

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

PELOTON INTERACTIVE, INC.,
Petitioner,

v.

NEC CORPORATION,
Patent Owner.

Case No. IPR2023-01239
Patent No. 8,752,101

DECLARATION OF DR. JEREMY COOPERSTOCK
IN SUPPORT OF PATENT OWNER'S RESPONSE

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I, Jeremy Cooperstock, Ph.D. declare as follows:

1. I make this Declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.
2. I understand that Peloton Interactive, Inc. (“Petitioner” or “Peloton”) submitted a petition (“Petition”) for *inter partes* review, challenging Claims 1, 2, 4, 5, 7, 11, 12, 14-18, 20-23, and 25-29 (the “Challenged Claims”) of U.S. Patent No. 8,752,101 (the “’101 Patent”). I have been asked by counsel for Patent Owner, NEC Corporation (“Patent Owner” or “NEC”) to provide technical opinions in connection with the *inter partes* review.
3. I submit this Declaration in support of Patent Owner’s Response.

I reserve the right to supplement my opinions, should I be requested to provide additional analysis in connection with the patentability of the Challenged Claims.

I. INTRODUCTION

A. Background and Qualifications

4. I am an expert in the field of media streaming technologies. I have studied, taught, practiced, and researched this field for over 30 years. I have summarized in this section my educational background, work experience, and other relevant qualifications, as reflected in my curriculum vitae. A copy of my complete curriculum vitae is attached to this declaration as Appendix A.
5. I earned a Bachelor of Applied Science (B.A.Sc) degree in Electrical

Engineering (Computer Engineering Option) with Honors from the University of British Columbia in 1990, a Master of Science (M.Sc.) degree in Computer Science from the University of Toronto in 1992, and a Doctor of Philosophy (Ph.D.) degree in Electrical and Computer Engineering from the University of Toronto in 1996. My dissertation on “Reactive Environments and Augmented Media Spaces” was nominated by the University of Toronto for the Natural Sciences and Engineering Research Council (NSERC) Doctoral Dissertation Award.

6. From 1987 to 1988, I worked at IBM Research on very large scale integration (VLSI) circuit simulation, and in 1989, I worked at the IBM T.J. Watson Research Center on very long instruction word (VLIW) simulation. In 1990, I worked at Fibronics Research to develop and test an FDDI-to-token ring bridge for network communication.

7. After obtaining my Doctorate degree, I carried out research and development work at the Sony Computer Science Laboratory in Tokyo, Japan from 1996 to 1997.

8. I have been employed at McGill University since November 1997, where I am currently a Full Professor in the Department of Electrical and Computer Engineering. In this capacity, I conduct and supervise research activities, and teach courses at the upper undergraduate and graduate level. Over the course of my academic career, I have supervised more than 100 graduate students and post-doctoral fellows, and more than 250 undergraduate research students.

9. I am a member of the Centre for Intelligent Machines, and a founding member of the Centre for Interdisciplinary Research in Music Media and Technology, a member of the International Laboratory on Learning System, a member of the McGill Institute for Aerospace Engineering, and an associate member of Biomedical Engineering at McGill University. I presently direct a group of approximately 50 researchers at the Shared Reality Lab, which focuses on computer mediation to facilitate high-fidelity human communication and the synthesis of perceptually engaging, multimodal, immersive environments.

10. I have been developing and working with network media distribution technologies since 1990. I led the development and demonstrations of the world's first high-fidelity multichannel audio streaming system over the Internet in 1999 and 2000, recognized by a Distinction Award from the Audio Engineering Society, and followed in 2005 by simultaneous low-latency transmission of multiple streams of uncompressed high-definition video as part of the McGill Ultra-Videoconferencing system. This work was recognized by an award for Most Innovative Use of New Technology from the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) Supercomputing.

11. Among other projects, I led the development and supported ongoing use of a semi-automated classroom environment (the "Intelligent Classroom"), a high-fidelity orchestra rehearsal simulator ("Open Orchestra,"), a simulation environment

that renders graphic, audio, and vibrotactile effects in response to footsteps (“Natural Interactive Walking”), and a mobile game treatment for amblyopia that was licensed to Novartis.

12. The research and development I supervised on the Autour project earned the Hochhausen Research Award from the Canadian National Institute for the Blind and an Impact Award from the Canadian Internet Registry Association. My Real-Time Emergency Response project won the Gold Prize (brainstorm round) of the Mozilla Ignite Challenge. I have carried out significant research involving design and implementation of haptic feedback systems, virtual and augmented reality, and mobile computing applications.

13. I have worked with IBM at the Haifa Research Center, Israel, and the Watson Research Center in Yorktown Heights, New York, the Sony Computer Science Laboratory in Tokyo, Japan, and was a visiting professor at Bang & Olufsen, Denmark, where I conducted research on telepresence technologies as part of the World Opera Project.

14. I led the theme of Enabling Technologies for a Networks of Centres of Excellence on Graphics, Animation, and New Media (GRAND), chaired the Technical Committee on Network Audio Systems, and served as an Associate Editor of the Journal of the Audio Engineering Society. I was invited to serve as an Associate Editor for the IEEE Transactions on Haptics, Associate Editor for the

Frontiers in Virtual Reality, and Associate Editor for the World Haptics Conference.

15. I have authored and co-authored more than 200 journal articles and peer-reviewed conference proceedings papers, mostly concerning human-computer interaction and network media. Eight of my publications were finalists or winners of “best paper”, “honorable mention”, and similar awards from scholarly societies.

16. I have developed and taught courses on human-computer interaction, artificial intelligence, embedded systems, haptic interaction design, computer architecture, and operating systems. A complete list of my publications and the courses I have developed and/or taught is also contained in my curriculum vitae.

17. My research activities are funded by industry contracts, collaboration programs, and government grants. In the past 5 years, I have obtained grants and contracts for my research program in excess of three million dollars.

18. My professional affiliations include services in various professional organizations and serving as a reviewer for a number of technical publications, journals, and conferences, which are listed in my curriculum vitae.

19. I have also served as an expert in certain legal proceedings, both on behalf of patent owners and petitioners. A list of cases in which I have provided written declarations, testified at trial or by deposition is provided in my curriculum vitae.

20. My experience in academic and practical situations as well as my hands-on experience with low-latency media streaming, and more generally, IP

communication over computer networks, provides me with an appreciation of, and expertise in, the technology involved with U.S. Patent No. 8,752,101.

21. I have been retained by counsel for Patent Owner to provide my expert opinion in connection with the above-captioned proceeding as set forth herein. I am being compensated for my work in this case at my standard consulting rate. This compensation is not contingent upon my performance, the outcome of this case, or any issues involved in or related to this case. I have no financial interest in this matter.

B. Summary of Opinion

22. As noted above, I have been asked to provide my opinions regarding validity of the '101 Patent in connection with the *inter partes* review Petition filed by Peloton. It is my opinion that Petitioner fails to show that any of the Challenged Claims are unpatentable. To assist review, and not to limit the scope of my opinions expressed herein, I provide a high-level summary of my opinions below. I understand that I may have an additional opportunity to offer opinions if the Petition is instituted. I reserve the right to provide additional opinions and rationale.

23. The '101 Patent discloses an innovative content delivery system directed to streaming content data at one of a plurality of code rates. This is an approach known in the industry as adaptive code rate streaming, which did not become widely used for content distribution until well into the 2010s. The innovative content delivery

system claimed by the '101 Patent includes a code rate determining unit that is able to determine the code rate of the content data to be delivered from the server device based on an available reproduction time, which is a time available for reproducing the content based on the content data stored at the reception device and a remaining time, which is a time set at which the reception device starts reproduction of the content from a present moment. In this way, the '101 Patent provides a distribution system and method that allows for better quality of service and ensures that content is able to start on time without unnecessarily lowering the code rate (and thereby the quality of the content reproduced to the user).

24. Petitioner does not allege that any of the prior art references anticipate the invention of the '101 Patent claimed by the Challenged Claims.

25. Nor are the Challenged Claims rendered obvious by any of the prior art references, alone or in any of the combinations alleged by Petitioner. Petitioner has failed to show any working modification or combination of prior art will achieve the '101 Patent's invention. Petitioner has also failed to identify and show any motivation to combine the cited references.

26. Accordingly, it is my opinion that all of the Challenged Claims are not unpatentable.

C. Materials Considered

27. The analysis that I provide in this Declaration is based on my education,

research, and experience, as well as the documents I have considered, which are cited throughout this Declaration. In forming my opinions, I have read and considered the '101 Patent (Ex. 1001) and relevant portions of its prosecution history (Ex. 1002). I have also read and considered the Petition and exhibits thereto, including the Declaration of Clifford Reader, Ph.D., in Support of Petition for Inter Partes Review of U.S. Patent No. 8,752,101 (Ex. 1006, the "Reader Declaration") as well as the prior art references cited. I have also read and considered the Patent Owner Preliminary Response and exhibits thereto, including the Declaration of Dr. Dan Schonfeld submitted with the Reply and agree with Dr. Schonfeld's opinions and analyses as demonstrated by my opinions and analyses herein.

II. UNDERSTANDING OF THE LAW

28. My opinions are also informed by my understanding of the relevant law as provided by counsel, as set forth below. I understand that the patentability of a patent is analyzed on a claim-by-claim basis, from the perspective of a hypothetical person of ordinary skill in the art ("POSITA").

A. The Level of Ordinary Skill in the Art

29. I understand that this proceeding is an *inter partes* review ("IPR") proceeding before the Patent Trial and Appeal Board (the "Board"). I understand that claims are to be construed in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history

pertaining to the patent.

30. When interpreting a patent, I understand that it is important to view the disclosure and the claims of that patent from a perspective of a POSITA at the time of the invention.

31. I understand that Petitioner and Petitioner's expert, Dr. Clifford Reader, assert that a POSITA as of the time of invention would have had a bachelor's degree, or equivalent, in electrical engineering, computer science, or a related field, and 2-3 years of experience researching, designing, or developing content delivery systems and related hardware, software, and firmware or equivalent experience. A person having less education but more relevant practical experience, or more education and less experience, might also meet this standard. For the purposes of this Declaration, I will apply this definition of a POSITA.

32. With respect to the '101 Patent, I understand that the time of invention is at the latest November 5, 2009, which is the earliest priority date claimed on the face of the patent. I also understand that Patent Owner may submit evidence that the date of invention for the '101 Patent may be earlier than this date. For the purposes of this Declaration, I will treat November 5, 2009, as the date of invention of the '101 Patent, though I reserve the right to modify this date as I review further evidence.

33. Based on the above definition, I possess, and at the time of invention possessed, at least ordinary skill in the art, and my qualifications and experience

exceed those of a POSITA at the time of invention of the '101 Patent.

34. As such, in arriving at my opinions and conclusions in this Declaration, I have considered the issues from the perspective of a POSITA at the time of invention of the '101 Patent.

B. Prior Art

35. I understand that earlier publications and patents, which may be referred to as “prior art,” may act to render a patent unpatentable based on: (a) anticipation and (b) obviousness. I further understand that the prior art must be viewed from the perspective of a POSITA at the time of invention. I understand from counsel that the earliest priority date of the application for the '101 Patent, November 5, 2009, may be treated as the time of the invention for purposes of my analysis in this Declaration.

36. For purposes of this Declaration, I understand that the alleged “prior art” in the present Petition includes U.S. Patent Pub. No. 2006/0143678 A1 to *Chou* (Ex. 1004), U.S. Pat. No. 7,606,928 to *Wang* (Ex. 1016), and Japanese Patent Pub. No. JP2007-013705 to *Nobuyoshi* (original as Ex. 1009 and certified translation as Ex. 1014).

C. Obviousness

37. I understand that the prior art may render a patent claim “obvious.” Prior art references (*e.g.*, articles, patents, or other publications) that individually disclose fewer than all elements of a patent claim may nevertheless be relied upon to render

a patent claim obvious if the claimed invention would have been obvious to a POSITA based on the collective teachings of the prior art and the knowledge of a POSITA at the time of invention. A patent claim is obvious if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious, at the priority date, to a POSITA to which said subject matter pertains.

38. I understand that obviousness is based on the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and secondary indications of obviousness and non-obviousness. Under the doctrine of obviousness, a claim may be invalid if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the priority date to a POSITA.

39. I further understand that obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rationale to support the legal conclusion of obviousness. Obviousness must be established by providing a sufficient explanation of how the references may be combined, from the perspective of one with ordinary skill in the art, to arrive at the claimed invention, and why the proffered combination accounts for all the features of each claim.

40. In particular, I understand that an obviousness theory must explain why a POSITA would have combined elements from specific references in the way the

claimed invention does.

41. I understand that Petitioner has challenged the Challenged Claims of the '101 Patent as unpatentable based on three different obviousness grounds.

III. THE CHALLENGED PATENT

42. In my opinion, Petitioner fails to show that it is more likely than not that at least one of the claims is unpatentable.

A. Technical Background

43. At the time of the priority date of the '101 Patent, in November 2009, various network streaming protocols had recently emerged or were on the cusp, including HLS (Apple), HTTP Dynamic Streaming (Adobe), MPEG-DASH, and Smooth Streaming Protocol (Microsoft). However, it was not clear which approach(es) to network streaming was going to become the most prominent, and whether any of these adaptive bitrate streaming protocols would supplant other techniques.

44. As an example, one approach to video communications was to download the entire video file and reproduce the video from the downloaded file, which is commonly referred to as video download. Ex. 2008, 713-714. For instance, early forms of on-demand video delivery used a method where the video file needed to be downloaded and stored on a storage device in its entirety before it could be reproduced. *Id.* The disadvantage was that this required a subscriber to wait for the entire download to finish before watching the video. Ex. 2008, 714 (“Most

customers [sic] do not want to wait an hour for their ‘video on demand.’”). Thus, this approach had very long startup times and had significant storage capacity requirements.

45. Another approach utilized transport stream protocols. *See, e.g.,* Ex. 2009. Transport stream protocols allowed for quicker startup times, relative to downloading the entire video, but were prone to problems due to scaling and adaptability. That is, on-demand streaming protocols at the time of the invention did not scale easily to a large number of subscribers because they required dedicated servers. Additionally, the streaming protocols were sensitive to variable network conditions and thus prone to freezing, resulting in poor image quality and various undesirable artifacts.

46. Transport streaming applications required great communications and computing resources and were thus curtailed by computer system managers using firewalls, while also exploited by bad actors in denial-of-service attacks. Ex. 2009, 10 (“A firewall may need to understand the SETUP method to open a ‘hole’ for the UDP media stream.”). Progressive video was introduced as an approach to video streaming designed to circumvent firewalls by masking video streaming as simple web browsing. Ex. 2007, 684 (“The use of HTTP over TCP also allows the video to traverse firewalls and NATs more easily (which are often configured to block most UDP traffic but to allow most HTTP traffic).”). In this approach, the encoded video

file is divided into small segments that are stored on a web server. The receiver then makes web requests for delivery of individual segments that are then decoded and reproduced for display by the receiver. Ex. 2007, 148 (“When a user wants to see the video, the client establishes a TCP connection with the server and issues an HTTP GET request for that URL.”). But progressive video suffered “a major shortcoming: All clients receive the same encoding of the video, despite the large variations in the amount of bandwidth available to a client, both across different clients and also over time for the same client.” *Id.*

47. Progressive video served as an impetus to yet another approach to video streaming based on adaptive bitrate streaming. Ex. 2007, 148. In this approach, the video content was encoded at multiple bitrates and the encoded video stream was divided into multiple smaller segments, just like progressive video. *Id.* Individual video segments at various bitrates were selected by the receiver based on the network and buffer conditions and transmitted by the server to the receiver. *Id.* The ’101 Patent is directed to such adaptive code rate streaming.

48. All of these methods had various advantages and disadvantages and had different hardware and software requirements. At the time, there were a number of considerations related to issues of network ownership, management, and availability, hardware and software requirements on content ingest and encoding, player hardware and software support, and overall system complexity. These concerns were

exacerbated by the fact that new hardware (*e.g.*, set-top boxes, smartphones, laptops, tablets, etc.) was rapidly advancing and, as a result, each had different hardware and software constraints. *See, e.g.*, Ex. 2008, 526 (“When buffer space no longer limits the maximum flow, another bottleneck will appear: the carrying capacity of the network.”). The optimal approach to video streaming was not clear as the various methods presented trade-offs that had to be considered.

49. Adaptive bitrate streaming was still in its infancy in 2009 (when the ’101 Patent was filed), and it was not yet clear whether it would prevail as the dominant video delivery method in the industry. Ex. 2010, Abstract (explaining that, in 2011, “Adaptive (video) streaming over HTTP [was then] gradually being adopted.”). Indeed, at the time of the priority date, the industry had yet to adopt or perfect the nuances of the adaptive code rate approach as indicated by a paper published nearly *two years after* the priority date of the ’101 Patent, which promotes “focus on the rate-adaption mechanisms of adaptive streaming.” *Id.*

50. Because of these challenges, and the nascent era of adaptive bitrate streaming, it was challenging to design a video streaming distribution system employing such streaming techniques. Nonetheless, the inventors of the ’101 Patent proposed a solution to stream “one content coded with any one code rate of *a plurality of code rates* different from each other,” as claimed. Ex. 1001, Claim 1.

B. The '101 Patent

51. The '101 Patent brings together numerous elements and methods previously unknown in the field of content streaming at the time of the invention to provide a better content distribution system. The claimed invention allows server devices to stream content to many different user devices at the best possible quality and adapt to varying network conditions and the quality of the network infrastructure that services each of the devices, while accommodating their different capabilities and minimizing any perceptible video quality impairments. Indeed, the specification of the '101 Patent highlights multiple considerations of how software and hardware would need to be implemented in order to provide reliable adaptive bitrate streaming. And the claims themselves make clear that the invention was directed to a unique approach related to adaptive code rate streaming. Ex. 1001, Claim 1 (“[T]he transmission device being equipped with a content transmitting unit for *transmitting content data*, which is one content coded with any one code rate of a *plurality of code rates different from each other*, to the reception device[.]”) (emphasis added).

52. The '101 Patent explains that the communication speed (*i.e.*, the amount of data that a reception device receives from a transmission device per unit time) varied depending on the status of use of a particular communication line that connected them. Ex. 1001, 1:54-58. In a case where the communication speed became very low, the reception device would not start reproduction of content at the reproduction

start time. *Id.*, 1:62-64. Nevertheless, the inventors of the '101 Patent set course to provide a solution that could adapt to all of these constraints. *Id.*, 2:21-25 (“Accordingly, an object of the present invention is to provide a distribution system capable of solving the abovementioned problems, ‘the code rate may be [set to] be extremely high’ and ‘the reception device [may] be unable to start reproduce content a set reproduction start time.’”).

53. To solve these problems, the '101 Patent provides a distribution system that determines the code rate using a remaining time before reproduction start time, which is set as a time at which the reception device starts reproduction of the content from a present moment, and an available reproduction time, which is a time available for reproduction of the content based on the stored data. *Id.*, 2:39-46. That is, the system determines the code rate using a value set as time at which the reception device starts reproduction of the content about to be transmitted by the transmission device and a value set as time available for reproduction of the content using the content data already received and stored at the reception device. *Id.*, 2:47-49. The transmission device is then able to change the code rate of the content data to be transmitted at the determined code rate. *Id.*, 2:47-49.

54. In this way, the inventors provided a system that allowed reception devices to start the reproduction of content at set reproduction times while avoiding unnecessarily lowering the code rate (and thereby the quality of the media content),

and thus provided an improved content streaming system. *Id.*, 4:14-17.

IV. CLAIM CONSTRUCTION

55. Petitioner has alleged that no claim terms require construction. Pet., 17. I agree. Using the plain and ordinary meaning of the claim terms, it is my opinion that the prior art references do not anticipate the Challenged Claims of the '101 Patent or render the Challenged Claims obvious, either individually or in combination with each other.

V. VALIDITY OF THE '101 PATENT – CLAIM LIMITATION 1[D] IS NOT OBVIOUS IN VIEW OF THE CITED REFERENCES AND KNOWLEDGE OF A POSITA

A. The claims require the available time and remaining time to be values that are used as the basis for the determination of the code rate.

“Available Reproduction Time”

56. The Institution Decision states that “we find no requirement to examine buffer duration recited by claim 1, only to determine the code rate based on available reproduction time.” ID, 41. In my opinion, this conclusion is based on an incomplete reading of the claims. For example, Claim 1 recites determining the code rate based on *inter alia* the “available reproduction time,” which the claims expressly state is “a time available for reproducing the content based on the content data stored in the storage device of the reception device.” EX1001, Claim 1. Accordingly, a POSITA would understand the “available reproduction time” to be an amount of time, corresponding to the time it would take for the stored content to be played up until

the moment that playback ends.

57. Moreover, in my opinion, a POSITA would understand that if an available reproduction time is not examined, acquired, or determined, then no determination could be made based on the available time. That is, a POSITA reading the '101 Patent and Claim 1 would understand determining the code rate for subsequent content data to be transmitted requires using a value of the available time as an input to the determination of the code rate, which necessitates that the available reproduction time must first exist in a tangible form usable by the system (*e.g.*, via determining, acquiring, examining, etc.). EX1001, 9:60-10:18; 10:65-11:3; Claim 1. Particularly, Claim 1 requires the available time to be “based on content data stored in the storage device of the reception device,” which a POSITA would understand to mean that the system looks to (*i.e.*, examines) the content data that is stored at (or near) the time of determining the code rate to obtain, determine, and/or acquire the available time. EX1001, 9:60-10:18; 10:65-11:3; Claim 1.

58. In my opinion, Claim 3 further confirms that the “available reproduction time” is a value of time. Claim 3 states, in part, “*multiplying* the acquired communication speed and the remaining time by a value of a result of subtracting *the available reproduction time* from the target available reproduction time,” as further described in Equations 4 and 5, which demonstrates that the available reproduction time is a value representative of the actual time available for reproduction and is used as an

input into the determination of the code rate. EX1001, Claim 3, 10:24-59. As another example, Claim 2 describes the comparison of the “available reproduction time” by describing that the system “determine[s] a value becoming smaller as the available reproduction time becomes shorter than a target available reproduction time ... as the code rate.” EX1001, Claim 2. A POSITA reading this would understand that the “available reproduction time” is an actual value of time available for reproduction that may “become shorter” than its “target” time.

“Remaining Time”

59. Similarly, Claim 1 requires the code rate to be determined based on “a remaining time” that the claim itself defines as “*a remaining time before reproduction start time set as time* at which the reception device starts reproduction of the content from *a present moment*.” A POSITA would understand this to be a value used as an input to the determining the code rate step for the same reasons as for the “available reproduction time.” Moreover, in my opinion, a POSITA reading the claims and the ’101 Patent would understand that the remaining time is a time at which the reception device starts reproduction of the content that is about to be transmitted at the determined code rate. EX1001, 2:47-49. The cited references in the Petition do not disclose such elements are used to determine the code rate for subsequent frames (*e.g.*, the alleged “content data”).

60. Accordingly, in my opinion, a POSITA would understand that Claim 1

requires the available reproduction time that was first determined, acquired, or “examined” using the content data stored in the storage device of the reception device and that value then being used as an input into the determination of the code rate. EX1001, 9:60-10:18, 10:65-11:3, Claim 1.

1. The '101 Patent Confirms That “Based On” Means that a Value of “the available reproduction time” and “remaining time” are used in the Determination.

61. The '101 Patent is directed to systems and methods of a distribution system having a transmission device and a reception device. EX1001, Abstract; 5:12-20. The transmission device is configured to transmit content coded with any one code rate of a plurality of code rates different from each other to the reception device. *Id.*, 8:46-52. The reception device is configured to receive the content data transmitted by the transmission device, stores received data into a storage device, and also reproduces content based on the stored content data. EX1001, Abstract. In order to determine the code rate of the content data to be transmitted by the transmission device and received by the reception device, the '101 Patent teaches of various algorithms where the code rate is determined “based on a remaining time before reproduction start time set as time at which the reception device starts reproduction of the content from a present moment” and “an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device.” EX1001, Claims 1, 11, 16, 21, 22, 26,

10:44-11:3; 19:10-18.

62. When discussing the determining the code rate “based on” the “available reproduction time” and the “remaining time”, the ’101 Patent describes it as an actual value that is determined prior to it being directly used to “determine the code rate.” For example, the ’101 Patent describes an “available reproduction time” of a transmission part 34 of the terminal device 20a [that] acquires an available reproduction time, which is a time that the content reproduction execution part 33c can reproduce the content based on the content data stored by the buffer part 33b, every time an acquisition period (a change period) set in advance elapses.” *Id.*, 9:60-65. The ’101 Patent further describes that after the value is received by the “code rate determining part 47,” it then “determines a code rate for the terminal device having transmitted the available reproduction time information, based on a remaining time before the acquired (*i.e.*, set) reproduction start time from the present moment and the available reproduction time included in the available reproduction time information.” *Id.*, 10:7-18.

63. Indeed, the ’101 Patent itself clarifies its use of “based on” as an “input.” For example, the ’101 Patent provides an exemplary equation (5) that may be used to determine “a code rate r_{n+1} ” by using the “remaining time” calculated as “ $t_s - t_n$,”

which is the “time at the present moment” subtracted from “reproduction start time”¹ and “ T_n ,” which “denotes the available reproduction time received this time (*i.e.*, at the present moment).” *Id.*, 10:33-59.

$$r_{n+1} = B_n \cdot (t_s - t_n) / (T_d - T_n) \quad (5)$$

Id., 10:54. The ’101 Patent explains that this is an example of what is meant by the “based on.” For example, after the detailed discussion of equation (5), the ’101 Patent states, “[t]hat is to say, the content transmitting part 45 changes the code rate of the content data to be transmitted to the terminal device having transmitted the available reproduction time information, to the code rate determined based on the available reproduction time information.” *Id.*, 10:65-11:3.

64. In other words, the ’101 Patent makes clear that the term “based on” is used to signify a direct use of the values representing the “available reproduction time” and the “remaining time,” as defined by the claims themselves, when determining the code rate.

B. Ground 1 –*Chou* fails to render obvious “determining the code rate ... based on the available reproduction time” for several reasons

65. I understand Petitioner alleges Claims 1, 2, 4, 5, 7, 11, 12, 14-18, 20-23, and 25-29 are obvious in view of *Chou*. (Pet., 6.) Petitioner asserts Claim 1 of the ’101

¹ Note that the ’101 refers to the “reproduction start time” only using a capital ‘T’ so the lower-case usage in equation (5) is presumably a typo.

