UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE LLC,
Petitioner,

v.

138 EAST LCD ADVANCEMENTS LIMITED,
Patent Owner.

Case No. IPR2024-00957
U.S. Patent No. 7,454,056

DECLARATION OF NIKOLAOS PAPANIKOLOPOULOS, PH.D.

I, Nikolaos Papanikolopoulos, of Minneapolis, Minnesota, declare that:

I. ASSIGNMENT

1. I have been retained by Robins Kaplan LLP on behalf of 138 East LCD Advancements Ltd. ("138 East") as an expert with regard to this matter. I understand that Petitioner Google LLC ("Google" or "Petitioner") is requesting that the Patent Trial and Appeal Board ("Board") institute *inter partes* review (IPR) of U.S. Pat. No. 7,454,056 ("the '056 patent") (Ex. 1001).

2. In my capacity as an expert, I have been asked to provide my independent analysis and opinions regarding the '056 patent, the prosecution history of the '056 patent, the alleged prior art relied upon by Petitioner, the meaning of various claim terms from the '056 patent from the perspective of a person of ordinary skill in the art ("POSITA"), and the opinions offered by Petitioner's expert, Kenneth A. Parulski, in his declaration ("Parulski Declaration," Ex. 1003). My opinions and conclusions are fully discussed in later sections of this declaration.

3. I am an independent consultant, and I am not, and have never been, an employee of 138 East or Google. I received no compensation for this declaration beyond my normal hourly compensation ($450) based on my time spent analyzing the '056 patent, the prosecution history of the '056 patent, the prior art publications relied upon by Petitioner, the Parulski Declaration, and other related materials. I

will not receive any added compensation based on the outcome of any IPR or other proceedings involving the ’056 patent.

4. This declaration and my opinions are in support of Patent Owner’s Preliminary Response, and I understand that the content of this declaration may be expressed and reproduced in the POPR.

II. BACKGROUND AND QUALIFICATIONS

5. I am the McKnight Presidential Endowed Professor and Distinguished McKnight University Professor in the Department of Computer Science and Engineering of the University of Minnesota in Minneapolis, Minnesota. I am also the Director for the Minnesota Robotics Institute.

6. I have been retained as an expert in the fields of image processing/computer vision, sensing, and related technologies. I am being compensated at my normal consulting rate of $450 per hour. My compensation is not dependent on and in no way affects the substance of my statements in this declaration.

7. I have been a professor at the University of Minnesota (originally as an assistant professor, and then as an associate professor) since the Fall 1992. Between Fall 2001 and Spring 2004, and between Fall 2010 and Spring 2013, I was the Director of Undergraduate Studies of the Department of Computer Science and Engineering.

8. In 1992, I received my Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University. My thesis was entitled "Controlled Active Vision" and focused on using computer vision in a controlled fashion to detect, track, and manipulate objects in the environment. In 1988, I also received my M.S. in Electrical and Computer Engineering from Carnegie Mellon University. My B.S. in Electrical Engineering was received in 1987 from the National Technical University in Athens, Greece.

9. For over thirty years, my research and teaching work has focused on image processing, computer vision, intelligent transportation systems, and robotics. This research has included detection and tracking of humans and objects such as faces using information from stationary or moving cameras. It has also included main object detection and recognition including work with artificial intelligence and pattern recognition systems for surveillance applications.

10. I currently teach or have been teaching three courses related to image processing and computer vision: (i) CSci 5561 Computer Vision, (ii) CSci 5511 Artificial Intelligence, and (iii) CSci 5551 Introduction to Intelligent Robotic Systems. In particular, I have been teaching the class in Computer Vision since 1992.

11. I am currently serving as a Senior Editor in the IEEE Transactions on Intelligent Transportation Systems with responsibility in the area of imaging. I was Associate Editor in the same journal for twelve years.

12. I have received research grants for various projects involving computer vision and image processing as applied to medicine and surveillance, including face detection and tracking of humans. My industrial experience includes founding a robotics company in 2005 named ReconRobotics Inc. that develops different robotic platforms. I have also been a consultant since 1997 for numerous companies and provided technical expertise in developing computer vision algorithms for human tracking, object recognition, fingerprint recognition, vehicle tracking, camera calibration, inspection, and precision agriculture. In one of my consulting assignments, I had to develop computer vision algorithms for inspection of industrial parts by using different illumination sources (Banner Engineering). I have licensed my algorithms to several industries with the most recent one being Sentera Inc., which is using image processing and image segmentation for precision agriculture.

13. My research has produced more than 380 journal and conference publications. More than 90 publications are in refereed journals including top journals in imaging such as IEEE Trans. on Pattern Analysis and Machine Intelligence, IEEE Trans. on Image Processing, and International Journal of

Computer Vision. Many of my publications and research grants relate to human detection and tracking systems. Some examples include:

Walczak, N., Fasching, J., Cullen, K., Morellas, V., and Papanikolopoulos, N.P., "Toward Identifying Behavioral Risk Markers for Mental Health Disorders: An Assistive System for Monitoring Children's Movements in a Preschool Classroom," Machine Vision and Applications, Volume 29, No. 4, May 2018, PP. 703-717.

Cook, D., Morris, T., Morellas, V., and Papanikolopoulos, N., "An Automated System for Persistent Real-Time Truck Parking Detection and Information Dissemination," *Proceedings of the 2014 IEEE Int. Conference on Robotics and Automation*, Hong Kong, China, May 31 – June 7, 2014, PP. 3989-3994.

Somasundaram, G., Sivalingam, R., Morellas, V., and Papanikolopoulos, N.P., "Classification and Counting of Composite Objects in Traffic Scenes Using Global and Local Image Analysis", *IEEE Trans. on Intelligent Transportation Systems,* Volume 14, No. 1, March 2013, PP. 69-81.

Veeraraghavan, H., Atev, S., Bird. N., Schrater, P., and Papanikolopoulos, N., "Driver Activity Monitoring through Supervised and Unsupervised Learning," Proceedings of the IEEE 8th Int. Conf. on Intelligent Transportation Systems (ITSC 2005), PP. 895-900, Vienna, Austria, September, 2005.

Wahlstrom, E., Masoud, O., and Papanikolopoulos, N., "Vision-based Methods for Driver Monitoring," Proceedings of the IEEE 6th Int. Conf. on Intelligent Transportation Systems (ITSC 2003), PP. 903-908, Shanghai, China, October 12-15, 2003.

Masoud, O., and Papanikolopoulos, N.P., "A Novel Method for Tracking and Counting Pedestrians in Real-time Using a Single Camera," *IEEE Trans. on Vehicular Technology,* Volume 50, No. 5, September 2001, PP. 1267-1278.

Singh, S., and Papanikolopoulos, N. P., "Monitoring Driver Fatigue Using Facial Analysis Techniques," Proceedings of the 1999 IEEE/IEEJ/JSAI International Conference on Intelligent Transportation Systems, PP. 314-318, Tokyo, Japan, October 5-8, 1999.

14. I have worked extensively in the use of sensors to monitor driver faces and fatigue. The work extended to monitor driver fitness to drive. We have developed a computer vision-based system that detects faces and analyzes facial features and eye movements to detect signs of drowsiness and driver fatigue. By monitoring factors such as eye closure, head pose, and blink patterns, the system can alert drivers when they show signs of fatigue and suggest appropriate actions (this research started in the late 90s and evolved through the next decade). It should be noted that the proposed algorithms and systems considered the continuously evolving light conditions that vehicular systems operate within.

15. It should be noted that our group has made significant contributions to the field of face detection and tracking (the face is the main object segmented), particularly in the context of security and transportation applications. Our research includes the development of robust face detection algorithms capable of operating in complex, real-world environments with varying lighting conditions and

orientations. My team has focused on creating real-time tracking systems that can maintain performance even with partial occlusions or rapid movements.

16. Our research has explored multi-modal approaches, combining visual and audio cues for more accurate tracking, and has addressed privacy concerns by developing techniques that can detect and track faces without necessarily identifying individuals. In the realm of security and surveillance, we have applied our face detection and tracking techniques to crowd monitoring and anomaly detection. Moreover, we have implemented adaptive learning techniques to improve face detection over time, extended this work to 3D face modeling, and explored emotion and expression recognition. Throughout my career, I have consistently emphasized the importance of scalability and efficiency, working to optimize algorithms for use in resource-constrained environments. Some results from the aforementioned efforts are shown in the figures below.

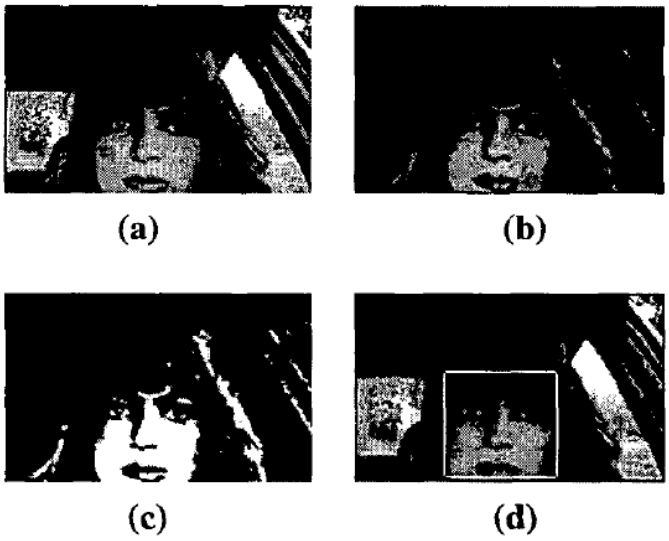


Figure 1: It is taken from the paper "Monitoring Driver Fatigue Using Facial Analysis Techniques" and shows detection of face using skin color information.



Figure 2: It is taken from the paper "Vision-based Methods for Driver Monitoring and shows driver features being tracked.



Figure 3: It is taken from the paper "Driver Activity Monitoring through Supervised and Unsupervised Learning" and shows skin color detection (bottom row) on various images (top). Skin color is indicated in black. The results are post-processed by a sequence of morphological erosions and dilations.

17. My work in vehicle detection and tracking has focused on using image and video processing techniques, including object detection, tracking, and recognition, to accurately track vehicles in real-time. These algorithms have been applied to different scenarios, such as urban traffic monitoring and surveillance. Moreover, machine learning techniques have helped in the improvement of these methodologies.

18. My work has been extended to tracking autonomous vehicles, where the challenges are different from traditional vehicle tracking that uses information from static sensors (e.g., cameras). My interests include developing tracking algorithms and systems that can handle the complexities of autonomous vehicles,

including predicting their future movements and understanding their intentions. The work has been extended to monitor the intentions of pedestrians (where pedestrians are segmented as the main objects).

19. These vehicle tracking systems enable continuous monitoring and tracking of vehicles, providing valuable information for traffic management, law enforcement, and security purposes.

20. My paper "Detection and Classification of Vehicles", published in the IEEE Transactions on Intelligent Transportation Systems in March 2002 is one of the most cited papers in the history of this journal (more than a thousand citations). The paper among other contributions shows how to segment thee main object from videos and images in low-light conditions. I also have nine patents in pertinent areas. One of them is the "Crowd Counting and Monitoring" with P. Kilambi and O. Masoud. It discloses a system and method for accurately estimating the number of people in a crowded area and monitoring their behavior. The invention utilizes computer vision techniques and machine learning algorithms to analyze video feeds from cameras overlooking the target area. It employs techniques such as background subtraction, main object detection, and tracking to identify individual people within the crowd.

21. The system uses density estimation methods to handle areas where individuals are difficult to distinguish. Advanced features might include the ability

to detect and track movement patterns, identify unusual behaviors or potential security threats, and predict crowd flow.

22. Our research work has been funded by several government funding agencies. For example, we have received funding from the Department of Homeland Security to monitor threats at Mass Transit Sites like the 30th Street Station in Philadelphia, PA, and the Light Rail Station in the Minneapolis-Saint Paul International Airport. Tracking humans was an essential task for which we developed a variety of image processing algorithms and tools.

23. For more than a decade, we have been developing computer vision-based systems to assess truck parking availability at truck rest areas. The funding came from FHWA, MnDOT, WiscDOT, and KansasDOT. The approach uses multiple cameras to detect trucks and other vehicles and determine empty spaces. The system operates in all weather conditions around the clock.

24. I have received numerous honors and awards for my research and contributions. I have been a Distinguished McKnight University Professor at the University of Minnesota since 2007 and have been a McKnight Presidential Endowed Professor in Computer Science since 2016. Also in 2007, I was nominated and became an IEEE Fellow. In 2016, I received the IEEE RAS George Saridis Leadership Award in Robotics and Automation as well as the Center for Transportation Studies Research Partnership Award. I have also received the IEEE

VTS 2001 Best Land Transportation Paper Award for the paper "A Novel Method for Tracking and Counting Pedestrians in Real-Time Using a Single Camera" (with Osama Masoud).

25. As a result of my work and research, I am familiar with the design, operation, and functionality of systems such as those described in the ’056 patent.

26. Further details regarding my employment and academic history are included in my curriculum vitae, attached as Exhibit A.

III. LEVEL OF SKILL IN THE ART AND BASIS FOR OPINIONS

27. Mr. Parulski contends that a POSITA “would have had a bachelor’s degree or equivalent in electrical engineering, computer science, or a related field, in addition to three years in research, design, or development in digital image processing.” Ex. 1003 ¶ 69. He goes on to note that his opinion “is based, for example, on the language and level of detail included in the patent specification and claims. Each claim requires the determination of a specific subject area in an acquired image, the calculation of a specific subject characteristic value, the calculation of a correction value for color balance correction using the specific subject characteristic value, and the execution of color balance correction on the acquired image using the calculated correction value. This was the framework for many well-known prior art techniques for executing color balance correction based on the subject matter in an image, and a POSITA as described above would have

been familiar with these techniques." *Id.* I disagree with Mr. Parulski's suggestion that a POSITA would need three years of relevant research/work experience in addition to the noted degree. I also disagree with Mr. Parulski's insinuation that the '056 patent claims a "framework for many well-known prior art techniques" and that a POSITA would have been familiar with those techniques, as I discuss in this declaration.

