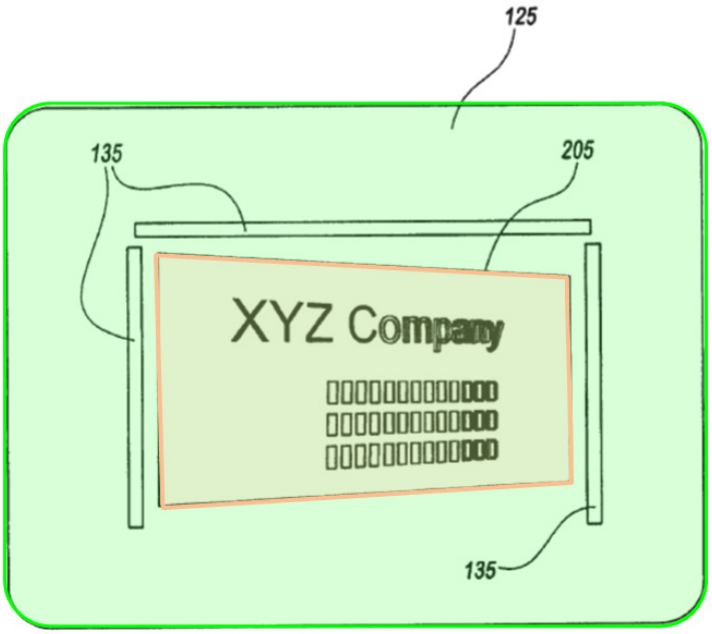


Fig. 5

A person of ordinary skill in the art would have understood Luo's on-screen

reference lines to be an **alignment guide** as recited in the '095 patent claims because these lines are intended to be used by the user for facilitating (or guiding) **alignment** of the **document** within the **camera preview window**. That is, ensuring that the edges of a **document** are parallel with one or more **reference lines** discloses guiding **alignment** of the **document** in the **camera** view. Luo therefore discloses "overlaying an **alignment guide** on the live video of the [**document**] in the field of view of the **camera**," which in the combination with Garcia would be a live video of a check.

216. Therefore, Garcia/Luo/Meier render obvious "overlaying an **alignment guide** on the live video of the check in the field of view of the **camera**." As I explained in Section XI.A.1.a, a person of ordinary skill in the art would have been motivated to capture images in Garcia's mobile check deposit system and method using Luo's **reference lines**.

h. Claims 1[g], 9[e], 18[f], 26[f]

217. The combination of Garcia/Luo/Meier teach "monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion."

218. As I explained above in Sections XI.A.1.a and XI.A.2.f, the combination of Garcia/Luo/Meier discloses displaying live video of the check in the

field of view of the **camera**.

219. After beginning to display the **reference line** 135 in the **preview window** 125, Luo teaches that "when the **straight edge** 205 [of the **document**] displayed in the **preview window** 125 is substantially parallel to the corresponding **reference line** 135, an indication is provided to the user. In step 620, only when the **straight edge** 205 shown in the **preview window** 125 is substantially parallel to the corresponding **reference line** 135 can the image of the object be captured." EX1004-Luo, 7; *see also id.*, Abstract, 5 ("The present invention ensures that the front of the object being imaged is substantially parallel to the image plane 320 of the **camera system** 100 to reduce the projective distortion of the image. For example, when the system 100 is in the **document** capture mode, the system 100 provides the user with an image of a captured object, such as a business card, only when the **straight edge** 205 of the business card is substantially parallel to the corresponding **reference line** 135 displayed in the **preview window** 125."), 6 ("Therefore, additional sensitivity is added to the embodiment of the present invention, wherein only when two parallel **straight edges** 205 of the object displayed in the **preview window** 125 have substantially the same length and are substantially parallel to the corresponding **reference line** 135 can the image be captured."), claims 1, 4, 8, 12. An unaligned **document** in a **preview window** is

shown below in Luo's Figure 2:

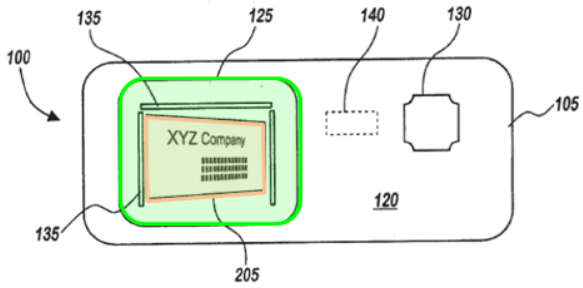


Fig. 2

Id., FIG.2. From this disclosure, a person of ordinary skill in the art would have understood that Luo discloses monitoring the video feed shown in the **preview window** to determine that the **straight edge** 205 is parallel with (i.e., **aligns** with) the displayed one or more **reference lines** 135. Because Luo disclose that image capture is possible "only when" this condition is met, Luo's system would have to monitor such **alignment** to determine when the image can be captured. In the combination with Garcia, Luo, and Meier, such monitoring would be performed on the live video provided by the Camera API.

220. Luo teaches that capturing the image of the **document** "only when" the **straight edge** 205 **aligns** with the displayed one or more **reference lines** 135 helps to reduce the effects of "projective distortion" and blur in the image, which makes the text on the image easier to read using techniques such as OCR. *Id*., 5, 7. It accomplishes this by visually encouraging the user to move the check and/or the

camera phone in such a way to properly line up the check with the **alignment** mark(s). *Id*., 5-7.

221. Therefore, the combination of Garcia/Luo/Meier teaches "monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

i. Claims 1[h], 9[f], 18[g], 26[g]

222. The combination of Garcia/Luo/Meier teach "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame."

223. As I explained above in Sections XI.A.1.a, XI.A.2.f, and XI.A.2.h, the combination of Garcia/Luo/Meier monitoring a video frame of the live video of the check for a monitoring criterion.

224. Based on the monitoring of the video feed from the **camera**, Luo further teaches that the **mobile device** "**automatically capture[s]** the selected image" in which "the **straight edge** 205 displayed on the **preview window** 125 is substantially parallel to the corresponding **reference line** 135…." EX1004-Luo, 6.; *see also id*., Abstract, 7, claims 3, 10. In the combination with Meier, the "selected

image" would have been a frame from the live video feed of the **camera**, for example obtained by using Meier's Camera API. Therefore, the combination of Luo/Meier teaches "automatically capturing the video frame."

225. Moreover, as I explained in Section XI.A.2.h, capture is permitted "only when" Luo's system has determined that "the **straight edge** 205 displayed on the **preview window** 125 is substantially parallel to the corresponding **reference line** 135," which a person of ordinary skill in the art would have considered a monitoring criterion. *See, e.g.*, EX1004-Luo, 6. A person having ordinary skill in the art would have understood Luo's disclosure to capture an image "only when" such a condition satisfied to disclose capturing the image when a monitoring criterion is satisfied. Therefore, Luo teaches "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion."

226. Therefore, the combination of Garcia/Luo/Meier teaches "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

j. Claims 1[i], 9[g], 18[h], 26[h]

227. The combination of Garcia/Luo/Meier/Cohen teach "when the video frame of the live video of the check in the field of view of the **camera** is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured."

228. As I explained in Section XI.A.2.i, the combination of Garcia/Luo/Meier teaches when the video frame of the live video of the check in the field of view of the **camera** is determined to satisfy the at least one monitoring criterion.

229. Multiple references—including Garcia, Luo, and Cohen—teach that the application running on the user's **mobile device** providing feedback advising the user that the check has been captured.

230. **Regarding Luo**: As I explained in Section XI.A.2.e, Luo teaches providing instructions to the user as well as "indicat[ing] to the user that an appropriate number of **reference lines** 135 are substantially parallel to the respective **straight edges** 205 of the object depicted in the **preview window** 125," for example using "sounds," "illuminat[ion]," or displaying an "image indicator." EX1004-Luo, 6, 7, claim 13. A person of ordinary skill in the art would have understood each of these disclosures to teach indications to the user that the image has been captured, as each is triggered when the monitoring criterion is satisfied, and thus the image is

captured. Finally, Luo teaches that "when the system 100 is in the **document** capture mode, the system 100 provides the user with an image of a captured object, such as a business card, only when the **straight edge** 205 of the business card is substantially parallel to the corresponding **reference line** 135 displayed in the **preview window** 125." *Id.*, 5. Providing a user with a captured image is further feedback that the image has been captured.

231. **Regarding Garcia**: in addition or as an alternative to Luo's teachings, and similar to Luo, Garcia teaches "[t]he immediate displaying of the digital image by the user" and "[t]he **receiving institution** makes available to the user a digital image of the **document**…." EX1003-Garcia, 6:6-7, 11:15-19; *see also id.*, 8:8-11 (The user of this service avoids unnecessary trips to the bank branch to present **documents** for collection, and the immediate display of the image in his account.), claim 1. Providing a user with a captured image is further feedback that the image has been captured. These disclosures represent two distinct forms of confirmation: first, immediate confirmation to the user that the image has been captured on the device—e.g., the live video preview stops moving, indicating capture; and second, confirmation from the bank that it has received the image, indirectly implying that the image was captured by the user's device.

232. **Regarding Cohen**: in addition or as an alternative to Luo's and

Garcia's teachings, and similar to Luo and Garcia, Cohen teaches that "images and **MICR** information are captured and displayed on the computer screen for verification and possible removal and rescanning." EX1006-Cohen, [0072]; *see also id.*, [0078] ("Based upon the confidence levels for each item, and values defined within the profile, a Correct and Verify program module displays various items on screen and allows the user to view and override values provided by the Recognition program module."), [0091]-[0092] ("The DirectFed™ client application incorporates a sophisticated coupon definition module which allows the administrator/user to scan in a sample coupon, using the same scanner used for item processing, so that it may be displayed on the definition module screen."). Providing a user with a captured image and information read therefrom is further feedback that the image has been captured.

233. Therefore, each of Luo, Garcia, and Cohen teach "when the video frame of the live video of the check in the field of view of the **camera** is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured."

234. Therefore, the combination of Garcia/Luo/Meier/Cohen teaches "when the video frame of the live video of the check in the field of view of the **camera** is determined to satisfy the at least one monitoring criterion, providing

feedback advising the user that the check has been captured." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious. As I explained in Section XI.A.1.b, implementing Garcia's mobile check deposit system and method with Cohen's check image verification steps would have been obvious.

k. Claims 1[j], 9[h] 18[i], 26[i]

235. The combination of Garcia/Luo/Meier teach "using a wireless network, transmitting a digital image of the check from the user's **mobile device** and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, [wherein the digital image is the captured video frame or is based on the captured video frame]."[10]

236. As I explained in Section XI.A.2.i, the combination of Garcia/Luo/Meier teaches automatically capturing a video frame corresponding to

[10] Instead of the bracketed text, limitation 9[h] instead reads as follows: "the digital image of the check being the captured video frame or being based on the captured video frame." It is my opinion that this limitation would have been obvious for the same reasons "wherein the digital image is the captured video frame or is based on the captured video frame" would have been obvious.

the image of the check. Garcia also repeatedly teaches that the image of the check used for deposit is a "digital image." EX1003-Garcia, 4:1-8, 4:11-18, 5:21-6:7, 6:12-20, 10:10-18, 11:15-19, claim 1.

237. Garcia further teaches "[t]ransmitting the digital image and the recognition data, once encrypted, to the institution that must accept the **document**" using a "**mobile telephone** communications network, for example a GSM/GPRS network…." EX1003-Garcia, 6:3-5, 1:6-13, 4:11-18, 5:1-10, 10:16-18, 11:7:15, claims 1-2. **Mobile telephone** communications networks, such as GSM/GPRS, are well known wireless networks. This is consistent with the '095 patent's disclosure, which lists GSM and GPRS (which I assume to be a typo indicating GPRS) as example "communications network." EX1001-USP095, 13:42-46. The word "mobile" itself indicates a wireless network, because persons of skill in the art would not have understood devices connected to wires to be "mobile." The combination of Garcia/Luo/Meier therefore teaches "using a wireless network, transmitting a digital image of the check from the user's **mobile device**." Moreover, the transmitted image is the image of the check, and is thus "the captured video frame or is based on the captured video frame."

238. In addition, Garcia teaches that the transmitted image from the ***mobile*** **device** is submitted for "**deposit** into the existing account at a **banking**

institution…." EX1003-Garcia, 4:14-15, 7:20-21, 16:19-20. Because such image is transmitted after capture, a person would have understood that the image is submitted after capture as well. Therefore, Garcia teaches "submitting the check for mobile check deposit in the bank after [(i)] automatically capturing [the check image]," and (ii) associating it with the depositor's account. This is distinct from merely transmitting an image; "submitting" implies an intent to deposit, and that the bank can identify the sender and the purpose of the transmission—e.g., via login credentials or account metadata. In the combination with Meier/Luo, this could occur after automatically capturing the video frame, or semi-automatically with user confirmation.

239. Therefore, the combination of Garcia/Luo/Meier teaches "using a wireless network, transmitting a digital image of the check from the user's **mobile device** and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

l. Claims 1[k], 9[j], 18[j], 26[j]

240. The combination of Garcia/Cohen teach "confirming that the mobile check deposit can go forward after optical character recognition is performed on the check [in the digital image], a **magnetic ink character recognition (MICR) line** on the check [in the digital image] is recognized, and an amount payable on the check [in the digital image] is validated."

241. In order to process the check image for deposit, Garcia teaches that "the institution that renders the service must have certain electronic means of recognizing, verifying and processing the information sent by the user," which includes an "**computer equipment** connected to the Internet that has an **optical character recognition (OCR) system**…." EX1003-Garcia, 11:7-15; *see also id.*, 2:7-14, 4:11-18, 5:1-10, 12:17-22, claim 4. Garcia also discloses **"[c]apturing the data associated with the document, such as the amount** and the check number." *Id.*, 10:12-14. From this disclosure, a person of ordinary skill in the art would have understood that Garcia teaches or renders obvious applying the **receiving institution's** OCR system to capture (i.e., recognize or detect) information on the check image. As was well known in the art, the **MICR line** and an amount payable are essential items for completing check deposit. *See, supra*, §VI.A. Thus, the natural and obvious implication of Garcia's disclosure to use OCR on the received check image is to OCR would be to perform OCR to read or detect the **MICR line**

and an amount payable. This is consistent with Garcia's disclosure that "[t]he **receiving institution**" has a "**document** processing system" and "makes available to the user a digital image of the **document** in its bank account and processes the **document** in question by the usual means (truncation systems)." EX1003-Garcia, 11:7-15. As I explained in Section VI.B, truncation systems replace a physical check with its digital image. Therefore, Garcia teaches "optical character recognition is performed on the check in the digital image" and teaches or renders obvious "a **magnetic ink character recognition (MICR) line** on the check in the digital image is recognized."

242. In addition to performing OCR, Garcia also teaches that the **receiving institution** performs other functions, such as "verifying" and "validating" the information on the check image. EX1003-Garcia, 1:6-13, 2:7-14, 4:11-18, 5:1-10, 6:8-10, 11:7-15, 12:17-22, claims 1, 4. Additionally, Garcia contemplates "Entering…data associated with the **document** itself, such as the amount and/or the **document** number." *Id*., 5:14-20, 9:19-10:13, 12:9-13, claim 1.

243. From these disclosures, a person of ordinary skill in the art would have understood Garcia to teach or render obvious verifying and validating the amount payable on the check. For example, as was known in the art, a person of ordinary skill in the art would have understood the combination of OCRing data

from the check and entering an amount to teach, suggest, or render obvious comparing different combinations of such data—which should be consistent if read and entered properly. For example, a person of ordinary skill in the art would have found it obvious to compare the legal amount to the courtesy amount read via OCR from the check. As another example, a person of ordinary skill in the art would have found it obvious to compare the amount entered by the user to the legal or courtesy amount read via OCR from the check image. Each of these comparisons would add confidence that the correct deposit amount had been read and/or entered.

244. These types of comparisons were well known at the time in the field of check processing, especially using images of checks. For example, Gustin discloses that "for checks, it is desired to be able to read the CAR amount and the LAR amount and to compare the same to detect whether or not the CAR line has been changed, for example, a '1' has been changed to a '4' or a '7' by merely adding pen strokes to the '1'." EX1049-Gustin, [0005], [0017], [0211]-[0213], claims 14, 36. Gustin also teaches "When paying a bill or making a deposit, the amount field of the **document** is analyzed on the bill or the deposit slip and compared to the amount manually entered by the machine user. This provides one validation procedure." *Id.*, [0028]. A person of ordinary skill in the art would have found these well-known techniques to be obvious, especially in light of Garcia's teaching to

"validat[e]" information received by the **remote institution**. Therefore, Garcia teaches or renders obvious "an amount payable on the check in the digital image is validated."

245. Similar to Garcia, Cohen teaches a system and method for remote check deposit that involves performing certain processing steps on the user's device, including "OCR and parsing processes return value data, including: (1) check amount; (2) bank routing number; (3) bank account number; and (4) check number" and "parsing of the **MICR Line** information." EX1006-Cohen, [0022], [0043]; *see also id*. [0017], [0019]-[0021], [0059], [0076], FIG.2, claims 8, 14. As I explained in Section VI.A, the "(2) bank routing number; (3) bank account number; and (4) check number" disclosed by Cohen are the **MICR line**. Therefore, Cohen also teaches "optical character recognition is performed on the check in the digital image" and "a **magnetic ink character recognition (MICR) line** on the check in the digital image is recognized."

246. In addition, Cohen discloses that the user device's "processes also return quantitative measurements, or values, representing the confidence level of the accuracy of the OCR results pertaining to each of the respective pieces of data," which as discussed above would have included the "**MICR Line** information" and the "check amount…." EX1006-Cohen, [0022]. In light of this disclosure, and

consistent with well-known principles regarding processing of digital check images, a person of ordinary skill in the art would have understood that Cohen's disclosure of calculating a confidence level for a check amount involves validating the amount payable.[11] *Id.*, [0022], FIG.2.

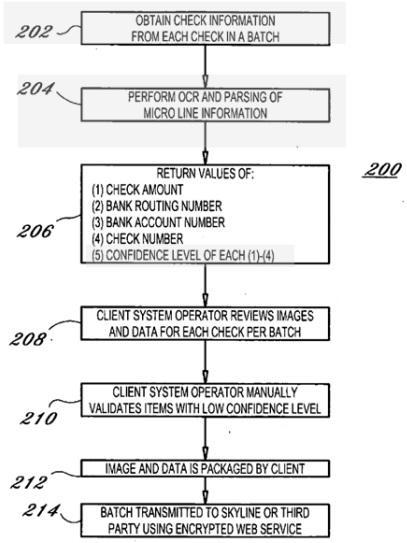


FIG. 2

[11] Cohen's disclosure is consistent with the '095 patent disclosure regarding validating an amount. For example, the '095 patent discloses "determine[ing] whether the…amount payable, or the like may be readable such that they may be parsed and processed." EX1001-USP095, 5:10-12. This is similar to Cohen's "confidence level of the accuracy of the OCR results…." EX1006-Cohen, [0022].

EX1006-Cohen, FIG.2. Therefore, Cohen also teaches "an amount payable on the check in the digital image is validated."

247. Cohen's disclosure provides three steps that a person of ordinary skill in the art would have understood to disclose "confirming that the [] check deposit can go forward." Each of Cohen's three examples occurs after information has been read and validated from the check, but before the user's device submits the checks for deposit.

248. As a first example, Cohen discloses that determining that "there is a high degree of confidence" that information read from an image is accurate. EX1006-Cohen, [0044]; *see also id.*, [0022], [0043], [0077]-[0088], [0093], FIG.2. When there is low confidence, the user manually confirms the data; whereas when there is high confidence, such high confidence itself confirms that deposit can go forward successfully. EX1006-Cohen, [0032]-[0035], [0043]-[0044], [0077]-[0078].

249. Cohen's second example is consistent with the '095 patent, which discloses "receiving confirmation that the user 102 wishes to proceed…." EX1001-USP095, 12:61-67, claims 1, 2, 5, 6, 8-11, 14, 15. Specifically, Cohen teaches that "a remote operator at the local merchant site 100 reviews the images and data for each check in the batch," which can include both high and low confidence

images/data. EX1006-Cohen, [0022], [0043]-[0044], [0077]-[0088], [0093], FIG.2. The user then reviews that data to "inspect[] for errors" and "manually correct items based on their respective confidence level…." *Id.*, [0022], [0042], [0044]. "After reviewing, and correcting as necessary, each item, the operator marks the batch as being verified." *Id.* A person of ordinary skill in the art would have also understood Cohen's disclosure to approve the check images and information read therefrom to be confirming that check deposit can go forward, since failing this step means that new information or images are needed.

250. As I explained in Section XI.A.1.b, a person of ordinary skill in the art would have found it obvious to perform processing, which would have included Garcia's and/or Cohen's OCR processing, **MICR** recognition, and amount validation, either on the user's **mobile device** or on a remote server.

251. Therefore, the combination of Garcia/Cohen teaches "confirming that the mobile check deposit can go forward after optical character recognition is performed on the check in the digital image, a **magnetic ink character recognition (MICR) line** on the check in the digital image is recognized, and an amount payable on the check in the digital image is validated." As I explained in Section XI.A.1.b, implementing Garcia's mobile check deposit system and method with Cohen's check processing steps would have been obvious.

m. Claim 1[l]

252. Garcia teaches "a server, remote from the user's **mobile device**, comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the server to perform operations including."

253. As I explained in Section XI.A.2.k, Garcia teaches transmitting the digital check image to a **remote financial institution**. EX1003-Garcia, Abstract, 4:11-18, 5:1-9, 6:3-5, 12-20, 10:16-18, 11:10-15, 20-12:3, 12:9-13, claims 1, 2. Garcia further explains that by using the **mobile device** to capture the image of a check, instead of "the truncation process is performed by remote devices external to the **financial institution**." *Id.*, 8:6-8. Therefore, the purpose of Garcia's invention is to allow the **institution** and **mobile device** to be "remote" from one another. *Id.* Therefore, Garcia teaches "a server, remote from the user's **mobile device**."

254. Garcia further teaches that "[t]he institution that receives the message"—which includes the check image—"proceeds to validate and encrypt it, ultimately obtaining a **digital photograph of the check** and a data set that allows it to automatically process the deposit of the check…." *Id.*, 12:17-22, 11:7-10, 5:1-9 ("receiving said **document**"). In Garcia's systema and method, the **receiving institution** (i.e., a bank) has "**computer equipment**…that provides the service to the user" and "system and means of transmitting data to the **institution's document**

processing system." *Id.*, 9:16-19, 11:14-15. As was common at the time, an enterprise like a bank would have known to implement such **computer equipment** as a server. Servers were well known at the time, and were capable of performing many complex tasks like processing large volumes of remote deposits, as would have been required in the system of Garcia. Such servers were well-known to include memories that stored computer instructions that run on one or more processors. Therefore, a person of ordinary skill in the art would have understood Garcia's teaching of a "**computer equipment**" to include or render obvious "a server…comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the server to perform operations." As I explain more below, these operations performed by the **receiving institution** would have included the steps described in Sections XI.A.2.n, XI.A.2.o.

255. Therefore, Garcia teaches "a server, remote from the user's **mobile device**, comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the server to perform operations including."

n. Claim 1[m]

256. Garcia teaches "receiving the digital image of the check transmitted by the user's **mobile device**."

257. As I explained above in Section XI.A.2.m, Garcia's **institution**

includes a **computer equipment** that "ultimately obtain[s] a ***digital photograph of the check*** and a data set that allows it to automatically process the deposit of the check…." *Id.*, 11:7-10, 5:1-9, 12:17-22. From this disclosure, a person of ordinary skill in the art would have understood that the **institution** "obtain[s]" the check image transmitted from the **mobile device** by receiving it. Therefore, Garcia teaches "receiving the digital image of the check transmitted by the user's **mobile device**."

o. Claim 1[n]

258. The combination of Garcia/Cohen teach "processing the digital image of the check including performing optical character recognition on the check in the digital image and verifying that the digital image of the check is acceptable for mobile check deposit, the user's **mobile device** receiving an Indication of a result of the server's processing before confirming that the mobile check deposit can go forward."

259. As I explained in Section XI.A.2.l, the combination of Garcia/Cohen teaches techniques for processing images of a check that include OCRing information in the image. The combination of Garcia therefore teaches "processing the digital image of the check including performing optical character recognition on the check in the digital image."

260. In addition, the combination of Garcia/Cohen teach "verifying that

the digital image of the check is acceptable for mobile check deposit." As one example, Garcia expressly discloses the separate steps of "verifying" and "validat[ing]" the information received from the **mobile device** before deposit is completed. EX1003-Garcia, 1:6-13, 2:7-14, 5:1-10, 6:8-10, 11:7-15, 12:17-22, claims 1, 4. From this disclosure, and because the verification is performed by a **receiving institution** that facilitates the deposit process, a person of ordinary skill in the art would have understood Garcia's disclosure of "verifying" to teach or render obvious "verifying that the digital image of the check is acceptable for mobile check deposit."

261. As I explained in Section XI.A.1.b, Cohen also teaches this limitation. Cohen discloses systems and "methods of scanning, recognition, and verification of batches." EX1006-Cohen, [0032]. As an example, Cohen teaches a "verification process" in which:

> [T]he operator is shown the image of a check and the four values read from the check. Next to each value is a visual, colored indication (green, yellow, or red) representing confidence levels. Green indicates that there is a high degree of confidence in the data, yellow indicates moderate confidence in the resulting data value, and red

> indicates low confidence in the data value. The operator is forced to review and manually correct items based on their respective confidence level coupled with the aforementioned examination rigor profile setting. After reviewing, and correcting as necessary, each item, the operator marks the batch as being verified.

EX1006-Cohen, [0044]; *see also id.*, [0022], [0032]-[0035], [0043], [0077]-[0088], [0093]. Thus, Cohen's confidence levels and user verification, which are performed on the check image itself, are used to determine whether the information needs correction before submitting for deposit. Cohen therefore teaches "verifying that the digital image of the check is acceptable for mobile check deposit."

262. As I explained in Sections XI.A.2.b and XI.A.2.l, a person of ordinary skill in the art, when faced with the decision of where to perform the above-mentioned check processing steps, would have found it obvious to perform such steps on either Garcia's **mobile device** or at the **remote institution**. As I also outlined in Section XI.A.2.j, two of Cohen's three disclosures that satisfy the claimed confirming step must be performed after information is read from the check image. For example, Cohen's teachings to allow a user to verify images and choose when to submit a batch of checks each requires that the user is first presented with

confidence levels for the check image and all of the data read therefrom. Therefore, the user's device would need to receive an indication of a result of the processing including the display of confidence levels—either from its own internal processing or (as would apply to limitation 1[n] which requires the processing step to be performed by a "server, remote from the user's **mobile device**") from the remote server—before the user can confirm that the information is acceptable. Thus, Cohen teaches "the user's **mobile device** receiving an Indication of a result of the server's processing before confirming that the mobile check deposit can go forward."

263. Therefore, the combination of Garcia/Meier/Cohen teaches "processing the digital image of the check including performing optical character recognition on the check in the digital image and verifying that the digital image of the check is acceptable for mobile check deposit, the user's **mobile device** receiving an Indication of a result of the server's processing before confirming that the mobile check deposit can go forward." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Meier's software architecture would have been obvious. As I explained in Section XI.A.1.b, implementing Garcia's mobile check deposit system and method with Cohen's check processing steps would have been obvious.

p. Claims 1[o], 9[k], 18[k], 26[l]

264. The combination of Garcia/Cohen teach "a [computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer][12] to update a balance of an account at a **financial institution** of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's **mobile device**, after the [submitting the check] for mobile check deposit [in the bank], [the] confirming that the mobile check deposit can go forward, and [the] [verifying that the digital image of the check is acceptable for mobile check deposit]."[13]

265. As I explained in Sections XI.A.2.k, XI.A.2.l, and XI.A.2.o, the combination of Garcia/Cohen teaches (1) confirming that the mobile check deposit can go forward, (2) verifying that the digital image of the check is acceptable for mobile check deposit, and (3) submitting the check for mobile check deposit in the

[12] Instead of the bracketed text, limitations 9[k] and 26[l] instead recite "a [bank] computer programmed." It is my opinion that this limitation would have been obvious for the same reasons that "computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer" would have been obvious.

[13] Limitation 18[k] does not recite a verifying step.

bank.

266. Garcia further teaches that once the **financial institution** receives the image of the check, it "automatically process[es] the deposit of the check in question into the service user's account." EX1003-Garcia, 4:11-18, 7:18-8:3, 12:17-22, claim 4. A person of ordinary skill in the art would have understood processing the deposit of a check into an account to include updating the users account balance to indicate that additional funds have been added. Indeed, even prior to remote check deposit, it was common for ATM machines or bank computers to provide an updated balance after deposit. This is consistent with Garcia's disclosure that "[t]he immediate processing of the information transmitted by this system and the electronic treatment thereof allows the immediate availability in the user's account…." *Id.*, 7:22-8:3. Because Garcia's disclosure of making the funds available is contingent on receiving the submitted check image, it occurs after the submitting, confirming, and verifying steps. *See, supra*, §§XI.A.2.k, XI.A.2.l, XI.A.2.o.