Patent to be obvious in view of U.S. Patent Application Pub. No. 2006/0143678 A1 (“*Chou*”) (Ex. 1004). (Pet., §IX.A.1 (Claim 1)².) In my opinion, *Chou* does not render Claim 1³ obvious. In my opinion, a POSITA would understand that Claim 1 requires that a value of available time for reproduction (based on the content data already stored) be used as a basis (*i.e.*, an input) to the determination of the code rate for subsequent content data to be transmitted by the server. *Supra*, §V.A. *Chou* does not disclose this. The Board and Petitioner have seemingly come to different conclusions regarding what in *Chou* corresponds to “an available reproduction time,” both of which are addressed in the following paragraphs.

66. In the Institution Decision, the Board found that the “target buffer duration” of *Chou* “teaches the argued ‘available reproduction time.’” ID, 41 (citing Pet., 8). In my opinion, the Petition never alleges that the “target buffer duration” of *Chou* is the “available reproduction time.” Pet., 8, 38-40. Instead, the Petition appears to point to the “gap” between the “*arrival schedule*” and the “playback deadline” the

² The Petition appears to contain an error that caused there to be two §IX.A.1’s. (See Pet., iii.) One is directed to Claim 1 and the second is directed to Claim 7. For the purposes of Claim 1, I refer to the section related to Claim 1 that begins on page 24 of the Petition.

³ Claims 11, 16, 21, 22, 26, 27, 28, and 29 are the other independent Challenged Claims. The Petition merely cross-references its analysis of Claims 11, 16, 21, 22, 26, 27, 28, and 29 (Pet., 50-61) to Claim 1 for its allegation that *Chou* renders these claims obvious. In my opinion, *Chou* does not render Claims 11, 16, 21, 22, 26, 27, 28, and 29 obvious for the same reasons as described herein with reference to Claim 1.

as allegedly corresponding to the “available reproduction time” of Claim 1, whereas the “target buffer duration” (*i.e.*, the “desired client buffer duration”) is taught to be the difference between the “playback deadline” and the “*target schedule*.” EX1004, Fig. 6; ¶74; *see infra* ¶67.

67. To the extent the Petition had advanced the theory that the “target buffer duration” (*i.e.*, “desired client buffer duration”) of *Chou* satisfied the “available reproduction time” limitation, in my opinion, such an argument would fail for the reasons described below. *Infra*, §V.B.2.

68. With respect to the allegations in the Petition, Petitioner’s argument relies on the incorrect assumption (without supporting evidence) that *Chou* discloses an available reproduction time determined based on the content data ***stored in the storage device***. Pet., 39-40 (arguing that *Chou* “examines the current buffer duration to determine whether arrival of a subsequent frame needs to be accelerated (increasing buffer duration) or delayed (decreasing buffer duration).”). Petitioner appears to advance two different theories: (i) that the “gap” between the “*arrival schedule*” and the “playback deadline” is the claimed available time (*See* Pet., 8) and (ii) that the “gap” between the “*arrival time*” (*i.e.*, actual arrival time) of a frame and the “playback deadline” is the available time (*See* Pet., 39-40). But, as explained below, the first would be impossible. *Infra*, §V.B.3. Moreover, Petitioner’s latter arguments are flawed because, as a threshold matter, the Petition fails to point to any

evidence that a value of the “gap” is “examined” (*e.g.*, determined, monitored, or otherwise acquired), much less used in the determination of the code rate for subsequent frames. *Infra*, §§V.B.3.a, V.B.3.c. Moreover, as demonstrated below, the alleged “gap” does not correspond to the claimed available reproduction time. *Infra*, §V.B.3.b. A POSITA would understand that *Chou*’s disclosed method does not suggest using an available reproduction time to determine the code rate. *Infra*, §V.B.3. Indeed, a POSITA reading *Chou* would understand that *Chou* expressly teaches away from utilizing the available reproduction time. *Infra*, §V.B.5. But first, a brief explanation of the disclosure of *Chou* is provided.

1. Overview of Chou

69. *Chou* differs significantly from the approach recited in the Challenged Claims. For instance, *Chou* controls the code rate of content to achieve an upper bound of time of arrival of bits into the client’s buffer and grows the size of the client’s buffer over time. EX1004, ¶¶19-20. In contrast, the Challenged Claims do not depend on controlling an upper bound that is a limit imposed by the encoder side buffer (EX1004, ¶¶19-20; 22-25) to influence buffer size at the client. Instead, the Challenged Claims adjust the code rate of content data to be transmitted based on: (1) the time remaining before playback will begin, and (2) the amount of time the data currently in the buffer would take to playback at a normal playback/reproduction rate (“available reproduction time”). Because of these

substantially different approaches, nothing in *Chou* corresponds to either the claimed “remaining time” or the “available reproduction time.”

70. In *Chou*’s system, the problem of determining code rates for subsequent frames is “formulated as a standard problem in linear quadratic optimal control” that incorporates a “leaky bucket model into the control loop.” EX1004, ¶19. *Chou* discloses that the “leaky bucket model” can be visualized by imagining a scenario where the encoder and the decoder run in real time over a network, which is best visualized in Figures 2 and 3. EX1004, ¶60.

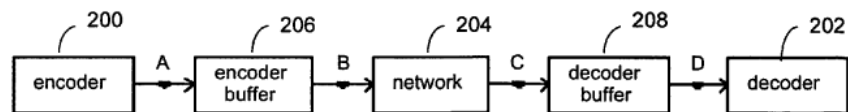


FIG. 2

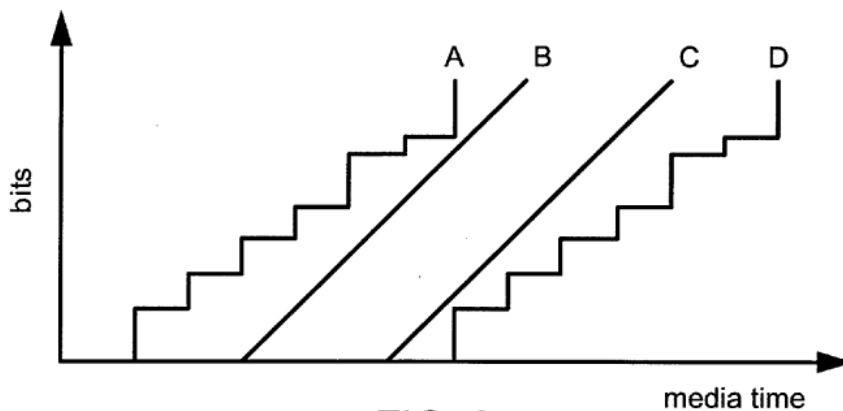
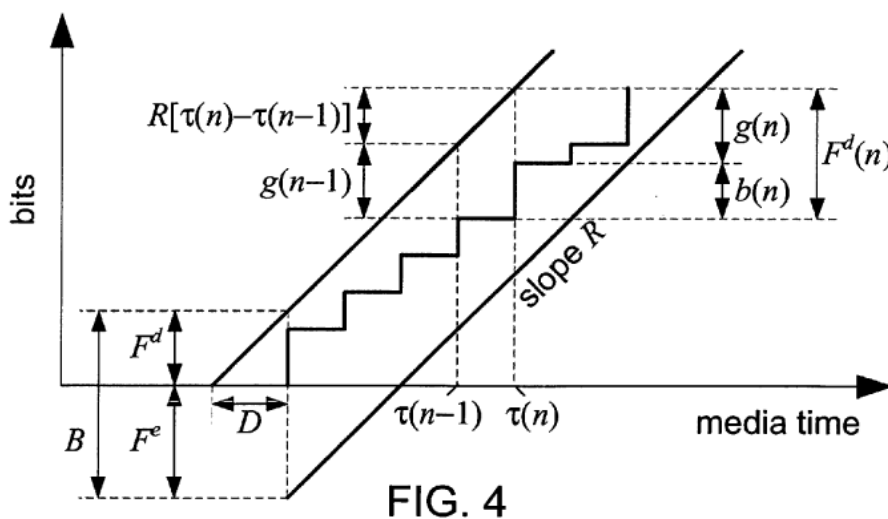


FIG. 3

EX1004, Figs. 2-3.

71. Schedule A is the schedule at which captured frames are encoded and placed into the encoder buffer 206 with each “step” representing a frame having the number of bits that correspond to the encoding of that frame. EX1004, ¶60. Schedules B and

C are the “schedules at which bits respectively enter and leave the communication channel,” which is to say Schedule B represents when each bit leaves the encoder buffer 206 and Schedule C represents when each bit is received by the decoder buffer. *Id.* Schedule D is the “schedule at which frames are removed from decoder buffer” and decoded for presentation. *Id.* Importantly, *Chou* discloses that Schedule B is a “lower bound” to Schedule A, Schedule C is an “upper bound” to Schedule D. *Id.* Thus, since the system in *Chou* utilizes both an encoder buffer and a decoder buffer, Schedules B and C are disclosed to be the “buffer tube” that is said to bound both buffer schedules, which is shown in Figure 4. *Id.*



EX1004, Fig. 4.

72. *Chou* then extrapolates this model by dividing the y-axis, which was “bits” by “ r_a ” which is the rate “that bits arrive at the client,” to derive Figure 5. EX1004, ¶67.

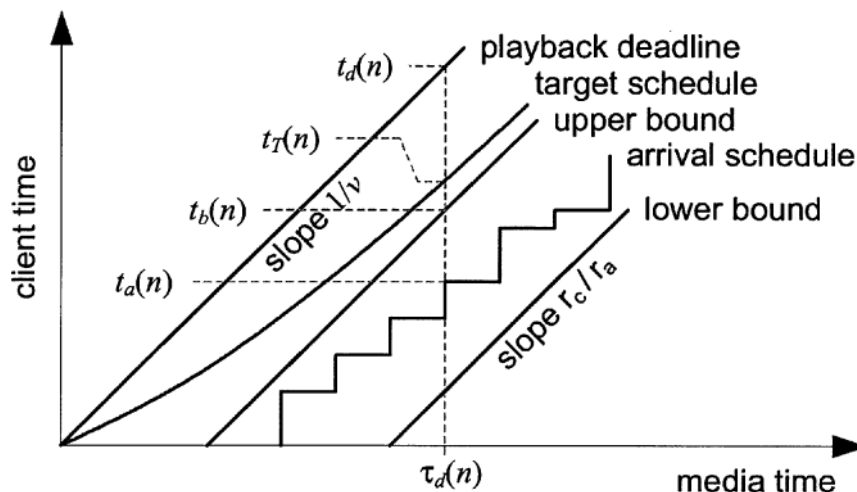


FIG. 5

EX1004, Fig. 5. Figure 5 also includes a “playback deadline,” which is the time “ $t_d(n)$ ” at which frame “ n ” is scheduled to be played, and a “target schedule” that is an idealized schedule of time “ $t_T(n)$ ” at which frame “ n ” would ideally arrive. EX1004, ¶¶67, 72. Importantly, the idealized schedule of time “ $t_T(n)$ ” is different from the actual time “ $t_a(n)$ ” of arrival of frame “ n .” *Chou* discloses that “[b]y regulating the coding bit rate, it is attempted to control the buffer tube upper bound so that it tracks the target schedule.”⁴ EX1004, ¶70. *Chou* discloses that controlling the “buffer tube upper bound” is done via use of equation (18) to approximate “ $t_b(n)$ ” to “ $t_T(n)$ ” by controlling “the coding bit rate $r_c(n)$.” EX1004, ¶69, 72.

⁴ Petitioner alleges that the “coding bit rate” of *Chou* corresponds to the “code rate” of the ’101 Patent. Throughout this declaration, I refer to them both as the “code rate” unless directly quoting from *Chou*.

$$t_b(n) = t_b(n-1) + \frac{r_c(n)}{f(n)\tilde{r}_a(n)} + w(n-1), \text{ where} \quad (18)$$

EX1004, ¶68.

73. This understanding gives meaning to *Chou*'s express statement of “[i]t is noted that in the present system and process, it is not the actual fullness of the client buffer that is controlled, but an upper bound on the time of arrival of bits into the client buffer, to a target level” because the actual arrival of bits is never actually determined or controlled. EX1004, ¶19. Indeed, *Chou* warns that “controlling the actual arrival times (rather than their upper bounds) to the target would result in an approximately constant number of bits per frame, which would in turn result in very poor quality overall.” EX1004, ¶70. Additionally, *Chou* warns that because of the nature of its system “at time $t_a(n)$, frame $n+2$ is the earliest frame for which the controller can determine the coding bit rate. Hence, at time $t_a(n)$, the controller's job must be to choose $rc(n+2)$.” EX1004, ¶81.

74. *Chou* discloses determining the code rate based on an estimation between an “upper bound” that is defined by the constraints of the encoder buffer and an idealized “target schedule.” EX1004, Fig. 5, ¶67. Yet, in my opinion, neither of these elements are (or include) “an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device” or “a remaining time before reproduction start time set as time

at which the reception device starts reproduction of the content from a present moment” as required by Claim 1.

2. Chou’s “target buffer duration” does not render obvious “determining the code rate ... based on the available reproduction time”

75. As noted above, in the Institution Decision, the Board stated that “Petitioner has established that *Chou*’s target buffer duration ... teaches the argued ‘available reproduction time.’” ID, 41. In my opinion, a POSITA would not understand the “target buffer duration” to teach a “determining the code rate ... based on an available reproduction time” because (a) the available reproduction time is not a “target” time (*infra*, §V.B.2.a); (b) the “target buffer duration” is not based on what is stored in the storage device of the reception device (*infra*, §V.B.2.b); and (c) even if a value of the “target buffer duration” was calculated (it is not), the value is not used as an input to determine the code rate (*infra*, §V.B.2.c).

76. The “target buffer duration” (*i.e.*, “desired buffer duration”) of *Chou* is the difference between the “playback deadline” and the “*target schedule*.” EX1004, Fig. 6; ¶74. Figures 5 and 6 of *Chou* are reproduced below for reference.

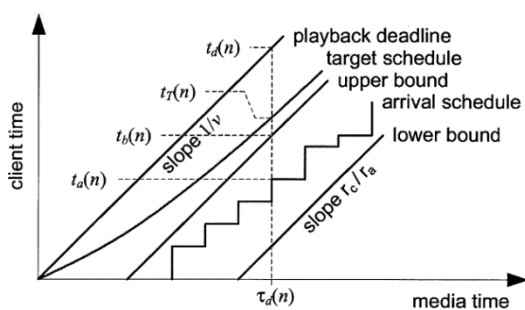


FIG. 5

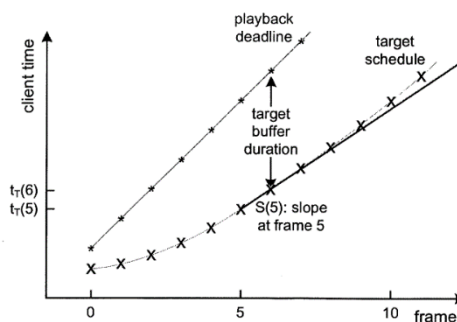


FIG. 6

EX1004; Figs 5 and 6. As shown in Fig. 5, *Chou*'s "target buffer duration" (*i.e.*, "desired buffer duration") is what *Chou* describes as a "gap" between the "playback deadline" and its "target arrival." EX1004, ¶74; Fig. 6. *Chou* describes this value in theoretical terms by explaining that "if the gap grows slowly over time, it gradually increases the receiver's ability to counter jitter, delays, and throughput changes." EX1004, ¶74. But *Chou* does not disclose, teach, or suggest that this theoretical relationship between the "playback deadline" and the "target schedule" is an "available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device," as recited by Claim 1.

77. *Chou* describes the "playback deadline" as "the time $t_d(n)$ at which frame n is scheduled to be played." EX1004, ¶67. In my opinion, a POSITA reading *Chou* would understand the "target schedule" to be an idealized "target" schedule at which frames arrive. EX1004, ¶27. Importantly, however, as seen in Figure 5, the "target schedule" is different from the "upper bound" and the "arrival schedule" of frames. *Chou* teaches that its primary goal is to control the code rate to approximate the "upper bound" to the "target schedule." EX1004, ¶70.

**a) *Chou*'s "target buffer duration" is a target time, but the
"available reproduction time" is not a target time**

78. The "available reproduction time" is not a "target value" and thus the "target buffer duration" of *Chou* is not an "available reproduction time." A POSITA would

understand the “available reproduction time” is a value representative of a “time available for reproducing the content” and that the value is “based on the content data *stored* in the storage device of the reception device” at the time of (or prior to) the determining of the code rate, as recited by Claim 1. In view of the claim language, a POSITA would not understand “the available reproduction time” to be a “target value.”

79. The dependent claims also demonstrate that the “available reproduction time” is not a “target” time. In particular, the dependent claims do recite “a *target* available reproduction time” defined as “a *target value* of the available reproduction time” and further explain various relationships of the “target available reproduction time” time to the “available reproduction time.” ’101 Patent, Claims 2, 3, 6, 9, 10, 12, 13, 18, 19, and 23. For example, Claim 2 states the system “determine[s] a value becoming smaller as *the* available reproduction time becomes shorter than *a target* available reproduction time ... as the code rate,” which would not make sense if the “available reproduction time” was a “*target* available reproduction time.” EX1001, Claim 2.

80. Accordingly, in my opinion, a POSITA would understand the “available reproduction time” is not a “target” and therefore that the “target buffer duration” of *Chou* does not disclose the “available reproduction time” of Claim 1.

b) *Chou*'s "target buffer duration" is not "based on content data stored in the storage device" as required by Claim [1d]

81. The "target buffer duration" is not an available reproduction time because the target buffer duration is not "based on content data stored in the storage device of the reception device" as required by Claim 1. *Chou* describes the "target buffer duration" depicted in Fig. 6 as "the desired client buffer duration." EX1004, ¶74. A POSITA reading *Chou* would understand this to mean that the "target buffer duration" is not tied to any data that is already stored in the storage device of the reception device. In my opinion, a POSITA would understand that the "target buffer duration" specifies the *desired* amount of content data to be stored in the storage device at some future time, and *not* a value based on the content data already *stored* in the storage device. Thus, a POSITA would understand that even if this value was determined and used as a basis for determining the code rate for future frames, it would not render claim 1[d] obvious because it would mean that the code rate was being determined based on a desired time and not based on the "time available for reproduction" that is based on data that has *already been stored* in the reception device.

82. Accordingly, in my opinion, even if *Chou*'s "determination of the code rate" were directly or indirectly based on the "target buffer time," *Chou* does not disclose this claim element because the "target buffer time" is not the claimed "available

reproduction time.”

**c) *Chou*’s “target buffer duration” is never used to
“determine the code rate”**

83. Claim 1 requires the “determining the code rate ... based on an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device.” EX1001, Claim 1. A POSITA would understand this to mean that a value of the “available reproduction time” is used as an input to the determination of the code rate. *Supra* §V.A. Thus, if the “target buffer duration” is alleged to be the “available reproduction time” (it is not for the stated reasons above), then for *Chou* to disclose this claim limitation, *Chou* must disclose that a value of the “target buffer duration” is used to determine the code rate of the “content data to be transmitted.” EX1001, Claim 1. It does not.

84. As explained above, *Chou*’s control algorithm regulates the code rate in “attempt[] to control the buffer tube upper bound so that it tracks the target schedule.” EX1004, ¶70. *Chou* determines a code rate by approximating the “upper bound” to the “target schedule” for a future frame by utilizing equation (18). EX1004, ¶70. But nowhere in equation (18) is a “target buffer duration” used. A POSITA would understand that in order to meet this limitation, a value representative of “a *time* available for reproducing the content” needs to be part of the determination for the future frames.

85. A POSITA would understand that *Chou* does not disclose this limitation because the “target buffer duration” value (*i.e.*, a time) is never calculated and used in the determination of the code rate for subsequent frames. To the extent it is argued that approximating the “upper bound” to the “target schedule” means that the “target buffer duration” is indirectly used to determine the code rate, that point is moot because a POSITA would understand that the “target schedule” is not based on the “content data stored in the storage device of the reception device” as required by Claim 1. Instead, *Chou* describes that the target arrival time (“scheduled target arrival time”) for each frame is “chosen so as to make the amount of time between the target time of a frame and its playback time large enough [...] do not result in the frame arriving after its scheduled playback time.” EX1004, ¶27. For example, *Chou* describes that the “target schedule” can be set one of two ways: (1) “by setting the target arrival time for each frame using a logarithmic target schedule”; or (2) “by setting the target arrival time for each frame using a two-piece linear target schedule where the difference between the target arrival time and the playback time for a frame arriving during the startup period increases linearly to a prescribed amount of time that is large enough to account for the network jitter, delays and throughput changes and after which the difference remains substantially constant.” *Id.* A POSITA would understand that these descriptions do not suggest the “target schedule” is based on the decoder buffer fullness. Instead, the “target schedule” is

set based on the “playback deadlines” of frames to be played during playback of the content, which a POSITA would understand is independent of what is stored in the buffer. Chou’s system then adjusts the code rate of the data to control the slope of the “upper bound” so that the “upper bound” converges to the “target schedule,” which a POSITA would understand to be independent of what is stored in the buffer. Rather, the “target schedule” is an idealized time of when frames *should arrive in the future* and the “upper bound” is an encoder-side buffer limitation that dictates the earliest time that frames *could arrive in the future*. That is, even if the “upper bound” matches the “target schedule”, it merely means that *frames will arrive in the future* no earlier than the target schedule, which is independent of what has *already been stored*.

86. Thus, in my opinion, *Chou* does not disclose, teach, or suggest this element of Claim 1.

3. *Chou’s “gap between the arrival schedule and the playback deadline” does not render obvious “determining the code rate ... based on the available reproduction time”*

87. For clarity, the Petition alleges that the “gap between the arrival schedule and the playback deadline” corresponds to the claimed “available reproduction time.” Pet., 8, 38-40. This is different from *Chou’s* “gap” between the “target schedule” and the “playback deadline,” which is the “target buffer duration,” which is what was identified by the Institution Decision found to be the “available reproduction

time.” EX1004, Fig. 5; ID, 41. As an initial matter, in my opinion, the “gap” between the “*arrival schedule*” and the “playback deadline” cannot be calculated (*i.e.*, determined) with any degree of certainty for any of the frames that have not arrived yet. Indeed, a POSITA would recognize that network conditions would most certainly cause future frames to arrive before or after a scheduled time of arrival or, in some cases, the frame may be dropped and never arrive (without a request for retransmission).

88. In the Institution Decision, the Board stated that “Patent Owner’s arguments concerning examining buffer fullness and calculating a difference in playback and arrive times do not appear to be commensurate in scope with claim 1, which has no such requirements, much less a requirement to monitor the actual reproduction time of content data stored in the storage device of the reception device.” ID, 41. Yet, in my opinion, as explained in Section V.A above, a POSITA would not understand the claims in this way.

89. In my opinion, in order for *Chou* to disclose this element, *Chou* must disclose determining a value of time available for reproduction of the content on the basis of the content data *stored* in the storage device and further use that value in the determination process. Petitioner’s argued “gap” in FIG. 5 between the “arrival schedule” and “playback deadline” fails this test because a POSITA would understand that it would be impossible to calculate this time value for frames that

have not arrived – and even if it were possible, it is not based on what is already *stored* at the reception device, as a POSITA would understand to be required by the claims.

90. To the extent the Petition meant the “gap” between a frame’s playback deadline and its *actual* arrival time is the claimed available reproduction time, that argument similarly fails because the value of that “gap” is (a) never determined (*i.e.*, acquired, calculated, monitored, etc.) (*infra*, §V.B.3.a); (b) even if its value were to be determined, the value would *not* be a “time available for reproduction of the content based on the content data *stored*” at the reception device (*infra*, §V.B.3.b); and (c) *Chou* does not teach or suggest using such a value in determining the code rate, and instead warns against attempting to control the “actual arrival” of frames and “the actual buffer fullness” (*infra*, §V.B.3.c).

a) A value of *Chou*’s “gap” between the “arrival schedule” and the “playback deadline” is never determined.

91. *Chou* does not disclose ever calculating the “gap” between the “arrival time” and the “playback deadline.” In *Chou*, the code rate is calculated by estimating the “upper bound” of the arrival of bits to a “target schedule.” EX1004, ¶67. Importantly, the “upper bound” is not the “arrival time.” EX1004, Fig. 5. Moreover, *Chou* is clear “that controlling the actual arrival times (rather than their upper bounds) to the target would result in an approximately constant number of bits per frame, which would in turn result in very poor quality overall.” EX1004, ¶70.

92. Accordingly, a POSITA would understand, based on these teachings, that it is undesirable to control the “actual arrival times” of frames, from which a POSITA would conclude that *Chou*’s calculation of the code rate should not be based on the actual “gap” between the “arrival time” and the “playback deadline” because such an action would suggest that the system cares when the actual arrival occurred – contrary to the teachings of *Chou* that suggest the system should ignore the actual arrival time of frames. In other words, a POSITA would conclude that a “gap” between the “arrival time” and the “playback deadline” is not ever determined (or used in the calculation of the code rate for subsequent frames) because, as *Chou* warns, any attempts to control such parameter would “result in very poor quality overall.”

b) A value of *Chou*’s “gap,” even if it were taught to be determined (it is not) is not the “time available for reproducing content based on the content data stored,” as required by Claim [1d]

93. Even if a “gap between a frame’s arrival time and its playback deadline” was calculated (it is not) it is still not the claimed “available reproduction time” that is “based on the content data stored in the storage device” because such a “gap” does not correspond to “a time available for reproducing the content based on the content data stored in the storage device of the reception device,” as required by Claim 1. In particular, (i) a calculation of the gap yields a value that is different from a time available for reproducing the content and (ii) such calculation is not based on the

content data stored. These points are demonstrated below with respect to annotated Figure 5 of *Chou*.