28. However, I apply Mr. Parulski's definition of a POSITA for purposes of this declaration, which does not affect my opinion that the Petitioner fails to show that the challenged claims are unpatentable in view of the asserted prior art references. I reserve all rights that I may have to rebut Mr. Parulski's definition of a POSITA, present my own opinions regarding the appropriate level of skill and experience of a POSITA, and address the effect that a POSITA's skill level may have on the patentability of the '056 patent in subsequent proceedings.

29. Based on my experience and record of accomplishments, I am qualified to render opinions regarding the technology claimed and described in the '056 patent. Based on my expertise and qualifications, I am qualified to provide an opinion as to what a POSITA would have understood, known, or concluded as of approximately 2001.

30. In reaching my opinions and conclusions, I have relied upon my education, my work experience in the relevant field, and my training, and considered and relied upon my review and analysis of the Petition and all Exhibits.

IV. RELEVANT LEGAL PRINCIPLES

31. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my analysis and opinions. I have applied these legal principles in rendering my opinions below.

A. Claim Construction

32. I understand that the ordinary and customary meaning of a claim term is the meaning that the term would have to a POSITA at the time of the invention.

33. In the absence of an express intent on the part of the inventor to give a special meaning to the claim terms, the words are presumed to take on the ordinary and customary meanings attributed to them by a POSITA.

34. I understand that it is the use of the words in the context of the written description, and as customarily used by those skilled in the relevant art, that accurately reflects both the ordinary and the customary meaning of the terms in the claims.

35. I understand that the basis for a term's ordinary and customary meaning may be derived from a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and

extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art at the time of the invention.

36. I have been instructed that dictionary definitions or definitions from technical references can be used to inform or confirm the ordinary and customary meaning of words found in a claim, but that in construing claim terms, the general meanings gleaned from reference sources, such as dictionaries, must always be compared against the use of the terms in the context of the claim itself.

37. I understand that a patent applicant is entitled to be his or her own lexicographer (in other words, provide his or her own meaning to a word or phrase) and may rebut the presumption that claim terms are to be given their plain and ordinary meaning. To do so, the applicant must clearly set forth a definition of the term that is different from its ordinary and customary meaning. Where the applicant provides an explicit definition for a term, that definition will control interpretation of the term as it is used in the claim in which it appears. I understand that the specification can also be relied on for more than just explicit lexicography to determine the meaning of a claim term. For example, I understand that the meaning of a particular claim term may also be determined by implication, that is, according to the usage of the term in the context of the specification.

B. Obviousness

38. I understand that under U.S. patent law, 35 U.S.C. § 103, a claim is invalid as obvious if the differences sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

39. I am informed that an obviousness analysis requires an assessment of the scope and content of the prior art, the differences between the art and the claims at issue, and the level of ordinary skill in the art. I am told that it is against this backdrop that obviousness is assessed.

40. I am informed that a POSITA is a hypothetical person who is presumed to be aware of all the pertinent prior art. I am also informed that an obviousness analysis may take account of the inferences and creative steps that a POSITA would employ.

V. THE ’056 PATENT

A. Overview of the ’056 Patent

41. The ’056 patent describes and claims an improved digital image data processing technique: how to render more accurately a subject in an image, including using particular information to determine the subject, to analyze the image data corresponding to the subject, and to perform color balance correction

based on that image data corresponding to the subject. *See, e.g.*, Ex. 1001 at 14:45-15:3, 16:32-56 (claims 1, 10); *see also id.* at 1:38-2:3, 2:29-65, 3:24-34, 5:33-6:9, 8:4-18, 8:53-9:42, 11:42-63, 12:59-13:7.

42. More specifically, the '056 patent describes and claims an improved color balance correction process. Claim 10, for example, recites analyzing a "target area" to determine "a specific subject area." *Id.* at 16:32-56. The specification describes how that technique may include dividing image data into sections (for example, a 16-by-16 grid) and analyzing the data in a particular section or sections (a claimed "target area," or the "target of processing") as part of determining whether the section contains a subject (e.g., a face). *Id.* at 6:47-56. The '056 patent describes analyzing pixel values of the data in the target area, for example, thereby determining the proportion of pixel color values that correspond to a "flesh color." *Id.* at 6:57-7:2.

43. The '056 patent also describes and claims "using . . . a position of said target area" as part of determining the subject area. *Id.* at 16:32-56. The specification describes that process as evaluating where in the image the target area under review resides. *Id.* at 7:10-30. Figures 5 and 6 illustrate an example analysis of image data in a target area to determine areas (labeled "FA," meaning "face area") corresponding to a subject (here, a face):

Fig.5

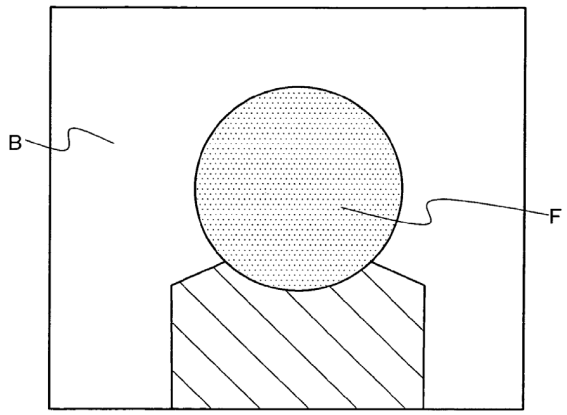
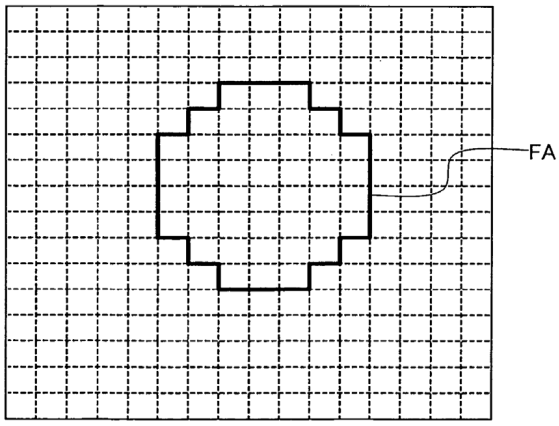


Fig.6



Id. at Figs. 5, 6, 7:3-30, 7:52-56.

44. After determining a "specific subject area," the claimed inventions "calculate[] a specific subject characteristic value," which represents a characteristic of image data corresponding to the determined specific subject area. *Id.* at 16:45-49. The specification provides an example of this calculation: a "flesh color pixel average value." *Id.* at 6:4-9, 8:4-18. In the example, the invention determines "a weighted average value of the pixel value of the flesh color pixel data contained in the face area FA." *Id.* at 8:4-18. The '056 patent describes calculating specific subject characteristic values using a weight factor "determined according to the position of the flesh color pixel data in the face area FA," Figure 7, or, when analyzing a plurality of face areas, "according to the size of each face area," Figure 8:

Fig.7

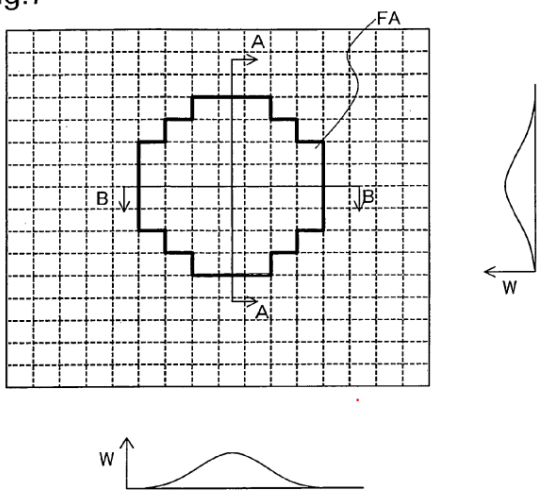
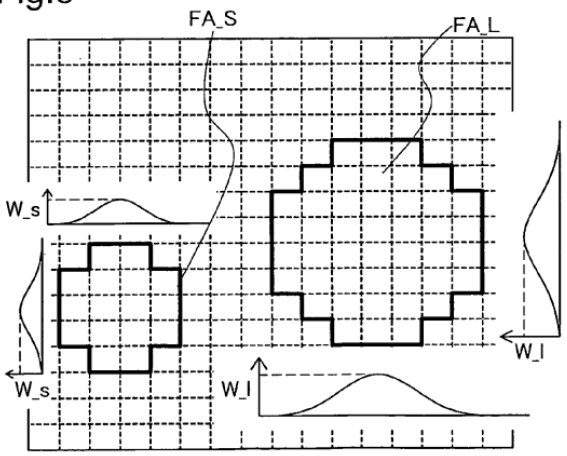


Fig.8



Id. at 8:19-52, Figs. 7, 8.

45. The ’056 patent next “calculates a correction value for color balance correction using said calculated specific subject characteristic value and a preset characteristic target value.” *See, e.g.*, *id.* at 16:50-53. The specification describes a “preset characteristic target value” as, for example, a “flesh color target value,” which represents “a flesh color that is desirable as the flesh color of the human subject.” *Id.* at 9:5-10. The specification describes calculating “flesh color reference correction values” based on differences between the “flesh color target value” and the “flesh color pixel average pixel value” calculated based on the image’s subject—from the determined “face area FA.” *Id.* at 9:5-42. Then the ’056 patent’s technique “executes said color balance correction on said image data using said calculated correction value.” *See, e.g.*, *id.* at 16:54-56, 10:11-16.

46. Claim 1 recites an example of calculating a specific subject characteristic value using a particular weighted distribution:

> 1. An image processing device for executing color balance correction on image data of a photographed image, said image processing device comprising:
>
> [a] an image data acquisition module that acquires said image data;
>
> [b] a specific subject area determination module that determines a specific subject area in said photographed image, wherein said specific subject area contains a specific subject in said photographed image;
>
> [c] a specific subject characteristic value calculation module that calculates a specific subject characteristic value, wherein said specific subject characteristic value represents a characteristic of image data corresponding to said determined specific subject area,
>
> [d] wherein said specific subject characteristic value calculation is executed using weighted distribution, and wherein said weighted distribution is set so as to be a

> weight in a center area of said specific subject area larger than a weight in an area outside said center area;
>
> [e] a correction value calculation module that calculates a correction value for color balance correction using said calculated specific subject characteristic value and a preset characteristic target value; and
>
> [f] a correction execution module that executes said color balance correction on said image data using said calculated correction value.

Id. at 14:63-15:5.

47. Claim 10 recites an example of determining a specific subject area using particular information, i.e., position of the target area:

> 10. An image processing device for executing color balance correction on image data of a photographed image, said image processing device comprising:
>
> [a] an image data acquisition module that acquires said image data[;]
>
> [b] a specific subject area determination module that determines a specific subject area in said photographed

image, wherein said specific subject area contains a specific subject in said photographed image, and

[c] wherein said specific subject area determination module determines said specific subject area using pixel values of pixel data included in a target area for determination, and a position of said target area in said photographed image;

[d] a specific subject characteristic value calculation module that calculates a specific subject characteristic value, wherein said specific subject characteristic value represents a characteristic of image data corresponding to said determined specific subject area;

[e] a correction value calculation module that calculates a correction value for color balance correction using said calculated specific subject characteristic value and a preset characteristic target value; and

[f] a correction execution module that executes said color balance correction on said image data using said calculated correction value.

Id. at 16:32-56.

B. Related District Court Litigation

48. I am aware of a related District Court case involving the same parties, and where the ’056 patent was asserted.

VI. ANALYSIS OF YANO AND SCHRODER (GROUND 1)

A. Overview of Yano

49. Yano “relates to an image processing apparatus which corrects gradation and color reproduction characteristics of an image photographed (or shot) by a digital camera or the like.” Ex. 1005 ¶[0002]. Yano describes a process that “automatically correct[s] image data” and outputs “optimum characteristic[s].” *Id.* ¶[0007].

50. Yano describes an image processing apparatus including an image obtaining processing unit and “a face region extraction processing unit.” *Id.* ¶[0024], Fig. 1. Yano teaches that its “face region extraction” process begins after the face region extraction processing unit extracts the face region. *See id.* ¶¶[0032] (“That is, first, the face region is extracted from the image data. Then . . . .”). Notably, Yano does not describe *how* it identifies and extracts that face region, nor does it describe the use of position information to identify and extract a face region. Rather, at most Yano explains that after extracting a face region, Yano filters and reduces that extracted image data, identifies and extracts “eye candidates” in the extracted region, and, if “the extracted pair of eye candidates

indicates the eyes," "sets a rectangular region" based on the eye candidates. *Id.* ¶¶[0032]-[0034], Figs. 3B, 3C. But even in this "eye candidates" process, Yano does not describe the use of position information. A POSITA would not have found Yano's method informative regarding the claimed specific subject determination.