267. In case of Garcia, check images are sent to a computer at the **financial/remote institution** for processing and deposit. EX1003-Garcia, 1: :6-13, 3:13-14, 4:1-8, 4:11-18, 9:11-18, 12:4-9, FIG.2. A person of ordinary skill in the art would have understood the **financial/remote institution** to be a bank. *Id.*, 1:15-19

("Electronic banking processes involve the use of digital data transmission techniques via electronic means and their processing by the **financial institution**."). A person of ordinary skill in the art would have therefore considered Garcia's computer at the **remote institution** to be a "bank computer" as recited in limitations 9[k] and 26[l].

268. As was common at the time, an enterprise like a bank would have known to implement such **computer equipment** as a server. Servers were well known at the time, and were capable of performing many complex tasks like processing large volumes of remote deposits and updating balances for many users, as would have been required in the system of Garcia. Such servers were well-known to include memories that stored computer instructions that run on one or more processors. Therefore, a person of ordinary skill in the art would have understood Garcia's teaching of a "a [computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer]" to perform the operations described above.

269. Therefore, the combination of Garcia/Cohen teaches "a [computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer] to update a balance of an account at a **financial institution** of the user to reflect an amount of funds associated with the

check submitted for mobile check deposit by the user's **mobile device**, after the [submitting the check] for mobile check deposit [in the bank], [the] confirming that the mobile check deposit can go forward, and [the] [verifying that the digital image of the check is acceptable for mobile check deposit]." As I explained in Section XI.A.1.b, implementing Garcia's mobile check deposit system and method with Cohen's check processing steps would have been obvious.

q. Claim 9[i]

270. The combination of Garcia/Cohen teach "processing the digital image of the check Including performing optical character recognition and verifying that the digital image of the check Is acceptable for mobile check deposit." It is my opinion that this limitation would have been obvious for the same reasons that I explained in Section XI.A.2.o.

r. Claim 26[k]

271. The combination of Garcia/Cohen teach "the system configured to perform image processing operations on an image of the check, the image processing operations including performing optical character recognition and verifying that the image of the check is acceptable for mobile check deposit, wherein the image of the check is the digital image transmitted by the user's **mobile device** or is based on the digital image transmitted by the user's **mobile device**." It is my opinion that this limitation would have been obvious for the same reasons that I explained in Section

XI.A.2.n.

3. Dependent Claims 2-4, 6-8, 10-12, 14-17, 19-21, 23-25, 27-30

a. Claims 2[a], 10[a], 19[a], 27[a]

272. The combination of Garcia/Meier/Luo teach "wherein the downloaded app causes the user's **mobile device** to perform additional operations." As I explained in in Sections XI.A.2.c and XI.A.2.d the combination of Garcia/Meier teaches "a downloaded app,…, [the downloaded app comprising Instructions that, when executed by the processor, cause the user's **mobile device**] to perform operations," which in the combination with Luo would have included Luo's autocapture features. *See, supra*, §XI.A.1.a. In my opinion, the limitations that I discuss in Sections XI.A.3.b and XI.A.3.c would have been obvious for the same reasons that I discussed above with regard to Section XI.A.1.a and XI.A.2.e-XI.A.2.l.

b. Claims 2[b], 10[b], 19[b], 27[b]

273. The combination of Garcia/Luo/Meier teach "before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion."

274. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination

of Garcia/Luo/Meier teaches that a **mobile device** generates and monitors live video frames (for example, those discussed in Luo and Meier) to ascertain when a **document** (for example, Garcia's check) displayed in the **mobile device's** video feed in a viewfinder is positioned such that its edges are parallel to a **reference line** (for example, as disclosed by Luo), at which point Luo teaches that image can be captured. From this disclosure a person of ordinary skill in the art would have understood that Luo's **mobile device** had previously determined that the **document's** edge(s) are not parallel to a **reference line**, and thus that determined that a particular frame in the live video did not satisfy the monitoring criterion. That is, until the **mobile device** determines that the two or more lines are in fact parallel, it also determines that the lines are not parallel.

275. Therefore, the combination of Garcia/Luo/Meier teaches "before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

c. Claims 2[c], 10[c], 19[c], 27[c]

276. The combination of Garcia/Luo teach "after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user."

277. As I explained in Section XI.A.2.j, the combination of Garcia/Luo/Meier/Cohen teaches or render obvious "when the video frame of the live video of the check in the field of view of the **camera** is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured." Moreover, I also explained in Section XI.A.3.b how the combination of Garcia/Luo/Meier teaches "determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion." As I explain below, in the event that the monitoring criterion is determined not to be satisfied, Luo teaches providing a different kind of feedback.

278. For example, Luo teaches providing instructions to the user as well as "indicat[ing] to the user that an appropriate number of **reference lines** 135 are substantially parallel to the respective **straight edges** 205 of the object depicted in the **preview window**125," for example using "sounds," "illuminat[ion]," or displaying an "image indicator." EX1004-Luo, 6-7, claim 13. In the case of an "image indicator," Luo teaches that the "**reference line** 135 may change color or flicker individually." *Id.*, 6. From this disclosure, a person of ordinary skill in the

art would have understood that the **reference line(s)** 135 have an **initial** color that then changes after the **document** edge is found to be parallel therewith. Therefore, the **reference line** in its initial color provides feedback indicating that there is insufficient **alignment** with the **reference line(s)** 135 to capture the image.

279. Luo's disclosure of multiple **reference line(s)** further confirms that the initial color of the **reference lines** provides feedback to the user. For example, Luo teaches that "different numbers of **reference lines** 135 may be used according to different embodiments of the present invention, such as two, three, four or more baselines 135." *Id.*, 5-7, Abstract, claims 1, 2, 8, 9, FIG.2. In an implementation with two or more **reference lines**, one **reference line** may be determined to be parallel to one edge of the **document**, while another is not—because, for example, the user is holding the **mobile phone camera** so that the **document** is parallel to one of the **reference lines** but not the other. In that case, one **reference line** would change color to indicate **alignment** whereas the other would remain in its initial color. Thus, the **reference line** remaining in its initial color, in contrast to another **line** that changed color, would indicate to a user that the unchanged **reference line** is not parallel to a **document** edge. The same would be true when other techniques to indicate **alignment** are used, such as flickering.

280. As another example in addition to Luo's disclosure regarding

reference lines, and as I explained in Section XI.A.2.e, Luo also expressly teaches providing "**instructions** to the user when the **straight edge** displayed in the **preview window** is substantially parallel to the corresponding **reference line** **before capturing the image of the object**." EX1004-Luo, 6, claim 5; *see also id.*, Abstract, claims 11, 13, FIG.6. A person of ordinary skill in the art, exercising normal creativity, would have found a number of different types of instructions to be obvious, including, for example, instructions indicating how to reposition the check such that the **document** edge is parallel to **reference lines**. These instructions need not be written or spoken; real-time visual feedback—such as watching the check through the viewfinder and adjusting its position accordingly—serves as a simple, effective form of instruction.

281. These types of instructions were standard in mobile imaging applications at the time. *See, e.g.*, EX1016-MotoRokr, 95 ("Tip: Tap Help to see instructions on how to position and frame the business card that you want to capture."). The art abounds with other examples. EX1045-Zhu, 9 ("The technical solution of the present invention is further characterized in that said **camera** system displays on said screen instructional text guiding the **mobile phone** user to perform correct operations during the execution of each step."); EX1046-Lin, [0154]; EX1017-Acharya, 7:5–13; EX1004-Luo, 6; EX1007-Yoon, [0022], [0026], [0028].

Providing instructions in the event of failure to properly **align** the **document** with the **reference lines** would have produced a better check image more quickly by informing the user which steps are required to allow for image capture. Because Luo already discloses determining that one or more monitoring criteria is not satisfied, implementing these instructions would have merely involved writing additional code to cause the **mobile device** to display text indicating how to better position the check in the viewfinder.

282. The combination of Garcia/Luo therefore teaches "after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user." As I explained in Section XI.A.1.a and XI.A.3.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process would have been obvious.

d. Claims 3, 12, 20, 28

283. Luo teaches "wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and **magnetic ink character recognition (MICR) line detection**."

284. As I explained in Section XI.A.2.h, Luo describes a number of

different monitoring criteria. As one example, Luo teaches "edge detection" in which "well known in the art[] image edge detection techniques can be used to reliably calculate the angle between a specific **reference line** 135 and the corresponding **straight edge** 205 in the **document** preview image." EX1004-Luo, 5, 7, FIG.5.

285. As another example, Luo specifically discusses techniques for reducing "projective distortion." EX1004-Luo, 1, 5-7. This occurs, for example, when "the surface of the [**document**] is tilted in relative to the image plane," for example as shown in Figures 4 and 5. *Id.*, 5 ("For the purpose of illustration, the image plane 320 of the business card shown is tilted in relative to system 100 so that the top **straight edge** 205 of the card cannot be substantially parallel to the corresponding top **reference line** 135."). In this context, a person of ordinary skill in the art would have understood Luo's disclosure of tilt to disclose "skew." As another example, Luo discloses:

> Based on the "vanishing point" effect, when one of the edges 205 is further away from the image sensor 115, the two relatively parallel straight edges 205 of the rectangular document have different lengths based on the display of the two-dimensional image. Therefore, in FIG.5, the

> vertical straight edge 205 on the right side of the business card, which is farther from the camera system 100, is shorter than the vertical straight edge 205 on the left side of the business card.

Id., 6.

286. This is another example of both skew and tilt. Luo teaches that "additional sensitivity is added to the embodiment of the present invention, wherein only when two parallel **straight edges** 205 of the object displayed in the **preview window** 125 have substantially the same length and are substantially parallel to the corresponding **reference line** 135 can the image be captured." *Id.*, 6. Thus, Luo's criteria, such as **alignment** with two parallel **reference lines** teaches monitoring for edge detection, angular alignment, and check positioning.

287. As another example, as shown for example in Figure 2 below, Luo further teaches monitoring for multiple perpendicular **reference lines**. These perpendicular **reference lines** intersect at the corner of a **document**. Thus, when both perpendicular edges of the **document align** with the perpendicular **reference lines**, the system would detect a corner of the **document** at that intersection point. This is consistent with well-known corner detection techniques, which frequently involve looking for intersecting edges of a **document**. Thus, a person of ordinary

skill in the art would have understood that identifying two perpendicular edges on a **document** discloses corner detection.

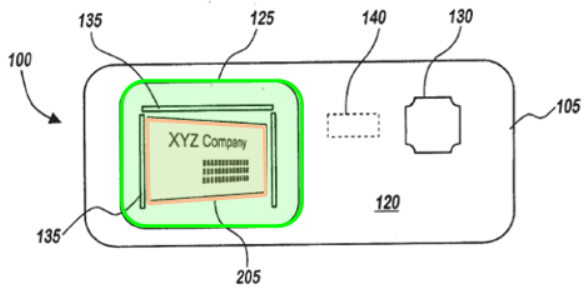


Fig. 2

EX1004-Luo, FIG.2.

288. As another example, by placing **reference lines** at a particular location on the viewfinder, a person of ordinary skill in the art would have understood Luo to teach determining check positioning on the screen and check dimensions.

289. As a final example, Luo's disclosure of detecting "**straight**" **edges** with known edge detection techniques also teaches monitoring for warped **documents** that would not have **straight edges**. This also implicitly encourages the user to hold the **camera** close enough to the check to capture a sufficiently large image, thereby facilitating later image processing steps and reducing the risk that the check, while aligned, appears too small in the frame.

290. Because Luo teaches applying each of these techniques at once, for

example by detecting straight edges of documents that are parallel to three reference lines, two of which are parallel, and one of which is perpendicular to and intersects the others, Luo teaches using two or more monitoring criteria at the same time.

291. Therefore, Luo teaches "wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and magnetic ink character recognition (MICR) line detection." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

e. Claims 4, 29

292. The combination of Garcia/Luo/Cohen render obvious "wherein the plurality of monitoring criteria Includes a criterion based on magnetic ink character recognition (MICR) line detection."

293. As I explained in Sections XI.A.1.a, XI.A.2.h, XI.A.2.i, and XI.A.3.d, the Garcia/Luo combination teaches applying multiple monitoring criteria at the same time, and automatically capturing a check image when the criteria are

satisfied. According to Luo, and consistent with the knowledge of a person of ordinary skill in the art, this would have helped to make the captured image more readable, for example by reducing the effects of projective distortion and blur. Thus, the combination of Garcia/Luo teaches "wherein the plurality of monitoring criteria being based on…one or both of corner detection and edge detection" in claim 21.

294. Cohen teaches or renders the additional limitations in claims 3, 6, and 12, including "wherein the plurality of monitoring criteria includes a criterion based on **magnetic ink character recognition (MICR) line** detection" in claims 3, 16 and "wherein the plurality of monitoring criteria being based on **magnetic ink character recognition (MICR) line** detection…" in claim 21.

295. For example, Cohen makes clear that for check deposit, a readable **MICR line** is "required information." EX1006-Cohen, [0075] ("Applicant-developed documentation describes the location, specifications for the images, and XML data definitions for the **MICR line** and other required information."), [0079] ("The specifications for input are published (from Skyline Data) with the documentation describing the location, specifications for the images, and XML data definitions for the **MICR line** and other required information."). As I explained in Section XI.A.2.l, Cohen teaches obtaining the **MICR line** by reading it with "OCR and Parsing," determining "the confidence level of the accuracy of the OCR

results" including the **MICR line**, and displaying each of these items to a user alongside the check image to allow the user to verify that there are no errors before the check is submitted. *See* EX1006-Cohen, [0022], [0043]-[0044], [0077]-[0088], [0093]. According to Cohen, check images that have even "potentially inadequate or poor quality images" are "remove[d] and rescan[ned]." *Id.*, [0042], [0072].

296. These teachings would have led a person of ordinary skill in the art to use **MICR line** detection as an additional criterion to satisfy before capturing an image of the check, in addition to those taught by Luo such as edge detection and **alignment** with a **guide**. For example, these teachings demonstrate that a person of ordinary skill in the art would have understood the **MICR line** do be a required data item for deposit. Without a readable **MICR line**, a check could not be deposited using its image. Therefore, a person of ordinary skill in the art would have been motivated to use **MICR line** detection, for example by confirming that **MICR line** can be read from the image after Luo's requirements have been. As I explained above in Sections VI.A and VI.B, the **MICR line** is one of the easiest data items to read from the check image. Therefore, performing this **MICR line** detection step before capturing the image and conducting additional processing such as reading the amount payable and other information in the check image (and/or before sending the image to a server) would have helped increase the odds that the image is sufficiently

high quality before deciding to capture the image. Detecting the **MICR line** before capturing the image would have produced similar benefits as Luo's use of **reference lines**. For example, a person of ordinary skill in the art would have understood that performing **MICR line** detection before sending the check to a remote server for further processing would have reduced bandwidth usage and transmission delays. EX1004-Luo, 6, 7. Likewise, performing **MICR line** detection before capturing the image of the check and further processing the check image locally would have reduced the computational burden on the **mobile device** by ceasing image processing if the **MICR line** cannot be detected. A person of ordinary skill in the art would have also understood that performing **MICR line** detection before capturing the image of the check would have improved the user experience by determining that the **MICR line** can be read before capturing providing feedback to the user that image capture was successful. *See, e.g.*, §XI.A.2.j.

297. My opinion that a person of ordinary skill in the art would have reasonably expected success performing **MICR line** detection is consistent with the '095 patent's disclosure. The '095 patent states that "[a]ny known **MICR line** detection technique(s) may be used by the **camera** 207, the **mobile device** 106, and/or the **financial institution**." EX1001-USP095, 8:59-62. Therefore, the '095 patent suggest that **MICR line** detection was known, and was not the purported

invention. Moreover, the '095 patent does not provide any details regarding how to perform such detection on a **mobile device**. The '095 patent therefore confirms my opinion that a person of ordinary skill in the art would have found it obvious to perform **MICR line** detection at any point in time during image capture and processing, and that it would have been obvious to do so as a monitoring criterion to avoid delays, unnecessary bandwidth usage, and expenditure of processing resources on reading other information before confirming that the **MICR line** can be detected.

298. A person of ordinary skill in the art would have also had a reasonable expectation of success in adding **MICR** detection to the Garcia/Luo combination. As I explained above in Section XI.A.1.a, Luo is directed to increasing the readability an image of a **document** by waiting to capture an image of the **document** until certain conditions are met. EX1004-Luo, 1, 5, 7, FIG.4. Based on this disclosure, a person of ordinary skill in the art would have reasonably expected that it would have been possible to detect the **MICR line** once Luo's conditions are met.

299. This is consistent with the state of the art at the relevant time period, which I discuss in more detail in Section XI.B. For example, prior art like Yoon teaches the using multiple monitoring criteria in succession. These teachings would have led a person of ordinary skill in the art to expect success in combining criteria like **MICR line** detection with Luo's conditions, such as **aligning** the edge of a

document such that it is parallel with **reference lines** displayed in a **camera preview window**. As I explained in Section VI.C, Automatic capture was also well known, including automatic capture conditioned upon first detecting that an important element in the image is recognized. Examples include:

- Reading text in a **document** image, including OCR in real-time. *See, e.g.*, EX1050-Pilu, [0050]; EX1004-Luo, 4; EX1007-Yoon, [0022]-[0023]; EX1016-MotoRokr-Manual, 95-96.
- Real time recognition of bar codes. EX1043-Attia, 6:19-27, 4:13-18.
- Detecting human faces and smiles. EX1051-Jeong, [0036]; EX1052-VX-11000, 5.
- Detecting movement. EX1053-Landschaft, [0014].
- Detecting other objects, like screens of other electronic devices. EX1054-Gejdos, [0022].

Additional related technology confirms that implementing **MICR line** detection would have been within the level of ordinary skill. For example, it was already known to track text using a **camera** devices, which demonstrates that it was already known and within the level of ordinary skill to analyze text in a live video without any of Luo's other conditions for capturing an image. EX1055-Merino. 10-11, 13-17. Adding **MICR line** detection *after* Luo's additional **reference lines** conditions

are satisfied would have been even more likely to successfully read text in the image than Merino's techniques, which do not ensure **alignment** or correct for projective distortion. The addition of **MICR line** detection to the Garcia/Luo/Cohen combination would have therefore involved merely applying other known automatic capture techniques to the field of check deposit.

300. Confirming that the **MICR line** can be read before capturing the check image would have been well within the level of ordinary skill of a person of ordinary skill in the art. For example, a skilled artisan could have written computer code to apply **MICR line** detection (which the '095 patent concedes was known)[14] to the image of the check in Luo's viewfinder before capturing the image.

301. Finally, I note that existing **mobile devices** could have supported real-time **MICR line** detection. As I explained above, numerous references teach recognizing items in images from a **mobile device camera** in real time. These real-time image analysis techniques on **mobile device** included performing OCR on an image, detecting a barcode in an image, recognizing e gestures in a video feed, and

[14] EX1001-USP095, 8:59-62 ("Any known **MICR line** detection technique(s) may be used by the **camera** 207, the **mobile device** 106, and/or the **financial institution**")

producing a new augmented image with rendered items to support augmented reality. EX1050-Pilu, [0050]; EX1043-Attia, 4:13-18, 6:19-27; EX1056-Haro, 2, 4; EX1057-Handel, 8:62-9:14.

f. Claims 6, 14, 23

302. The combination of Garcia/Cohen teach "wherein the confirming that the mobile check deposit can go forward is performed after the transmitting the digital image of the check from the user's **mobile device**."

303. As I explained in Sections XI.A.1.b, XI.A.2.l, and XI.A.2.o, a person of ordinary skill in the art would have found it obvious to perform check processing steps either on the **mobile device** or at the bank. As I also explained in Section XI.A.2.o, the combination of Garcia/Cohen teaches "the user's **mobile device** receiving an Indication of a result of the server's processing." I also explained that the received indication would have been either from the **mobile device's** own internal processing or from processing done at Garcia's **receiving institution**, and that the indication would have been received "before confirming that the mobile check deposit can go forward," for example as taught by Cohen.

304. When performing the processing on the computer/server at Garcia's **receiving institution**, the step of "that the mobile check deposit can go forward" would necessarily occur "after the transmitting the digital image of the check from

the user's **mobile device**," because the **mobile device** would first need to receive the indication of the result of processing, and therefore would have needed to transmit the image of the check to the **receiving institution** for processing before confirming.

305. Therefore, the combination of Garcia/Cohen teaches "wherein the confirming that the mobile check deposit can go forward is performed after the transmitting the digital image of the check from the user's **mobile device**." As I explained in Section XI.A.1.b, implementing Garcia's mobile check deposit system and method with Cohen's check processing steps would have been obvious.

g. Claims 7, 24

306. Garcia/Luo/Meier teaches "wherein the digital image is a modified version of the captured video frame."

307. As I explained in Section XI.A.2.k, Garcia transmitting the check image to a **receiving institution**, which in the combination with Luo/Meier would have included a video frame. Before, doing so, Garcia teaches encrypting the information to be transmitted:

> d) Digitally encrypting and certifying the data and/or images captured in the previous points.
>
> e) Transmitting the digital image and the recognition data, once encrypted, to the institution that must accept the

> document.
>
> …
>
> According to an important feature of the present invention, both the capture of images and the entry of data, the encryption thereof and the transmission of data and images and the other operations described in sections a), b), c), d), and e) are performed with a mobile device with incorporated digital camera, able to capture and transmit digital images, as well as the usual telephony operations.

EX1003-Garcia, 6:1-4, 6:12-20.

> f) Digitally encrypting and certifying the data and/or images captured in the preceding points.
>
> g) Transmitting the digital image and the recognition data, once encrypted, to the institution that must accept the document.

Id., 10:14-18.

> Once the message is encrypted and accompanied by a digital certification through the mobile network (GSM, GPRS, or any future technology) of a telecommunications

> operator company. The institution that receives the message proceeds to validate and encrypt it, ultimately obtaining a digital photograph of the check and a data set that allows it to automatically process the deposit of the check in question into the service user's account.

Id., 12:13-22; *see also id.*, claims 1-2. A person of ordinary skill in the art would have understood encrypting the image of the check would have produced a "modified version of the captured video frame" by changing the file format.

308. Therefore, the combination of Garcia/Luo/Meier teaches "wherein the digital image is a modified version of the captured video frame." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image capture process and Meier's software architecture would have been obvious.

h. Claims 8, 17, 25, 30

309. Garcia teaches "wherein the wireless network is a cellular network."

310. As I explained above in Section XI.A.2.k, Garcia discloses transmitting the check image over a wireless network. More specifically, Garcia discloses "[t]ransmitting the digital image and the recognition data, once encrypted, to the **institution** that must accept the **document**" using a "**mobile telephone**

communications network, for example a GSM/GPRS network…." EX1003-Garcia, 6:3-5, 1:6-13, 4:11-18, 5:1-10, 10:16-18, 11:7:15, claims 1-2. A person of ordinary skill in the art would have understood a "**[m]obile telephone** communications network," including "GSM/GRPS"[15] to refer to a "cellular network." This is consistent with the '095 patent's disclosure, which provides GSM and GPRS as example "communications network." EX1001-USP095, 13:42-46. The '095 patent does not use the term "cellular network" in the specification or identify which networks are "cellular," which is consistent with my opinion that a person of ordinary skill in the art would recognize that a "**mobile telephone** communications network, for example a GSM/GPRS network" as disclosed by Garcia is a cellular network.

311. Moreover, setting aside the disclosure of GSM/GPRs, the term "mobile" in "**mobile telephone** communications network" would have also indicated to a person of ordinary skill in the art that Garcia discloses a cellular network, because "**mobile device**" and "mobile network" were often considered to

[15] Garcia refers to "GRPS," which a person of ordinary skill in the art would understand to be a typo referring to the well-known "GPRS" ("General Packet Radio Service") cellular networks, which were common in the 2000s.

be synonymous with "cellular device" and "cellular network."

312. Therefore, Garcia teaches "wherein the wireless network is a cellular network."

i. Claim 11

313. The combination of Garcia/Luo/Meier renders obvious "further comprising one or more computers programmed to perform operations comprising the monitoring, the determining, or both the monitoring and the determining."

314. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Meier teaches the following steps:

(1) "monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion," and

(2) "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame…"

315. I explain in additional detail in Section X.D why a person of ordinary skill in the art would have found it obvious to perform either or both of the monitoring and determining steps at Garcia's **remote institution**, which would have been a computer. A person of ordinary skill in the art would have found this limitation obvious either based on the combination of Garcia/Luo/Meier alone or in

view of the additional teachings found in Attia.

j. Claim 15

316. The combination of Garcia/Cohen teach "wherein the user's **mobile device** receives an Indication of a result of the processing the digital image of the check before the confirming step." It is my opinion that this limitation is obvious for the reasons I explained in Section XI.A.2.o.

k. Claim 16

317. The combination of Garcia/Luo/Meier teach "wherein the one or more computers include the bank computer."

318. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Meier teaches the following steps:

(1) "monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion,", and

(2) "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame…"

319. I explain in additional detail in Section XI.D why a person of ordinary skill in the art would have found it obvious to perform either or both of the monitoring and determining steps at Garcia's **remote institution**, which would have been a bank computer. A person of ordinary skill in the art would have found this

limitation obvious either based on the combination of Garcia/Luo/Meier alone or in view of the additional teachings found in Attia.

l. Claim 21

320. The combination of Garcia/Luo/Cohen renders obvious "wherein the plurality of monitoring criteria being based on **magnetic ink character recognition (MICR) line** detection and one or both of corner detection and edge detection." It is my opinion that this limitation is obvious for the reasons I explained in Section XI.A.3.d regarding corner and edge detection and Section XI.A.3.e regarding **MICR line** detection. It would have been obvious to use each of these for the reasons discussed in Sections XI.A.1, XI.A.3.d, and XI.A.3.e, it would have been obvious to use each of these different criteria when determining whether to capture an image.

B. Ground II: Claims 5, 13, 22 are Obvious Over Garcia in Combination with Luo, Meier, Cohen, and Yoon ("Garcia/Luo/Meier/Cohen/Yoon")

321. As I explained above in Section XI.A, in my opinion, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen. It is also my opinion that the additional limitations in claims 5, 13, and 22 would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen and further in view of Yoon, which teaches the use of brightness as a prerequisite to automatically capturing an image of a **document**.

I have reviewed the Garcia, Luo, Meier, Cohen, and Yoon references. It is my opinion that each is analogous art to the '095 patent claims. It is also my opinion that a person of ordinary skill in the art would have been motivated to combine them with a reasonable expectation of success.

322. The combination of Garcia/Luo/Yoon also renders obvious "[t]he method of claim 3[or 12 or 20], wherein the plurality of monitoring criteria includes criteria based on light brightness, skewing, and warping."

323. As I explained in Section XI.A.3.d, Luo teaches using skewing and warping as conditions that must be satisfied before capturing an image of a **document**. EX1004-Luo, 1, 4-6; EX1007-Yoon, [0022], [0023]. Luo also teaches that during the process of capturing an image using a **camera**, "light 305 propagates through the lens 315 from the object plane 310 onto the image plane 320." EX1004-Luo, 4. This is consistent with the knowledge of persons of ordinary skill in the art, who would have understood that sufficient light must pass from an object to a **camera** for a clear, readable image to be captured. These teachings would have lead a person of ordinary skill in the art to other prior art references that, like Luo, teach conditions required to capture readable images, and further disclose using brightness of an image as one such condition.

324. Yoon is one such prior art reference. Yoon, like Luo, identifies

potential impediments to recognizing text on **documents** (e.g., business cards) in images captured by **cameras**. For example, Yoon teaches that "the probability of satisfactorily recognizing the [**document**] in order to obtain the information contained in the [**document**] varies depending on photographing conditions, such as the…brightness…of the photographed business card." EX1007-Yoon, [0007]. As a solution, Yoon discloses that "the controller 100" associated with a **camera** unit 102 "receives brightness data from the **camera** unit 102, checks a brightness environment under which the [**document**] is to be photographed, and controls whether to perform automatic photographing…." *Id.*, [0019]. To accomplish this, the "the **camera** unit 102 converts the brightness of an image received from the **camera** sensor into measurable brightness data, and transmits the brightness data to the controller 100." *Id.*, [0020]. Yoon's technique further includes "comparing the brightness data with a reference brightness value for recognizing the business card." *Id.*, [0025]. "If it is determined that the current brightness is not appropriate for photographing the business card, the portable terminal displays a message indicating this fact on the display unit 106 in step 227, and" does not capture the image of the **document**. *Id.*, [0026]. Brightness is included among other requirements, including "recogniz[ing] the boundary lines of the business card" and "determine[ing] whether at least one of the reference boundary lines (upper, lower, left, and right boundary

lines) coincides with the boundary lines of the photographed business card." *Id.*; *see also id.*, [0019]-[0020], FIG.2. Therefore, Yoon teaches "wherein the plurality of monitoring criteria includes criteria based on light brightness."

