

**UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD**

FIFTH THIRD BANK, NATIONAL ASSOCIATION
Petitioner,

v.

UNITED SERVICES AUTOMOBILE ASSOCIATION
Patent Owner

INTER PARTES REVIEW OF U.S. PATENT NO. 12,632,899
Case No. IPR2026-00488

**DECLARATION OF JOHN C. HART, PHD IN SUPPORT OF PETITION
FOR *INTER PARTES REVIEW***

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I, John C. Hart, PhD, declare as follows:

I. INTRODUCTION

1. I have been retained by counsel for Petitioner Fifth Third Bank, National Association (“Fifth Third” or “Petitioner”) to provide my opinion about the validity of claims 1-30 of U.S. Patent No. 12,632,899 (the “Challenged Claims” of the “’899 patent,” EX1001), which is owned by United Services Automobile Association (“USAA,” “Patent Owner,” or “PO”). For the reasons set forth below, it is my conclusion that the Challenged Claims are invalid. I submit this declaration in support of Petitioner’s petition for inter partes review.

2. I have submitted declarations in Petitioner’s petitions for *inter partes* reviews of related patents, U.S. Patent Nos. 12,159,310 and 12,211,095 (the “’310” and “’095 patents”), which are pending with the Board in IPR2026-00279 and IPR2026-00277, respectively. As those were copycat petitions, I submitted short declarations adopting the declaration of Dr. Daniel Lopresti. The ’899 patent claims recite many of the same limitations found in the claims of the ’310 and ’095 patents, and as such, my analysis of those limitations is consistent with the opinions set forth in Dr. Lopresti’s declaration. I have also submitted a declaration in Petitioner’s petitions for inter partes reviews of related patent U.S. Patent No. 12,505,414.

3. I am associated with Gerson Lehrman Group, which I understand is being compensated for my time at a rate of \$1,300/hour. I understand that I will be

reimbursed for any reasonable expenses I incur while performing this work. I have no financial or other personal interest in the '899 patent, and my compensation is not contingent on the outcome of this matter or the specifics of my testimony.

II. BACKGROUND AND QUALIFICATIONS

4. I am a tenured full Professor in the Siebel School of Computing and Data Science at the University of Illinois at Urbana-Champaign, a computer science program consistently ranked in the top five according to US News and World Report. I also served as the area chair for its Graphics, Visualization and Human-Computer Interaction area from 2004-2011. I received a Ph.D. in Electrical Engineering and Computer Science from the University of Illinois at Chicago in 1991. I have also received an M.S. in Electrical Engineering and Computer Science from the University of Illinois at Chicago in 1989, and a B.S. in Computer Science from Aurora University in 1987.

5. My area of research is visual computing, including computer graphics, data visualization, virtual reality and imaging systems. Over the past nearly four decades, I have contributed over a hundred papers, videos and patents to this area. My research in visual computing has been funded by Adobe, Intel, Microsoft, Nokia and Nvidia as well as the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA).

6. In 2011, I was funded by the National Science Foundation's Advanced

Digitization of Biodiversity Collections to design and deliver an imaging infrastructure to scan the nation's entomological collections of insect drawers. This project required the fusion of 51,791 photographic images of small portions of insect drawers, vials and slides to make the collections available via the Internet as high-resolution zoomable composite images. This effort included the design and deployment of a custom robotic photographic imaging system, designed specifically to capture and integrate numerous photographs of each specimen drawer, as described in: C. Dietrich, J. Hart, D. Raila, U. Ravaioli, N. Sobh, O. Sobh, C. Taylor. InvertNet: a new paradigm for digital access to invertebrate collections. ZooKeys 209, July 2012, pp. 165-181.

7. I am an internationally recognized leader in the field of visual computing. The Association for Computing Machinery (ACM) is the main worldwide organization for computing professionals. From 1994 to 1999, I served on the executive committee of the ACM Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH). From 2002 to 2008, I was the Editor-in-Chief of the ACM Transactions on Computer Graphics, the top journal in that field. From 2014 to 2022, I was a founding member of the editorial board of ACM Books, served as its area editor for visual computing, and oversaw the publication of such books including "The VR Book: Human-Centered Design for Virtual Reality."

8. I have also served as an educator in interactive computing for nearly four decades. I have taught courses to thousands of students on a variety of topics in visual computing, including computer graphics, data visualization, virtual reality, and imaging systems.

9. I have worked on a variety of methods and systems for the processing of images and video. For example, in 2008, I was granted patent #7,365,744 “Method and Systems for Image Modification” on techniques for learning a surface appearance from one photograph and realistically applying it to a different surface in another photograph.

10. My curriculum vitae (“CV”) is being submitted along with this declaration and includes a more detailed list of my qualifications and experience, as well as the cases in which I have testified as an expert at trial or by deposition.

III. LEGAL STANDARDS

11. I am not an attorney, but counsel has explained to me the following legal principles, which I applied in conducting the analyses expressed in this declaration.

12. I understand that patent claims may be invalid as “anticipated” in view of a single prior art reference, or “obvious” in view of one or more prior art references.

13. Counsel has explained that a prior art reference anticipates a patent

claim when it discloses, either expressly or inherently, every limitation of the claim as arranged in the claim. A reference does not need to explicitly disclose what was already well-known to a person of ordinary skill in the art. Furthermore, I have been informed that a prior art reference should be considered for everything it teaches, and not limited merely to a particular embodiment or the specific invention claimed therein.

14. I understand that a patent claim is unpatentable if the claimed invention would have been obvious to a person of ordinary skill in the art at the time the alleged invention was made. An obviousness determination requires consideration of several factors: (1) the scope and content of the prior art; (2) any differences between the prior art and the claims at issue; (3) the level of ordinary skill in the pertinent art; and (4) objective indicia of non-obviousness, also known as secondary considerations.

15. I have been informed that for a finding of obviousness, 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 arrive at the claimed invention, along with a reasonable expectation of success in doing so. However, obviousness does not require that a particular combination or modification be the best or preferred approach; it need only have been desirable in view of the prior art.

16. I have been informed that exemplary rationales supporting obviousness include: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) using a known technique to improve similar devices, methods, or products in the same way; (d) applying a known technique to a known device, method, or product ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success; (f) adapting work from one field of endeavor for use in the same or a different field based on design incentives or market forces where the variations are predictable; and (g) some teaching, suggestion, or motivation in the prior art that would lead one of ordinary skill to modify the prior art reference or combine references to arrive at the claimed invention.

IV. SUMMARY OF OPINION

17. In my opinion, claims 1-30 of U.S. Patent No. 12,632,899 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)¹

- Chinese Patent Application Publication No. CN 1897644A (“Luo”)²
(EX1004)

¹ Garcia was originally published in Spanish. Exhibit A of EX1003 includes the original Spanish publication, and Exhibits B and C of EX1003 are certified translations of the Spanish publication. This Declaration’s citations to “EX1003” refer specifically to Exhibit B of EX1003. I have reviewed both the Exhibit C translation of Garcia and Exhibit B, the translation submitted in the petitions for *inter partes* review of related patents U.S. Patent Nos. 12,159,310 and 12,211,095 (IPR2026-00279 and IPR2026-00277, respectively) and find no differences that affect my analysis.

² Luo was originally published in Chinese. Exhibit A of EX1004 includes the original Chinese publication; Exhibits B and C of EX1004 are certified translations of the Chinese publication. This Declaration’s citations to “EX1004” refer specifically to Exhibit B of EX1004. I have reviewed both the Exhibit C translation of Luo and Exhibit B, the translation submitted in the petitions for *inter partes* review of related patents U.S. Patent Nos. 12,159,310 and 12,211,095 (IPR2026-00279 and IPR2026-00277, respectively) and find no differences that affect my analysis.

- Richard Harrison & Mark Shackman, Symbian OS C++ for Mobile Phones, Volume 3 (2007) (“Harrison”) (EX1005)³
- U.S. Patent Application Publication No. 2007/0194102 (“Cohen”)

³ I have submitted declarations in the *inter partes* reviews of related patents (IPR2026-00279 and IPR2026-00277) addressing grounds of unpatentability based in part on Reto Meier, Professional Android™ Application Development, Wiley Publishing (June 25, 2008) (“Meier”). I understand that in those proceedings, Patent Owner has raised an issue with the accessibility date of Meier. I do not address those arguments here and this declaration should not be understood as expressing any opinion regarding them. In my opinion, the technical concepts reflected in Harrison and Meier—including the use of operating-system APIs to provide application access to mobile-device hardware such as cameras—were well known to a person of ordinary skill in the art at the relevant time and are reflected in numerous prior art references. Consistent with that understanding, the ’899 patent itself recognizes that multiple mobile operating systems, including Symbian OS, Android, Windows Mobile, iPhone OS, Palm OS, and BlackBerry OS, provided APIs through which applications could access camera functionality. EX1001-USP899, 11:39-41.

(EX1006)

- U.S. Patent Application Publication No. 2007/0269124 (“Li”)
- U.S. Patent Application Publication No. 2007/0262148 (“Yoon”)

(EX1007)

- Vikram Goyal, Pro Java ME MMAPi: Mobile Media API for Java Micro Edition, Apress (2006) (“Goyal”) (EX1008)

- U.S. Patent Application Publication No. 2006/0106717 (“Randle”)
- (EX1048)

- U.S. Patent No. 7,156,311 (“Attia”) (EX1043)

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

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

VI	Garcia, Luo, Goyal, Cohen, Li, Yoon	§103	5, 13, 22
VII	Garcia, Luo, Goyal, Cohen, Li, Randle	§103	7, 24
VIII	Garcia, Luo, Goyal, Cohen, Li, Attia	§103	11, 16

V. DESCRIPTION OF THE RELEVANT FIELD

18. I have reviewed and understand the specification, claims, and file history of the '899 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

19. In this section, I discuss the state of the art with respect to certain technologies relevant to the subject matter of the '899 patent.

A. Checks

20. 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 it.

21. To identify the payor'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), (2) the payor's account number with that bank (which identifies the account from which the check will be drawn), and (3) the check number (a unique number assigned to each check that can be used for keeping track of particular checks and for security purposes):

John Smith 2 Jefferson Rd E. Brunswick, NJ		April 29, 1999
Pay To The Order Of:	COMCS	\$ 37 no/00
Thirty-Seven and no/100		
John Smith		
0210000891: 1234567891 ■ 0000003700		

EX1014-Slater, FIG.11.

22. **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

23. 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.

24. 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. By the early 2000s, OCR had improved such that it could accurately read most handwriting and read typeset text from lower quality images.

25. 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.

26. 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.

27. 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-Richardson, [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].

28. 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

29. 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 overlaid 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].

30. 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 increase the accuracy of OCR output from **document** images captured by **mobile devices** when the OCR is run on the **mobile device**.

31. 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 keystone 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.

32. 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.

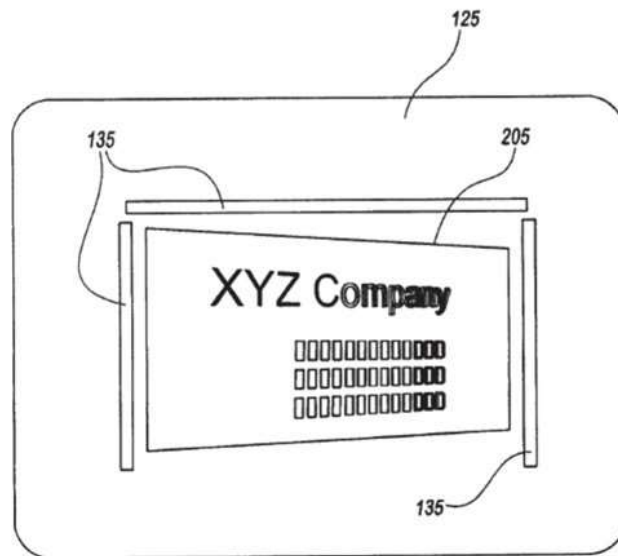


Fig. 5

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

- Edge detection (EX1045-Zhu, 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])

33. 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. 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.

34. 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

35. Small form factor **devices**, like **PDA**s 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.

36. **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.

37. 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 (EX1081-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 '899 patent—Handango was adding more than 11,000 software titles in a year that were available to millions of consumers. EX1066-Handango.

38. 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-Harrison, 5; EX1008-Goyal, 1, 127, 174; EX1081-Meier, 5-6; 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()` (EX1081-Meier, 319-21)
- Windows Mobile: `CameraCaptureDialog` (EX1067-Windows), `SHCameraCapture` (EX1040-CodeGuru)
- Symbian: `CCamera`, `MCameraObserver` (EX1005-Harrison, 699-706; 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)

39. 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**. EX1081-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 '899 PATENT

A. Brief Description

40. As I show in Figure 2 (reproduced below), the '899 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-USP899, 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 '899 patent.

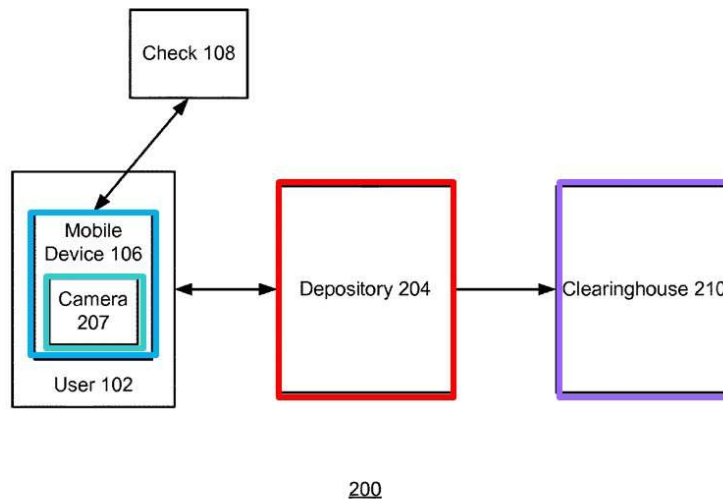


FIG. 2

Id., FIG.2.⁴

41. As I also discussed in Section VI.B with respect to the technical background of the '899 patent, using a **mobile phone** to take an image of a check was already known. Therefore, the '899 patent purports to 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 “[f]eedback” “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 **camera** and provid[ing] [the image] to a **financial institution**.” EX1001-

⁴ All annotations added unless otherwise noted.

USP899, Abstract; *see also id.*, 1:43-63. 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.

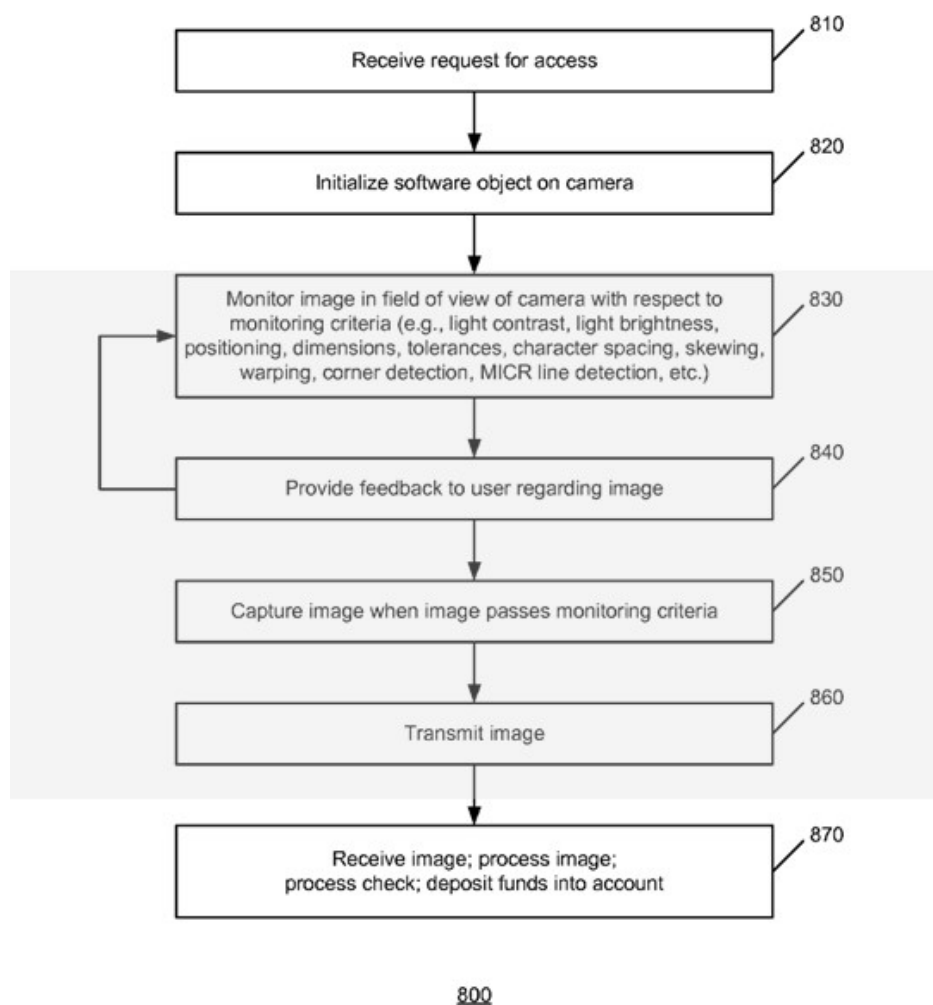


FIG. 8

Id., FIG.8.

42. 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-USP899, 4:15-19.

43. As I discussed above in VI.C with reference to the technology background, many of these techniques were already known. My review of the ’899 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).”); 7:66-67 (“Any known technique(s) for edge detection and/or corner detection may be used.”); 8:59-63 (“Any known **MICR line** detection technique(s) may be used....”); 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)”; 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....”); 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 ’899 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....” *Id.*, 7:28-43. However, the ’899 patent does not explain how to determine what feedback is appropriate to provide based on the current image.

44. 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 ’899 patent refers to the well-known software components available at the time for implementing the ’899 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-USP899, 11:26-28. As with monitoring criteria and consistent with the state of the art I discussed in Section VI, the ’899 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.*, 11:31-41. I identified various known camera control APIs for these operating systems in Section VI.D.

B. Prosecution History

45. I have read the prosecution history of U.S. Patent Application No. 19/321,167 (the “’899 Application”), filed September 5, 2025, that granted as the ’899 patent. EX1001-USP899, cover; EX1033-FH899, 1-100. I have also been informed and understand that the pending claims were rejected on the ground of nonstatutory obviousness-type double patenting over claims of the ’095 and ’310 patents and claims of the 19/038,702 and 18/988,097 applications. I have also been informed and understand that in response, applicant USAA filed a Terminal Disclaimer. The examiner issued a Notice of Allowance on February 2, 2026. 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

46. It is my understanding that when considering the claims of the ’899 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.

47. 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.

48. 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 2008⁵) of the '899 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.⁶ Less work experience may be compensated by a higher level of

⁵ I have been informed that the owner of the '899 patent has argued that the '095 patent, of which the '899 is a continuation, 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.

⁶ I have been informed and understand that, in related IPRs, the owner of the '899 patent has argued that a person of ordinary skill in the art would have had two years of prior experience with “(1) the capture and processing of video in mobile devices, including the transfer of video to a server for further processing, and (2) software

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

49. 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 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.

50. 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

application for mobile devices.” My opinions below are the same under either definition.

specification, to all claim terms in my analysis.

X. OVERVIEW OF PRIOR ART REFERENCES

A. Garcia (EX1003)

51. I understand that International Patent Application Publication No. WO2005/043857 (“Garcia”) (EX1003) was published on May 12, 2005, and is therefore prior art to the ’899 patent.

52. Garcia’s “Field of Invention” is as follows:

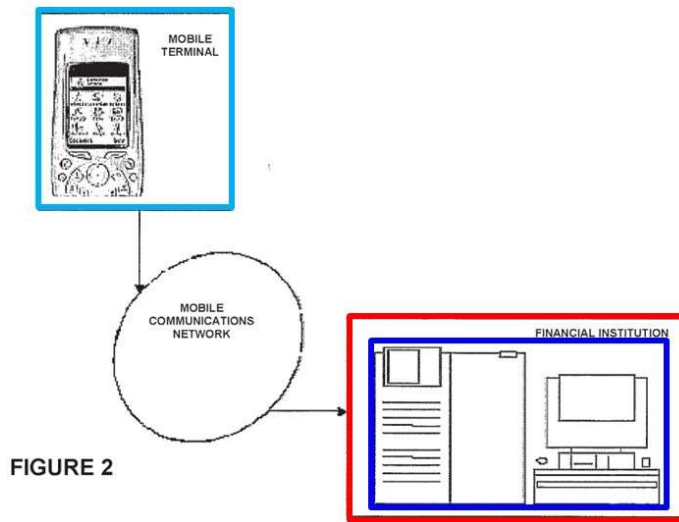
The present invention, as its title implies, relates to a method for processing and accepting documents, such as, for example, bank checks, with guarantee of authentication of the issuer and the document itself, using electronic media for its implementation through a mobile device capable of capturing and sending images via an Internet connection.