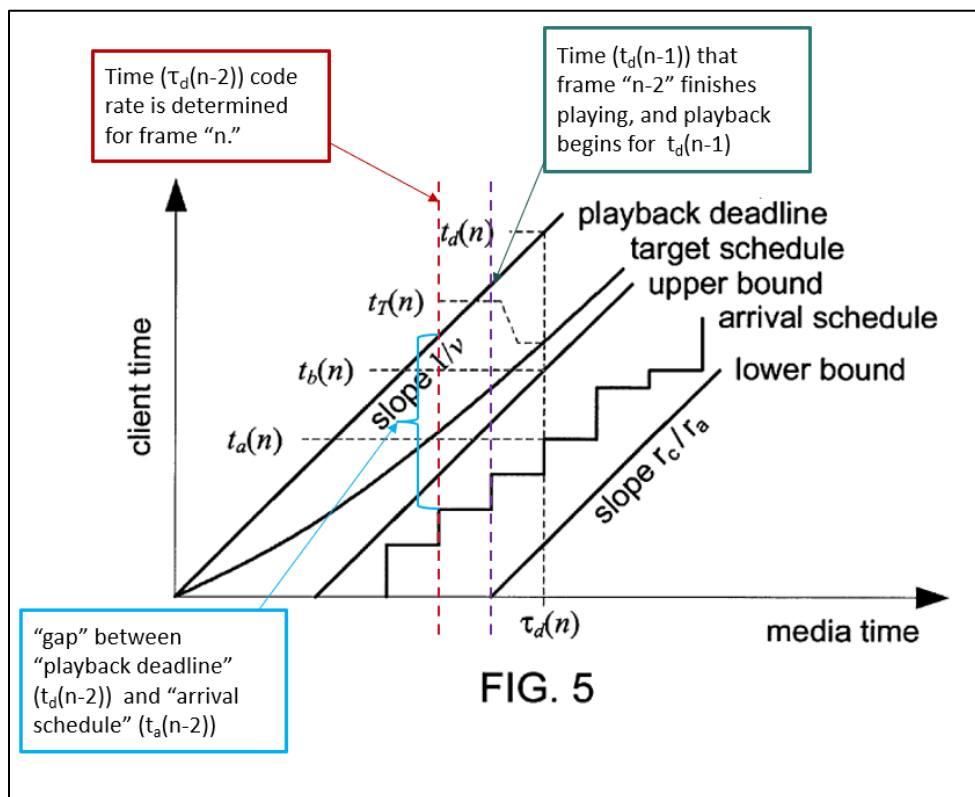


FIG. 5

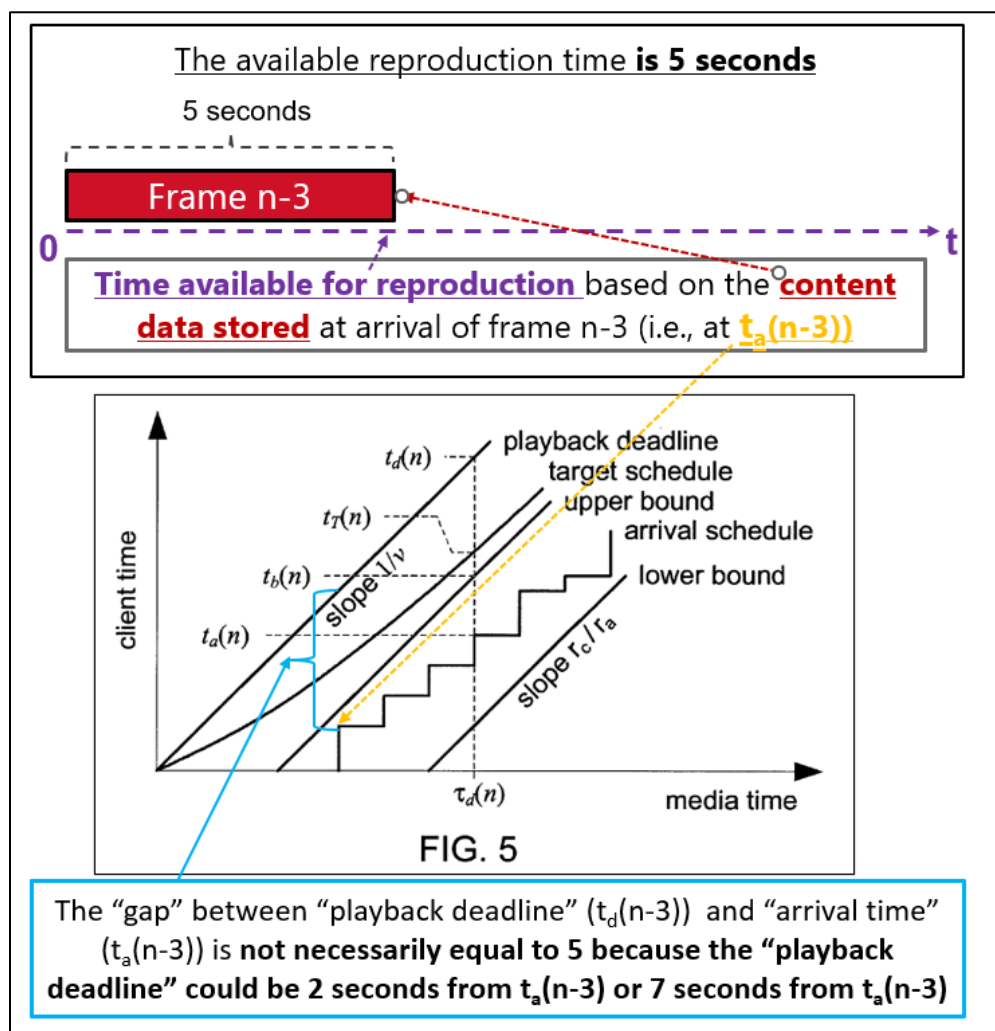
EX1004, Fig. 5 (annotated). As can be seen, a calculation of the “gap” between the “playback deadline” and the “arrival schedule” for frame “n-2” is depicted in blue. Time $t_a(n-2)$ corresponds to the time at which the code rate for frame “n” would need to be calculated, according to *Chou*. EX1004, ¶81 (“Indeed, at time $t_a(n)$, frame n+2 is the earliest frame for which the controller can determine the coding bit rate. Hence at time $t_a(n)$, the controller's job must be to choose $r_c(n+2)$. This one-frame delay in the feedback loop must be explicitly accounted for.”). But as can be seen from Figure 5, if the “gap” at time $t_a(n-2)$ was determined (it is not) for the code rate

to be determined based on the value of that gap, it would not be the “available reproduction time.” For example, the “gap” at frame “n-2” in blue would yield a result of $t_d(n-2) - t_a(n-2)$, but the client device would not stop playing until frame “n-2” *finished* playing at time “ $t_d(n-1)$.”⁵ Thus, in my opinion, a POSITA would understand that the “gap” between the “playback deadline” and the “arrival schedule” (if the frame even arrived on schedule) would not correspond to the “available reproduction time, which is *a time available for reproducing the content* based on the content data *stored* in the storage device of the reception device” as required by Claim 1.

94. This example, in addition to the examples raised in the POPR, demonstrate that the “gap” between the “playback deadline” and the “arrival schedule” are not the “available reproduction time” as the Petition suggests. For example, in the POPR, Patent Owner argued, in the alternative, that even if a value of the “gap” between the “arrival schedule” and the “playback deadline” were to be calculated then that value of the “gap” would not be “a time available for reproducing the content based on the content data stored in the storage device” because “it does not account for times where the buffer may not have any content data.” POPR, 22. In particular, Patent Owner’s point was that the “gap” is not necessarily tied to the

⁵ For additional accuracy, I note that the client would in fact stop playing **just before** (*i.e.*, 1 audio sample before) time $t_d(n-1)$.”

actual content data ***stored*** in the storage device because (1) frames could have been dropped and thus not received, which would not be accounted for by referencing the “arrival *schedule*,” and (2) at various times, such as at startup, a value of the “gap” would not correspond to the actual frames that are ***stored*** in the storage device, as required by the claims, which is demonstrated here using the illustration below.



95. In the Institution Decision, the Board responded to these arguments stating that “[e]ven if correct, Patent Owner does not explain why this special case negates *Chou’s* ‘gap’ otherwise representing a time available for reproducing the content

(e.g., during normal operations when the buffer does store content.)” ID., 43. But the examples here demonstrate that a value of the gap does not *necessarily* correspond to a “time available for reproducing the content” because it is not “based on the content data *stored* in the storage device,” as required by Claim 1. In other words, these examples demonstrate that such a value of the gap is divorced from the time available for reproduction that would be determined based on the “content data stored in the storage device.”

96. Accordingly, a POSITA would understand that *Chou* fails to disclose that a value of the “gap” between the “arrival schedule” and the “playback deadline” is ever determined. Moreover, a POSITA would understand that, even if a value of the gap were calculated, it would not correspond to the claimed “available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device,” as required by Claim 1.

c) A value of *Chou*’s “gap” between the “arrival schedule” and the “playback deadline” is never used to “determine the code rate”

97. As explained above, *Chou* discloses controlling “an upper bound on the time of arrival of bits into the client buffer” to the “target schedule.” EX1004, ¶70. *Chou* teaches that, by use of equation (18) a controller can approximate the “upper bound” to the “target time” by adjusting the code rate. EX1004, ¶69 (“Then using Eq. (18), the client can control the coding bit rate $r_c(n)$ so that $t_b(n)$ reaches a desired value,

assuming the frame rate and arrival rate remain roughly constant.”). But *Chou* does not teach that a value of the “gap” between the “arrival schedule” and the “playback deadline” should be determined, or more specifically, that the determination of the code rate for subsequent frames should be determined based on the value of the “gap” at or before the time that the code rate is determined, which a POSITA would understand to be required for *Chou* to teach the claim element. *See supra* §V.A. To the contrary, a POSITA would understand that *Chou* teaches **not** to utilize such a “gap” in calculating new code rates. *infra* §V.B.5.

98. *Chou* discloses that the “gap” between “a frame’s *arrival time* and its playback deadline is the client buffer duration *at the time of the frame arrival*.” EX1004, ¶67. And *Chou* also discloses that is “**not** the actual fullness of the buffer” that is controlled. EX1004, ¶19. A POSITA would understand that *Chou* is teaching that a value of the “gap,” which is the “client buffer duration *at the time of the frame arrival*” should **not** be used to determine the code rate for subsequent frames because doing so implies attempting to control the actual fullness of the buffer on the basis of the actual arrival times of frames, which *Chou* warns would result in “very poor quality overall.” EX1004, ¶70. Thus, a POSITA would conclude *Chou* does not teach determining the code rate based on the “gap” between a frame’s “arrival time” and the frame’s “playback deadline.”

99. Thus, given this backdrop and in view of the fact that *Chou* does not disclose,

teach, or suggest that the “gap” between the “arrival schedule” and the “playback deadline” should be calculated (and/or used) in the determination of the code rate for subsequent frames, a POSITA would understand that *Chou* does not disclosing “determining the code rate ... based on an available reproduction time, which is a time available for reproduction based on content data stored in the storage device,” as Claim 1 recites.

4. *Chou’s disclosure to control “an upper bound on the time of arrival of bits into the client buffer, to a target level” does not disclose “determining the code rate ... based on the available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device”*

100. In the Institution Decision, the Board stated that “Patent Owner fails to explain why *Chou*’s disclosed control of an upper bound on the arrival of bits, thereby controlling a frame’s arrival time, fails to result in also controlling (albeit indirectly) buffer duration.” ID, 42. In my opinion, a POSITA would understand that “controlling buffer duration,” regardless of whether it is direct or indirect, is not sufficient to teach this limitation because, as explained above, the claim requires the “available reproduction time” to be a value of the time available for reproduction based on the content data that is stored in the storage device at (or near) the time of the determination, and requires it to be used in determining the code rate. *See supra* §V.A. Moreover, as explained *infra* §V.B.5, *Chou* expressly warns that “controlling a frame’s arrival time” as suggested by the Board, would result in “very poor

quality.”

101. *Chou* does not suggest ever using an available time in its calculation of the new code rate, or that it would be desirable to do so. Instead, equation (18) of *Chou* teaches using an update equation to approximate an “upper bound” to an approximated “target schedule.” This equation does not in any way consider the actual time available for reproduction based on what is stored in the storage device. Moreover, as explained above, *Chou* discloses that the earliest frame that can have a new code rate at time “ $t(n)$ ” is time “ $t(n+2)$.” A POSITA would understand this to mean that at time “ n ” the determination of the code rate needs to use a time available for reproduction based on what is in the storage device of the reception device. Yet, *Chou* does not disclose this nor does the Petition allege that *Chou* discloses this.

102. Accordingly, a POSITA would understand that controlling a bound on the earliest arrival of subsequent frames to a target time does not mean that the code rate is determined based on the claimed “available reproduction time” as required by Claim 1.

5. *Chou teaches against controlling the “actual fullness of the buffer”*

103. *Chou* is clear that it is “**not** the actual fullness of the client buffer that is controlled.” EX1004, ¶19. Moreover, *Chou* explicitly warns against determining the code rate based on the “the actual arrival times (rather than their upper bounds) to the target would result in an approximately constant number of bits per frame []

would in turn result in very poor quality overall.” EX1004, ¶70. These explicit disclosures and warnings would color the rest of a POSITA’s analysis of what *Chou* is disclosing. A POSITA would understand that controlling the actual fullness of the buffer would need to be achieved by controlling the actual arrival times of the frames, which *Chou* states should not be done. As such, a POSITA would understand that using the actual fullness of the buffer at the time of arrival of a frame “n,” which *Chou* teaches is the difference between frame “n’s” playback time and actual arrival time, would mean that the determination of the code rate for frame “n+2” is being determined on the basis of the actual arrival time of the frames – which a POSITA would understand to be hazardous to the quality of playback in view of *Chou*’s warnings. EX1004, ¶70. In other words, in my opinion, a POSITA would understand that *Chou* teaches the actual buffer fullness should not be considered in calculating the code rate for subsequent frames.

104. The Institution Decision states that “Patent Owner provides insufficient evidence that *Chou* teaches against also monitoring actual fullness of the client buffer.” ID, 42. In particular, the Board states, to the contrary, “*Chou* discloses” (i) “a client requesting a new coding bit rate ‘if the current client buffer duration exceeds the desired duration level by [a specified] amount’” and (ii) “a fast startup technique wherein ‘playback can begin while the buffer duration is still low’ by choosing a low initial coding bit rate to grow the client buffer ‘until the buffer

duration [is] sufficiently high to guarantee continuous playback over the long term.”

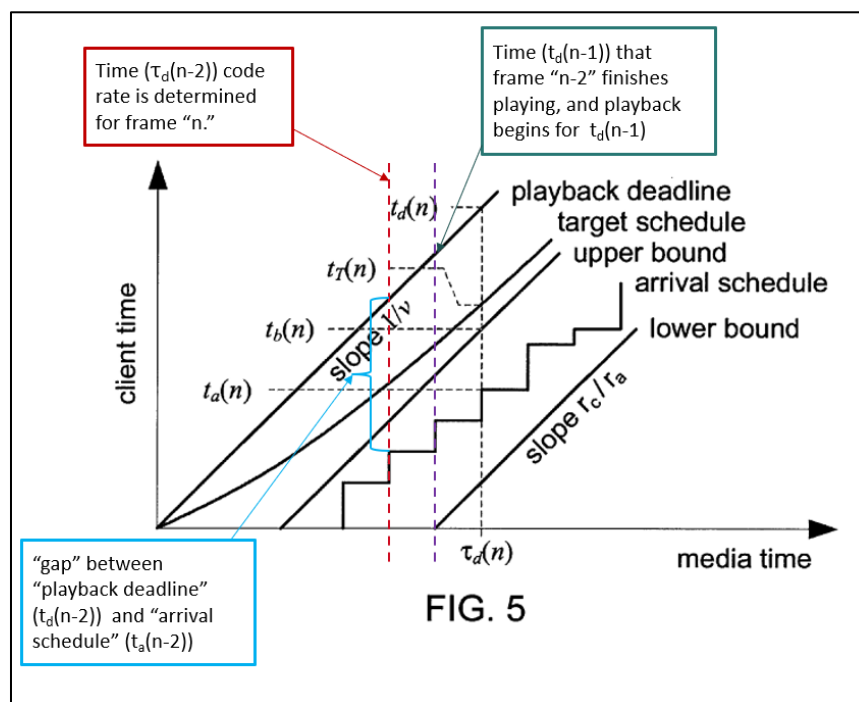
ID, 42. In my opinion, the POPR did not advance an argument that “Chou teaches against also monitoring actual fullness of the client buffer.” POPR, 24-25. Instead, the POPR stated that “not only does Chou *not* disclose ‘determining a code rate ... based on ... the available reproduction time,’ it expressly *teaches against* doing so ...” *Id.*

105. In my opinion, the examples provided by the Board were not alleged in the Petition to teach this element or cited to support a finding for this element. But even if the Petition did rely on these examples, *Chou* still would not disclose “determining the code rate ... based on an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device,” as required by Claim 1 for the reasons described below.

a) Even if the “current client buffer” was found to be used in the process of “determining the code rate” it is not “an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device” as required by Claim 1

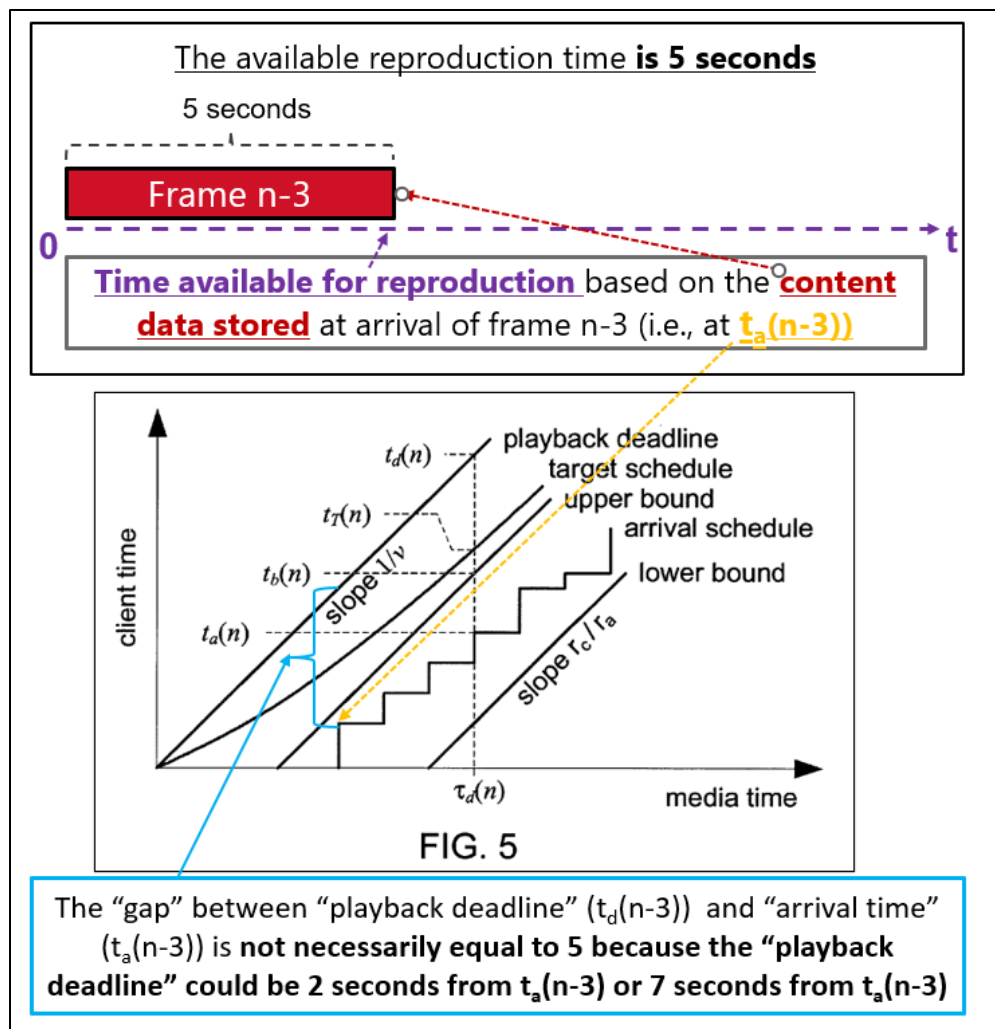
106. *Chou*’s “current client buffer duration” is not “a time available for reproducing the content based on the content data stored in the storage device of the reception device” as required by Claim 1. For example, *Chou* teaches that “the gap between a frame's arrival time and its playback deadline is the client buffer duration at the time of the frame arrival.” EX1004, ¶67. Thus, *Chou* discloses that the current

client buffer duration at time “n-2” is the “difference between” the “arrival time” of frame “n-2” and its “playback time,” but this is not “a time available for reproducing the content based on the content data stored in the storage device of the reception device.” This is demonstrated below with respect to annotated Figure 5 of *Chou*.



107. A POSITA reading *Chou* would understand the “current client buffer” is the “buffer duration,” at a (current) point in time, which *Chou* describes as “the gap between a frame’s arrival time and its playback deadline is the client buffer duration at the time of the frame arrival.” EX1004, ¶67. Thus, a POSITA would understand at the time of arrival of any particular frame, for example, frame n-2, the “current client buffer duration” is the “gap.” But, as explained above, in §V.B.3, the “gap”

$(t_d(n-2) - t_a(n-2))$, which *Chou* discloses as the “client buffer duration at the time of the frame arrival,” is not “a time available for reproducing the content based on the content data stored in the storage device of the reception device” for two reasons. First, frame $n-2$ will not *finish* its playback until $t_d(n-1)$, when frame $n-1$ is scheduled for playback, and thus the “time available for reproduction” is actually $(t_d(n-1) - t_a(n-2))$ and **not** *Chou*’s disclosure of $(t_d(n-2) - t_a(n-2))$. Second, as explained above, a POSITA would understand that the simplistic calculation of *Chou*’s “gap” does not look to stored data and therefore is not based on the “content data **stored** in the storage device,” as required by Claim 1. For example, as demonstrated in the figure below, the calculation is incorrect at the beginning of playback of the first frame, “ $n-3$ ” (with for example, 5 seconds of playback time). At the arrival time of this frame, a value of the gap could be calculated to be larger than 5 seconds if its “playback deadline” was more than 5 seconds away or smaller than 5 seconds if its “playback deadline” was less than 5 seconds away (either of which is very likely), and is incorrect whenever there is a change in playback (*e.g.*, pausing, seeking, etc.).



108. As another example, turning to the assumed situation proposed by Petitioner, Pet., 64, packets are transmitted at one packet per second, there are five packets in the buffer at a current time, with “n-3” being the first such packet, and playback for packet “n-3” will begin at a time when eight packets are received in the buffer. Accordingly, this playback deadline would be five seconds only in the case where packet reception proceeds exactly at the packet transmission rate of one packet per second. However, if packet reception is faster or slower than one packet per second, which, a POSITA would recognize, is highly probable, the time when eight packets

are received in the buffer may well differ from five seconds, and accordingly, would not match the expected “playback deadline” for packet “n-3”. This demonstrates that the simplistic calculation of the gap in *Chou* is divorced from the claimed available time that is “a time available for reproducing content” and a POSITA would understand that *Chou*’s “current client buffer duration” is not “a time available for reproducing the content based on the content data stored in the storage device of the reception device.”

**b) *Chou*’s fast startup technique does not disclose
“determining the code rate ... based on an available
reproduction time”**

109. As indicated above, in the Institution Decision, the Board relied on *Chou*’s “fast startup technique” as evidence that “Chou does not teach away from monitoring, much less controlling, the actual fullness of the client buffer.” ID., 42. In my opinion, I respectfully disagree. *Chou*’s fast startup technique does not disclose “determining the code rate” based on the “available reproduction time.” *Chou* discloses that its “fast startup time” is merely a technique of dividing the “arrival rate r_a ,” which is the speed of the transmission of bits of the network, by two to determine the code rate r_c . EX1004, ¶90. In other words, *Chou* discloses that the network alone should be used to determine the code rate, which is not the claimed “available reproduction time.” *Chou*’s discussion that the buffer duration will grow is moot because it merely discusses the known correlative byproduct of code rates

of data and network performance, but does not in any way suggest that the buffer duration, at the time of determination of the code rate, is utilized.

110. Moreover, a POSITA would understand that such a fast startup technique would result in an unnecessarily low code rate (resulting in a low quality video displayed to the user), a problem that the '101 Patent explicitly seeks to solve. EX1001; 4:15-18 (“the present invention enables a reception device to securely start reproduction of content at set reproduction start time while *avoiding meaninglessly lowering a code rate.*”). Accordingly, a POSITA would understand that *Chou*’s “fast startup technique” does not disclose the claimed “determining the code rate ... based on an available reproduction time.”