325. It is my opinion that a person of ordinary skill in the art would have been motivated to combine Garcia/Luo and Yoon by adding Yoon's teaching to use brightness as an additional condition before capturing an image with a reasonable expectation of success.

326. **Analogous Art**: In my opinion, like Garcia and Luo, Yoon is analogous art to the '095 patent claims. As I explained in Section XI.A.1.a, the '095 patent claims are in the field of capturing and processing **document** images. Yoon is in the same field of capturing and processing **document** images. For example, Yoon discloses "an apparatus and method for photographing a business card in a portable terminal." EX1007-Yoon, Abstract, [0003], [0006]-[0007], [0032], FIG.2. Yoon also describes various techniques for improving image capture, and therefore the readability of the captured image, including ensuring that the boundary lines of the rectangular **document** coincides with reference boundary lines and automatically capturing the image of the **document** when this condition, among others, is satisfied. *Id.*, [0019]-[0020], [0025]-[0026]. Thus, Yoon is directed to capturing and processing an image of a **document**, just like the '095 patent claims.

327. **Motivation to Combine**: In my opinion, a person of ordinary skill in the art would have been motivated to implement Yoon's disclosure of using brightness as a condition for automatically capturing an image into Garcia's mobile check deposit system for the same reasons I explained in Section XI.A.1.a with respect to Luo's monitoring criteria and autocapture approach. Yoon teaches that comparing the brightness to a reference brightness value a before automatically capturing an image of a **document** increases the readability of the captured **document**. EX1007-Yoon, [0006], [0019], [0025]-[0026], [0032], FIG.2. A person of ordinary skill in the art would have recognized that these teachings in Yoon would have similarly improved Garcia's image capture for checks. Doing so would have provided additional improvements to the images captured by Luo's method, which does not expressly contemplate monitoring brightness of the image. As I explained above, Yoon even contemplates combining brightness with other monitoring criteria, such as ensuring that the boundary lines of the rectangular **document** coincide with reference boundary lines, which are similar to Luo's **reference lines**.

328. As I explained in Section III.C, one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. Another consideration is whether the alleged invention applies a known technique to a known device or method that was ready for

improvement to yield predictable results. In my opinion, this describes the combination of Garcia with Yoon. For example, implementing Garcia's mobile check deposit method and system using Yoon's additional brightness-based monitoring criteria would have involved using and applying known techniques—here, Yoon's brightness monitoring techniques—to a known or similar device or method—here, Garcia's **mobile phone** equipped with a **camera** for capturing a check image—ready for improvement—here, to improve OCR of Garcia's images—in the same way—here, by ensuring the image is sufficiently bright—to yield predictable results—here, a better check image.

329. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing the combination of Garcia's mobile check deposit method and system using the teachings of both Luo's and Yoon's capture methods and systems. As with the combination of Garcia and Luo, the similarities between the references would have also led a person of skill in the art to expect success. For example, similar to Garcia and Luo, Yoon teaches capturing an image with a **camera** and image capture software. Yoon further teaches that the capture process is performed with an image processor 102, which would have included software to accomplish the disclosed functions. EX1007-Yoon, [0031] (discussing "computer readable code"); Abstract,

[0019], [0032], claim 1. These similar teachings would have suggested to a person of ordinary skill in the art that the teaching from one disclosure could have easily been applied to the teachings of others.

330. A person of ordinary skill in the art would have also expected success in the combination because Garcia, Luo, and Yoon each teach capturing an image of the same item. Similar to Garcia and Luo, which I discuss in Section XI.A.1.a above, Yoon teaches capturing an image of a small paper **document** with text, like a business card. EX1003-Garcia, 12:4-9; EX1004-Luo, 1, 4, 6; EX1007-Yoon, Abstract, [0018]-[0019].

331. In addition, as I explained in Section XI.A.1.a, consistent with the level of ordinary skill in the art and the readily available solutions for image capture (*see, supra*, Sections VI.C and VI.D), a person of ordinary skill in the art would have understood Garcia to teach that implementing known details like Yoon's brightness monitoring would have been within the capability set and knowledge of a person of ordinary skill in the art. Moreover, implementing the Garcia/Luo/Yoon combination would have simply involved writing computer code using readily accessible software development kits, like the Android SDK taught be Meier. Yoon contemplate using such computer code. EX1007-Yoon, [0031].

332. Finally, as I explained above, Yoon teaches using reference

boundary lines similar to Luo's **reference lines** as an additional condition after confirming sufficient brightness. EX1007-Yoon, [0019], [0022], [0024]-[0030], FIG.2. Thus, a person of ordinary skill in the art would have expected success in implementing both Yoon's brightness monitoring with Luo's **reference lines** as conditions to satisfy before capturing the **document** image.

333. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia and Luo with Yoon to incorporate Yoon's teaching to monitor an image's brightness and automatically capture the image after the brightness exceeds a reference brightness value.

C. Ground III: Claims 7 and 24 are Obvious Over Garcia in Combination with Luo, Meier, Cohen, and Randle ("Garcia/Luo/Meier/Cohen/Randle")

334. The combination of Garcia/Luo/Meier/Randle teaches "wherein the digital image is a modified version of the captured video frame."

335. As I explained in Section XI.A.3.g, before transmitting the digital image of a check to the **receiving institution**, Garcia's **mobile device** encrypts the digital image, which teaches "wherein the digital image is a modified version of the captured video frame." Randle discloses additional techniques for modifying the check image that would have been obvious to include in the combination of

Garcia/Luo/Meier.

336. As I explained in Section X.G, Randle teaches performing processing steps on a check image during the deposit process as a way to provide "quality assurance." EX1048-Randle, Abstract, [0004], [0014], [0019], [0021]. One of those steps includes reducing the check image size. Randle teaches:

> Image data reduction options with QA are supported with QA being available before and after data reduction. The capture of a check in an 8 bit gray scale (or color) high dpi format (100 dpi or 200 dpi) may be needed to assure a high level of quality for a QA process. Once that QA process is completed on the high resolution image (stamped with a QA√ signature; for example, as shown by the "QA√" check marks in the drawings) then the image is converted to a less size intensive format for transmission and use in the check processing chain. The QA signature provides an audit trail for this process and assures QA is not lost as part of the data reduction process. Examples of data reduction include: 1) 8 bit gray scale to bi-tonal (black and white); 2) 200 dpi color to 100 dpi bi-tonal; 3) 100 dpi to 50 dpi

> bi-tonal, 4) 24 bit color to 8 bit gray scale; 5) 8 bit gray scale to 4 bit gray scale, 6) color (grey scale or full color) to bi-tonal (black and white), and 7) equivalent or similar reductions in tone, color, contrast, resolution or other parameters.…Data reduction may also include variations in pixel resolution and/or color depth.

Id., [0043]. Randle teaches that "data reduction is performed (keeping the unique digital signature and transitive QA) as a method to reduce file size which increases transmission speed and reduces storage requirements." *Id.* Randle teaches that the QA process—which includes data reduction—can be performed anywhere along the deposit process. *Id.*, [0014] ("Quality assurance performed at any of the QA identification points shown (designated 'QA' with a check mark, QA√) allow an agreed to QA value to be accepted at any point in processing."), FIG.4.

337. Therefore, Randle teaches "a modified version of the" check image. In the combination with Garcia/Luo/Meier, the modified or converted image would have been "a modified version of the captured video frame." The combination of Garcia/Luo/Meier/Randle therefore teaches "wherein the digital image is a modified version of the captured video frame." As I explained in Section XI.A.1.a, implementing Garcia's mobile check deposit system and method with Luo's image

capture process and Meier's software architecture would have been obvious.

338. A person of ordinary skill in the art would have also found it obvious to combine Garcia/Luo/Meier and Randle to incorporate Randle's teaching to modify the check image.

339. **Analogous Art**: In my opinion, like Garcia, Randle is analogous art to the Challenged Claims because it is in the same field as the Challenged Claims—capturing and processing **document** images. For example, Randle discloses presenting a check image from various sources for deposit:

> An advantage of the invention is the ability of the system to capture, validate and clear transactions rapidly and inexpensively to include the electronic capture of paper items at the point of sale or presentment. To accomplish this, rules are established, based on the preferences of the bank or bank's customer, that allow decisions to be made based on, for example, source, paying bank, QA value, value of item, item type, risk profile of the customer, risk profile of the item, risk profile of the transaction, time of day, best clearing path, or proximity to clearing deadlines. The capture source may be a branch teller, the back

> counter of a branch for bulk capture, an image-enabled ATM, an image-enabled point of purchase device, or a corporate or correspondent back office.

EX1048-Randle, [0007].

> In FIG.1B, central processing engine of the invention 1 is shown interconnected at various points 131, 132, 133, and 134 through the SMFSN or a private network connection with various financial instrument, i.e., check, sources at 134 such as 101 teller, 102 point of sale, 103 image ATM/kiosk, 104 commercial and corporate, 105 branch back counter, 106 image POD (sorter farm), 107 remittance (sorter farm), 108 inclearing (sorter farm), and 109 inbound image exchange.

Id., [0020]; *see also id.*, [0019], [0028], [0036], [0054], [0074].

340. The image is then processed to provide quality assurance:

> The sources, described below, of transactions to which the invention is applicable are categorized as either interactive or bulk capture. Dynamic quality assurance (QA) is performed on the image and the transaction and a QA

> value is established and associated with the item prior to the acceptance (or further processing in the event of rejection) of the item. Dynamic QA allows the QA to be tailored to the transaction profile. This may include multiple QA paths depending on the profile which may include decisioning based on the level of risk, the profile of the customer, the cost of QA, the presentment method or environment, and the value of the transaction.…The results of these validation steps are communicated back to the source presenting the check either prior to acceptance of the check or as an adjustment back to the presenter in the case where the presenter is not part of an interactive real time session. The validation activities and results are uniquely associated with the transaction file as the file moves to settlement and clearing.

Id., [0021]; *see also id.*, [0019], [0042]-[0043], [0054], [0074]. Thus, Randle is directed to capturing and processing an image of a **document**, just like the '095 patent claims.

341. **Motivation to Combine**: In my opinion, a person of ordinary skill

in the art would have been motivated to implement Randle's image conversion process in Garcia's mobile check deposit system. A person of ordinary skill in the art would have done so for multiple reasons.

342. First, Randle's disclosure provides reasons to convert the check image to a reduced size. For example, Randle teaches that reducing the image size "increases transmission speed and reduces storage requirements." EX1048-Randle, [0043]. A person of ordinary skill in the art would have been particularly interested in increasing transmission speed and reducing storage requirements in Garcia's mobile check deposit system. As I explained in Section XI.A.2.k, Garcia discloses transmitting the check image from the **mobile device** to the **financial institution** over a wireless network. It was well known that wireless networks, and upload speeds in particular, had limited bandwidth and were expensive to use. Therefore, transmitting a smaller image size would have reduced the time it would take to upload Garcia's check image to the **financial institution**, and reduced the cost for sending the check image. Moreover, as I explained in Section XI.A.1.a, it would have been obvious to perform check processing either on Garcia's **mobile device** or at the **financial institution**. In either case, a person of ordinary skill in the art would have recognized that reducing the image before transmission would have reduced bandwidth usage and the time required to transmit the image. Based on Randle's

teachings and the known bandwidth sensitivity of cellular networks, a person of ordinary skill in the art would have been motivated to reduce the size of the check image *before* it is transmitted to Garcia's **financial institution**.

343. Second, a person of ordinary skill in the art would have been motivated to convert the check image to improve OCR and facilitate downstream uses of the check image. Binarized or bi-tonal images are black and white images that have pixels that can only have one of two binarized values—black or white. Binarized images are often converted from color images, which can include many different color gradients for each pixel. Binarized images take up less storage space than color images because they contain less information per pixel. Prior to the '095 patent, it was well known to persons of ordinary skill in the art that it was easier to perform OCR on binarized images. Binarized images make it easier to distinguish text from noise and therefore make character boundaries clearer. This increases the accuracy of OCR results while also reducing the processing burden, as binarized images take up less space. Thus, it was common to convert images taken by **mobile devices** to a binarized format (including by doing so on the **mobile devices** itself) before performing OCR. *See, e.g.*, EX1072-Bae, 539-40, 544; EX1076-Laine, 1, 5; EX1078-Liu, 29-32; EX1079-Wu, 3-4. Based on this well known fact, a person of ordinary skill in the art would have been motivated to reduce the size of the check

image on the **mobile device** *before* it is processed, and thus before transmission.

344. Finally, as I explained above in Section VI.B, the early 2000s saw numerous developments that helped standardized the processing of check images. As one example, Federal Reserve Bank adopted the DSTU X9.37-2003 specification, which detailed particular formatting requirements for check images. One such requirement is that check images submitted to the Federal Reserve must be in a bi-tonal TIFF format. EX1015-DSTU. TIFF was a well-known image format at the time, but was an uncommon output from **mobile device cameras**. Therefore, a person of ordinary skill in the art would have been motivated to convert the check image produced by the **mobile device camera** into a bi-tonal TIFF format to facilitate compliance with the Federal Reserve's image requirements.

345. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing Randle's image conversion techniques in Garcia's mobile check deposit system. The similarities between the references would have also led a person of skill in the art to expect success. For example, similar to Garcia, Randle teaches check image processing steps, such as OCR and various validation steps on check images. EX1048-Randle, [0002], [0006]-[0007], [0074]. These similar teachings would have suggested to a person of ordinary skill in the art that the teaching from one

disclosure could have easily been applied to the teachings of others.

346. In addition, as I explained in Section XI.A.1.b, consistent with the level of ordinary skill in the art and the readily available solutions for check image processing (*see, supra*, Sections VI.B), a person of ordinary skill in the art would have understood Garcia to teach that implementing known details like Randle's image conversion would have been within the capability set and knowledge of a person of ordinary skill in the art. EX10048-Randle, [0043]. This is confirmed by the fact that, as I explained above, binarizing images before OCR was well known and common in the art, including images captured by **mobile devices**.

347. Randles's teachings also suggest predictability and success, including for converting a check image before transmission to Garcia's **receiving institution**. Specifically, Randle teaches that QA can be performed "at any point in processing." *Id.*, [0014], Fig.4. A person of ordinary skill in the art would have understood this disclosure to include image conversion. Moreover, to the extent that additional detail in the image is needed, Randle teaches a segmentation process that maintains important portions of the image at a higher level of quality. *Id.*, [0044].

348. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to implement Randle's image conversion techniques into Garcia's mobile check deposit system to improve check image

processing, for example by reducing bandwidth and storage usage and producing a check image that is ready for OCR and use in the Federal Reserve's back-end system.

D. Ground IV: Claims 11 and 16 are Obvious Over Garcia in Combination with Luo, Meier, Cohen, and Attia ("Garcia/Luo/Meier/Cohen/Attia")

349. Garcia/Luo/Meier/Cohen/Attia teaches the limitations in claims 11 and 16.

1. Combination of Garcia in view of Luo/Meier/Cohen/Attia ("Garcia/Luo/Meier/Cohen/Attia")

350. As I explained in Sections XI.A.1.a, XI.A.2.h, and XI.A.2.i, the combination of Garcia/Luo/Meier teaches:

(1) "monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion" and

(2) "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame…"

Attia discloses additional details regarding how and where to perform such monitoring and determining (including on a bank computer) that it would have been obvious to include in the combination of Garcia/Luo/Meier.

351. **Analogous Art**: In my opinion, like Garcia/Luo/Meier/Cohen, Attia is analogous art to the Challenged Claims because it is in the same field as the

Challenged Claims—capturing and processing **document** images. For example, Attia discloses "a system and method for decoding barcodes using **mobile device**." EX1043-Attia, Abstract; *see also id.*, 1:12-16, 3:14-20, 3:24-27, 4:1-7, FIGs.2A-C, 4B, 5A. Attia provides examples of barcodes on "scanned items" such as compact discs or food items, which a person of ordinary skill in the art would have understood to suggest bar codes on a wide variety of items, including documents such as forms or flyers. *Id.*, 4:19-29. Thus, Attia is directed to capturing and processing an image of a **document**, just like the '095 patent claims.

352. **Motivation to Combine**: In my opinion, a person of ordinary skill in the art would have been motivated to incorporate Attia's teachings to perform image processing steps such as monitoring and determining when to capture **document** images on a remote server into the combination of Garcia/Luo/Meier/Cohen. As I explained above in Section XI.A.1.a, the combination of Garcia/Luo/Meier teaches automatically capturing images of a check by first monitoring to then determining whether a monitoring criterion is satisfied (e.g., alignment of edges with a guide. As I explained in Section XI.A.1.b, the combination in further view of Cohen teaches processing the captured check image to extract information relevant to deposit—such as the **MICR line** and amount payable. A person of ordinary skill in the art would have also found it obvious to

perform those image processing steps either on the **mobile device** or at a remote bank server for the reasons I discussed in Section XI.A.1.b. For similar reasons, it would have also been obvious to a person of ordinary skill in the art to perform other check processing steps, like monitoring for alignment with a guide as taught by Luo, at either location (i.e., on the **mobile device** or a server located at the **financial institution**), both in view of Luo and Cohen's teachings discussed above in Section XI.A.1 and optionally further in view of Attia's teachings explained below.

353. More specifically, Luo and Attia teach two equally obvious implementations. Luo teaches performing image monitoring and determining steps on the **mobile device**, whereas Attia teaches performing processing steps either on the **mobile device** or a server. For example, Luo teaches that "when the **straight edge** 205 [of the **document**] displayed in the **preview window** 125 is substantially parallel to the corresponding **reference line** 135, an indication is provided to the user. In step 620, only when the **straight edge** 205 shown in the **preview window** 125 is substantially parallel to the corresponding **reference line** 135 can the image of the object be captured." EX1004-Luo, 7. Luo discusses this functionality with reference to the **mobile device**, but does not specifically mention the involvement of a remote computer for any steps except performing OCR. *Id.*, 7 ("Step 625 in method 600 may be performed using software stored in **camera system** 100, or

alternatively, step 625 may be performed at a remote location. For example, the **camera system** 100 can be used to capture only precise, clear text data images, which can be downloaded to another location before any optical character recognition is performed.”). Attia expressly teaches a system for monitoring images of a barcode to determine when the image can be decoded in which the monitoring and decoding are performed either on the **mobile device** or a server.

> The location of the decoding depends entirely upon the processing capabilities of the mobile device utilized. For example, if the ScanZoom software is operating on a mobile device with lower system capabilities, such as a first generation camera phone, the mobile device will automatically send the digital image of the barcode to a server for decoding.
>
> …
>
> Additionally, the barcode decoding may also be performed in real time. The ScanZoom software accomplishes this by constantly capturing and processing the image of the barcode until it is correctly decoded. This eliminates the extra step of the user having to press a button to capture an

image of the barcode.

EX1043-Attia, 4:8-18. A person of ordinary skill in the art would have understood Attia's decoding to be similar to Luo's determining that the **straight edge** is substantially parallel to one or more **reference lines**.

354. A person of ordinary skill in the art would have therefore been faced with two alternatives approaches: one involving performing the monitoring/determining steps on the **mobile device** and another performing such steps on the remote server. In light of these teachings, a person of ordinary skill in the art would have recognized the benefits of each approach and found each implementation to be obvious.

355. As I noted on Section XI.A.1.b, Garcia teaches performing various processing and validation steps on computer located at the **financial institution** instead of on the **mobile device**. A person of ordinary skill in the art would have considered these teachings to suggest performing other steps, such as Luo's monitoring and determining steps at a computer of the **financial institution** where other image and check processing steps take place. EX1043-Attia, 4:1-7; EX1044-Nepomniachtchi, 10:29-48. Doing so would reduce the processing burden on the **mobile device**. Thus, performing Luo's monitoring and determining steps at a computer of the **financial institution** would have been obvious based on the

teachings of Garcia/Luo/Meier alone.

356. These teachings are reinforced by Attia's disclosure. As I explained in Section X.H and above, Attia teaches systems and methods for decoding barcodes using images from a **mobile device**. Specifically, Attia teaches monitoring an image of a barcode to determine when it can be decoded. EX1043-Attia, 4:8-18. Attia discloses doing so in real-time. These steps are analogous to Luo's monitoring the image and determining that "the **straight edge** 205 displayed on the **preview window** 125 is substantially parallel to the corresponding **reference line** 135…." EX1004-Luo, 6. Attai further explains that "[t]he location of the decoding depends entirely upon the processing capabilities of the **mobile device** utilized" and that "if the…software is operating on a **mobile device** with lower system capabilities…the **mobile device** will automatically send the digital image of the barcode to a server for decoding." *Id.*, 4:1-7. Attia therefore teaches that real-time image monitoring and decoding can be performed in one of two locations: on a **mobile device** or at a remote server. A person of ordinary skill in the art applying Attia's teachings (e.g., to monitor in real time an image of a barcode taken by a **mobile device** using processing capabilities on server so as to determine when the image is of sufficient quality to decode the barcode, which is akin to passing a monitoring criteria) to the combination of Garcia/Luo/Meier/Cohen would have found it obvious to move

Luo's document edge monitoring and determining steps to the computer at Garcia's **receiving institution**. As with Attia's implementation, doing so would have reduced the processing burden on the **mobile device** (especially for more primitive **mobile devices**).

357. As I explained in Section III.C, one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. Another consideration is whether the alleged invention applies a known technique to a known device or method that was ready for improvement to yield predictable results. In my opinion, this describes the combination of Garcia/Luo/Meier/Cohen with Attia. For example, the combination of Attia with Garcia/Luo/Meier/Cohen merely amounts to using a known technique—here, Attia's teaching of image monitoring and decoding at the server—to improve a similar device—here, Garcia/Luo/Meier/Cohen's **mobile device** image processing system—in the same way—here, applying image monitoring and decoding at the server to improve performance of monitoring and determining—to yield predictable results—here, a better check image.

358. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing Attia's teachings of monitoring/determining on a server into

Garcia/Luo/Meier/Cohen's system. Attia's suggestion to perform image monitoring and barcode decoding either on a **mobile device** or remote server without suggesting any difficulties would have suggested to a person of ordinary skill in the art that similar remote monitoring and determining would have been possible in the combination of Garcia/Luo/Meier. Moreover, the combination could have been implemented using then-existing techniques for transmitting video over a wireless network. Indeed, **camera phones** capable of streaming video to a remote location had already been known since at least 1999. EX1080-Kyocera.

359. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia/Luo/Meier/Cohen with Attia to incorporate into Garcia/Luo/Meier/Cohen Attia's teachings to monitor an image at a remote location.

2. Claim 11

360. The combination of Garcia/Luo/Meier/Attia render teaches "further comprising one or more computers programmed to perform operations comprising the monitoring, the determining, or both the monitoring and the determining."

361. As I explained in in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Meier teaches

(1) "monitoring the live video of the check in the field of view of the

camera with respect to at least one monitoring criterion" and

(2) "determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame…"

362. In the combination with Attia, the monitoring and determining steps would have been performed by a remote server. *See, supra*, §XI.D.1. Therefore, the combination of Garcia/Luo/Meier/Attia render teaches "further comprising one or more computers programmed to perform operations comprising the monitoring, the determining, or both the monitoring and the determining." As I explained in Section XI.D.1., implementing Garcia's mobile check deposit system and method with Luo's image capture process using a remote server for monitoring and image processing as taught by Attia would have been obvious.

3. Claim 16

363. The combination of Garcia/Luo/Meier/Attia teaches "wherein the one or more computers include the bank computer."

364. As I explained in Section XI.D.2, the combination of Garcia/Luo/Meier/Attia teaches that it would have been obvious to perform monitoring and determining satisfaction of a monitoring criteria at a remote server, for example as taught by Attia. As I also explained in Sections XI.A.2.k and

XI.A.2.p, Garcia teaches that after capture, the images are sent to a bank computer at the **financial institution**. EX1003-Garcia, 1:15-19, 4:1-8, 4:11-18.

365. In light of these teachings, a person of ordinary skill in the art would have found it obvious to use the same bank computer to perform both the post-capture processing steps, including those taught by Garcia/Cohen, as well as the pre-capture monitoring and determining steps, including those taught by the combination of Garcia/Luo/Meier. A person of ordinary skill in the art would have recognized that doing so would have given the bank full control over which images to use in the deposit process before moving forward with deposit. In addition, doing so would have helped to reduce the number of remote servers required to implement the Garcia/Luo/Meier/Attia combination. As was well known in the art, the same server could have interfaced with Garcia's **mobile device** to perform both the pre-capture and post-capture image processing functions.

366. Therefore, the combination of Garcia/Luo/Meier/Attia teaches "wherein the one or more computers include the bank computer." As I explained in Section XI.D.1, implementing Garcia's mobile check deposit system and method with Luo's image capture process using a remote server for monitoring and image processing as taught by Attia would have been obvious.

E. Ground V: 1-4, 6-12, 14-21, 23-30 are Obvious Over Garcia in Combination with Luo, Goyal, and Cohen

("Garcia/Luo/Goyal/Cohen")

367. As I explained in Section XI.A, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen. It is also my opinion that claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen. First, I explain why a person of ordinary skill in the art would have been motivated to combine the Garcia with the Luo, Goyal, and Cohen references (Section XI.E.1). Next, I explain why that combination of prior art references would have rendered claims 1-3, 5, 6, 8-12, 14-16 obvious (Section XI.E.2).

1. Combination of Garcia, Luo, Goyal, and Cohen ("Garcia/Luo/Goya/Cohen")

368. I have reviewed the Garcia, Luo, Goyal, and Cohen references. It is my opinion that each is analogous art to the '095 patent claims. It is also my opinion that a person of ordinary skill in the art would have been motivated to combine them with a reasonable expectation of success.

369. In Section XI.E.1.a, I explain why a person of ordinary skill in the art would have been motivated to modify Garcia with Luo's teachings of displaying an **alignment guide**, providing feedback and other instructions to the user, and automatically capture an image of a **document**, and further why a person of ordinary skill in the art would have been motivated to implement those teachings using

Goyal's software architecture, including a downloaded application and **camera** control APIs.

370. In Section XI.E.1.b, I explain why a person of ordinary skill in the art would have been motivated to modify Garcia with Cohen's teachings regarding various remote check deposit steps.

a. Combination of Garcia in view of Luo and Goyal ("Garcia/Luo/Goyal")

371. **Analogous Art**: In my opinion, like Garcia and Luo, Goyal is analogous art to the '095 patent claims. As I explained in Section XI.A.1.a, the '095 patent claims are in the field of capturing and processing **document** images. Goyal is in the same field of capturing and processing **document** images. More specifically, Goyal discloses a set of "API that developers use to embed advanced multimedia capabilities in any Java-enabled device." EX1008-Goyal, 1. Goyal teaches that "MMAPI allows you to create applications for Java-enabled devices that can discover and use the multimedia capabilities of the **device** that they are running on." *Id.* As an example, "the MMAPI implementation on [a **device** containing a **camera**] may provide means to capture snapshots or full videos." *Id.*, 27. A person of ordinary skill in the art would have understood that the subject of Goyal's snapshots or videos could be a **document**. Thus, Goyal directed to capturing and processing **document** images.

372. **Motivation to Combine**: In my opinion, a person of ordinary skill in the art would have been motivated to implement Goyal's software architecture, including a downloaded application and APIs for controlling **mobile device cameras** in Garcia's mobile check deposit system and Luo's monitoring criteria and autocapture approach for the same reasons I explained in Section XI.A.1.a with respect to Meier's downloaded application and APIs As I explain more in Section XI.E.2 below, Goyal teaches a downloaded application and APIs for controlling **mobile device cameras** to capture images from live video, which a person of ordinary skill in the art would have understood would have been the software components needed to implement Garcia's mobile check deposit method/Luo's images capturing method. Accordingly, a person of ordinary skill in the art would have been motivated to apply teachings from the prior art like Goyal to fill in implementation details in the Garcia/Luo combination, just like in the combination of Garcia/Luo with Meier.