EX1003-Garcia, 1:5-13; *see also id.*, 4:10-18. That is, like the ’899 patent, Garcia is directed to remotely depositing a check using an image captured by a **mobile device**. *Id.*; *see also id.*, 6:12-18.

53. 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.



EX1003-Garcia, FIG.2.

54. 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

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

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.").

55. The **financial institution** receives the image and associated information from the **mobile** device and performs various steps to "automatically process" the check and complete **the** 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.

56. As shown below, in Garcia's Figure 1, the check "**photo**" is used

throughout the process, including by the **financial institution** for “financial processing.”

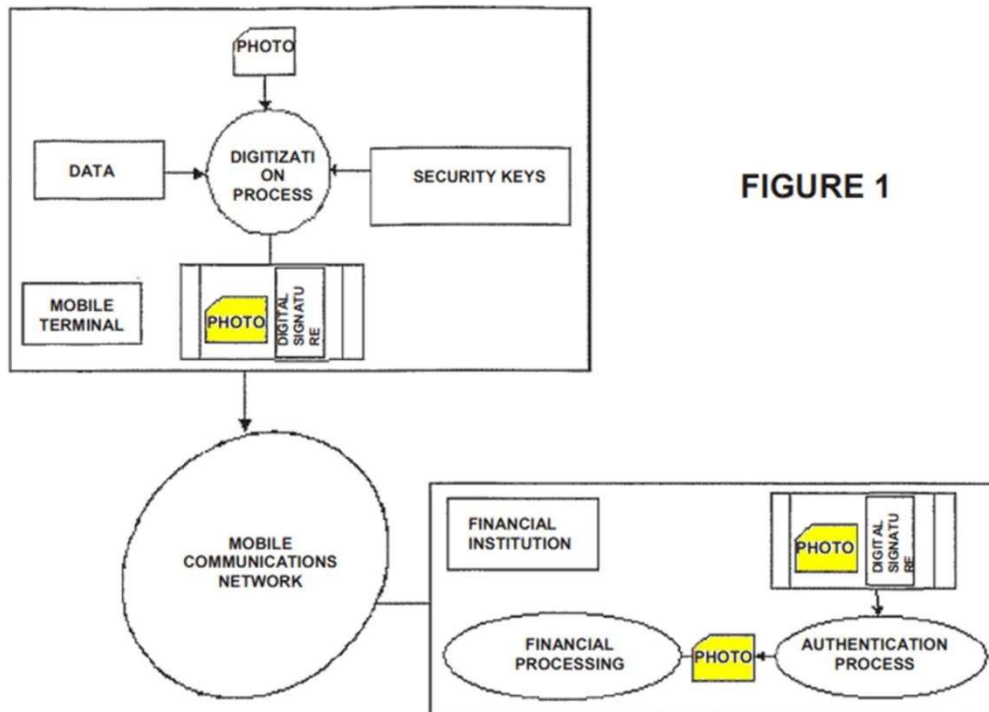


FIGURE 1

EX1003-Garcia, FIG.1.

57. 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)

58. I understand that Chinese Patent Application Publication No. CN

1897644A (“Luo”) (EX1004) was published on January 17, 2007, and is therefore prior art to the ’899 patent.

59. Luo’s “Field of the Invention” is as follows:

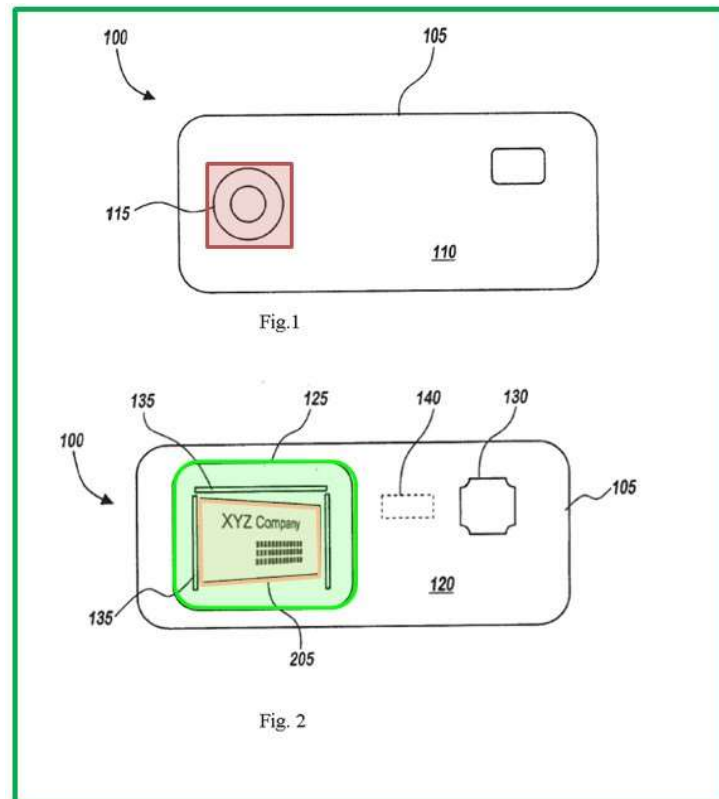
The present invention relates generally to a method and system for capturing images using a digital camera, especially (but not exclusively) a method and system for capturing images of documents such as business cards.

EX1004-Luo, 1.

60. 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. *Id.*, 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 ’899 patent and Garcia, Luo is directed to imaging and optically reading special case paper **documents** using a **mobile device**.

61. 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.

62. 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.

63. 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 '899 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.

64. 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:

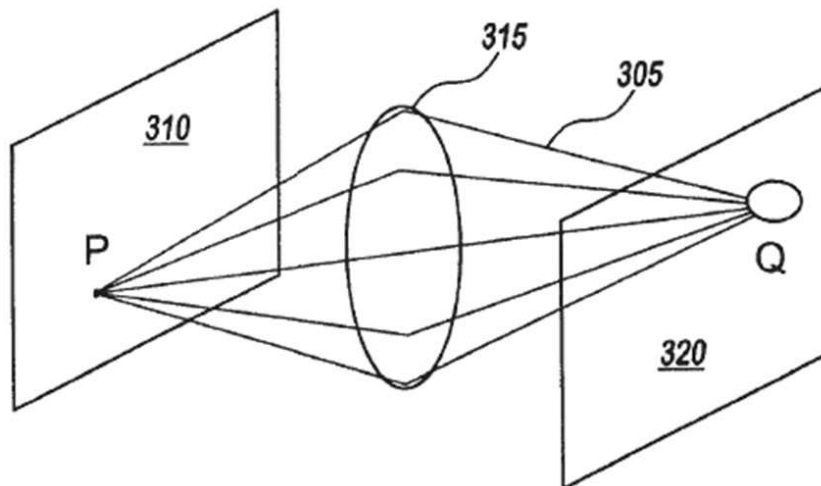


Fig. 3

Id., FIG.3.

65. 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:

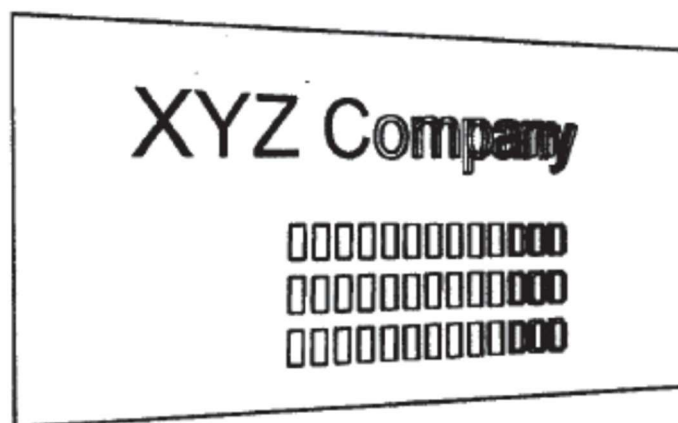


Fig. 4

Id., FIG.4.

66. As was known in the art, and like the '899 patent's "**alignment guide**," which "may take any shape such as a bounding rectangle or other bounding box or shape, horizontal and/or vertical bars, parallel lines, etc.," Luo teaches reducing these unwanted effects by displaying "**reference lines**" 135/235 in the "**preview window**" 125. EX1001-USP899, 8:7-19; 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.

67. 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.

68. Luo's **reference lines** in Figure 5 are shown below along with a depiction of an **alignment guide** in Figure 3 of the '899 patent:

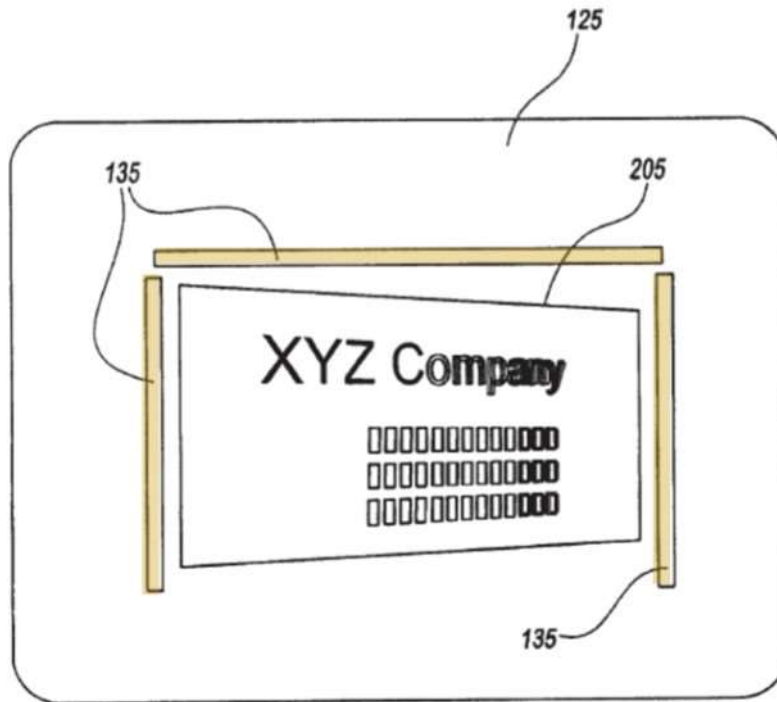


Fig. 5

EX1004-Luo, FIG.5

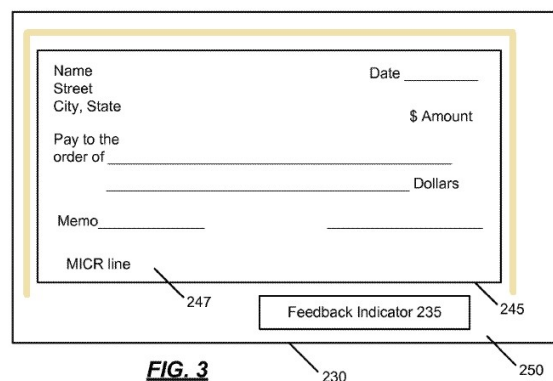


FIG. 3

EX1001-USP899, FIG.3; EX1001-USP899, 8:7-19 (“The alignment guide may take any shape such as a bounding rectangle or other bounding box or shape, horizontal and/or vertical bars, parallel lines, etc., for example.”).

69. 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.

EX1004-Luo, 4, 6, FIG.6, claim 5.

70. Luo also teaches that “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.

C. Harrison (EX1005)

71. I understand that Richard Harrison & Mark Shackman, Symbian OS C++ for Mobile Phones, Volume 3, Wiley & Sons (2007) (“Harrison”) (EX1005) was publicly available by August 31, 2007, and is therefore prior art to the ’899 patent.

72. Harrison is a guide for developing mobile applications. EX1005-Harrison, xxiii-xxiv. Specifically, Harrison is directed to writing applications for Symbian OS-based devices, which is one of the well-known prior art mobile operating systems that the ’899 patent identifies as having appropriate **camera** control APIs for use with the purported invention. *Id.*; EX1001-USP899, 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 mobile OSs include Symbian OS, iPhone OS, Palm OS, BlackBerry OS, and Android.”). Symbian OS is a mobile operating system that enables third-party developers to write applications for a **mobile device**. “Symbian

OS is intended to run on open (to third-party installable applications), small, battery-powered portable computers, that is, modern advanced **mobile phones**.” EX1005-Harrison, 17.

73. As was known in the art, Harrison explains that Symbian OS gives developers “unparalleled opportunities in mass-market, enterprise and system programming.” EX1005-Harrison, xxiv. Like in the ’899 patent, Symbian OS provides “APIs” that allow both system and third-party applications to access the hardware of the **mobile device** like the **camera**. For example, Harrison explains:

Symbian OS APIs are divided into categories that correspond to the different types of program: ... application engines expose APIs to the applications that use them.

EX1005-Harrison, 36-37.

This chapter describes the Multimedia Framework and the associated Multimedia APIs that are present in Symbian OS v9.1. These APIs can be used to play and record audio and video data, perform image processing and manipulation, and access any camera and radio tuner hardware present on a phone.

Id., 651.

Symbian OS v9.1 provides the ECAM API to allow access to any onboard camera on the phone. It provides functionality to display a viewfinder and capture still images from the camera. It is also possible to capture video using the ECAM API.

Id., 699.

74. As one example pertinent to the '899 patent, Harrison teaches that the Symbian OS Camera API can be used to “display a viewfinder” and “capture still **images** from the **camera**,” as well as to “capture video.” EX1005-Harrison, 699. Harrison discusses specific APIs, such as `StartViewFinderDirectL()` and `StartViewFinderBitmapsL()` for previewing a live video stream from the **camera** and `CaptureImage()` for capturing an **image**, as well as example code. *Id.*, 702-06.

75. Harrison also discusses various considerations for developers seeking to deploy their mobile application. In particular, Harrison teaches that a completed application is packaged into a “Symbian OS installation (SIS) file[,]” and that end users can obtain such a file by transferring it “from a PC using connectivity software, Bluetooth, infrared or even email and an Internet connection,” including by downloading it “straight from a website.” EX1005-Harrison, 269, 279-80. Harrison further explains that network operators and phone manufacturers distribute such

applications to end users through their own “portals” and “channels,” which therefore provide any Symbian OS user with access to a range of third-party downloadable applications. *Id.*, 273-74.

D. Li (EX1088)

76. I understand that U.S. Patent Application Publication No. 2007/0269124 (“Li”) (EX1088) was published on November 22, 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 ’899 patent.

77. Li’s “Field of the Invention” is as follows:

The present embodiments relate generally to processing
images of whiteboards, blackboards, or documents.

EX1088-Li, [0003].

78. Specifically, Li describes techniques for “processing images of whiteboard, blackboard, or document content to improve the visibility of the content while also being robust and efficient for implementation on a mobile platform (such as a camera or phone camera).” *Id.*, [0005]. Li explains that the image may be captured by a device such as “a mobile phone ... with a camera.” *Id.*, [0043]. The “typical captured image 320 comprises an image of a medium 410 (e.g., whiteboard, blackboard, document, etc.), an image of content 420 (e.g., text, lines, drawings, sketches, etc.) on the medium, and an image of a background 430 surrounding the

medium.” *Id.*, [0050], FIG. 4. Li explains that the document may be “of any color (e.g., black or white)” and examples include “sheet of paper, a business card, or any other type of printable or readable medium.” *Id.*, [0049].

79. Li teaches image processing including separating the document from the background, as well as detecting and correcting geometric distortion in the content image. *Id.*, [0111]-[0112]. Li’s image processing may be implemented on the image-capturing device itself, such as a mobile phone with a camera, or on a separate device that receives the captured image. *Id.*, [0008], [0043]-[0047].

80. Li describes techniques to remove the background image by determining the boundary of the document within the image. *Id.*, [0068]–[0069]. To determine the boundary, Li explains that the image (EX1088-Li, [0071], FIG.16), is divided into a plurality of sub-blocks. *Id.*, [0084]. Specifically, the image is “partitioned into four equal-sized sub-blocks” wherein “each sub-block would contain a ‘corner’ of the medium image.” *Id.*, [0084]. As such, similar to the ’899 patent, Li partitions images of a document where each partition contains document image and background image.

Li, FIGURE 16

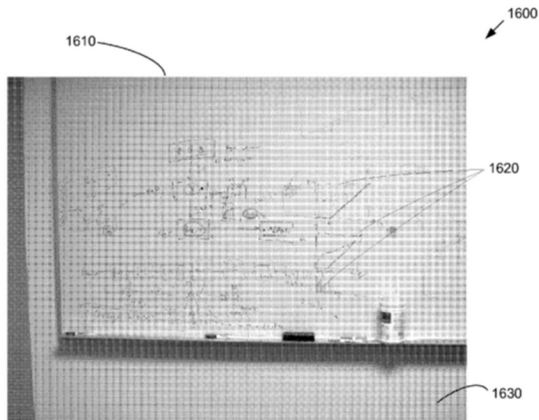


FIG. 16

Li, FIGURE 20

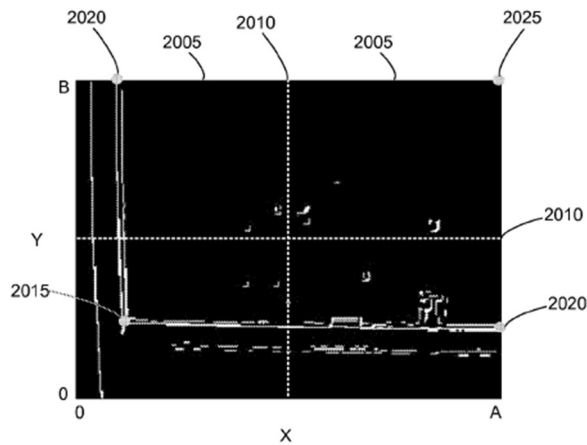


FIG. 20

'899 Patent, FIGURE 4

FIG. 4

EX1088-Li, Fig.20; EX1001-USP899, Fig.4; 10:4-8 (“segments may be formed by any techniques, take any shape, and have any area, subject to a constraint that each

segment comprises a portion of the check data **247** and a portion of the background data **250** separated by a portion of the edge **245**").

Li uses edge detection, X- and Y-one-dimensional projections, and two-dimensional corner-edge filtering, including coarse and fine searches, to locate the corners. EX1088-Li, [0084]-[0085], [0095]-[0101], FIG. 15, FIG. 20, claims 1, 9. Li then determines the medium boundary from the corner positions and removes the background image. *Id.*, [0107]-[0110].

E. Cohen (EX1006)

81. I understand that U.S. Patent Application Publication No. 2007/0194102 ("Cohen") (EX1006) was published on August 23, 2007, and is therefore prior art to the '899 patent.

82. 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].

83. Cohen explains that “Technology for check image capturing, performing optical character recognition (OCR) and image assessment, is well known in the art.” Id., [0002]. Taking advantage of this technology, Cohen discloses that a merchant can deposit checks using a “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. Id., [0022]. Therefore, like Garcia and the ’899 patent, Cohen is directed to depositing a check using its image. Id., [0008], [0022].

84. 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....” EX1006-Cohen, [0021].

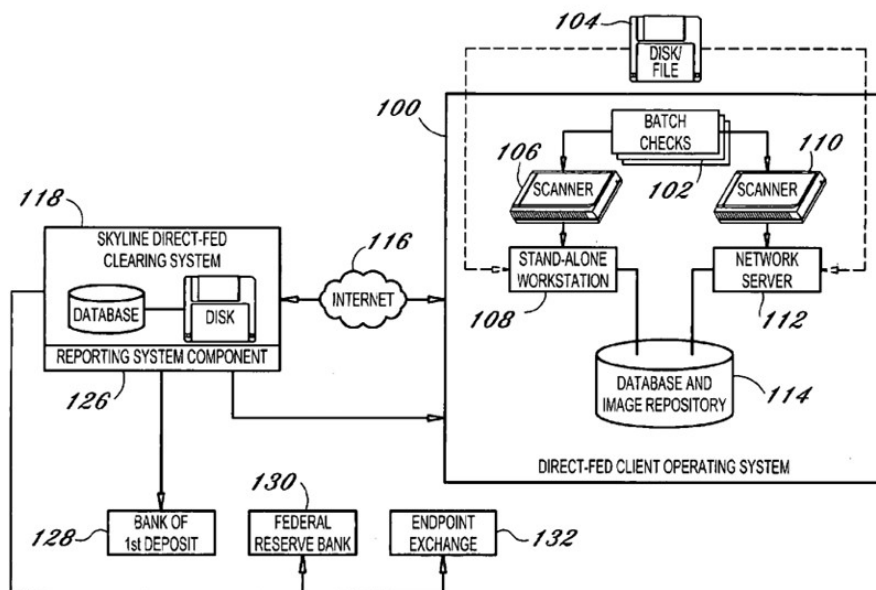


FIG. 1

Id., FIG.1.