FIG. 3B

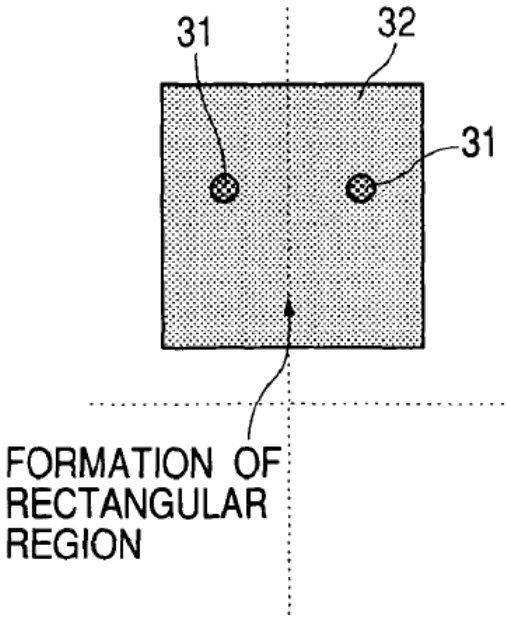
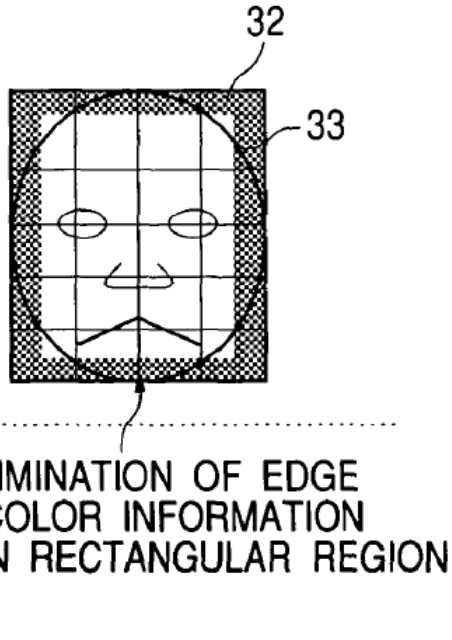


FIG. 3C



51. During the face region extraction process, Yano's "image feature amount calculation unit" calculates an "image feature amount," for example, a "lightness distribution" calculation. *Id.* ¶¶[0025], [0040]. Yano describes performing a calculation per pixel: Yano "calculates histograms, average values and distribution values of the lightness, hue and the like in regard to each pixel of

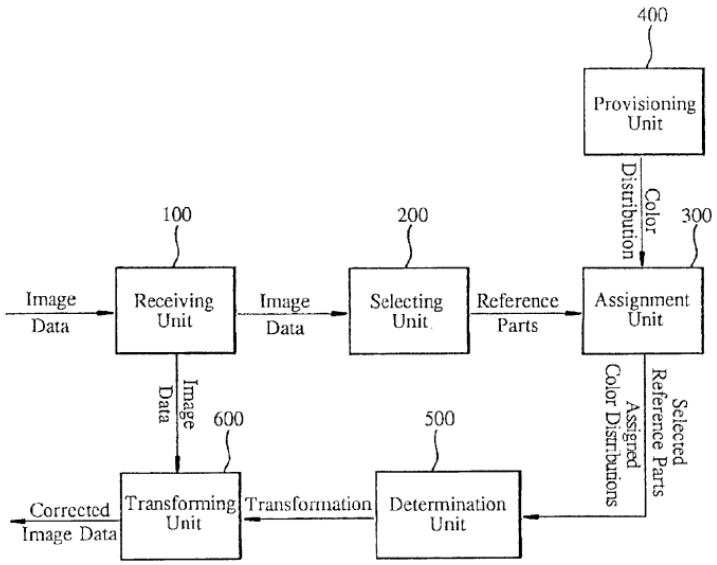
the face region 33, and calculates the total number of pixels included in the face region 33." *Id.* ¶[0040]. Yano does not describe using a weighted distribution as part of calculating "image feature amounts."

B. Overview of Schroder

52. Schroder "relates to the field of correction of colors of photographic images" and "using memory colors as a reference for the correction." Ex. 1006 at 1:8-9, 2:19-21. "Memory colors" or "reference colors" "represent colors characteristic for a significant part of most photographic images." *Id.* at 2:50-54. Schroder describes storing memory color distributions, accessing the information as needed, and/or updating the information based on new statistical inputs (e.g., new images to inform the "memory color"). *Id.* at 2:54-61, 3:40-43.

53. Relevant here, Schroder's color correction method includes receiving image data and selecting "one or more reference parts of the image represented by the image data." *Id.* at 3:44-65. Schroder does not describe how to select "reference parts," other than providing that a user may select parts "by means of a mouse" or via a "user interface," or via an "algorithm" that analyzes color values or patterns "to detect regions related to reference colors." *Id.* at 6:36-60; *see also id.* at Figs. 2, 3. Like Yano, Schroder also does not teach or suggest using position information to identify reference parts.

54. Schroder's process determines a "transformation" for those pixels, "based on the reference colors (memory colors) assigned to the selected parts [reference parts] of the image." *Id.* at 4:12-35. In particular, Schroder discloses assigning a color value to a reference part that includes more than one pixel: "the color value assigned to the relevance part may be a function of the color values of the pixels in the relevance part," for example, the mean or median value, "or the color values in the center of the relevance part may be more weighted than the color values of the pixels in the periphery of the reference part." *Id.* at 10:47-60. Notably, Schroder *does not select reference parts based on image-specific subjects*. Rather, Schroder explains that a "reference part of the image usually represents a spatial section of the image," based on color. *Id.* at 3:55-56. Thus, like Yano, Schroder also does not teach or suggest calculating a "specific subject characteristic value," for image data corresponding to a determined specific subject area, using a weighted distribution.



Id. at Fig. 7. In my opinion, applying a weighted scheme that emphasizes the center of a subject over its edges offers numerous advantages in the context of the '056 patent not discussed in Schroder (using a weighted distribution *to calculate a specific subject characteristic value*). An inventive aspect focuses on salient information typically found in the center, reduces edge effects and sensitivity to partial occlusions, and improves stability in possible specific subject tracking and detection tasks. It aligns with biological vision systems, leading to more natural-seeming results. Center-weighting can enhance computational efficiency by allowing less intensive processing at the edges, improve feature representation for tasks like specific subject recognition, and better handle boundary uncertainties. But Schroder does not discuss specific subjects or these advantages.

C. The teachings of Yano in view of Schroder do not satisfy all elements of any of claims 1, 3-7, and 11 of the '056 patent.

55. In my opinion, Yano in view of Schroder does not render obvious all limitations of any challenged claim.

56. I disagree with Mr. Parulski's opinion that Yano in view of Schroder renders obvious "wherein said specific subject characteristic value calculation is executed using weighted distribution, and wherein said weighted distribution is set so as to be a weight in a center area of said specific subject area larger than a weight in an area outside said center area." Ex. 1003 ¶¶ 109-115. Mr. Parulski concedes that Yano does not disclose calculating a specific subject characteristic value using weighted distribution. And Mr. Parulski fails to show that Schroder does.

57. In my opinion, Schroder does not calculate a specific subject characteristic value of image data corresponding to said determined specific subject area. Instead, Schroder describes selecting "reference parts." Schroder selects "reference parts" throughout an image based on color and spatial patterns—reference parts are merely regions in which "usually at least most of the color values and the part are similar or even equal." Ex. 1006 at 4:1-2; *see also id.* at 3:55-56 ("A reference part of the image usually represents a spatial section of the image."), 6:46-60 (describing algorithm to select reference parts that analyzes

color values and/or spatial distribution "to detect regions related to reference colors"). Mr. Parulski cites no evidence that Schroder's "reference" or "relevance" parts *represent a specific subject area*, as the claim recites.

58. Thus, in my opinion, the Petition fails to show that Yano in view of Schroder renders obvious "wherein said specific subject characteristic value calculation [of image data corresponding to said determined specific subject area] is executed using weighted distribution, and wherein said weighted distribution is set so as to be a weight in a center area of said specific subject area larger than a weight in an area outside said center area."

59. Claims 1 and 11 recite this limitation, and claims 3-7 depend from claim 1 (or from claim 4, which depends from claim 1). Thus, my analysis applies to all of claims 1, 3-7, and 11.

VII. ANALYSIS OF YANO AND SCHRODER AND STEINBERG (GROUND 2)

A. Overview of Steinberg

60. Steinberg "relates to digital image processing, particularly automatic suggesting or processing of enhancements of a digital image using information gained from identifying and analyzing faces appearing within the image." Ex. 1007 at 1:45-48. For example, Steinberg "detects and isolates the faces from the rest of the picture, and determines sizes and locations of the faces relative to other

portions of the image or the entire image." *Id.* at 7:56-58. And "[b]ased on information regarding detected faces, preferably separate modules of the system collect facial data and perform image enhancement operations based on the collected facial data." *Id.* at 7:59-62.

61. Relevant here, Steinberg describes "a method of perfecting the auto focus mechanism of the adjustable optical system as part of an image capture process using face detection." *Id.* at 11:11-50. Steinberg notes that the method may use a "weighted average." *Id.*; *see also id.* at 23:46-61 (describing "applying some weighted average" when using auto focus). Steinberg also describes weighting "groups of pixels" "based on relative size[]" as part of "perfecting the exposure of an acquired digital image" and activating a "built-in flash unit." *Id.* at 11:66-12:19. Steinberg also describes "using face detection to improve output or rendering parameters," and that the process may include assigning faces "a weight based on size of the faces, location within the frame, other parameters described herein, etc., which define the importance of the face in relation to other faces detected." *Id.* at 18:32-63. But Steinberg does not teach or suggest how, if at all, to use detected face "weight" or "importance" in calculating pixel attributes or other values.

62. In my opinion, Steinberg does not teach or suggest calculating a specific subject characteristic value using weighted distribution based on the size of specific subject areas.

B. The teachings of Yano in view of Schroder and Steinberg do not satisfy all elements of any of claims 2, 8, 12-16, and 18 of the '056 patent.

63. In my opinion, Yano in view of Schroder and Steinberg does not render obvious all limitations of any challenged claim.

64. I disagree with Mr. Parulski's opinion that Yano in view of Schroder and Steinberg renders obvious "when a plurality of said specific subject areas are determined, said specific subject characteristic value calculation is executed using weighted distribution, wherein said weighted distribution is set according to a size of each specific subject area on each specific subject characteristic value of said plurality of specific subject areas." Ex. 1003 ¶¶ 153-159. Mr. Parulski concedes that neither Yano nor Schroder teaches this limitation. *Id.* And Mr. Parulski fails to show that Steinberg discloses calculating a specific subject characteristic value using a weighted distribution based on the size of specific subject areas.

65. Mr. Parulski notes that Steinberg describes "a process where each of the faces [in an image] is given a weight based on size of the faces, location within the frame, other parameters described herein, etc., which define the importance of the face in relation to other faces detected." *Id.* ¶ 156 (citing Ex. 1007 at 18:56-63). But Mr. Parulski cites no evidence that suggests that Steinberg teaches using those weights to calculate a specific subject characteristic value or other attribute. Mr. Parulski appears to cite two excerpts from Steinberg's disclosure, neither of which

describes calculating a specific subject characteristic value using weighted distribution based on the size of specific subject areas. Steinberg discloses *no* calculation using its "weight" or "importance" designations.

66. First, Mr. Parulski cites Steinberg at 12:9-19, which describes "a method of perfecting the exposure of an acquired digital image using face detection in the acquired image." Ex. 1007 at 11:67-12:1. Steinberg provides that "[a]n analysis is performed of the corresponding attributes of the groups of pixels" ("image attributes may include exposure"), and Steinberg determines whether and to what extent to activate a built-in flash. *Id.* at 12:4-8. Steinberg states that "[t]he groups of pixels of faces may be given a certain weight based on weight criteria," and "[t]he weight criteria may be calculated based on relative sizes of the groups of pixels." *Id.* at 12:15-19. In my opinion, Steinberg describes at most weighting pixel groups as part of setting exposure or using flash. Mr. Parulski cites no evidence that suggests that Steinberg discloses calculating a specific subject characteristic value for a plurality of specific subject areas using the weight criteria.

67. Second, Mr. Parulski cites Steinberg at 18:56-63, which describes detecting and marking faces in a captured image. *Id.* at 18:56-63. Steinberg explains that detecting "may be more than a binary process of selecting whether a face is detected or not[.] It may also be designed as part of a process where each of the faces is given a weight based on size of the faces," "which define the

importance of the face in relation to other faces detected." *Id.* Steinberg does not describe *using* the weight assignments. Indeed, Steinberg goes on to state that—seemingly regardless of weight assignments—the process compares the face attributes to default values to "determine a potential transformation"; in my opinion, Steinberg describes no relationship between the weight assignments and the attributes. *Id.* at 19:8-12. Mr. Parulski cites no evidence that suggests that Steinberg discloses calculating a specific subject characteristic value for a plurality of specific subject areas using the weight assignments.

68. Thus, in my opinion, the Petition fails to show that Yano in view of Schroder and Steinberg renders obvious "when a plurality of said specific subject areas are determined, said specific subject characteristic value calculation [of image data corresponding to said determined specific subject area] is executed using weighted distribution, wherein said weighted distribution is set according to a size of each specific subject area on each specific subject characteristic value of said plurality of specific subject areas."

69. Claims 8, 12, and 18 recite this limitation (or substantively identical variations of this limitation), and claims 13-16 depend from claim 12 (or from claim 13, which depends from claim 12). Thus, my analysis applies to all of claims 8, 12-16, and 18.

70. Regarding claim 2, as discussed, in my opinion, the Petition fails to show that Yano in view of Schroder renders obvious claim 1, thus the Petition fails to show that Yano in view of Schroder renders obvious claim 2 (depends from claim 1). Mr. Parulski relies on his Ground 1 arguments and adds Steinberg to show that the "specific subject characteristic value calculation is executed by obtaining a weighted average value of each specific subject characteristic value of a plurality of specific subject areas." Ex. 1003 ¶ 186. In my opinion, Petition also fails to show that Steinberg discloses calculating a specific subject characteristic value using a weighted average, as discussed, and for this independent reason, the Petition fails to show that Yano in view of Schroder and Steinberg invalidates claim 2.

VIII. ANALYSIS OF YANO AND KUWATA AND SCHRODER (GROUNDS 3 AND 4)

71. I have not been asked to render opinions regarding Grounds 3 and 4 and the Kuwata reference, because I understand that Patent Owner has disclaimed claims 9 and 17.