373. Like Meier, Goyal supplies implementation details for Garcia in the form of well-known and readily available software components. In the field of software development, persons of skill in the art frequently consult guides or other reference materials to understand how to write computer code a particular computing environment. I have used these types of resources many times in my career. Goyal

is on such guide for building applications using MMAPI, and teaches developers how to "take full advantage of the [mobile] device's features" including the **device camera** with well-known and readily available software components in the MMAPI specification. EX1008-Goyal, 1, 127. Goyal describes a many software features relevant to Garcia and Luo. For example, Meier provides techniques for loading application software on a **mobile device**. Specifically, Goyal teaches that mobile applications can be downloaded onto the device using the well-known OTA interface, which Goyal refers to as "Over the Air provisioning." *Id.*, 66-67. As I explain in more detail in Section XI.E.2.a, in the context of **mobile devices**, a person of ordinary skill in the art would have understood OTA to refer to downloading mobile applications.

374. In addition, Goyal teaches that MMAPI-based applications can "capture snapshots or full videos." *Id.*, 127. Specifically, Goyal further discloses that the MMAPI, when implemented on a **mobile device**, provides application developers with "full control of the [device's] capabilities that it wants enabled and can do so with a single API interface." *Id.*, 127. These capabilities include the ability to "capture snapshots or full videos" with a device **camera**. *Id.*; *see also id.*, 12, 128-30, 174-79 (summarizing "MMAPIs"). According to Goyal, the **camera** and video APIs are MMAPI's "biggest advantage." *Id.*, 127.

375. A person of ordinary skill in the art would have therefore been motivated to implement the Garcia/Luo combination with Goyal's teachings of a downloaded application and Camera APIs that access the **mobile device camera** hardware. As I outlined in Sections VI.C and VI.D, mobile applications were becoming increasingly popular in the early and mid-2000s. *See, supra*, §§VI.C, VI.D; EX1008-Goyal, 1, 3, 6, 127, 174, back cover. These included, for example, mobile applications that accessed **camera** functionality to preview images in a viewfinder and capture pictures. I outlined numerous examples in Sections VI.C and VI.D above. *Id.*

376. As I explained in Section XI.A.1.a, downloaded applications were also becoming increasingly popular, and therefore would have been an attractive architecture with which to build mobile functionality, like Garcia's mobile check deposit and Luo's image capture techniques. These downloaded applications provide numerous useful functionalities and benefits for third-party developers, which I outlined in Section XI.A.1.a.

377. A person of ordinary skill in the art would have recognized additional benefits to downloaded applications. For example, downloaded applications also provide third parties with access to device hardware like accelerometers and GPS systems. In the case of the Garcia/Luo/Goyal combination,

a downloaded application can provide access to the **camera** with pre-written, and readily accessible software APIs. EX1008-Goyal, 1, 66, 127, 174-79. Thus, a third party wishing to use a device **camera** could simply use those APIs and would not need to write new **mobile device** software from the ground up. Without such APIs, a third party would likely need access to proprietary hardware and software features typically known only to the device manufacturer. Writing code to access hardware features would have been duplicative and inefficient, especially given that APIs for performing the same functionality were already known.

378. As I explained in Section XI.A.1.a, implementing the Garcia/Luo combination with a downloaded application and APIs for controlling image capture would have also involved the application of techniques that were already being used for remote desktop deposit to the field of **mobile devices**. Thus, when extending remote deposit capabilities to a **mobile device**, a person of ordinary skill in the art would have been motivated and found it obvious to use the equivalent software architecture for **mobile devices**. A person of ordinary skill in the art would have recognized that Java ME was the mobile equivalent to the well-known Java environment for downloaded desktop applications.

379. A person of ordinary skill in the art would have been motivated to look to how-to guides like Goyal—which explain available software features for

mobile devices, for example using the Java ME platform——to implement the teachings of the Garcia/Luo combination on a **mobile device**. In the Garcia/Luo/Goyal combination, when implementing the combination of Garcia/Luo with Meier's teachings, a person of ordinary skill in the art would have recognized that Meier's downloadable application and Camera APIs provide the software features needed to implement for Garcia's/Luo's teachings. As a few non-limiting examples, Goyal's downloaded application would been used to implement Luo's **preview window** and image capture using, for example, the Camera API that provides third-party mobile applications access to video preview from a device **camera** (e.g., on **devices** like Motorola C975 or BenQ M75). In the Java ME system, the video display could be set using the `Canvas` feature. As another example, Goyal's teaching to use a downloaded application would have also been used to implement Luo's and Garcia's teachings to capture a picture or a single frame from a video feed. For example, Goyal teaches implementation details for capturing a picture from a video feed, the `getSnapshot()` API. EX1004-Luo, Abstract, 5-7, claims 5, 11, 13, FIG.6; EX1008-Goyal, 174; *see also id.*, 13-14, 66, 175-79, 191. Goyal's teachings are not limited to these features—Goyal also provides additional implementation details regarding how to initialize the **camera** and how to control additional settings. *See, e.g.*, EX1008-Goyal, 1, 13-14, 174-79, 253.

380. As I explained in Section III.C, one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. Another consideration is whether the alleged invention applies a known technique to a known device or method that was ready for improvement to yield predictable results. In my opinion, this describes the combination of Garcia with Luo. For example, implementing Garcia's/Luo's software with Goyal's teaching to use a downloaded application and **camera** control API would have involved to applying a known technique or method—here, Goyal's well-known software architecture that includes downloaded applications and APIs—to a known device or method—here, Garcia/Luo's mobile check capture and processing software—ready for improvement—here, by facilitating Garcia/Luo's deposit and image capture teachings without the need to download software for each deposit and without the need for a developer to write **camera** control software—in the same way—here, by using well-known software components and software deployment techniques—to yield predictable results—here, capturing and processing a check image with a **mobile device**.

381. **Reasonable Expectation of Success**: In my opinion, a person of ordinary skill in the art would have reasonably expected success in implementing the combination of Garcia's mobile check deposit method and system using the

teachings of Luo's capture method and system and Goyal's software architecture. For example, the similarity between the references themselves would have led a person of ordinary skill in the art to reasonably expect success. Garcia, Luo, and Goyal each teach the use of **mobile devices** with **cameras** and software for capturing images. I outline Garcia's and Luo's teachings in Section XI.A.1.a. As another example, Goyal teaches:

> By being an open-ended API, MMAPI provides a single, simple yet powerful medium to embed audio and video in your MID lets. Device manufacturers decide which part of the API they want to and can support and consequently provide implementations that take full advantage of the device's features. For example, if the device contains a camera, the MMAPI implementation on it may provide means to capture snapshots or full videos. The point is that the device manufacture is in full control of the capabilities that it wants enabled and can do so with a single API interface.

EX1008-Goyal, 127; *see also id.*, 1. Goyal further discloses:

> After you have a Player instance hooked into a video

> camera, it's a simple matter of extracting a VideoControl from it to look through its viewfinder and display this video to the user. Note that to look through a viewfinder, you need to use a VideoControl and not a RecordControl, because you are not recording anything (yet).

Id., 174. These similar teachings would have suggested to a person of ordinary skill in the art that the teaching from one disclosure could have easily been applied to the teachings of others.

382. A person of ordinary skill in the art would have also expected success in the combination based on the references' own teachings. For example, Garcia discloses a "computer application in the **mobile telephone** in which an interactive session is established with the **receiving institution** through the mobile communications operator" without describing any challenges that a person of skill in the art would have faced implementing such features. EX1003-Garcia, 9:19-10:18. Consistent with the level of ordinary skill in the art and the readily available solutions for image capture and mobile software architecture (*see, supra*, Sections VI.C and VI.D), a person of ordinary skill in the art would have understood Garcia to teach that implementing known details like Luo's image capture process or Goyal's software architecture would have been within the capability set and

knowledge of a person of ordinary skill in the art. EX1004-Luo, 1, 3, 7, 8; EX1008-Goyal, 1, 127, 174. Moreover, implementing the Garcia/Luo/Goyal combination would have simply involved writing computer code using readily accessible software development kits, like the Java ME MMAPIs taught be Goyal. Consistent with my understanding of the level of skill in the art and the disclosure of the references themselves, other prior art disclosures teach that it was "trivial for a mobile application developer to access a **camera**…." EX1040-CodeGuru, 1. This too is consistent with Goyal's teachings. Goyal discloses that embedding live video into an application is "the biggest advantage that MMAPI can bring" and MMAPI is "a single, simple yet powerful medium" that "provides the means using your device." EX1008-Goyal, 127. Moreover, as I explained above in Section XI.A.1.a, my opinion that a person of ordinary skill in the art would have reasonably expected success in the Garcia/Luo/Goyal combination is consistent with the '095 patent's disclosure.

383. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia/Luo with Goyal to incorporate Goyal's teaching to use a software application for download for Garcia's mobile check deposit method and Luo's capture process, and to control the **camera** with an API.

b. Combination of Garcia in view of Cohen ("Garcia/Cohen")

384. As I explained above in Section XI.A.1.b, a person of ordinary skill in the art would have been motivated to combine the teachings of Garcia with the teachings of Cohen. For example, a person of ordinary skill in the art would have been motivated to incorporate into Garcia Cohen's teachings regarding performing OCR, reading the **MICR line**, confirmation/verification steps, and image processing location. I explain above in Section XI.E.2 why this combination discloses various limitations of the '095 patent claims.

2. Claims 1-4, 6-12, 14-21, 23-30

a. Goyal Renders Obvious a Downloaded Applications (Limitations 1[c], 1[e], 2[a], 9[a], 9[c], 18[c], 18[e], 19[a], 26[c], 27[e], 27[a])

385. As I explained in Sections XI.A.2.d, XI.A.2.f, and XI.A.3.a, claim limitations involving a downloaded application would have been obvious in view of Meier. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

386. As I explained in Section XI.A.2.d, Garcia teaches performing remote check deposit by using a **mobile device** with a **camera** to capture an image of a check using a "computer application" resident on the device. As I explained, a person of ordinary skill in the art would have understood that the "computer

application" would have been an *app for download*. EX1003-Garcia, 9:19-10:18. Goyal also discloses a downloadable application like that described in Garcia. EX1008-Goyal, 1, 66, 127. As I explain below, Goyal's downloaded application can implement Garcia's disclosure to capture an image of a check using a **mobile device**.

387. Goyal is directed to Java-based mobile applications called "MIDlets." EX1008-Goyal, 1, 3-4. MIDlets are written by third-party application developers to implement a wide variety of functions. *Id.* One such function includes accessing a **device's** hardware features, such as a **camera**. *Id.*, 16, 127, 174-79. A person of ordinary skill in the art, in view of Goyal's disclosure of discrete third-party application developers, would have found it obvious to download such applications. Downloaded applications were well known by persons of ordinary skill in the art. *See, supra*, §V.D. Thus, persons of skill in the art had already begun downloading Java API-based software applications by 2004—well before the '095 patent. For example, a website for the Nokia Series 60 platform available at least as of April 2004 explains that "Java and Symbian OS" allow users to "[d]ownload, install and run software applications." EX1058-Series60. As another example, a Java mobile edition ("J2ME") reference guide explains that downloading a Java-based application "[o]ver a network to which the device is connected…is the most

common way in which MIDlets are downloaded to **cell phones** and similar **wireless devices**, although it is also applicable to network-connected **PDAs**." EX1059-Topley, 75-76. Downloading the app over a network is held in contrast to other mechanisms, like downloading "[f]rom a local host computer." *Id.* A person of ordinary skill in the art would have understood Goyal to teach or render obvious a downloaded application for two reasons.

388. First, a person of ordinary skill in the art would have recognized that there are only a handful of options for how software can be loaded onto a **mobile device**. These include preinstalling the software on the **mobile device** (e.g., by the device manufacturer), downloading the software from the web, or loading the software from a storage device accessible to a host computer connected to the **mobile device**. When making this choice, a person of ordinary skill in the art would have considered downloading an application to have numerous benefits. These include allowing end users of the application to select which applications they want on their device and which they do not. In addition, downloading an application allows third parties to deploy applications outside of a manufacturer's initial software installation or later software updates, thus providing flexibility to third-party application developers and avoiding the need to negotiate with the manufacturer regarding availability of a third-party application. In addition, downloading an application

reduces the potential number of unnecessary or unwanted applications stored on the **mobile device**. That is, if all third-party applications had to be pre-installed, there would be little room for a marketplace of apps, and much less space on the **mobile device** for storing other information or **documents**. As another example, downloading an application is easier than plugging the **mobile device** into a host computer or storage medium to obtain new software, and can be done from anywhere without the need of a specialized cable or particular storage media.

389. Second, Goyal's disclosure of "over the air" ("OTA") provisioning teaches downloading an application. Goyal teaches deploying MIDlet applications using OTA. EX1008-Goyal, 66-67. OTA was a well-known process for obtaining MIDlets that a person of ordinary skill in the art would have understood to teach downloading such applications. For example, a Java mobile edition ("J2ME") reference guide makes clear that "[OTA] is the most common way in which MIDlets are downloaded to **cell phones** and similar **wireless devices**, although it is also applicable to network-connected **PDAs**. The process of deploying MIDlet suites over a network ***is referred to as over-the-air provisioning, or OTA provisioning*** for short." EX1059-Topley, 75-77. As I explained in Section XI.E.1.a, downloading applications was a well-known, common, and obvious way for installing an application on a **mobile device**. Thus, a person of ordinary skill in the art would

have understood Goyal's disclosure of OTA to teach or render obvious downloading the MIDlet or mobile application.

390. As I explained in Section XI.E.1.a, implementing Garcia's computer application with Goyal's downloaded application would have been obvious. In the combination of Garcia/Goyal, the downloaded app would be provided by and associated with a bank for the same reasons I explained with reference to Section XI.A.2.d. *See also* EX1003-Garcia, 4:1-8.

b. Goyal Renders Obvious a Software Abstraction Layer that Controls a Device Camera (Limitations 1[b]-1[c], 1[e], 18[b]-18[c], 18[e], 26[b]-26[c], 26[e])

391. As I explained in Sections XI.A.2.c, XI.A.2.d, and XI.A.2.f, limitations involving the use of a software abstraction layer to control a **mobile device camera** would have been obvious in view of Meier. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

392. As I explained in Section XI.E.1.a, Goyal further teaches that a downloadable application can use an API to control the **mobile device camera**. For example, Goyal discloses that the available APIs are used "to hook into a **device camera** …." EX1008-Goyal, 127, 174; *see also id.*, 1, 66, 130, 173, 179, 191. Goyal further teaches that an API of a **mobile device** can be used to "provide means to capture snapshots or full videos" for devices with a **camera**. EX1008-Goyal, 127;

see also id., 1, 130, 173, 179. More specifically, Goyal teaches that relevant APIs for previewing video include the `Canvas` and `CaptureVideoCanvas` APIs, which allows a user "to display the video through the viewfinder to the user." EX1008-Goyal, 174; *id.* ("So, can you just hook into the **camera**, without actually recording anything, to first show the user the view through the video? Of course!"), 177. A person of ordinary skill in the art would have understood the previewed video to be live video.

393. When a user wishes to capture an image from the displayed video, Goyal discloses using the `getSnapshot` API, which has access to image capture and video preview from a **device camera**. *Id.*, 174, ("The `getSnapshot()` method in `VideoControl` allows you to take a snapshot of the image that is playing on the device screen. Of course, because the `getSnapshot ()` method is a method of the `VideoControl` class, you can take an image of any video that is playing on a device screen, not just captured video."), 178 ("Taking a snapshot is now easy, given that you only need to use the `getSnapshot(StringimageFormat)` method of the `VideoControl` control."), 191 ("[F]irst the user is shown the viewfinder of the onboard **camera** and then shown the associated snapshot that is taken when the user presses the Done menu item."). Consistent with the '095 patent's disclosure, a person of ordinary skill

in the art would have understood the above-mentioned APIs to disclose a software abstraction layer. Goyal provides numerous examples of how to use the above-mentioned APIs. *See, e.g.*, *id.*, 174-77 ("Looking Through a Camera's Viewfinder and Displaying Onscreen"); 178-79 ("Taking Snapshots").

```
    // now create the canvas
    canvas = new CaptureVideoCanvas(this);
    canvas.addCommand(exitCommand);
    canvas.setCommandListener(this);
} catch(Exception e) {
    error(e);
```

Id., 175.

394. In addition, Goyal's API and associated software, can be executed to perform numerous other operations, including controlling "the exposure, the flash, focus, zoom, and burst shooting of snapshots" and "shutter control, **camera** rotation." EX1008-Goyal, 253. In the combination of Garcia/Luo/Cohen, the software would also perform additional operations described in other claim limitations based on the output of Goyal's APIs. §§XI.A.2.e-XI.A.2.l, XI.E.1.

395. As I explained in Section XI.E.1.a, implementing Garcia's computer application using Goyal's **camera** control API would have been obvious. In the combination of Garcia and Goyal, the image capture and processing steps described below with reference to limitations 1[d]-1[k] and other similar requirements would

have been performed by the downloaded app.

c. Goyal Renders Obvious Using Live Video Frames (Limitations 1[pre], 1[e]-1[j], 2[b]-2[c], 7, 9[pre], 9[c]-9[h], 10[b]-10[c], 18[pre], 18[e]-18[i], 19[b]-19[c], 24, 26[pre], 26[e]-26[i], 27[b]-27[c])

396. As I explained in Sections XI.A.2.a, XI.A.2.f-XI.A.2.k, XI.A.3.b, XI.A.3.c, and XI.A.3.g, limitations involving the use of (live) video frames would have been obvious in view of Meier. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

397. As I explained in Section XI.E.2.b, Goyal teaches that the image capture process involves "previewing video" before capturing the image. For example, Goyal teaches that APIs for controlling the **camera** by "us[ing] a `Canvas` to display the video through the viewfinder to the user." EX1008-Goyal, 174; *see also id*., 13, 14, 66, 175-79, 191. From this disclosure, a person of ordinary skill in the art would have understood the "viewfinder" and "previewing" to include accessing and displaying live video. Persons of ordinary skill in the art would have understood a digital viewfinder, such as that disclosed by Goyal, to be the digital version of lens-based viewfinders previously available on film-based **cameras**. Viewfinders are used by photographers to view the scene to be captured in the **camera** view the instant before they capture an image. Lens-based viewfinders, by virtue of redirecting light, did not have any sources of delay. Digital viewfinders,

which replace lens-based viewfinders with a digital image from the **camera**, must mimic that feature to allow for the photographer to view the scene that will be captured the instant before they capture it. Thus, a person of ordinary skill in the art would understand digital viewfinders to provide live video.

398. Because the Camera APIs I outlined above in Section XI.E.2.b (which are software abstraction layers), are the software elements that interface with the **camera** hardware to control image settings and preview, the downloaded app in the Garcia/Luo/Goyal combination would cause the live video to be generated/displayed by controlling the **camera** through the software abstraction layer. *See* EX1008-Goyal, 174-178.

399. As I also explained in Section XI.E.2.b, Goyal also teaches that an API of a **mobile device** can "provide means to capture snapshots or full videos" for **devices** with **camera**. EX1008-Goyal, 127; *see also id.*, 1, 130, 173-174, 178-179, 191. For example, Goyal teaches capturing an image or frame from the preview displayed on a viewfinder that I explained above. EX1008-Goyal, 174 ("[T]he `getSnapshot()` method is a method of the `VideoControl` class, you can take an image of any video that is playing on a device screen, not just captured video.").

400. Therefore, it is my opinion that Goyal teaches or renders obvious the additional limitations in the '095 patent claims that require the use of live video

frames, for example for displaying, monitoring, and capturing images, for similar reasons that Meier teaches or renders obvious such limitations. As I explained in Section XI.E.1.a, implementing Garcia's computer application using Goyal's monitoring and capture of live video would have been obvious.

d. Additional Limitations

401. In my opinion, the remaining limitations in claims 1-4, 6-12, 14-21, 23-30 would have been obvious in view of Garcia, Luo, Goyal, and Cohen for the same reasons I explained in Sections XI.A.2.b, XI.A.2.e, XI.1A.2.l-XI.A.2.r, XI.A.3.d-XI.A.3.f, XI.A.3.h-XI.A.3.l.

F. Ground VI: Claims 5, 13, 22 are Obvious Over Garcia in Combination with Luo, Goyal, Cohen, and Yoon ("Garcia/Luo/Goyal/Cohen/Yoon")

402. As I explained above in Section XI.E, in my opinion, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen. It is also my opinion that the additional limitations in claims 5, 13, 22 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen and further in view of Yoon, which teaches the use of brightness as a prerequisite to automatically capturing an image of a **document**, for similar reasons as to why the same claims would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen and further in view of Yoon (Section XI.B).

G. Ground VII: Claims 7 and 24 are Obvious Over Garcia in Combination with Luo, Meier, Cohen, and Randle ("Garcia/Luo/Goyal/Cohen/Randle")

403. As I explained above in Section XI.E, in my opinion, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen. It is also my opinion that the additional limitations in claims 7 and 24 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen and further in view of Randle, which teaches image conversion techniques, for similar reasons as to why the same claims would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen and further in view of Randle (Section XI.C).

H. Ground VIII: Claims 11 and 16 are Obvious Over Garcia in Combination with Luo, Meier, Cohen, and Attia ("Garcia/Luo/Goyal/Cohen/Attia")

404. As I explained above in Section XI.E, in my opinion, claims 1-4, 6-12, 14-21, 23-30 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen. It is also my opinion that the additional limitations in claims 11 and 16 would have been obvious over the combination of Garcia in view of Luo, Goyal, and Cohen and further in view of Attia, which teaches performing image monitoring/decoding on a server instead of a **mobile device**, for similar reasons as to why the same claims would have been obvious over the combination of Garcia in view of Luo, Meier, and Cohen and further in view of Attia (Section

XI.D).

XII. CONCLUSION

405. Based on the foregoing, claims 1-30 of the '095 patent recite subject matter that would have been obvious to a person of ordinary skill at the relevant times.

XIII. AVAILABILITY FOR CROSS-EXAMINATION

406. In signing this declaration, I recognize that this declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross- examination.

XIV. RIGHT TO SUPPLEMENT

407. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises and to take into account new information as it becomes available to me.

XV. ACKNOWLEDGMENT

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the full knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code.

Dated:



Dr. Daniel Lopresti

APPENDIX A

LISTING OF CLAIMS

Claim 1	
Limitation	**Claim Language**
1[pre]	A system enabling mobile check deposit auto-capture functionality via video frame processing, the system comprising:
1[a]	a mobile device of a user, the user's mobile device including a camera, a processor, and a memory coupled to the processor, the memory storing
1[b]	a software abstraction layer for controlling the camera, the software abstraction layer comprising Instructions that, when executed by the processor, control the camera; and
1[c]	a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the camera through the software abstraction layer, the downloaded app comprising Instructions that, when executed by the processor, cause the user's mobile device to perform operations including:
1[d]	providing Instructions to the user for capturing an image of a check;

1[e]	generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;
1[f]	overlaying an alignment guide on the live video of the check in the field of view of the camera;
1[g]	monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;
1[h]	determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;
1[i]	when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;
1[j]	using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the

	video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and
1[k]	confirming that the mobile check deposit can go forward after optical character recognition is performed on the check in the digital image, a magnetic ink character recognition (MICR) line on the check in the digital image is recognized, and an amount payable on the check in the digital image is validated;
1[l]	a server, remote from the user's mobile device, comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the server to perform operations including:
1[m]	receiving the digital image of the check transmitted by the user's mobile device, and
1[n]	processing the digital image of the check including performing optical character recognition on the check in the digital image and verifying that the digital image of the check is acceptable for mobile check deposit, the user's mobile device receiving an Indication of a result of the server's processing before confirming that the mobile check deposit can go forward; and

1[o]	a computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer to update a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the submitting the check for mobile check deposit in the bank, the confirming that the mobile check deposit can go forward, and the verifying that the digital image of the check is acceptable for mobile check deposit.

Claim 2	
Limitation	**Claim Language**
2[a]	The system of claim 1, wherein the downloaded app causes the user's mobile device to perform additional operations including:
2[b]	before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion; and

2[c]	after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user.

Claim 3
The system of claim 1, wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and magnetic ink character recognition (MICR) line detection.

Claim 4
The system of claim 3, wherein the plurality of monitoring criteria Includes a criterion based on magnetic ink character recognition (MICR) line detection.

Claim 5
The system of claim 3, wherein the plurality of monitoring criteria Includes criteria based on light brightness, skewing, and warping.

Claim 6
The system of claim 1, wherein the confirming that the mobile check deposit can go forward is performed after the transmitting the digital image of the check from the user's mobile device.

Claim 7
The system of claim 1, wherein the digital image is a modified version of the captured video frame.

Claim 8
The system of claim 1, wherein the wireless network is a cellular network.

Claim 9	
Limitation	**Claim Language**
9[pre]	A system enabling mobile check deposit auto-capture functionality via video frame processing, the system comprising:
9[a]	a mobile device of a user, the user's mobile device including a camera, a processor, and a memory coupled to the processor, the

	memory storing a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the camera, the system being configured to perform operations including:
9[b]	providing Instructions to the user for capturing an image of a check;
9[c]	generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera;
9[d]	overlaying an alignment guide on the live video of the check in the field of view of the camera;
9[e]	monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;
9[f]	determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;
9[g]	Wh9en the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one

	monitoring criterion, providing feedback advising the user that the check has been captured;
9[h]	using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, the digital image of the check being the captured video frame or being based on the captured video frame;
9[i]	processing the digital image of the check Including performing optical character recognition and verifying that the digital image of the check Is acceptable for mobile check deposit; and
9[j]	confirming that the mobile check deposit can go forward after optical character recognition is performed on the check in the digital image, a magnetic ink character recognition (MICR) line on the check in the digital image is recognized, and an amount payable on the check in the digital image is validated; and
9[k]	a bank computer programmed to update a balance of an account at a financial institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the check is submitted for mobile

	check deposit in the bank, confirming that the mobile check deposit can go forward, and verifying that the digital image of the check is acceptable for mobile check deposit.

Claim 10	
Limitation	**Claim Language**
10[a]	The system of claim 9, wherein the system is configured to perform additional operations including:
10[b]	before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion; and
10[c]	after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user.

Claim 11

The system of claim 9, further comprising one or more computers programmed to perform operations comprising the monitoring, the determining, or both the monitoring and the determining.

Claim 12
A The system of claim 9, wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and magnetic ink character recognition (MICR) line detection.

Claim 13
The system of claim 12, wherein the plurality of monitoring criteria Includes criteria based on light brightness, skewing, and warping.

Claim 14
The system of claim 9, wherein the confirming that the mobile check deposit can go forward is performed after the transmitting the digital image of the check from the user's mobile device.

Claim 15
The system of claim 14, wherein the user's mobile device receives an Indication of a result of the processing the digital image of the check before the confirming step.

Claim 16
The system of claim 11, wherein the one or more computers include the bank computer.

Claim 17
The system of claim 9, wherein the wireless network is a cellular network.

Claim 18	
Limitation	**Claim Language**
18[pre]	A system enabling mobile check deposit auto-capture functionality via video frame processing, the system comprising:

18[a]	a mobile device of a user, the user's mobile device including a camera, a processor, and a memory coupled to the processor, the memory storing:
18[b]	a software abstraction layer, the software abstraction layer comprising Instructions that, when executed by the processor, control the camera; and
18[c]	a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the camera through the software abstraction layer, the downloaded app comprising Instructions that, when executed by the processor, cause the user's mobile device to perform operations including:
18[d]	providing Instructions to the user for capturing an image of a check;
18[e]	generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;
18[f]	monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;

18[g]	determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;
18[h]	when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;
18[i]	using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and
18[j]	confirming that the mobile check deposit can go forward after optical character recognition is performed on the check, a magnetic ink character recognition (MICR) line on the check is recognized, and an amount payable on the check is validated; and
18[k]	a computer comprising a processor coupled to a memory storing Instructions that, when executed by the processor, cause the computer to update a balance of an account at a financial

	institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by the user's mobile device, after the submitting the check for mobile check deposit and the confirming that the mobile check deposit can go forward.

Claim 19	
Limitation	**Claim Language**
19[a]	The system of claim 18, wherein the downloaded app causes the user's mobile device to perform additional operations including:
19[b]	before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion; and
19[c]	after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user.

Claim 20

The system of claim 18, wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and magnetic ink character recognition (MICR) line detection.

Claim 21
The system of claim 20, wherein the plurality of monitoring criteria being based on magnetic ink character recognition (MICR) line detection and one or both of corner detection and edge detection.

Claim 22
The system of claim 20, wherein the plurality of monitoring criteria Includes criteria based on light brightness, skewing, and warping.

Claim 23
The system of claim 18, wherein the confirming that the mobile check deposit can go forward is performed after the transmitting the digital image of the check from the user's mobile device.

Claim 24
The system of claim 18, wherein the digital image is a modified version of the captured video frame.

Claim 25
The system of claim 18, wherein the wireless network is a cellular network.