85. Like Luo and the '899 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." EX1006-Cohen, [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.

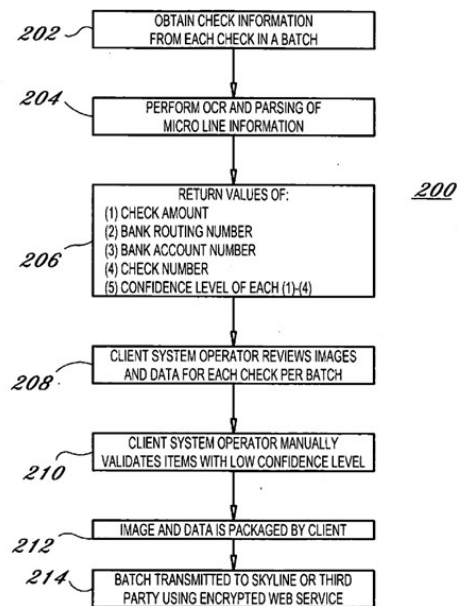


FIG. 2

Id., FIG.2.

F. Yoon (EX1007)

86. 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 ’899 patent.

87. 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].

88. 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 ’899 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.

89. 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 ’899 patent, describes various criteria that can be used for automatically capturing an image of a **document**. For example, like Luo and the ’899 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].

90. 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.

G. Randle (EX1048)

91. I understand that U.S. Patent Application Publication No. 2006/0106717 (“Randle”) (EX1048) was published on May 18, 2006, and is therefore prior art to the ’899 patent.

92. Like Garcia and the ’899 patent, Randle teaches using a check image to perform deposit. EX1048-Randle, [0002], [0006]-[0007]. More specifically, Randle 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:

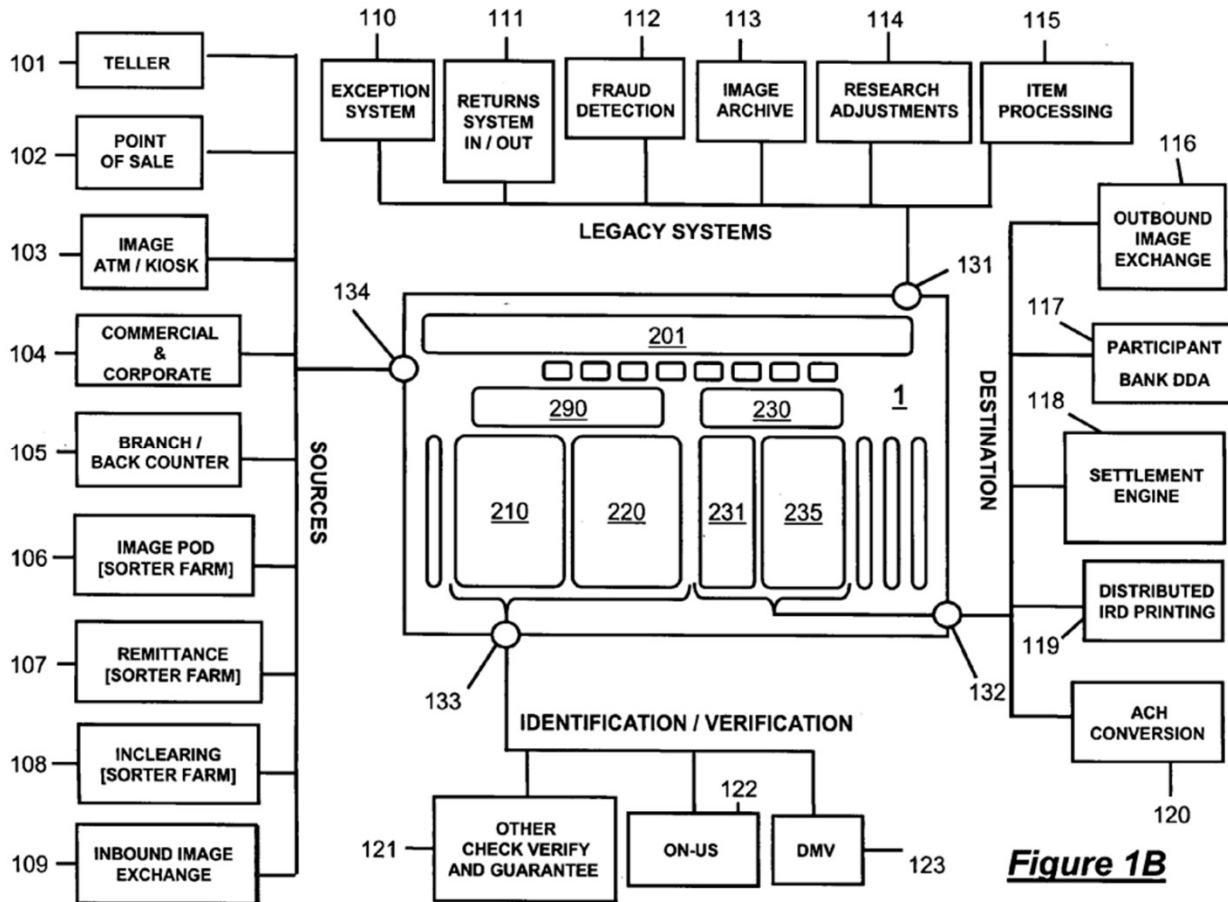
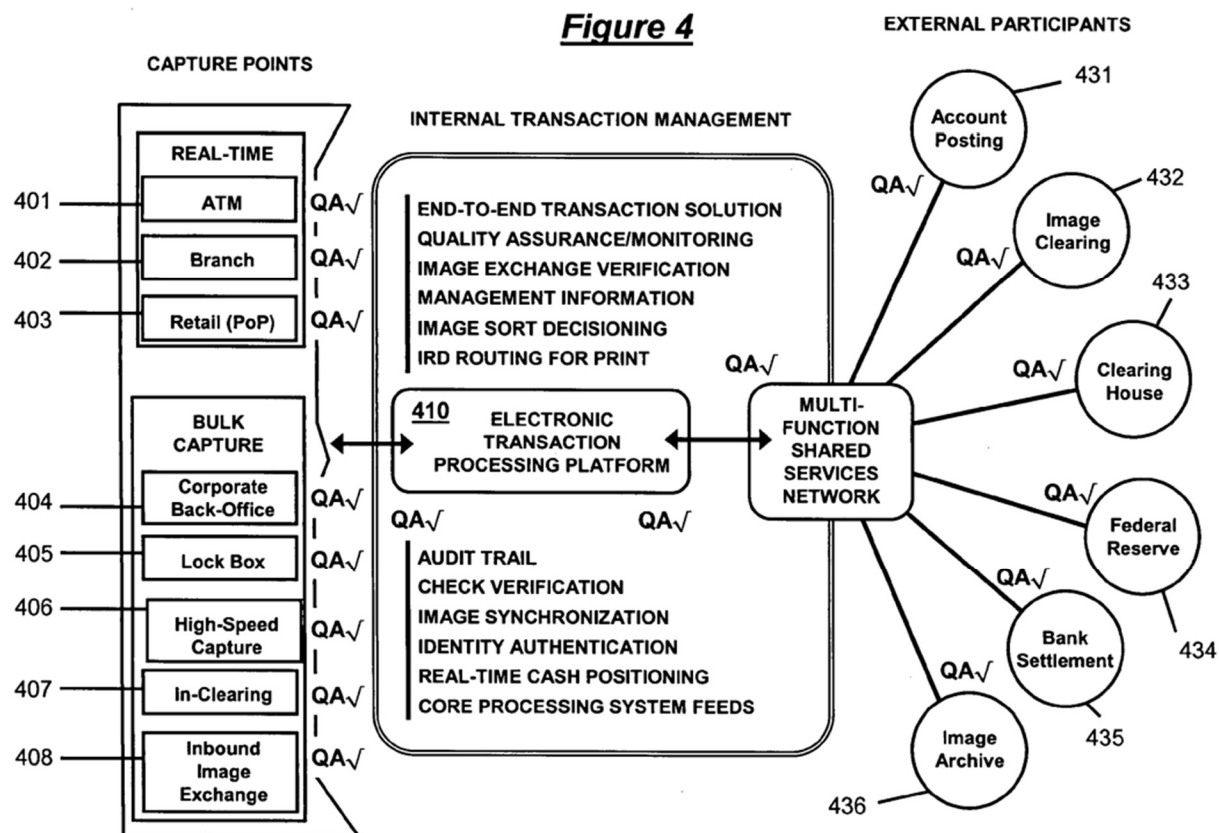


Figure 1B

Id., Fig.1B.

93. 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:

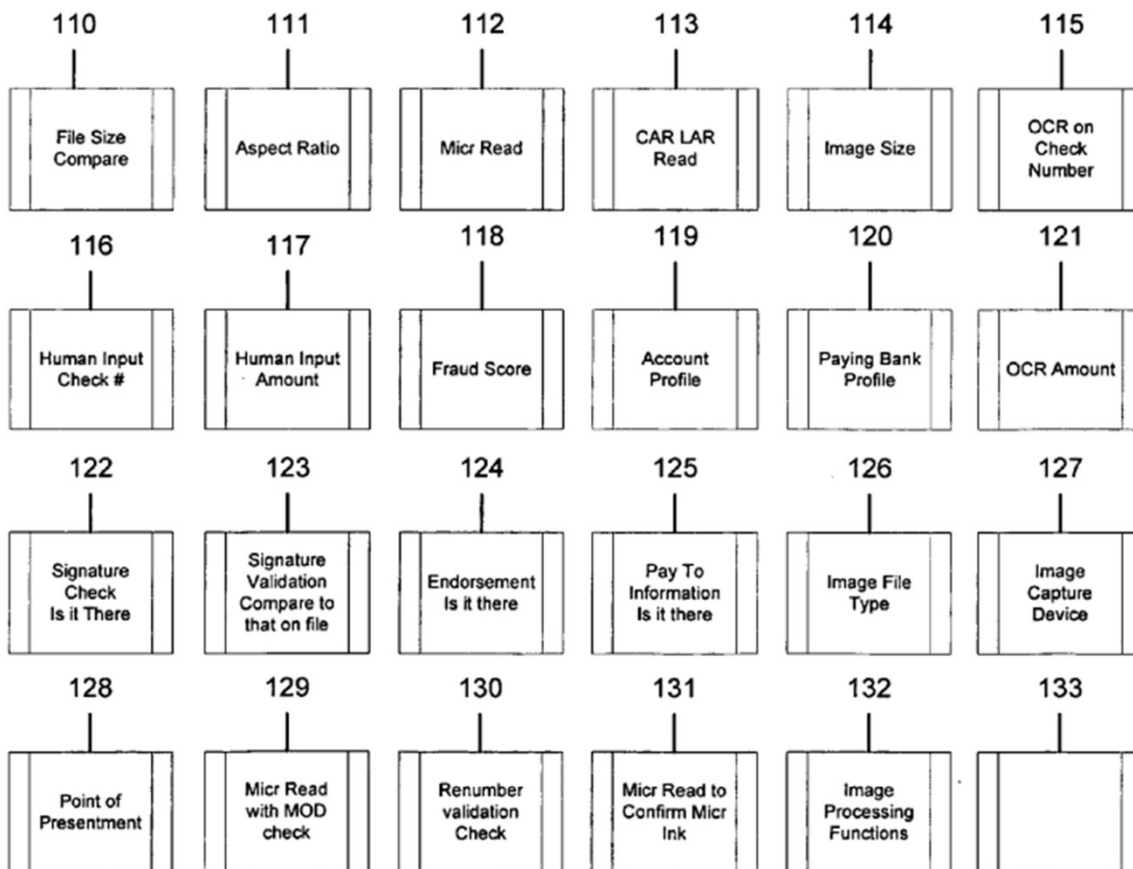
The ability to establish virtual electronic processing bins and flows as depicted in the figures allows for an infinite range of QA processes, sorting routines, and exception routing and workflow processes to be established and managed within the system. This supports a broad range of custom QA sorting 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].

94. 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



95. As one example, Randle teaches "132 image processing functions...."

EX1048-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].

96. 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)

97. Attia, like Garcia and the '899 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.

98. 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. Attia 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.

I. Goyal (EX1008)

99. I understand that Vikram Goyal, Pro Java ME MMAPI: Mobile Media API for Java Micro Edition, Apress (2006) (“Goyal”) (EX1008) was publicly available on or about June 19, 2006, and at least by January 25, 2007, and is therefore prior art to the ’899 patent.

100. Like Harrison, 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 specifically 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 as “MIDlets,” which are “applications for Java-enabled **mobile devices**, such as **mobile phones** and **PDA**s” 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 ’899 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.

101. As one example pertinent to the ’899 patent, Goyal teaches that MMAPIs can be used to “capture snapshots or full videos” from within a mobile application. EX1008-Goyal, 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.

102. 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 **PDA**s. 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

XI. SPECIFIC GROUNDS FOR UNPATENTABILITY

103. In my opinion, claims 1-30 of the ’899 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, Harrison, Cohen, Li	§103	1-4, 6-12, 14-21, 23-30

II	Garcia, Luo, Harrison, Cohen, Li, Yoon	§103	5, 13, 22
III	Garcia, Luo, Harrison, Cohen, Li, Randle	§103	7, 24
IV	Garcia, Luo, Goyal, Cohen, Li	§103	11, 16
V	Garcia, Luo, Goyal, Cohen, Li	§103	1-4, 6-12, 14-21, 23-30
VI	Garcia, Luo, Goyal, Cohen, Li, Yoon	§103	5, 13, 22
VII	Garcia, Luo, Goyal, Cohen, Li, Randle	§103	7, 24
VIII	Garcia, Luo, Goyal, Cohen, Li, Attia	§103	11, 16

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

104. 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, Harrison, Li, and Cohen. First, I explain why a person of ordinary skill in the art would have been motivated to combine Garcia with the Luo, Harrison, Li, 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, and 23-30 obvious (Sections XI.A.2 and XI.A.3).

1. Combination of Garcia, Luo, Harrison, Li, and Cohen (“Garcia/Luo/Harrison/Li/Cohen”)

105. I have reviewed the Garcia, Luo, Harrison, Li, and Cohen references. It

is my opinion that each is analogous art to the '899 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.

106. In Section XI.A.1.a, I explain (1) 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 capturing an image of a **document**, (2) why a person of ordinary skill would have been motivated to modify Garcia with Li's teachings regarding dividing a video frame into partitions to isolate the image of a document from background data, and (3) further why a person of ordinary skill in the art would have been motivated to implement those teachings using Harrison's software architecture, including a downloaded application and **camera** control APIs.

107. 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, Harrison, and Li
("Garcia/Luo/Harrison/Li")**

108. **Analogous Art:** In my opinion, Garcia, Luo, Harrison, and Li are analogous art to the '899 patent claims. The '899 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 uses “an app for download to a **mobile device** of a user,” “a **camera** and a memory storing,” and “control[s] the **camera**” to facilitate “auto-capture” of a check image via “the video frame of the live video of the check...” EX1001-USP899, 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 ’899 patent is directed to capturing and processing images of a **document** (i.e., a check).

109. Garcia, Luo, Harrison, and Li 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.

110. 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 ’899 patent claims.

111. Harrison discloses a software development guide and example mobile application computer code for capturing images using Symbian OS devices. For example, Harrison teaches that the disclosed Camera API “provide[s] access to any onboard camera on the phone” and “provides functionality to display a viewfinder and capture still images from the camera.” EX1005-Harrison, 699-706. 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, Harrison is directed to techniques for capturing an image, including an image of a **document**, just like the ’899 patent claims.

112. Finally, Li discloses methods for processing captured images of whiteboards, blackboards, and documents. EX1088-Li, [0005], [0049]-[0050]. Li explains that a captured image includes an image of a medium such as a document,

an image of content such as text, lines, or drawings, and an image of a background surrounding the medium. *Id.* “Examples of a document are a sheet of paper, a business card, or any other type of printable or readable medium.” *Id.* Thus, Li is directed to techniques for capturing an image, including an image of a **document**, just like the ’899 patent claims.

113. **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 been motivated to incorporate Li’s teachings regarding processing an image of a document by partitioning an image into subdivisions containing document/content and background. EX1088-Li, [0050], [0068]-[0069], [0084]-[0085]. 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 Harrison’s software architecture, including a downloaded application and APIs for controlling **mobile device cameras**.

114. 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, Harrison, and Li to supply implementation details. For example, a person of ordinary skill in the art

would have been motivated to look to references like Luo and Li for additional teachings regarding how to 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 Harrison regarding the particular software implementation on Garcia's **mobile device**.

115. 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.

116. 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.

117. In my opinion, a person of ordinary skill in the art would have been motivated to incorporate Luo’s teachings described above into Garcia’s 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.

118. 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 method. 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 method 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.

119. As I explained in Section III, 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.

120. A person of ordinary skill in the art would have further been motivated to incorporate Li’s teachings into the combination of Garcia/Luo. Li provides a technique for processing an image containing a document or other medium and its surrounding background by dividing the image into sub-blocks and analyzing the sub-blocks to identify the document’s corners and boundary. Li teaches that a captured document image includes a medium/document image, a content image, and

a background image, and that the background may be removed by detecting the boundary of the medium. EX1088-Li, [0050], [0068]-[0070]. Li further teaches using edge and corner information within the sub-blocks to determine the location of the medium's corners and, from those corners, the medium boundary. Id., [0084]-[0085], [0095]-[0101].

121. Garcia/Luo uses the camera's monitored image to determine whether the check is suitably positioned for capture and to automatically capture an image when the requisite conditions are satisfied. Li also relies on camera positioning (similar to the positioning of Garcia/Luo), to ensure it is approximately centered on the rectangular blackboard/whiteboard/document, such that each quadrant of the camera image contains no more than one corner of the blackboard/whiteboard/document. A person of ordinary skill would have been motivated to incorporate Li's techniques for edge detection, corner detection, and boundary determination, which would have provided concrete tools for analyzing the sub-blocks, or segments, of a video frame to determine whether the check was sufficiently within the field of view, appropriately positioned, or sufficiently aligned before triggering automatic capture. EX1088-Li, [0084]-[0085], [0095]-[0101], claims 1, 9. This would be a natural extension of Li's teachings. Li also identifies additional benefits of its image-processing techniques, including the document image having "improved visibility (e.g., have clearer image quality, better contrast,

etc.) with less geometric distortion and have the background image removed” as well as a “smaller file size.” EX1088-Li, [0007]. These benefits would have provided further reasons for a person of ordinary skill to employ Li’s techniques in the Garcia/Luo system.

122. 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. Li discloses similar teachings regarding processing images of documents on mobile platforms, including an “image processing module” implemented on an “embedded device” comprising a **mobile phone** with a **camera**. EX1088-Li, [0043]-[0047]. Li explains that the image-processing module receives a captured image and processes it, and that the image-capturing device and processing module may be implemented on the same device or on separate devices. *Id.*, [0008], [0043]-[0047]. A person of ordinary skill in the art, when faced with Garcia’s, Luo’s, and Li’s teachings regarding **mobile devices** and associated software, would have been motivated to look to other teachings from the prior art like Harrison to supply implementation details. For

example, Harrison supplies the software architecture (and how such software is loaded onto the **mobile device**) required to implement Garcia's and Luo's teachings.

123. Harrison 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 in a particular computing environment. I have used these types of resources many times in my career. Harrison is one such guide in the field of mobile application development for Symbian OS. Specifically, Harrison describes itself as “provid[ing] a thorough grounding in writing C++ applications for mobile phones that use Symbian OS” that helps application developers “to exploit the potential of mobile solutions with Symbian OS technology.” EX1005-Harrison, xxiii-xxiv; *see also id.* (“Symbian OS C++ for Mobile Phones Volume 3 complements Symbian OS software development kits. When you've put this book down, the UIQ and S60 SDKs will be your first resource for reference information on the central Symbian OS APIs that we cover here.”). This includes helping developers take advantage of the **device camera**. *Id.*, 651 (“This chapter describes the Multimedia Framework and the associated Multimedia APIs that are present in Symbian OS v9.1. These APIs can be used to play and record audio and video data, perform image processing and manipulation, and access any camera and radio tuner hardware present on a phone.”), 699 (“Symbian OS v9.1

provides the ECAM API to allow access to any onboard camera on the phone. It provides functionality to display a viewfinder and capture still images from the camera. It is also possible to capture video using the ECAM API.”), 713 (“The ECAM camera API provides access to any onboard camera on the phone. It provides functionality to display a viewfinder and capture still images from the camera.”).