IX. ANALYSIS OF YANO AND NAKAMURA AND SCHRODER (GROUNDS 5 AND 6)

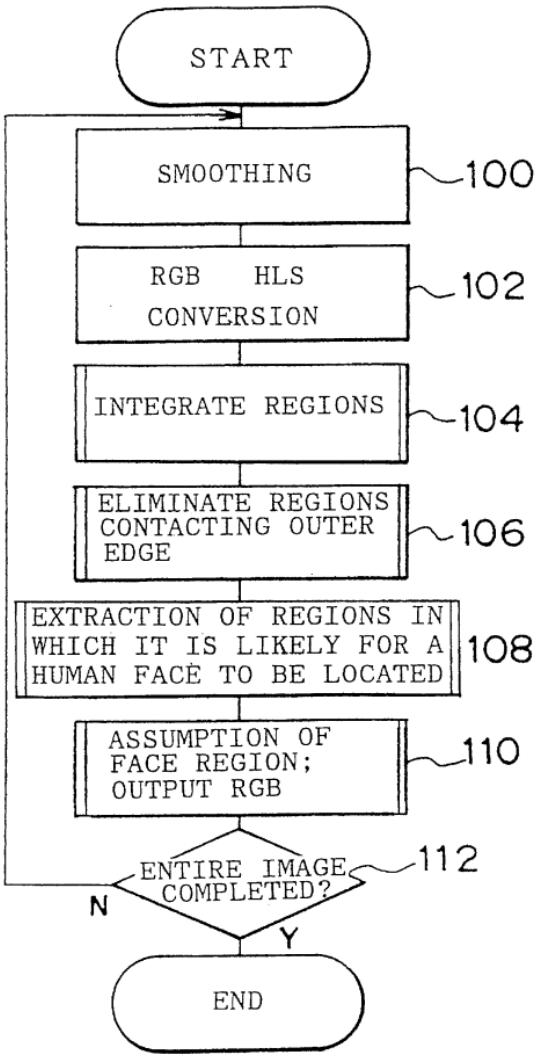
A. Overview of Nakamura

72. Nakamura relates to "a method of extracting characteristic image data, such as density data or the like of a human face, which is used when a color

original image is copied onto a color copy material or a black-and-white copy material." Ex. 1009 at 1:10-15. Nakamura provides that "an object of the present invention is to provide a method of extracting characteristic image data in which only characteristic image data such as human face data is automatically extracted with high accuracy from a color original image such as a negative film." *Id.* at 3:27-31. Nakamura describes a rudimentary process that includes "dividing a color original image into a plurality of pixels" and "breaking down" the pixels into their RGB values, dividing the image "into color regions having the same or similar hue values," and "selecting at least one color region, which is a divided color region and which is a color region other than color regions which contact an outer edge of the color original image, and extracting data of the selected divided region as characteristic image data." *Id.* at 3:41-52. Thus, Nakamura discloses extracting "characteristic image data." *Id.* at 3:61-4:12.

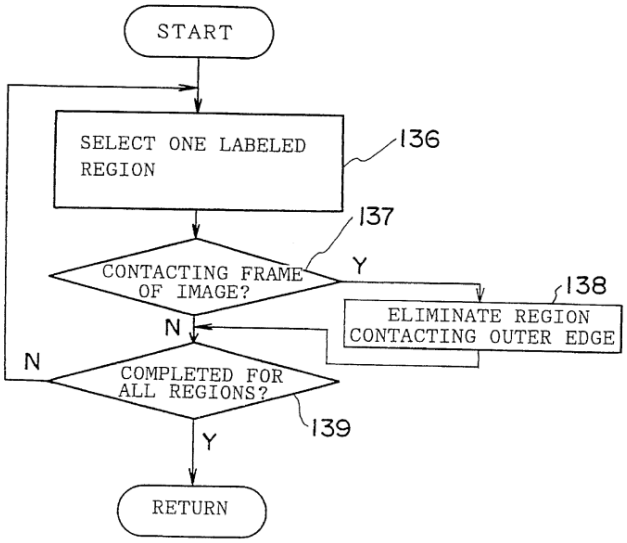
73. Nakamura does not describe determining a specific subject area using a position of a target area for that subject for determination. Rather, Nakamura's process *eliminates* regions and evaluates all remaining areas. Nakamura describes (1) removing "regions contacting the outer edge of the original image" (step 106), (2) extracting the remaining regions, "in which it is likely that a human face will be located" (step 108), and (3) *assuming* a face region (step 110):

FIG. 2



Id. at Fig. 2, 9:1-15. Figure 6 provides additional detail regarding Nakamura's "eliminate regions" step, disclosing that Nakamura processes "all of the regions," creating a "high probability that a characteristic image, e.g., a region including a face, remains." *Id.* at 10:64-11:19.

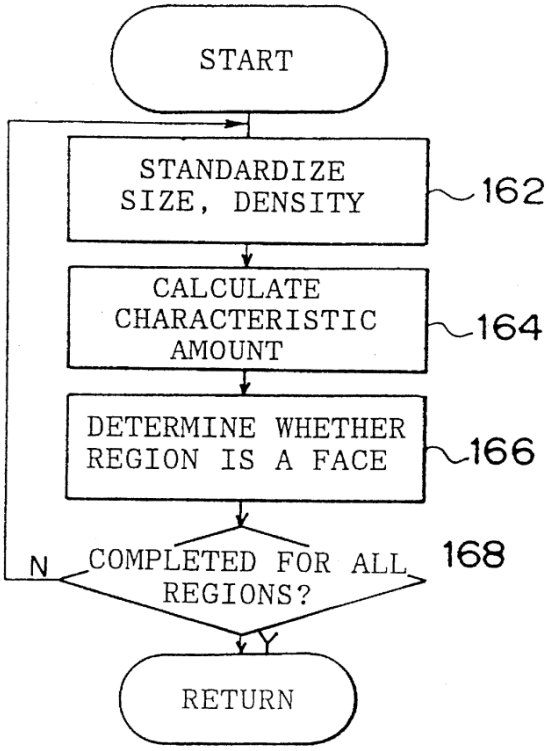
FIG. 6



Id. at Fig. 6.

74. Nakamura's process continues to eliminate regions, including, for example, "extremely small regions." *Id.* at 11:20-43, Fig. 7. Then Nakamura's process selects a region "as a region of notice." *Id.* at 11:44-46, Fig. 8. Nakamura does not describe how to select that region. Indeed, Nakamura selects the region and *then* determines whether it contains a human face. Nakamura repeats this process for all remaining image regions. *Id.* at 11:44-12:44.

FIG. 8



Id. at Fig. 8.

B. The teachings of Yano in view of Nakamura or Yano in view of Schroder and Nakamura do not satisfy all elements of claim 10 of the '056 patent.

75. In my opinion, Yano in view of Nakamura or Yano in view of Schroder and Nakamura does not render obvious all limitations of any challenged claim.

76. I disagree with Mr. Parulski's opinion that Yano in view of Nakamura or Yano in view of Schroder and Nakamura renders obvious "wherein said specific subject area determination module determines said specific subject area using pixel

values of pixel data included in a target area for determination, and a position of said target area in said photographed image." Ex. 1003 ¶¶ 209-214. Mr. Parulski concedes that Yano does not disclose determining a specific subject area using "a position of said target area in said photographed image." *Id.* Instead, Mr. Parulski relies on Nakamura. But in my opinion, Nakamura does not disclose determining a specific subject area using "a position of said target area in said photographed image." It should be noted that Mr. Parulski argues only that a POSITA would have found it obvious to implement Nakamura's "exclusion of potential face regions that contact the outer edge of the image." *Id.* ¶ 212. Moreover, Mr. Parulski all but confirms Nakamura's disclosures providing that Nakamura does *not* determine a specific subject area using position information for that target area for determination. In my opinion, Nakamura discloses the inverse: removing areas based on edge information and analyzing the remaining regions.

77. Nakamura describes analyzing pixel data, creating "color regions," and eliminating regions if the region contacts the image's outer edge. Ex. 1009 at 3:39-4:12. The Petition cannot reconcile its arguments with Nakamura's disclosure. Nakamura does not determine a specific subject area, much less determine a specific subject area using position information for said target area for determination—rather, after eliminating "edge" regions, Nakamura assumes that a "region of notice" appears "in a vicinity of the center of a color original image"

and selects, at random, a color region not for its location or its content but because it does not contact an outer edge. *Id.* Nothing in Nakamura considers a position of a target area for determination of a specific subject area in the image.

78. Thus, in my opinion, the Petition fails to show that Yano in view of Nakamura discloses "wherein said specific subject area determination module determines said specific subject area using pixel values of pixel data included in a target area for determination, and a position of said target area in said photographed image."

X. ADDITIONAL REMARKS

79. I reserve any right that I may have to supplement this declaration if further information becomes available or if I am asked to consider additional information or to submit an additional declaration if *inter partes* review is instituted. Furthermore, I reserve any right that I may have to consider and comment on any additional expert statements and testimony of Petitioner's expert in this matter.

80. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare 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 Section 1001 of Title 18 of the United States Code and that such

willful false statements may jeopardize the validity of the application or any patents issued thereon.



Dated: October 15, 2024

Nikolaos Papanikolopoulos, Ph.D.

Exhibit A

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Education

- Carnegie Mellon University, Pittsburgh, Pennsylvania
  Doctor of Philosophy in Electrical and Computer Engineering, August 1992.
  GPA: 4.0 / 4.0.

  Thesis: "Controlled Active Vision" under the supervision of Professor Pradeep K. Khosla.

- Carnegie Mellon University, Pittsburgh, Pennsylvania
  Master of Science in Electrical and Computer Engineering, December 1988.
  GPA: 4.0 / 4.0.

  Project: "FORS: Flexible Organizations" under the supervision of Professor Sarosh Talukdar.

- National Technical University of Athens, Athens, Greece
  Diploma of Engineering in Electrical and Computer Engineering, July 1987.
  GPA: 8.75 / 10.0.

  Project: "Use of Fuzzy Logic in the Selection of Gains of the PID Controller" under the supervision of Professor Spyros Tzafestas.

Professional Experience

- Director Minnesota Robotics Institute: University of Minnesota, Minneapolis, Minnesota.
  July 2019 - present.

- Professor: University of Minnesota, Minneapolis, Minnesota.
  Fall 2001 - present.

- Associate Professor: University of Minnesota, Minneapolis, Minnesota.
  Fall 1996 - 2001.

- Assistant Professor: University of Minnesota, Minneapolis, Minnesota.
  Fall 1992 - 1996.

Research Experience

- University of Minnesota, September 1992 - Present

  Computer Vision
  Image Processing
  Machine Learning
  Robotics
  Intelligent Transportation Systems
  Medical Robotics
  Sensor Networks
  Robotic Visual Tracking and Servoing
  Sensor-Based Control in Transportation Systems
  Active Vision
  Computer Engineering
  Signature Recognition and Identification

- Carnegie Mellon University, August 1987 - August 1992

  Robotics, Computer Vision, and Control
  Computer Integrated Manufacturing
  Tool Integration
  Software Engineering

- National Technical University of Athens, September 1986 - July 1987

  Fuzzy and Intelligent Control

Industrial Experience

- Consultant: University of Cyprus, Nicosia Cyprus.
  Helped in the creation of the Department of Electrical and Computer Engineering, 2001 - 2005.

- Consultant: Banner Engineering, Carnegie Robotics, Sentera, KYOS, Tennant, ISS, Best Buy, Moai Technologies, MOVE eye, VideoNEXT Inc., DATACARD Inc., etc., Minneapolis, MN.
  Developed computer vision algorithms for vehicle tracking, camera calibration, precision agriculture, human tracking, object recognition, and fingerprint recognition, 1997 - Present.

- Consultant: IMS ExpertServices, ABB, Toyota, Canon, Intel, Tetra Tech, iRobot, Kenyon and Kenyon, Orrick, Perkins Coie LLP, Fish & Richardson, Finnegan, Henderson, Farabow, Garrett & Dunner LLP, Oblon, McClelland, Maier & Neustadt, LLP, Phillips Nizer LLP, Andrews Kurth Kenyon LLP, and Bartlit Beck Herman Palenchar & Scott LLP, Minneapolis, MN.
  Provided technical expertise in litigation that involves surveillance systems, robotics, computer vision, vehicle monitoring systems, human activity monitoring, and motion control devices, 2012 - Present.

- Consultant: Architecture Technology Corporation, Eden Prairie, MN.
  Developed algorithms and software for multi-robot teams, 2003 - 2005.

- Founder: ReconRobotics Inc., Edina, MN.
  Developed different robotic platforms, 2005-Present.

- Software Engineer: Piraeus Service Bureau, Piraeus, Greece.

Developed software for inventory control, accounting, and factory automation. August 1983 - July 1987.

Teaching Experience

- Professor: University of Minnesota,
  Minneapolis, Minnesota.
  Taught several undergraduate and graduate courses, Fall 2001 - Present.

- Director of Undergraduate Studies: University of Minnesota,
  Minneapolis, Minnesota.
  Supervised the CSE Undergraduate Program, Fall 2001 – Spring 2004.

- Associate Professor: University of Minnesota, Minneapolis, Minnesota.
  Taught several undergraduate and graduate courses, Fall 1996 - 2001.

- Assistant Professor: University of Minnesota, Minneapolis, Minnesota.
  Taught several undergraduate and graduate courses, Fall 1992 - 1996.

- Teaching Assistant: Carnegie Mellon University, Pittsburgh, Pennsylvania.
  Assisted in the teaching of the graduate course “Robotic Systems”, Spring 1989.

Publications

Journal Papers (Significant papers are in bold)

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5. Mallery, K., Canelon, D., Hong, J., and Papanikolopoulos, N.P., “Design and Experiments with a Robot-Driven Underwater Holographic Microscope for Low-Cost In Situ Particle Measurements”, *Journal of Intelligent and Robotic Systems*, Volume 102, No. 2, 2021.

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10. Zermas, D., Nelson, H., Stanitsas, P., Morellas, V., Mulla, D., and Papanikolopoulos, N.P., "A Methodology for the Detection of Nitrogen Deficiency in Corn Fields Using High-Resolution RGB Imagery*", IEEE Transactions on Automation Science and Engineering*, October 2020.

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13. Beksi, W., and Papanikolopoulos, N.P., "A Topology-based Descriptor for 3D Point Cloud Modeling: Theory and Experiments", *Image and Vision Computing*, Volume 88, August 2019, pp 84-95.

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Selected Recent Grants

- "Kidney Cancer Radiomics Data Collection and Processing", Johnson & Johnson, December 19, 2022 – April 30, 2024.
- "NRI: INT: COLLAB: Cooperative Robotic Systems for Precision Agriculture and Plant Health Management" (with Co-PIs D. Mulla, D. Kaiser, and C. Yang), USDA-NIFA, May 1, 2020 – April 30, 2025.
- "Phase II IUCRC University of Minnesota: Center for Robots and Sensors for the Human Well-being" (Co-PI, PI: V. Morellas), NSF, March 15, 2020 – February 28, 2025.
- "MRI: Development of Real-time 3D Social Signal Imaging System (SSIS)" (Co-PI, PI: H.S. Park), NSF, October 1, 2019 – September 30, 2024.
- "Using Non-Expert Crowds to Quickly and Efficiently Collect High-Quality Segmentations of Renal Anatomy and Tumors in Cross-Sectional Imaging", Intuitive Foundation, January 1, 2021 – December 31, 2021.