Claim 26	
Limitation	**Claim Language**
26[pre]	A system enabling mobile check deposit auto-capture functionality via video frame processing, the system comprising:
26[a]	a mobile device of a user, the user's mobile device including a camera, a processor, and a memory coupled to the processor, the memory storing:
26[b]	a software abstraction layer, the software abstraction layer comprising Instructions that, when executed by the processor, control the camera; and

26[c]	a downloaded app, the downloaded app associated with a bank to control check deposit by controlling the camera through the software abstraction layer, the downloaded app comprising Instructions that, when executed by the processor, cause the user's mobile device to perform operations including:
26[d]	providing Instructions to the user for capturing a check;
26[e]	generating a live video of the check in a field of view of the camera, the downloaded app causing the live video to be generated by controlling the camera through the software abstraction layer;
26[f]	monitoring the live video of the check in the field of view of the camera with respect to at least one monitoring criterion;
26[g]	determining that a video frame of the live video of the check satisfies the at least one monitoring criterion and then automatically capturing the video frame;
26[h]	when the video frame of the live video of the check in the field of view of the camera is determined to satisfy the at least one monitoring criterion, providing feedback advising the user that the check has been captured;

26[i]	using a wireless network, transmitting a digital image of the check from the user's mobile device and submitting the check for mobile check deposit in the bank after automatically capturing the video frame, wherein the digital image is the captured video frame or is based on the captured video frame; and
26[j]	confirming that the mobile check deposit can go forward after optical character recognition is performed on the check, a magnetic ink character recognition (MICR) line on the check is recognized, and an amount payable on the check is validated;
26[k]	the system configured to perform image processing operations on an image of the check, the image processing operations including performing optical character recognition and verifying that the image of the check is acceptable for mobile check deposit, wherein the image of the check is the digital image transmitted by the user's mobile device or is based on the digital image transmitted by the user's mobile device; and
26[l]	a computer programmed to update a balance of an account at a financial Institution of the user to reflect an amount of funds associated with the check submitted for mobile check deposit by

	the user's mobile device, after the submitting the check for mobile check deposit in the bank, the confirming that the mobile check deposit can go forward, and the verifying that the image of the check is acceptable for mobile check deposit.

Claim 27	
Limitation	**Claim Language**
27[a]	The system of claim 26, wherein the downloaded app causes the user's mobile device to perform additional operations including:
27[b]	before determining that the video frame of the live video of the check satisfies the at least one monitoring criterion, determining that a different video frame of the live video of the check does not satisfy the at least one monitoring criterion; and
27[c]	after determining that the different video frame of the live video of the check does not satisfy the at least one monitoring criterion, providing feedback to the user.

Claim 28

The system of claim 26, wherein the at least one monitoring criterion is a plurality of monitoring criteria based on two or more selected from a group consisting of light contrast, light brightness, check positioning, check dimensions, character spacing, skewing, warping, corner detection, edge detection, and magnetic ink character recognition (MICR) line detection.

Claim 29
The system of claim 28, wherein the plurality of monitoring criteria Includes a criterion based on magnetic ink character recognition (MICR) line detection.

Claim 30
The system of claim 26, wherein the wireless network is a cellular network.

MATERIALS CONSIDERED

Exhibit Number	Description
1001	U.S. Patent No. 12,211,095 ("USP095")
1003	International Patent Application Publication No. WO 2005/043857 and Declaration of Translation ("Garcia")
1004	Chinese Patent Application Publication No. CN 1897644A and Declaration of Translation ("Luo")
1005	Meier, Reto, Professional Android™ Application Development, June 25, 2008 ("Meier")
1006	U.S. Patent Application Publication No. 2007/0194102 ("Cohen")
1007	U.S. Patent Application Publication No. 2007/0262148 ("Yoon")
1008	Selected Pages from Goyal, Vikram, Pro JAVA ME MMAPI: Mobile Media API for Java Micro Edition, June 14, 2006 ("Goyal")
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APPENDIX B

Daniel P. Lopresti
Curriculum Vitae
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A. Biographical Information

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Educational History

- A.B. (Bachelor of Arts), Mathematics and Engineering Science, Dartmouth College, Hanover, NH, June 1982.

- M.S.E. (Master of Science in Engineering), Electrical Engineering and Computer Science, Princeton University, Princeton, NJ, June 1983.

- M.A. (Master of Arts), Electrical Engineering and Computer Science, Princeton University, Princeton, NJ, June 1984.

- Ph.D. (Doctor of Philosophy), Computer Science, Princeton University, Princeton, NJ, January 1987.

Professional Experience

- Assistant Professor of Computer Science, Brown University, Providence, RI, September 1986 – May 1991.

- Principal Scientist, Matsushita Information Technology Laboratory, Princeton, NJ, June 1991 – October 1997.

- Member of Technical Staff, Bell Labs, Lucent Technologies, Murray Hill, NJ, October

1997 – December 2002.

- Visiting Research Scientist, Palo Alto Research Center, Palo Alto, CA, December 2002 – June 2003.

- Research Fellow, Information Security Institute, Johns Hopkins University, Baltimore, MD, February 2003 – June 2003.

- Visiting Research Associate Professor, Electrical, Computer & Systems Engineering, Rensselaer Polytechnic Institute, Troy, NY, February 2003 – June 2003.

- Associate Professor, Computer Science & Engineering, Lehigh University, Bethlehem, PA, July 2003 – May 2009. Class of 1961 Professorship, September 2005 – May 2007.

- Professor, Computer Science & Engineering, Lehigh University, Bethlehem, PA, May 2009 – present.

- Department Chair, Computer Science & Engineering, Lehigh University, Bethlehem, PA, July 2009 – June 2012 (first term), July 2012 – June 2014 (second term), July 2015 – June 2019 (third term).

- Interim Dean, P. C. Rossin College of Engineering and Applied Science, Lehigh University, Bethlehem, PA, July 2014 – June 2015.

- Director, Data X Strategic Initiative, Lehigh University, Bethlehem, PA, July 2015 – June 2020.

B. Publications and Creative Activities

Books Edited

E1. *Document Recognition V*, Proceedings of SPIE Vol. 3305, D. Lopresti and J. Zhou (editors), January 1998.

E2. *Document Recognition and Retrieval VI*, Proceedings of SPIE Vol. 3651, D. Lopresti and J. Zhou (editors), January 1999.

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E6. *Human Interactive Proofs*, Lecture Notes in Computer Science Vol. 3517, H. Baird and D. Lopresti (editors), Springer-Verlag, May 2005.

E7. *Proceedings of the Second Workshop on Analytics for Noisy Unstructured Text Data*, ACM International Conference Proceeding Series (ACM Digital Library), D. Lopresti, S. Roy, K. Schulz, and L. V. Subramaniam (editors), July 2008.

E8. *Proceedings of the Third Workshop on Analytics for Noisy Unstructured Text Data*, ACM International Conference Proceeding Series (ACM Digital Library), D. Lopresti, S. Roy, K. Schulz, and L. V. Subramaniam (editors), July 2009.

E9. *Proceedings of the Ninth IAPR International Workshop on Document Analysis Systems*, ACM International Conference Proceeding Series (ACM Digital Library), D. Doermann, V. Govindaraju, D. Lopresti, and P. Natarajan (editors), June 2010.

E10. *Proceedings of the Fourth Workshop on Analytics for Noisy Unstructured Text Data*, ACM International Conference Proceeding Series (ACM Digital Library), R. Basili, D. Lopresti, C. Ringlstetter, S. Roy, K. Schulz, and L. V. Subramaniam (editors), October 2010.

E11. *Proceedings of the Joint Workshop on Multilingual OCR and Analytics for Noisy Unstructured Text Data*, ACM International Conference Proceeding Series (ACM Digital Library), L. Dey, V. Govindaraju, D. Lopresti, P. Natarajan, C. Ringlstetter, and S. Roy (editors), September 2011.

E12. *Proceedings of the Eleventh International Conference on Document Analysis and Recognition*, IEEE Xplore Digital Library, T. Breuel, D. Lopresti, and C. L. Tan (program co-chairs), September 2011.

E13. *Reproducible Research in Pattern Recognition: Second International Workshop*, Lecture Notes in Computer Science Vol. 11455, B. Kerautret, M. Colom, D. Lopresti, P. Monasse, and H. Talbot (editors), Springer Nature, 2019.

E14. *Proceedings of the Fourteenth IAPR International Workshop on Document Analysis Systems*, Vol. 12116, X. Bai, D. Karatzas, and D. Lopresti (editors), Springer Nature, 2020.

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Chapters in Books

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C105. "Document Analysis Issues in Reading Optical Scan Ballots," D. Lopresti, G. Nagy, and E. Barney Smith, *Proceedings of the Ninth IAPR International Workshop on Document Analysis Systems*, June 2010, Boston, MA, pp. 105-112.

C106. "Ruling Line Removal in Handwritten Page Images," D. Lopresti and E.

Kavallieratou, *Proceedings of the Twentieth International Conference on Pattern Recognition*, August 2010, Istanbul, Turkey, pp. 2704-2707.

C107. "A Platform for Storing, Visualizing, and Interpreting Collections of Noisy Documents," B. Lamiroy and D. Lopresti, *Proceedings of the Fourth Workshop on Analytics for Noisy Unstructured Text Data*, October 2010, Toronto, Canada, pp. 11-18.

C108. "The Impact of Ruling Lines on Writer Identification," J. Chen, D. Lopresti, and E. Kavallieratou, *Proceedings of the Twelfth International Conference on Frontiers in Handwriting Recognition*, November 2010, Kolkata, India, pp. 439-444.

C109. "Characterizing Challenged Minnesota Ballots," G. Nagy, D. Lopresti, E. H. Barney Smith, and Z. Wu, *Document Recognition and Retrieval XVIII (IS&T/SPIE International Symposium on Electronic Imaging)*, January 2011, San Francisco, CA, pp. 787413-1 - 787413-10.

C110. "Parameter Calibration for Synthesizing Realistic-Looking Variability in Offline Handwriting," W. Cheng and D. Lopresti, *Document Recognition and Retrieval XVIII (IS&T/SPIE International Symposium on Electronic Imaging)*, January 2011, San Francisco, CA, pp. 78740Y-1 - 78740Y-10.

C111. "Using Perturbed Handwriting to Support Writer Identification in the Presence of Severe Data Constraints," J. Chen, W. Cheng, and D. Lopresti, *Document Recognition and Retrieval XVIII (IS&T/SPIE International Symposium on Electronic Imaging)*, January 2011, San Francisco, CA, pp. 78740G-1 - 78740G-8.

C112. "Ruling Line Detection and Removal," E. Kavallieratou, D. Lopresti, and J. Chen, *Document Recognition and Retrieval XVIII (IS&T/SPIE International Symposium on Electronic Imaging)*, January 2011, San Francisco, CA, pp. 78740V-1 - 78740V-7.

C113. "How Carefully Designed Open Resource Sharing Can Help and Expand Document Analysis Research," B. Lamiroy, D. Lopresti, H. Korth and J. Heflin, *Document Recognition and Retrieval XVIII (IS&T/SPIE International Symposium on Electronic Imaging)*, January 2011, San Francisco, CA, pp. 78740O-1 - 78740O-14.

C114. "Speech Biometric Mapping for Cryptographic Key Generation," K. Inthavisas and D. Lopresti, *Biometric Technology for Human Identification VIII (SPIE Defense, Security, and Sensing)*, April 2011, Orlando, FL, pp. 80291P-1 - 80291P-12.

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C117. "Biometric Template Protection for Dynamic Time Warping-based User Authentication," K. Inthavisas and D. Lopresti, *Proceedings of the International Conference on Image Processing, Computer Vision, and Pattern Recognition (IPCV 2011)*, July 2011, Las Vegas, NV, pp. 303-309.

C118. "A Real-World Noisy Unstructured Handwritten Notebook Corpus for Document Image Analysis Research," J. Chen, D. Lopresti and B. Lamiroy, *Proceedings of the Joint Workshop on Multilingual OCR and Analytics for Noisy Unstructured Text Data (J-MOCR-AND 2011)*, September 2011, Beijing, China, 8 pages, http://doi.acm.org/10.1145/2034617.2034620.

C119. "When is a Problem Solved?" D. Lopresti and G. Nagy, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 32-36.

C120. "An Open Architecture for End-to-End Document Analysis Benchmarking," B. Lamiroy and D. Lopresti, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 42-47.

C121. "Table Detection in Noisy Off-line Handwritten Documents," J. Chen and D. Lopresti, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 399-403.

C122. "A Model-based Ruling Line Detection Algorithm for Noisy Handwritten Documents," J. Chen and D. Lopresti, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 404-408.

C123. "Towards Improved Paper-based Election Technology," E. Barney Smith, D. Lopresti, G. Nagy, and Z. Wu, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 1255-1259.

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C124. "Evaluation of Voting with Form Dropout Techniques for Ballot Vote Counting," E. Barney Smith, S. Goyal, R. Scott, and D. Lopresti, *Proceedings of the Eleventh International Conference on Document Analysis and Recognition (ICDAR 2011)*, September 2011, Beijing, China, pp. 473-477.

C125. "Speech Cryptographic Key Regeneration Based on Password," K. Inthavisas and D. Lopresti, *Proceedings of the International Joint Conference on Biometrics (IJCB 2011)*, October 2011, Arlington, VA, 7 pages, DOI: 10.1109/IJCB.2011.6117553.

C126. "The Non-Geek's Guide to the DAE Platform," B. Lamiroy and D. Lopresti, *Proceedings of the Tenth IAPR International Workshop on Document Analysis Systems*, March 2012, Gold Coast, Australia, 6 pages.

C127. "Adapting the Turing Test for Declaring Document Analysis Problems Solved," D. Lopresti and G. Nagy, *Proceedings of the Tenth IAPR International Workshop on Document Analysis Systems (DAS 2012)*, March 2012, Gold Coast, Australia, 5 pages.

C128. "Model-based Tabular Structure Detection and Recognition in Noisy Handwritten Documents," J. Chen and D. Lopresti, *Proceedings of the Thirteenth International Conference on Frontiers in Handwriting Recognition (ICFHR 2012)*, September 2012, Bari, Italy, pp. 75-80.

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C130. "Exploiting Ruling Line Artifacts in Writer Identification," J. Chen and D. Lopresti, *Proceedings of the Twenty-First International Conference on Pattern Recognition (ICPR 2012)*, November 2012, Tsukuba, Japan, pp. 3737-3740.

C131. "Optimal Policy for Labeling Training Samples," L. Lipsky, D. Lopresti, and G. Nagy, *Proceedings of Document Recognition and Retrieval XX (IS&T/SPIE International Symposium on Electronic Imaging)*, February 2013, San Francisco, CA, pp. 865809-1 – 865809-9.

C132. "Boxy, Semi-Structured Document Elements," G. Nagy, D. W. Embley, and D. P. Lopresti, *Proceedings of the Tenth IAPR International Workshop on Graphics Recognition (GREC 2013)*, August 2013, Bethlehem, PA, 7 pages.

C133. "Alternatives for Page Skew Compensation in Writer Identification," J. Chen and D. Lopresti, *Proceedings of the Twelfth International Conference on Document Analysis and Recognition (ICDAR 2013)*, August 2013, Washington, DC, pp. 927-931.

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C135. "Form Similarity via Levenshtein Distance Between Ortho-Filtered Logarithmic Ruling-Gap Ratios," G. Nagy and D. Lopresti, *Proceedings of Document Recognition and Retrieval XXI (IS&T/SPIE International Symposium on Electronic Imaging)*, February 2014, San Francisco, CA, pp. 902106-1 - 902106-8.

C136. "The DAE Platform: A Framework for Reproducible Research in Document Image Analysis," B. Lamiroy and D. Lopresti, *Proceedings of the First International Workshop on Reproducible Research in Pattern Recognition*, December 2016, Cancun, Mexico, Springer LNCS Vol. 10214, pp. 17-29.

C137. "A New Common Points Detection-Based Method for Classification of 2D and 3D Texts in Video/Scene Images," L. Nandanwar, P. Shivakumara, A. Kumar, T. Lu, U. Pal, and D. Lopresti, *Proceedings of the Fourteenth International Workshop on Document Analysis Systems (DAS 2020)*, July 2020, Wuhan, China (virtual), Springer LNCS Vol. 12116, pp. 512-528.

C138. "A New Context-Based Method for Restoring Occluded Text in Natural Scene Images," A. Mittal, P. Shivakumara, U. Pal, T. Lu, M. Blumenstein, and D. Lopresti, *Proceedings of the Fourteenth International Workshop on Document Analysis Systems (DAS 2020)*, July 2020, Wuhan, China (virtual), Springer LNCS Vol. 12116, pp. 466-480.

C139. "A New Method for Detecting Altered Text in Document Images," L. Nandanwar, P. Shivakumara, U. Pal, T. Lu, D. Lopresti, B. Seraogi, and B. B. Chaudhuri, *Proceedings of the Second International Conference on Pattern Recognition and Artificial Intelligence (ICPRAI 2020)*, October 2020, Zhongshan City, China (virtual), Springer LNCS Vol. 12068, pp. 93-108.

C140. "Reproducibility: Evaluating the Evaluations," D. Lopresti and G. Nagy, *Reproducible Research in Pattern Recognition: Third International Workshop (RRPR 2020)*, January 2021, Milan, Italy (virtual), Springer LNCS Vol. 12636, pp. 12-23.

C141. "Local Gradient Difference Features for Classification of 2D-3D Natural Scene Text Images," L. Nandanwar, S. Palaiahnakote, R. Ramachandra, T. Lu, U. Pal, D. Lopresti, and N. B. Anuar, *Proceedings of the Twenty-Fifth International Conference on Pattern Recognition (ICPR 2020)*, January 2021, Milan, Italy (virtual), IEEE Computer Society Press, pp. 1,112-1,119.

C142. "Chebyshev Harmonic Fourier Moments and Deep CNNs for Detecting Forged

Handwriting," L. Nandanwar, S. Palaiahnakote, K. Sayani, U. Pal, T. Lu, D. Lopresti, *Proceedings of the Twenty-Fifth International Conference on Pattern Recognition (ICPR 2020)*, January 2021, Milan, Italy (virtual), IEEE Computer Society Press, pp. 6,562-6,569.

C143. "Competition and Collaboration in Document Analysis and Recognition," D. Lopresti and G. Nagy*, Proceedings of the Sixteenth International Conference on Document Analysis and Recognition (ICDAR 2021)*, September 2021, Lausanne, Switzerland (hybrid), Springer LNCS Vol. 12821, pp. 176-187.

C144. "Personality Trait Prediction from Twitter Data (X) Based on Image, Text, and Image-Text Features," K. Biswas, S. Palaiahnakote, U. Pal, D. Lopresti, and T. Lu, to be presented at the *Nineteenth International Conference on Document Analysis and Recognition (ICDAR 2025)*, September 2025, Wuhan, China.

Edited Publications and Other Articles (including invited and non-refereed)

O1. "Gene Matching Using Microcomputers," D. Lopresti, *Encyclopedia of Microcomputers*, vol. 7, New York: Marcel Dekker, 1991, pp. 419-431.

O2. Special Issue Editor, *SPIE/IS&T International Electronic Imaging Working Group Newsletter*, vol. 8, no. 2, June 1998.

O3. "Electronic Ink as First-Class Computer Data," D. Lopresti, *1999 McGraw-Hill Yearbook of Science and Technology*, pp. 96-98.

O4. "Information Retrieval," D. Lopresti and G. Wilfong, *2001 McGraw-Hill Yearbook of Science and Technology*, pp. 204-206.

O5. Guest Editor (with J. Hu and R. Kashi), Special Issue on Document Analysis Systems, *International Journal of Document Analysis and Recognition*, vol. 6, no. 3, March 2003.

O6. "Human/Machine Differentiation," H. Baird and D. Lopresti, *2005 McGraw-Hill Yearbook of Science and Technology*, pp. 144-147.

O7. "Act Now to Ensure Safe and Secure Elections," D. Lopresti, op-ed piece, *Lehigh Alumni Bulletin*, Fall 2007, pg. 89.

O8. Guest Editor (with C. Knoblock, S. Roy, and L. V. Subramaniam), Special Issue on Noisy Text Analytics, *International Journal of Document Analysis and Recognition*, vol. 10, nos. 3-4, December 2007.

O9. Guest Editor (with S. Roy, K. Schulz, and L. V. Subramaniam), Special Issue on Noisy Text Analytics, *International Journal of Document Analysis and Recognition*, vol. 12, no. 3, October 2009.

O10. Guest Editor (with J. Lladós and S. Uchida), Special Issue on Advanced Topics in Document Analysis and Recognition, *International Journal of Document Analysis and Recognition*, vol. 24, no. 3, September 2021.

Reviews (Book, Film, Software, Exhibit, Performance, etc.) and Notes

R1. Book review of *Image Description and Retrieval*, Enrico Vicario, ed., Plenum Press, Daniel Lopresti, in *Pattern Analysis & Applications*, vol. 4, no. 1, 2001, pp. 75-76.

Patents

P1. "Certifiable Optical Character Recognition," D. Lopresti, H. Korth, J. Sandberg, and R. Lipton, U.S. Patent No. 5,625,721, issued April 1997.

P2. "Certifiable Optical Character Recognition," D. Lopresti, H. Korth, J. Sandberg, and R. Lipton, U.S. Patent No. 5,703,972, issued December 1997.

P3. "Pictographic Bitmap Naming of Files in Pen-Based Computer Systems," D. Lopresti and A. Tomkins, U.S. Patent No. 5,734,882, issued March 1998.

P4. "A Method and Means for Enhancing Optical Character Recognition of Printed Documents," D. Lopresti and J. Sandberg, U.S. Patent No. 5,748,807, issued May 1998.

P5. "System and Method for Archiving Digital Versions of Documents and for Generating Quality Printed Documents Therefrom," D. Lopresti, J. Esakov, and J. Zhou, U.S. Patent No. 5,754,308, issued May 1998.

P6. "System and Method for Handwriting Matching Using Edit Distance Computation in a Systolic Array Processor," D. Lopresti, U.S. Patent No. 5,757,959, issued May 1998.

P7. "Multimedia Rendering Marker and Method," D. Lopresti and J. Sandberg, U.S. Patent No. 5,793,903, issued August 1998.

P8. "Method of Locating a Penstroke Sequence in a Computer," D. Lopresti and A. Tomkins, U.S. Patent No. 5,809,498, issued September 1998.

P9. "Document Search and Retrieval System with Partial Match Searching of User-Drawn Annotations," D. Lopresti, Y. Ma, and J. Zhou, U.S. Patent No. 5,832,474, issued November 1998.

P10. "Multimedia Rendering Marker and Method," D. Lopresti and J. Sandberg, U.S. Patent No. 5,852,684, issued December 1998.

P11. “A Clock-Free Two-Dimensional Barcode and Method for Printing and Reading the Same,” D. Lopresti, J. Esakov, and J. Zhou, U.S. Patent No. 5,862,270, issued January 1999.

P12. “Video User’s Environment,” D. Lopresti, Y. Ma, A. Tomkins, and J. Zhou, U.S. Patent No. 5,889,506, issued March 1999.

P13. “Title, Caption and Photo Extraction from Scanned Document Images,” J. Zhou and D. Lopresti, U.S. Patent No. 5,892,843, issued April 1999.

P14. “Method of Locating a Machine-Readable Two-Dimensional Barcode Within an Image,” J. Zhou and D. Lopresti, U.S. Patent No. 5,974,200, issued October 1999.

P15. “Method and Means for Enhancing Optical Character Recognition of Printed Documents,” D. Lopresti and J. Sandberg, U.S. Patent No. 6,047,093, issued April 2000.

P16. “A Clock-Free Two-Dimensional Barcode and Method for Printing and Reading the Same,” D. Lopresti, J. Esakov, and J. Zhou, U.S. Patent No. 6,115,508, issued September 2000.

P17. “Border-less Clock Free Two-Dimensional Barcode and Method for Printing and Reading the Same,” J. Zhou, D. Lopresti, and A. Tomkins, U.S. Patent No. 6,201,901, issued March 2001.

P18. “Storage Management System for Document Image Database,” D. Lopresti, U.S. Patent No. 6,298,173, issued October 2001.

P19. “Identification of Logos from Document Images,” J. Zhou, D. Lopresti, and P. Sarkar, U.S. Patent No. 6,327,388, issued December 2001.

P20. “Border-less Clock Free Two-Dimensional Barcode and Method for Printing and Reading the Same,” J. Zhou, D. Lopresti, and A. Tomkins, U.S. Patent No. 6,418,244, issued July 2002.

P21. “Method for Identifying and Using Table Structures,” J. Hu, R. Kashi, D. Lopresti, and G. Wilfong, U.S. Patent No. 7,054,871, issued May 2006.

P22. “Methods and Apparatus for Defending Against Telephone-based Robotic Attacks Using Random Personal Codes,” H. Baird, J. Bentley, D. Lopresti, and S.Y. Wang, U.S. Patent No. 7,978,831, issued July 2011.

P23. “Methods and Apparatus for Defending Against Telephone-based Robotic Attacks Using Contextual-based Degradation,” H. Baird, J. Bentley, D. Lopresti, and S.Y. Wang, U.S. Patent No. 8,005,197, issued August 2011.

P24. "Methods and Apparatus for Defending Against Telephone-based Robotic Attacks Using Permutation of an IVR Menu," H. Baird, J. Bentley, D. Lopresti, and S.Y. Wang, U.S. Patent No. 8,005,198, issued August 2011.

Patent Publications

PP1. "Method and Apparatus for Filtering E-mail Infected with a Previously Unidentified Computer Virus," M. R. Andrews, G. P. Kochanski, D. P. Lopresti and C. L. Shih, U.S. Patent Publication No. 20030204569A1, October 2003.

PP2. "Method and Apparatus for Providing Resource-Optimized Delivery of Web Images to Resource-Constrained Devices," D. P. Lopresti and Y. Wu, U.S. Patent Publication No. 20040120589A1, June 2004.

C. Honors and Awards

- A.B. Degree magna cum laude, Dartmouth College, 1982.
- Phi Beta Kappa Honorific Society, Dartmouth College, 1982.
- New Jersey Garden State Graduate Fellowship, Princeton University, 1982 – 1986.
- Gordon Bell Prize Honorable Mention (with W. Holmes), IEEE Software, 1989.
- Sigma Xi Honorific Society, 1991.
- Elected Senior Member of Institute of Electrical and Electronics Engineers, 2003.
- Alumni Council Award for Service to Princeton University, 2005.
- Class of 1961 Professorship, Lehigh University, 2005 – 2007.
- Election Verification Network Award (with A. Appel and D. Jones), 2015.
- TCFPGA Hall of Fame Class of 2018 (ACM/SIGDA Technical Committee on FPGAs): "SPLASH – Experience Building and Programming a Highly Parallel Programmable Logic Array," M. Gokhale, W. Holmes, A. Kopser, S. Lucas, R. Minnich, D. Sweely, and D. Lopresti, *IEEE Computer*, January 1991, pp. 81-89.

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D. Research Funding and Training Grants

Competitively Awarded Research Grants

- "Research in Parallel VLSI Architectures," Principal Investigator, AT&T Foundation, $20,283, 1987.

- "Systolic Array Architectures for String Comparisons," Principal Investigator, NSF, $70,000, 1987 – 1989.

- "Multiparadigm Design Environments," Co-Principal Investigator (with J. Savage, E. Charniak, T. Doeppner, T. Dean, P. Kanellakis, L. Morgenstern, S. Reiss, A. van Dam, J. Vitter, P. Wegner, K. Zadeck, and S. Zdonik), NSF, $3,451,000, 1988 – 1992.

- "High-Performance Design Environments," Co-Principal Investigator (with J. Savage, E. Charniak, T. Doeppner, J. Hughes, P. Kanellakis, P. Klein, F. Preparata, S. Reiss, R. Tamassia, A. van Dam, P. van Hentenryck, J. Vitter, P. Wegner, K. Zadeck, and S. Zdonik), DARPA, $2,654,835, 1991 – 1994.

- "Investigations in Programmable Systolic Architectures," Principal Investigator, NSF, $180,882, 1991 – 1993.

- "Using Generative Models to Evaluate and Strengthen Biometrically Enhanced Systems," Co-Principal Investigator (with F. Monrose and M. Reiter), NSF, $287,950, 2004 – 2008.

- "Keystone Alliance (KA) for Homeland Security – Cyber Security," Co-Principal Investigator (with H. Korth), The Pennsylvania State University, $25,000, 2004 – 2006.

- "Following the Paper Trail: Reliable Processing of Voting Records for Trustworthy Elections," Co-Principal Investigator (with C. Borick, E. Barney Smith, Z. Munson, and G. Nagy), NSF, $200,000, 2007 – 2009.