C. Ground 1 – *Chou* fails to render obvious “determining the code rate based on a remaining time before reproduction start time set as time at which the reception device starts reproduction of the content from a present moment”

111. The Petition alleges that *Chou*’s disclosure of “target buffer duration” corresponds to the claimed “remaining time.” Pet., 35-36. The Petition concludes its argument on this term by stating “[a]ccordingly, at the moment *Chou*’s system is determining the new coding bit rate, it examines the desired target arrival time based on the target schedule for that frame (*e.g.*, by looking at the slope) and adjusts the coding bit rate accordingly.” Pet., 38. But this analysis is flawed for the reasons described below. At a high level, Petitioner’s argument is built on an unsupported assumption that *Chou*’s approximation of the “upper bound” to the “target schedule”

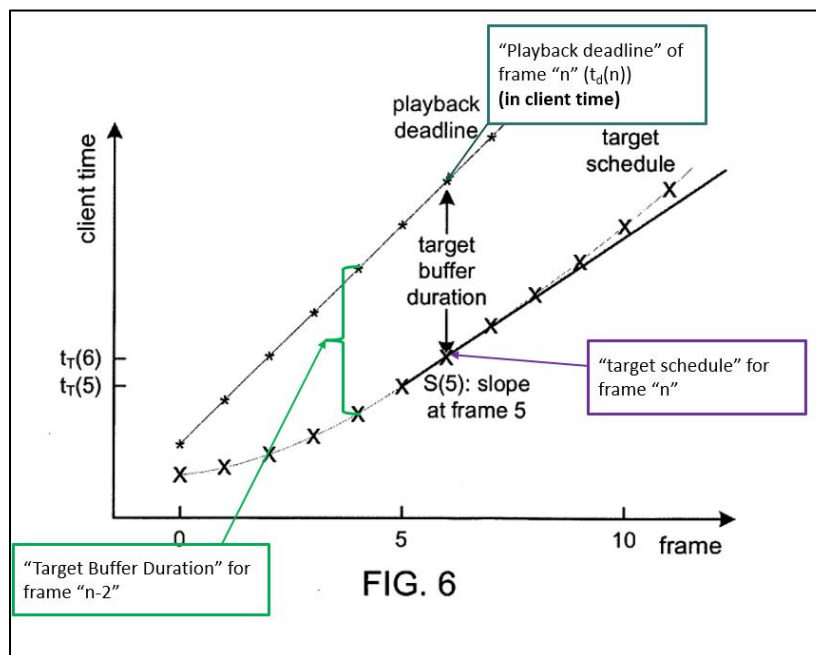
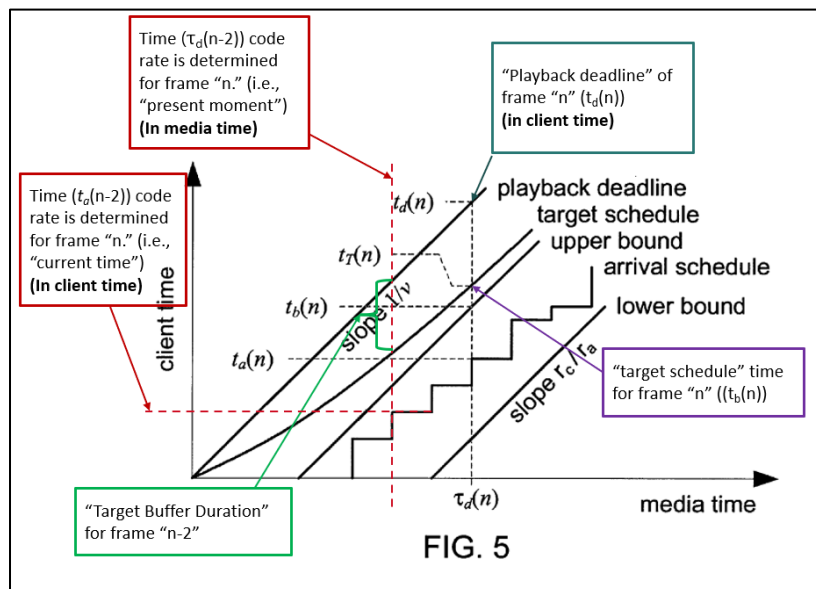
to control the code rate is somehow based on a remaining time that is “set as time at which the reception device starts reproduction of the content from a present moment.” *Id.*, 35-36. But *Chou*’s method for determining the code rate is not based on the claimed “remaining time,” which is a measure of how long the reception device will take, from the present moment, to begin the playback of the frame to be transmitted at the new code rate.

1. Chou’s “target buffer duration” is not a remaining time

112. Petitioner alleges that the “target buffer duration” or the “gap between the time at which *Chou*’s system is determining the coding bit rate for a given frame (to meet the target arrival schedule) and the playback deadline for that frame, is the claimed ‘remaining time before reproduction start time set as time at which the reception device is to start reproduction of the content from a present moment.’” Pet. 37. Not so.

113. The Petition abstracts the process that *Chou* teaches to determine the code rate for a subsequent frame. *Chou* does not base its determination of a code rate on “remaining time before reproduction start time *set as time* at which the reception device is to start reproduction of the content *from a present moment*” as required by Claim 1. As shown below, at the time of determination of a code rate for a subsequent frame, *Chou* does not utilize a time set as the “playback time” from a “*present moment*” as required by Claim 1.

114. As explained in §V.B.1, *Chou* teaches that its primary goal is to “control the buffer tube upper bound so that it tracks the target schedule.” EX1004, ¶70. Annotated Figures 5 and 6 are provided below for reference.



EX1004, Figs. 5 and 6 (Annotated). At time $\tau_d(n-2)$ (in media time), which corresponds to frame "n-2," the earliest that the code rate can be changed according

to *Chou* is the code rate for frame “n.” EX1004, ¶81 (“Indeed, at time $t_a(n)$, frame $n+2$ is the earliest frame for which the controller can determine the coding bit rate. Hence at time $t_a(n)$, the controller's job must be to choose $r_c(n+2)$.”). Accordingly, *in media time*, time $\tau_d(n-2)$ is the “present moment” (e.g., the present moment of when the code rate is being determined for frame “n”) and the “reproduction start time” corresponds to the “playback deadline” (in media time) of frame “n,” $\tau_d(n)$. EX1004, ¶59. Moreover, a POSITA would understand that, *in client time*, time $t_a(n-2)$ is the “present moment” (e.g., the present moment of when the code rate is being determined for frame “n”) and the “reproduction start time” corresponds to the “playback deadline” (in client time) of frame “n,” $t_d(n)$.

115. In other words, a POSITA would understand that in order for the code rate of *Chou* to be determined based on a “remaining time,” the code rate would need to be determined based on the value of the “reproduction start time from a present moment” or $(t_d(n) - t_a(n-2))$ (in client time) or, for the specific example of *Chou*’s Figure 5, $(\tau_d(n) - \tau_d(n-2))$ (in media time). However, *Chou* does not disclose, teach, or suggest that this, or anything analogous to it, occurs. In summary, the Petition alleges that the “target buffer duration” is the “remaining time,” but as plainly seen in the annotated Figures, the “target buffer duration” is not a “remaining time” that would be the “present moment” of $t_d(n-2)$ subtracted from the time at which frame “n” begins playback $t_d(n)$.)

116. Indeed, a POSITA would not understand the “a remaining time before reproduction start time set as time at which the reception device starts reproduction of the content from a present moment” to be a “target” value. Rather, a POSITA would understand that the “remaining time” is a value before reproduction start time *set as time* at which the reception device starts reproduction of the content from a present moment, as required by Claim 1.

117. Moreover, a POSITA would understand that a “playback deadline” is not sufficient to disclose this element because the “playback deadline” is merely a value expressed in client time or media time that alone is not “from a present moment,” as required by Claim 1. A POSITA would understand that without reference to a “present moment” the “playback deadline” is just a clock value in a time domain such as media time or client time, leaving a POSITA clueless to what domain the value is with reference to. For example, as shown, the “playback deadline” for frame “n” could be $\tau_d(n)$ in media time or $t_d(n)$ in client time, which would be two different values, neither of which is expressed relative to the present moment. Thus, contrary to the Petition’s statement that the “playback deadline for the subject frame [is] (the time reproduction will start from the present moment),” it is not because the “playback deadline” of *Chou* is not “from a present moment,” as demonstrated above and understood by a POSITA. Pet., 36. For example, as demonstrated in the table below, a value of playback deadline is not equal to the “remaining time” without the

reference of the “current time” (*i.e.*, a present moment).

Frame No.	Playback Deadline (Media Time)	Playback Deadline (Client Time)	Arrival Time (Media Time)	Arrival Time (Client Time)
N-3	0s	1:01:30 PM	-5s	1:01:25 PM
N-2	30s	1:02:00 PM	15s	1:01:45 PM
N-1	60s	1:02:30 PM	Unknown	Unknown
N	90s	1:03:00 PM	Unknown	Unknown
N+1	120s	1:03:30 PM	Unknown	Unknown

Frame **N-2** has arrived, the system is calculating the code rate for frame **N**. **Therefore, the “current time” (present moment for determining code rate of frame N) is the arrival time of frame N-2, which is 15s (media time) or 1:01:45 PM (client time).**

“Remaining Time” (for frame N) = 75s
(*e.g.*, “90s – 15s” in media time; or 1:03:00PM – 1:01:45PM)
Thus, **playback deadline (90s) is not equal to remaining time (75s).**

“Available Reproduction Time” = 45s
(*e.g.*, frame **N-2** will play for 30s in addition to the 15s left of playback for **N-2**)
Thus, “playback deadline” minus “arrival time” (30s – 15s = 15s) is **not equal to available reproduction time (45s).**

118. As described above, *Chou* discloses its primary goal as approximating the “upper bound” for frame “n” to the “target schedule,” and does not consider the “remaining time” because there is no value in equation (18) (or any of the equations) that suggest taking into account (*i.e.*, basing the code rate determination on) a “remaining time.” The “upper bound” does not control the actual arrival of frames, and *Chou* warns against controlling the actual arrival of frames. EX1004, ¶70. Moreover, the “upper bound” is not tied to the “playback time” from a “present moment.” Instead, it is merely a constraint of the encoder side buffer that sets a

theoretical limit of when subsequent frames can be encoded and transmitted via the network. EX1004, ¶61 (“A leaky bucket is a metaphor for the encoder buffer.”). The “target schedule” is an idealized algorithmic schedule at which the actual frames would arrive, which is not tied to a value of the playback deadline from a present moment as required by the claim. EX1004, ¶¶76-77. A POSITA would understand, as shown above, that, at the time of determining the code rate for a subject frame, that determination is not based on the claimed remaining time.

D. Ground 2 –*Wang* does not cure the deficiencies of *Chou*

1. Overview of Wang

119. *Wang* is directed to systems deploying RTP having a new RTCP message format. EX1016, Abstract. As background, RTP is a transport-layer protocol (typically running over user datagram protocol (UDP) or transport control protocol (TCP) that send messages between devices over Internet protocol (IP) networks,) and is commonly used for streaming applications such as, for example, voice-over-IP (VoIP). EX2004; *see also* EX2005. RTP streams consist of packets that carry media content (*e.g.*, audio and video), each having a sequence number and a timestamp. EX2004, 4. The sequence number is a 16-bit unsigned integer that allows the receiver to reorder the packets upon arrival and thus accommodate out-of-order delivery of packets. EX2004, 4-6, 14. The timestamp allows the receiver to manage proper playback of media streams, and synchronize multiple media streams such as,

for example, audio and video streams. EX2004, 14-16. RTP is used in conjunction with real-time transport control protocol (RTCP), which is used to monitor transmission quality parameters by having the receiver send periodic reports containing statistics and control information regarding the media stream carried by RTP (*e.g.*, packet count, packet loss, packet delay variation, round-trip delay, etc.). EX2005, 40. RTCP reports can be used by the sender to improve the media streaming quality including the delay and jitter of the media stream as well as multiple media stream synchronization. EX2005, 40-46.

120. *Wang* discloses a modification of RTCP packets that includes “receiver buffer information.” EX1016, 4:64-67; The new RTCP packet proposed by *Wang* includes information that is indicative of any sequence number of a packet within the receiver’s buffer and the time difference between the current time and the scheduled playout time of that packet. EX1016, Abstract. *Wang* then suggests that this information can be used to calculate the current actual receiver buffer fullness level based on the time difference between the current time and the scheduled playout time of the selected packet within the receiver buffer. EX1016, 3:48-55; *Wang* discloses that this is necessary because in the prior art, “there are no mechanisms to prevent the incorrect assumptions from happening and to eliminate the difference between the actual fullness level and the server assumed fullness level in the receiver buffer.” EX1016, 2:4-7; In particular, *Wang* describes the problem that “when the

server executes the rate adaptation operations relying on the assumed receiver buffer fullness level, underflow or overflow in the receiver buffer may occur.” EX1016, 1:67-2:3.

121. As the Petition acknowledges, “Wang discloses adjusting ‘the transmission rate and/or nominal playout rate ... to maintain the receive[r] buffer fullness level[.]’” Pet., 62 (citing EX1016, 7:13-18). The “transmission rate” is the number of packets that the sender sends per unit of time. The transmission rate therefore refers to the rate of packet transmission⁶, not to changes to the code allowing for distinct code rates as required by the Challenged Claims of the ’101 Patent. EX1016, Abstract. The “nominal playout rate” is the rate the receiver reproduces the content per unit of time. The nominal playout rate therefore refers to the rate of packet reproduction at the receiver and is unrelated to changes to the code allowing for distinct code rates as required by the Challenged Claims of the ’101 Patent. Neither the transmission nor playback rates suggest determining or changing *a code rate* of the underlying data carried by RTP packets.

122. As stated above, the new RTCP packet proposed by *Wang* includes the time difference between the current time and the scheduled playout time of that packet,

⁶ I note that even if *Wang*’s “transmission rate” refers to transmission in bits per second, this would not imply “a code rate” but rather, modifications of the number of bits transmitted by the transmission device per unit time, which is still independent of code rate of the underlying content data (subject to not exhausting the input buffer).

which *Wang* suggests can be used to calculate the current actual receiver buffer fullness level based on the time difference between the current time and the scheduled playout time of the last selected packet within the receiver buffer. EX1016, 3:48-55.

123. Accordingly, Wang offers no solution that is analogous to determining a bitrate at all much less via using a remaining time and an available reproduction time that is based on the underlying content data stored in the storage device of the receiver.

2. *The Petition's arguments for motivations to combine fail because they are conclusory and change the principle of operation of the underlying references.*

124. The Petition discusses the alleged motivation to combine *Chou* (directed to dynamic encoding) and *Wang* (directed to a streaming protocol) in §IX.D.1, but a POSITA would not be motivated to combine the two references because (1) as discussed above, a POSITA would understand that *Chou* teaches away from determining the code rate based on the available time (*supra* §V.B.5), even if it was allegedly taught by *Wang* (which it does not); and (2) *Wang* and *Chou* are directed to different technologies—dynamic encoding applications and transport-layer protocols, respectively—within the broad field of multimedia systems that are deployed at different network layers and operate independently to preserve efficiency and modularity in network system design. Pet., 68-75; EX2006, 313

(depicting encoding standards isolated from RTP in the network stack).

125. In general, the Petition discusses only abstractions of *Chou* and *Wang* to conclude that they both “manage buffer duration/fullness (based on time) in order to prevent buffer underflow[.]” Pet., 69. The Petition then concludes *Chou* and *Wang* “both measure similar buffer characteristics to the ’101 Patent.[.]” Pet., 70. But the Petition provides no rational underpinning for these conclusions and does not discuss how these conclusions would provide motivation to a POSITA. The Petition then continues on to allege that *Chou* and *Wang* “both disclose controlling [the] code rate to control buffer duration/fullness to prevent buffer underflow” and that a “POSITA would have been motivated” to combine them. Pet., 72-73. But the Petition does not explain what the proposed modifications would be, why, or how a POSITA could combine them. Contrary to these unsupported conclusions, a POSITA would not and could not combine *Chou* and *Wang*.

126. From the Petition itself, in my opinion, it is not clear what element from *Wang* Petitioner is alleging could or should be incorporated into *Chou*. For example, it is unclear whether the Petition is arguing that *Wang* could theoretically be combined with *Chou* (the primary reference) to (i) remedy the entire deficiency of *Chou*’s failure to disclose Claim Element [1d], or (ii) if the Petition is arguing that *Wang* could be combined with *Chou* to remedy only a portion of Claim Element [1d]. Pet., §IX.D.1. That is, in my opinion, the Petition does not explain what element of *Wang*

is to be incorporated into *Chou*, which is problematic because, without this starting point, there can be no rationale as to how a POSITA would combine them. For example, the Petition fails to identify any specific teachings of *Chou* and *Wang* that would motivate a POSITA to take one or more elements or techniques of *Wang* and implement them with the system disclosed by *Chou*.

a) Petitioner’s proposed combination of *Chou* and *Wang* together to meet limitation [1d] fails.

127. As stated by the Board, “Petitioner does not clearly indicate that a POSITA would have had reason to combine Wang’s teaching of criteria used to maintain buffer fullness with Chou’s teaching of determining a code rate...”. ID, 54-55. Additionally, as noted by the Board, “Petitioner does not make any reference to Chou for teaching any aspect of limitation [1d] in connection [with] the combination of Ground 2.” ID, 54. I agree.

128. To the extent that Petitioner’s lone recitation that “a POSITA would have been motivated to use the buffer characteristic measurements disclosed in Wang as a basis for Chou to determine whether, and how much of, a code rate change is required” means that the Petition is arguing that *Chou* fails to disclose “a remaining time” and “an available reproduction time” as recited in Claim Element [1d] after the word “determining” and is instead relying on *Wang* for these elements, a POSITA would not be motivated to combine *Chou* and *Wang* for two reasons. Pet., 74-75.

129. First, the Petition fails to explain how a POSITA would have substituted or

supplemented the proposed “linear quadratic formula” disclosed by *Chou* (which specifically proclaims that “it is *not* the actual fullness of the client buffer that is controlled”) with the elements from *Wang*. EX1004, ¶19. In my opinion, the “linear quadratic formula” that utilizes the “leaky bucket model” would not (and could not) accept the elements of *Wang* without substantial changes. That is, because *Chou* discloses that a variable that represents the actual buffer fullness is never determined or utilized, it is unclear how the algorithm could operate if such variable were now introduced. Neither the Petition nor the expert declaration provide an explanation for this. Indeed, modifying the algorithm of *Chou* in such a way could not be accomplished without undue experimentation.

130. Second, by substituting the alleged elements from *Wang* into *Chou*, the entire purported novelty of *Chou* would be lost because *Chou* would no longer use its allegedly novel linear quadratic formula to control the code rate, and would instead, implement a technique that *Chou* explicitly teaches against. EX1004, ¶¶19, 70. Accordingly, in my opinion, a POSITA would not be motivated to change *Chou* to control the buffer fullness level.

131. Such a combination would rest on a modification to the disclosed algorithm of *Chou* that would change the principle of operation of *Chou* and not be possible without significant effort and experimentation. Therefore, a POSITA would not be motivated to combine *Chou* and *Wang*.

b) A POSITA would lack motivation to combine *Chou* and *Wang* where *Wang* allegedly teaches the entirety of limitation [1d].

132. To the extent that Petitioner is arguing that *Wang* discloses the entirety of limitation [1d] (it does not, as explained *infra*), a POSITA would lack motivation to combine *Wang* and *Chou*.

133. First, such a combination would rest on a modification to *Chou* that would change the principle of operation of *Chou* in a manner that removes the purported novel algorithm. In other words, such a proposed combination would necessitate that the entirety of *Chou*'s purported invention be removed to make way for *Wang*. But a POSITA would not be motivated to do so, and the Petition fails to articulate *why* a POSITA would make this change. To the contrary, *Wang* teaches that its purported invention is to control the receiver buffer via controlling the “transmission frequency at the sender of RTP packets.” EX1016, 5:4-8, while *Chou* warns that “controlling the actual arrival rates [of frames] ... would in turn result in a very poor quality overall.” EX1004, ¶70. A POSITA reading these statements would understand that *Chou* warns against what *Wang* is suggesting. In other words, a POSITA would not be motivated to combine *Chou* and *Wang* because *Wang*'s proposed solution touts that it is controlling the actual frequency that RTP packets are sent (and thereby controlling the actual arrival rates), which *Chou* expressly warns will “result in very poor quality overall.” Moreover, as stated above, *Chou* expressly states that it is *not*

the actual buffer fullness that is controlled, which Petitioner does not (and cannot) reconcile with its allegation that a POSITA would want to utilize the actual buffer fullness. Indeed, even if *Wang* taught the entirety of limitation [1d] (it does not), in order to combine them, a POSITA would have to ignore the teachings of both *Chou* and *Wang*. Accordingly, a POSITA would not be motivated to combine them.

134. Second, as explained above, *Wang* and *Chou* are directed to different technologies. The Petition fails to reconcile the fact that *Wang* is not directed to an encoding scheme that would allow for a code rate to be selected and changed and the Petition fails to explain why a POSITA would ignore the teachings of *Chou* to substitute *Wang*. That is, *Wang* is directed to a streaming protocol that is from the dynamic coding application techniques disclosed by *Chou*, and the Petition fails to explain why a POSITA would have combined them. This is a particularly problematic deficiency because *Wang* does not disclose, teach, or even suggest that the code rate of the underlying data is of any concern. Instead, *Wang* suggests only adjusting the transmission rate, which is either going to slow down or speed up the number of packets transmitted over a period of time and not change the code rate of the underlying content.

135. Accordingly, Petitioner fails to show that Claim 1 of the '101 Patent is obvious over a combination of *Chou* and *Wang*.

3. *Wang fails to teach “determin[ing] the code rate based on a remaining time before reproduction start time set as time at which*

the reception device starts reproduction of the content from a present moment and based on an available reproduction time, which is a time available for reproducing the content based on the content data stored in the storage device of the reception device”

a) *Wang* fails to disclose “determining the code rate”

136. As a threshold matter, *Wang* does not disclose “a code rate.” In the Institution Decision, the Board agreed, stating that “at this preliminary stage, we are not persuaded by Petitioner’s contentions that *Wang* teaches [1d]’s code rate.” ID., 53. But not only does *Wang* fail to disclose a “code rate,” it fails to suggest “determining” such a code rate is ever done.

137. The Petition conclusorily alleges that *Wang* discloses a “code rate determining unit for determining the code rate.” Pet., §IX.B.1. *Wang* does not disclose such an element. The Petition states that *Wang* discloses adjusting the “transmission rate” or the “nominal playout rate.” Pet., 62-65. But these rates are not “code rate[s]” as recited in Claim 1. Neither the transmission nor playout rates suggest determining or changing a code rate of the underlying data carried by RTP packets. *See supra* §V.D.1.

138. As discussed above, *Wang* discloses that the invention is used in conjunction with an RTP media stream. EX1016, 2:50-53. RTP is a protocol that carries media stream segments in packets over transport protocols such as UDP or TCP. Media coding is performed by higher-level application systems (*i.e.*, encoder) and a POSITA would thus not have understood the “transmission rate” or the “nominal

playout rate” to have any determination of the code rate of the underlying media content. The Petition cites a portion of *Wang* for this allegation that states, in full, “[f]or example, the server can change the transmission characteristic by bitstream switching, transmission rate decoupling where the transmission rate is different from the designated rate in order to increase or decrease the receiver buffer level.” Pet., 63 (quoting EX1016, 6:31-35). Yet, my understanding of the “designated rate” is that it refers to the designated rate of transmitting a number of packets per unit time. To the extent that Petitioner is taking the position that “designated rate” refers to “code rate,” I disagree given the contents of *Wang*. Accordingly, contrary to Petitioner’s allegation, this sentence of *Wang* does not disclose that a code rate of the underlying data is determined because it only discusses the transmission characteristics and not the characteristics of the data (*e.g.*, code rate) that is being transmitted. In fact, to the extent that the “designated [transmission] rate” refers to the code rate of the bitstream, this portion of *Wang* suggests that the code rate remains unchanged and it is only the transmission rate that is adjusted.

139. Notably, Petitioner relies only on its expert’s declaration to fill this gap. Pet., 63 (citing EX1006, ¶253). Yet, the Reader Declaration does no more than allege generally that *Wang* discloses “changing the transmission characteristic” and that “[t]hese transmission characteristics include changing the code rate.” (citing EX1006, ¶253). This statement is unsupported. Petitioner’s attempt to extrapolate

the teachings of *Wang* are unfounded and not applicable to the general transmission rate that *Wang* discusses. *Wang* itself discloses that the variable “ T_{last} ” is intended to be used to cause changes to the transmission rate or the nominal playout rate, or to “synchronize” a clock of a remote camera live streaming to a clock receiving the live stream at the studio. EX1016, 7:50-55. *Wang* never suggests that a code rate of the media content can be changed, much less determined. Accordingly, *Wang* fails to disclose a “code rate determining unit for determining the code rate.”

**b) *Wang* fails to disclose “determining the code rate ...
based on an available reproduction time”**

140. The Petition maps *Wang*’s disclosure of the variable “ T_{last} ,” which is the “time difference between the current time and the scheduled playout time” of the last packet in the buffer, to an “available reproduction time.” Pet., 63 (internal citations omitted). However, the value of the time difference between the current time and the scheduled playout time of the last packet in the buffer is not necessarily an available reproduction time, which “is a time for reproducing the content.” For example, given that network transport protocols, such as UDP, typically used in media streaming, do not guarantee in-order packet delivery, if the current last packet has arrived before earlier packets in the bitstream have arrived, the “time available for reproducing the content based on the content data stored in the storage device of the reception device” will be smaller than the “time difference between the current time and the scheduled playout time of the last packet in the buffer.” As a hypothetical example

of this, if the buffer has received a packet that is the last packet to be played at a later time, but before the earlier scheduled packets arrive at the buffer, and calculates the time difference from the present moment to the playout time of that packet, there will be no content that is reproduced until that packet is scheduled to start to play.

141. In the Institution Decision, the Board stated that “Patent Owner does not explain why, in other cases wherein, for example, the packets do arrive in order, ‘ T_{last} ’ does teach an available reproduction time or why a POSITA would not have made appropriate adjustments to account for such cases.” ID, 55. In some circumstances the value of “ T_{last} ” *may* correspond to a value of “a time available for reproducing the content based on the content data stored in the storage device of the reception device,” but it does not *necessarily* correspond to the same value as evidenced by the examples above. In other words, the value of “ T_{last} ” is not inherently “a time available for reproducing the content based on the content data stored in the storage device of the reception device” because the situations in which this is the case rely on assumptions of loss-free, in-order packet delivery, which is rare in practice. The Petition provides no rationale as to what adjustments a POSITA could make to account for these typical occurrences of packet loss or out-of-order packet delivery. To the contrary, a POSITA would not have the common knowledge to correct for these errors. For example, a POSITA would not know how to determine, in real-time, at the sender, which packets were being delivered out of

order, because the RTCP protocol does not provide information regarding out-of-order deliveries. Accordingly, a POSITA would need to modify the protocols to remedy this issue, which would not be a simple task. Importantly, the Petition fails to allege a POSITA would be motivated to modify the protocols in such a way.

142. Moreover, as explained in greater detail below, the Petition itself demonstrates why “ T_{last} ” is not the “available reproduction time.” *See infra*, §V.D.3.c. Indeed, as demonstrated in the next section, the hypothetical given by Dr. Reader, demonstrates that the value of “ T_{last} ” does not correspond to the “available reproduction time” even in operating conditions unimpeded by the real-world constraints of a network.

143. For these reasons, the “time difference between the current time and the scheduled playout time of the last packet in the buffer” is not “an available reproduction time, which is a time for reproducing the content based on the data stored in the storage device,” as required by Claim 1.

c) *Wang* does not teach “determining the code rate based on a remaining time before reproduction start time... and based on an available reproduction time”

144. Element [1d] recites, in part, “a code rate determining unit for determining the code rate based on a remaining time before reproduction start time... based on an available reproduction time.” Petitioner identifies *Wang* generally as disclosing this element. Pet., §IX.B.1. *Wang* does not disclose such an element.