124. Harrison describes many software features relevant to Garcia and Luo. For example, Harrison provides techniques for loading application software on a **mobile device**. Specifically, Harrison teaches downloading mobile applications onto the **device**. *Id.*, 269, 279-80 (“[E]nd users install all the code, packaged in Symbian OS installation (SIS) files. ... [Y]ou can download a SIS file straight from a website.”). Harrison also teaches that such downloaded applications can access “any onboard **camera** on the phone” to “display a viewfinder and capture still images from the camera,” as well as to “capture video.” *Id.*, 699; *see also id.*, 651, 713. In order to access the **mobile device camera**, Harrison teaches the use of well known Multimedia APIs, explaining that “[t]hese APIs can be used to play and record audio and video data, perform image processing and manipulation, and access any **camera** and radio tuner hardware present on a phone.” *Id.*, 651; *see also id.*, 674-75 (discussing video recording API); 699-706 (discussing “Camera API” relating to the camera viewfinder and capturing images/video).

125. A person of ordinary skill in the art would have therefore been

motivated to implement the Garcia/Luo/Li combination with Harrison'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-Harrison, xxiv. 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.*

126. 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, Luo's image capture techniques, and Li's image processing. 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 later use. *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 Harrison, and would have motivated a person of ordinary

skill in the art to implement the Garcia/Luo combination with a downloaded application.

127. 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/Li/Harrison combination, a downloaded application can provide access to the **camera** with pre-written, and readily accessible software APIs. EX1005-Harrison, 269, 279-80, 651, 674-75, 699-706, 712-713. 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.

128. Implementing the Garcia/Luo/Li 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.

129. A person of ordinary skill in the art would have been motivated to look to how-to guides like Harrison, which explain available software features for **mobile devices**, for example using the Symbian OS platform—to implement the Garcia/Luo/Li combination on a **mobile device**. When implementing the combination of Garcia/Luo/Li with Harrison’s teachings, a person of ordinary skill in the art would have recognized that Harrison’s downloadable application and Camera API provide the software features needed to implement for Garcia’s/Luo’s/Li’s teachings. As a few non-limiting examples, Harrison’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 Symbian OS SDK, the Camera API includes `StartViewFinderDirectL` and `StartViewFinderBitmapsL`, which allows a developer to add a **camera preview window** to their mobile applications. As another example, Harrison’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 Symbian OS SDK, the Camera API includes `CaptureImage`, 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-Harrison, 699-706. Harrison's teachings are not limited to these features—Harrison 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-Harrison, 700-05.

130. As I explained in Section III, 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/Li. For example, implementing Garcia's/Luo's/Li's software with Harrison's teaching to use a downloaded application and **camera** control API would have involved applying a known technique or method—here, Harrison's well-known software architecture that includes downloaded applications and APIs—to a known or similar device or method—here, Garcia/Luo/Li's mobile check capture and processing software—ready for improvement—here, by facilitating Garcia/Luo/Li'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, Luo, and Li.

131. **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, Harrison’s software architecture, and Li’s image segmentation and analysis techniques. 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, Harrison, and Li 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.

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”). Li discloses:

FIG. 1 is a block diagram of an embedded device 10 in which some embodiments are implemented. The embedded device 10 comprises, for example, a camera, a mobile phone (with voice transmission capabilities) with a camera, or another type of device (as discussed below in relation to FIG. 3). In this exemplary embodiment, the embedded device 10 comprises a mobile phone with a camera. The device 10 comprises a memory 12 that stores image files 14, a camera unit/image capturing device 16, an image processing module 26, and a mobile communication processor 24. These components are coupled to each other via a data bus 22.

EX1088-Li, [0043] (describing use of mobile phone with **camera** to capture and process images). Harrison discloses:

This chapter describes the Multimedia Framework and the associated Multimedia APIs that are present in Symbian OS v9.1. These APIs can be used to play and record audio and video data, perform image processing and manipulation, and access any camera and radio tuner hardware present on a phone.

EX1005-Harrison, 651.

132. 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.

133. A person of ordinary skill in the art would have also expected success in the combination because Garcia, Luo, and Li 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 **have** recognized would have included Garcia's "bank checks." EX1003-Garcia, 12:4-9; EX1004-Luo, 1, 4, 6. Similarly, Li teaches capturing and processing an image of a **document**, such as a business card, which a person of ordinary skill would have recognized included Garcia's "bank checks." EX1088-Li, [0049].

134. A person of ordinary skill would also have had a reasonable expectation of success in applying Li's image-processing techniques to video frames in Garcia/Luo. The relevant image characteristics for Li's processing—the check, surrounding background, and boundary between them—are present in the video frame generated by Garcia/Luo. EX1088-Li, [0064]-[0065]. [0084]-[0084], [0110]. Applying Li's edge, corner, and boundary-detection operations to that video frame would therefore involve using the same known image-processing operations on the

same types of image information. The modification would not require changing the underlying techniques taught by Li, but merely performing them on a video frame already being generated and monitored by Garcia/Luo.

135. 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, Li's image processing or Harrison'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-Harrison, xxiv, 651, 699-706. Moreover, implementing the Garcia/Luo/Li/Harrison combination would have simply involved writing computer code using readily accessible software development kits, like the Symbian OS SDK taught by Harrison. 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 Harrison’s teachings. Harrison identifies itself as a handbook directed to C++ programmers “at **any** level,” “**any** other programmer or manager looking to exploit the potential of mobile solutions with Symbian OS technology,” and “**anyone** with an interest in system design.” EX1005-Harrison, xxiv.

136. Finally, my opinion that a person of ordinary skill in the art would have reasonably expected success in the Garcia/Luo/Li/Harrison combination is consistent with the ’899 patent’s disclosure. Like Garcia, the ’899 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 Harrison). EX1001-USP899, 7:54-60, 8:7-19, 24-30, 10:42-51, 11:26-51, 16:19-39, 21:1-27, claims 1, 4. The ’899 patent lacks various implementation details disclosed by Luo and Harrison, such as specific APIs, example code, or particular monitoring criterion parameters.

137. 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. It is also 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 Li to incorporate Li's teachings to segment. 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 Harrison to incorporate Harrison'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")

138. **Analogous Art:** In my opinion, like Garcia, Cohen is also analogous art to the '899 patent claims. As I explained in Section XI.A.1, the '899 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 '899 patent claims.

139. **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.

140. 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.

141. For example, Cohen discloses techniques for verifying and processing 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.

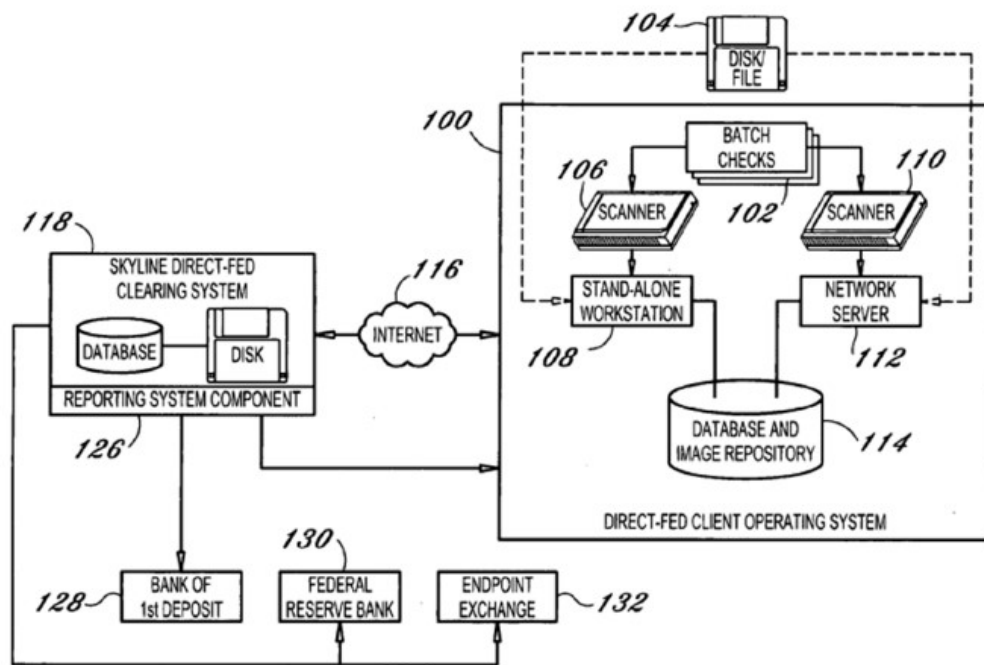


FIG. 1

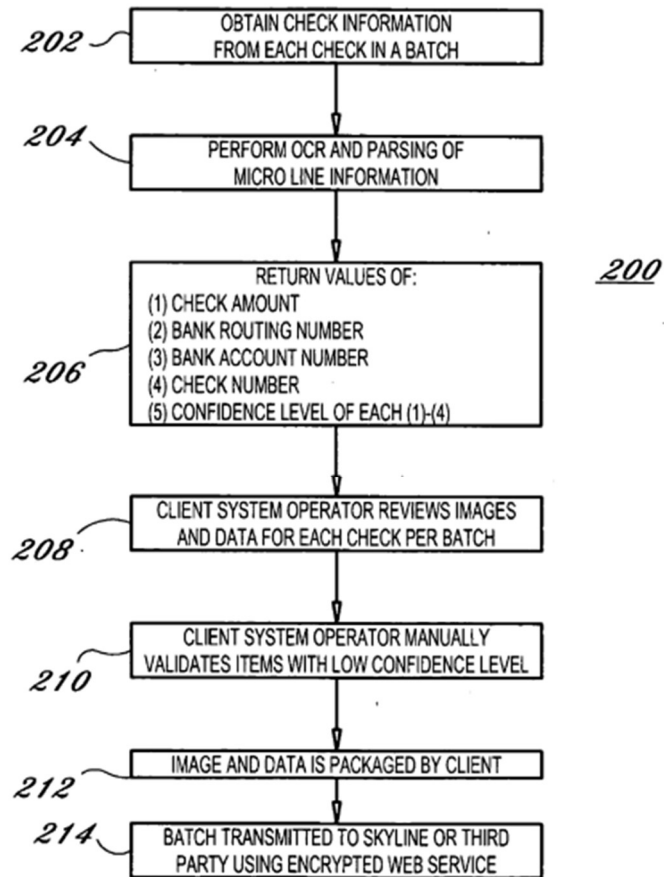


FIG. 2

Id., FIGs.1, 2.

142. 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, is 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.

143. The user’s review occurs after processing but before transmitting the batch of checks for 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].

144. 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.

145. Garcia itself teaches that its mobile remote check deposit method 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, 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**.

146. 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.

147. 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 a bandwidth-constrained network.

148. 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.

149. When faced with the decision as to whether 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.

150. 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.

151. **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].

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 regarding check image processing steps could have easily been applied to Garcia's images as well.

152. 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.

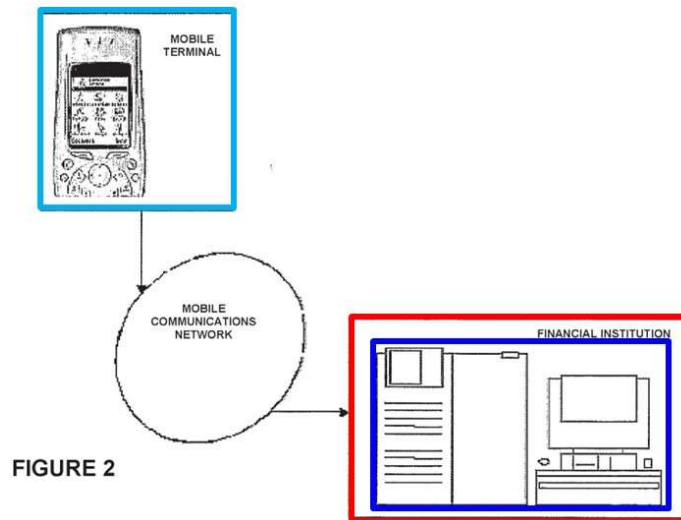
153. Therefore, it is my opinion that it would have been obvious for a person of ordinary skill in the art to combine the teachings of Garcia with Cohen to incorporate into Garcia Cohen's teachings regarding performing OCR, reading the **MICR line**, user validation/confirmation steps, and the image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

2. Independent Claims 1, 9, 18, 26

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

154. The combination of Garcia/Harrison/Luo teaches “a system enabling mobile check deposit auto-capture functionality via video frame processing.”

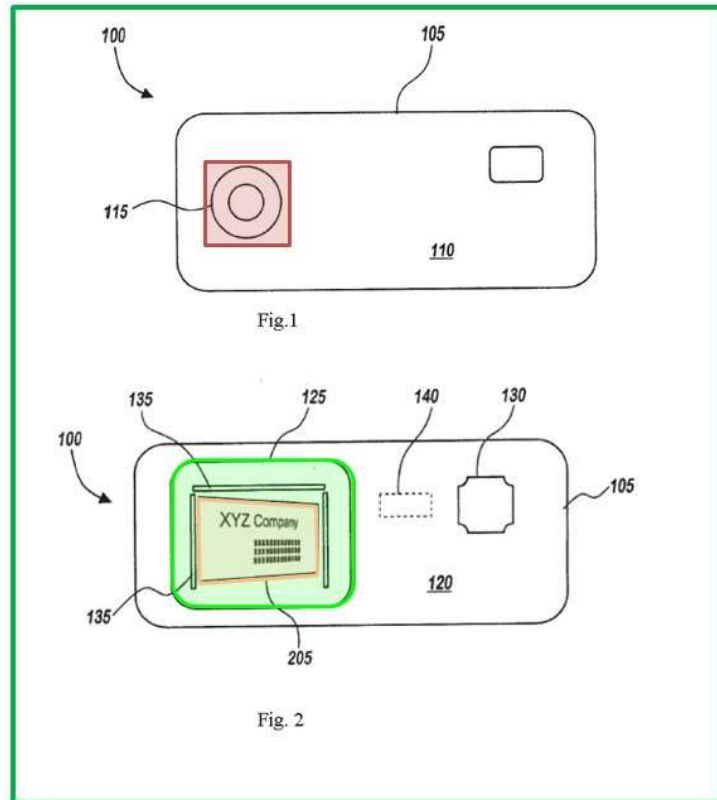
155. Garcia discloses a method and system for mobile check deposit in which a **mobile device** captures an image of a check and transmits the image over a communications network to a remote **banking institution** for processing and deposit. EX1003-Garcia, 1:6-13, 3:13-14, 4:11-18, 9:11-18, 12:4-9,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



EX1003-Garcia, FIG.2.

Thus, Garcia discloses “a system enabling mobile check deposit.”

156. 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.

157. 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.”

158. Harrison discloses software for use on Symbian OS-based **mobile devices**. *See, e.g.*, EX1005-Harrison, xxiii-xxiv. As one example, Harrison teaches methods and systems that allow a **mobile device** to display and process video frames from a **camera** using APIs from the Symbian OS software development kit. *Id.*, 651 (“This chapter describes the Multimedia Framework and the associated Multimedia APIs that are present in Symbian OS v9.1. These APIs can be used to play and record audio and video data, perform image processing and manipulation, and access any camera and radio tuner hardware present on a phone.”), 699 (“Symbian OS v9.1 provides the ECAM API to allow access to any onboard camera on the phone. It provides functionality to display a viewfinder and capture still images from the camera. It is also possible to capture video using the ECAM API.”). With Symbian OS’s Camera API, a user can use the bitmap-based viewfinder to access the **camera’s** streaming video, and incorporate live video into an application. EX1005-Harrison, 702-03 (“[T]he camera passes bitmaps to the application at regular intervals, and the application draws them on the screen as appropriate,” with the bitmaps “passed at a rate fast enough to ensure a smooth viewfinder display.”). The viewfinder bitmap “can be drawn to the screen in the usual way” in real time. *Id.*, 703. A person of ordinary skill in the art would have understood that these successive preview bitmaps, delivered at a rate sufficient to produce a smooth viewfinder

display, constitute live camera preview (i.e., live video) and permit the application to incorporate and display that live camera feed.

159. A person of ordinary skill in the art would have understood that the delivery of bitmaps would allow the application receiving the bitmaps to process the images/frames from the **camera** feed. Harrison further explains that “[v]ideo is recorded from the built-in camera on the phone,” and that a call to “Record()...starts the capturing and encoding of video frames from the camera.” EX1005-Harrison, 674-75, 705. Thus, the Camera API provides an application with successive frames from the mobile-device camera that can be processed as they are received. Harrison, therefore, discloses “video frame processing” by performing further processing on live images generated from the **mobile device camera**.

160. The combination of Garcia, Luo, and Harrison 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 Harrison would have been obvious.

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

161. 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.”

162. 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 an 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 of 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.”

163. 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]

164. The combination of Garcia/Harrison teaches “a software abstraction layer [for controlling the camera], the software abstraction layer comprising

instructions that, when executed by the processor, control the **camera**.”

165. 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**. Harrison 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-Harrison, xxiii-xxiv. For example, Harrison teaches that a completed application is packaged into a “Symbian OS installation (SIS) file[,],” and that end users can download the SIS from a website onto their **mobile device**. *Id.*, 269, 279-80 (“[E]nd users install all the code, packaged in Symbian OS installation (SIS) files. ... [Y]ou can download a SIS file straight from a website.”).

166. In addition, Harrison teaches that APIs of the **mobile device** can be used to “access **camera** hardware.” Specifically, Harrison explains that the ECAM API “allow[s] access to any onboard **camera** on the phone,” and “provides functionality to display a viewfinder and capture still images from the camera” or to “capture video.” *Id.*, 699, 651. Consistent with the knowledge of a person of ordinary skill in the art

and the '899 patent's disclosure,⁸ a person of ordinary skill in the art would have recognized an API to be an example of “a software abstraction layer” and that such an API would run on the device processor.

167. As I explained in Section XI.A.1.a, Harrison's API and associated software, such as the computer application disclosed in Garcia, can be used to configure image capture settings, capture images, and manipulate the live **camera** viewfinder stream via “PrepareImageCaptureL(),” “CaptureImage(),” “StartViewFinderDirectL(),” “StartViewFinderBitmapsL(),” and “StopViewFinder().” EX1005-Harrison, 702-06. Therefore, the combination of Garcia/Harrison renders obvious “a software abstraction layer [for controlling the **camera**], the software abstraction layer comprising Instructions that, when executed by the processor, control the **camera**.”

168. Harrison, 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

⁸ EX1001-USP899 11:26-28 (“In an alternate example, the software object may operate through a software abstraction layer, such as an application programming interface (API).”).

“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 Harrison’s APIs. *See* §§XI.A.2.e-XI.A.2.1, XI.A.1.a, XI.A.1.b.

169. As I explained in Section XI.A.1.a, implementing Garcia’s mobile check deposit system and method with Harrison’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]

170. The combination of Garcia/Harrison teaches “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.”

171. As I explained above in Section XI.A.2.c, the combination of Garcia/Harrison 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

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

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/Harrison teaches “a downloaded app, the downloaded app...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.”

172. A person of ordinary skill in the art would have been motivated to implement Garcia’s “computer application” with Harrison’s downloaded application and **camera** control API for the reasons I discussed in Section XI.A.1.a. In the Garcia/Harrison 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 '899 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, Harrison, and Cohen, these steps would have been performed by the downloaded application.

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

173. The combination of Garcia/Luo teach “providing instructions to the user for capturing [an image of] a check.”

174. 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.”

175. 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.

176. 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]**

177. The combination of Garcia/Luo/Harrison teaches “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].”

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

179. 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.

180. Harrison also teaches “generating a live video of the check in a field of view of the **camera**.” Harrison discloses “Multimedia APIs” that provide access to “any **camera** ... hardware present on the phone” and functionality “to display a viewfinder and capture still images from the camera,” as well as to “capture video.” EX1005-Harrison, 651, 699; *id.*, 651 (“This chapter describes the Multimedia Framework and the associated Multimedia APIs that are present in Symbian OS v9.1. These APIs can be used to play and record audio and video data, perform image processing and manipulation.”). “[T]he camera passes bitmaps to the application at regular intervals, and the application draws them on the screen as appropriate,” meaning a developer can incorporate **live video** into an application. *Id.*, 702-703. For example, the CCamera class lets a developer configure capture settings via “PrepareImageCaptureL(),” take pictures via “CaptureImage(),” and start or stop the streaming camera viewfinder via

“StartViewFinderDirectL(),” “StartViewFinderBitmapsL(),” and “StopViewFinder().” *Id.*, 699-706. A person of ordinary skill in the art would have understood the “viewfinder” to display **live video**, given that bitmaps are “passed at a rate fast enough to ensure a smooth viewfinder display.” *Id.*, 702-703. Thus, Harrison teaches “generating a live video of the check in the field of view of the **camera**.”