- "PLATO: A System for Taming MADCAT (Multilingual Automatic Document Classification, Analysis, and Translation)," Co-Principal Investigator (with H. Baird) prior to 2011, Principal Investigator from 2011 onward, DARPA (via Raytheon BBN Technologies), $813,046 (requested over multiple years), 2007 – 2013.

- "Structuring, Reasoning, and Querying in a Very Large Medical Image Database," Co-Principal Investigator (with X. Huang, G. Tan, and G. Nagy), NSF, $392,000, 2008 – 2010.

- "CISE-RV: Computing Community Consortium," Principal Investigator from 2024 – 2025 (with T. Camp and M. L. Maher), National Science Foundation Cooperative Agreement with Computing Research Association, $5,000,000, 2024 – 2027.

Non-competitively Awarded and/or Internal Research Grants

- "Implicit and Multi-Modal CAPTCHAs," Co-Principal Investigator (with H. Baird), Avaya Labs Research, $30,000, 2005 – 2006.

- "Document Understanding: Survey and Evaluation of the State-of-the-Art," Co-Principal Investigator (with H. Baird), DARPA (via BBN Technologies), $115,926, 2005 – 2006.
- "National Resource for Document Analysis and Exploitation," Co-Principal Investigator (with H. Baird), FY2009 Department of Defense Appropriation (Defensewide RDT&E, Information and Communications Technology), $1,600,000, 2009 – 2010.

- "Multidisciplinary & Community Partnership to Develop a Mobile Applications for Enhancing the Provision of Home Visiting to Young Children who Experience Poverty" (with P. Manz, M. C. Chuah, L. Brook Sawyer, S. Woodhouse), Lehigh University Collaborative Research Opportunity Grant, $60,000, 2014 – 2015.

- "Sports and Evolution Lab," Co-Principal Investigator (with J. Pettegrew and Z. Munson), Lehigh Mountaintop Project, $31,500, Summer 2016.

- "Computing Community Consortium III," Co-Principal Investigator (with L. Bradley and A. Drobnis), National Science Foundation Cooperative Agreement (subaward beginning 2020 via Computing Research Association), $7,346,277, 2018 – 2023.

- Computing Community Consortium III (Supplement)," Principal Investigator (with A. Schwartz and N. Bliss), National Science Foundation Cooperative Agreement with Computing Research Association, $499,998, 2023.

Competitively Awarded Training Grants

- Grant to support the fabrication of VLSI class projects, Principal Investigator, NSF, $2,925, 1989 – 1990.

- Grant to support the fabrication of VLSI class projects, Principal Investigator, NSF, $3,520, 1990 – 1991.

- "A Facility for the Study of Computational Problems from Molecular and Population Biology," Co-Principal Investigator (with L. Brooks), Committee on Academic Computing, Brown University, $3,368, 1991.

- "1992 Brown/MIT Conference on Advanced Research in VLSI and Parallel Systems," Co-Principal Investigator (with C. Leiserson), NSF, $11,000, 1992.

- "The Undergraduate Science Education Program," Senior Personnel (with N. Simon

and V. Ware, Principal Investigators), Howard Hughes Medical Institute, $1,800,000, 2006 – 2010.

- "Integrating Computational and Experimental Methods in the Analysis of Molecular Complexity in Nature," Co-Principal Investigator (with S. Maas), Lehigh Biosystems Dynamics Summer Institute (funding provided by Howard Hughes Medical Institute), Summer 2006.

- "A Combined Bioinformatics and Molecular Biological Approach for the Identification of Post-transcriptional Recoding Events in the Human Transcriptome," Co-Principal Investigator (with S. Maas), Lehigh Biosystems Dynamics Summer Institute (funding provided by Howard Hughes Medical Institute), Summer 2008.

- "Bioinformatics, Butterflies, and Penguins," Co-Principal Investigator (with S. Mullen), Lehigh Biosystems Dynamics Summer Institute (funding provided by Howard Hughes Medical Institute), Summer 2009.

- Pennsylvania Governor's School for Engineering and Technology, Team Pennsylvania Foundation, $120,000, 2014.

- "REU Site: The Lehigh Smart Spaces Project," Senior Personnel (with M. Chuah and J. Spletzer, Principal Investigators), NSF, $340,000, 2014 – 2017.

- "Identification of Driver Mutations in Experimental Evolution," Co-Principal Investigator (with G. Lang), Lehigh Biosystems Dynamics Summer Institute (funding provided by Howard Hughes Medical Institute), $44,375, Summer 2014.

Contract/Consulting Work

- KYOS Systems Inc., Canton, MA, research and development in online handwriting recognition, 2004 – 2007.

- Expert witness on behalf of the plaintiffs, Banfield v. Cortes, No. 922 A.2d 36 (Pa. Commw. Ct., 2007), filed August 2006. Deposed in August 2011. At issue: whether the Pennsylvania Secretary of State properly certified electronic voting equipment used throughout the state. Work with law firm Drinker Biddle & Reath as well as independent counsels.

- Expert witness on behalf of the plaintiffs, National Association for the Advancement of Colored People State Conference of Pennsylvania, et al. v. Pedro A. Cortés, Secretary of the Commonwealth of Pennsylvania, et al., No. 08-5048 (US District Court, 2008), filed October 2008. At issue: whether emergency paper ballots can be used when less than all of the electronic voting machines in a precinct have failed on election day.

- Testifying expert witness on behalf of the plaintiffs, Nuance Communications v.

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Abbyy Software, No. 3:08-cv-02912 (U.S. District Court for the Northern District of California), 2008 – 2013. Work with law firms Wilson Sonsini Goodrich & Rosati and Morrison & Foerster. Deposed in January 2013; testified at jury trial in August 2013. In a separate but related matter, work with law firm Wolf, Greenfield & Sacks regarding US Patent Office actions.

- Designated as testifying expert witness on behalf of the plaintiffs, Secured Mail Solutions v. Advanced Image Direct, et al., No. SA-CV-01090 DOC (U.S. District Court for the Central District of California), 2013 – 2014. Work with law firm O'Melveny & Myers.

- Designated as testifying expert witness on behalf of the defendants, Thermo Fisher Scientific Inc., et al. v. Yourway Transport, Inc., et al., No. GD 2011-C-4631 (Common Pleas of Lehigh County, PA, Civil Division), 2013 – 2014. Work with law firms Weir & Partners, Karoly Law Firm, and Robert E. Goldman.

- Designated as testifying expert witness on behalf of the plaintiffs, Modevity LLC v. Findaway World (American Arbitration Association, ARBNo. 14 117 Y00633 13), 2014. Deposed in March 2014. Work with law firm Stradley, Ronin, Stevens & Young.

- Expert witness on behalf of the petitioner, Smartmatic v. Avante, Inter Partes Review before the US Patent and Trademark Office, 2019. Work with law firm DLA Piper.

- Designated as testifying expert witness on behalf of the patent owner, Election Systems & Software LLC v. Hart Intercivic Inc., Inter Partes Review before the US Patent and Trademark Office, Case No. PGR2020-00031, 2020 – 2021. Deposed in February 2021. Work with law firm Baker Botts.

- Designated as testifying expert witness on behalf of the petitioner, Google LLC v. Human Differential Intelligence LLC, Inter Partes Review before the US Patent and Trademark Office, 2020. Work with law firm Wolf, Greenfield & Sacks. Settled January 2021.

- Designated as testifying expert witness on behalf of the defendant, Health Discovery Corporation v. Intel Corporation, Civil Action No. 6:20-cv-666, 2021 – 2023. Work with law firms King & Spalding and Perkins Coie.

- Designated as testifying expert witness on behalf of the petitioner, Google LLC v. Defenders of the American Dream, LLC, Inter Partes Review before the US Patent and Trademark Office, Case No. TBD, 2021 – 2022. Work with law firm Wolf, Greenfield & Sacks.

- Designated as testifying expert witness on behalf of the petitioner, Google LLC v. Nobots LLC, Inter Partes Review before the US Patent and Trademark Office, Case No. TBD, 2022 – 2023. Work with law firm Wolf, Greenfield & Sacks.

- Designated as testifying expert witness on behalf of the petitioner, Nike Inc. v. Valmarc Corporation, Inter Partes Review before the US Patent and Trademark Office, Case Nos. IPR2022-01403 and IPR2022-01404, 2022. Work with law firm DLA Piper.

- Designated as testifying expert witness on behalf of the defendants, Planner 5D v. Meta Platforms, Inc.; Facebook Technologies, LLC; The Trustees of Princeton University; et al., Case No. 3:19-cv-03132-WHO (SK), Case No. 3:20-cv-08261-WHO (SK) (U.S. District Court for the Northern District of California), 2021 – present. Deposed in February 2023. Deposed in November 2024. Work with law firms Kirkland & Ellis and Jenner & Block.

- Designated as testifying expert witness on behalf of the plaintiff, Zentian Ltd. v. Apple Inc. and Zentian Ltd. v. Amazon.com Services LLC and Amazon Web Services, Inc., Case Nos. 6:22-cv-00122-ADA and 6:22-cv-00123-ADA (U.S. District Court for the Western District of Texas), 2023 – present. Work with law firm Bartlit Beck LLP.

- Designated as testifying expert witness on behalf of the petitioners, Intuition Machines, Inc. and Cloudflare, Inc. v. Human Differential Intelligence LLC, Inter Partes Review before the US Patent and Trademark Office, Case Nos. IPR2023-00631 and IPR2023-00632, 2023 – present. Work with law firm Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.

- Designated as testifying expert witness on behalf of the petitioners, Aktana, Inc. v. Veeva Systems, Inc., Inter Partes Review before the US Patent and Trademark Office, Case Nos. IPR2024-01443 and IPR2024-01444, 2024 – present. Work with law firm Desmarais, LLP.

- Designated as testifying expert witness on behalf of the petitioners, DataDome S.A. and DataDome Solutions, Inc. v. Arkose Labs Holdings, Inc., Inter Partes Review before the US Patent and Trademark Office, Case Nos. IPR2025-00693 and IPR2025-00694, 2024 – present. Work with law firm Orrick, Herrington & Sutcliffe LLP.

- Designated as testifying expert witness on behalf of the petitioner, Google LLC v. Pointwise Ventures LLC, Inter Partes Review before the US Patent and Trademark Office, Case No. IPR2025-01102, 2025 – present. Work with law firm Finnegan, Henderson, Farabow, Garrett & Dunner, LLP.

- Plus other intellectual property cases not disclosed for reasons of confidentiality.

- Expert witness in several separate academic integrity cases involving alleged programming assignment plagiarism at a large midwestern university, 2020 – 2021.

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E. Editor/Editorial Review Board Membership for Scholarly Publications

- Editorial Board, *International Journal of Document Analysis and Recognition*, Springer-Verlag, 1997 – present.

- Co-Editor-in-Chief (with K. Kise, S. Marinai, and J. Lladós), *International Journal of Document Analysis and Recognition*, Springer-Verlag, 2014 – present.

- Associate Editor, *ACM SIGMOD Digital Symposium Collection (DiSC)*, 2004 – 2006.

- Associate Editor, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2005 – 2010.

- Area Editor, *Computer Vision and Image Understanding*, Elsevier, 2011 – present.

- Review Editor, *Frontiers in Digital Humanities: Cultural Heritage Digitization Section*, Open Access, 2015 – 2017.

- Advisory Board, *Artificial Intelligence and Applications*, Bon View Publishing, 2024 – present.

F. Professional Presentations

Invited Presentations / Lectures / Colloquia / Workshops / Performances

- Invited Lectures: although too numerous to list, I estimate I have given 40 to 60 invited talks over my career to date. A recent memorable example surrounds a keynote talk I was invited to give on biometric security at the *First Korea-Japan Joint Workshop on Pattern Recognition* which was held in Jeju, Korea in 2006. While overseas, I gave two more invited technical talks, one at Tokyo University of Agriculture and Technology and another at Hitachi Central Research Laboratory. I was also asked to give an invited talk on the tenure system in the U.S. for high-level administrators, including the president, at Tokyo University of Agriculture and Technology. In June 2013 and May 2014, I delivered invited lectures at the *International Document Image Processing Summer School* in Fourni, Greece. In June 2015, I delivered an invited keynote lecture at the *Seventh Mexican Conference on Pattern Recognition*. In December 2015, I served as an invited panelist at the *Internet of Things World Forum* in Dubai, UAE. In August 2021, I gave an invited talk on "Synergies from Document Analysis" at the *79th Annual General Meeting of the American Society of Questioned Document Examiners*. In December 2021, I will give an invited talk on the societal benefits of AI at the *Forward Research and Innovation Summit* organized by the Puerto Rico Science, Technology and Research Trust.

- Participant in Conference Panel Sessions: I have served on 10 or more conference panel sessions over my career.

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Organized or Chaired Sessions / Colloquia / Exhibits / Performances

- Chair of Conference Sessions: I have chaired dozens of conference sessions to date.

- Panel Session Organizer/Moderator, "Meta-Data: What Good is it?" (with F. R. Chen, S. Dennis, D. Doermann, and A. Tomkins), *Document Recognition and Retrieval VI (IS&T/SPIE International Symposium on Electronic Imaging)*, January 1999, San Jose, CA.

- Panel Session Organizer/Moderator, "Synergies Between Document Analysis Research and Digital Libraries" (with H. Baird, A. Downton, Y. LeCun, M. Nakagawa, and M. Worring), *Sixth International Conference on Document Analysis and Recognition*, September 2001, Seattle, WA.

- Panel Session Organizer, "The E-voting Controversy: What are the Risks?" (with H. Stewart-Gambino, C. Borick, B. Freeman, S. Freeman, and M. A. Gould), Lehigh University Department of Computer Science, April 2006, Bethlehem, PA.

- Panel Session Organizer/Moderator, "Noisy Text Analytics: An Exercise in Futility?" (with S. Balakrishnan, H. T. Ng, and R. Srihari), *IJCAI Workshop on Analytics for Noisy Unstructured Text Data*, January 2007, Hyderabad, India.

- Moderator, Congressional briefing on "Intelligent Infrastructure" for the House Committee on Science, Space and Technology, with panelists H. Schulzrinne (Columbia University), M. Wansley (nuTonomy), N. Bliss (Arizona State University), and E. Mynatt (Georgia Tech), Jan. 30, 2018, Washington, DC.
- Moderator, panel session on ""Rethinking Approaches to Disaster Management and Public Safety With Intelligent Infrastructure" at the Annual Meeting of the American Association for the Advancement of Science, with panelists M. Dunaway (University of Louisiana, Lafayette), R. Murphy (Texas A&M University), and N. Venkatasubramanian (University of California, Irvine), Feb. 16, 2018, Austin, TX.

Other

- Invited Debate Participant, "Defect Models are Important to Advance the State-of-the-Art of Optical Character Recognition" (with H. S. Baird, R. Haralick, and G. Nagy), *Fifth Annual Symposium on Document Analysis and Information Retrieval*, April 1996, Las Vegas, NV.

G. Teaching and Advising

Courses Taught (since joining Lehigh)

- CSE 303, *Operating System Design*, Fall 2003, 82 students enrolled in course (co-instructor with Donald Hillman).

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- CSE 397-497, *Computational Issues in Molecular Biology*, Spring 2004, 15 students enrolled in course.

- CSE 303, *Operating System Design*, Fall 2004, 85 students enrolled in course (co-instructor with Donald Hillman).

- CSE 397-497, *Bioinformatics: Issues and Algorithms*, Spring 2005, 15 students enrolled in course.

- CSE 303, *Operating System Design*, Fall 2005, 66 students enrolled in course (co-instructor with Donald Hillman).

- CSE 397-497, *Special Topics in Bioinformatics*, Fall 2005, 5 students enrolled in course.

- CSE 398-498, *Bioinformatics: Issues and Algorithms*, Spring 2006, 16 students enrolled in course.

- Engr 005, *Introduction to Engineering Practice* (project supervisor), Fall 2006, 43 students enrolled in project over two sessions.
- CSE 303, *Operating System Design*, Fall 2006, 38 students enrolled in course.

- CSE 450, *Special Topics in Bioinformatics*, Fall 2006, 5 students enrolled in course.

- CSE 097, *Intelligent Machine: The Computer in Popular Culture*, Spring 2007, 33 students enrolled in course.

- CSE 308-408, *Bioinformatics: Issues and Algorithms*, Spring 2007, 19 students enrolled in course.

- Engr 005, *Introduction to Engineering Practice* (project supervisor), Spring 2007, 38 students enrolled in project over two sessions.

- CSE 303, *Operating System Design*, Fall 2007, 24 students enrolled in course.

- CSE 308-408, *Bioinformatics: Issues and Algorithms*, Fall 2007, 8 students enrolled in course.

- CSE 098, *Intelligent Machine: The Computer in Popular Culture*, Spring 2008, 26 students enrolled in course.

- CSE 498, *Computing in My Country*, Spring 2008, 4 students enrolled in course.

- CSE 303, *Operating System Design*, Fall 2008, 35 students enrolled in course.

- CSE 350-450, *Special Topics in Electronic Voting Systems*, Fall 2008, 7 students enrolled in course.

- CSE 098, *Intelligent Machine: The Computer in Popular Culture*, Spring 2009, 24 students enrolled in course.

- CSE 308-408, *Bioinformatics: Issues and Algorithms*, Spring 2009, 9 students enrolled in course.

- CSE 090, *Intelligent Machine: The Computer in Popular Culture*, Fall 2009, 20 students enrolled in course (first-year seminar in College of Arts & Sciences).

- CSE 130, *Technical Presentation*, Spring 2010, 15 students enrolled in course.

- CSE 308-408, *Bioinformatics: Issues and Algorithms*, Spring 2010, 8 students enrolled in course.

- CSE 090 / COGS 90, *Intelligent Machine: The Computer in Popular Culture*, Fall 2010, 23 students enrolled in course (first-year seminar in College of Arts & Sciences).

- CSE 303, *Operating System Design*, Spring 2011, 18 students enrolled in course.

- CSE 497, *Research Methodologies and Tools*, Fall 2011, 8 students enrolled in course.

- CSE 303, *Operating System Design*, Spring 2012, 15 students enrolled in course.
- CSE 347-447, *Data Mining*, Fall 2012, 25 students enrolled in course.

- CSE 252 / STS 252 / EMC 252, *Computers, Internet, and Society*, Spring 2013, 52 students enrolled in course (co-instructor with Ron Crane).

- CSE 406, *Research Methods*, Fall 2013, 6 students enrolled in course.

- CSE 347-447, *Data Mining*, Spring 2014, 46 students enrolled in course.

- CSE 397, *Issues in Cybersecurity*, Fall 2015, 8 students enrolled in course.

- CSE 398-498, *Big Data Analytics*, Spring 2016, 5 students enrolled in course.

- CSE 001, *Breadth of Computing*, Fall 2016, 38 students enrolled in course.

- CSE 098, *Women in Technology*, Spring 2017, 18 students enrolled in course (co-instructor with Samantha Kahoe, Managing Director of Lehigh@NasdaqCenter).

- CSE 350, *Special Topics in Cloud Computing Security*, Spring 2017, 7 students enrolled in course.

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- CSE 398-498, *Big Data Analytics*, Spring 2017, 8 students enrolled in course.
- CSE 001, *Breadth of Computing*, Fall 2017, 35 students enrolled in course.
- CSE 098, *Women in Technology*, Spring 2018 (co-instructor with Samantha Dewalt, Managing Director of Lehigh@NasdaqCenter), 14 students enrolled in course.
- CSB 098 / CSE 098, *Software Product Management*, Spring 2018 (co-instructor with Samantha Dewalt, Managing Director of Lehigh@NasdaqCenter), 15 students enrolled in course.
- CSE 398-498, *Big Data Analytics*, Spring 2018, 20 students enrolled in course.
- CSE 001, *Breadth of Computing*, Fall 2018, 34 students enrolled in course.
- CSE 098, *Women in Technology*, Spring 2019 (co-instructor with Samantha Dewalt, Managing Director of Lehigh@NasdaqCenter), 20 students enrolled in course.
- CSE 350-450, *AI for Social Good*, Spring 2019, 14 students enrolled in course.
- CSE 098, *Women in Technology and Innovation*, Spring 2020 (co-instructor with Samantha Walravens, author of *Geek Girl Rising*, and Samantha Dewalt, Managing Director of Lehigh@NasdaqCenter), 10 students enrolled in course.
- CSE 327 / COGS 327, *Artificial Intelligence: Theory and Practice*, Spring 2020, 51 students enrolled in course.
- CSE 398, *Applying AI for Social Good*, Spring 2020, 9 students enrolled in course.
- CSE 398-498, *Big Data Analytics*, Fall 2020, 14 students enrolled in course.
- CSE 098, *Women in Technology and Innovation*, Spring 2021 (co-instructor with Samantha Walravens, author of *Geek Girl Rising*, and Samantha Dewalt, Managing Director of Lehigh@NasdaqCenter), 18 students enrolled in course.
- CSE 327 / COGS 327, *Artificial Intelligence: Theory and Practice*, Spring 2021, 47 students enrolled in course.
- CSE 398-498, *Big Data Analytics*, Fall 2021, 16 students enrolled in course.
- CSE 327 / COGS 327, *Artificial Intelligence: Theory and Practice*, Spring 2022, 47 students enrolled in course.
- CSE 349-449, *Big Data Analytics*, Fall 2022, 11 students enrolled in course.
- CSE 327 / COGS 327, *Artificial Intelligence: Theory and Practice*, Spring 2023, 55

students enrolled in course.

- CSE 349-449, *Big Data Analytics*, Fall 2023, 13 students enrolled in course.
- CSE 327 / COGS 327 / CSE 498, *Artificial Intelligence: Theory and Practice*, Spring 2024, 70 students enrolled in course.
- CSE 349-449, *Big Data Analytics*, Fall 2024, 8 students enrolled in course.
- CSE 406, *Research Methods*, Fall 2024, 13 students enrolled in course.
- CSE 349-449, *Big Data Analytics*, Fall 2025, enrollment TBD.
- CSE 406, *Research Methods*, Fall 2025, enrollment TBD.

Course or Curriculum Development (since joining Lehigh)

- When I first arrived at Lehigh, I revamped our teaching of operating systems (CSE 303) and taught the course a number of times before it was taken over by a newer faculty member. I then developed a new course on bioinformatics algorithms and taught it several times on an experimental basis; it is now a regular offering by the department (CSE 308/408), and was taken over by a colleague. This course is also cross-listed as an elective in the undergraduate Bioengineering program. In Spring 2007, I introduced a new course, titled "Intelligent Machine: The Computer in Popular Culture," which was designed to attract a broad range of students, not just CSE majors. I am also involved as a regular guest lecturer in an innovative survey course in the Life Sciences (BioS 095) as a result of HHMI support Lehigh has received over the years, which was taught for the first time in Fall 2007. In Spring 2008, I introduced another novel course named "Computing in My Country," a seminar that was aimed both at highlighting important advances in the field that are taking place outside of the United States as well as developing communication skills in our graduate students. In Fall 2008, I led a special topics course on electronic voting timed to coincide with the presidential election that year. In Fall 2015, I offered a new seminar course on cybersecurity that integrated technological, business, and policy issues. For Spring 2016, I developed a new course on big data analytics using Apache Spark and the Scala programming language, which has continued each Spring since then. For Spring 2017, I co-developed a new course on Women in Technology working with Samantha Kahoe from Lehigh and Tom Gillis, the co-founder and CEO of Bracket Computing, which was again be repeated in 2018, along with a new course on Software Product Management. Both of these courses made extensive use of a new telepresence room we created during the renovation of Mountaintop Building C, linking us with guest speakers who were experts in their areas in Silicon Valley. I also developed and lead the Software Engineering Track for the highly successful Lehigh Silicon Valley Program (LSV++). For 2018, we visited Lawrence Livermore National Laboratory, OSIsoft, Adobe, Cisco, Google, Plug & Play Tech Center, and Bracket Computing.

Independent Studies Taught (since joining Lehigh)

- Tyler Lund, “Civil War Letter Decryption,” Computer Science Senior Project, Fall 2006.
- Joel Reisteter, “Voter Verified Paper Audit Trail: Audit Verification Program,” Computer Science Senior Project, Fall 2006.
- Mark Weindling, “Test Procedures for an Electronic Voting System,” Computer Science Senior Project, Fall 2006.
- Semih Demribag, “Dissecting a Voting Machine,” Computer Science Senior Project, Fall 2007.
- Jeffrey Kleeblatt, “A System for 'Blind' Auditing of Paper Ballot Images,” Compuer Science Senior Project, Fall 2007.
- Andrew Plummer, “A Hybrid Voting Machine,” Computer Science Senior Project, Fall 2007.
- Arther Loder, “Advanced Readings in Computational Biology,” Graduate Independent Study, Spring 2004.
- Kris Molendyke, “Research in Speech-Based Computer Security,” Graduate Independent Study, Summer 2004.
- Deepthi Bollu, “A Web-Based Platform to Support Document Analysis Research,” Graduate Independent Study, Spring 2005.
- Mark Strohmaier, “Algorithms and Architectures to Support Investigations in RNA Editing Effects,” Graduate Independent Study, Fall 2006.
- Wen Cheng, “Issues in Bioinformatics,” Graduate Independent Study, Spring 2007.
- Mark Strohmaier, “Algorithms and Architectures to Support Investigations in RNA Editing Effects,” Graduate Independent Study, Spring 2007.
- Wen Cheng, “Grammar-Based Approaches for Describing 2-D RNA Secondary Structure,” Graduate Independent Study, Fall 2007.
- Keerati Inthavisas, “Generative Attacks on Behavioral Biometric Security,” Graduate Independent Study, Fall 2007.
- Nicholas Hinnerschitz, “A Web-Based Synthetic Ballot Generator,” Independent Spring 2008.

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- Joseph Siefers, “Firmware Analysis of the Danaher 1242 Electronic Voting Machine,” Independent Study, Spring 2008.

- Paul Beruti, “Data Mining Applied to the Search for RNA Editing Events,” Eckardt Scholar Project, Fall 2008 – Spring 2009.

- Wen Cheng, “Techniques for Amplifying Offline Handwriting Datasets,” Graduate Independent Study, Fall 2008.

- Young Suk and Rebecca Rovner, “Cracking an Unsolved Civil War Cipher,” Computer Science Senior Project, Fall 2008.

- Michael Kott, “Document Analysis and Exploitation User Experience Enhancement,” Independent Study, Spring 2011.

- Barri Bruno, “The Lehigh Steel Collection,” Independent Study, Fall 2013.

- Zachary Daniels, “Solving Cross-Cut Document Shredder Puzzles,” Independent Study, Fall 2013.

- Connor Tench, “Investigations in Free Space Gesture Recognition,” Independent Study, Fall 2013.

- Daniel Andsager and Marc Greenspan, “Remote Sensing Blimp,” Computer Engineering Senior Project, Fall 2015 – Spring 2016.

- Hannah St. Lifer, “Data Mining from Social Network Sources,” CogSci Honors Thesis, Fall 2015 – Spring 2016.

- Casey Caruso, “Stow Away: A Personal Savings App,” Independent Study, Spring 2016.

- Lauren Mentzer, “Anime Tracking Application,” Independent Study, Summer 2016.

- Harry Eaton and Cameron Clifton, “Environmental Monitoring System,” Computer Engineering Senior Project, Fall 2016 – Spring 2017.

- Victoria Campell, JohnDerek Daniels, and Charles Sengor, “Investigations in Text Analytics,” Rapidly Accelerated Research Experience: a focused science immersion program for students from backgrounds underrepresented in STEM fields, funded through Lehigh/HHMI, Summer 2017.

- Robert Salay and Joshua Whitton, “Automatic Music Transcription,” Computer Science Senior Project, Fall 2017 (jointly supervised with Tom Collins, Psychology).

- Andrew Borghesani and Collin Messics, “IoT Automated Terrarium,” Computer

Engineering Senior Project, Fall 2017 – Spring 2018.

- Jasmin Cornejo and Rafia Islam, "Interactive Learning Platform for Nano-Human Interfaces," CSE Department REU, Summer 2020.

- Grant Armstrong, "Stylistic Imitation in First Person Shooter Games using Data Driven Spatial Analytics," CogSci Honors Thesis, Fall 2020 – Spring 2021.

- Jasmin Cornejo, "Interactive Learning Platform for Nano-Human Interfaces (continuation of Summer REU)," Research Intern, California State University Louis Stokes Alliance For Minority Participation Program, Fall 2020 – Spring 2021.

- Jiageng Zheng, "Reinforcement Learning for the Game of Go," Independent Study, Summer 2021, Summer 2022.

- Chloe Moros, Marcon Fellow, Summer 2022.

- Rakene Chowdhury, "Investigations in Machine Learning," Independent Study, Fall 2022.

- Kendra Marable, "Investigations in AI Gaming," Independent Study, Fall 2022.

- AJ Tabarani, "Recognition of Hand-Drawn Hieroglyphics Text," CSE Department REU, Summer 2023.