145. First, the Petition is deficient in its support and reasoning. The Petition maps *Wang*'s disclosure of the variable " T_x ," which is the "time difference between the current time and the scheduled playout time" of packet "x" to the "remaining time" of Claim 1. Pet., 62-63. But " T_x " is not the claimed remaining time because packet "x" has already been sent – and is used only to determine " T_{last} ". Moreover, the Petition also maps that same variable " T_{last} ", when packet "x" corresponds to the last packet in the buffer, to the "available reproduction time." Pet., 63. The Petition then cites *Wang* as disclosing "adjusting 'the transmission rate and/or the nominal playout rate of the different media to maintain the receive[r] buffer.'" Pet., 62 (quoting EX1016, 7:13-20). But the Petition fails to reason how or why " T_x " is the "remaining time before reproduction start time ... from a present moment" for a *particular packet for which the code rate is allegedly being determined*. Additionally, variable " T_{last} " is not "an available reproduction time" for the reasons stated above, and thus, *Wang* cannot disclose that anything is determined based on "an available reproduction time." *See supra*, §V.D.3.b

146. The Petition also presents a different theory via a hypothetical situation created by Petitioner. Pet., 64-65. This theory only includes two citations to the *Wang* reference and the remainder of the theory either includes no citation or only cites to the expert declaration. The entire theory is conjecture made up by Petitioner and its expert. Even if it draws support for some of its assumptions from the

specification, the surrounding assumptions make the entire hypothetical scenario nonsensical. For example, Petitioner argues that “‘ T_{first} ’, which corresponds to ‘the time difference between the current time and the scheduled playout time of’ the first packet” can be mapped to the “remaining time” of Claim 1 to determine a code rate in a device that has yet to begin playback. Pet., 64. Yet, four sentences later, the Petition instructs the reader to “assume that playback is set to begin when eight packets are received in the buffer” without ever explaining how “ T_{first} ” could be calculated if the beginning of the playback for the first packet depends on having already received eight packets under real world conditions. “ T_{first} ” could not possibly be calculated in this scenario because “ T_{first} ” corresponds to playout time (*e.g.*, start of playback) of the first packet when that playout time is unknown until eight packets have been received at the buffer. Thus, the assumptions are not tied to a real situation, and Petitioner is merely attempting to add disclosure to the *Wang* reference.

147. Nonetheless, accepting the assumptions presented by the hypothetical, the *Wang* reference itself contradicts the conclusions made in the Petition and demonstrates why T_{last} is **not** the claimed “available reproduction time.” For example, the Petition states that “Wang teaches that ‘the current actual receiver buffer fullness level’ can be calculated, which would be calculated to be five seconds (*i.e.*, five packets in the buffer at one second of playback time each)[,]” but this is

not true. Pet., 64-65. *Wang* discloses that T_{last} would be equal to the playout time of the last packet from the current time. EX1016, 5:20-24, 5:35-37, 5:57-59. Thus, in the hypothetical given, if the playback of the first packet (which the Petition asks us to assume) begins three seconds from now, and there are five packets in the buffer (which the Petition again asks us to assume), the time calculated for playout of the last packet (*i.e.*, packet number five) would be **seven** seconds (*i.e.*, four seconds of buffer time, corresponding to packets 1 through 4, plus three seconds before buffer playout begins) and **not five** seconds, as the Petition alleges. Pet., 64-65. That is, using the equation provided by *Wang*, the timestamp of the first packet (1) subtracted from the timestamp of the last packet (5) would be four, which is added to “time difference between the current time and the scheduled playout time of the first packet” of the first packet (3 seconds), which yields a value that is not equal to available reproduction time, which is a time that the reception device can reproduce content based on content data that is stored at the reception device. EX1016, 5:51. In addition, Petitioner’s scenario has further complications, as described above, that would further divorce the value of “ T_{last} ” from the “time available for reproducing the content based on the content data stored” at the reception device. *See supra*, §V.D.3.b. These examples demonstrate that “ T_{last} ” would produce a value that is not representative of the time available for reproducing the content. *See supra*, §V.D.3.b. Indeed, as Petitioner’s **own** hypothetical proves, T_{last} is not the “available

reproduction time.” As such, *Wang* does not disclose “determining a code rate” based on a “remaining time” and “available reproduction time,” as required by Claim 1.

148. Accordingly, not only does the hypothetical example provided in the Petition not remedy *Wang*’s deficiencies described above, it demonstrates why *Wang* fails to disclose Claim Element [1d].

E. Ground 3- *Nobuyoshi* does not cure the deficiencies of *Chou*.

149. In addition to the above, Petitioner also alleges that Claims 5, 7, and 15, which depend from Claims 1 and 11, are obvious in view of *Chou* combined with *Nobuyoshi*.

1. Overview of Nobuyoshi

150. *Nobuyoshi* is a Japanese Patent that is discussed in the background of the ’101 Patent and cited on the face of the ’101 Patent. EX1001, Cover. *Nobuyoshi* states that its problem to be solved is “[t]o provide a technology whereby a terminal can take a midway participation in the simultaneous playback processing among the other terminals while the other terminals share data and simultaneously reproduce the shared data.” EX1014, Abstract. As the ’101 Patent itself explains, *Nobuyoshi* discloses “a system that allows a plurality of reception devices to synchronously reproduce content even if time to start reproduction of the content varies depending on the reception device. In this distribution system, while a first reception device is

reproducing content, a second reception device estimates a time required to start reproduction of the content and determines reproduction start time based on the estimated time. Then, the second reception device transmits the determined reproduction start time to the transmission device.” EX1001, 1:33-41.

2. Claims 5, 7, and 15 Are Not Obvious in View of Chou combined with Nobuyoshi

151. Each of Claims 5, 7, and 15 depend from either Claim 1 or Claim 11. As discussed above, Petitioner has failed to show that Claim 1 or Claim 11 are obvious in view of *Chou*. See *supra*, §V.B-C. As such, Claims 5, 7, and 15, which depend from these claims, are valid at least because of their dependence from those claims.

152. *Nobuyoshi* was considered at the time the ’101 Patent was prosecuted as evidenced by *Nobuyoshi*’s citation on the face of the patent. *Nobuyoshi* is relied on in combination with *Chou* as allegedly disclosing Claims 5, 7, and 15. (Pet., §IX.C.) The Petition does not allege that *Nobuyoshi* remedies the deficiencies of *Chou* as they relate to Claim Element [1d] discussed above. Indeed, as evidenced by the Examiner’s consideration of *Nobuyoshi* during prosecution, it does not disclose, teach, or suggest the elements of Claim 1 (or the other independent claims).

F. Dependent Claims 2, 4, 5, and 7 Are Not Obvious In View of At Least Their Dependence from Claim 1

153. Each of Claims 2, 4, 5, and 7 depend, directly or indirectly, from Claim 1 of the ’101 Patent. As discussed above, *Chou* fails to disclose each and every element

of Claim 1 of the '101 Patent. (*See supra*, §§V.A-C.)

154. As such, it is my opinion that Petitioner has failed to demonstrate that Claims 2, 4, 5, and 7 are obvious in view of the cited references.

G. Claims 11, 12, 14-18, 20-23, and 25-29 Are Not Obvious In View of the Cited Art

155. Claims 11, 16, 21, 22, 26, 27, 28, and 29 are each independent and each recite (as shown below) at least one element which, as discussed above, is not disclosed, taught, or suggested in the cited art relied upon by Petitioner. (*See supra*, §§V.A-D.)

156. These two elements, repeated substantively identically in each of Claims 11, 16, 21, 22, 26, 27, 28, and 29, differentiate each claim from the cited art, as discussed above with respect to Claim 1. (*See supra*, §§V.A-D.) For each of these independent claims, the Petition merely cites back to Claim 1. (Pet., 50-60⁷.) Each of Claims 12, 14, 15, 17, 18, 20, 23, and 25 depend, directly or indirectly, from a respective independent Claim 11, 16, or 21 and therefore it is my opinion that Petitioner has failed to demonstrate these claims are obvious in view of *Chou*.

157. As such, it is my opinion that Petitioner has failed to show that the Challenged Claims are obvious in view of *Chou*.

⁷ The section numerals in the Petition that correspond to the other claims repeat section numerals corresponding to other claims. (*See* Pet., iii (listing §IX.A.1-4 multiple times).) For this reason, I refer not to the relevant section numerals, but instead to the page numbers to avoid confusion.

VI. RIGHT TO SUPPLEMENT

158. My opinions relating to the validity of the Challenged Claims of the '101 Patent are addressed in this Declaration. This Declaration is based on the information presently available to me. To the extent any additional information is provided at a later time, I reserve the right to amend or supplement this Declaration based on that information.

159. I reserve the right to supplement my opinions in light of any responsive opinions or critique from or on behalf of Petitioner.

160. I reserve the right to augment or modify these opinions if additional information becomes available, in response to potential institution by the Board, and/or in rebuttal to positions taken by Petitioner.

VII. CONCLUSION

161. For the reasons set forth herein, I am of the opinion that all of the Challenged Claims are not unpatentable.

I hereby declare under penalty of perjury under the laws of the United States of America that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine, imprisonment, or both, under 18 U.S.C. § 1001. I attest to having a final and complete copy of this Declaration before me at the time I add my signature.



Jeremy Cooperstock, Ph.D.

May 31, 2024
Date

APPENDIX A

CURRICULUM VITAE

Jeremy R. Cooperstock
Version as of May 25, 2024

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EDUCATION

Ph.D. Electrical and Computer Engineering, University of Toronto, 1996.
Thesis: “Reactive Environments and Augmented Media Spaces.”
(Nominated for NSERC Doctoral Dissertation Award)
Advisors: Prof. K.C. Smith and Prof. W. Buxton

M.Sc. Computer Science, University of Toronto, 1992.
Thesis: “Neural Network Operated Vision-Guided Mobile Robot Arm
for Docking and Reaching.” Advisor: Prof. E. Milios.

B.A.Sc. Electrical Engineering, Computer Engineering Option, University of
British Columbia, 1990 (Honours)

AWARDS AND DISTINCTIONS

2024-2029	Werner Graupe Distinguished Chair in Automation Engineering, McGill University (\$15,000 plus research stipend of \$30,000 per annum)
2022	Honorable Mention, “The Sound of Hallucinations: Toward a more convincing emulation of internalized voices” (top 5% of papers), Human Factors in Computing Systems (CHI) [C5]
2022	Finalist, Best Applications Paper Award, “Speaking Haptically: from Phonemes to Phrases with a Mobile Haptic Communication System”, Transactions on Haptics [J4]
2019	Honorable Mention, “Detecting Perception of Smartphone Notifications using Skin Conductance Responses” (top 5% of papers), Human Factors in Computing Systems (CHI) [C34]
2019	San Diego Opera, Opera Hack award, Hamsafar! (\$10,000, with 5 co-awardees)
2018	Best poster presentation award, “Enhanced Pressure-Based Multi-modal Immersive Experiences”, Augmented Human [CP12]
2015	Gerald W. Farnell Teaching Scholar, Faculty of Engineering (\$12,500)

2014	US Ignite Best App in Education, Augmented Reality for Improved Training of First Responders
2013	Canadian National Institute for the Blind, Hochhausen Access Technology Research Award (\$10,000)
2013	Best paper award, “Vibrotactile Rendering of Splashing Fluids”, Transactions on Haptics [J17]
2013	Best use of sound award, “The Walking Straight Mobile Application: Helping the Visually Impaired Avoid Veering, International Conference on Auditory Displays [C62]
2012	Mozilla Foundation and NSF Gold Prize in the Mozilla Ignite Challenge (out of 305 submissions in the Brainstorming Round) (\$5,000) for Real-Time Emergency Response
2012	Canadian Internet Registry Association .CA Impact Award (Applications category) for In-Situ Audio Services Project (\$5,000)
2011	Best paper award, “What’s around me? Spatialized audio augmented reality for blind users with a smartphone”, Mobile and Ubiquitous Systems [C73]
2010	Best paper award, “Design of a Vibrotactile Display via a Rigid Surface”, Haptics Symposium [C82]
2009, 2010	Nominee, NSERC Brockhouse Canada Prize
2009	Best paper award, “SoundPark: Exploring Ubiquitous Computing through a Mixed Reality Multi-player Game Experiment”, 9e Conférence Internationale sur Les NOuvelles TEchnologies de la REpartition [C92]
2005	ACM/IEEE Supercomputing, Most Innovative Use of New Technology for Wide Screen Window on the World: Life Size HD Videoconferencing
2001	Audio Engineering Society Citation Award for pioneering the technology enabling collaborative multichannel performance over the broadband internet

WORK EXPERIENCE

CAREER HIGHLIGHTS

Haptic Information Delivery (2018-2021) My lab's haptics research has resulted in prominent visibility in the preeminent journal, IEEE Transactions on Haptics, and the two top-tier international conferences in the field, IEEE Haptics Symposium and IEEE World Haptics Conference, with a dozen publications in these forums between 2020 and 2021. Given my recognition in the field, I was invited to serve on the editorial boards of all of these bodies, in addition to the specialty section on haptics of the Frontiers Journal in Virtual Reality. Specific examples of significant contributions include the performance attained through use of our two-actuator apparatus and phonemic encoding for tactile communication of natural language [C31, J4, C9], which outperformed the previously cited best results on this task, achieved by Facebook Research Labs. A second contribution relates to the high recognition rates we attained for multi-dimensional tacton delivery (3 parameters, each at 3 levels), targeting clinical patient-monitoring scenarios. This work inspired studies of wearable vibrotactile devices for physiological monitoring of patients [C30, C19]. While our results were achieved initially using a set of three actuators [C44, C41, C32, C22], we subsequently demonstrated equivalent recognition performance via only a single vibrotactile actuator, with a novel parameter encoding scheme [C21]. We further demonstrated achievement of the highest information transfer rates reported in the literature for such a single-actuator device [C16].

Physiological Sensing (2017-2020) Our research for detection of smartphone notifications was recognized by an Honourable Mention (top 5% of papers) from the top-tier ACM Conference on Human Factors in Computing ([C34]), and led to a recent patent filing ([P5]). This work has the potential to serve as not only for more intelligent, context-sensitive notification delivery, but also, as a tool that can be exploited to combat the prevalent and adverse effects of Internet addiction, driven largely by “fear of missing out.”

Real-Time Emergency Response (rtER) (2012-2013) provides an envisionment of the future of next-generation 911 (NG-911) technologies, supporting enhanced situational awareness for first responders through the use of citizen-supplied smartphone video streams and other relevant data [J15]. Our work was recognized by the *Gold Prize* from the Mozilla Ignite Fund, featured on the web site of the White House Office of Science and Technology, and prompted the launch of a funding program by the U.S. Department of Justice.

Autour (2009-2018) is an “eyes-free” app for the blind, which provides a rich, spatialized audio representation of one's environment [J22, C73, C64, C61]. The project further motivated a rigorous analysis of smartphone sensor reliability, resulting in what was the first comprehensive examination of practical limits on smartphone sensors, including the problems of gyro drift [C64].

Mobile Treatment Device for Amblyopia (2009-2012, in collaboration with ophthalmologist R. Hess) is a patented prototype Mobile Treatment Device for Amblyopia [P10] (“lazy eye”). Initial trials [J21], based on the popular Tetris game, provided highly promising early results [J29, J24], not only restoring the use of both eyes in a majority of patients but even resulting in binocular (3D) depth perception in some. Most significantly, the treatment has been found to work successfully

on adult populations, whereas the prevailing wisdom had been that treatment was only possible on children. The technology has now been acquired by Novartis, who are commercializing the system.

Natural Interactive Walking (2008-2017) investigated multimodal interaction with virtual ground surfaces, resulting in important findings of tactile discrimination ability [J23] and the role of vibrotactile stimulation in perception of compliance [J30]. Our “Ecotile” prototype (patent [P7]) was showcased at numerous venues including SIGGRAPH, and led to related research involving limb modeling [C75, C59, C53], foot-water interaction [J17], and variable-friction walking interfaces [C69, C60, J8].

Ultra-Videoconferencing (2002-2006) is our low-latency, high-fidelity network transport, used for distance music teaching with Maestro Pinchas Zuckerman, cross-continental jazz jams, and remote sign language interpretation. The *Globe and Mail* described Cooperstock’s 2001 demonstration as “a watershed event for the elite club of the world’s computer network engineers.” Ultra-Videoconferencing garnered my research group a prestigious Citation Award from the Audio Engineering Society and the Award for Most Innovative Use of New Technology from ACM/IEEE Supercomputing (2005). This research directly constituted the basis for subsequent funding of \$2.2M from Valorisation Recherche Quebec and over \$4M from Canarie, and influenced the designs of similar telepresence videoconferencing systems from Cisco, HP, and Polycom. Our follow-up work on **Open Orchestra** (with HQP N. Bouillot, A. Olmos, T. Knight, M. Tomiyoshi), resulted in an immersive simulator for orchestral training, used by professional and semi-professional musicians [J20].

ACADEMIC EXPERIENCE

May 2024–present	McGill University, Montreal, QC Werner Graupe Distinguished Chair in Automation Engineering
Oct 2023–present	McGill University, Montreal, QC Associate Member, Biomedical Engineering
Dec 2022–present	McGill University, Montreal, QC Member, McGill Institute for Aerospace Engineering
May 2022–present	McGill University, Montreal, QC Member, International Laboratory on Learning Systems
Jan 2018–present	McGill University, Montreal, QC Full Professor, Electrical and Computer Engineering. Director, Shared Reality Lab Associate Member, Faculty of Music, Department of Theory Founding Member, Centre for Interdisciplinary Research in Music, Media and Technology Member, Centre for Intelligent Machines
Feb 2022–present	York University, Ontario Affiliate Member, Vision: Science to Applications (VISTA)
Sep 2018–Jun 2019	Technion–Israel Institute of Technology, Haifa, Israel Visiting Professor, Industrial Engineering and Management
Sep 2018–Jun 2019	IDC, Herzliya, Israel Visiting Professor, Department of Computer Science
May 2003–Dec 2017	McGill University, Montreal, QC Associate Professor, Electrical and Computer Engineering
Aug 2011–Jul 2012	University of Auckland, New Zealand Invited Professor, Department of Computer Science
May–June 2009	Bang & Olufsen, Denmark Visiting Professor, World Opera Project
Jan 2009–present	Bielefeld University, Germany Virtual Member, Center of Excellence Cognitive Interaction Technology (CITEC)
Feb 2008	Arizona State University Visiting Scholar, School of Arts, Media and Engineering
Sep 2004–Aug 2005	Université de Paris VI, Paris France Invited Professor, Laboratoire des Instruments et Systemes d'Ile-de-France
Nov 1997–May 2003	McGill University, Montreal, QC Assistant Professor, Electrical and Computer Engineering.

INDUSTRIAL AND CONSULTING EXPERIENCE

Sep 2019–Oct 2021	RedPill Canada VR, Montreal Director and Advisor
Apr–Jun 2019	(Confidential project as consulting expert) Providing expert report on topics concerning Human-Computer Interaction.
Aug–Nov 2014	Menya Solutions and DRDC-Valcartier Providing expert advice related to human-computer interfaces, visualization, and collaboration.
Aug 2012	Tamaggo Inc. Provide guidance and advice on digital imagery
May 2012	York University Review draft application to Canada Excellence Research Chairs program
May 2002 –Nov 2003	Solicitor General of Canada Media streaming configuration and user interface design.
May 2001	National Research Council Instructor of short course in Soft Computing, Institut des Matériaux Industriels.
Jan–Sep 1999	Audio Engineering Society Technical leader of demonstration of multichannel and multimedia audio distribution
Jan–Aug 1999	Ontario Science Center Scientific Director of Timescape Millenium Exhibit
Jul 1998	Nortel Instructor of short course in videoconferencing systems for the Nortel International SL-1 User's Association (ILUA), Long Beach
Sep 1996–Oct 1997	Sony Computer Science Laboratory Visiting Researcher, Sony Computer Science Laboratory, Tokyo, Japan. Developed speech-interface controlled VCR with visual tape database functionality. Wrote two patent applications, one filed.
Jun–Aug 1990	Fibronics Research Visiting Researcher, Fibronics Advanced Research Center, Haifa, Israel. Developed and tested an FDDI-to-token ring bridge.
May–Aug 1989	IBM T.J. Watson Research Center Research Intern, IBM T.J. Watson Research Center, Yorktown Heights, NY. Improved implementation of a VLIW architecture simulator.

LITIGATION AND EXPERT WITNESS EXPERIENCE

Parties I represented are marked by an asterisk.

Jan 2024–ongoing	Immersion Corp. v. Valve Corp.,* Case No. 2-23-cv-00712 (W.D. Wash.) related to U.S. Patent Nos. 7,336,260, 8,749,507, 9,430,042, 9,116,546, 10,627,907, 10,665,067, and 11,175,738
Nov 2023–ongoing	Sitnet LLC v. Meta Platforms, Inc.,* United States District Court, S.D. New York, Case No. 1:23-cv-6389 (AS) and related <i>Inter Partes</i> Review proceedings of U.S. Patent Nos. 8,249,932, 8,332,454, 9,877,345, and 11,470,682
Aug 2023–ongoing	NEC Corporation* v. Peloton Interactive, Inc. et al., United States District Court, District of Delaware, Case No. 1:2022cv00987 and related <i>Inter Partes</i> Review proceedings of U.S. Patent No. 9,769,427
Aug 2023–ongoing	Resonant Systems, Inc. d/b/a RevelHMI v. Samsung Electronics Co., Ltd.,* et al. United States District Court, Eastern District of Texas, Case No. 2:22-cv-00423-JRG
May 2023–ongoing	LoganTree LP v. Fossil Group, Inc.* United States District Court, District of Delaware Case No. 1:21-cv-00385-JDW and related <i>Inter Partes</i> Review proceedings
Feb–May 2023	Immersion Corp. v. Meta Platforms, Inc.* United States District Court, Western District of Texas Case No. 6:22-cv-00541-ADA and related <i>Inter Partes</i> Review proceedings of U.S. Patent Nos. 8,469,806, 8,896,524, 9,727,217, 10,248,298, 10,269,222, and 10,664,143
Feb–May 2023	Playvuu, Inc. v. Snap Inc.* United States District Court, Central District of California Case No. 2:22-cv-06019. Involved in litigation matters related to U.S. Patent No. 10,931,911.
Sep 2022	Apple* v. Taction Technologies, Inc. Retained for <i>Reexamination Requests</i> of U.S. Patent Nos. 10,659,885 and 10,820,117 in the United States Patent and Trademark Office.
Aug 2022–ongoing	Westwood One, LLC v. Local Radio Networks, LLC* United States District Court, Northern District of Indiana, Case No. 1:21-cv-00088-HAB-SLC. Involved in litigation matters related to U.S. Patent Nos. 7,412,203 and 7,860,448
Jan–May 2022	Peloton Interactive v. iFIT Inc. f/k/a ICON Health & Fitness* United States District Court, District of Delaware, Civil Action No. 20-cv-1386-RGA. Prepared reports on patent invalidity and non-infringement.

Sep 2021–ongoing	Brazos* v. Google United States District Court, Western District of Texas Waco Division, Case Nos. 6:20-CV-00571-ADA through 6:20-CV-00585-ADA. Deposition testimony on expert report (2 depositions)
Sep 2021–Aug 2022	Allstate Insurance Co. v. Atos LLC* Involved in <i>Inter Partes</i> Review, IPR2021-01118, of U.S. Patent No. 8,527,140, covering smartphone-based vehicle operation detection. Deposition testimony on expert report.
Jan 2021–Apr 2022	GUI Global Products, Ltd. v. Apple* United States District Court, Southern District of Texas, Case No. 4:20-cv-2652 and <i>Inter Partes</i> Review of U.S. Patent Nos. 10,259,020, 10,259,021, 10,562,077, and 10,589,320 in the United States Patent and Trademark Office. Deposition testimony on expert report (2 depositions)
Dec 2020–Feb 2021	Expert consultation re possible litigation in IT-related matter Work done on behalf of Sheridan Ross P.C.
Nov 2020–Jun 2022	Koss v. Apple* United States District Court, Western District of Texas Civil Action No. 6:20-cv-00665. Involved in <i>Inter Partes</i> Review of U.S. Patent Nos. 10,206,025, 10,469,934, 10,506,325, 10,491,982, and 10,298,451 before the United States Patent and Trademark Office. Deposition testimony on expert reports (4 depositions).
Oct 2020–Oct 2021	Triller v. ByteDance* and TikTok* <i>Inter Partes</i> Review of U.S. Patent No. 9,691,429 before the United States Patent and Trademark Office. Deposition testimony on expert report.
Sep 2020–Jan 2023	Content Square v. Quantum Metric* and Decibel Insight* United States District Court, Massachusetts District Court, Case No. 1-20-cv-11184 and Delaware District Court, Case No. 20-cv-00832. Involved in invalidity arguments and petitions for <i>Inter Partes</i> Review. Deposition testimony on expert reports (5 depositions).
Sep 2020	Wiesel v. Apple* United States District Court, Eastern District of New York, Case No. 1:19-cv-7261. Engaged for source code review of products related to the Apple Watch (case presently stayed).
Aug–Oct 2020	Finish Time* v. Garmin United States District Court, District of Maine, Case No. 2:20-cv-00184. Involved in review of infringement arguments, discovery, related to fitness applications.