181. In addition, as explained above in Sections XI.A.2.c-XI.A.2.d, Harrison’s Multimedia APIs are “software abstraction layer[s].” Because Harrison’s Camera API 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/Harrison combination is configured to “cause the live video to be generated by controlling the **camera** through the software abstraction layer.” See EX1005-Harrison, 699-706; *supra* §§XI.A.2.c-XI.A.2.d.

182. Therefore, Garcia/Luo/Harrison 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 Harrison’s downloaded application and **camera** control API.

g. Claim 1[f]

183. The combination of Garcia/Luo/Harrison teaches “overlaying an alignment guide on the live video of the check in the field of view of the **camera**.”

184. As I explained in Section XI.A.1.a, when combining Garcia with Luo and Harrison, 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/Harrison renders obvious previewing the check in the field of view of the **camera**.

185. 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:

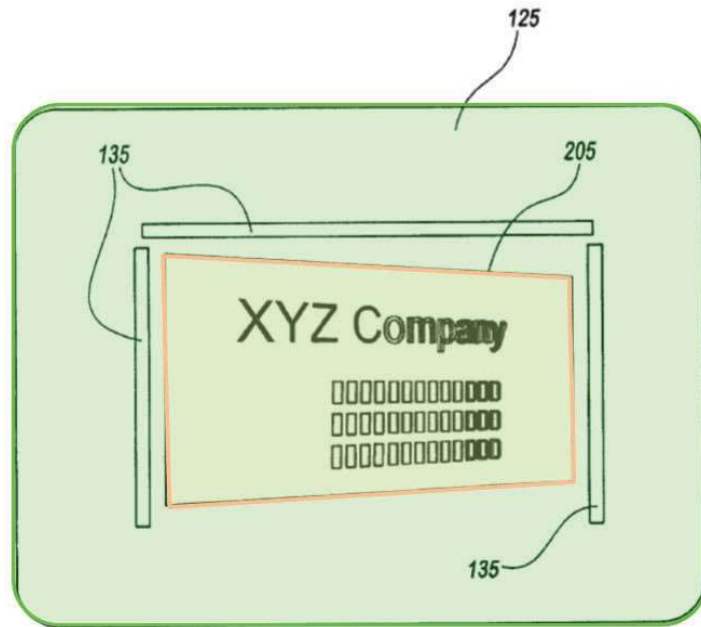


Fig. 5

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 '899 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.

186. Therefore, Garcia/Luo/Harrison renders 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[d], 18[f], 26[f]

187. The combination of Garcia/Luo/Harrison teaches “monitoring the live video of the check in the field of view of the **camera** with respect to at least one monitoring criterion.”

188. As I explained above in Sections XI.A.1.a and XI.A.2.f, the combination of Garcia/Luo/Harrison discloses displaying live video of the check in the field of view of the **camera**.

189. 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:

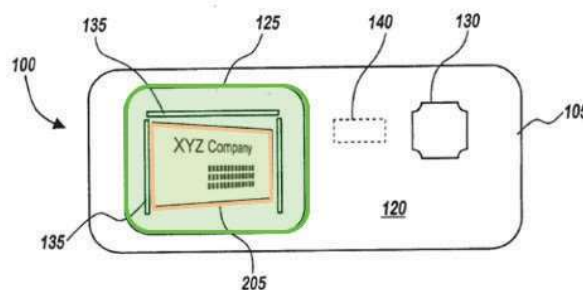


Fig. 2

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 combination with Garcia, Luo, and Harrison, such monitoring would be performed on the live video provided by the Camera

API.

190. 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.

191. Therefore, the combination of Garcia/Luo/Harrison 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 Harrison’s software architecture would have been obvious.

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

192. The combination of Garcia/Luo/Harrison/Li 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, the determining including dividing the video frame into segments comprising check data and background data and analyzing the segments to determine that the video frame satisfies the at least one monitoring criterion.”

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

194. 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 combination with Harrison, the “selected image” would have been a frame from the live video feed of the **camera**, for example obtained by using Harrison’s Camera API. Therefore, the combination of Luo/Harrison teaches “automatically capturing the video frame.”

195. 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.”

196. As such, the combination of Garcia/Luo/Harrison teaches automatically capturing the image 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. Li provides additional teachings specifically directed to how that determining is performed—by dividing the captured image into segments and analyzing those segments to identify the document and its boundaries. *See* EX1088-Li, [0006]-[0008], [0050].

197. Li teaches that a captured image of a document contains a medium image (the document itself, e.g., a whiteboard, blackboard, or document), a content image (text, lines, drawings, or sketches) on the medium, and a background image surrounding the medium. EX1088-Li, [0050]. The image is “split into a plurality of sub-blocks” where “each sub-block would contain a ‘corner’ of the medium image.” *See* EX1088-Li, [0084]. Because a corner of the medium is the location at which the medium meets the surrounding background, each such sub-block necessarily contains a portion of the medium image and a portion of the surrounding background. A person of ordinary skill in the art would have understood Li’s teaching to disclose dividing an image into sub-blocks (the “segments” in the ’899 patent) comprising document data (the “check data” in the ’899 patent claims) and background data.

198. Li further teaches analyzing these sub-blocks, or segments, to

determine the location of the document boundary. Specifically, Li teaches removing the background image by detecting the boundary of the medium image. EX1088-Li, [0006]-[0007], [0068]-[0070]. To accomplish this, Li determines the position of corners within each subdivision using edge detection and corner detection techniques. EX1088-Li, [0084]-[0085], [0095]-[0101], FIG. 15, FIG. 20, claims 1, 9. Li, thus, analyzes image information within the sub-blocks to obtain spatial information concerning the document's boundary and position.

199. In the Garcia/Luo/Harrison/Li combination, the spatial information from Li's image processing techniques provides information that may be used to make the monitoring determination taught by Luo. In particular, Li provides detected document boundary and corner positions that provide information regarding the check's position and orientation within the camera's field of view. The combination therefore would analyze the image's sub-blocks to determine whether the monitored frame satisfies the applicable positioning or alignment criterion before capture. Once that criterion is satisfied, Luo teaches automatically capturing the selected image. Thus, the combination teaches "analyzing the segments to determine that the video frame satisfies the at least one monitoring criterion," as well as the claimed automatic capture of the video frame.

200. Therefore, the combination of Garcia/Luo/Harrison/Li 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, the determining including dividing the video frame into segments comprising check data and background data and analyzing the segments to determine that the video frame satisfies 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, Li’s image partitioning and processing technique, and Harrison’s software architecture would have been obvious.

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

201. The combination of Garcia/Luo/Harrison/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.”

202. As I explained in Section XI.A.2.i, the combination of Garcia/Luo/Harrison 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.

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

204. **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.

205. **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.

206. **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.

207. Therefore, each of Luo, Garcia, and 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.”

208. Therefore, the combination of Garcia/Luo/Harrison/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 Harrison’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[g] 18[i], 26[i]

209. The combination of Garcia/Luo/Harrison 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].”¹⁰

¹⁰ Instead of the bracketed text, limitation 9[g] reads as follows: “the digital image of the check being the captured video frame or being based on the captured video

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

211. 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 ’899 patent’s disclosure, which lists GSM/GPR3 (which I assume to be a typo indicating GPRS) as an example “communications network.” EX1001-USP899, 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/Harrison therefore teaches “using a wireless network, transmitting a

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.

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.”

212. 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 combination with Harrison/Luo, this could occur after automatically capturing the video frame, or semi-automatically with user confirmation.

213. Therefore, the combination of Garcia/Luo/Harrison 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 Harrison's software architecture would have been obvious.

I. Claim 1[k]

214. 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."

215. 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 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.”

216. 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.

217. 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.

218. 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.”

219. 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.”

220. 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.

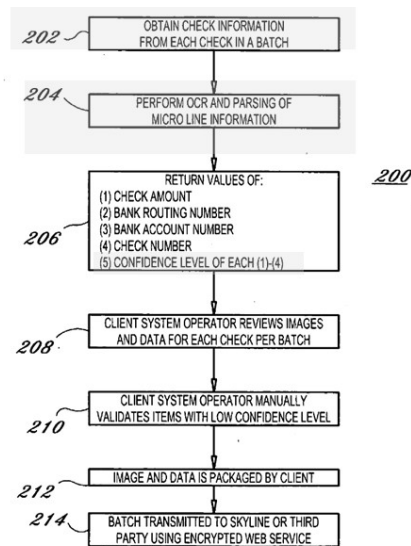


FIG. 2

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

221. 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

¹¹ Cohen’s disclosure is consistent with the ’899 patent’s disclosure regarding validating an amount. For example, the ’899 patent discloses “determin[ing] whether the...amount payable, or the like may be readable such that they may be parsed and processed.” EX1001-USP899, 5:10-12. This is similar to Cohen’s “confidence level of the accuracy of the OCR results...” EX1006-Cohen, [0022].

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.

222. As a first example, Cohen discloses 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].

223. Cohen’s second example is consistent with the ’899 patent, which discloses “receiving confirmation that the user 102 wishes to proceed....” EX1001-USP899, 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.* And third, 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.

224. 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.

225. 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]

226. 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."

227. 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.* Accordingly, Garcia teaches “a server, remote from the user’s **mobile device**.”

228. 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 system 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 further below, these operations performed by the **receiving institution** would have included the steps described in Sections XI.A.2.n, XI.A.2.o.

229. 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]

230. Garcia teaches “receiving the digital image of the check transmitted by the user’s **mobile device**.”

231. 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]

232. The combination of Garcia/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 after the transmitting the digital image of the check from the user's mobile device."

233. As I explained in Section XI.A.2.1, the combination of Garcia/Cohen teaches techniques for processing images of a check that include OCRing information in the image. The combination of Garcia/Cohen therefore teaches "processing the digital image of the check including performing optical character recognition on the check in the digital image."

234. 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."

235. 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.”

236. As I explained in Sections XI.A.2.b and XI.A.2.1, 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 necessarily 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**” (limitation 1[l])) from the remote server—after transmitting an image of the check. Thus, Cohen teaches “the user's **mobile device** receiving an indication of a result of the server's processing after the transmitting the digital image of the check from the user's mobile device.”

237. Therefore, the combination of Garcia/Harrison/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 after the transmitting the digital

image of the check from the user's mobile device.” As I explained in Section XI.A.1.a, implementing Garcia’s mobile check deposit system and method with Harrison’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[i], 18[j], 26[k]

238. 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]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].”

¹² Instead of the bracketed text, limitations 9[i] and 26[k] 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.

239. 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 bank.

240. 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.

241. In the 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].

242. 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.

243. 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[h]

244. The combination of Garcia/Cohen teaches "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[j]

245. The combination of Garcia/Cohen teaches "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], 14[a], 19[a], 23[a], 27[a]

246. The combination of Garcia/Harrison/Luo teaches “wherein the downloaded app causes the user’s **mobile device** to perform additional operations.” As I explained in Sections XI.A.2.c and XI.A.2.d, the combination of Garcia/Harrison 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]

247. The combination of Garcia/Luo/Harrison 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.”

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

Garcia/Luo/Harrison teaches that a **mobile device** generates and monitors live video frames (for example, those discussed in Luo and Harrison) 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.

249. Therefore, the combination of Garcia/Luo/Harrison 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 Harrison's software architecture would have been obvious.

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

250. The combination of Garcia/Luo 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.”

251. As I explained in Section XI.A.2.j, the combination of Garcia/Luo/Harrison/Cohen teaches or renders 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/Harrison 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.

252. 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.

253. 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.

254. 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.

255. 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.

256. 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 Sections 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

257. 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**.”

258. 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.

259. 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.

260. 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.

261. 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.

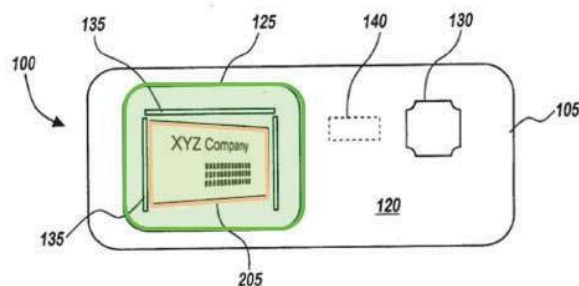


Fig. 2

EX1004-Luo, FIG.2.

262. 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.

263. 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.

264. 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.

265. 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 Harrison's software architecture would have been obvious.

e. Claims 4, 29

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

267. 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.

268. Cohen teaches or renders obvious 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.

269. 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.2.1, 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].

270. 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** to 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 and providing feedback to the user that image capture was successful. *See, e.g.*, §XI.A.2.j.

271. My opinion that a person of ordinary skill in the art would have reasonably expected success performing **MICR line** detection is consistent with the '899 patent's disclosure. The '899 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-USP899, 8:59-62. Therefore, the '899 patent suggests that **MICR line** detection was known, and was not the purported invention. Moreover, the '899 patent does not provide any details regarding how to perform such detection on a **mobile device**. The '899 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.

272. 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 of 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.

273. 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 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 **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.

274. 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 '899 patent concedes was known)¹³ to the image of the check in Luo's viewfinder before capturing the image.

¹³ EX1001-USP899, 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**").

275. 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 devices** included performing OCR on an image, detecting a barcode in an image, recognizing gestures in a video feed, and 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[c], 23[c]

276. 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**.”

277. 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.p, 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 “after the transmitting the digital image

of the check from the user's **mobile device**," for example as taught by Cohen.

278. Similarly, 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.

279. 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

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

281. As I explained in Section XI.A.2.k, Garcia **teaches** transmitting the check image to a **receiving institution**, which in the combination with Luo/Harrison 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 that encrypting the image of the check would have produced a “modified version of the captured video frame” by changing the file format.

282. Therefore, the combination of Garcia/Luo/Harrison 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 Harrison's software architecture would have been obvious.

h. Claim 8

283. Garcia teaches “wherein the wireless network is a cellular network.”

284. 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”¹⁴ to refer to a “cellular network.” This is consistent with the ’899 patent’s disclosure, which provides GSM and GPRS as an example “communications network.” EX1001-USP899, 13:42-46. The ’899 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.

285. 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

¹⁴ Garcia refers to “GRP3,” 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.

network, because “**mobile device**” and “mobile network” were often considered to be synonymous with cellular connectivity.

286. Therefore, Garcia teaches “wherein the wireless network is a cellular network.”

i. Claim 11

287. The combination of Garcia/Luo/Harrison renders obvious “further comprising one or more computers programmed to perform operations comprising the monitoring, the determining, or both the monitoring and the determining.”

288. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Harrison 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...”

289. I explain in additional detail in Section X.E 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/Harrison alone or in view of the additional teachings found in Attia.

j. Claims 14[b], 23[b]

290. 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.” It is my opinion that this limitation is obvious for the reasons I explained in Section XI.A.2.m.

k. Claim 15

291. The combination of Garcia/Cohen teaches “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.

l. Claim 16

292. The combination of Garcia/Luo/Harrison teaches “wherein the one or more computers include the bank computer.”

293. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Harrison 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...”

294. 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/Harrison alone or in view of the additional teachings found in Attia.

m. Claims 17, 25, 30

295. The combination of Garcia/Luo/Li teaches “the determining includes dividing the video frame into segments comprising check data and background data and analyzing the segments to determine that the video frame satisfies the at least one monitoring criterion.” It is my opinion that this limitation is obvious for the reasons I explained in Section XI.A.2.j.

n. Claim 21

296. 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, *i.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, Harrison, Li, Cohen, and Yoon (“Garcia/Luo/Harrison/Li/Cohen/Yoon”)

297. 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, Harrison, Li 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, Harrison, Li, 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, Harrison, Li, Cohen, and Yoon references. It is my opinion that each is analogous art to the ’899 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.

298. 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.”

299. 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 led 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.

300. 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.”

301. 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.

302. **Analogous Art:** In my opinion, like Garcia and Luo, Yoon is analogous

art to the '899 patent claims. As I explained in Section XI.A.1.a, the '899 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** coincide 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 '899 patent claims.

303. **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 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**.

304. 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.

305. **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.

306. 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].

307. 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 Symbian OS SDK taught by Harrison. Yoon contemplates using such computer code. EX1007-Yoon, [0031].

308. 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 Yoon’s brightness monitoring with Luo’s **reference lines** as conditions to satisfy before capturing the **document** image.

309. 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, Harrison, Li, Cohen, and Randle (“Garcia/Luo/Harrison/Li/Cohen/Randle”)

310. The combination of Garcia/Luo/Harrison/Li/Cohen/Randle teaches

“wherein the digital image is a modified version of the captured video frame.”

311. 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/Harrison/Li.

312. 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.

313. Therefore, Randle teaches “a modified version of the” check image. In the combination with Garcia/Luo/Harrison, the modified or converted image would

have been “a modified version of the captured video frame.” The combination of Garcia/Luo/Harrison/Li/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 Harrison’s software architecture would have been obvious.

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

315. **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].

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 '899 patent claims.

316. **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 for multiple reasons.

317. 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**.

318. 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 '899 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.

319. 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.

320. **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.

321. 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. EX1048-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**.

322. Randle’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].

323. 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, Harrison, Li, Cohen, and Attia

(“Garcia/Luo/Harrison/Li/Cohen/Attia”)

324. The combination of Garcia/Luo/Harrison/Li/Cohen/Attia teaches the limitations in claims 11 and 16.

1. Combination of Garcia in view of Luo/Harrison/Cohen/Attia (“Garcia/Luo/Harrison/Li/Cohen/Attia”)

325. As I explained in Sections XI.A.1.a, XI.A.2.h, and XI.A.2.i, the combination of Garcia/Luo/Harrison/Li 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/Harrison/Li.

326. **Analogous Art:** In my opinion, like Garcia/Luo/Harrison/Li/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 '899 patent claims.

327. **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/Harrison/Li/Cohen. As I explained above in Section XI.A.1.a, the combination of Garcia/Luo/Harrison/Li teaches automatically capturing images of a check by first monitoring and 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.

328. 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**.

329. A person of ordinary skill in the art would have therefore been faced with two alternative 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.

330. As I noted in Section XI.A.1.b, Garcia teaches performing various processing and validation steps on a 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/Harrison alone.

331. These teachings are reinforced by Attia's disclosure. As I explained in Section X.G 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. Attia 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 a server so as to determine when the image is of sufficient quality to decode the barcode, which is akin to passing a monitoring criterion) to the combination of Garcia/Luo/Harrison/Li/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**).

332. As I explained in Section III.C, I understand that one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. I understand that 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/Harrison/Li/Cohen with Attia. For

example, the combination of Attia with Garcia/Luo/Harrison/Li/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/Harrison/Li/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.

333. 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/Harrison/Li/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/Harrison/Li. 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.

334. 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/Harrison/Li/Cohen with Attia to incorporate into Garcia/Luo/Harrison/Li/Cohen Attia's teachings to monitor an image at a remote location.

2. Claim 11

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

336. As I explained in Sections XI.A.2.h and XI.A.2.i, the combination of Garcia/Luo/Harrison/Li 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..."

337. In 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/Harrison/Li/Attia 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

338. The combination of Garcia/Luo/Harrison/Li/Attia renders obvious “wherein the one or more computers include the bank computer.”

339. As I explained in Section XI.D.2, the combination of Garcia/Luo/Harrison/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.

340. 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/Harrison/Li. 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/Harrison/Li/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.

341. Therefore, the combination of Garcia/Luo/Harrison/Li/Attia renders obvious "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: Claims 1-4, 6-12, 14-21, 23-30 are Obvious Over Garcia in Combination with Luo, Goyal, Li, and Cohen ("Garcia/Luo/Goyal/Li/Cohen")

342. 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, Harrison, Li, 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, Li, and Cohen. First, I explain why a person of ordinary skill in the art would have been motivated to combine Garcia with the Luo, Goyal, Li, 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, Li and Cohen ("Garcia/Luo/Goyal/Li/Cohen")

343. I have reviewed the Garcia, Luo, Goyal, Li and Cohen references. It is my opinion that each is analogous art to the '899 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.

344. 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 capturing an image of a **document**, and with Li's teachings of image processing, 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.