- Daniella Prado Arroyo, "AI and Music," Independent Study, Fall 2023, Spring 2024.

- Kunj Shah, "AI Ethics," Independent Study, Spring 2024.

- Ethan Feldman, "Issues in Generating and Evaluating Synthetic Data for Sensitive Machine Learning Applications," CSE Department REU, Summer 2024.

Advising, Other than Research Direction (since joining Lehigh): Undergraduate

- Freshman Engineering Advisees: 10 students in 2004 – 2005, 13 students in 2005 – 2006, 13 students in 2006 – 2007, 10 students in 2007 – 2008, 13 students in 2008 – 2009, 12 students in 2009-2010, 11 students in 2010-11.

- CSE Majors (including IBE/CS): 8 students in 2003 – 2004, 8 students in 2004 – 2005, 8 students in 2005 – 2006, 4 students in 2006 – 2007, 11 students in 2007 – 2008, 14 students in 2008 – 2009, 13 students in 2009-2010, 13 students in 2010-11, 14 students in 2013-14.

- Masters in CS: 26 students in 2020 – 2021, 37 students in 2021 – 2022.

Advising, Research Direction (since joining Lehigh): PhD Thesis Committees

- Carolyn Buckley, Lehigh Department of Biological Sciences (advisor J. Schneider), "Metabolic and Hormonal Signals Involved in Food Deprivation Induced Hoarding and Hunger Motivation in Syrian Hamsters," 2004 – 2006.

- Ashutosh Joshi, Department of Electrical, Computer, and Systems Engineering, Rensselaer Polytechnic Institute (advisor G. Nagy), "Symbolic Indirect Correlation Classifier," 2004 – 2006.

- Baoning Wu (advisor B. Davison), "Finding and Fighting Search Engine Spam," 2004 – 2007.

- Lucas Ballard, Department of Computer Science, Johns Hopkins University (advisor F. Monrose), "Secure Biometric Cryptographic Key Generators," 2007 – 2008.

- Michael Moll (advisor H. Baird), "Voracious Classifiers," 2006 – 2008.

- Lan Nie (advisor B. Davison), "Mining the Hyperlinks of the Web Graph," 2006 – 2008.

- Erdem Arslan (advisor I. Laurenzi), Lehigh Department of Chemical Engineering, "Stochastic Approach to Engineering and Analysis of DNA-based Microarray Technology," 2006 – 2008.

- Dylan Dupuis, Lehigh Department of Biological Sciences (advisors S. Maas, M. Kuchka), "Alu Repetitive Elements Transcribed by RNA Polymerase III are A-to-I RNA Editing Targets," 2008 – 2012.

- Na Dai (advisor B. Davison), "Mining Web Dynamics for Search," 2011 – 2013.
- Hongsheng Li (advisor X. Huang), "Mathematical Models for Object Matching and Their Application to Computer Vision and Biomedical Imaging" 2011 – 2012.

- Ting Xu (advisor X. Huang), "Model-based Curvilinear Network Segmentation and Tracking toward Quantitative Microscopy," 2013 – 2016.

- Zobeir Raisi, Department of Systems Design Engineering, University of Waterloo (advisor J. Zelek), "Text Detection and Recognition in the Wild," 2022.

Advising, Research Direction: Master's Students Supervised

- James Meyers, "Automating Multi-Locus Viability Analyses for Human Linkage with 'Emilie'," Brown University, Master's Degree completed July 1991, now President and CEO of Framework, Inc.

- Dishant Patel, "Online Handwriting as a Biometric," completed September 2006.

- Ivan Stoev, “A Machine Learning Approach to Prediction of RNA Editing Events,” completed May 2010.

Advising, Research Direction: PhD Students Supervised

- Cheryl Harkness, “An Approach to Uncertainty in VLSI Design,” Brown University, PhD degree completed June 1990, first position with Hewlett-Packard Design Technology Center, most recently self-employed.

- Richard Hughey, “An Architecture for Programmable Systolic Arrays,” Brown University, PhD degree completed June 1991, most recently Professor and Chair of Computer Engineering at UC Santa Cruz.

- Keerati Inthavisas, “Secure Speech Biometric Templates,” PhD degree completed November 2011, most recently Lecturer in Computer Engineering at Rajamangala University of Technology Srivijaya, Thailand.

- Yaoyao Zhu, “Towards More Desirable Segmentations via User Interactions,” PhD degree completed September 2012, most recently with Checkpoint Systems (co-advised with X. Huang).

- Jin Chen, “Information Preserving Processing of Noisy Handwritten Document Images,” PhD degree completed May 2015, first position with Nuance Communications, most recently with Apple.

- Nathan Kern, “Reducing Barriers to Entry in Molecular Dynamics,” Fall 2017 – Spring 2025 (co-advised with W. Im).

Advising, Research Direction: Post-Docs Supervised

- Arti Taneja, “Investigations in Human-in-the-Loop Image Interpretation,” Spring 2019 – Spring 2020 (co-advised with M. Harmer).

H. Service

Service to University

- Accompanied President Greg Farrington and other representatives of Lehigh on *Inside Lehigh* west coast fundraising trip, June 2004.

- Represented Lehigh at University of Pittsburgh's kick-off event for “Center of Excellence First Responder Consortium,” April 2004.

- Participant in panel session at *Campaign for Lehigh* kick-off event: “Worldwide

Threats: Converging Dangers in a Post 9/11 World" (with R. Blum, J. Bially Mattern, P. McHale, and A. Romig), October 2004.

- Faculty Steering Committee, RCEAS Representative, 2006 – 2010; Chair 2008 – 2009.

- Rules and Procedures Subcommittee of the Faculty Steering Committee, 2006 – 2010; Chair, 2007 – 2008.

- Barry M. Goldwater Scholarship Nomination Committee, 2006 – 2016.

- Department of Admissions, various undergraduate recruiting activities including serving as a featured speaker at "Lehigh Life Days" events, 2006 – present.

- Presidential Inauguration Committee, 2006 – 2007. University-wide coordinator for *An Exhibition of Student Research and Scholarship at Lehigh*, held April 12, 2007.

- Lehigh Strategic Thinking Initiative, Co-Chair of the Faculty & Staff Working Group (with S. Cady), Spring 2008.

- Provost Search Committee, Fall 2008 – Spring 2009.

- Advisory Committee, *2009 Academic Symposium: A Tradition of Excellence*, held April 16, 2009.

- Advisory Committee, Lehigh Howard Hughes Medical Institute program, 2009 – 2014.

- Department Chairs Executive Committee, 2009 – 2014. 2016 – 2019; Chair, 2011 – 2012.

- Lehigh Strategic Plan Implementation, Co-Chair of the Cluster Development Working Group (with A. Anderson), Spring 2010.

- Lehigh / Universiti Teknologi Petronas (Malaysia) R&D Collaboration Working Committee, 2010 – 2011.

- University Nominations Committee, 2010 – 2013; Chair, 2011 – 2012.

- Lehigh Strategic Plan Implementation, Co-Chair of the Cluster Faculty Hiring Committee (with A. Anderson), Fall 2010 – Spring 2013. Led to the establishment of three faculty-conceived interdisciplinary clusters at Lehigh: Africana Studies, Integrated Networks for Electricity (SmartGrid), and Community Health.

- Accompanied Vice President of International Affairs Mohamed El-Aasser and other representatives of Lehigh on trip to develop research and educational collaborations

with Malaysian universities, October 2010.

- Advisory Committee, *2011 Academic Symposium*, held March 29, 2011.
- Board of Trustees Academic Affairs Committee, 2011 – 2012 (faculty representative).
- Advisory Committee, *2013 Academic Symposium*, April 4, 2013.
- Lehigh Mountaintop Development Working Group, 2013 – 2015.
- Lehigh Cyber Governance, Risk Management and Compliance Committee, 2013 – present; Privacy Policy Subcommittee, 2025 – present.
- Lehigh ADVANCE Male Allies for Gender Equity, Fall 2013 – present.
- Lehigh ADVANCE Leadership Team, Spring 2014 – present.
- Academic Infrastructure Working Group, 2016 – 2018.
- Consulting Committee, NEH Next Generation Humanities Ph.D. Planning Grant (awarded to Lehigh Departments of English and History), 2016 – 2017.
- As Director of the Data X Initiative from 2015 – 2020, I provided support to strategic interdisciplinary faculty hiring activities across the university with emphasis on computing and data analytics and particular focus in the areas of data mining, cybersecurity, computer systems, consumer analytics, digital media, and connected health. I was also the primary faculty lead for the large-scale renovation of a massive former industrial building on Lehigh's Mountaintop campus inspired by Data X.
- Creator and leader of the Software Engineering Track for the highly successful Lehigh Silicon Valley Program (LSV++), 2017 – 2019.
- Steering Committee, IDEAS Program (Integrated Degree in Engineering, Arts, and Sciences), 2020 – present.
- Lehigh Library and Technology Services Faculty Committee, 2023 – present; Privacy Policy Subcommittee, 2025.
- Advisory Board, Marcon Institute, 2024 – present.
- Lehigh Faculty Recruitment Ambassador, 2024 – present.

Service to College and Interdisciplinary Programs

- Bioengineering Graduate Program Committee, 2004 – 2019.

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- RCEAS Bio, Environmental, and Molecular Engineering Advisory Council, 2006 – 2019.

- RCEAS Faculty Retreat Planning Committee, 2008 – 2009.

- RCEAS Workshop on Computational Engineering & Science Organizing Committee, October 2009.

- Global Citizenship Faculty Seminar participant, January 2007 – April 2007.

- Diversity Across the Curriculum Faculty Seminar participant, April 2009 – May 2009.

- RCEAS Council of Chairs, 2009 – 2019.

- RCEAS Professorship Appointment Committee, 2013.

- Co-leader of the Nano/Human Interfaces Presidential Engineering Research Initiative (with Martin Harmer, Jeffrey Rickman, Anand Jagota, and Kate Arrington), 2017 – present.

- Co-Chair, Bioengineering Department Chair Search Committee (with Xuanhong Cheng), Spring 2018.

- Bioengineering Department Chair Search Committee, Fall 2019 – Spring 2020.

- Master's Program Incentives Ad Hoc Committee, Fall 2020.

Service to Department

- CSE Department Faculty Recruiting Committee, where I helped to recruit Professor Henry Baird to Lehigh, 2003 – 2004.

- CSE Department Graduate Program Committee, where I helped to craft a major overhaul of our PhD program qualifier requirements designed to strengthen the quality of our pool of graduate students, 2003 – 2004.

- Chair of CSE Department Community Committee, which has instituted a series of successful "study breaks" to bring together faculty and students (especially undergraduates), 2004 – 2005.

- CSE Department Colloquium Committee, where I have invited and served as host for a number of speakers in our department seminar series, 2004 – 2005.

- I established a weekly "brown bag lunch" series that brings together faculty, staff, and students with interests in the area of digital libraries, 2004 – 2006.

- I have participated in Candidates' Day, Parents' Day, and information sessions for high school students considering Lehigh, 2004 – present.

- Chair of CSE Department Colloquium Committee, where I conceived and organized our Distinguished Seminar Series, 2005 – 2006.

- CSE Department Faculty Recruiting Committee, where I helped to recruit Professor Xiaolei Huang to Lehigh, 2005 – 2006.

- Chair of CSE Department Publicity and Undergraduate Recruiting Committee, 2006 – 2007, where I have organized outreach activities to local schools.

- Chair of CSE Department Faculty Recruiting Committee, where I helped to recruit Professor Gang Tan to Lehigh, 2007 – 2008.

- CSE Department Faculty Recruiting Committee, 2008 – 2009.

- CSE Department Graduate Admissions Committee, 2020 – 2023.

- Masters in Computer Science program: Director, 2020 – 2022; Co-Director (with C. Montella), 2023.

- CSE Department Student Honors and Awards Committee, 2022 – present; Chair, 2022 – 2024.

- CSE Department Faculty Recruiting Committee, 2023 – present; Co-Chair (with R. Palmieri), 2024 – present.

Professional: Offices and Committee Memberships Held in Professional Organizations

- Local Arrangements Chair, *Brown/MIT Conference on Advanced Research in VLSI and Parallel Systems*, Providence, RI, March 1992.

- Co-Chair (with J. Zhou), *Document Recognition V (IS&T/SPIE International Symposium on Electronic Imaging)*, San Jose, CA, January 1998.

- Local Arrangements Chair, Document Understanding Working Group Meeting, Murray Hill, NJ, August 1998.

- Co-Chair (with J. Zhou), *Document Recognition and Retrieval VI (IS&T/SPIE International Symposium on Electronic Imaging)*, San Jose, CA, January 1999

- Co-Chair (with J. Zhou), *Document Recognition and Retrieval VII (IS&T/SPIE International Symposium on Electronic Imaging)*, San Jose, CA, January 2000.

- Co-Chair (with P. Kantor and J. Zhou), *Document Recognition and Retrieval VIII*

(IS&T/SPIE International Symposium on Electronic Imaging), San Jose, CA, January 2001.

- Co-Chair (with J. Hu and R. Kashi), *Fifth International Workshop on Document Analysis Systems*, Princeton, NJ, August 2002.

- Co-Chair (with H. Baird), *Second International Workshop on Human Interactive Proofs*, Bethlehem, PA, May 2005.

- Founding Co-Chair (with C. Knoblock, S. Roy, and L. V. Subramaniam), *Workshop on Analytics for Noisy Unstructured Text Data (in association with the Twentieth International Joint Conference on Artificial Intelligence)*, Hyderabad, India, January 2007.

- Co-Chair (with S. Roy, K. Schulz, and L. V. Subramaniam), *Second Workshop on Analytics for Noisy Unstructured Text Data (in association with the Thirty-First International ACM SIGIR Conference)*, Singapore, July 2008.

- Co-Chair (with S. Roy, K. Schulz, and L. V. Subramaniam), *Third Workshop on Analytics for Noisy Unstructured Text Data (in association with the Tenth International Conference on Document Analysis and Recognition)*, Barcelona, Spain, July 2009.

- Program Co-Chair (with S. Chaudhury), *Second International Workshop on Multilingual OCR (in association with the Tenth International Conference on Document Analysis and Recognition)*, Barcelona, Spain, July 2009.

- Co-Chair (with P. Natarajan, V. Govindaraju, and D. Doermann), *Nineth International Workshop on Document Analysis Systems*, Cambridge, MA, June 2010.

- Co-Chair (with R. Basili, C. Ringlstetter, S. Roy, K. Schulz, and L. V. Subramaniam), *Fourth Workshop on Analytics for Noisy Unstructured Text Data (in association with the Nineteenth ACM International Conference on Information and Knowledge Management)*, Toronto, Canada, October 2010.

- Co-Chair (with S. Chaudhury, L. Day, V. Govindaraju, P. Natarajan, C. Ringlstetter, and S. Roy), *Joint Workshop on Multilingual OCR and Analytics for Noisy Unstructured Text Data (in association with the Eleventh International Conference on Document Analysis and Recognition)*, Beijing, China, September 2011.

- Founding Chair, *IAPR 2011 Doctoral Consortium (in association with the Eleventh International Conference on Document Analysis and Recognition)*, Beijing, China, September 2011.

- Program Co-Chair, *Eleventh International Conference on Document Analysis and Recognition*, Beijing, China, September 2011.

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- Track Co-Chair (with K. Kise), *Twenty-First International Conference on Pattern Recognition*, Tsukuba Science City, Japan, November 2012.

- Co-Chair (with C. Ringlstetter, L. Day, S. Roy, and L. V. Subramaniam), *Sixth Workshop on Analytics for Noisy Unstructured Text Data (in association with the Twenty-Fourth International Conference on Computational Linguistics)*, Mumbai, India, December 2012.

- Local Arrangements Chair, *Tenth IAPR International Workshop on Graphics Recognition*, Bethlehem, PA, August 2013.

- Executive Co-Chair, *Twelfth International Conference on Document Analysis and Recognition*, Washington, DC, August 2013.

- Program Co-Chair (with J. LLadós and M. Blumenstein), *Twelfth International Workshop on Document Analysis Systems*, Santorini, Greece, April 2016.

- Area Chair (Document Analysis, Biometrics and Pattern Recognition Applications), *Twenty-Third International Conference on Pattern Recognition*, Cancun, Mexico, December 2016.

- Program Co-Chair (with M. Liwicki, M. Coustaty, and B. Lamiroy), *International Workshop on Open Services and Tools for Document Analysis*, Kyoto, Japan, November 2017.

- Program Co-Chair (with D. Karatzas and C.V. Jawahar), *Fourteenth International Conference on Document Analysis and Recognition*, Kyoto, Japan, November 2017.

- WiDS Ambassador, Lehigh livestream for *Stanford Women in Data Science Conference*, March 2018, March 2019.

- Program Co-Chair (with B. Gatos, J-M Ogier, and K. Kise), *Thirteenth International Workshop on Document Analysis Systems*, Vienna, Austria, April 2018.

- Co-Chair (with B. Kerautret, M. Colom, B. Lamiroy, P. Monasse, J-M Morel, and H. Talbot), *Second Workshop on Reproducible Research in Pattern Recognition*, Beijing, China, August 2018.

- Area Chair (Document Analysis and Recognition), Publications Chair, *Twenty-Fourth International Conference on Pattern Recognition*, Beijing, China, August 2018.

- International Advisory Committee, *Third International Conference on Computer Vision & Image Processing*, Jabalpur, India, September-October 2018.

- Organizing Committee, *Code 8.7 Conference on Using Computational Science and*

Artificial Intelligence to End Modern Slavery, UN Headquarters, New York, NY, February 2019.

- Tutorials Co-Chair (with J. Lladós), *Fifteenth International Conference on Document Analysis and Recognition*, Sydney, Australia, September 2019.

- Workshop Co-Chair, *CCC / Code 8.7 Workshop on Applying AI in the Fight Against Modern Slavery*, Washington, DC, March 2020.

- Program Co-Chair (with X. Bai and D. Karatzas), *Fourteenth International Workshop on Document Analysis Systems*, Wuhan, China (virtual), July 2020.

- Tutorials Chair, *Seventeenth International Conference on Frontiers in Handwriting Recognition*, Dortmund, Germany, September 2020.

- International Advisory Committee, *Fifth International Conference on Computer Vision & Image Processing*, Allahabad, India, October 2020.

- Area Chair (Document Analysis and Recognition), *Twenty-Fifth International Conference on Pattern Recognition*, Milan, Italy, January 2021.

- Co-Chair (with B. Kerautret, M. Colom, P. Monasse, J-M Morel, and H. Talbot), *Third Workshop on Reproducible Research in Pattern Recognition*, Milan, Italy, January 2021.

- Program Co-Chair (with J. Lladós and S. Uchida), *Sixteenth International Conference on Document Analysis and Recognition*, Lausanne, Switzerland, September 2021.

- International Advisory Committee, *Sixth International Conference on Computer Vision & Image Processing*, Punjab, India, December 2021.

- Doctoral Consortium Co-Chair (with V. Elgin), *Third International Conference on Pattern Recognition and Artificial Intelligence*, Paris, France, June 2022.

- International Advisory Committee, *International Conference on Computer Vision & Machine Intelligence*, Allahabad, India, August 2022.

- Co-Chair (with B. Kerautret, M. Colom, P. Monasse, J-M Morel, B. Perret, H. Talbot, and B. Yildiz), *Fourth Workshop on Reproducible Research in Pattern Recognition*, Montréal, Canada, August 2022.

- International Advisory Committee, *Seventh International Conference on Computer Vision & Image Processing*, Nagpur, India, November 2022.

- International Advisory Committee, *Third International Conference on Computer Vision & Machine Intelligence*, Allahabad, India, October 2024.

- Co-Chair (with B. Kerautret, M. Colom, P. Monasse, J-M Morel, B. Perret, H. Talbot, and B. Yildiz), *Fifth Workshop on Reproducible Research in Pattern Recognition*, Kolkata, India, December 2024.

- Doctoral Consortium Co-Chair (with V. Elgin), *Twenty-Seventh International Conference on Pattern Recognition*, Kolkata, India, December 2024.

- Program Co-Chair (with X-C Yin and D. Karatzas), *Nineteenth International Conference on Document Analysis and Recognition*, Wuhan, China, September 2025.

- International Advisory Committee, Tenth International Conference on Computer Vision & Image Processing, Ropar, India, December 2025.

- General Co-Chair (with J-M Ogier, T. K. Ho, and C-L Liu), *Twenty-Eighth International Conference on Pattern Recognition*, Lyon, France, August 2026.

- Program Co-Chair (with G. Fink, A. Fornes, and K. Kise), *Twentieth International Conference on Document Analysis and Recognition*, Vienna, Austria, August-September 2026.

- General Co-Chair (with U. Pal, J-M Ogier, and C-L Liu), *Twenty-First International Conference on Document Analysis and Recognition*, Kuala Lumpur, Malaysia, August 2027.

- Scientific Advisory Board, KYOS Systems Inc., Canton, MA, June 2005 – 2007.

- Lehigh University Chapter of Sigma Xi Honorific Society: Secretary-Elect, 2005 – 2006; Secretary, 2006 – 2007.

- Board of Directors, Manufacturer's Resource Center, Allentown, PA, Sept. 2014 – Sept. 2016.

- Appointed Member, Northampton County Election Commission, First Term Jan. 2020 – Dec. 2021, Second Term Jan. 2022 – Dec. 2023, Third Term Jan. 2024 – Dec. 2025.

- Leadership Team (Seed Fund Steering Committee), Northeast Big Data Innovation Hub, 2020 – 2021.

- International Association for Pattern Recognition (IAPR)*

  Conferences and Meetings Committee, 2003 – 2018, Chair 2014 – 2018; Technical Committee 11 ("Reading Systems") Chair 2009 – 2013; Ad Hoc Committee on IAPR 50th Anniversary Celebration, Chair 2022 – 2024; Technical Committee 22 ("Reproducible Research in Pattern Recognition") Co-Founder 2024 – present; IAPR Executive Committee 2018 – 2024; Treasurer (elected) 2018 – 2021; President (elected) 2021 – 2022; Past-President 2022 – 2024; Nominating Committee 2022 –

present, Chair 2022 – 2024; Advisory Committee 2022 – present.

** The IAPR is an international association of non-profit, scientific, and professional organizations (national, multi-national, or international in scope) concerned with research in pattern recognition, computer vision, and image processing. IAPR was established in January 1978 and currently consists of 50 national societies, bringing together nearly 10,000 researchers in these fields. The organizational structure of IAPR include 13 Standing Committees and 17 Technical Committees. IAPR sponsors or endorses several dozen conferences and workshops annually for the benefit of the international scientific community.*

- Computing Research Association (CRA)*

  Board of Directors (ex officio), 2022 – 2024; Finance Committee, 2022 – 2024; Working Group on Socially Responsible Computing, 2023 – present, Ethics Education Subcommittee, 2024 – present; CRA-Microsoft Responsible AI Training Network Advisory Committee, 2025 – present.
- "Conference Submission and Review Policies to Foster Responsible Computing Research" (CRA Report), L. Cranor, K. Hazelwood, D. Lopresti, and A. Stent, July 2024.

  ** The Computing Research Association (CRA) has origins dating back to 1972 as the Computer Science Board. CRA counts among its members more than 200 North American organizations active in computing research: academic departments of computer science and computer engineering; laboratories and centers in industry, government, and academia; and affiliated professional societies (AAAI, ACM, CACS/AIC, IEEE Computer Society, SIAM, and USENIX).*

- Computing Research Association's Computing Community Consortium (CCC)*

  CCC Council, 2015 – 2025; Nominations Committee, 2017, Chair 2020 – 2022; Executive Committee, 2017 – 2025; Intelligent Infrastructure Task Force, Co-Chair with B. Zorn, 2017 – 2018, Co-Chair with E. Mynatt, 2018 – 2019; Cybersecurity and Cybercrime Task Force, 2018 – 2019, Chair 2019 – 2020; Roadmap for Artificial Intelligence Research Steering Committee, 2018 – 2019; Technology for a Connected and Distributed Life Task Force, 2020 – 2021; Visioning Workshop Ad Hoc Committee, Chair 2020 – 2021; CCC Council Vice Chair, 2020 – 2022; Computing Innovation Fellows Selection Committee, 2021; Security, Integrity, and Trust Task Force, 2021 – 2022; NextGen AI Task Force, 2022 – 2023; Grand Challenges in Computing Task Force, 2023 – 2025; CCC Council Chair, 2022 – 2024; CCC Council Chair Emeritus, 2024 – 2025; CCC Visioning Proposal Review Committee, Chair 2024 – 2025.
- "Systems Computing Challenges in the Internet of Things" (CCC Whitepaper), R. Alur, E. Berger, A. W. Drobnis, L. Fix, K. Fu, G. D. Hager, D. Lopresti, K. Nahrstedt, E. Mynatt, S. Patel, J. Rexford, J. A. Stankovic, and B. Zorn, September 2015.
- "Smart Communities Internet of Things" (CCC Whitepaper), K. Nahrstedt, D. Lopresti, B. Zorn, A. W. Drobnis, E. Mynatt, S. Patel, and H. V. Wright, January 2016.
- "The Future of Computing Research: Industry-Academia Collaborations" (CCC Whitepaper), N. Boules, K. Douglas, S. Feldman, L. Fix, G. Hager, B. Hailpern, M. Hebert, D. Lopresti, B. Mynatt, Chris Rossbach, and Helen Wright, May 2016.
- "Safety, Security, and Privacy Threats Posed by Accelerating Trends in the Internet of

Things" (CCC Whitepaper), K. Fu, T. Kohno, D. Lopresti, E. Mynatt, K. Nahrstedt, S. Patel, D. Richardson, and B. Zorn, February 2017.

- "Computing Community Consortium (CCC) Response to NITRD 'Smart Cities and Communities Federal Strategic Plan: Exploring Innovation Together'" (CCC Whitepaper), E. Mynatt, D. Lopresti, K. Nahrstedt, S. Patel, J. Rexford, and B. Zorn, March 2017.
- "A National Research Agenda for Intelligent Infrastructure" (CCC Whitepaper), E. Mynatt, J. Clark, G. Hager, D. Lopresti, G. Morrisett, K. Nahrstedt, G. Pappas, S. Patel, J. Rexford, H. Wright, and B. Zorn, March 2017.
- "Research Agenda in Intelligent Infrastructure to Enhance Disaster Management, Community Resilience and Public Safety" (CCC Whitepaper), M. Dunaway, R. Murphy, N. Venkatasubramanian, L. Palen, and D. Lopresti, March 2017.
- "Rethinking Approaches to Disaster Management and Public Safety with Intelligent Infrastructure" (AAAS Panel Session), M. Dunaway, R. Murphy, and N. Venkatasubramanian, with D. Lopresti moderator, Annual Meeting of the American Association for the Advancement of Science, Austin, TX, February 2018.
- Featured guest on several CCC Catalyzing Computing Podcasts, 2019.
- "Artificial Intelligence Research: A Community Roadmap" (AAAS Panel Session), Y. Gil, B. Selman, and D. Lopresti, with A. Drobnis moderator, Annual Meeting of the American Association for the Advancement of Science, Seattle, WA, February 2020.
- Co-Chair (with N. Bliss, M. Briers, A. Eckstein, J. Goulding, A. Mazumder, and G. Smith), CCC / Code 8.7 Workshop on Applying AI in the Fight Against Modern Slavery, Washington, DC, March 2020.
- "Computing Research Challenges in Next Generation Wireless Networking" (CCC Whitepaper), E. Bertino, D. Bliss, D. Lopresti, L. Peterson, and H. Schulzrinne, October 2020.
- "A Research Ecosystem for Secure Computing" (CCC Whitepaper), N. Bliss, L. A. Gordon, D. Lopresti, F. Schneider, and S. Venkatasubramanian, November 2020.
- "Pandemic Informatics: Preparation, Robustness and Resilience" (CCC Whitepaper), E. Bradley, W. Gropp, D. Lopresti, M. Marathe, and M. Moses, November 2020. Also addenda: "Pandemic Informatics: Vaccine Distribution, Logistics, and Prioritization," March 2021; "Pandemic Informatics: Variants of Concern (VOC)," April 2021.
- "Artificial Intelligence and Cooperation" (CCC Whitepaper), E. Bertino, F. Doshi-Velez, M. Gini, D. Lopresti, and D. Parkes, November 2020.
- "Next Wave Artificial Intelligence: Robust, Explainable, Adaptable, Ethical, and Accountable" (CCC Whitepaper), O. C. Jenkins, D. Lopresti, and M. Mitchell, November 2020.
- "A National Research Agenda for Intelligent Infrastructure: 2021 Update" (CCC Whitepaper), D. Lopresti and S. Shekhar, December 2020.
- "A National Discovery Cloud: Preparing the US for Global Competitiveness in the New Era of 21st Century Digital Transformation" (CCC Whitepaper), I. Foster, D. Lopresti, B. Gropp, M. Hill, and K. Schuman, April 2021.
- "CCC / Code 8.7 Applying AI in the Fight Against Modern Slavery" (CCC Whitepaper), D. Lopresti, N. Bliss, M. Briers, A. Eckstein, J. Goulding, A. Mazumder, and G. Smith, June 2021.
- CCC Liaison for Workshop on Artificial Intelligence / Operations Research, co-sponsored by CCC, INFORMS, and SIGAI, Virtual, September 2021.