Dec 2019–Nov 2022	Pinn v. Apple* United States District Court, Central District of California, Case No. 8:19-cv1805, <i>Inter Partes</i> Review IPR2020-00999, Post Grant Review PGR2020-00066 and PGR2020-00073. Involved in preparation of expert witness declarations, code analysis involving multiple products related to earbuds and charging circuitry. Deposition testimony on expert reports, in-court trial testimony.
Oct 2019	Qualcomm v. Apple* <i>Inter Partes</i> Review, IPR2018-01279. Deposition testimony on expert witness declaration related to multimedia messaging.
Mar 2019–Feb 2022	Cruz Hernandez* v. Air Canada and Lufthansa Canadian Transportation Agency Case no. 20-01712, Petitioner before the Agency regarding passengers' rights to compensation under EC 261/2014
May 2018–May 2019	Immersion Incorporated v. Samsung Inc.* Civil Action No. 2:18-cv-00055 in the Eastern District of Texas and <i>Inter Partes</i> Review, IPR2018-01499. Consulted on technical details and involved in preparation of two expert witness declarations related to haptic feedback effects and force feedback in a multimodal system. (Patent Nos. 6,429,846, 7,969,288, 7,982,720, 8,031,181, 9,323,332 and 8,619,051)
May 2016–Nov 2017	Cooperstock* v. Air Canada Petitioner before the Canadian Transportation Agency. Brought successful complaint against Air Canada for the airline's making false or misleading statements to the public, Decision No. 105-C-A-2017 (otc-cta.gc.ca/eng/ruling/105-c-a-2017)
Jan–May 2014	St. Lewis v. Rancourt* Provided expert report on web server location, Ontario Superior Court File No. 11-51657
Mar–Sep 2013	Cooperstock* v. United Airlines Brought and argued successful appeal regarding anti-SLAPP legislation before the Quebec Court of Appeal, Decision 2013 QCCA 1670 (goo.gl/pgz301). Argued appeal in person (September 26, 2013)
Nov 2012–Aug 2017	United Airlines v. Cooperstock* Pro se litigant, Federal Court File No. T-2084-12. Deposition as litigant (August 2013) and testified at trial (December 2016).
Nov 2012–Jan 2017	United Airlines v. Cooperstock* Pro se litigant, Quebec Superior Court File No. 500-17-074743-124. Deposition as litigant (October 2014) and testified at trial (April 2016).
Sep 2012	Lukács* v. Air Canada Provided expert report on database query and execution times, Canadian Transportation Agency File No. M4120-3/11-06673, Decision No. 204-C-A-2013

May 2007–Jan 2008	Market Maker c. Brim Solutions* Provided expert witness report and in-court testimony (October 2007) on software-related intellectual property case. Quebec Superior Court File No. 500-17-036750-076.
Feb–Oct 2004	Crawford Adjusters Canada Provided analysis of artifacts in high definition video
Jul 2002–May 2016	Court of Quebec, Small Claims Division Brought 14 consumer rights complaints before the Court, 11 of which were successful

RESEARCH DISSEMINATION

Notes on publication strategy: In my research field, papers in the ACM CHI (H5-index=87), UIST (H5-index=46), DIS (H5-index=33), and Mobile HCI (H5-index=28) conferences are considered to be top-tier, archival publications, competitive with the top HCI journals in terms of impact and visibility. Overall acceptance rates for these conferences are typically in the 20-25% range. As a measure of research impact, my publications have garnered over 5200 citations to date (Google Scholar) with approximately half of these since 2018, an h-index of 38, and i10-index of 110. HQP under my supervision (names in bold) are typically given first authorship on co-authored work.

ARTICLES IN REFEREED PUBLICATIONS

- [J1] **J. Regimbal, J. R. Blum, C. Kuo**, and J. R. Cooperstock. “IMAGE: An Open-Source, Extensible Framework for Deploying Accessible Audio and Haptic Renderings of Web Graphics.” In: *Transactions on Accessible Computing* (2024). DOI: doi.org/10.1145/3665223. URL: <https://dl.acm.org/doi/10.1145/3665223>.
- [J2] **A. Talhan, Y. Yoo**, and J. R. Cooperstock. “Soft Pneumatic Haptic Wearable to Create the Illusion of Human Touch.” In: *IEEE Transactions on Haptics* (Aug. 2023), pp. 1–14. DOI: [10.1109/TOH.2023.3305495](https://doi.org/10.1109/TOH.2023.3305495). URL: <https://ieeexplore.ieee.org/document/10219022>.
- [J3] **N. Duarte**, R. K. Arora, G. Bennett, M. Wang, M. P. Snyder, J. R. Cooperstock, and C. E. Wagner. “Deploying wearable sensors for pandemic mitigation: a counterfactual modelling study of Canada’s second COVID-19 wave.” In: *PLOS Digital Health* PDIG-D-22-00126R1 (Sept. 2022). DOI: [10.1371/journal.pdig.0000100](https://doi.org/10.1371/journal.pdig.0000100). URL: <https://journals.plos.org/digitalhealth/article?id=10.1371/journal.pdig.0000100>.
- [J4] **M. F. de Vargas, D. Marino, A. Weill–Duflos**, and J. R. Cooperstock. “Speaking Haptically: from Phonemes to Phrases with a Mobile Haptic Communication System.” In: *Transactions on Haptics* 14.3 (July 2021), pp. 479–490. DOI: [10.1109/TOH.2021.3054812](https://doi.org/10.1109/TOH.2021.3054812). URL: <https://ieeexplore.ieee.org/document/9337220>. 🏆 Finalist, Best Applications Paper Award.
- [J5] **P. Vyas, F. Al-Taha, J. R. Blum, A. Weill–Duflos**, and J. R. Cooperstock. “Ten Little Fingers, Ten Little Toes: Can Toes Match Fingers for Haptic Discrimination?” In: *Transactions on Haptics* 13.1 (2020). DOI: [10.1109/TOH.2020.2966969](https://doi.org/10.1109/TOH.2020.2966969). URL: <https://ieeexplore.ieee.org/document/8960637>. Also presented at Haptics Symposium 2020.
- [J6] **E. Sulmont**, E. Patitsas, and J. R. Cooperstock. “What Is Hard About Teaching Machine Learning to Non-Majors? Insights From Classifying Instructors’ Learning Goals.” In: *Transactions on Computing Education, Special Issue on Machine Learning Education* 19.4 (Aug. 2019). DOI: [10.1145/3336124](https://doi.org/10.1145/3336124). URL: <http://dl.acm.org/authorize?N682238>.

- [J7] **J. Blum, P. Fortin, F. Al-Taha, P. Alirezaee, M. Demers, A. Weill–Duflos,** and J. R. Cooperstock. “Getting Your Hands Dirty Outside the Lab: A Practical Primer for Conducting Wearable Vibrotactile Haptics Research.” In: *IEEE Transactions on Haptics, Special Issue on Wearable and Hand-held Haptics* 12.3 (July 2019), pp. 232–246. DOI: [10.1109/TOH.2019.2930608](https://doi.org/10.1109/TOH.2019.2930608). URL: <https://ieeexplore.ieee.org/document/8770138>.
- [J8] **G. Millet, M. Otis, D. Horodniczy,** and J. R. Cooperstock. “Design of Variable-Friction Devices for Shoe-Floor Contact.” In: *Mechatronics* 46 (2017), pp. 115–125. DOI: [10.1016/j.mechatronics.2017.07.005](https://doi.org/10.1016/j.mechatronics.2017.07.005). URL: <https://www.sciencedirect.com/science/article/abs/pii/S0957415817301034>.
- [J9] **P. Fortin** and J. R. Cooperstock. “Laughter and Tickles: Toward Novel Approaches for Emotion and Behavior Elicitation.” In: *IEEE Transactions on Affective Computing* 8.4 (2017). TAFFCSI-2016-07-0124.R1, pp. 508–521. DOI: [10.1109/TAFFC.2017.2757491](https://doi.org/10.1109/TAFFC.2017.2757491). URL: <http://ieeexplore.ieee.org/document/8052511/>.
- [J10] E. Aguilera, J. J. Lopez, and J. R. Cooperstock. “Spatial Audio for Audioconferencing in Mobile Devices: Investigating the Importance of Virtual Mobility and Private Communication and Optimizations.” In: *Journal of the Audio Engineering Society* 64.5 (May 2016), pp. 332–341. DOI: [10.17743/jaes.2016.0009](https://doi.org/10.17743/jaes.2016.0009). URL: <http://www.aes.org/e-lib/browse.cfm?elib=18138>.
- [J11] **D. El-Shimy** and J. R. Cooperstock. “User-Driven Techniques for the Design and Evaluation of New Musical Interfaces.” In: *Computer Music Journal* 40.2 (2016), pp. 35–46. DOI: [10.1162/COMJ_a_00357](https://doi.org/10.1162/COMJ_a_00357). URL: http://www.mitpressjournals.org/doi/pdf/10.1162/COMJ_a_00357.
- [J12] **F. Tordini,** A. Bregman, and J. R. Cooperstock. “Prioritizing foreground selection of natural chirp sounds by tempo and spectral centroid.” In: *Multimodal User Interfaces, Special Issue on Auditory Display* 10.3 (Sept. 2016). Ed. by B. Katz and G. Marentakis, pp. 221–234. DOI: [10.1007/s12193-016-0223-x](https://doi.org/10.1007/s12193-016-0223-x). URL: <http://link.springer.com/article/10.1007%2Fs12193-016-0223-x>.
- [J13] R. F. Hess, **L. To,** J. Zhou, **G. Wang,** and J. Cooperstock. “3D Vision: the haves and havenots.” In: *i-Perception* 6.3 (July 2015). DOI: [10.1177/2041669515593028](https://doi.org/10.1177/2041669515593028). URL: <http://ipe.sagepub.com/content/6/3/2041669515593028.full.pdf+html>.
- [J14] **N. Hieda** and J. R. Cooperstock. “Digital Facial Augmentation for Interactive Entertainment.” In: *EAI Endorsed Transactions on e-Learning* 15.8 (Aug. 2015). DOI: [10.4108/icst.intetain.2015.259444](https://doi.org/10.4108/icst.intetain.2015.259444). URL: <https://eudl.eu/doi/10.4108/icst.intetain.2015.259444>.
- [J15] **J. Blum, A. Eichhorn, S. Smith, M. Sterle-Contala,** and J. R. Cooperstock. “Real-Time Emergency Response: Improved Management of Real-Time Information During Crisis Situations.” In: *Multimodal User Interfaces* 8.2 (July 2014). JMUI-D-13-00047R3, pp. 161–173. DOI: [10.1007/s12193-013-0139-7](https://doi.org/10.1007/s12193-013-0139-7). URL: <https://link.springer.com/article/10.1007/s12193-013-0139-7>.
- [J16] **D. Dansereau,** N. Brock, and J. R. Cooperstock. “A Particle Filter for Predicting an Orchestral Conductor’s Baton Movements.” In: *Computer Music J.* 37.2 (Apr. 2013), pp. 28–45. URL: http://www.mitpressjournals.org/doi/pdf/10.1162/COMJ_a_00173.

- [J17] **G. Cirio**, M. Marchal, A. Lécuyer, and J. R. Cooperstock. “Vibrotactile Rendering of Splashing Fluids.” In: *Transactions on Haptics* 6.1 (May 2013), pp. 117–122. URL: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6226398. 🏆 Best paper award.
- [J18] F. Grond, **A. Olmos**, and J. Cooperstock. “Making Sculptures Audible through Participatory Sound Design (Artists’ statement).” In: *Leonardo Music J.* 23 (Dec. 2013), pp. 12–13. DOI: [doi:10.1162/LMJ_a_00140](https://doi.org/10.1162/LMJ_a_00140). URL: <https://srl.mcgill.ca/publications/2013-LEONARDO.pdf>.
- [J19] **S. Pelletier** and J. R. Cooperstock. “Real-time free viewpoint video from a range sensor and color cameras.” In: *Machine Vision and Applications* 24.4 (May 2013), pp. 739–751. URL: <http://link.springer.com/article/10.1007%2Fs00138-012-0428-2>.
- [J20] **A. Olmos**, N. Bouillot, **T. Knight**, N. Mabire, **J. Redel**, and J. R. Cooperstock. “A High-Fidelity Orchestra Simulator for Individual Musicians’ Practice.” In: *Computer Music Journal* 36.2 (2012), pp. 55–73. URL: http://www.mitpressjournals.org/doi/pdf/10.1162/COMJ_a_00119.
- [J21] J. M. Black, R. F. Hess, J. R. Cooperstock, **L. To**, and B. Thompson. “The measurement and treatment of suppression in amblyopia.” In: *Visualized Experiments* 14.70 (Dec. 2012). DOI: [10.3791/3927](https://doi.org/10.3791/3927). URL: <http://www.jove.com/video/3927/the-measurement-and-treatment-of-suppression-in-amblyopia>.
- [J22] **D. El-Shimy**, F. Grond, **A. Olmos**, and J. R. Cooperstock. “Eyes-Free Environmental Awareness for Navigation.” In: *Multimodal User Interfaces, Special Issue on Interactive Sonification* 5.3-4 (2012), pp. 131–141. DOI: [10.1007/s12193-011-0065-5](https://doi.org/10.1007/s12193-011-0065-5). URL: <http://www.springerlink.com/content/857h542884084ql2/>.
- [J23] B. L. Giordano, **Y. Visell**, H. Yao, V. Hayward, J. R. Cooperstock, and S. McAdams. “Identification of walked-upon materials in auditory, kinesthetic, haptic and audio-haptic conditions.” In: *Acoustical Society of America* 131.5 (May 2012). URL: <https://srl.mcgill.ca/publications/2012-JASA.pdf>.
- [J24] R. F. Hess, B. Thompson, J. M. Black, G. Maehara, P. Zhang, W. R. Bobier, **L. To**, and J. R. Cooperstock. “An iPod treatment for amblyopia: An updated binocular approach.” In: *Optometry* 83.2 (Feb. 2012), pp. 87–94. URL: <http://www.ncbi.nlm.nih.gov/pubmed/23231369>.
- [J25] **J. Blum**, **M. Bouchard**, and J. R. Cooperstock. “Spatialized audio environmental awareness for blind users with a smartphone.” In: *Mobile Networks and Applications* 18.3 (Dec. 2012), pp. 295–309. DOI: [10.1007/s11036-012-0425-8](https://doi.org/10.1007/s11036-012-0425-8). URL: <https://srl.mcgill.ca/publications/2012-MONET.pdf>.
- [J26] **S. Pelletier** and J. R. Cooperstock. “Preconditioning for Edge-Preserving Image Super-Resolution.” In: *IEEE Transactions on Image Processing* 21.1 (June 2012), pp. 67–79. URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5898412>.
- [J27] **Z. Qi** and J. R. Cooperstock. “Toward Dynamic Image Mosaic Generation With Robustness to Parallax.” In: *IEEE Transactions on Image Processing* 21.1 (Jan. 2012), pp. 366–378. URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5959979>.

- [J28] J. R. Cooperstock. “Multimodal Telepresence Systems: Supporting Demanding Collaborative Human Activities.” In: *IEEE Signal Processing* 28.1 (Jan. 2011). special issue on Immersive Communications, pp. 77–86. DOI: [10.1109/MSP.2010.939040](https://doi.org/10.1109/MSP.2010.939040).
- [J29] **L. To**, B. Thompson, **J.R. Blum**, G. Maehara, R. Hess, and J. R. Cooperstock. “A game platform for treatment of amblyopia.” In: *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 19.3 (Feb. 2011), pp. 280–289. URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5713843>.
- [J30] **Y. Visell**, B. Giordano, **G. Millet**, and J. R. Cooperstock. “Vibration Influences Haptic Perception of Surface Compliance During Walking.” In: *PLoS ONE* 6.3:e17697 (Mar. 2011). DOI: [doi:10.1371/journal.pone.0017697](https://doi.org/10.1371/journal.pone.0017697). URL: <http://dx.plos.org/10.1371/journal.pone.0017697>.
- [J31] **R. Pellerin**, **N. Bouillot**, **T. Pietkiewicz**, M. Wozniowski, Z. Settel, E. Gressier-Soudan, and J. R. Cooperstock. “SoundPark: Exploring Ubiquitous Computing through a Mixed Reality Multi-player Game Experiment.” In: *Studia Informatica Universalis* 8.3 (2010). Special Issue: Best Papers from NOTERE 2009, 21 pages. URL: <https://srl.mcgill.ca/publications/2009-NOTERE.pdf>.
- [J32] R. H. Ellaway, D. Topps, K. Lachapelle, and J. R. Cooperstock. “Integrating Simulation Devices and Systems.” In: *Studies in Health Technology and Informatics* 142 (Jan. 2009). Ed. by J. D. Westwood, S. W. Westwood, R. S. Haluck, H. M. Hoffman, G. T. Mogel, R. Phillips, R. A. Robb, and K. G. Vosburgh, pp. 88–90. URL: <https://srl.mcgill.ca/publications/2009-MMVR-Ellaway.pdf>.
- [J33] **G. Wang**, L. Mercier, D. L. Collins, and J. R. Cooperstock. “A Comparative Study of Monoscopic and Stereoscopic Display for a Probe-Positioning Task.” In: *Studies in Health Technology and Informatics* 142 (Jan. 2009). Ed. by J. D. Westwood, S. W. Westwood, R. S. Haluck, H. M. Hoffman, G. T. Mogel, R. Phillips, R. A. Robb, and K. G. Vosburgh, pp. 417–419. URL: <https://srl.mcgill.ca/publications/2009-MMVR-Wang.pdf>.
- [J34] V. N. Salimpoor, **M. Benovoy**, G. Longo, J. R. Cooperstock, and R. J. Zatorre. “The Rewarding Aspects of Music Listening are Related to Degree of Emotional Arousal.” In: *PLoS ONE* 4.10:e7487 (2009). DOI: [10.1371/journal.pone.0007487](https://doi.org/10.1371/journal.pone.0007487). URL: <http://dx.plos.org/10.1371/journal.pone.0007487>.
- [J35] **Y. Visell**, **A. Law**, and J. R. Cooperstock. “Touch Is Everywhere: Floor Surfaces as Ambient Haptic Interfaces.” In: *IEEE Transactions on Haptics* 2.3 (July 2009), pp. 148–159. DOI: [10.1109/TOH.2009.31](https://doi.org/10.1109/TOH.2009.31). URL: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5166445.
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- [J38] **J. Yin** and J. R. Cooperstock. “Color Correction Methods with Applications to Digital Projection Environments.” In: *Journal of Winter School of Computer Graphics* 12.3 (2004), pp. 499–506. URL: <https://srl.mcgill.ca/publications/2004-WSCG-color.pdf>.
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- [P9] J. R. Cooperstock, **G. Millet**, and **M. Otis**. “Floor-Based Variable Friction Display.” provisional application US 61/577,148 (expired) (United States). 2011.
- [P10] J. R. Cooperstock, **L. To**, and R. Hess. “Binocular vision assessment and/or therapy.” US 8,066,372 (United States). Nov. 2011.
- [P11] **S. Spackman**, **S. Pelletier**, and J. R. Cooperstock. “High-resolution Video Synthesis.” application 2,435,791 filed July 24, 2003 (expired) (Canada). 2003.
- [P12] J. R. Cooperstock, **Y. Zhang**, and **S. Spackman**. “Adaptive Compression for the Storage, Transmission, and Arbitrary Quality Reconstruction of Spatial Data.” US 60/339,816, provisional application filed Dec. 17, 2001 (expired) (United States). 2001.
- [P13] J. R. Cooperstock and **S. Arseneau**. “A robust person tracking method and system.” US 60/234,197 provisional application, filed Sept. 20, 2000 (expired) (United States). 2000.
- [P14] J. R. Cooperstock. “Pixel Count-Sensitive PDA Tool Mechanism with Cut/Paste and/or Copy/Paste Function.” P09-022797, filed in Japan by Sony Corp. (Japan). Feb. 1997.

TECHNOLOGY TRANSFER

License agreement signed in 2014 with amblyotech.com to commercialize amblyopia treatment (protected under US patent 8,066,372 “Binocular vision assessment and/or therapy”). The technology was subsequently [acquired by Novartis](#) in April 2020.

RESEARCH DEMONSTRATIONS

- [D1] 3D Printed Haptic Illusions and Demonstrations. IEEE World Haptics, Tokyo, Japan (conducted by Antoine Weill-Duflos and Pascal Fortin), July 2019.
- [D2] Distributed Musical Practice and Performance, I Medici di McGill, Oscar Peterson Hall, Montreal, April 28, 2008.
- [D3] Wide Screen Window on the World: Life Size HD Videoconferencing. Supercomputing 2005, Bandwidth Challenge, Seattle, November 16, 2005.
- [D4] Streaming DSD Audio comes to the AES. Audio Engineering Society 117th Convention, San Francisco, October 31, 2004.
- [D5] Cross-continental low-latency ultra-videoconferencing. McGill-Stanford jazz jam, June 13, 2002.
- [D6] Remote master’s class using SDI video and multichannel audio. McGill-National Research Council session with Pinchas Zukerman, March 25, 2002.

[D7] SDI video and multichannel audio. CANARIE's 7th Advanced Networks Workshop, Toronto, November 28, 2001.

[D8] Low-latency distributed violin duet in full-frame video. RISQ 2001 Conference, Montreal, November 5, 2001.

The Globe and Mail noted that *"Cooperstock's demonstration was a watershed event for the elite club of the world's computer network engineers. No one had ever before been able to demonstrate that, under the right conditions, it is possible for natural, normal human interaction to occur over the Internet."*

[D9] The Recording Studio that Spans a Continent. Audio Engineering Society 109th Convention, Los Angeles, September 23, 2000.

The Audio Engineering Society noted that this *"Landmark demonstration shows cost effective and high performance transmission systems for high quality 24-bit, 96kHz uncompressed multichannel audio are on horizon"*

[D10] Dolby Digital 5.1 audio with MPEG-2 video around the world. Internet Global Summit INET 2000 Conference, Yokohama, July 20, 2000.

CBC Radio noted that *"McGill University in Montreal has made Internet history by setting up the first intercontinental netcast of a live concert in surround sound and full-screen video."*

[D11] Dolby Digital 5.1 audio with MPEG-2 video. CANARIE's 5th Advanced Networks Workshop, Toronto, November 29, 1999.

[D12] First real-time Multichannel Audio Internet demo. Audio Engineering Society 107th Convention, New York, September 26, 1999.

The Learning Technologies Networked noted that *"The performance marked the first real time multichannel audio Internet transmission, a feat made possible by software developed at McGill University by a team under the leadership of Professor Jeremy Cooperstock."*

INVITED TALKS

Invited Talks to Industry, Students, and the Public

[T1] "HCI at the Shared Reality Lab", Marianopolis Engineering Society, Marianopolis College, Montreal, November 16, 2023.

[T2] "Engineering of Technologies to Improve the Lives of People Living with Vision Loss", Bio-engineering and Biomedical Engineering, McGill University, September 15, 2023.

[T3] "Using smartphones to answer 'What's around me?', 'Am I crossing the street safely?' and 'Where's the entrance?'"', Accessible Coding Demonstrations for Youth with Visual Impairment, Science Odyssey 2021, May 1, 2021.

[T4] "From flight simulators to the passenger experience: what can we learn from pilot-training tools to improve airline customer service", AIST-NRC Collaboration Meeting on Improving Client-Agent Interaction, January 17, 2020.

- [T5] “I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery”, Department of Information Engineering and Computer Science, University of Trento, July 4, 2019.
- [T6] “I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery”, Department of Industrial Engineering and Management, Ben Gurion University, March 11, 2019.
- [T7] “I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery”, Information Systems, University of Haifa, November 7, 2018.
- [T8] “What’s around me? Audio augmented reality for blind users with a smartphone, Pint of Science, Montreal, May 15, 2018.
- [T9] Presenter at Canadian National Institute for the Blind’s TechnoVision+ Conference, Montreal, May 5, 2017.
- [T10] “Innovations for Gaming, AR, Simulation & Training”, Innovations for gaming, augmented reality, simulation and training, and other applications, Centre d’entreprises et d’innovation de Montreal (CEIM), April 8, 2016.
- [T11] “Enhanced Human: Wearable computing that transforms how we perceive and interact with our world”, Department of Computer Science, Technion–Israel Institute of Technology, February 11, 2016.
- [T12] “Is Humanity Smart Enough for AI?”, McGill Science Outreach Program, Freaky Friday public outreach lecture, October 23, 2015.
- [T13] “Delivering a Compelling User Experience in a Computer-Mediated Environment”, HCIN 5300, Interactive Entertainment Technologies, Carleton University, March 7, 2014.
- [T14] “Multimedia as a Building Block: How audio, video and haptics integrate in a Shared Reality”, Multimedia Systems, GLIS 633, School of Information Studies, McGill University, February 13, 2014.
- [T15] “Are we there yet? Cognitive Science Challenges in Telepresence and Virtual Reality”, Student Association of Cognitive Science, Cognitive Science Research Day, McGill University, November 13, 2013.
- [T16] “Telepresence doesn’t quite cut it: Multimodal Challenges in Virtual and Shared Reality”, Institute of Telecommunications and Multimedia Applications, Universidad Politècnica de València, July 10, 2013.
- [T17] “Telepresence doesn’t quite cut it: Multimodal Challenges in Virtual and Shared Reality”, Dawson College, First Choice Science speakers series, April 17, 2013.
- [T18] “Dangerous AI or dangerous us?”, Academia Week Artificial Intelligence event, Science Undergraduate Society, McGill University, January 24, 2013.

- [T19] “They don’t use Skype on the Holodeck”, Department of Computer Science, University of British Columbia, July 4, 2012.
- [T20] “But can the Holodeck do a good Shiraz?”, School of Computer Science and IT, Royal Melbourne Institute of Technology, February 17, 2012.
- [T21] “But can the Holodeck do a good Shiraz?”, School of Information Technologies, University of Sydney, February 15, 2012.
- [T22] “Distributed Music Performance and Latency Issues”, School of Drama, Fine Art and Music, University of Newcastle (Australia), February 13, 2012.
- [T23] “But can the Holodeck do a good Pinot noir?”, Department of Computer Science, University of Otago, January 23, 2012.
- [T24] “Shared Reality: Toward perceptually convincing computer-mediated environments”, Department of Computer Science, University of Auckland, August 25, 2011.
- [T25] “This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments”, Vanier College, Science Week Presentation, March 24, 2011.
- [T26] “This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments”, Simula Lab, Oslo, May 15, 2009.
- [T27] “This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments”, Ambient Intelligence Group, CITEC, Bielefeld University, May 6, 2009.
- [T28] “Distributed and Multimodal Interaction in Virtual and Augmented Reality Environments”, McGill University, School of Physical and Occupational Therapy, November 25, 2008.
- [T29] “Shared Reality: Effective Interaction for (Demanding) Distributed Tasks”, University of Victoria, September 16, 2008.
- [T30] “Bidirectional video communication for real-time applications”, Institut für Telematik, University of Lübeck, Germany, May 15, 2008.
- [T31] “Shared Reality: Effective Interaction for (Demanding) Distributed Tasks”, Aalborg University, Esbjerg, Denmark, May 14, 2008.
- [T32] “Distributed Multimodal Interaction”, Bang & Olufsen, Struer, Denmark, May 13, 2008.
- [T33] “Distributed Musical Practice and Performance”, Biology and Music Lecture, I Medici di McGill, April 28, 2008.
- [T34] “Shared Reality: Effective Interaction for (Demanding) Distributed Tasks”, Arts, Media and Engineering, Arizona State University, February 29, 2008
- [T35] “From Videoconferencing to Shared Reality” Department of Electrical and Computer Engineering, University of British Columbia, October 4, 2007.