345. 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, Li and Goyal
("Garcia/Luo/Li/Goyal")**

346. **Analogous Art:** In my opinion, like Garcia, Luo, and Li, Goyal is analogous art to the '899 patent claims. As I explained in Section XI.A.1.a, the '899 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 **is** directed to capturing and processing **document** images.

347. **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 Harrison’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 system/Luo’s images capturing system. 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/Li combination, just like in the combination of Garcia/Luo/Li with Harrison.

348. Like Harrison, 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 one 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 many software features relevant to Garcia and Luo. For example, Harrison 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.

349. 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.

350. A person of ordinary skill in the art would have therefore been motivated to implement the Garcia/Luo/Li 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.*

351. 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.

352. 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/Li/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.

353. As I explained in Section XI.A.1.a, implementing the Garcia/Luo/Li 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.

354. 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/Li/Goyal combination, when implementing the combination of Garcia/Luo/Li with Harrison’s teachings, a person of ordinary skill in the art would have recognized that Harrison’s downloadable application and Camera APIs provide the software features needed to implement Garcia’s/Luo’s/Li’s teachings. As a few non-limiting examples, Goyal’s 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** (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.

355. As I explained in Section III.C, I understand that one consideration for obviousness is whether the alleged invention uses a known technique to improve a similar device or method in the same way. I understand that 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 and Li. For example, implementing Garcia's/Luo's/Li's software with Goyal's teaching to use a downloaded application and **camera** control API would have involved 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/Li's mobile check capture and processing software—ready for improvement—here, by facilitating Garcia/Luo's/Li'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**.

356. 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, Li's image processing 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, Li, and Goyal each teach the use of **mobile devices** with **cameras** and software for capturing images. I outline Garcia's, Luo's, and Li'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.

357. 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, Li's

image processing, 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/Li/Goyal combination would have simply involved writing computer code using readily accessible software development kits, like the Java ME MMAPIs taught by 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/Li/Goyal combination is consistent with the '899 patent's disclosure.

358. 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/Li with Goyal to incorporate Goyal'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. Combination of Garcia in view of Cohen
("Garcia/Cohen")**

359. 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 '899 patent claims.

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

**a. Goyal Renders Obvious a Downloaded Application
(Limitations 1[c], 1[e], 2[a], 9[a], 9[c], 18[c], 18[e],
19[a], 23[a], 26[c], 26[e], 27[a])**

360. 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 Harrison. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

361. 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**.

362. 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 ’899 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.

363. First, a person of ordinary skill in the art would have recognized that there were only a handful (finite number) of predictable 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.

364. 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 **PDA**s. 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.

365. 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])

366. 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 Harrison. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

367. 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.

368. 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 ’899 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.

369. 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.

370. 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[g], 10[b]-10[c], 17, 18[pre], 18[e]-18[i], 19[b]-19[c], 24, 25, 26[pre], 26[e]-26[i], 27[b]-27[c], 30)

371. 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 Harrison. In my opinion, these limitations would have also been obvious in view of Goyal for similar reasons.

372. 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.

373. 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.

374. 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.”).

375. Therefore, it is my opinion that Goyal teaches or renders obvious the additional limitations in the ’899 patent claims that recite the use of live video frames, for example for displaying, monitoring, and capturing images, for similar reasons that Harrison 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

376. 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, Li, Goyal, and Cohen for the

same reasons I explained in Sections XI.A.2.b, XI.A.2.e, XI.A.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, Li, Cohen, and Yoon (“Garcia/Luo/Goyal/Li/Cohen/Yoon”)

377. 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, Li, 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, Li, 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, Harrison, Li, 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, Goyal, Li, Cohen, and Randle (“Garcia/Luo/Goyal/Li/Cohen/Randle”)

378. 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, Li, 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, Li, 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, Harrison, Li, 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, Goyal, Li, Cohen, and Attia (“Garcia/Luo/Goyal/Li/Cohen/Attia”)

379. 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, Li, 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, Li, 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, Harrison, Li, and Cohen and further in view of Attia (Section XI.D).

XII. CONCLUSION

380. Based on the foregoing, claims 1-30 of the '899 patent recite subject matter that would have been obvious to a person of ordinary skill at the relevant times.

XIII. AVAILABILITY FOR CROSS-EXAMINATION

381. 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

382. 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. ACKNOWLEDGEMENT

383. I hereby 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 knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: September 18, 2026

A handwritten signature in black ink, appearing to read 'John C. Hart', written over a horizontal line.

John C. Hart, PhD

Curriculum Vitæ

John C. Hart

Director
Office for Professional Education
Office of the Provost

Professor
Siebel School of Computing and Data Science
Grainger College of Engineering

University of Illinois Urbana Champaign

(217) 649-1695 – jch@illinois.edu – <http://graphics.cs.illinois.edu/~jch>

∞ Experience ∞

Education

- **Ph.D.** Electrical Engineering and Computer Science Dept., University of Illinois at Chicago, 1991. Thesis title: "Computer Display of Linear Fractal Surfaces." Advisor: Thomas A. DeFanti.
- **M.S.** EECS Dept., University of Illinois at Chicago, 1989. Thesis title: "Image Space Algorithms for Visualizing Quaternion Julia Sets." Advisor: Thomas A. DeFanti.
- **B.S.** College of Liberal Arts and Science, Aurora University, 1987. Major: Computer Science.

Academic Positions

- **Director, Office of Professional Education**, University of Illinois at Urbana-Champaign, 2021-.
- **Director of Online Programs**, Dept. of Computer Science, UIUC, 2018-2021.
- **Director**, Master of Computer Science in Data Science program, UIUC CS, 2016-2017.
- **Executive Associate Dean**. Graduate College, UIUC, 2015-2021.
- **Associate Dean**. Graduate College, UIUC, 2014-2015.
- **Director for Graduate Studies**. UIUC CS, 2013.
- **Full Professor**. UIUC CS, 2006-.
- **Area Chair**, Graphics, Visualization and Human-Computer Interaction, UIUC CS, 2004-2011.
- **Associate Professor**. UIUC CS, 2000-2006.
- **Associate Professor**. School of Electrical Engineering and Computer Science, Washington State University, 1998-2000.
- **Assistant Professor**. School of EECS, Washington State University, 1992-1998.
- **Postdoctoral Research Associate**. Electronic Visualization Laboratory, University of Illinois at Chicago, and National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, 1991-1992.

- **Research Assistant.** Electronic Visualization Laboratory, Electrical Engineering and Computer Science Dept., University of Illinois at Chicago, 1988-1991.
- **Teaching Assistant.** Analog & digital circuit design courses, EECS Dept. University of Illinois at Chicago, 1987-1988.

Awards and Honors

- **The Excellence in Online & Distance Teaching Award.** UIUC, 2021.
- **Fellow.** Academic Leadership Program, Big Ten Academic Alliance, 2016-2017.
- **Outstanding Advisor.** College of Engineering, 2010 and 2015.
- **Winner.** 2004 Fantasy Graphics League.
- **Champion.** SIGGRAPH Bowl II, SIGGRAPH 94. Captain of the EVL Alumni Team.
- **First Runner-Up.** Truevision Videographics Competition, SIGGRAPH 90.
- **Graduate Fellowship.** Graduate College, University of Illinois at Chicago, 1990-1991.

Industry Consulting

- **Intrinsic Medical Imaging LLC**, Bloomfield Hills, MI. Consultant, 2012-13. Mesh construction and simulation of coronary arterial blood flow.
- **Pratt & Whitney**, Hartford, CT. Consultant, 2011. Flux estimation in a lensed system.
- **Science Applications International Corp. (SAIC)**, Champaign, IL. Consultant, 2008. Ray-NURBS intersection.
- **Adobe Systems, Inc.**, Seattle, WA. Visiting Researcher, 2007. Project: Rendering meshed objects as stylized vector art.
- **The Teaching Company**, Chantilly, VA. Consultant, 2003. Produced custom educational video elements on the platonic solids.
- **Evans & Sutherland Computer Corp.**, Salt Lake City, Utah. Consultant, 1999-2000. Project: Design of the Evans & Sutherland Multi-Texturing Language.
- **Blue Sky | VIFX, Inc.**, Culver City, California. Consultant, 1998. Project: development of a custom software plug-in for the Houdini procedural animation package to polygonize a feature film villain modeled as a complex implicit surface.
- **Evans & Sutherland Computer Corp.**, (group formerly known as Silicon Reality, Inc.) Federal Way, Washington. Consultant, 1997-8. Project: design of graphics hardware to support antialiased procedural solid texturing.
- **Kleiser-Walczak Construction Company (a visual effects production company).** Lennox, Massachusetts. Consultant, 1992-1993. Project: development of a new fractal-based video transition effect for an attraction at the Luxor Hotel, Las Vegas.
- **AT&T Pixel Machines.** AT&T Bell Laboratories, Holmdel, New Jersey. Summer Intern, 1990.
- **IBM T.J. Watson Research Center.** Hawthorne, New York. Summer Intern, 1989.

Expert Testimony

(Only includes disclosed engagements.)

- **VusionGroup SES Imagotag**, IPR 2024-00118 on Patent 11,405,669. Retained by Perkins Coie. July, 2024 – ongoing. Authored expert decl.
- **Advanced Micro Devices (AMD) v. RealTek**, TCL. US International Trade Commission Case #337-TA-1318. Retained by Mintz, Levin, Cohn, Ferris, Glovsky and Popeo PC. Testified at Markman Hearing 9/6/22. Deposed Jan. 2023. Testified Mar. 2023. Authored declarations for IPRs 2023-00564 and 2023-00687. Deposed Apr. 4th & 5th, 2023.
- **LG Electronics, Inc. v. TCL**. US District Court, Eastern District of Texas, Marshall Division. C.A. No. 2:22-cv-122-JRG. Retained by Baker Botts, LLP. Authored expert decl. on claim construction, 4/18/23. Settled.
- **Interactive Graphics Solutions v. Microsoft**, US District Court, Western District of Washington, C.A. No. 2:2022cv00554. Retained by Nelson Bumgardner Conroy. Oct. 2021 – Aug. 2022. Authored declaration in support of claim construction.
- **Stratos Audio**, IPR's and trials regarding Patents 8,200,203, 8,688,028 and 8,903,307. Retained by White & Case LLP. Dec. 2021 – July 2022.. Deposed 3/31/22, 7/8/22, 7/12/22 and 7/20/22.
- **Intellectual Pixels**, Inter Partes Review for Patent 10,681,109. Retained by Armond Wilson. Jul. 2021 – June 2022. Authored declaration. Deposed 6 Nov. 2021.
- **Infernal Technologies v. Sony Interactive Entertainment**, US District Court, Eastern District of Texas Marshall Division, C.A. No. 2:19-cv-248-JRG. Retained by Beuther, Joe & Counselors. Authored expert reports on infringement (Aug. 2020) and validity (Sep. 2020). Testified in jury trial Oct. 2021.
- **Intellectual Pixels**, Inter Partes Review for Patent 8,667,093. Retained by Armond Wilson. Mar. 2021 – June 2022. Authored declaration. Deposed 18 June 2021.
- **CorePhotonics**, Inter Partes Reviews for Patents 10,225,479 and 10,230,898. Retained by Russ, August & Kabat. Jan. 2021. Authored declarations. Deposed 29 Apr. 2021 and 21 May 2021. Authored invalidity rebuttal and infringement reports for CorePhotonics v. Apple 3:18-cv-06457-JD on Jan. 2024. Settled.
- **LG Electronics Inc.**, US District Court, Central District of California, Western Division. Case No. 2:19-cv-09474-JAK. Retained by Sidley Austin Jan. 2020. Authored Sep 2020 expert report on claim construction.
- **Align Technology, Inc.**, US District Court for the District of Delaware, C.A. No. 17-1647-LPS-CJB. Retained by Morrison Foerester Mar. 2019. Authored infringement report and reply report on validity. Deposed 19 June 2020. Settled Feb. 2022.
- **Adsync Technologies**, Middle District of Florida, Orlando Division, Case 6:18-cv-1176-Orl-40TBS. Retained by Akerman Jun. 2019. Declaration in defense of Amended Complaint from Adacel and in support of counter complaint from Adsync. Deposed 24 Jan 2020. Settled Jan. 2021.
- **ZiiLabs** (subsidiary of Creative Technology), Certain Graphics Processors and Products Containing the Same, US International Trade Commission Case #337-TA-1099. Retained by Pepper Hamilton Sep. 2017. Deposed 12 Nov. 2018.
- **Samsung**. - FotoNation Ltd. et al. v. Samsung Electronics. Co., Ltd., et al., No. 2:17-cv-00669 (E.D. Tex.). Retained by O'Melveny & Myers Oct. 2017. Settled, Jan. 2019.
- **Samsung**, Inter Partes Reviews for of patents filed by Image Processing Technologies LLC: 6,717,518, 6,959,293, 7,650,015, 8,805,001, 8,983,134 and 8,989,445. Retained by O'Melveny & Myers Oct. 2016. Deposed Dec. 2017.

- **ZiiLabs** (subsidiary of Creative Technology), Certain Graphics Processors, DDR Memory Controllers, and Products Containing the Same, US International Trade Commission Case #337-TA-1037, for Pepper Hamilton LLP, Sep. 2016 – July 2017. Testified to the International Trade Commission for Markman hearing.
- **Advanced Silicon Technology**, Certain Computing or Graphics Systems, Components Thereof, and Vehicles Containing Same, US International Trade Commission Case #337-TA-984, for Mintz, Levin, Cohn, Ferris, Glovsky and Popeo PC, Aug. 2015 – Aug. 2016. Testified to the International Trade Commission for Markman hearing and authored validity report. Written declarations submitted for IPR2016-00894, -00897 and 01060).
- **ZiiLabs** (subsidiary of Creative Technology), Eastern District of Texas, Marshall Division, Case 2:14-cv-00203, for Heim, Payne & Chorush LLP and Susman Godfrey LLP. Sep. 2014 – Dec. 2015. Prepared invalidity rebuttal report for four patents and damages report for nine patents, all on graphics hardware. Deposed over two sequential days on both reports.
- **Graphics Property Holdings** (formerly SGI), Certain Consumer Electronics with Display and Processing Capabilities, US International Trade Commission Case #337-TA-884, for Mintz, Levin, Cohn, Ferris, Glovsky and Popeo . Graphics hardware expert on floating point rasterization, Authored report on patent validity. Deposed Feb. 2014. Testified to the International Trade Commission Apr. 2014.
- **Microsoft Xbox**, Illinois Northern District Court (Eastern Division) Case #08-C-393, for Sidley Austin LLP. Dec. 2009 – May 2010. Prepared non-infringement rebuttal report and invalidity report.
- **NVIDIA & AMD (ATI)**, California Northern District Court Case # 3:07-cv-00302, for Cooley Godward Kronish LLP. July 2008 – Sep. 2008. Provided expertise on graphics hardware and insight into the industry-wide process for the deployment of innovative features.
- **Broadcom**, California Southern District Court Case #06-CV-0660, for McAndrews, Held & Malloy, Ltd, Dec. 2006 – Mar. 2007.

Research Funding

From Industry

- **Caterpillar**, through the **Digital Manufacturing & Design Innovation Institute**. \$410,000, Co-PI with Placid Ferreira and Shiv Kapoor.
- **Intel**. Intel Illinois Parallelism Center. \$2,500,000, Co-PI, 2011-2012.
- **Intel**. Leveraging Larrabee’s Programmable Rasterization. \$130,000, 2009-2011.
- **Intel/Microsoft**. Universal Parallel Computing Research Center. \$18,000,000, Co-PI, 2008-2012.
- **NAVTEQ**. “Surface Classification and Reconstruction from LIDAR and images.” \$60,000, 2008.
- **Thomas M. Siebel**. “MethMorph: Visual Simulation of Methamphetamine Addiction.” \$35,000, Spring 2006.
- **NVidia Corp.** \$15,000 annually through the UIUC CS Affiliates Program, 2004–, and \$125,000 total to date in Ph.D. student fellowships (\$25K directly to the student to support one year of Ph.D. research): Nate Carr: 2002 & 2003, Jesse Hall: 2003 & 2004, Jared Hoberock: 2005 & 2008.
- **Microsoft Research**. “Precomputed Radiance Transfer Compression.” \$15,000, Sep. 2002.
- **Evans & Sutherland Computer Corp.** “Real Time Procedural Solid Texturing.” \$83,246, June 1999 – May 2000.

- **Evans & Sutherland Computer Corp. and Washington Technology Center.** “APST: Computer Graphics Hardware for Antialiased Procedural Solid Texturing.” \$77,089. Aug. 16, 1998 - Aug. 15, 1999.
- **Intel Natural Data Types Group.** “Procedural Modeling.” \$43,000. Aug. 16, 1997 - Aug. 15, 1998.
- **Intel Natural Data Types Group.** “Recurrent Modeling -- Beyond Fractal Block Coding.” (Co-PI with P. Flynn.) \$93,000. Apr. 1, 1995 - Mar. 31, 1997.

From Government Agencies

- **NSF. #OAC-1550554** “SI2-SSI: Collaborative Research: ParaTreet: Parallel Software for Spatial Trees in Simulation & Analysis” (co-PI with Laxmikant Kale), \$170,000, Sep. 2016 – Aug. 2018.
- **NSF. #OCI-1216788** “Collaborative Research: Conceptualizing an Institute for Using Inter-Domain Abstractions to Support Inter-Disciplinary Applications” (co-PI with David Padua and Philippe Geubelle, and other collaborators at Purdue and UT-Austin), \$135,000, Oct. 2012 – Sep. 2016.
- **NSF. #EF-1115112** “Collaborative Research: Digitization TCN: InvertNet--An Integrative Platform for Research on Environmental Change, Species Discovery and Identification” (co-PI with Christopher Dietrich, Christopher Taylor, Nahil Sobh and Umberto Ravaioli), \$2,809,463, July 2011-June 2015.
- **NSF. #OCI-1047764** “SI2-SSE: Collaborative Research: Lagrangian Coherent Structures for Accurate Flow Structure Analysis” (co-PI with Shawn Shadden) \$251,643, Sep. 2010 – Aug. 2013.
- **NSF. #IIS-0534485** “Analysis and Visualization of Complex Graphs” (co-PI with Michael Garland) \$300,000, Sep. 2006 – Aug. 2009.
- **UIUC Critical Research Initiative.** “A New Approach to Bone Replacement.” (Co-PI with Russ Jamison, Michael Goldwasser, Ben Grosser, Matei Stroila and Amy Wagoner Johnson.) \$100,000, Sep. 2005 – Aug. 2006.
- **NSF Small Grant for Exploratory Research.** “Application Directed Surface Parameterization.” \$97,868, Jan. 2005 – Dec. 2005.
- **NSF/DARPA CARGO (Computational and Algorithmic Representations of Geometric Objects) Award.** “Robust Lagrangian Surface Propagation with Topological Control.” (Lead PI, with Michael Heath, Jim Jiao and John Sullivan), \$400,000, May 2003 – May 2006.
- **NSF Information Technology Research. #NSG-0219594** “Making 3D Visibility Practical.” (Co-PI with Steve LaValle, Jeff Erickson, Fredo Durand) \$499,923. Aug. 2002 – Aug. 2005.
- **CNRS (Centre National de la Recherche Scientifique).** Supplement to “Making 3D Visibility Practical” to support UIUC – INRIA collaboration, \$7,000, 2003-5.
- **NSF Information Technology Research. #ACI-0113968** “Multipass Programming for Personal High-Performance Computing.” \$489,671, Aug. 2001 – July 2006.
- **NSF Information Technology Research. #ACI-0121288** “Procedural Representation and Visualization Enabling Personalized Computational Fluid Dynamics.” (Co-PI with David Ebert, David Marcum, Kelly Gaither and Penny Rheingans) \$3,989,773. Aug. 2001 – July 2006.
- **NSF. #NSG-9732379** “Applications of Morse Theory and Catastrophe Theory to Computer Graphics.” (Co-PI with R. Lewis.) \$220,541. Aug. 16, 1997 – Aug. 15 2000.
- **NSF. #CCR-9529809** “Recurrent Modeling.” (Co-PI with P. Flynn.) \$206,435. June 15, 1996 - May 31, 1999. Research Experience for Undergraduates Supplement: \$5,000. Jan. 1, 1998 - May. 31, 1999.
- **NSF Research Initiation Award. #CCR-9309210** “Modeling, Rendering and Animation of Implicit Surfaces.” \$97,925. July 1, 1993 - June 30, 1996. Research Experience for Undergraduates Supplement: \$4,885. Jan. 1, 1995 - Dec. 31, 1995.