- "MRI: Development of an Instrument that Performs Behavioral Analysis for Neuropsychiatric Disorders like Tourette Syndrome" (with Co-PIs V. Interrante, D. Keefe, G. Bernstein, C. Conelea, and S. Guy), NSF, October 1, 2019 – September 30, 2025.
- "CPS: TTP Option: Synergy: Collaborative Research: Dynamic Methods of Traffic Control that Impact Quality of Life in Smart Cities" (with Co-PIs J. Hourdos, M. Jovanovic, and S. Guy), NSF, September 15, 2015 – February 28, 2021.
- "Autonomous Mobile Pavement Density Profiling Robot to Reduce Worker Risk", Mn\DOT, March 14, 2019 – June 30, 2021.
- "SCH: Active Learning for Medical Applications" (with Co-PIs R. Kuang, S. Truskinovsky, and C. Weight), NIH/NCI, February 1, 2018 – January 31, 2022.
- "Maintenance for the Truck Parking Availability System of the State of Kansas," KDOT, January 1, 2019 – December 31, 2023.
- "Cloud Computing for Kansas Truck Parking Detection and Information System and Verification Tool Development", KDOT, July 1, 2019 – October 31, 2021.
- "A Real-Time Truck Parking Availability System for the State of Wisconsin", MnDOT, June 30, 2016 – December 31, 2019.
- "A Real-time Truck Parking Availability System for the State of Kansas", KDOT, October 1, 2016 – August 31, 2021.
- "MRI: Development of a Solar UAV Instrument" (with Co-PIs M. Hondzo, F. Sotiropoulos, and J. Hong), NSF, October 1, 2015 – March 31, 2022.
- "NRI: Collaborative Research: Robotics 2.0 for Disaster Response and Relief Operations" (with Co-PIs M. Hondzo, and J. Hong), NSF, August 15, 2014 – July 31, 2019.
- "I/UCRC FRP: Collaborative Research: Autonomous Perception and Manipulation in Search and Rescue", NSF, August 15, 2014 – July 31, 2016.
- "MRI: Development of an Instrument that Monitors Behaviors Associated with Obsessive-Compulsive Behaviors and Schizophrenia" (with Co-PIs K. Lim and G. Bernstein), NSF, October 1, 2013 – September 30, 2021.
- "A Comprehensive System for Assessing Truck Parking Availability", FHWA and Mn\DOT, January 11, 2012 – November 30, 2016.
- "I/UCRC FRP: Collaborative Research: A Software Framework for Controlling Multi-Robot Teams", NSF, August 1, 2013 – July 31, 2017.
- "MRI: Development of a Video-Based Robotic Instrument for Behavioral Analysis and Diagnosis of At-Risk Children" (with Co-PIs K. Lim and G. Sapiro), NSF, October 1, 2010 – September 30, 2019.
- "Sensing for HOV/HOT Lanes Enforcement", Mn\DOT, March 11, 2014 – August 30, 2016.
- "CDI-Type II: Computational Tools for Behavioral Analysis, Diagnosis, and Intervention of at Risk Children" (with Co-PIs K. Lim, G. Sapiro, and A. Banerjee), NSF, September 15, 2010 – August 31, 2016.
- "Center for Safety, Security, and Rescue Robotics" (with M. Gini, T. Hadjiyanni, and S. Roumeliotis), NSF, August 15, 2003 – July 31, 2016.
- I/UCRC Membership, Honeywell Labs, December 1, 2010 – December 30, 2014.
- I/UCRC Membership, Minnesota Corn Growers, December 1, 2013 – December 30, 2015.

Patents

- "Miniature Robotic Vehicles and Methods for Controlling Same" Patent #6,548,982 with Richard Voyles, Bradley Nelson, Paul Rybski, and Donald Krantz.
- "Adjustable Diameter Wheel Assembly, and Methods and Vehicles Using Same" Patent #6,860,346 with Ian Burt.
- "Ruggedized Robotic Vehicles" Patent #7,559,385 with Ian Burt.
- "Crowd Counting and Monitoring" Patent #8,116,564 with Prahlad Kilambi and Osama Masoud.
- "Robotic Vehicle System" Patent #8,260,459 with Sam Herbert.

- **“**Miniature Robotic Vehicle with Ground And Flight Capability**”** Patent #8,342,440 with Alex Kossett**.**
- “Determining Parking Space Occupancy Using a 3D Representation” Patent #9,858,816 with Douglas Cook, Vassilios Morellas, and Theodore Morris.
- ‘‘Automated Detection of Nitrogen Deficiency in Crop” Patent #10,599,926 with Vassilios Morellas, Dimitris Zermas, David Mulla, Michael Bazakos, and Daniel Kaiser.
- “Computer Vision for Cancerous Tissue” Patent #11,449,985 with Panagiotis Stanitsas, Anoop Cherian, Vassilios Morellas, and Alexander Truskinovsky.

Courses

- “Introduction to Intelligent Robotic Systems”, CS-5551, Fall 2022, evaluation: 4.1/5, registration: 79 students.
- “Introduction to Intelligent Robotic Systems”, CS-5551, Fall 2021, evaluation: 4.0/5, registration: 66 students.
- “Introduction to Intelligent Robotic Systems”, CS-5551, Fall 2020, evaluation: 4.1/5, registration: 47 students.
- “Artificial Intelligence I”, CS-5511, Fall 2019, evaluation: 4.6/5, registration: 56 students.
- “Readings in Computational Vision”, CS-8980, Spring 2019, evaluation: 4.8/5, registration: 28 students.
- “Artificial Intelligence I”, CS-5511, Fall 2018, evaluation: 4.8/5, registration: 67 students.
- “Computer Vision”, CS-5561, Spring 2018, evaluation: 4.5/5, registration: 54 students.
- “Artificial Intelligence I”, CS-5511, Fall 2017, evaluation: 4.7/5, registration: 70 students.
- “Readings in Computational Vision”, CS-8980, Spring 2017, evaluation: 4.9/5, registration: 13 students.
- “Algorithms and Data Structures”, CS-4041, Fall 2016, evaluation: 4.8/5, registration: 77 students.
- “Computer Vision”, CS-5561, Spring 2016, evaluation: 4.4/5, registration: 46 students.
- “Introduction to Intelligent Robotic Systems”, CS-5551, Fall 2015, evaluation: 4.2/5, registration: 38 students.
- “Algorithms and Data Structures”, CS-4041H, Fall 2014, evaluation: 4.7/5, registration: 13 students.
- “Readings in Computational Vision”, CS-8980, Spring 2014, evaluation: 4.8/5, registration: 12 students.
- “Artificial Intelligence I”, CS-5511, Fall 2013, evaluation: 4.3/5, registration: 33 students.
- “Computer Vision”, CS-5561, Spring 2013, evaluation: 4.0/5, registration: 32 students.
- “Artificial Intelligence I”, CS-5511, Fall 2012, evaluation: 4.2/5, registration: 47 students.
- “Computer Vision”, CS-5561, Spring 2012, evaluation: 4.6/5, registration: 24 students.
- “Artificial Intelligence I”, CS-5511, Fall 2011, evaluation: 4.4/5, registration: 53 students.
- “Readings in Computational Vision”, CS-8980, Spring 2011, evaluation: 4.6/5, registration: 20 students.
- “Artificial Intelligence I”, CS-5511, Fall 2010, evaluation: 4.4/5, registration: 55 students.
- “Computer Vision”, CS-5561, Spring 2010, evaluation: 4.6/5, registration: 25 students.
- “Artificial Intelligence I”, CS-5511, Fall 2009, evaluation: 4.6/5, registration: 26 students.
- “Readings in Computational Vision”, CS-8980, Spring 2009, evaluation: 4.6/5, registration: 24 students.
- “Introduction to Intelligent Robotic Systems”, CS-5551, Fall 2008, evaluation: 4.6/5, registration: 33 students.
- “Computer Vision”, CS-5561, Spring 2008, evaluation: 4.5/5, registration: 23 students.
- “Readings in Computational Vision and Robotics”, CS-8980, Spring 2007, evaluation: 4.2/5, registration: 26 students.
- “Artificial Intelligence I”, CS-5511, Fall 2006, evaluation: 3.7/5, registration: 60 students.
- “Computer Vision”, CS-5561, Spring 2006, evaluation: 3.5/5, registration: 50 students.
- “Artificial Intelligence I”, CS-5511, Fall 2005, evaluation: 3.1/5, registration: 60 students.
- “Readings in Computational Vision”, CS-8980, Spring 2005, evaluation: 4.0/5, registration: 22 students.
- “Computer Vision”, CS-5561, Spring 2004, evaluation: 3.2/5, registration: 28 students.
- “Artificial Intelligence I”, CS-5511, Fall 2003, evaluation: 3.8/5, registration: 69 students.
- “Readings in Computational Vision”, CS-8980, Spring 2003, evaluation: 4.4/5, registration: 19 students.

- "Introduction to Intelligent Robotic Systems", CS-5551, Fall 2002, evaluation: 4.1/5, registration: 32 students.
- "Computer Vision", CS-5561, Spring 2002, evaluation: 4.5/5, registration: 31 students.
- "Artificial Intelligence I", CS-5511, Fall 2001, evaluation: 4.1/5, registration: 68 students.
- "Computer Vision", CS-5561, Spring 2001, evaluation: 4.2/5, registration: 40 students.
- "Senior Design Project", ECE-4951, Spring 2001, registration: 5 students.
- "Algorithms and Data Structures", CS-4041, Spring 2001, evaluation: 3.5/5, registration: 137 students.
- "Computer Vision", CS-5561, Spring 2000, evaluation: 4.2/5, registration: 34 students.
- "Intelligent Agents", CS-8551, Fall 1999, evaluation: 4.5/5, registration: 32 students.
- "Algorithms and Data Structures II", CS-3322, Spring 1999, evaluation: 4.3/5, registration: 151 students.
- "Computer Vision", CS-5561, Fall 1998, evaluation: 3.3/5, registration: 25 students.
- "Algorithms and Data Structures II", CS-3322, Spring 1998, evaluation: 4.0/5, registration: 121 students.
- "Readings in Computational Vision", CS-8561, Winter 1998, evaluation: 3.9/5, registration: 12 students.
- "Computer Vision", CS-5561, Fall 1997, evaluation: 3.9/5, registration: 34 students.
- "Introduction to Intelligent Robotic Systems", CS-5551, Spring 1997, evaluation: 4.4/5, registration: 22 students.
- "Algorithms and Data Structures II", CS-3322, Winter 1997, evaluation: 4.1/5, registration: 55 students.
- "Algorithms and Data Structures II", CS-3322, Spring 1996, evaluation: 3.9/5, registration: 95 students.
- "Readings in Computational Vision", CS-8561, Winter 1996, evaluation: 4.8/5, registration: 12 students.
- "Computer Vision", CS-5561, Fall 1995, evaluation: 4.1/5, registration: 15 students.
- "Algorithms and Data Structures II", CS-3322, Spring 1995, evaluation: 3.9/5, registration: 77 students.
- "Computer Vision", CS-5561, Winter 1995, evaluation: 4.1/5, registration: 22 students.
- "Introduction to Intelligent Robotic Systems", CS-5551, Fall 1994, evaluation 3.9/5, registration: 24 students.
- "Algorithms and Data Structures II", CS-3322, Spring 1994, evaluation: 4.0/5, registration: 62 students.
- "Readings in Computational Vision", CS-8561, Winter 1994, evaluation: 4.3/5, registration: 14 students.
- "Computer Vision", CS-5561, Fall 1993, evaluation: 4.5/5, registration: 34 students.
- "Problems in Artificial Intelligence", CS-5599, Spring 1993, evaluation: 4.4/5, registration: 20 students.
- "Algorithms and Data Structures II", CS-3322, Winter 1993, evaluation: 4.2/5, registration: 71 students.
- "Computer Vision", CS-5561, Fall 1992, evaluation: 4.3/5, registration: 13 students.

Courses Introduced

- "Introduction to Intelligent Robotic Systems", CS-5551.
- "Program Design and Development", CS-3081W.

Students

- Patrick Lau, Ph.D. student (graduated, Thesis title: "A Maximum Variance Approach to Basis Selection for Image Transformation," National University of Singapore).