- [T36] “Engaging Technolog(ies) for Effective Interaction” Department of Computer Science, Hebrew University of Jerusalem, April 19, 2005.
- [T37] “Engaging Technolog(ies) for Effective Interaction” Intelligence, Agents, Multimedia Group, University of Southampton, UK, March 7, 2005.
- [T38] “From Videoconferencing to Shared Reality” l’Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris, November 25, 2004.
- [T39] “From Videoconferencing to Shared Reality” Taiyuan University, Taiyuan, China, April 18, 2004.
- [T40] “From Videoconferencing to Shared Reality” Tsinghua University, Beijing, China, April 14, 2004.
- [T41] “From Videoconferencing to Shared Reality” Beijing University, Beijing, China, April 14, 2004.
- [T42] “From Videoconferencing to Shared Reality” Beihang University, Beijing, China, April 12, 2004.
- [T43] “From Videoconferencing to Shared Reality” Advanced Telecommunications Research (ATR), Nara, Japan, April 9, 2004.
- [T44] “From Videoconferencing to Shared Reality” Dept. of Industrial Engineering, Musashi Institute of Technology, April 5, 2004.
- [T45] “High-fidelity telepresence” Graphics and Geometric Computing Seminar Series, Technion – Israel Institute of Technology, January 1, 2003.
- [T46] “The Virtual Studio” Royal Conservatory of Music, Toronto, February 25, 2002.
- [T47] “Building a Shared Reality” Department of Computer Science, University of Toronto, February 25, 2002.
- [T48] “Distributed Concerts and Shared Reality: Just how much streamed data and computation do we need to support effective interaction?” Department of Computer Science, Clarkson University, November 1, 2001.
- [T49] “Robotics and Design” Round Table Panel, Centre Design UQAM, February 9, 2000.
- [T50] “The Shared Reality Environment” Department of Electrical and Computer Engineering, Ecole Polytechnique, Montreal, May 28, 1999.

Invited Talks in Scholarly Conferences and Workshops

- [T51] “Intelligent Systems to Enhance Human Experience”, International Laboratory of Learning Systems–DATAIA Workshop, Paris, May 25, 2023.
- [T52] Speaker in “Ethics Research I am Excited About”, Laidley Centre for Business Ethics, Montreal, April 28, 2023.
- [T53] Speaker in “Next Gen Health Powered By The Open Grid And Edge AI”, IEEE Future Networks Forum, Montreal, October 14, 2022.
- [T54] “Touch and feel when it isn’t real: Integrating haptics into the XR experience”, InterDigital Scientific Seminar series, December 4, 2020.
- [T55] “Taking Haptics Out of the Lab and Into the Wild”, Introduction to Haptics for Next Generation XR. International Conference on Intelligent Robots and Systems Tutorial Session, October 29, 2020.
- [T56] “Assistive Technology Research in the Shared Reality Lab”, Conférence scientifique du CRIR-Institut Nazareth et Louis-Braille, September 25, 2019.
- [T57] “Learning from sparse feedback: Adapting an environmental awareness app to visually impaired user preferences”, ACM-SIGCHI sponsored summer school on Intelligent User Interfaces in the Era of IoT and Smart Environments, Haifa, Israel, October 3, 2018.
- [T58] Speaker in “AR/VR panel”, IEEE Multimedia Signal Processing Workshop, Montreal, September 23, 2016.
- [T59] “Immersive multimedia and mobile interaction: Applications to new media, gaming, medicine, and beyond” Keynote speaker, Entertainment Technology Summit, Concordia University, Montreal, September 17, 2016.
- [T60] “Leveraging video in public safety scenarios”, Ninth Canadian Public Safety Interoperability Workshop (CITIG 9), Toronto, December 1, 2015.
- [T61] “Future Cities (2040) – Mind: Human and Machine”, Institute for the Public Life of Arts and Ideas, Symposium on Future Cities, March 13, 2015.
- [T62] “UltraVideo and the Quest for Minimal Latency”, International Workshop on High Quality Dynamic cross-continental Networked Artistic interaction, World Opera Association, Struer, Denmark, August 29, 2013.
- [T63] “Assisting the blind and treating amblyopia: Two more things you can do with your smart-phone”, 15e Symposium scientifique sur l’incapacité visuelle et la réadaptation (presented with J. Blum). University of Montreal, February 12, 2013.
- [T64] “Revolutions in human-device interaction: How new paradigms impact user experience”, International Conference on Consumer Electronics, Consumer Electronics Society, Las Vegas, January 12, 2013.

- [T65] “Around the World in 80 ms.” Panel presentation in Workshop of the Audio Engineering Society Convention, San Francisco, November 5, 2010.
- [T66] “UltraVideo and Virtual Presence: A Video Perspective.” Presentation on Teaching in Distributed Performance, Tromsø, Norway, October 15, 2010.
- [T67] “Future Interfaces for Audio.” Panel presentation in Workshop of the Audio Engineering Society Convention, New York, October 10, 2009.
- [T68] “World Opera Technologies and Tests”, Danish Sound Technology Network, Aalborg University, June 8, 2009.
- [T69] “The Montreal World Opera Experiments”. Presentation at the World Opera Symposium, Struer, Denmark, May 12, 2009.
- [T70] “Audio-Visual-Haptic-Tactile: Putting them all together for an engaging immersive experience”. Panel presentation in Workshop of the Audio Engineering Society Convention, Munich, Germany, May 10, 2009.
- [T71] “New Technologies for Audio over IP”. Panel presentation in Workshop of the Audio Engineering Society Convention, Munich, Germany, May 10, 2009.
- [T72] “A Platform to Create and Support Ocean Science Virtual Organizations (Oceans 2.0)” and “HSVO Health Services Virtual Organization”, RISQ 2008 Colloquium, Montreal, November 14, 2008.
- [T73] “The Future of VC: Music Teaching and High Fidelity Video”, Elevate 2008: Reaching New Heights in Educational Video-conferencing, Banff, August 27–28, 2008.
- [T74] “Creating an immersive video space”, International Symposium on The World Opera: When the Opera stage becomes worldwide, Tromsø, Norway, May 9, 2008.
- [T75] “Multimodal Streaming and Distributed Audio Interaction”, High Quality Audio over Networks (ANET II) Summit, Banff Centre, April 12, 2008.
- [T76] “Music and Games: How Fun Applications Stimulate Core Technologies”, Canadian University Software Engineering Conference, January 19, 2008.
- [T77] “From Teleoperation to Teleimmersion: Design Challenges for Distributed Interaction”, Canadian University Software Engineering Conference, January 19, 2007.
- [T78] “CANARIE sur UCLP et ROADM, deux technologies qui changent le monde des télécoms”, Round Table panel, RISQ Annual Conference, Quebec City, October 16, 2006.
- [T79] “La recherche sur en ultra-videoconference”, Panel on “Vitrine technopédagogique sur la vidéoconférence”, RISQ Annual Conference, Quebec City, October 16, 2006.
- [T80] “Broadband transmission of multimodal content at the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT)”, RISQ-CA*net4 Advanced Networking Day, Montreal, October 24, 2005.

- [T81] “Low-Latency Ultra-Videoconferencing and Shared Reality” Interfaces Montreal, Rencontre du Génie numérique et des Affaires. Montreal, October 11, 2005.
- [T82] “Shared Spaces” Asia-Pacific Advanced Networks (APAN) Conference, Taipei Aug. 22–27, 2005.
- [T83] “Engaging Technolog(ies) for Effective Interaction” Keynote speaker, World Conference on Educational Multimedia, Hypermedia and Telecommunications, Montreal, June 29, 2005.
- [T84] “Broadband Distance Education in 2007: Views from the Demand Side” Invited Panelist. World Conference on Educational Multimedia, Hypermedia and Telecommunications, Montreal, June 29, 2005.
- [T85] “Ultra-Videoconferencing and Intelligent Classrooms” Keynote speaker, Canadian Higher Education and Information Technology Conference, Montreal, June 28, 2005.
- [T86] “From Videoconferencing to Shared Reality” Bell University Laboratories’ Annual Conference, Toronto, November 3, 2004.
- [T87] “History of Internet Audio Experiments at McGill” High Quality Audio over Networks (ANET) Summit, Banff Centre, August 20–22, 2004.
- [T88] “Advanced Video Applications: Developments in Extreme Video” Southeastern Universities Research Association Video Development Initiative (SURA/ViDe) 6th Annual Digital Video Workshop. Indianapolis, March 24, 2004.
- [T89] “The Democratic Revolutions – Peer to Peer Meets Open Source: Design, Philosophy, Engineering” Intimate Technologies/Dangerous Zones. Banff New Media Institute, Banff Centre, April 27, 2002.
- [T90] “The Development of Ultra VC Applications and Technology” Southeastern Universities Research Association Video Development Initiative (SURA/ViDe) 4th Annual Digital Video Workshop. University of Alabama at Birmingham, April 25, 2002.
- [T91] “High quality wide-screen SDI video and multichannel audio over CA*net3” CANARIE’s 7th Advanced Networks Workshop, Toronto, November 28, 2001.
- [T92] “Low-latency comes to videoconferencing: The Frères Jacques duet at a distance” RISQ 2001 Conference, Montreal, November 5, 2001.
- [T93] Advanced Networking and the Arts: Innovations in Outreach, Collaboration, and Performance. Panel Discussion at Internet Global Summit INET 2001 Conference, Stockholm, June 6, 2001.
- [T94] “The McGill–Calgary Advanced Learnware Network” CANARIE’s 6th Advanced Networks Workshop, Montreal, November 29, 2000.
- [T95] “Networks and Music Instruction” Panel Discussion with Pinchas Zukerman and Wieslaw Woszczyk, CANARIE’s 6th Advanced Networks Workshop, Montreal, November 29, 2000.

- [T96] “Tools for Distributed VR” Canadian Working Group on Virtualized Reality Systems, Montreal, November 28, 2000.
- [T97] “Evolution of the Intelligent Classroom” Multicultural Perspectives on the use of Technology in Education. Montreal, October 2, 2000.
- [T98] The Brave New World of Ubiquitous Bandwidth” Internet Global Summit INET 2000 Conference, Yokohama, July 20, 2000.
- [T99] “Multichannel Audio over the Internet: The Next Phase” RISQ 2000 Conference, May 31, 2000.
- [T100] “Multichannel Audio over the Internet” CANARIE’s 5th Advanced Networks Workshop, Toronto, November 29, 1999.
- [T101] “When Telemedicine feels like Regular Medicine” Communications and Information Technology Ontario (CITO) Healthcare for the Future: Telemedicine, February 18, 1999.

MEDIA EXPOSURE

- [M1] Ami-Télé, Ça me regarde, February 8, 2018
- [M2] Forbes, March 9, 2017
- [M3] Discovery Channel, Daily Planet, Mar. 7, 2017
- [M4] Télé-Québec, Electrons Libre, Jan. 17, 2017
- [M5] ACB Radio, Mainstream, Nov. 18, 2016
- [M6] CBC Radio, Tech Column, Aug. 8, 2016
- [M7] CJAD Radio, Tech Talk, Aug. 6, 2016
- [M8] Mobile Syrup, Aug. 4, 2016
- [M9] CBC News, Aug. 4, 2016
- [M10] Betakit, Aug. 3, 2016
- [M11] Accessible Media Inc., Live from Studio 5, Aug. 2, 2016
- [M12] La Presse, Jul. 31, 2016
- [M13] CTV News, Jul. 29, 2016
- [M14] Stevivor, Mar. 2015
- [M15] Venture Beat, Mar. 3, 2015
- [M16] Club Social (TV5), Feb. 4, 2011
- [M17] Global TV (National), Jan. 29, 2009
- [M18] Global TV (Montreal), Jan. 27, 2009
- [M19] CBC Radio, As it Happens, Jan. 27, 2009
- [M20] National Post, Jan. 27, 2009

- [M21] Montreal Gazette, Jan. 27, 2009
- [M22] Montreal Gazette, Feb. 20, 2009
- [M23] Inside Higher Education, Sept. 3, 2008
- [M24] CBC Radio (Daybreak), Sept. 3, 2008
- [M25] CJAD radio, Sept. 2, 2008
- [M26] Cabling Networking Systems, Jan. 2006
- [M27] McGill Reporter, Nov. 24, 2005
- [M28] CTV Quebec, Global News, Dec. 23, 2002
- [M29] New York Times, Technology Section, Dec. 19, 2002
- [M30] Discovery Channel, Daily Planet, Oct. 30, 2002
- [M31] CFCF (CTV Quebec) Global News, June 19, 2002
- [M32] National Post, June 15, 2002
- [M33] CBC Television, The National, May 3, 2002
- [M34] McGill Reporter, Learning the Strings, April 11, 2002
- [M35] Ottawa Citizen, March 29, 2002
- [M36] Montreal Gazette, March 27, 2002
- [M37] Globe & Mail, Dec. 1, 2001
- [M38] Canal Z, La Revanche des Nerds, Nov. 13, 2001
- [M39] Montreal Gazette, Nov. 10, 2001
- [M40] CJAD Radio, The World Today, July 31, 2001
- [M41] McGill Reporter, April 5, 2001
- [M42] Globe & Mail Report on Business, Oct. 28, 2000
- [M43] TQS Double Clic!, Oct. 7, 2000
- [M44] McGill Reporter, Sept. 21, 2000
- [M45] UPath.com, Vol 40, 2000
- [M46] CBC (Montreal) Home Run, Aug. 22, 2000
- [M47] Montreal Gazette, Aug. 22, 2000
- [M48] CFCF (CTV Quebec) Pulse News, Aug. 21, 2000
- [M49] CBC Radio The Arts Report, July 20, 2000
- [M50] Elle Quebec, June 2000
- [M51] Journal Le Monde des Affaires, May 2000
- [M52] Canal Z, Technofolie, May 3, 2000
- [M53] TQS Double Click, April 29, 2000
- [M54] McGill Reporter, April 6, 2000

- [M55] Briefing Digital, April 2000
- [M56] Interface: La Revue de la Recherche, Vol. 21, No. 2, March-April 2000
- [M57] American Society of Mechanical Engineers, Mechanical Advantage, Vol 9, No 3, March 2000
- [M58] Canal Z, La Revanche des Nerds, Feb. 2000
- [M59] CFCF (CTV Quebec) Pulse News, Feb. 29, 2000
- [M60] Canal Vox: CityMag, Jan. 15, 2000
- [M61] Montreal Mirror, Jan. 6, 2000
- [M62] Plan Mega: La revue du genie québécois, Ordre des ingenieurs du Québec. Vol 1, Jan. 2000
- [M63] Radio Corporation of Singapore: Science and Technology Watch, Dec. 1999
- [M64] Radio Canada (CBC French) Les Annees lumiere, Nov. 28, 1999
- [M65] Financial Times Life/Technology, Nov. 25, 1999
- [M66] CBC Radio: As it Happens, Nov. 22, 1999
- [M67] Journal de Montreal, Nov. 19, 1999
- [M68] Le Devoir, Nov. 18, 1999
- [M69] TVA CyberClub, Nov. 13, 1999
- [M70] La Presse, Sept. 26, 1999
- [M71] CJAD Radio, April 11, 1999
- [M72] Montreal Mirror, April 8, 1999
- [M73] McGill Reporter, Jan. 14, 1999
- [M74] High-Tech Shower International, Nov. 26, 1997
- [M75] CBC Newsworld "Futureworld", Oct. 5, 1996
- [M76] Discovery Channel, Sept. 18, 1996
- [M77] Toronto Star, Sept. 15, 1996
- [M78] University of Toronto Varsity, Sept. 3, 1996
- [M79] TV Ontario "Studio Two", June 26, 1995

RESEARCH SUPERVISION

RESEARCH PROFESSIONALS

Name	Period	Project title	Present Position
Singh, Jaydeep	Sep 2021–	web developer, IMAGE project	
Novack, Kaylee	Sep 2021–Apr 2022	medical doctor researcher on Avatar Therapy project	Medical Resident, Université de Montréal
Kuo, Cyan	Aug 2021 – Dec 2023	Usability Research Lead, IMAGE project	
Patil, Gandharv	Jun 2021 – Mar 2022	ML Research Lead, IMAGE project	PhD student, McGill
Grond, Florian	Apr 2021 – Mar 2023	Audio Research Lead, IMAGE project	Assistant Professor, Concordia University
Eichhorn, Alexander	Feb 2013 – Aug 2013	research associate under GRAND	CTO of Kidtsunami
Bouchard, Mathieu	Jan 2011 – Nov 2018	research assistant under MSG project	
Chen, Guangyi	Jan 2010 – Jul 2010	research associate under Canarie NEP	
Vincent, Coralie	Oct 2010 – Mar 2011	research assistant	Research Engineer, IRCAM, France
Dansereau, Don	Jun 2009 – Jan 2010	research associate under FRQNT grant	Senior Lecturer, University of Sydney
To, Long	Jan 2009 – Sep 2011	research associate under NSERC I2I	Software engineer, Abcam
Blum, Jeff	Oct 2008 – Aug 2013	research assistant under MSG project	

Continued on next page

Name	Period	Project title	Present Position
Olmos, Adriana	Sep 2008 – July 2012	user interface engineer under Canarie NEP	Interaction designer, Google/YouTube
Sun, Haijian	Sep 2008 – Oct 2010	computer engineer under Canarie NEP	ECM Consultant, JCDS Solutions Inc.
Soukhodolski, I.	Oct 2005 – Dec 2007	web services programmer under Ca- narie IIP	Owner, W4 Tech- nology
Kiewe, Howard	Oct 2005 – Dec 2007	user interface developer under Canarie IIP	consultant
Spackman, S.	2000–2006	research associate on Canarie and VRQ projects	Google, Mountain View
Sarikaya, Deniz	2003–2004	research assistant on VRQ projects	deceased
Soucy, Gilbert	1999	research associate on CFI project	Imaging Specialist, 36pix Inc., Mon- treal

POST-DOCTORAL FELLOWS

Name	Period	Project title	Present Position
Byeon, Yeong-Hyeon	Jan 2024-	Bionic Ear Project	
Bouzekri, Élodie	Sep 2023-	ADAIR Project	
Fontana De Vargas, Mauricio	Jan 2023 – Nov 2023	Ai-Digital Nurse Avatar (ADiNA)	AI+VR Research Scientist, Meta, Toronto
Sullivan, John	Sep 2021 – Apr 2022	Multimodal Rendering for the IMAGE Project	post-doctoral fellow, Université Paris-Saclay
Jyoti, Vishav	Mar 2021 – Feb 2022	Mixed-Reality Platform for Simulation and Synthesis of Multi-Modal Hallucinations	Software Engineer, Youtube, India
Talhan, Aishwari	Jan 2021 – Dec 2022	Wearable Haptics	Research Scientist, SUNY Research Foundation, Albany, New York
Yoo, Yongjae	Mar 2020 – Jul 2022	Wearable Haptics and Haptics Lead, IMAGE project	Assistant Professor, Hanyang University ERICA, South Korea
Weill-Duflos, A.	Jan 2018 – Jan 2021	Wearable Haptics	Director of Research and Product Integration, Haply Robotics
Arnold, Andre	Oct 2017 – Dec 2017	Wearable Haptics	Product Manager – AI Nuvoola
Panëels, S.	Jan 2011 – Jan 2012	Natural Interactive Walking and In-Situ Audio Services	Researcher, Commissariat à l'énergie atomique et aux énergies alternatives (CEA)

Continued on next page

Name	Period	Project title	Present Position
Pelletier, S.	Nov 2009 – Jun 2011	Real-time Image-based Rendering (Canarie NEP, 2009-2010)	
		Parallax Barrier Display rendering software optimization (NSERC EN- GAGE, 2011)	Game Programmer, Behaviour Interac- tive
Otis, Martin	Jan 2010 – Dec 2010	Natural Interactive Walking (FRQNT Scholarship)	Assoc. Profes- sor, U. Québec à Chicoutimi
Millet, G.	Nov 2009 – Mar 2012	Natural Interactive Walking	Patent Examiner, EPO, The Hague
Bouilliot, Nicolas	Sep 2007 – Dec 2011	Mobile Audio Interaction (NSERC New Media Initiative, 2007-2009)	
		Open Orchestra (Canarie NEP-2 Project)	Co-Founder - Lab148
Darolti, Cristina	Jan – Dec 2009	Real-time Image-based Rendering (Canarie NEP)	Patent Examiner, EPO, The Hague
Wang, Guangyu	Sep 2007 – Mar 2011	Neurosurgical Visualization and Vir- tual Presence (NSERC Strategic and NCE)	Facebook, Moun- tain View
Wang, Yan	2002–2003	Channel and spatial view allocation for videoconferencing (VRQ)	V.P. Marketing, AMH Canada

PH.D. STUDENTS

Name	Period	Thesis title	Present Position
Kuo, Cyan	Jan 2024– present	Multimodal Perception in Sensory Substitution Frameworks	
Knappe, Sabrina*	Jan 2023– present	Advanced Airspace Usability	
Samuel, Segun*	Jan 2023– present	Spatial content representation strategies for blind and low-vision users	
Conan, Corentin*	Sep 2022– present	Advanced Airspace Usability	
Astles, Samantha*	Sep 2022– present	Advanced Airspace Usability	
Shen, Lichao*	Oct 2021– Aug 2023	Social telepresence	
Regimbal, J.* ^{◇‡}	Sep 2021– present	Audio-haptic authoring for information rich content delivery	
Fortin, P.* [◇]	Sep 2016– Sep 2021	Methods and Interfaces for Closed-Loop Smartphone Communications	Asst. Professor, U. Québec à Chicoutimi
Blum, Jeff* ^{†g}	Sep 2013– present	Implicit Communication for Enriched Human Interaction	
Erfani-Joorabchi, M.*	Jan 2013– Jan 2015		iOS Software Engineer, Google
Anlauff, Jan*	Jan 2011– present	Sensor-Actor Wearables	
Tordini, F.	Jan 2011– Feb 2018	Auditory salience modeling for continuous processes sonification	Technology Transfer Manager, Innovation and Partnerships, McGill University

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Name	Period	Thesis title	Present Position
Ghourchian, N. ^{*†}	Jan 2010– Apr 2011	Affective Evaluation	transferred to another group
El-Shimy, D. [†]	Jan 2009– Nov 2014	Reactive Environment for Network Music Performance	Director of UX Research, WISE, London UK
Benovoy, M. [†]	Oct 2007– Aug 2010	Biosignals analysis	transferred to another group
Visell, Yon	Sep 2005– Mar 2011	Walking on virtual ground: physics, perception, and interface design	Assistant Professor (ECE), UC Santa Barbara
Qi, Zhi	Jan 2004– Dec 2008	Towards dynamic mosaic generation with robustness to parallax effects	Associate Professor (School of Electronic Science & Engineering), Southeast University, China
Pelletier, S. ^p	Jan 2003– Oct 2009	Acceleration methods for image super-resolution	Game Programmer, Behaviour Interactive
Yin, Jianfeng	Sep 2000– Aug 2008	Toward an Alternative Approach to Multi-Camera Scene Reconstruction	Software engineer, Geomagical Labs
Sun, Wei	2002–2006	Multi-camera Object Segmentation in Dynamically Textured Scenes Using Disparity Contours	Apple Inc., Cupertino
Cayouette, F. [†]	2003–2006	human tracking (withdrew from program)	Generalist Programmer, Reflector Entertainment
Arseneau, S.	2000–2006	Representing Junctions through Asymmetric Tensor Diffusion	Chief Technology Officer, MVP, Austin

* McGill Engineering Doctoral Award recipient

† NSERC PGS D Scholarship recipient

‡ NSERC CGS D Scholarship recipient

◊ FRQNT Scholarship recipient

^g Graphics Animation and New Media (GRAND) Scholarship recipient

^p Precarn Scholarship

ADDITIONAL PH.D. SUPERVISORY SERVICE

I co-supervised a portion of the thesis work of the following students:

- Du, X. (Sep 2023-), visiting student from Southeast University, Nanjing, China
- Mousavi, M. (Sep 2023-), visiting student from Azad University, Tehran, Iran
- Liu, X. (Nov 2013-Dec 2015), visiting student from University of Electronic Science and Technology, China
- Xie, M. (Sep 2012-Mar 2014), visiting student from Beijing University of Aeronautics and Astronautics, China
- Grond, F. (Jul-Dec 2010), visiting student from Bielefeld University, Germany
- Zambon, S. (Jul-Oct 2010), visiting student from Verona University, Italy
- Cirio, G. (Jun-Aug 2010), visiting student from INRIA-IRISA, France
- Rizutti, C. (Sep-Oct 2008), visiting student from Università della Calabria, Italy
- Bossi, E. (Sep-Oct 2008), visiting student from Università della Calabria, Italy
- Pellerin, R. (Jun-Sep 2008), visiting student from Conservatoire Nationale des Arts et Métiers, France
- Cupellini, E. (Jul-Aug 2007), visiting student from Università della Calabria, Italy
- Usher, J. (2003-2004), Ph.D. student, Faculty of Music, McGill University
- Mohammadi, M. (Feb-Aug 2004). visiting student from Sharif University, Iran

I served as external reviewer or examiner of the following theses:

- Mauricio Fontana de Vargas, School of Information Studies, McGill University (2022)
- Richard Olayniyan, Department of Computer Science, McGill University (2021)
- Xavier de Tingu, Université Rennes, France (2020)
- Damien Brun, Le Mans Université, France (2020)
- Cheryl Savery, Queen's University (2014)
- Alexandre Plouznikoff, École Polytechnique de Montréal (2009)
- Xiaoyong Sun, School of Information Technology and Engineering, University of Ottawa (2007)
- Nicolas Bouillot, Conservatoire Nationale des Arts et Métiers, France (2006)
- Harold Okai-Tettey, Computer Science, Rhodes University, South Africa (2006)

I served on the supervisory and/or examination committees of the following students:

- Department of Electrical and Computer Engineering: Amir Abbas Haji Abolhassani, Lixiao (Sean) Zhu, Shalaleh Rismani, Edouard Antoniou, Oliver Astley, Carmen Au, Marc Boulé, Wei Chu, Olivier St-Martin Cormier, Vincent Levesque, Muhua Li, Rui Ma, Dante De Nigris Moreno, Jun Ouyang, Jerome Pasquero, Andrew Phan, Ala Qumsieh, Harkirat Sahambi, Wei Sun, Yick Kei Wong, Dingrong Yi, Olivier St-Martin Cormier, Karl Fayad, Shalaleh Rismani, Lixiao Zhu
- School of Physical and Occupational Therapy: Jackie Girgis
- School of Information Studies: Xiaofeng (Allan) Yong
- Faculty of Music: Jason Corey, Cory McKay, Caroline Medeiros, Sean Olive, Dale Stammen, Vanessa Yarmechuk, Mark Zadel
- Grad. School of Library and Information Studies: Charles-Antoine Julien
- Department of Educational Psychology and Counselling: Adam Finkelstein
- Department of Mechanical Engineering: Zahir Albadawi, Omar Wyman
- School of Computer Science: Paul Haroun, Wisam Al Abed