- Co-Chair (with S. Banerjee, M. Gini, and H. Yanko), CCC Hybrid Workshop on Best Practices for Hybrid Workshops, Multiple Sites and Virtual, October 2021.
- "Response to RFI on Public and Private Sector Uses of Biometric Technologies" (CCC RFI Response), D. Danks, M. Gini, O. C. Jenkins, D. Lopresti, M. Mitchell, and K. Siek, January 2022.
- "Intelligent Infrastructure for All: Challenges and Opportunities" (AAAS Panel Session), M. Ryerson, A. Tomer, and C. Krintz, with S. Shekhar moderator and D. Lopresti co-organizer, Annual Meeting of the American Association for the Advancement of Science, Philadelphia, PA, February 2022.
- "Response to RFI to the Update of the National Artificial Intelligence Research and Development Strategic Plan" (CCC RFI Response), D. Danks, M. Gini, O. C. Jenkins, S. Koenig, D. Lopresti, M. Mitchell, K. Siek, U. Topcu, H. Yanco, and M. Hunter, March 2022.
- "'Meta Hybrid' Visioning Activity Report Out" (CCC Visioning Workshop Report), S. Banerjee, M. Gini, D. Lopresti, and H. Yanco, March 2022.
- "Reboot!" (CCC Panel Session at 2022 CRA Conference at Snowbird), S. Banerjee, N. Bliss, L. Bradley, W. Gropp, and D. Lopresti, July 2022.
- "Response to RFI on the 2023 Federal Cybersecurity Research and Development Strategic Plan" (CCC RFI Response), N. Bliss, E. Bradley, R. Burns, T. M. Conte, D. Danks, N. Evans, K. Fu, H. Griffen, W. D. Gropp, D. Jensen, C. Krintz, B. LaMacchia, D. Lopresti, M. Marathe, M. Moses, A. W. Schwartz, U. Topcu, and P. Wisniewski, March 2023.
- "Response to RFI on AI Accountability Policy" (CCC RFI Response), N. Bliss, D. Danks, M. Gini, J. Gorman, W. Gropp, M. Hunter, O. C. Jenkins, D. Jensen, D. Lopresti, B. Selman, U. Topcu, T. Toscos, and P. Wisniewski, June 2023.
- "Response to RFI on National Priorities for Artificial Intelligence" (CCC RFI Response), J. Biddle, E. Bradley, D. Danks, M. Gini, A.K. Goel, A. Guha, M. Hunter, D. Jensen, S. Koenig, C. Krintz, D. Lopresti, A. McGovern, D. Molzahn, R. Rajaraman, A. Singh, M. Turk, and H. Yanco, July 2023.
- "Response to PCAST Working Group on Generative AI Invites Public Input" (CCC RFI Response), M. Gini, M. Hunter, S. Koenig, D. Lopresti, R. Rajaraman, U. Topcu, M. Turk, and H. Yanco, July 2023.
- "Response to RFI on Developing a Roadmap for the Directorate for Technology, Innovation, and Partnerships at the National Science Foundation" (CCC and GAC RFI Response), A. Aiken, N. Bliss, E. Bradley, K. Butler, T. Camp, D. Danks, C. Gill, W. Gropp, P. Harsha, C. Krintz, B. LaMacchia, D. Lopresti, B. Mosley, A. Schwartz, K. Siek, M. Taufer, U. Topcu, P. Wisniewski, and H. Yanko, July 2023.
- "Response to White House National Cyber Director Requests Feedback on Open-source Software Security" (CCC RFI Response), K. Butler, D. Danks, D. Lopresti, and M. Hunter, October 2023.
- "Response to the Office of Management and Budget's Request for Comments on Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence Draft Memorandum" (CCC RFI Response), D. Danks, H. Griffin, D. Jensen, C. Krintz, D. Lopresti, R. Rajaraman, M. Turk, and H. Yanco, December 2023.
- "Response to the Request for Information (RFI) Related to NIST's Assignments Under Sections 4.1, 4.5 and 11 of the Executive Order Concerning Artificial Intelligence (Sections 4.1, 4.5, and 11)" (CCC RFI Response), D. Danks, C. Gill, D. Lopresti, R.

Rajaraman, M. Taufer, U. Topcu, M. Turk, and H. Yanco, February 2024.

- "Response to the National Telecommunications and Information Administration (NTIA) Request for Information: Dual Use Foundation Artificial Intelligence Models With Widely Available Model Weights" (CCC RFI Response), M. Buehler, D. Danks, C. Fiesler, C. Gill, D. Lopresti, and D. Watson-Parris, April 2024.
- "Response to the National Institute of Justice's Request for Input on Section 7.1(b) of Executive Order 14110, "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence"" (CCC RFI Response), N. Bliss, K. Butler, D. Danks, S. Forrest, C. Gill, D. Lopresti, M. L. Maher, H. Mentis, C. Moore, S. Shekhar, A. Stent, and M. Turk, May 2024.
- CCC Liaison for Workshop on the Future of Information Retrieval Research in the Age of Generative AI, J. Allen, E. Choi, and H. Zamani, co-organizers, Washington, DC, July 2024.
- "Response to the Defense Industrial Base Adoption of Artificial Intelligence for Defense Applications; Notice of Availability" (CCC RFI Response), A. Aiken, N. Bliss, D. Danks, C. Gill, D. Jensen, D. Lopresti, M. L. Maher, C. Moore, W. Regli, and M. Turk, July 2024.
- "Response to the Networking and Information Technology Research and Development Request for Information on Digital Twins Research and Development" (CCC RFI Response), D. Danks, C. Gill, C. Krintz, B. LaMacchia, D. Lopresti, M. L. Maher, and P. Wisniewski, July 2024.
- "Response to the Request for Comments on the U.S. Artificial Intelligence Safety Institute's Draft Document: Managing Misuse Risk for Dual-Use Foundation Models" (CCC RFI Response), D. Danks, C. Gill, M. Lin, D. Lopresti, M. Parashar, W. Regli, and M. Turk, September 2024.
- "Response to the National Science Board–National Science Foundation (NSF) Commission on Merit Review (MRX) Request for Information on Informing the MRX's Review of NSF's Merit Review Criteria, Policy, and Processes" (CCC RFI Response), D. Lopresti, K. Siek, E. Bruce, S. Koenig, M. L. Maher and H. Griffin, September 2024.
- "CCC's Response to the DOE's Request for Information (RFI) on Frontiers in AI for Science, Security, and Technology (FASST) Initiative" (CCC RFI Response), D. Danks, C. Gill, I. Foster, W. Gropp, D. Lopresti, M. Parashar, M. Turk, and K. Yelick, November 2024.
- "CCC's Response to the Request for Information on the CHIPS and Science Act Section 10343. Research Ethics" (CCC RFI Response), R. Burns, D. Danks, S. Dwarkadas, C. Gill, D. Lopresti, and M. Taufer, November 2024.
- "Future of Information Retrieval Research in the Age of Generative AI CCC Workshop Report," J. Allan, E. Choi, D. Lopresti, and H. Zamani, December 2024.
- "Lessons for Cybersecurity from the American Public Health System" (CRA CCC Quadrennial Paper), A. Shostack, L. J. Camp, Y. T. Chua, J. Dykstra, B. LaMacchia, and D. Lopresti, January 2025.
- "Enabling the AI Revolution in Healthcare" (CRA CCC Quadrennial Paper), M. Singh, K. Siek, D. Danks, R. Ghani, H. Griffin, B. LaMacchia, D. Lopresti, and T. Toscos, February 2025.
- "CCC's Response to the Request for Comments on NSF's Proposed Intellectual Property Options" (CCC RFI Response), D. Danks, C. Gill, D.Lopresti, B. Mosely, P. Wisniewski, and H. Yanco, February 2025.

- "CRA's Response to the Request for Information on the Development of an Artificial Intelligence (AI) Action Plan" (CRA RFI Response), A. Aiken, G. Allen, O. Daescu, D. Danks, S. Elbaum, R. Ghani, C. Gill, W. Gropp, D. Jensen, M. Lin, D. Lopresti, B. Mosley, M. Parashar, R. Rajaraman, W. Regli, E. Schooler, S. Shekhar, R. Sloan, M. Taufer, M. Turk, H. Wright, and H. Yanco, March 2025.
- "CCC's Response to the Request for Information on the Development of a 2025 National Artificial Intelligence (AI) Research and Development (R&D) Strategic Plan," (CCC RFI Response), C. Gill, W. Gropp, M. Lin, D. Lopresti, M. L. Maher, B. Mosely, M. Parashar, K. Siek, M. Taufer, and A. Wierman, May 2025.

** CCC was established in 2006 in response to an NSF solicitation indicating a desire to establish a Computing Community Consortium. The CCC proposal received letters of support from 132 Ph.D.-granting academic programs, 16 leading corporations, seven major national laboratories and research centers, and five professional societies in the field. CCC operates through a cooperative agreement between NSF and CRA, the Computing Research Association. Today, the CCC Council has 20 members serving 3-year staggered terms, representing the diverse nature of the computing research field. The mission of the CCC is to enable the pursuit of innovative, high-impact computing research that aligns with pressing national and global challenges. CCC is a major programmatic committee of the CRA.*

- Member of Conference Program Committees for: Second IAPR Workshop on Document Analysis Systems (October 1996), Third IAPR Workshop on Document Analysis Systems, (November 1998), Fifth International Conference on Document Analysis and Recognition (September 1999), IEEE Conference on Computer Vision and Pattern Recognition (June 2000), Seventh International Workshop on Frontiers in Handwriting Recognition (August 2000), Fourth IAPR Workshop on Document Analysis Systems (December 2000), International Workshop on Web Document Analysis (September 2001), Sixth International Conference on Document Analysis and Recognition (September 2001), Seventh International Workshop on Multimedia Information Systems (November 2001), Document Recognition and Retrieval IX (January 2002), Fourth International Workshop on Multimedia Information Retrieval (December 2002), Document Recognition and Retrieval X (January 2003), Workshop on Document Image Analysis and Retrieval (June 2003), Seventh International Conference on Document Analysis and Recognition (August 2003), Second International Workshop on Web Document Analysis (August 2003), Document Recognition and Retrieval XI (January 2004), International Workshop on Document Analysis for Digital Libraries (January 2004), Sixth International Workshop on Document Analysis Systems (September 2004), Document Recognition and Retrieval XII (January 2005), 20th Annual ACM Symposium on Applied Computing (March 2005), Third International Workshop on Web Document Analysis (August 2005), Eighth International Conference on Document Analysis and Recognition (August 2005), Third International Conference on Advances in Pattern Recognition (September 2005), International Conference on Cognition and Recognition (December 2005), Document Recognition and Retrieval XIII (January 2006), Seventh International Workshop on Document Analysis Systems (February 2006), 21st Annual ACM Symposium on Applied Computing (April 2006), 18th International Conference on Pattern Recognition (August 2006), Workshop on Analytics for Noisy Unstructured Text Data (January 2007), Document Recognition and Retrieval XIV (January-

February 2007), 22nd Annual ACM Symposium on Applied Computing (March 2007), International Workshop on Advances in Pattern Recognition (July 2007), Ninth International Conference on Document Analysis and Recognition (September 2007), Document Recognition and Retrieval XV (January 2008), 23rd Annual ACM Symposium on Applied Computing (March 2008), 11th International Conference on Frontiers in Handwriting Recognition (August 2008), Eighth International Workshop on Document Analysis Systems (September 2008), 19th International Conference on Pattern Recognition (December 2008), Document Recognition and Retrieval XVI (January 2009), 10th International Conference on Document Analysis and Recognition (July 2009), Document Recognition and Retrieval XVII (January 2010), 25th Annual ACM Symposium on Applied Computing (March 2010), 22nd International Conference on Tools with Artificial Intelligence (October 2010), 12th International Conference on Frontiers in Handwriting Recognition (November 2010), Document Recognition and Retrieval XVIII (January 2011), 26th Annual ACM Symposium on Applied Computing (March 2011), 11th International Conference on Document Analysis and Recognition (September 2011), 23rd International Conference on Tools with Artificial Intelligence (November 2011), Document Recognition and Retrieval XIX (January 2012), 27th Annual ACM Symposium on Applied Computing (March 2012), 10th IAPR International Workshop on Document Analysis Systems (March 2012), LREC Workshop: @NLP can u tag #user_generated_content ?! (May 2012), 13th International Conference on Frontiers in Handwriting Recognition (September 2012), 24th International Conference on Tools with Artificial Intelligence (November 2012), Document Recognition and Retrieval XX (February 2013), Biometric and Surveillance Technology for Human and Activity Identification X (Apr.-May 2013), 25th International Conference on Tools with Artificial Intelligence (November 2013), Document Recognition and Retrieval XXI (February 2014), 11th IAPR International Workshop on Document Analysis Systems (April 2014), Biometric and Surveillance Technology for Human and Activity Identification XI (April 2014), 22nd International Conference on Pattern Recognition (August 2014), 14th International Conference on Frontiers in Handwriting Recognition (September 2014), 26th International Conference on Tools with Artificial Intelligence (November 2014), Document Recognition and Retrieval XXII (February 2015), Biometric and Surveillance Technology for Human and Activity Identification XII (April 2015). 13th International Conference on Document Analysis and Recognition (August 2015), 27th International Conference on Tools with Artificial Intelligence (November 2015), Document Recognition and Retrieval XXIII (February 2016), 15th International Conference on Frontiers of Handwriting Recognition (October 2016), 23rd International Conference on Pattern Recognition (December 2016), Computing Research: Addressing National Priorities and Societal Needs (October 2017), International Workshop on Open Services and Tools for Document Analysis (November 2017), 14th International Conference on Document Analysis and Recognition (November 2017), 13th International Workshop on Document Analysis Systems (April 2018), 24th International Conference on Pattern Recognition (August 2018), First IEEE International Conference on Artificial Intelligence for Industries (September 2018), 15th International Conference on Document Analysis and Recognition (September 2019), Second IEEE International Conference on Artificial Intelligence for Industries (September 2019), Fifth Asian

Conference on Pattern Recognition (November 2019), 17th International Conference on Frontiers in Handwriting Recognition (September 2020), Third IEEE International Conference on Artificial Intelligence for Industries (September 2020), International Symposium on Geometry and Vision (November 2020), 25th International Conference on Pattern Recognition (January 2021), Fourth International Conference on Artificial Intelligence for Industries (September 2021), 15th International Workshop on Document Analysis Systems (May 2022), Third International Conference on Pattern Recognition and Artificial Intelligence (June 2022) 26th International Conference on Pattern Recognition (August 2022), Fifth International Conference on Artificial Intelligence for Industries (September 2022), First International Workshop on Election Infrastructure Security (September 2022), 29th IEEE International Conference on Image Processing (October 2022), 18th International Conference on Frontiers in Handwriting Recognition (December 2022), 17th International Conference on Document Analysis and Recognition (August 2023), Sixth International Conference on Artificial Intelligence for Industries (September 2023), 12th International Conference on Computing and Pattern Recognition (October 2023), 18th International Conference on Document Analysis and Recognition (August-September 2024), 7th International Conference on Artificial Intelligence and Pattern Recognition (September 2024), First IEEE International Conference on Artificial Intelligence x Science, Engineering, and Technology (September-October 2024), 13th International Conference on Computing and Pattern Recognition (October 2024), Second IEEE International Conference on Artificial Intelligence x Science, Engineering, and Technology (September-October 2025).

Other Committees, Commissions, Panels, Societies, etc.

- Department of Electrical and Computer Engineering, University of Miami, Industrial Advisory Committee, 2002.

- Department of Computer Science and Engineering, University of Notre Dame, External Assessment Committee, Fall 2013.

- Invited panelist, "The Benefits of ABET Accreditation to a Quality Computing Program," *ACM Technical Symposium on Computer Science Education (SIGCSE 2014)*, Atlanta, GA, March 2014.

- Invited panelist, "Nuts and Bolts of Managing a Department," *Computing Research Association (CRA) Conference at Snowbird*, Snowbird, UT, July 2014.

- Invited participant, Engineering Deans and Minority Engineering Program Strategic Retention Roundtable, *National Society of Black Engineers (NSBE) 41st Annual Convention*, Anaheim, CA, March 2015.

- Special Award Judge, *Intel International Science and Engineering Fair*, Pittsburgh, PA, May 2015.

- Panelist, "Perspectives and Practical Skills for Men as Advocates for Gender Equity (with R. Green, E. Holloway, A. Holmes, B. Kirkmeyer, K. Kokini, and Y, A. Minerick)," *122nd ASEE Annual Conference & Exposition*, Seattle, WA, June 2015.

- External Assessor in Image Processing and Artificial Intelligence, University of Malaya, Kuala Lumpur, Malaysia, 2015 – 2018.

- Department of Computer Science & Information Systems, Bradley University, Academic Program Review Committee, Spring 2018.

- Member of Steering Committee for City of Allentown's Comprehensive and Economic Development Plan, 2018 – 2019.

- Code 8.7 Organizing Committee, Using Computational Science and Artificial Intelligence to End Modern Slavery, 2019 – 2022.

- Advisor to University of Tampa on development of new Department of Computer Science, Fall 2019.

- External Evaluator to SUNY Polytechnic on development of new M.S. in Data Science and Analytics degree program, Spring 2020.

- Department of Computer Science and Engineering, University of Notre Dame, External Assessment Committee, Fall 2020 (postponed due to COVID-19).

- George Mason University, Thematic Hires in Computing Proposal Review Committee, Fall 2020.

- Dartmouth College Harold C. Ripley '29 Society, 2009 – present; Bartlett Tower Society, 2021 – present.

- Lehigh University South Mountain Society, 2010 – present.

- Association of Princeton Graduate Alumni (APGA)*

  Governing Board, 1997 – 2011; Treasurer, 1998 – 2000; Vice President, 2004 – 2006; President, 2006 – 2008; Departmental Affairs Committee, Chair 2001 – 2003; Nominations and Awards Committee, 2004 – 2011; Executive Committee, 1998 – 2008; Andrew Fleming West Society, 2012 – present.

  ** APGA was founded in 1949 and is focused on building a strong community of Princeton graduate alumni. There are over 30,000 living graduate alumni, representing 30% of Princeton's total alumni body. The APGA connects and supports graduate alumni in scholarship, fellowship, and leadership, in the Nation's service and the service of humanity. The Governing Board of the APGA is responsible for developing, promoting, and executing APGA programs with the help of committee volunteers. To recognize the distinction of Graduate School alumni and parallel the undergraduate alumni presence at Alumni Day, the APGA established the James Madison Medal. First awarded in 1973, the Madison Medal recognizes an alumnus of the Graduate School who has had a distinguished career, advanced graduate education, and/or public service. At the same time the APGA continues to serve graduate alumni, it has also increased its support of current graduate students.*

- Princeton University Alumni Council

  Technology Advisory Committee, 1998 – 2017, Vice Chair 1999 – 2001, Chair 2001 – 2003; Alumni Council Executive Committee, 1999 – 2008, 2010 – 2011, 2021 – 2023;

Planning & Review Committee, 2001 – 2003; Maclean Society, 2001 – present; Alumni Schools Committee, 2002 – present; Committee to Nominate Alumni Trustees*, 2008 – 2011; Chair 2010 – 2011; Service of Remembrance Committee, 2008 – present; Princetoniana Committee, 2019 – present, Vice Chair 2021 – 2023, Communications and Technology Committee Liaison, 2023 -- present.

** First graduate alumnus ever selected to Chair the Committee to Nominate Alumni Trustees.*

- Princeton University Reunions

  P-rade Marshal, 2003 – present; P-rade Grand Marshal*, 2016 – 2018; P-rade FitzRandolph Gate Gatekeeper, 2019, 2022 – present; Society of the Claw, 2016 – present.

  ** First graduate alumnus ever selected as the P-rade Grand Marshal.*

- Princeton University Stewardship Advisory Committee, 2008 – 2013.

- Princeton University Ad Hoc Committee on Leadership Engagement, 2014 – 2015.

- Princeton University Search Committee, Deputy Vice President for Alumni Affairs, 2018.

- Princeton University 1746 Society, 2021 – present.

Review Service Activities Not Listed Above

- Research Grant Review Service: American Association for the Advancement of Science; NSF Trustworthy Computing Panels; NSF CISE Instrumentation Panel; NSF Computing Research Infrastructure Panel; NSF Information and Intelligent Systems Panel; NSF Disrupting Operations of Illicit Supply Networks – Human Trafficking Panel; NSF Microelectronic Systems Architecture; NSF Experimental Systems; NSF Partnerships for Innovation – Cybersecurity Panel; NSF Civic Innovation Challenge; NSF Pathways to Enable Open-Source Ecosystems; Puerto Rico Science, Technology, and Research Trust; United States – Israel Binational Science Foundation; NIH Bridge to Artificial Intelligence (Bridge2AI); United States – Israel Binational Industrial Research and Development (BIRD) Foundation; NSF Partnerships for Innovation – Digital Health Panel; KU Leuven (University of Leuven, Belgium) Interdisciplinary Research Grant Program; NSF Partnerships for Innovation – Data Science and Cybersecurity Panel; NSF Leading Engineering for America's Prosperity, Health, and Infrastructure (LEAP-HI) Panel.

- Journal Article Review Service: ACM Computing Surveys, ACM Transactions on Algorithms, ACM Transactions on Asian Language Information Processing, IEEE Transactions on Computers, IEEE Transactions on Medical Imaging, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on VLSI Systems, International Journal on Document Analysis and Recognition, Journal of the Association for Computing Machinery, Journal of Discrete Algorithms, Journal of Electronic Imaging, Journal of Image and Vision Computing, Journal of Parallel and Distributed Computing, Journal of Supercomputing, Journal of Visual Languages and

Computing, Journal of VLSI Signal Processing, Journal of Web Engineering, Machine Vision and Applications Journal, Forensic Science International: Digital Investigation.

- Conference Paper Review Service: ACM Symposium on Applied Computing, American Association for the Advancement of Science Annual Meeting, Design Automation Conference, Document Recognition and Retrieval Conference, IEEE Conference on Computer Vision and Pattern Recognition, IEEE International Conference on Image Processing, IEEE International Symposium on Computer-Based Medical Systems, International Conference on Advances in Computing, International Conference on Computer Engineering & Systems, International Conference on Computer Processing of Oriental Languages, International Conference on Document Analysis and Recognition, International Conference on Parallel Processing, International Conference on Pattern Recognition, International Workshop on Document Analysis Systems, International Workshop on Document Image Analysis for Digital Libraries, International Workshop on Frontiers in Handwriting Recognition, International Workshop on Multimedia Information Retrieval, International Workshop on Multimedia Information Systems, International Workshop on Web Document Analysis, Workshop on Document Image Analysis and Retrieval, Biometric and Surveillance Technology for Human and Activity Identification, ASEE Collaborative Network for Engineering and Computing Diversity Conference, International Conference on Computer Vision & Image Processing.

- Other Review Service: AAAS 2022 Scientific Sessions Panels, AAAS 2023 Scientific Sessions Panels, AAAS 2024 Scientific Sessions Panels, Open Research Europe.

Professional Society Memberships

- Association for the Advancement of Artificial Intelligence (AAAI).
- Association for Computing Machinery (ACM).
- Institute of Electrical and Electronics Engineers (IEEE), Life Member.
- International Association for Pattern Recognition (IAPR).

Honorary Society Memberships

- Phi Beta Kappa.
- Sigma Xi.

Media

- Guest technical expert on electronic voting systems, WNJC's (1360AM) “Voice of the Voters” radio show hosted by Mary Ann Gould, October 25, 2006.

- Guest panelist for a discussion on electronic voting systems (with M. A. Gould and J. Passarella), NBC 10's (Philadelphia) “Live at Issue” hosted by Steve Highsmith, September 23, 2007.

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- Guest technical expert on electronic voting systems, WNJC's (1360AM) “Voice of the Voters” radio show hosted by Mary Ann Gould, December 19, 2007.

- Guest panelist for a discussion on electronic voting systems (with S. Sterner, K. Kraft, S. Bannon-Shillea, and A. Brau), WFMZ 69's “Business Matters” hosted by Tony Iannelli, May 12, 2008.

- Radio interview on electronic voting systems, WDHP 1620 AM (Reef Broadcasting, U.S. Virgin Islands) hosted by Mario Moorhead, May 3, 2012.

- Quoted as an expert on document analysis in AP news story “Media Sometimes Try, Fail to Keep NSA's Secrets” by Raphael Satter, February 8, 2014.

- Quoted as an expert on cybersecurity in Morning Call news story “Hackers may have attacked Las Vegas Sands websites through Bethlehem's portal” by Matt Assad, February 18, 2014.

- Quoted as an expert on cybersecurity in Morning Call news story “Data breaches likely as hackers stay a step ahead” by Peter Hall, March 8, 2014.

- Quoted as an expert on cybersecurity in Morning Call column “Heartbleed computer bug shouldn't be dismissed” by Paul Muschick, April 16, 2014.

- Quoted as an expert on curricular development in data science in Information Week column “Universities Expand Curriculum To Meet Data Scientist Demand” by Lisa Morgan, December 16, 2015.

- Quoted as an expert on electronic voting in PCWorld column “If the election is hacked, we may never know” by Patrick Thibodeau, October 5, 2016.

- Quoted as an expert on electronic voting in Network World column “Technology confirms election ballot error is less than .001%” by Steven Max Patterson, October 20, 2016.

- Quoted as an expert on electronic voting in Philadelphia Inquirer online article “Most Pa. voting machines are old, hackable, and will likely be used to count the 2020 votes” by Katlyn Alo and Jackie Botts, March 30, 2018. See also Peninsula Press article “Amid concerns over election interference, most Pennsylvania counties will continue to use vulnerable voting machines” by the same authors, April 2, 2018.

- Quoted as an expert on AI in the fight against human trafficking in Parentology online article “AI is Turning the Tables on Sex Traffickers” by Carmelo Spatazza, June 3, 2019.

- Quoted as an expert on electronic voting in a widely syndicated AP News story “Reliability of pricey new voting machines questioned” by Frank Bajak, February 23,

2020.

- Quoted as an expert on electronic voting in a Lifewire story “Voting Machines on eBay Could Pose Security Risk” by Sascha Brodsky, October 27, 2020.

- Quoted as an expert on cybersecurity in New England In-House story “Work-from-home creates new cybersecurity risk” by Melinda Rizzo, November 11, 2020.

- Radio interview on the impact of artificial intelligence, WDIY 88.1 FM (Lehigh Valley Public Radio) hosted by Prathysha Kothare, May 7, 2021.

- Quoted as an expert on technology for public safety in State Tech story “Radio Backhaul Could Enhance Police Data-Transfer Capability” by Adam Stone, February 16, 2022.

- Quoted as an expert on technology for public safety in WLVR / WITF / WESA (NPR) story “‘COVID Alert PA’ will be removed from app stores by end of July” by Megan Frank, July 12, 2022.

- Quoted as an expert on computer security in Wired story “Redacted Documents Are Not as Secure as You Think” by Matt Burgess, November 25, 2022.

- Quoted as an expert on computer security in 69 News (WFMZ-TV) story “LVHN reports cyberattack by Russian ransomware gang” by Rob Manch, February 20, 2023.

- Quoted as an expert on computer security in Morning Call column “Have questions about the LVHN ransomware hack? Here is what you need to know” by Leif Greiss, March 15, 2023.

- Television interview for a four-part series on the impact of AI, 69 News (WFMZ-TV) hosted by Priscilla Liguori, July 25-28, 2023.

- Guest panelist for a discussion on generative AI, WFMZ-Ch. 69 *Business Matters* hosted by Tony Iannelli, September 25, 2023.

- Television interview on generative AI (“AI experts warn about fake images being shared amid Israel - Hamas war”), 69 News (WFMZ-TV) hosted by Priscilla Liguori, October 23, 2023.

- Television interview on cybersecurity (“Water authority in western Pa. hacked by cyber criminals. Local cyber security expert discusses how common such attacks are”), 69 News (WFMZ-TV) hosted by Rob Manch, November 28, 2023.

- Television interview on cybersecurity (“Portions of Pennsylvania court systems website restored following cyberattack”), 69 News (WFMZ-TV) hosted by Bo Koltnow, February 5, 2024.