- Christopher Smith, Ph.D. student (graduated, recipient of the Graduate School Doctoral Dissertation Fellowship, Thesis title: “Visually Guided Manipulation of Static and Moving Objects,” Associate Professor, Lake Superior State University).
- Ioannis Pavlidis, Ph.D. student (graduated, Thesis title: “Physics-Based Methodologies for Recognizing Handwritten Signatures, Words, and Line Drawings,” Full Professor, University of Houston).
- Rahul Singh, Ph.D. student (graduated, Thesis title: “Shape Recognition by Shape Morphing and its Applications in Vision-Based Robotics,” Professor, San Francisco State University).
- Osama Masoud, Ph.D. student (graduated, Thesis title: “Tracking and Analysis of Articulated Motion with an Application to Human Motion,” Director of Research, Vital Images Inc.).
- Doug Perrin, Ph.D. student (graduated, Thesis title: “Vision-Based Tasks and Dynamic Contours,” Assistant Professor, Harvard Medical School).
- Sascha Stoeter, Ph.D. student (graduated, Thesis title: “Vision-based Control of Miniature Jumping Scout Robots,” Research Scientist, Hitachi ABB, Switzerland).
- Robert Bodor, Ph.D. student (graduated, Thesis title: “Multi-camera Human Activity Recognition in Unconstrained Indoor and Outdoor Environments,” CEO, ProtoLabs Inc.).
- Harini Veeraraghavan, Ph.D. student (graduated, Thesis title: Learning to Extract Interesting Events from Outdoor Image Sequences,” Research Scientist, Memorial Sloan Kettering Cancer Center).
- Monica Anderson, Ph.D. student (graduated, Thesis title: “Efficient Cooperative Multi-robot Team Search in Complex Indoor Environments,” Associate Professor, University of Alabama).
- Esra Kadioglu-Urtis, Ph.D. student (graduated, Thesis title: “Multi-Angle Pursuit of a Moving Target Using Mobile Robots,” Assistant Professor, Macalester College).
- Andrew Drenner, Ph.D. student (graduated, Thesis title: “A Framework for Distributed Mobile Robotics,” ReconRobotics Inc.).
- Evan Ribnick, Ph.D. student (graduated, Thesis title: “Inferring the 3D Structure of Periodic Motion in Video,” Reveal Technology).
- Nathaniel Bird, Ph.D. student (graduated, Thesis title: “Calibration and Component Placement in Structured Light Systems for 3D Reconstruction Tasks,” Staff Research Engineer, Abbott).
- Ajay Joshi, Ph.D. student (graduated, Thesis title: “Image Classification with Minimal Supervision”, Google Inc.).
- Amer Agovic, Ph.D. student (graduated, Thesis title: “Interface Issues in Robot Scrub Nurse Design”, Upperbound Technologies Inc.).
- Brett Hemes, Ph.D. student (graduated, Thesis title: “Locomotion of Serial Multiply-Actuated Tumbling Robots”, 3M).
- Stefan Atev, Ph.D. student (graduated, Thesis title: “Using Assymetry in the Spectral Clustering of Trajectories”, ProtoLabs Inc.).
- Hyeun J. Min, Ph.D. student (graduated, Thesis title: “Multi-Robot Formations and Cooperation with Visual Tracking Techniques”, Assistant Professor, Ajou University, Korea).
- Guruprasad Somasundaram, Ph.D. student (graduated, Thesis title: “Global Self Similarity and Saliency Measures Based on Sparse Representations for Classification of Objects and Spatio-temporal Sequences”, Meta).
- Anoop Cherian, Ph.D. student (graduated, Thesis title: “Similarity Search in Visual Data”, Mitsubishi Electric Research Laboratories).
- Duc Fehr, Ph.D. student (graduated, “Covariance Based Point Cloud Descriptors for Object Detection and Classification”, The Goodyear Tire & Rubber Company).
- Michael Janssen, Ph.D. student (graduated, “Robot Games: Translating Game Interaction to Robotic Interface”, Google).
- Ravishankar Sivalingam, Ph.D. student (graduated, “Sparse Models for Positive Definite Matrices”, Qualcomm).
- Jon Andersh, Ph.D. student (graduated, “Modeling the Human Visuo-Motor System for Remote-Control Operation”).
- Nicholas Walczak, Ph.D. student (graduated, “A Multi-Sensor RGB-D System for Preschool Classroom Behavior Analysis”, BBN).
- Joshua Fasching, Ph.D. student (graduated, “Behavior Monitoring Using Visual Data and Immersive Environments”, BBN).
- Panos Stanitsas, Ph.D. student (graduated, “Machine Learning Methods with Emphasis on Cancerous Tissue Recognition”, Insitro Inc.).

- Demetris Zermas, Ph.D. student (graduated, “Combining Machine Learning with Computer Vision for Precision Agriculture Applications, Sentera).
- William Beksi, Ph.D. student (graduated, “Topological Methods for 3D Cloud Processing”, Assistant Professor, University of Texas Arlington).
- Ruben D’Sa, Ph.D. student (graduated, “Design of a Transformable Unmanned Aerial Vehicle”, Talos Robotics).
- Nick Heller, Ph.D. student (WPE passed and proposal completed).
- Dario Canelon-Suarez, Ph.D. student (WPE passed and proposal competed).
- Athanasios Bacharis, Ph.D. student (WPE passed).
- Henry Nelson, Ph.D. student (WPE passed).
- Robert Martin, Ph.D. student (WPE passed).
- Rahul Singh, M.S. student (graduated).
- Marty Kenner, M.S. student (graduated).
- Yue Du, M.S. student (graduated).
- Mike Sullivan, M.S. student (graduated).
- Ioannis Pavlidis, M.S. student (graduated).
- Scott Brandt, M.S. student (graduated).
- Richard Nelson, M.S. student (graduated).
- Charles Richards, M.S. student (graduated).
- Jianzhong Xu, M.S. student (graduated).
- Alex Ozerkovsky, M.S. student (graduated).
- Igor Chechelnitsky, M.S. student (graduated).
- Martin Eriksson, M.S. student (graduated).
- Robert Sfarzo, M.S. student (graduated).
- Doug Perrin, M.S. student (graduated).
- Singh Kaur Sarbjit, M.S. student (graduated).
- Rotherick Tan, M.S.student (graduated).
- Thai Nguyen, M.S. student (graduated).
- Scott Rogers, M.S. student (graduated).
- Surendra Gupte, M.S. student (graduated).
- Brian Chapeau, M.S. student (graduated).
- Janice Pearce, M.S. student (graduated).
- Justin Thomas, M.S. student (graduated).
- Eric Wahlstrom, M.S. student (graduated).
- Bradley Kratochvil, M.S. student (graduated).
- Robert Martin, M.S. student (graduated).
- Harini Veeraraghavan, M.S. student (graduated).
- Andreas Robinson, M.S. student (graduated).
- Chuck Hays, M.S. student (graduated).
- Wiiliam Toczyski, M.S. student (graduated).
- Ian Burt, M.S. student (graduated).
- Nathaniel Bird, M.S. student (graduated).
- Prahlad Kilambi, M.S. student (graduated).
- Thanh Nguyen, M.S. student (graduated).
- Stefan Atev, M.S. student (graduated).
- Sushanth Rajasankar, M.S. student (graduated).
- Evan Ribnick, M.S. student (graduated).
- Jason Sollom, M.S. student (graduated).
- Ajay Joshi, M.S. student (graduated).
- Guruprasad Somasundaram, M.S. student (graduated).
- Pushkar Modi, M.S. student (graduated).
- Max Walter, M.S. student (graduated).
- Ravishankar Sivalingam, M.S. student (graduated).
- Alex Ivkin, M.S. student (graduated).
- Anoop Cherian, M.S. student (graduated).
- Vineet Bhatawadekar, M.S. student (graduated).
- Justin Dancs, M.S. student (graduated).

- Apostolos Kottas, M.S student (graduated).
- Andrew Carlson, M.S. student (graduated).
- Kuo-Shih Tseng, M.S. student (graduated).
- Nicholas Walczak, M.S. student (graduated).
- Joshua Fasching, M.S. student (graduated).
- Alex Kossett, M.S student (graduated).
- Alexander Popov, M.S student (graduated).
- Eric Holec, M.S student (graduated).
- Sydney Bergeron, M.S. student (graduated).
- Paul Hed, M.S. student (graduated).
- Ruben D'Sa, M.S. student (graduated).
- Karthik Buddha, M.S. student (graduated).
- Travis Henderson, M.S. student (graduated).
- Jamsrandorj Dagvadorj, M.S. student (graduated).
- Luis Guzman, M.S. student (graduated).
- Matthew Tlachac, M.S. student (graduated).
- Zixing Wang, M.S. student (graduated).
- Zane Smith, M.S. student (graduated).
- Athanasios Bacharis, M.S. student (graduated).
- Haoyi Shi, M.S. student.
- Haoyuan Du, M.S. student.
- Nikhilanj Venkata Pelluri, M.S. student.
- Scott Morton, M.S. student.
- P. Lee, L. Fiore, J. Purvey, A. Kossett, S. Kristoff, E. Holec, A. Carlson, F. Bazakos, A. Hambrock, A. Kottas, C. McMillen, C. Carlson, R. Cyrus, M. Belsky, Z. Johnson, K. Stubbs, I. Burt, G. Miller, E. Mueller, D. Goerke, M. Eriksson, S. Morton, R. D'sa, B. Neubauer, R. Redmond, W. Krepps, D. Tormoen, B. Bosch, A. Erickson, B. Gundrum, L. Scharber, I. Poteryakhin, Z. Stromquist, P. Wyman, D. Jenson, J. Spruth, T. Henderson, A. Young, N. Studanski, J. Killian, B. Schulz, M. Mikkelsen, M. Calvert, T. Heller, M. Diaz, S. Marquart, S. Paladugu, P. Leppink – Shands, C. Uebelhart, J. Dean, A. Schwartzwald, A. Shah, I. Mitha, S. Somrock, L. McCullough, R. Smith, E. Bowe, R. Favour, M. Sonnabend, J. Rickman, M. Smith, A. Johnson, and H. Stephenson (supported undergraduates).
- Frederic Lemauff, David Boutouiller, Nicolas Bernardeau, Olivier Huet, Guillaume Gasser, Chris Dos Santos, Nicolas Caramelli, Eric Bouteillon, Benjamin Maurin, Duc Fehr, Patrick Roessler, Arnaud Bruyas, and Florent Nageotte (supported foreign undergraduate students).
- J. Jasper, M. Smela, A. DeClue, and B. Asojo (supported high school students).

Post-Doctoral Associates

- Osama Masoud (currently: Director of Research, Vital Images Inc.).
- Vassilios Morellas (currently: Research Professor, UMN).
- Dean Hougen (currently: Associate Professor, University of Oklahoma).
- Yan-Bin Jia (currently: Professor, Iowa State University).

Participation in M.S. and Ph.D. Thesis Committees

Falai Li (Agriculture), Paul Rybski (CS), Hemanth Arumugam (CS), Kemal Berk Yesin (ME), Tracy Denk (EE), Don Krantz (CS), Pascal Mammasian (Psychology), Weining Zheng (EE), Huifuang Ng (Agriculture), Dean Hougen (CS), Pamela Lechleider (CS), Dirk Edmonds (CS), Bin Zhu (EE), You Yuli (EE), Vafa Ghazi-Moghadam (EE), Lan Tse-Hua (EE), Shaomin Peng (EE), John Chourdakis (CE), Liu Guoqin (CE), Todd Hardwick (EE), Saad Bedros (EE), John Shackleton (CS), Keesook Han (EE), Omar Santiago-Perez (ME), Rajeev Singh (AEM), Jennifer Treadway (Math), Bill Knecht (Psychology), Xuan

Liu (CS), Barmeshwar Vikramaditya (ME), Youngguyn Kim (EE), Praveen Gupta (Agriculture), Brad Nelson (Carnegie Mellon University), Mike Brady (Psychology), Jeff Thompson (CS), Kihyuk Han (ECE), Yu Zhou (ME), Paul Rybski (CS), Jianjun Zhan (CE), Matt Cruikshank (CS), Joshua Dudney (ME), Vinodh Kumar Chandram (CS), Saed Wadi (ECE), Seth Hulst (ECE), Vahid Emamian (ECE), Thomas Naselaris (Neuroscience), Michael Blocksome (CS), David Littau (CS), Yunqian Ma (ECE), Sunghee Kim (CS), A. Schoolcraft (CS), T. Corrigan (ME), G. Yang (ME), H. Yang (AEM), Jim Gaines (ME), Kraig Bottemiller (ECE), M. Lahmar (ME), Blake Larson (ME), Michael Baldea (Chem. Engin.), Rahul Joshi (ECE), Corey Bilot (CS), Dongwei Cao (CSE), Gerry Ruch (Astronomy), Rashmi Sundareswara (CSE), Yukikazu Hidaka (CSE), Luke Ludwig (CSE), Maitreyi Nanjanath (CSE), Nicole Sprague (CSE), Diego Rother (CompS), Tom Whipple (CSE), Vasillios Christopoulos (CSE), Steve Tousignant (CSE), Chen-chi Chu (AEM), Venkateshwar Korukanti (CSE), Chandra Tjhai (AEM), Ryan Lloyd (CSE), Nikhil Karnad (CSE), Ankur Sharma (CSE), Anuraag Pakanati (CSE), Elizabeth Jensen (CSE), Ignacio Ramirez (Scientific Computation), Xue Bai (ECE), Doug Cook (CSE), James Parker (CSE), Alexey Castrodad (ECE), Jordan Hashemi (ECE), Liron Yatziv (Scientific Computation), David Brajkovic (ME), Pratap Tokekar (CSE), Rodney Dockter II (ME), Mrinal Kanti Paul (CSE), John Harwell (CSE), Leonardo Le (AEM), Ahmed Medhat (CSE), Nikolaos Stefas (CSE), Robert Giaquinto (CSE), Kevin Mallery (ME), Baoquan Zhang (CSE), Debraj Bhattacharjee (ECE), Aditya Salapaka (ME), Sirisha Rambhatla (ECE), Sadman Enan (CSE), Abhinav Sambasivan (ECE), Abhinav Mehta (ME), Rostand Fezeu (CSE), Kazim Engin (CSE), Jungseok Hong (CSE), Sara Saunders (BME), Bobby Schulz (ECE), Jonathan Lemke (ME), Thomas Ringstrom (CSE), Udhaya Dayalan (CSE), Jared Floersch (ME), Shree Thandry Ramamurthy (ECE), Debarati Das (CSE), Praneet Bala (CSE), Yifeng Zhang (CSE), Ross Worobel (ECE), Tejveer Maddukuri (CSE), Angel Sylvester (CSE), Ruixuan Sun (CSE), Mo Houtti (CSE), Zhejun Liu (CE), James Klassen (NRSM), and Rong Chen (EE).