Education Projects

- **Nokia University Cooperation Funding.** “Teaching Mobile Augmented Reality on the Windows Phone Platform.” \$11,377.64. 2013.
- **UIUC College of Engineering Strategic Instructional Initiatives Program.** Improvement of key ME courses (Statics, Dynamics and Solid Mechanics), \$450,000, with MechSE Profs. Tortorelli, Dullerud Keane and West, 2012-2014.
- **NSF Special Project.** #EIA-9911033 “The Story of Computer Graphics Documentary Project.” \$48,000. Sept. 15, 1999 – Aug. 31, 2000.

Equipment Grants and Donations

- **Nokia.** Two Velodyne LIDAR scanners, 2013.
- **NVidia.** K20 graphics card, 2012.
- **Intel.** Dell XPS 12, \$1,000, 2012.
- **Intel.** Two Knights Ferry development workstations, \$4,940, 2009.
- **NVidia.** Various graphics cards, 2002-4.
- **ATI.** One graphics card, 2002.
- **Tektronix Phaser 340 Color Printer.** Tektronix. \$5,000. Oct. 1995.
- **High-Performance Networking and Computing Infrastructure for Imaging Research.** (Co-PI with T. Fischer, P. Flynn and R. Bamberger.) NSF Research Instrumentation and Infrastructure. CISE Instrumentation Program, Office of Cross-Disciplinary Activities. \$100,000. March 1, 1994 - April 30, 1996. Awarded: Jan. 1995.
- **Silicon Graphics Inc. Workstation Upgrade.** \$9,000. Apr. 1993.
- **XAOS Tools.** Software Donation. Pandemonium and n-title. \$6,500. Feb. 1993.
- **Karen Guzak.** Art Donation. 12 Prints. \$4,800. May 1995.

Publications

Most of the following publications are available online via
<http://graphics.cs.illinois.edu/~jch/papers>.

Reviewed Publications

1. A.I. Ellis, W. Hunt and J.C. Hart. Real-Time Analytic Antialiased Text for 3-D Environments. Proc. High-Performance Graphics, Computer Graphics Forum 38(8), 2019, pp. 23-32.
2. A.J. Christensen, V. Srinivasan, J.C. Hart and A. Marshall-Colon. Use of computational modeling combined with advanced visualization to develop strategies for the design of crop ideotypes to address food security. Nutrition Reviews 76(5), May 2018, pp. 332-347.
3. P-C Wang, A.I. Ellis, J.C. Hart, C-H Hsu. Optimizing next-generation cloud gaming platforms with planar map streaming and distributed rendering. Proc. NetGames (15th Annual Workshop on Network and Systems Support for Games), 2017.

4. A. Marshall-Colon, S.P. Long, D.K. Allen, G. Allen, D.A. Beard, B. Benes, S. von Caemmerer, A.J. Christensen, D.J. Cox, J.C. Hart, P.M. Hirst, K. Kannan, D.S. Katz, J.P. Lynch, A.J. Millar, B. Panneerselvam, N.D. Price, P. Prusinkiewicz, D. Raila, R.G. Shekar, S. Shrivastava, D. Shukla, V. Srinivasan, M. Stitt, M. Turk, E.O. Voit, Y. Wang, X. Yin, X. Zhu. Crops in silico: Generating Virtual Crops Using an Integrative and Multi-scale Modeling Platform. *Frontiers in Plant Science*, May 2017.
5. M. Chen, J.C. Hart and S. Shadden. Hierarchical Watershed Ridges for Visualizing Lagrangian Coherent Structures. Reviewed, accepted and presented at TopoInVis: Topology-Based Methods in Visualization, 2015. Published in: *Topological Methods in Data Analysis and Visualization IV*, H. Carr, C. Garth, T. Weinkauff, Eds. Springer Mathematics and Visualization Series, 2017, pp. 237-252.
6. A.I. Ellis, Warren Hunt and J.C. Hart. "SVGPU: Real Time 3D Rendering to Vector Graphics Formats." *Proc. High Performance Graphics*, 2016.
7. M. Chen, S. Shadden and J.C. Hart. "Fast Coherent Particle Advection through Time-Varying Unstructured Flow Datasets." *IEEE Transactions on Visualization and Computer Graphics* 22(8), pp. 1959-1972, 2016.
8. J. Kratt, M. Spicker, A. Guayaquil, M. Fiser, S. Pirk, O. Deussen, J.C. Hart, B. Benes. Woodification: User-Controlled Cambial Growth Modeling. *Proc. Eurographics, Computer Graphics Forum* 23(2), May 2015, pp. 361-372.
9. V. Lu, J.C. Hart. Multicore Construction of k-d Trees for High Dimensional Point Data. *Proc. Advances in Big Data Analytics*, July 2014.
10. P.R. Khorrami, V.V. Le, J.C. Hart, T.S. Huang. A System for Monitoring the Engagement of Remote Online Students using Eye Gaze Estimation. *Proc. IEEE ICME Workshop on Emerging Multimedia Systems and Applications*, July 2014.
11. V. Lu, I. Endres, M. Stroila and J.C. Hart. Accelerating Arrays of Linear Classifiers Using Approximate Range Queries. *Proc. Winter Conference on Applications of Computer Vision*, Mar. 2014.
12. D. Mayerich, J.C. Hart, Volume Visualization of Serial Electron Microscopy Images Using Local Variance. *Proc. BioVis (IEEE Symposium on Biological Data Visualization)*, pp. 9-16, Oct. 2012
13. C. Dietrich, J. Hart, D. Raila, U. Ravaioli, N. Sobh, O. Sobh, C. Taylor. InvertNet: a new paradigm for digital access to invertebrate collections. *ZooKeys* 209, July 2012, pp. 165-181.
14. Y. Jia, M. Garland, and J.C. Hart. Social Network Clustering and Visualization using Hierarchical Edge Bundles. *Computer Graphics Forum* 30(8), Dec. 2011, pp. 2314-2327.
15. Y. Jia, V. Lu, J. Hoberock, M.J. Garland, J.C. Hart. Edge v. Node Parallelism for Graph Centrality Metrics. *GPU Computing Gems – Jade Edition*, Oct. 2011, pp 15-28.
16. M. Kamali, F.N. Iandola, H. Fang, J.C. Hart. MethMorph: Simulating Facial Deformation due to Methamphetamine Usage. *Proc. International Symposium on Visual Computing*. Sep. 2011.
17. M. Kamali, J. Cho, M. Stroila, E. Shaffer, J.C. Hart. Robust Classification of Curvilinear and Surface-like Structures in 3D Point Cloud Data. *Proc. International Symposium on Visual Computing*. Sep. 2011.
18. M. Kamali, E. Ofek, F. Iandola, I. Omer, J.C. Hart. Linear Clutter Removal from Urban Panoramas. *Proc. International Symposium on Visual Computing*. Sep. 2011.
19. K. Karsch, J.C. Hart. Snaxels on a Plane. *Proc. Non-Photorealistic and Artistic Rendering*, Aug. 2011.
20. J. Hoberock, J.C. Hart. Arbitrary Importance Functions for Metropolis Light Transport. *Computer Graphics Forum* 29(6), 2010, pp. 1993-2003.
21. S. Shi, M. Kamali, K. Nahrstedt, J.C. Hart, R. Campbell. High-Quality Zero-Delay Remote Rendering System for 3D Video. *Proc. Multimedia*, Oct. 2010.
22. B. Choi, R. Komuravelli, V. Lu, H. Sung, R.L. Bochino, S.V. Adve, J.C. Hart. Parallel SAH k-D Tree Construction. *Proc. High Performance Graphics*, June. 2010.
23. Y. Jia, X. Ni, E. Lorimer, M. Mullan, R. Whitaker, J.C. Hart. RBF Dipole Surface Evolution. *Proc. Shape Modeling International*, June 2010.

24. W.-W. Feng, B.-U. Kim, Y. Yu, L. Peng, J.C. Hart, Feature-Preserving Triangular Geometry Images for Level-of-Detail Representation of Static and Skinned Meshes, *ACM Transactions on Graphics* 29(2), March 2010, Article 11.
25. J. Hoberock, V. Lu, Y. Jia, J.C. Hart. Stream Compaction for Deferred Shading. *Proc. High Performance Graphics*, Aug. 2009.
26. J.C Hart. Assistive Technology for the Aesthetically Impaired. *Proc. CHI Workshop on Computational Creativity Support*, Apr. 2009.
27. J. Hoberock, S. Hornus, J.C. Hart. On Constructing and Visualizing the Topological Structure of the Visibility and Radiance of Architectural Models. *Proc. TopoInVis: Topological Methods in Data Analysis and Visualization*, Feb. 2009.
28. Y. Jia, J. Hoberock, M. Garland, J.C. Hart. On the Visualization of Social and other Scale-Free Networks. (*Proc. Infovis*), *IEEE Transactions on Visualization and Computer Graphics* 14(6), Nov. 2008, pp. 1285-1292.
29. A. Godiyal, J. Hoberock, M. Garland, J.C. Hart. Rapid Multipole Graph Drawing on the GPU. *Proc. Graph Drawing*, Sep. 2008.
30. E. Eisemann, H. Winnemoller, J.C. Hart, D. Salesin. Stylized Vector Art from 3D Models with Region Support. (*Proc. Eurographics Rendering Symposium*), *Computer Graphics Forum* 27(4), June 2008, pp. 1199-1207.
31. M. Stroila, E. Eisemann, J.C. Hart. Clip Art Rendering of Smooth Isosurfaces. *IEEE Transactions on Visualization and Computer Graphics* 14(1), Jan. 2008, pp. 71-81.
32. H. Fang, J.C. Hart. Detail Perserving Shape Deformation in Image Editing. *Proc. SIGGRAPH, ACM Transactions on Graphics* 26(3), Aug. 2007, #12.
33. T. Bergstrom, K. Karahalios, J.C. Hart. Isochords: Visualizing Structure in Music. *Proc. Graphics Interface*, May 2007.
34. H. Fang, J.C. Hart. RotoTexture: Automated Tools for Texturing Raw Video. *IEEE Transactions on Visualization and Computer Graphics* 12(6), Nov. 2006, pp. 1580-1589.
35. X. Jiao, A. Colombi, X. Ni, J.C. Hart. Anisotropic Mesh Adaptation for Evolving Triangulated Surfaces. *Proc. Meshing Roundtable*, Sept. 2006, pp. 173-190.
36. S. Dong, P.-T. Bremer, M. Garland, V. Pascucci, J.C. Hart. Spectral Surface Quadrangulation. *Proc. SIGGRAPH, ACM Transactions on Graphics* 25(3), July 2006, pp. 1057-1066.
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39. P.-T. Bremer, J.C. Hart. A Sampling Theorem for MLS Surfaces. *Proc. Point Based Graphics*, June 2005.
40. J.O. Talton, N.A. Carr, J.C. Hart. Voronoi Rasterization of Sparse Point Sets. *Proc. Point Based Graphics*, June 2005.
41. W. Su, J.C. Hart, A Programmable Particle System Framework for Shape Modeling, *Proc. Shape Modeling International*, June 2005.
42. S. Zelinka, H. Fang, M. Garland, J.C. Hart. Interactive Material Replacement in Photographs. *Proc. Graphics Interface*, May 2005.
43. S. Hornus, J. Hoberock, S. Lefebvre and J.C. Hart. ZP+: Correct Z-pass Stencil Shadows. *Proc. ACM Symposium on Interactive 3-D Graphics and Games*, Apr. 2005. **(Highest ranked paper according to review score.)**
44. H. Fang, J.C. Hart, "Textureshop: Texture Synthesis as a Photograph Editing Tool," *ACM Transactions on Graphics* 23(3) (also in *Proc. SIGGRAPH* 2004), Aug. 2004, pp. 354-359.

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(Second highest ranked paper according to tertiary review score.)
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47. N. Carr, J.C. Hart, "Dynamic Clustering of Meshed Surfaces," Proc. Symposium on Geometry Processing, July 2004.
48. O.S. Lawlor, J.C. Hart, "Bounding Recursive Procedural Models using Convex Optimization," Proceedings of Pacific Graphics 2003, October 2003, pp. 283-292.
49. P-P. Sloan, J. Hall, J. Hart, J. Snyder. Clustered Principal Components for Precomputed Radiance Transfer. (Proc. SIGGRAPH 2003) ACM Transactions on Graphics 22(3), July 2003.
50. N.A. Carr, J.D. Hall and J.C. Hart, GPU Algorithms for Radiosity and Subsurface Scattering, Proc. Graphics Hardware, July 2003.
51. John C. Hart, Jeyprakash Michaelraj, Brent Baker. Structural Simulation of Tree Growth. The Visual Computer 19(2-3), May 2003, pp. 151-163.
52. P. Sherman, J.C. Hart. Direct Manipulation of Recurrent Models. Computers & Graphics 27(1), Feb. 2003, pp. 143-151.
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54. N.A. Carr, J.D. Hall and J.C. Hart. The Ray Engine. Proc. Graphics Hardware 2002, Sep. 2002.
55. H. Fang, J. Hart. Randomly Accessible Procedural Animation of Physically Approximate Turbulent Motion. Proc. Computer Animation 2002, June 2002.
56. J. Hart, E. Bachta, W. Jarosz, T. Fleury. Using Particles to Sample and Control More Complex Implicit Surfaces. Proc. Shape Modeling International 2002, May 2002, pp. 129-136.
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58. J.C. Hart. Perlin Noise Pixel Shaders. *Proc. Graphics Hardware 2001*, Aug. 2001.
59. W. Cochran, R. Lewis, J. Hart. The Normal of a Fractal Surface. *The Visual Computer* 17(4), 2001, pp. 209-218.
60. J.C. Hart. Using the CW-Complex to Represent the Topological Structure of Implicit Surfaces and Solids. *Proc. Implicit Surfaces '99*, Sept. 1999, pp. 107-112.
61. J.C. Hart, N. Carr, M. Kameya, S.A. Tibbitts, T.J. Coleman. Antialiased Parameterized Solid Texturing Simplified for Consumer-Level Hardware Implementation. *Proc. Graphics Hardware 99*, Aug. 1999, pp. 45-53.
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63. J.C. Hart. Morse Theory for Implicit Surface Modeling. In *Mathematical Visualization*, H-C Hege and K. Polthier, Eds., Springer-Verlag, Berlin, Oct. 1998, pp. 257-268. (Reviewed paper presented at VisMath '97, Berlin, 1997.)
64. W.O. Cochran, J.C. Hart, P.J. Flynn. On Approximating Rough Curves with Fractal Functions. *Proc. Graphics Interface '98*, June 1998, pp. 65-72.
65. A.K. Dunker, E. Garner, S. Guillot, P. Romero, K. Albrecht, J. Hart, Z. Obradovic, C. Kissinger and J.E. Villafranca. Protein Disorder and the Evolution of Molecular Recognition: Theory, Predictions and Observations. *Pacific Symposium on Biocomputing* 3: 435-446, Jan. 1998.
66. B. Stander, J.C. Hart. Guaranteeing the Topology of an Implicit Surface Polygonization. *Computer Graphics Annual Conference Series* (Proc. SIGGRAPH 97) Aug., 1997, pp. 279-286.

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68. B. Burch, J.C. Hart. Linear Fractal Shape Interpolation. *Proc. Graphics Interface '97*. May, 1997, pp. 155-162.
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73. J.C. Hart, B. Baker. Implicit Modeling of Tree Surfaces. *Proc. of Implicit Surfaces '96*, Oct. 1996, pp. 143-152.
74. J.C. Hart. Fractal image compression and the inverse problem of recurrent iterated function systems. *IEEE Computer Graphics and Applications* 16(4) July 1996, pp. 25-33.
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81. J.C. Hart. On recording virtual environments. *Proc. of IEEE Visualization '93 Symposium on Research Frontiers in Virtual Reality*, Nov. 1993, pp. 80-83.
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87. J.C. Hart, A. Norton. Use of curves in rendering fractures. *Proc. of SPIE/SPSE Symposium on Curves and Surfaces in Computer Vision and Graphics*. Feb. 1990.
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Books, Invited Book Chapters and Edited Course Notes

89. J. Torrellas, S.V. Adve, V.S. Adve, D. Dig, M.N. Do, M.J. Garzaran, J.C. Hart, T.S. Huang, W.W. Hwu, S.T. King, D. Marinov, K. Nahrstedt, D.A. Padua, M. Parthasarathy, S.J. Patel, M. Snir. "Making Parallel Programming Easy: Research Contributions from Illinois," Sep. 2013.
90. M. Olano, W. Heidrich, J. Hart and M. McCool, Real Time Shading, AK Peters, July 2002.
91. J.C. Hart, "Procedural Geometry," Chapter in Modeling and Texturing, a Procedural Approach, 3rd Edition, D. Ebert, Editor, Morgan Kaufman, November 2002.
92. J.C. Hart, "Real-Time Procedural Solid Texturing," Chapter in Modeling and Texturing, a Procedural Approach, 3rd Edition, D. Ebert, Editor, Morgan Kaufman, November 2002.
93. D. Ebert and J. Hart, Editors, "Procedural Implicit Techniques for Modeling and Texturing," ACM SIGGRAPH 1998 Course Notes, July 1998.
94. D. Ebert and J. Hart, Editors, "New Frontiers in Modeling and Texturing," ACM SIGGRAPH 1997 Course Notes, August 1997.
95. J. Hart and D. Saupe, Editors, "Fractal Models for Image Synthesis, Compression and Analysis," ACM SIGGRAPH 1996 Course Notes, August 1996.
96. J. Hart, Editor, "New Directions for Fractal Modeling in Computer Graphics," ACM SIGGRAPH 1994 Course Notes, July, 1994.
97. J. Hart and K. Musgrave, Editors, "Fractal Modeling in 3-D Computer Graphics and Imaging," ACM SIGGRAPH 1991 Course Notes, July 1991.

Patents

98. H. Fang and J.C. Hart, Methods and Systems for Image Modification. #7,365,744. Filed: 26 July 2004, Granted: 29 April 2008.
99. S. Tibbits, T. Coleman and J.C. Hart. Antialiased Procedural Solid Texturing Hardware. Provisional Patent #60,088,879. Evans & Sutherland, 1998.

Invited Papers, Articles, Tech Reports and Other Publications

100. S.V. Adve, V.S. Adve, G. Agha, M.I. Frank, M.J. Garzaran, J.C. Hart, W.W. Hwu, R.E. Johnson, L.V. Kale, R. Kumar, D. Marinov, K. Nahrstedt, D. Padua, M. Parthasarathy, S.J. Patel, G. Rosu, D. Roth, M. Snir, J. Torrellas, C. Zilles. Parallel Computing Research at Illinois: The UPCRC Agenda. Whitepaper, Nov. 2008.
101. S. Dong, P.-T. Bremer, M. Garland, V. Pascucci and J.C. Hart. Quadrangulating a Mesh using Laplacian Eigenvectors. Tech Rep. UIUCDCS-R-2005-2583, June 2005.
102. P. Lacz and J.C. Hart. Procedural Geometric Synthesis on the GPU. Poster (with accompanying manuscript) for SIGGRAPH 2004 and GP2: The ACM Workshop on General Purpose Computing on Graphics Processors, Aug. 2004.
103. J.D. Hall and J.C. Hart. GPU Acceleration of Iterative Clustering. Poster (with accompanying manuscript) for SIGGRAPH 2004 and GP2: The ACM Workshop on General Purpose Computing on Graphics Processors, Aug. 2004.
104. M. Mullan, R. Whitaker and J.C. Hart. Procedural Level Sets. Manuscript presented at NSF/DARPA CARGO Annual Meeting, May 2004.
105. J.D. Hall, N.A. Carr and J.C. Hart. Cache and Bandwidth Aware Matrix Multiplication on the GPU. Tech. Report UIUCDCS-R-2003-2328, May 2003.