Honors

- UMN Award for Outstanding Contributions to Graduate and Professional Education, Distinguished University Teacher, 2022-.
- McKnight Presidential Endowed Professor in CS, 2016-.
- IEEE RAS George Saridis Leadership Award in Robotics and Automation, 2016.
- CTS Research Partnership Award, 2016.
- A paper co-authored with A. Cherian and V. Morellas was the winner for the Best Student paper award at the 2012 IEEE Int. Conference on Image Processing (ICIP 2012), Orlando, FL, October 2012.
- IEEE-RAS Distinguished Service Award, 2011.
- Distinguished McKnight University Professor, 2007-.
- IEEE Felllow, 2007-.
- A paper co-authored with G. Gasser, N. Bird, and O. Masoud was finalist for the Best Vision Paper Award, 2004 IEEE Int. Conference on Robotics and Automation, New Orleans, April 2004.
- IEEE VTS 2001 Best Land Transportation Paper Award for the paper "A Novel Method for Tracking and Counting Pedestrians in Real-Time Using a Single Camera" (with Osama Masoud).
- Best Video Award, 2000 IEEE Int. Conference on Robotics and Automation, San Francisco, May 2000.
- Finalist for the 2000 Discover Magazine Award for Technological Innovation.
- UMN CSE Faculty Creativity Award, March 1999.
- McKnight Land-Grant Professorship Award, University of Minnesota, July 1995 - June 1997.
- Best Session Paper Presentation Award, American Control Conference, Seattle, June 1995.
- National Science Foundation Career Award, August 1995 - July 1998.
- National Science Foundation Research Initiation Award, August 1994 - July 1997.
- Finalist for the Anton Philips Award for Best Student Paper in the 1991 IEEE Robotics and Automation Conference.
- Kritski Fellowship, Greece, September 1985 - August 1987.
- IKY Fellowship, Greece, August 1986 - August 1987.
- First entrant at Ionidios High School, Piraeus, Greece.
- Seventh entrant at the Department of Electrical and Computer Engineering, National Technical University of Athens.

Presentations

- 14th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2022.
- ETH MSRL Robotics Symposium, May 2022.
- 3M Technical Forum Seminar, April 2022.
- IEEE Southern Minnesota Section, August 2020.
- 3M Mini Dental School Lecture Series, July 2020.
- NRI meeting, Breakout Research in Agricultural Robotics, February 2020.
- CSE Dean's Advisory Committee, University of Minnesota, Minneapolis, MN, October 2019.
- Robotics Roadmap Workshop, Chicago, IL, September 2019.
- 12th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2019.
- 27th Mediterranean Conference on Control and Automation (MED '19), Akko, Israel, July 2019.
- University of Minnesota Robotics Tech Talks, Minneapolis, MN, April 2019.
- Electrical and Computer Engineering, University of Florida, FL, April 2019.
- Mechanical and Aerospace Engineering, University of Florida, FL, April 2019.
- Minnesota Dermatological Society Winter Meeting, Minneapolis, MN, November 2018.
- UMN IEM HS Inspire, Minneapolis, MN, November 2018.
- Science Museum of Minnesota, St. Paul, MN, October 2018.
- "Machine Learning and Artificial Intelligence in Medical Imaging: Challenges and Opportunities" Workshop, Arlington, VA, September 2018.
- Distinguished Lecture, Computer Science and Engineering, Texas A&M, College Station, TX, January 2018.
- Robotics Frontiers 2017 Symposium, UC San Diego, San Diego, CA, September 2017.
- Honeywell Technology Symposium, Minneapolis, MN, May 2017.
- IMA Smart Urban Transportation Forum, IMA, University of Minnesota, Minneapolis, MN, May 2017.
- Energy Explorers, Great River Energy, Maple Grove, MN, February 2017.
- Distinguished Lecture, Computer Science and Engineering, Texas A&M, College Station, TX, December 2016.
- Institute for Robotics & Intelligent Machines (IRIM), Georgia Tech, Atlanta, GA, January 2016.
- Purdue Polytechnic Institute, Purdue University, West Lafayette, IN, September 2015.
- 8th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2015.
- 2015 Heritage Society Dinner, University of Minnesota Foundation, Minneapolis, MN, June 2015.
- Headliners, College of Continuing Education, University of Minnesota, St. Paul, MN, April 2015.
- Department of Computer Science and Engineering, University of Nevada, Reno, NV, March 2015.
- Electrical and Computer Engineering, Duke University, Durham, NC, February 2015.
- Department of Computer Science, Iowa State University, Ames, IA, February 2015.
- 7th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2014.
- IEEE Conference on Robotics and Automation, Hong Kong, China, June 2014.
- Department of Computer Science and Engineering, Minneapolis, MN, November 2013.
- Robotics Alley Conference, St. Paul, MN, November 2013.
- 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '13), Tokyo, Japan, November 2013.
- GOFIRST UMN, Minneapolis, MN, October 2013.
- IEEE Region 4 Leadership Conference, Minneapolis, MN, October 2013.
- Enterprise Minnesota, Maple Grove, MN, September 2013.
- 6th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2013.
- MN Corn Growers, Waseca, MN, March 2013.
- GOFIRST UMN, Minneapolis, MN, February 2013.
- 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '12), Vilamoura/Algarve, Portugal, October 2012.
- ETH Distinguished Lecture, Zurich, Switzerland, October 2012.
- IEEE Conference on Robotics and Automation, St. Paul, MN, May 2012.
- Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN, April 2012.

- CSE Science and Engineering Day, University of Minnesota, Minneapolis, MN, February 2012.
- University of Minnesota | Rochester, Rochester, MN, February 2012.
- CTS Executive Committee Meeting, University of Minnesota, Minneapolis, MN, February 2012.
- 1st Robotics Alley Conference, Minneapolis, MN, November 2011.
- CSE Dean's Advisory Committee, University of Minnesota, Minneapolis, MN, October 2011.
- 4th Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2011.
- 19th Mediterranean Conference on Control and Automation (MED' 11), Corfu, Greece, June 2011.
- 3M, St. Paul, MN, May 2011.
- "Educating Robotics Engineers and Scientists" Workshop, IEEE Conference on Robotics and Automation, Shanghai, China, May 2011.
- IEEE Conference on Robotics and Automation, Shanghai, China, May 2011.
- Normandale Community College, Minneapolis, MN, January 2011.
- Tech Forum Electronics Chapter, 3M, St. Paul, MN, November 2010.
- 3rd Cyprus Workshop on Signal Processing and Informatics, Nicosia, Cyprus, July 2010.
- 18th Mediterranean Conference on Control and Automation (MED' 10), Marrakech, Morocco, June 2010.
- IEEE Conference on Robotics and Automation, Anchorage, Alaska, May 2010.
- Tech Forum Electronics Chapter, 3M, St. Paul, MN, December 2009.
- Normandale Community College, Minneapolis, MN, October 2009.
- 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '09), Saint Louis, MO, August 2009.
- 17th Mediterranean Conference on Control and Automation (MED '09), Salonica, Greece, June 2009.
- IEEE Conference on Robotics and Automation, Kobe, Japan, May 2009.
- Department of Computer Science and Engineering, Texas A&M, TX, January 2009.
- IEEE Aerospace and Electronic Systems Society, Chapter of Twin Cities, Eagan, MN, December 2008.
- IEEE International Conference on Advanced Video and Signal Based Surveillance, Santa Fe, NM, September 2008.
- 1st International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '08), Athens, Greece, July 2008.
- 11th International Symposium on Experimental Robotics, Athens, Greece, July 2008.
- Science Museum of Minnesota, St. Paul, MN, June 2008.
- IEEE Conference on Robotics and Automation, Pasadena, CA, May 2008.
- ARO/NSF Workshop on Future Directions in Visual Navigation, Pasadena, CA, May 2008.
- National Science Foundation PAEMST Award Ceremony, Washington, DC, April 2008.
- Midwest Instruction and Computing Symposium, UW-La Crosse, La Crosse, WI, April 2008.
- Lockheed Martin Corporation, MN, April 2008.
- Center for Cognitive Sciences, MN, January 2008.
- Metro Transit, MN, January 2008.
- Computer Science Department, University of Southern California, CA, December 2007.
- The Technical Cooperation Program (TTCP) Symposium on the Science of Autonomy and Bio-Inspired Systems, Army Research Laboratory, MD, October 2007.
- Honeywell ACS Fellows Symposium, Minneapolis, MN, October 2007.
- Goodrich Corporation, MN, June 2007.
- IEEE Conference on Robotics and Automation, Rome, Italy, April 2007.
- Center for Cognitive Sciences, MN, March 2007.
- North Dakota State University, ND, January 2007.
- Digital Technology Workshop, Digital Technology Center, November 2006.
- Metropolitan Airport Commission, October 2006.
- Metro Transit, September 2006.
- Johnson Controls Inc., May 2006.
- Honeywell Labs, March 2006.
- 2005 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '05), Edmonton, Canada, August 2005.
- 13th Mediterranean Conference on Control and Automation (MED'05), June 2005.
- Tutorial "Video Surveillance", 2005 Spring NSF SSR-RC meeting, St. Petersbourgh, FL, March 2005.
- Workshop "Micro-Air-Vehicles - The Next 10 Years", 2004 IEEE Int. Conference on Robotics and Automation (ICRA '04), New Orleans, LA, April 2004.

- Workshop “Multi-robot Search and Rescue: Current Challenges and Future Directions”, 2004 IEEE Int. Conference on Robotics and Automation (ICRA ’04), New Orleans, LA, April 2004.
- Department of Electrical and Computer Engineering, University of Arizona, April 2004.
- Department of Electrical, Computer, and Systems Engineering, Rensselaer Polytechnic Institute, February 2004.
- Department of Electrical and Systems Engineering, Washington University in Saint Louis, January 2004.
- Department of Computer and Information Science, Ohio State University, January 2004.
- Department of Computer Science, University of North Carolina, December 2003.
- Workshop “Robotics in Emergency Response”, 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS ’03), Las Vegas, NV, October 2003.
- Workshop “Control and Cooperation of Intelligent Miniature Robots”, 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS ’03), Las Vegas, NV, October 2003.
- Department of Computer Science, University of Houston, October 2003.
- IEEE Conference on Robotics and Automation, Taipei, Taiwan, September 2003.
- 11th Mediterranean Conference on Control and Automation (MED’03), June 2003.
- Department of Computer Science and Engineering, Wright State University, May 2003.
- Digital Technology Center Industrial Affiliates Open House, May 2003.
- Picatinny Arsenal, NJ, May 2003.
- Computer and Information Science Department, University of Pennsylvania, February 2003.
- 3M Optical Inspection Mini-Chapter, February 2003.
- Digital Technology Center Seminar, December 2002.
- 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '02), Lausanne, Switzerland, October 2002.
- 14th International Conference on Digital Signal Processing, Santorini, Greece, 2002.
- ARO Workshop on Integrated System Approaches to Future Combat Systems, Washington, DC, May 2002.
- Multi-Robot Systems Workshop, Washington, DC, March 2002.
- Vision Science Colloquium, University of Minnesota, Minneapolis, MN, November 2001.
- Naval Research Laboratory (NRL), Washington, DC, November 2001.
- 2001 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '01), Maui, HI, October 2001.
- IEEE Conference on Robotics and Automation, Seoul, Korea, May 2001.
- IEEE Twin Cities Chapter, Minneapolis, MN, April 2001.
- Department of Electrical and Computer Engineering, University of New Mexico, NM, March 2001.
- AHEPANS, St. Paul, MN, USA, March 2001.
- Department of Electrical and Computer Engineering, University of Cyprus, Cyprus, February 2001.
- 2nd NASA/JPL Workshop on Biomorphic Explorers, Pasadena, CA, December 2000.
- Science Coalition Day, Washington, DC, July 2000.
- Department of Electrical and Computer Engineering, University of Patras, Greece, July 2000.
- 8th IEEE Mediterranean Conference on Control and Automation, Rio, Greece, July 2000.
- Department of Mechanical Engineering, National Technical University, Athens, Greece, July 2000.
- IEEE Conference on Robotics and Automation, San Francisco, CA, May 2000.
- Minnesota Society of Professional Engineers, Minneapolis, USA, April 19, 2000.
- Control Science and Dynamical Systems, University of Minnesota, Minneapolis, USA, March 2000.
- Department of Computer Science and Engineering, University of Minnesota, Minneapolis, USA, November 1999.
- 1999 IEEE/IEEJ/JSAI International Conference on Intelligent Transportation Systems, Tokyo, Japan, October 5-8, 1999.
- 1999 European Control Conference, Karlsruhe, Germany, August 31-September 3, 1999
- ITS Minnesota Annual Meeting and Guidestar Technology Forum, Minneapolis, MN, March 1999.
- University of Minnesota Foundation, Minneapolis, MN, February 1999.
- IMA Workshop on “Forging an Appropriate Immune Response as a Problem in Distributed Artificial Intelligence”, Minneapolis, MN, October 1998.
- 1998 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '98), Victoria, Canada, October 1998.
- ETH and MOVIC ’98, Switzerland, August 1998.
- DARPA “Distributed Robotics” PI meeting, August 1998.

- IEEE Conference on Robotics and Automation, Leuven, Belgium, May 1998.
- Workshop on “Robust Vision for Vision-Based Control”, IEEE Conference on Robotics and Automation, Leuven, Belgium, May 1998.
- CTS Faculty Round Table, Minneapolis, MN, March, 1998.
- Wright Patterson Base, Dayton, OH, January, 1998.
- Conference on Vision for Reach and Grasp, Minneapolis, MN, October 1997.
- NSF Block Island Workshop on Vision and Control, Block Island, RI, June 1997.
- 1997 Int. Robots and Vision Conference, Detroit, MI, May 1997.
- IEEE Conference on Robotics and Automation, Albuquerque, NM, April 1997.
- CTS Faculty Seminar Series, Minneapolis, MN, February, 1997.
- Department of Computer Science, University of Cyprus, Nicosia, Cyprus, September 1996.
- Department of Computer Science, University of Minnesota, Minneapolis, USA, March 1996.
- Workshop on Mathematical Methods in Computer Vision, Geometry Center, University of Minnesota, Minneapolis, USA, September 1995.
- 10th IEEE International Symposium on Intelligent Control, Monterey, USA, August 1995.
- 1995 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '95), Pittsburgh, USA, August 1995.
- 3rd IEEE Mediterranean Symposium on New Directions in Control and Automation, Limassol, Cyprus, July 1995.
- Department of Computer Science, University of Cyprus, Nicosia, Cyprus, July 1995.
- 1995 American Control Conference (Two Talks), Seattle, USA, June 1995.
- IEEE Conference on Robotics and Automation, Nagoya, Japan, May 1995.
- Center for Transportation Studies Faculty Seminar, University of Minnesota, Minneapolis, USA, February 1995.
- 33rd IEEE Conference on Decision and Control (33rd CDC), Orlando, USA, December 1994.
- Department of Mechanical Engineering, University of Minnesota, Minneapolis, USA, November 1994.
- SPIE's International Symposium on Photonics for Industrial Applications, Intelligent Vehicle Highway Systems, Boston, USA, November 1994.
- IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems, Las Vegas, USA, October 1994.
- IEEE Conference on Robotics and Automation (Two Talks), San Diego, USA, May 1994.
- Fifth Annual Transportation Research Conference, Minneapolis, USA, May 1994.
- 31st Allerton Conference, Champaign, USA, September 1993.
- 1993 IEEE International Symposium on Intelligent Control, Chicago, USA, August 1993.
- Department of Computer Science, University of Wisconsin, Madison, USA, August 1993.
- 1993 IEEE Conference on Computer Vision and Pattern Recognition, New York, USA, June 1993.
- 1993 American Control Conference, San Francisco, USA, June 1993.
- Department of Electrical Engineering, University of Minnesota, Minneapolis, USA, May 1993.
- Fifth Topical Meeting on Robotic and Remote Systems, Oak Ridge, USA, April 1993.
- 31st IEEE Conference on Decision and Control (31st CDC), Tucson, USA, December 1992.
- IEEE Workshop on Applications of Computer Vision, Palm Springs, USA, November 1992.
- Department of Computer Science, University of Minnesota, Minneapolis, USA, November 1992.
- 1992 American Control Conference, Chicago, USA, June 1992.
- Department of Electronic Engineering, Technical University of Crete, Greece, June 1992.
- Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA, March 1992.
- Department of Computer Science, University of Minnesota, Minneapolis, USA, February 1992.
- Center for Automation Research, University of Maryland, College Park, USA, January 1992.
- European Robotics and Intelligent Systems Conference, Corfu, Greece, June 1991.
- IEEE Conference on Robotics and Automation, Sacramento, USA, April 1991.
- Ohio State University Control Workshop, Columbus, USA, April 1991.
- IEEE Rensselaer Polytechnic Institute Second International Conference on Computer Integrated Manufacturing, Rensselaer Polytechnic Institute, USA, May 1990.
- Ohio State University Control Workshop, Columbus, USA, April 1990.

Professional

- Fellow Member of IEEE.
- Senior Editor, IEEE Transactions on ITS, 2016-.
- Associate Editor, IEEE Transactions on ITS, 2003-2015.
- Associate Editor, Transportation Research: Part C, 2006-2014.
- Associate Editor, Journal of Intelligent and Robotic Systems, 2006-2019.
- Honorary Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020).
- General Chair of the 2012 IEEE Robotics and Automation Conference.
- Vice President for Conferences, RAS, 2010-2013.
- Chair, Publication Ethics Committee, RAS, 2015-.
- Chair, Saridis and Service Awards Evaluation Committee, RAS, 2016-2018.
- ICRA-x Chair of the 2018 IEEE Robotics and Automation Conference.
- 2018, 2020, and 2022 IEEE CS Fellows Evaluation Committee.
- Program Co-Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018).
- Publicity Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2017).
- Publications Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2015).
- Publications Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2014).
- Member, RAS Long-Range Planning Committee, 2014-2015.
- Editor, RAS Conference Editorial Board, 2006-2009.
- Editor, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2011), Conference Editorial Board, 2011.
- Member of the IEEE Robotics and Automation Administrative Committee, 2000-2005.
- Member, RAS IEEE Fellow Nomination Committee, 2013-2014.
- Chairman, RAS IEEE Fellow Nomination Committee, 2007-2008.
- Chairman of the IEEE Robotics and Automation Technical Committee on Robot Vision, 2000-2006.
- America Program Co-Chair of the 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems.
- Awards Chair of the 2008 IEEE Robotics and Automation Conference.
- Program Chair of the 2006 IEEE Robotics and Automation Conference.
- America Program Co-Chair of the 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems.
- America Program Co-Chair of the 2004 IEEE Robotics and Automation Conference.
- Vice-Chairman of the 2001 IEEE/RSJ International Conference on Intelligent Robots and Systems.
- Chief organizing member of the Hellenic Student Association of Carnegie Mellon University.
- Participation in National Science Foundation review panels for regular proposals.
- Reviewer of proposals for the Department of Energy and the National Science Foundation.
- Participation in an IEEE review panel for senior member candidates.
- Participation in the faculty recruitment committee, Department of Electrical and Computer Engineering, University of Cyprus.
- Reviewer of proposals for the Austrian Science Fund, Europian Union, the Portuguese Ministry of Science and Technology (FCT program), the Qatar National Research Fund, the National Centre of Science and Technology Evaluation of Kazakhstan, the Kroatia Science Foundation, and the Hong Kong Research Grants Council.
- Member of the Technical Chamber of Greece.
- Organizer of the ARO/NSF Workshop on Future Directions in Visual Navigation, Pasadena, CA, May 2008.
- Editor of a special issue on "Analysis and Experiments in Distributed Multi-Robot Systems" of the *Journal Autonomous Robots* (2004).
- Guest Editor of a special issue on "Panoramic Robotics" of the *Robotics and Automation Magazine* (2003).
- Guest Editor of a special issue on "Applied Visual Servoing" of the *Robotics and Automation Magazine* (December 1998).

- Guest Editor of a special issue on "Modelling Issues for Visual Sensing" of the Journal *Mathematical and Computer Modelling.*
- Program committee member for the 2021 and 2023 International Conferences on Unmanned Aircraft Systems (ICUAS).
- Program committee member for the 31st Mediterranean Conference on Control and Automation, June 2023.
- Program committee member for the 10th International Symposium on Distributed Autonomous Robotic Systems.
- Program committee member for the 13th International Conference on Computer Vision.
- Program committee member for the 2010, 2011, and 2012 IEEE Conferences on Computer Vision and Pattern Recognition.
- Program committee member for the 1999, 2000, 2002, 2003, 2004, 2008, 2009, and 2014 IEEE/RSJ International Conferences on Intelligent Robots and Systems.
- Program committee member for the 2000, 2001, 2002, 2003, and 2005 IEEE Robotics and Automation Conferences.
- Program committee member for the 5th International Symposium on Visual Computing, November 2009.
- Program committee member for the 17th and 20th Mediterranean Conferences on Control and Automation, June 2009 and July 2012.
- Program committee member for the 2009 IEEE Intelligent Vehicles Symposium, June 2009.
- Program committee member for the 2nd International Conference on Pervasive Technologies Related to Assistive Environments, June 2009.
- Program committee member for the 5th IEEE Conference on Advanced Video and Signal Based Surveillance, September 2008.
- Program committee member for the 10th, 11th, 12th and 15th Annual IEEE Conferences on Intelligent Transportation Systems, 2007, 2008, 2009, 2012, and 2013.
- Program committee member for the 3rd and 4th International Symposiums on Visual Computing, 2007 and 2008.
- Program committee member for the 32nd Annual Conference of the IEEE Industrial Electronics Society, November 2006.
- Program committee member for the 9th Annual IEEE Conference on Intelligent Transportation Systems, September 2006.
- Program committee member for the International Conference on Intelligent Systems and Computing: Theory and Applications, July 2006.
- Program committee member of the 8th Annual IEEE Conference on Intelligent Transportation Systems, August 2005.
- Program committee member of the 13th Mediterranean Conference on Control and Automation, 2005.
- Program committee member of the IASTED Int. Conference on Robotics and Applications (RA 2005), 2005.
- Program committee member of the 2005 IEEE-RAS International Conference on Humanoid Robots, 2005.
- Program committee member of the 23rd IASTED Int. Conference on Modeling, Identification, and Control (MIC 2004), 2004.
- Program committee member of the IEEE Intelligent Vehicles Symposium, 2004.
- Program committee member for the European Workshop on Service and Humanoid Robots (SERVICEROB-2001).
- Program committee member for the International Congress on Autonomous Intelligent Systems, February 2002.
- Program committee member for the 6th Int'l Symp. on Artificial Intelligence, Robotics, & Automation in Space, 2001.
- Program committee member for the 4th Annual IEEE Conference on Intelligent Transportation Systems, August 2001.
- Program committee member of the 3rd Annual IEEE Conference on Intelligent Transportation Systems (ITSC-2000).
- Program committee member of the ISR 2000.
- Publicity chairman and program committee member of the 1998 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '98).

- Program committee member of the Third European Robotics, Intelligent Systems and Control Conf., 1998.
- Publicity chairman and program committee member of the 1997 IEEE Robotics and Automation Conference.
- Award Chairman for the IEEE Int. Joint Symposia on Intelligence and Systems, 1996.
- Local arrangements chairman of the 1996 IEEE Robotics and Automation Conference.
- Member of the program committee of the 1995 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '95).
- Member of the program committee of the 1994 IEEE Robotics and Automation Conference.
- Organizer of an invited session at the 1994 IEEE Robotics and Automation Conference.
- Invited sessions/tutorials chairman of the 1995 Symposium on Intelligent Control.
- Chairman of three sessions at the 2001 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '01).
- Chairman of one session at the 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2013, 2014, and 2015 IEEE Robotics and Automation Conferences.
- Chairman of one session at the 2000 IEEE International Symposium on Intelligent Control (ISIC 2000).
- Chairman of two sessions at the 11th Mediterranean Conference on Control and Automation (MED'03).
- Chairman of two sessions at the 1998 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '98).
- Chairman of one session at the 1998 IEEE Robotics and Automation Conference.
- Chairman of two sessions at the 1997 IEEE Robotics and Automation Conference.
- Chairman of two sessions at the 1996 IEEE Robotics and Automation Conference.
- Chairman of a session at the *10th IEEE International Symposium on Intelligent Control*.
- Chairman of a session at the *3rd IEEE Mediterranean Symposium on New Directions in Control and Automation*.
- Chairman of a session at the 1995 IEEE Robotics and Automation Conference.
- Chairman of a session at the 1995 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '95).
- Chairman of two sessions at the 1995 American Control Conference.
- Chairman of a session at the 1994 IEEE Robotics and Automation Conference.
- Chairman of a session at the 1994 IEEE Conference on Systems, Man, and Cybernetics.
- Chairman of two sessions at the 1994 IEEE Robotics and Automation Conference.
- Chairman of a session at the 1993 IEEE International Symposium on Intelligent Control.
- Chairman of a session at the 1993 American Control Conference.
- Chairman of a session at the 31st IEEE Conference on Decision and Control (31st CDC).
- Chairman of a session at the 1992 American Control Conference.
- Reviewer of the following journals:
  IEEE Transactions on Automatic Control
  IEEE Transactions on Intelligent Transportation Systems
  IEEE Transactions on Vehicular Technology
  IEEE Transactions on Mechatronics
  IEEE Transactions on Robotics and Automation
  IEEE Control Systems Magazine
  IEEE Robotics and Automation Magazine
  IEEE Transactions on Systems, Man, and Cybernetics
  IEEE Transactions on Control Systems Technology
  IEEE Transactions on Neural Networks
  International Journal of Computer Vision
  Journal of Intelligent Control and Systems
  Journal of Intelligent and Robotic Systems: Theory and Applications
  Automatica
  Mathematical and Computer Modelling
  IEE Proceedings in Vision, Image and Signal Processing
  International Journal of Robotics and Automation
  Journal of Robotic Systems
  Journal of Robotics and Autonomous Systems
  Optimal Control: Applications and Methods
  Image and Vision Computing

Computer Vision and Image Understanding
Autonomous Robots
Mechatronics.

- Reviewer for the 1990 through 2017 IEEE Conferences on Robotics and Automation.
- Reviewer for the 80th Annual TRB meeting, 2001.
- Reviewer for the IJCNN 2000.
- Reviewer for the ISR 2000.
- Reviewer for the 36th IEEE CDC, Kobe, Japan.
- Reviewer for the 1995, 1998, 1999, 2002, and 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '95, '98, '99, '02, and '03).
- Reviewer for the 4th IEEE Mediterranean Symposium on New Directions in Control and Automation.
- Reviewer for the 1995 American Control Conference.
- Reviewer for the 1st IEEE Conference on Control Applications.
- Reviewer for the 34th IEEE CDC, New Orleans, USA.
- Reviewer for the 30th IEEE CDC, Brighton, United Kingdom.
- Reviewer for the HICSS-24, Hawaii.

Contributions to Departmental and University Service

Administrative Duties

- Director of the Minnesota Robotics Institute (MnRI).
- Director of the Center for Distributed Robotics and SECTTRA.
- Leader of the effort to attract state (MnDRIVE) and donor funding for Robotics. This has resulted into more than $26M for the UMN Robotics.
- Acting Director of Graduate Studies, MS in Robotics, Fall 2020-.
- Director of Undergraduate Studies and Honors representative, Fall 2010-Spring 2013.
- Chair of the Research Funding Committee, Fall 2007-.
- Director of Undergraduate Studies and Honors representative, 2000-2004.

Committee Work

- Chair, CSE RSAM MnDRIVE Advising and Planning Committee, 2013-2019.
- Member of the UMN Benefits Advisory Committee, 2019-Present.
- CSE MnDRIVE Hiring Committee, 2013-2019.
- UMN Faculty Consultative Committee, 2016-Present.
- Chair, Committee for the Recruitment of the CSE Director of Strategic Sponsored Research Activities, 2022-2023.
- Member of the University Distinguished McKnight University Professor Selection Committee, 2014-2016.
- CSE College Scholarship and Award Committee, 2012-2021.
- Campus Committee on Student Behavior (CCSB), 2006-2010.
- Chair, CSE Department Head Evaluation Committee, 2010.
- Member of the Advisory/SPC Committee, 2009-2010.
- Member of the CTS Director Search Committee, 2010.
- Member of the DTC Director Search Committee, 2008.
- Member of the Faculty Recruitment committee, 2007-2008.
- Member of the IT P&T committee (2007-2010).
- Mentoring Chair for Prof. R. Kuang and Prof. H. Park.
- Mentoring committee member for Profs. V. Isler, J. Sattar, L. Yarosh, and W. Schuler.

Personal

- American Citizen