- 106.M. Kameya, and J.C. Hart. Bresenham noise. SIGGRAPH 2000 Conference Abstracts and Applications, July 2000.
- 107.J.J. Kim and J.C. Hart. Contour-Based Polygonization of Regular Grid Terrain Data. Proc. Western Computer Graphics Symposium. Mar. 1999.
- 108.A. Aceves, K. Hammil and J.C. Hart. Proposal and Partially Implemented: The Studio: A Large High Resolution Immersive Projection System for Research and Education. Proc. Western Computer Graphics Symposium. Mar. 1999.
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- 112.J.C. Hart. Computational Topology for Shape Modeling. Invited Talk and Paper. Proc. Shape Modeling International '99, Univ. Aizu, Japan, Mar. 1999, pp. 36-45.
- 113.J.C. Hart. Morse Theory for Computer Graphics. WSU Technical Report EECS-97-002. Chapter in ``New Frontiers in Modeling and Texturing," SIGGRAPH '97 course notes, J. Hart, D. Ebert eds., Aug. 1997.
- 114.I.M. Danciu, J.C. Hart. Fractal Color Image Compression in the $L^*a^*b^*$ Uniform Color Space. Poster. Abstract in: Proc. of Data Compression Conference '97. IEEE Computer Society Press, Apr. 1997, p. 434.
- 115.B.T. Stander, J.C. Hart. Topologically Guaranteed Blobby Surface Polygonization. Proceedings of Western Computer Graphics Symposium. Mar. 1996. pp. 1-9.
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- 117.W.O. Cochan, J.C. Hart, P.J. Flynn. Similarity and Affinity Hashing. Proceedings of Western Computer Graphics Symposium. Mar. 1996. pp. 89-98.
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- 119.W.O. Cochran, J.C. Hart, P.J. Flynn. Principal component classification for fractal volume compression. Proceedings of Western Computer Graphics Symposium. Mar. 1995.
- 120.J.C. Hart. Sphere tracing: simple robust antialiased rendering of distance-based implicit surfaces. WSU Technical Report EECS-93-015. Chapter in ``Design, Visualization and Animation of Implicit Surfaces," SIGGRAPH '93 course notes, J. Bloomenthal, B. Wyvill, eds., Aug. 1993.
- 121.J.C. Hart. Ray Tracing Implicit Surfaces. WSU Technical Report EECS-93-014. Chapter in ``Design, Visualization, and Animation of Implicit Surfaces," SIGGRAPH '93 intermediate course notes, J. Bloomenthal and B. Wyvill, eds., Aug. 1993.
- 122.T.A. DeFanti, J.C. Hart, D.J. Sandin, L.H. Kauffman. Visualization of multidimensional fractals. Proceedings of the Argonne National Lab. Seventh International Conference on Advanced Science and Technology. Mar. 1991, pp. 289-298.
- 123.T.A. DeFanti, D.J. Sandin, G.W. Lescinsky, J.C. Hart, M.D. Brown, L.H. Kauffman. Simulacra/Stimulacra::Fractal. Art Futura, Jan. 1991.
- 124.J.C. Hart. Parallel algorithms for visualization of multidimensional fractal objects (extended abstract.) Electronic Imaging East '90. Nov. 1990, pp. 459-462.
- 125.D.J. Sandin, J.C. Hart, L.H. Kauffman. Interactive visualization of complex, stacked and quaternion Julia sets. Proceedings of Ausgraph '90, Sep. 1990. (Invited paper.)

- 126.T.A. DeFanti, D.J. Sandin, J.C. Hart, G.W. Lescinsky. One picture's worth a thousand gigaflops (One animation's worth a thousand teraflops). Pixel 1(3) July 1990, pp. 40-41.
- 127.J.C. Hart, A. Norton. Use of curves in rendering fractures. IBM Technical Report. Aug. 1989.

Film and Animation Credits

- 128.Executive Producer (with C. Machover). "The Story of Computer Graphics." A SIGGRAPH Production of a feature-length documentary on the human struggle to bring computer graphics from the inspired revelation that computers can be used to draw pictures to the present, where low-cost graphics and the Internet combine to provide virtual environments for people to communicate. Premiered at a special event in the Shrine Auditorium, LA, as part of the SIGGRAPH 99 Computer Animation Festival.
- 129.Contributor. "Air on the Dirac Strings." Produced by L.H. Kauffman, G.K. Francis, D.J. Sandin. SIGGRAPH '93 Electronic Theater. SIGGRAPH Video Review 93, Aug. 1993.
- 130.Producer. "SIGGRAPH 93 Technical Session Sampler." SIGGRAPH '93 Electronic Theater. Video compilation, narrated by J. Blinn. SIGGRAPH Video Review 91, Aug. 1993
- 131.Producer. "Highlights from the SIGGRAPH '92 Technical Session." SIGGRAPH '92 Electronic Theater. Video compilation, narrated by J. Blinn.
- 132.Producer/Director/Animator. "Fun with Octrees: Graph Topologies on the Recurrent Cube." SIGGRAPH '92 Animation Screening Room. SIGGRAPH Video Review 87, Aug. 1992. Appears in: "The Fractal Universe: Animation," Media Magic, 1993.
- 133.Producer/Director/Animator. "unNatural Phenomena." SIGGRAPH '91 Electronic Theater. SIGGRAPH Video Review 71, Aug. 1991. Appears in: "The Fractal Universe: Animation," Media Magic, 1993. Excerpts appear in: "Beyond The Minds Eye," Mirimar, and "Prime Time Live," ABC.
- 134.Producer/Director/Animator (with S. Das.). "Sierpinski Blows His Gasket." SIGGRAPH '90 Animation Screening Room. SIGGRAPH Video Review 61, 1990. First Runner-Up, Truevision Videographics Competition, 1990. Appears in: "The Fractal Universe: Animation," Media Magic, 1993.
- 135.Producer/Director/Animator. "Dynamics in the Quaternions." SIGGRAPH Video Review 42, 1989. Appears in: "The Fractal Universe: Animation," Media Magic, 1993.

∞ Educational Activities ∞

Postdoctoral Associates

- Moussa Mansour, 2015-6. Visiting from Univ. Sao Paolo.
- Matei Stroila, 2005-6. Research Scientist, Navteq, Nokia, Here.
- Peer-Timo Bremer, 2004-6. Research Scientist, Lawrence Livermore National Labs.
- Nate Carr, 2004-5. Senior Research Scientist, Adobe.

Ph.D. Students

- Apollo Ellis. Apple Internship 2016.
- Mingcheng Chen (2016). Currently at Google.
- Victor Lu (2013). Currently at Nokia.

- Mahsa Kameya (2012). Currently at Microsoft. MSR Internship 2010.
- Yuntao Jia (2010). Currently at Facebook.
- Jared Hoberock (2008). Research Scientist, Nvidia. NVidia Fellowship 2005,2007. NVidia Internship 2005.
- Xinli Ni (2007). Currently at Google, Microsoft Internship 2005.
- Hui Fang (2006). Currently at Google. Adobe Internship 2005.
- Nate Carr (2004). Senior Research Scientist, Adobe. NVidia Fellowship 2002 and 2003. Intel Internship 1999. NVidia Internship 2002.
- Wayne Cochran (1998). Assistant Professor, School of Engineering and Computer Science, Washington State University, Vancouver.
- Bart Stander (1997), Full Professor, Computer and Information Technology, Dixie State College of Utah.

M.S. Students

- 2023: Sharon Lam. “MWEPI-VIZ: An Interactive Visualization Dashboard for Ensemble Simulations in Computational Epidemiology.”
- 2017: Yiwen Xu.
- 2015: Jared Saul.
- 2013: JohnMark Lau.
- 2011: Rajesh Bhasin.
- 2009: Apeksha Godiyal. Microsoft Visio.
- 2005: Jerry Talton (Ph.D. Stanford, 2012), Tony Kaap (Alias), Matei Stroila (NAVTEQ).
- 2004: Jesse Hall (NVidia, Microsoft Research Internship 2002. NVidia Fellowship 2003 and 2004), Patrick Lacz (RadTIME), Wen Su (NVidia).
- 2002: Hui Fang (continued), Ed Bachta (visualization programmer at IUPUI)
- 2000: Nate Carr (continued), Jay Kim.
- 1999: Chanikarn Kulratanayan.
- 1998: Jeyprakash Michaelraj (Alias).
- 1997: Paul Sherman (Periphery Consulting).
- 1996: Ioana Danciu. (Adobe), Brandon Burch (WSU Instructor), Yingjun Yu (Nokia), Wenbiao Jiang (CFD Research), Kurt Albrecht.
- 1994: Anand Ramagopalrao (Microsoft), Wayne Cochran (continued).
- 1992: Yongqi Yang (Adobe).

Courses Taught

UIUC Courses

- CS 498 Data Visualization (via the Coursera platform for the MCS-DS program)
- ENG 198 Grand Challenges (Fall 2012)

- CS 418 Interactive Graphics
- CS 419 Production Graphics
- CS 519 Scientific Visualization
- CS 497 JCH Advanced Shape Modeling (Fall 2000)
- CS 498 Procedural Modeling and Shading in Computer Graphics (Fall 2002)
- CS 498 Particle System Programming (Spring 2004, voluntary addition to course load)
- CS 498 Shape Modeling (Fall 2004)
- CS 498 Mobile Augmented Reality (Fall 2013, with Matei Stroila)
- CS 598 JCH Surface Reconstruction (2008)
- CS 491 EH Computational Topology Seminar (co-organized with J. Erickson)
- CS 491 GHY Graphics Seminar (co-organized with M. Garland, Y. Yu)

WSU Courses

- CptS 330 Numerical Computing
- CptS 442 Computer Graphics
- CptS 443 Computer-Human Interaction
- CptS 548 Advanced Computer Graphics

Coursera Courses

- Data Visualization, July-Aug. 2015. Enrollment: 88,399 from 198 different countries, including 1,197 with signature track credit toward the Data Mining certificate.

SIGGRAPH Reviewed One-Day Courses

- 2005: “Modern Techniques for Implicit Modeling” (Terry Yoo, James O’Brien), and “GPU Shading and Rendering” (Marc Olano)
- 2004: “Real Time Shading” (Marc Olano)
- 2003: “Beyond Blobs: Recent Advances in Implicit Surfaces” (Terry Yoo, Greg Turk) and “Real Time Shading” (Marc Olano)
- 2002: “Beyond Blobs: Recent Advances in Implicit Surfaces” (Terry Yoo and Greg Turk, org.) and “Real Time Shading” (Marc Olano).
- 2001: “Real Time Shading” (Marc Olano)
- 2000: “Approaches for Procedural Shading on Graphics Hardware” (Marc Olano)
- 1998: “Procedural Implicit Techniques for Modeling and Texturing” (Co-organizer with D. Ebert)
- 1997: “New Frontiers in Modeling and Texturing” (Co-organizer with D. Ebert.)
- 1996: “Fractal Models for Image Synthesis, Compression and Analysis” (Co-organizer with D. Saupe), “Procedural Modeling, Texturing, and Animation Techniques” (D. Ebert) and “Implicit Surfaces for Geometric Modelling and Computer Graphics (Jai Menon and Brian Wyvill)
- 1995: “Procedural Modeling, Texturing, and Animation Techniques” (D. Ebert).

- 1994: “New Directions for Fractal Modeling in Computer Graphics” (Course organizer).
- 1993: “Design, Visualization and Animation of Implicit Surfaces” (J. Bloomenthal, B. Wyvill).
- 1992: “Fractals: from Folk Art to Hyperreality” (P. Prusinkiewicz).
- 1991: “Fractal Modeling in 3-D Computer Graphics and Imaging” (Co-organizer with K. Musgrave).

Other

- Adler Planetarium, Scientific Visualization by Supercomputer. Chicago, Sept.-Nov. 1988.

Invited Colloquia and Presentations

Note: colloquia presented for the purpose of interviewing have been omitted.

- **Symposium on the Future of Data Analytics of the American & Canadian Societies of Animal Science**, invited talk on “Data Visualization,” July 2018.
- **Workshop High Throughput Phenotyping and Data Analytics**, invited talk on “Data Visualization,” Univ. Maryland, Nov. 2017.
- **31st Discovery Conference on Big Data Dairy Management**, invited talk on “Data Visualization,” Nov. 2016.
- **University of Lorraine**, June 2014.
- **University of Notre Dame**, Center for Research Computing, “High Performance Computer Vision, An Oxymoron?,” May 2012.
- **Graphics Interface Conference**, Keynote: Assistive Technology for the Aesthetically Impaired,” May 2011.
- **University of Iowa Computing Conference**, organized and invited by U. Iowa students, “Assistive Technology for the Aesthetically Impaired,” Feb. 2010.
- **AMS MathViz09**, U. Illinois, “It’s Nice to See This Stuff Actually Used for Something,” Mar. 2009. Host: George Francis.
- **INRIA**, Grenoble, France, “Assistive Technology for the Aesthetically Impaired,” Sep. 2009. Host: Elmar Eisemann.
- **Texas A&M University**. Distinguished Lecture: “Assistive Technology for the Aesthetically Impaired,” Feb. 2008. Host: Scott Schaeffer.
- **NAVTEQ**. “Industry Collaborations,” Nov. 2007, Chicago, IL. Host: Matei Stroila.
- **Adobe-MIT Research Retreat**. “Textureshop Redux,” Oct. 2007, Cambridge, MA. Host: David Salesin and Fredo Durand.
- **University of Konstanz Summerschool**. “Computational Topology of Implicit Surfaces” and “Computational Topology of Meshes,” Sep. 2006, Gaschurn, Austria. Host: Dietmar Saupe.
- **Wolfram Research**. “Mathematical Visualization,” May 2006, Champaign, IL. Host: Roger Germundsson.
- **Carnegie-Mellon University**. “Surface Constrained Particle Systems” and “Global Illumination on the GPU,” Feb. 2005. Host: Doug James.
- **Imagina**. “Global Illumination on the GPU,” Monaco, Feb. 2005.
- **3D Festival**. “Global Illumination on the GPU,” Copenhagen, Denmark, May 2004.

- **INRIA**, Grenoble, France, “Global Illumination on the GPU,” Mar. 2004, Host: Samuel Hornus.
- **University of Utah**. “Global Illumination on the GPU,” Oct. 2003, Host: Chuck Hansen.
- **NVidia U**. Keynote speaker. July 2003, Host: Herbert Hu.
- **Army High Performance Computing Research Center (AHPARC) Workshop on Graphics Modeling, Simulation and Visualization**. “Harnessing the Supercomputer in your PC’s Graphics Card,” June 2003. Host: Boquan Chen.
- **University of Illinois at Chicago (Math Dept.)**. “Computational Topology for Computer Graphics.” Apr. 2002. Host: Anatoly Libgaber.
- **Colorado Springs SIGGRAPH Chapter**. “The Quest for Real-Time Procedural Solid Texturing.” Mar. 2001. Host: Dino Schweitzer.
- **Northwestern University**. “The Quest for Real-Time Procedural Solid Texturing.” Oct. 2000. Host: Benjamin Watson.
- **Shape Modeling International**. Invited Speaker, Aizu, Japan, March 1999.
- **Universität Freiburg**. “Recurrent Modeling.” Sep. 1997. Host: Dietmar Saupe.
- **University of Utah**. “The Topology of Implicit Surfaces.” Feb. 1997. Host: Chuck Hansen.
- **University of Illinois at Chicago (EECS Dept.)**. “The Topology of Implicit Surfaces.” Feb. 1997. Host: Tom DeFanti.
- **Interval Research**. “Recurrent Modeling.” July 1996. Host: Sally Rosenthal.
- **University of Washington**. “Recurrent Modeling.” Dept. of Computer Science and Engineering. Jan. 1996. Host: Linda Shapiro.
- **Boeing Information & Support Services**. “Why Fractal Image Compression Isn’t Fractal.” Computer Graphics & Multimedia Group. Jan. 1996. Host: David Kerlick.
- **University of Idaho**. “Why Fractal Image Compression Isn’t Fractal.” Computer Science Dept. Nov. 1995. Host: Deborah Frincke.
- **NATO Advanced Study Institute** on Fractal Image Compression and Image Analysis. “Similarity Hashing: A model-based vision solution to the inverse problem of recurrent iterated function systems.” July 1995.
- **Simon Fraser University**. “Recurrent Modeling.” School of Computing Science. July 1995. Host: F. David Fracchia.
- **University of Calgary**. “Procedural Geometric Instancing.” Dept. of Computer Science. Jan. 1994. Host: Przemyslaw Prusinkiewicz.
- **Purdue University**. “Linear Fractals in Computer Graphics.” Computer Science Dept. June 1992. Host: Chandrajit Bajaj.

Professional Activities

Editorships and Papers Chairships

- Area Editor (Visual Computing) and Editorial Board Member, ACM Books 2014-2022.
- Papers Co-Chair (with Scott Schaefer), Shape Modeling International, 2012.
- Editor-in-Chief, ACM Transactions on Graphics, 2002-2008. Past EiC, 2008-2011.

- Associate Editor, ACM Transactions on Graphics, 2000-2002.
- Guest Editor, Communications of the ACM 35(6) June 1992.
- Guest Editor, SIGGRAPH Video Review 96, ``Video Supplement to the Conference Proceedings," Aug. 1993.
- Guest Editor (with E.E. Catmull), SIGGRAPH Video Review 86, ``Video Supplement to the Conference Proceedings," July 1992.

Professional Organization Leadership

- SIGGRAPH Specialized Conferences Committee, 2010-20.
- Chair, SIGGRAPH Service Award, 2005-8.
- ACM SIGGRAPH Advisory Board, 2005.
- Director for Communications, SIGGRAPH Executive Committee, 1996-9.
- Director at Large, SIGGRAPH Executive Committee, 1994-6.

Review Panels

- King Abdullah University of Science and Technology, Mar. 2012.
- Science Foundation Ireland, Oct. 2006.
- INRIA Systemes Cognitifs D, May 2006.
- Texas A&M University Dept. of Computer Science, Oct. 2024.

Conferences Chaired

- Co-Chair (with A. Marshall-Colon, S.P. Long and E.H. DeLucia), Plants-in-Silico, NCSA, UIUC, 2016.
- Co-Chair (with S. Gao, J. Jorge, K. Polthier and W. Wang), Shape Modeling International, Hong Kong, Oct. 2014.
- Co-Chair (with Marie-Paule Cani), Shape Modeling International, MIT, June 2005.
- Co-Chair (with K. van Overveld), Implicit Surfaces, Eindhoven, Netherlands, 1996.
- Chair. Western Computer Graphics Symposium, Panorama, BC, 1996.

Program Committees

- SIGGRAPH Papers Committee: 2001, 2006, 2007, 2010
- SIGGRAPH Asia Papers Committee, 2008.
- SIGGRAPH Sketches Jury: 1998, 1999.
- Symposium on Geometry Processing, since 2006.
- Interactive 3D Graphics and Games, since 2005.
- Pacific Graphics, since 2002.

- Shape Modeling International, since 1997.
- Implicit Surfaces (all).
- Eurographics 2004.
- Graphics Hardware, since 2004.
- Web3D 2003.
- IEEE Virtual Reality 2000, 2001, 2002.
- Virtual Reality Annual International Symposium 1998.
- Visualization and Mathematics 1997.
- Supercomputing 1991-3, 1995.

Memberships

- Association for Computing Machinery
- ACM Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH)
- IEEE Computer Society

University of Illinois Committees

University of Illinois System

- Steering Committee, Start MyResearch Portal for university system-wide research management software, 2014-2016.
- University Technology Management Team, 2012-2013.

Urbana-Champaign Campus

- Ex-Officio (Graduate College Representative), Senate Educational Policy Committee, 2014-21.
- Chair, Senate Subcommittee on IT, 2013-6, Member, 2008-10.
- University Senate Executive Committee, 2013-6.
- IT Governance Executive Committee, 2012-5.
- Chair, IT Governance Research Subcommittee, 2012-5.
- Chair, Stewarding Excellence IT Project Team, 2010.
- Human Factors Transition Committee, 2008-9.
- Senate, 2007-14,

College of Engineering

- Chair, Promotion & Tenure Committee, 2013, Member 2012-2013.
- Vice-Chair, Executive Committee, 2013. Secretary, 2012-2013. Member, 2011-2013.

- Chair, Engineering IT Steering Committee, 2010-11.

Dept. of Computer Science

- Department Head Search Committee, 2007-9.
- Advisory Committee (peer elected), 2005-2006.
- Industry Relations Committee, 2005-2007.
- Technology, Facilities and Services Committee (CS), 2005-2012.
- Engineering Open House CS Representative (CS), 2001-2006.
- Recruiting Committee, 2004, 2005.
- Curriculum Committee, 2002-3.
- Chair, Distinguished Lecture Series 2001-2002, Member 2000-2002.
- Computer Systems (CS), 2000-2001.
- Fellowships, Assistantships and Admissions, 2000-2001.

WSU

- School of EECS Computer Science Area Chair, 1998-2000.
- School of EECS Computer Science Accreditation Coordinator, 1999-2000.
- School of EECS Curriculum Committee 1998- (Chair, 1999-2000).
- School of EECS Graduate Studies Committee 1993-8.
- School of EECS Laboratory Committee 1994-6.
- WSU Center for Visualization, Analysis and Design in the Molecular Sciences (VADMS) Advisory Board 1994-2000.