MASTERS STUDENTS

Name	Period	Thesis title	Present Position
Buller, Abigail [◊]	Sep 2023–	Haptic displays for multi-patient vital sign monitoring	
Karve, Anay	Sep 2023–	ADvanced AIRspace Usability	
Naik, Khushi	Sep 2023–	Graphical displays for multi-patient vital sign monitoring	
Zou, Yichen	Sep 2023–	Bionic Ear	
Li, Heyang*	Jan 2023–	Emotion recognition and expression for ADiNA	
Fu, Jano	Jan 2023–	Dynamic multimodal chart representations for individuals who are blind	
Bazin, Romain	Sep 2022–	Deep Learning for Chart Explanations	
Quadros, Venissa Carol	Sep 2022–	Authoring of Audio-Tactile Content for Refreshable Tactile Displays	
Aubet, Antoine	Sep 2022–	Computationally efficient dynamic spatial audio rendering for distributed musical performance	
Liu, Yujing	Sep 2021–	Graphical rendering strategies for avatar therapy	
Wilson, É.	Sep 2021–	Depth-based image rendering techniques for blind and low-vision users	
Duarte, Nathan [◊]	Sep 2021–Aug 2023	Deploying wearable sensors for pandemic mitigation	Senior Associate, Boston Consulting Group
Henry, Max	Sep 2021–	Spatial-aware audio rendering for immersive telepresence	
Lewis-Lane, Jonathan	Sep 2021–Aug 2023	Haptic Interfaces for Musical Notation and Expression	Haptics Engineer, Apple Computer

Continued on next page

Name	Period	Thesis title	Present Position
Akut, Rohan	Jan 2021–Jul 2023	Enriching AI-based Image Descriptions for People who are Vision-Impaired	Machine Learning Engineer, iCAD Dental
Gannavarapu, S.	Sep 2020–Dec 2023	Haptic Perception and Multimodal Maps for the Visually Impaired	
Isran, Rayan	Sep 2020–Aug 2023	Investigating Audio-Haptic Rendering Methods To Deliver Chart Information to Blind and Low-Vision Individuals	Embedded Systems Engineer, AAVAA
Kirby, Linnea	Sep 2020–	Multimodal feedback to guide body-movement	
Knappe, Sabrina	Sep 2020 – Dec 2022–	Towards a User Interface for Audio-Haptic Exploration of Internet Graphics by People who are Blind and Partially Sighted	Ph.D. student (see above)
Regimbal, J.	Sep 2020 – Aug 2021	Haptic effects authoring in artistic and utilitarian contexts	(fast-tracked to Ph.D. program)
Ducher, Clara [‡]	Sep 2019 – Sep 2021	GAN-based interaction paradigms for photorealistic avatar creation	Pipeline Technical Director, Double Negative
Marino, David	Sep 2019 – Nov 2021	Implicitly Conveying Emotion While Teleconferencing	R&D Scientist, Hitachi Energy, Montreal
Lee, Hyejin	Sep 2019 – Apr 2022	Generating Convincing Simulation of Internalized Voices for Human-avatar Interaction	Full-stack developer, Société Générale, Montreal
Li, Yaxuan	Sep 2019 – May 2022	Towards Context-aware Automatic Multimodal Haptic Effect Generation for Home Theatre Environments	Ph.D. student, U. Michigan
Bouanane, Y.	Jan 2019 – Dec 2020	EchoDepth: Using a depth camera and sonification for blind navigation	Entrepreneur, sktch.io

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Name	Period	Thesis title	Present Position
Demers, Marc	Sep 2018 – Mar 2021	A Data-Driven Strategy for Evaluating Tacton Perceptual Similarity	Data Scientist, Maxen Technologies
Vyas, Preeti	Sep 2017 – Apr 2020	Foot-based Haptic Interfaces for Numeric Information Delivery and Dance Learning	Ph.D. student, UBC
Sulmont, E.	Sep 2017 – Dec 2018	Improved Learning of Machine Learning by Non-Majors	Curriculum Manager, DataCamp
Patil, Gandharv	Jan 2017 – Dec 2019	Min-Max Inverse Reinforcement Learning for learning bi-modal dialogue policies	Ph.D. student, McGill
Girgis, Roger	Sep 2016 – Apr 2019	Assessing the Use of Deep Learning in Assisting Visually Impaired People with Outdoor Exploration	Ph.D. student, MILA
Kim, Taeyong	Sep 2016 – Aug 2019	Exploration of foot based interaction for menu control and virtual reality applications	HRI Researcher, Hyundai Robotics
Alirezaee, P.	Sep 2016 – Dec 2019	Multimodal approaches to improved hospital alarms	Product Designer, Unity Technologies
Diaz, Manfred	Sep 2016 – Aug 2017	Interactive and Uncertainty-Aware Imitation Learning	Ph.D. student, MILA
Ahmer, Z.	Jan 2016 – Jan 2019	Automated musical accompaniment to children's stories	
Yin, G.	Sep 2015 – Oct 2018-	Augmented Reality Tools for Workplace Safety	Software Engineer, Kooltra
Fortin, P.	Sep 2015 – Aug 2016	Physiological Perception of Tickling Sensation	(fast-tracked to Ph.D. program)
Horodniczy, D. [†]	Sep 2014 – Dec 2016	Characterization and Application of a Variable-Friction Foot Device	Software Developer, Philips Innovative Imaging Technologies

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Name	Period	Thesis title	Present Position
Vuibert, Vanessa	Sep 2013 – Aug 2015	Efficient and Accurate Performance with Unconstrained Mid-air Interaction	Software Developer, Guavus
Hieda, Naoto	Sep 2012 – Aug 2015	Digital Video Projection for Interactive Entertainment	PhD student, Tallinn University, Estonia
Viswanathan, R.	Jan 2010 – Dec 2012	Testing the Two-Stream Hypothesis in an Immersive Virtual Environment	Senior Software Developer, Faurecia Irystec Inc
Knight, Trevor	Jan 2010 – Sep 2011	Music Visualization for Open Orchestra (CIRMMT Student Award)	Software Developer, Noteloop Systems
Li, Weizhong	Sep 2008 – May 2009	(recommended alternative supervision)	
Ip, Jessica	Sep 2008 – Mar 2011	Augmented Reality for Interactive Play in a Virtual and Physical Environment	iOS developer, Shopify, Toronto
Namit, Gaurav	May 2008 – Oct 2009	(withdrew in 2009 to pursue social entrepreneurship venture)	
El-Shimy, D.	Sep 2007 – Dec 2008	Gestural interaction for complex tasks	(fast-tracked to Ph.D. program)
Law, A.	Sep 2007 – Sep 2010	A Vibrotactile Floor for Enabling Interaction through Virtual Walking Spaces	Data Systems Engineer, AECOM, Vancouver
Benovoy, M.	Sep 2006 – Oct 2007	Biosignals analysis and its application in a performance setting	(fast-tracked to Ph.D. program)
Audet, Samuel [†]	2005-2007	Shadow Removal from Multi-Projector Displays via Three-Dimensional Modeling and Object Tracking	Deeplearning4j (Skymind), Tokyo, Japan

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Name	Period	Thesis title	Present Position
Wozniowski, M.	2003-2006	A framework for interactive three-dimensional sound and spatial audio processing in a virtual environment	research engineer, Société des arts technologiques, Montreal
Rudzicz, Frank*	2004-2006	CLAVIUS: Understanding Language Understaing in Multimodal Interaction	Associate Professor, University of Toronto (status) and Dalhousie University
Rioux, Francois [†]	2003-2005	Software Framework for Parsing and Interpreting Gestures in a Multimodal Virtual Reality Context	Ph.D., Laval; Software Architect, Thales Canada
Chan, Siu-Chi	2002-2005	Hand and Fingertip Tracking for Gesture Recognition	Technical Staff, AMD Toronto
Hilario, Nadia*	2002-2005	Occlusion Detecion in Front Projection Environments	Software Developer, Spiria
Perez, Michael	2002-2005	Multimodal Human-Computer Interaction for a Public Kiosk System	User Interface Designer, Nuance
Sud, Daniel	2002-2005	Design of a Multi-Projector Display System	Senior Producer, Lucky Hammers
Boussemart, Y.	2002-2005	Design and Implementation of Framework for Immersive Environments in a Shared Context	Chief Technology Officer, Xerxes Global
Pelletier, S.	2001-2003	High-Resolution Video Synthesis from Mixed-Resolution Video Based on the Estimate-and-Correct Method	(see above)
Gu, Jinhua	2000-2002	A distributed software architecture for the Shared Reality Environment.	VP, Radian Asset Assurance Inc., NY
Yao, Jie	2000-2002	Human Arm Gesture Detection and Recognition in a Classroom Environment.	Ph.D. student, Concordia University

Continued on next page

Name	Period	Thesis title	Present Position
Zhang, Yuan	2000-2002	An efficient coding method for spatial data: the rotating, hierarchical, overlapping representation.	Ph.D. student, University of Delaware
Doutriaux, S.	1998-1999	(withdrew in 1999 to launch start-up company)	
Arseneau, S.	1998-2000	Robust Image Segmentation Towards an Action Recognition Algorithm.	(see above)
Xu, Aoxiang	1998-2000	A High-Performance Audiovisual Communication System.	QNX Software Systems, Ottawa

* FRQNT Graduate Scholarship recipient

† NSERC PGS M Scholar recipient

‡ McGill nominee for Northeastern Association of Graduate Schools Distinguished Thesis Award

◇ McCall MacBain Scholar

ADDITIONAL MASTERS SUPERVISORY SERVICE

I co-supervised a portion of the thesis work of the following students:

- Albert, Nicolas (Jan-Jun 2024), visiting student from École Polytechnique Fédérale de Lausanne, Switzerland
- Dever, Ani (Sep 2017-Feb 2018), visiting student from Polytechnic University of Turin, Italy
- Gallo, Nicola (Sep 2015-Feb 2016), visiting student from Polytechnic University of Turin, Italy
- Roy, Louise (Jul-Dec 2015), visiting student from Ensimag, Grenoble, France
- Glessner, David (Feb-Jun 2012). visiting student from Ensimag, Grenoble, France
- Penin, O. (Jul-Aug 2011). visiting student from Paris-Sud 11, France
- Mabire, N. (Apr-Sep 2010). visiting student from Supélec, Metz, France
- Brulé, M. (Feb.-Aug 2009). visiting student from Université de Louis Pasteur, Strasbourg, France
- Anlauff, J. (Dec 2008-Mar 2009). visiting student from Bielefeld University, Germany
- Delattre, G. (Apr-Aug 2007). visiting student from Université Paris VI, France

I served on the supervisory and/or examination committees of the following students:

- Zhonghao Zhao (M. Eng. project), Electrical and Computer Engineering, McGill University
- Anne-Marie Burns, Faculty of Music, McGill University
- Frank Riggi, Electrical and Computer Engineering, McGill University

- Eric Benzacar, Electrical and Computer Engineering, McGill University
- Oles Protsiym, Faculty of Music, McGill University

FUNDING

INDIVIDUAL RESEARCH GRANTS AND CONTRACTS

Date	Source	Amount	Title/Description
2024-2029	NSERC	\$242,000	<i>Multimodal information communication to overcome environmental, sensory, and computer mediation limitations</i> Discovery grant
2024	HBHL/ HumanWare	\$370,867	<i>Advancing IMAGE Support for the HumanWare/APH Monarch</i> Healthy Brains, Healthy Lives (CFREF) with partner organization HumanWare
2023	MEDTEQ/ NSERC	\$268,115	<i>Improving Intelligibility of Speech in Noisy Environments.</i> MEDTEQ Partenar-IA and NSERC Alliance funding
2023	Humanware	\$33,600	<i>Prototype experience for IMAGE content on the Monarch</i> Research contract
2023-2024	MEDTEQ/ HBHL	\$282,188	<i>Haptic devices for conveying non-textual visual information on the internet for individuals with vision loss.</i> MEDTEQ Partenar-IA (Ministère de l'Économie, de l'Innovation et de l'Énergie) and Healthy Brains, Healthy Lives (CFREF)
2022	HBHL	\$50,000	<i>Extending Internet Multimodal Access to Graphical Exploration.</i> Healthy Brains, Healthy Lives (CFREF) Neuro Commercialization Ignite Grant
2022	Meta	\$30,000	Unrestricted gift
2021	Mitacs	\$13,333	<i>Analyse et recherche d'optimisation d'un processus d'adaptation de contenu issu de la numérisation 3D à un contenu photo-réaliste et interactif.</i> Mitacs Accelerate – Intern: Chen, Hongjun
2021-2022	ISED	\$608,594	<i>Enabling Access to Graphical Image Content Published via the Internet for People Who Are Blind, Deaf-Blind or Visually Impaired.</i> Innovation, Science and Economic Development Canada (ISED), Accessible Technology Program (Total project budget of \$765,787)
2019-2021	NSERC/ MEDTEQ	\$374,366	<i>Mixed-Reality Platform for Simulation and Synthesis of Multi-Modal Hallucinations with Applications to Schizophrenia Treatment.</i> Collaborative Research and Development Grant with Industrial Partners, iMD Research and IA Précision Santé Mentale
2019	NSERC	\$25,000	<i>360 degree imaging for navigation assistance for the visually impaired.</i> Engage Grants Program with Industrial Partner, ImmerVision.

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Date	Source	Amount	Title/Description
2019	Mitacs	\$15,000	<i>Advanced sensor control implementations for energy optimization in commercial buildings using machine learning and data visualisation applied to building automation systems.</i> Mitacs Accelerate – Intern: Demers, Marc
2019	Mitacs	\$6,000	<i>Facilitating Human Interaction with a Robotic Exercise Coach using Smart Objects.</i> Mitacs Globalink – Intern: Vyas, Preeti
2018	Mitacs	\$6,000	<i>Mobile Remote Implicit Communication.</i> Mitacs Globalink: Intern: Blum, Jeff
2018	NSERC	\$25,000	<i>Educational wine recommendations from initially sparse data.</i> Engage Grants Program with Industrial Partner, Wineout Inc.
2017-2018	McGill	\$7500	<i>Physiological confirmation of stimulus reception.</i> Faculty of Engineering TechAccelR Grant
2017-2020	NSERC	\$631,650	<i>Wearable Haptics.</i> Collaborative Research and Development Grant with InterDigital Corporation
2017-2018	CIRA	\$44,500	<i>Intelligent Agent for the Visually Impaired: Vision-based scene description and contextual awareness for Autour.</i> Canadian Internet Registry Authority .CA Community Investment Program
2017-2022	NSERC	\$ 222,000	<i>Multimodal Influences on Perception and Action in Computer-Mediated Environments.</i> Discovery grant.
2017-2018	MSP	\$177,673	<i>Social Media Monitoring Architecture.</i> Research Contract with Ministère de la Sécurité publique
2015	CIRA	\$53,878	<i>What's Around Me? Conveying Environmental Awareness to the Visually Impaired Community.</i> Canadian Internet Registry Authority .CA Community Investment Program
2014-2015	Mitacs	\$15,000	<i>Effect of Mobile Technologies in Emergency Response.</i> Mitacs Accelerate – Intern: Erfani-Joorabchi, Minoo
2014	NSERC	\$25,000	<i>Haptic user experience delivered through the shoes.</i> Engage Grants Program with Industrial Partner, InterDigital Canada
2013-2014	NSERC	\$137,474	<i>3D immersive projection infrastructure with full-body motion capture and analysis.</i> Research Tools and Instruments Grants
2012-2013	Mozilla	\$50,000	<i>Real-Time Emergency Response.</i> Mozilla Ignite Development Challenge (in partnership with the National Science Foundation)
2012-2017	NSERC	\$210,000	<i>Improved Shared Reality for Multi-Party, Multimodal Simulation and Interaction.</i> Discovery grant.

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Date	Source	Amount	Title/Description
2012	Toyota	\$30,000	<i>Haptic interaction with an augmented steering wheel.</i> Toyota Infotechnology Centre
2011	HP	\$60,950	<i>Capturing attention via spatialized audio cues.</i> HP Labs Innovation Research Program (IRP)
2011	NSERC	\$25,000	<i>Improved Parallax Barrier Autostereoscopic Display Software.</i> Engage Grants Program with Industrial Partner, Holoptick Technologies Inc.
2010-2011	Google	\$50,000	<i>A Spatialized Audio Map System for Mobile Blind Users.</i> Google Faculty Research Awards.
2010-2011	Honda	\$30,000	<i>Facial Expression Recognition for Machines.</i> Honda Research Institute.
2010	UVic	\$8,000	<i>NEPTUNE Pleora streamer.</i> University of Victoria software license
2008-2012	MDEIE	\$367,195	<i>Natural Interactive Walking.</i> Support for International Research and Innovation Initiatives, Ministère du Développement économique, de l'Innovation et de l'Exportation; for Canadian participation in EU FP-7 program with partners in France, Italy, and Denmark.
2007-2010	MDEIE	\$15,000	<i>Un environnement virtual pour la création de musique et de son à partir de systèmes chaotiques.</i> Support for International Research and Innovation Initiatives, Ministère du Développement économique, de l'Innovation et de l'Exportation.
2006-2009	NSERC	\$317,785	<i>A pervasive multi-user augmented space for mobile immersive interaction with sound and music.</i> (additional funding for artist collaborator received from Canada Council for the Arts) New Media Initiative STPGP 337999-06.
2006-2011	NSERC	\$100,000	<i>Enhanced video for shared reality environments.</i> Discovery grant.
2004-2006	NSERC	\$136,600	<i>Soundscape performance works via interactive environment for immersive audiovisual scene generation.</i> (additional funding for artist collaborator received from Canada Council for the Arts) New Media Initiative NMIPJ 307934-04.
2002-2006	NSERC	\$100,000	<i>Shared Reality Interaction over High Bandwidth Connectivity.</i> Discovery grant.
2000	LUB	\$100,000	<i>Distributed Visualization Environment.</i> Laboratoire universitaire Bell Equipment Grant.

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Date	Source	Amount	Title/Description
1999-2000	Petro-Canada	\$20,500	<i>Interactive Web Tools for Critique of Presentation Skills and Evaluation of Student Learning.</i> Young Innovator Award.
1999-2002	FCAR	\$45,000	<i>Augmenting an Electronic Classroom for Improved Instructor-Student Interaction.</i> New Researchers Award.
1999	FCAR	\$15,700	<i>Augmenting an Electronic Classroom for Improved Instructor-Student Interaction.</i> Equipment Grant.
1999	AES	\$25,000	<i>Multichannel audio over Internet.</i> Audio Engineering Society.
1999	OSC	\$15,000	<i>Timespace Exhibit.</i> Ontario Science Center contract.
1999	MFM	\$10,000	<i>Intelligent Classroom tools.</i> McGill Faculty of Management.
1998-2002	NSERC	\$76,000	<i>Reactive Hospital Environment.</i> Discovery research grant.
1998	FGSR	\$20,000	McGill Graduate Studies and Research Development Fund

TEAM RESEARCH GRANTS AND CONTRACTS

(Percentages refer to my portion.)

Date	Source	Amount	Title/Description
2024	Société inclusive	\$35,000 (33%)	<i>Perceptions des utilisateurs ayant une déficience visuelle concernant l'utilisation des électroménagers et la nécessité d'améliorer la connaissance ou l'expérience utilisateur pour des innovations futures</i> Société inclusive, Programme de recherche participative intersectorielle (with F. Poncet)
2023	Mitacs	\$150,000 (70%)	<i>*Avatar Care Provider for Seniors Residences</i> Mitacs Accelerate (with K. Moffatt)
2022-2025	CRIAQ	\$1,318,171 (35%)	[†] NSERC Alliance with Consortium for Aerospace Research and Innovation of Québec (CRIAQ) <i>ADvanced Airspace Usability (ADAIR)</i> (with P. Doyon-Poulin (Poltechnique), Joon Chung (Ryerson), and 6 aerospace industrial partners)
2020-2021	CIRMMT	\$1,500	<i>*Agile Seed Funding for Conveying paralinguistic cues and context while teleconferencing</i> (with students David Marino, Max Henry and Pascal Fortin)
2017-2018	SSHRC	\$199,680 (10%)	[†] <i>Real time impact signalling and collective goods</i> Partnership Development Grant (with R. Janda and 6 co-investigators)
2016-2017	NAKFI	\$100,000 (20%)	<i>Empathy Mirror</i> National Academies Keck Futures Initiative Art and Science, Engineering and Medicine Grant (with B. Korgel and 3 co-applicants)
2015-2018	FRQNT	\$182,880 (25%)	[†] <i>Étude des modèles d'interactivité humain-robot en réalité mixte afin de réduire l'apparition des troubles musculo-squelettiques en utilisant une cellule de travail hybride</i> Recherche en équipes (with M. Otis and 6 co-applicants)
2014	Mozilla	\$20,000 (90%)	<i>*Augmented Reality Tools for Improved Training of First Responders</i> Mozilla Gigabit Community Fund (with R. Dearden)
2011	CIRMMT	\$10,000 (90%)	<i>*Acoustic Sculptures</i> CIRMMT Strategic Innovation Fund Award (with A. Olmos and 3 others)
2010-2011	NSERC	\$49,815 (90%)	<i>*Novel Portable Treatment Device for Lazy Eye</i> Idea to Innovation (I2I) Booster (Phase Ib) (with R. Hess)

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Date	Source	Amount	Title/Description
2009-2011	MSG	\$200,000 (80%)	<i>*Location-Based Spatialized Audio Interaction for the Blind and Visually Impaired</i> Programme Appui au passage à la société de l'information (Support for the transition to an information society program), Ministère des Services gouvernementaux (MSG) (with M. Wozniowski and Z. Settel)
2010-2014	CHRP	\$327,000 (?)	<i>Computational and statistical tools for image guided neurosurgery of brain tumors</i> NSERC Collaborative Health Research Projects (with L. Collins and 7 others)
2009-2010	CCSIP	\$48,000 (4%)	<i>*Digitally Merged Environments</i> California-Canada Strategic Initiatives Program (with S. Brown, UCSD and 20 co-applicants)
2009-2011	Canarie	\$927,648 (40%)	<i>†Open Orchestra</i> Network-Enabled Platforms 2 (with J. Roston and W. Woszczyk)
2010-2014	NCE	\$23,000,000 (2%)	<i>†GRAND: Graphics, Animation and New Media</i> Networks of Centres of Excellence (With K. Booth and 49 others)
2009	DND	\$47,500	<i>†Video-Based Facial Recognition-Algorithm and Demonstration</i> Department of National Defence Contract (with M. Levine)
2008-2009	NSERC	\$120,250 (90%)	<i>*Novel Portable Treatment Device for Lazy Eye</i> Idea to Innovation (I2I) (with R. Hess)
2008-2010	Canarie	\$1,397,758 (7%)	<i>NEPTUNE: A Platform to Create and Support Ocean Science Virtual Organizations</i> Network-Enabled Platforms (with B. Pirenne and J. Roston)
2008-2010	Canarie	\$2,000,000 (18%)	<i>Health Services Virtual Organization</i> Network-Enabled Platforms (with R. Ellaway and 8 others)
2008-2010	NSERC	\$196,000 (50%)	<i>*3-D Visualization and gestural interaction with multimodal neurological data</i> Strategic Projects (with 5 others)
2006-2009	FRQNT	\$146,550 (50%)	<i>*Unités agenceables: Réseau d'Environnements Immersifs pour Collaboration à Distance</i> Recherche en équipes (with X.-W. Sha)
2005-2006	Canarie	\$825,000 (50%)	<i>Undersea Window-High Definition Video Online</i> Intelligent Infrastructure Program. (with J. Roston)
2005-2006	SAT	\$1,276,000 (1%)	<i>TOT2: Nouveau Territoires de la Création-Diffusion en Réseau</i> Heritage Canada New Media Research. (M. Savoie, PI)
2004-2006	Canarie	\$568,971 (33%)	<i>Shared Spaces – High Definition Ultra-Videoconferencing</i> Advanced Applications Program. (with J. Roston)
2003-2004	SAT	\$792,082 (1%)	<i>TOT1: Nouveau Territoires de la Création-Diffusion en Réseau</i> Heritage Canada New Media Research. (M. Savoie, PI)

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Date	Source	Amount	Title/Description
2002-2005	IRIS	\$573,000 (25%)	<i>*Parallel Distributed Camera Arrays for Intelligent Environments</i> (with J. Clark, S. Fels, R. Vertegaal)
2002-2005	VRQ	\$2,180,000 (20%)	<i>Real-time Communication Of High-res. Multi-sensory Content via Broadband Networks.</i> Valorisation-Recherche Quebec (with W. Woszczyk and others)
2001-2002	Canarie	\$391,000 (30%)	<i>Remote Video Sign-Language Interpreting.</i> Advanced Networking Apps. Services & Technologies. (with J. Roston and others)
2000-2002	Canarie	\$808,000 (35%)	<i>McGill Advanced Learnware Project.</i> Advanced Networking Applications Services and Technologies. (with B. Pennycook)
2000-2003	LUB	\$150,000 (50%)	<i>*Distributed Shared Visualization Environment.</i> Laboratoire universitaire Bell. (with B. Ozell)
2000-2001	Royal Bank	\$2,000 (80%)	<i>*Improving Teaching through an Interactive Critiquing System.</i> Teaching Improvement Fund Award. (with R. Harris and J. Blatter)
1999-2002	CFI	\$400,000 (50%)	<i>†The Shared Reality Environment.</i> New Opportunities Award. (with J. Clark)
1999-2000	Royal Bank	\$10,000 (80%)	<i>*Interactive Web Tools for Critique of Presentation Skills and Evaluation of Student Learning.</i> TIF (with R. Harris)

*Indicates grants on which I am project leader. †Grant on which I am co-investigator.

CENTRE RESEARCH GRANTS

Date	Source	Amount	Title/Description
2022-2026	ILLS	\$400,000	FRQNT International Laboratory on Learning Systems, funded jointly by CNRS (France) and FRQNT (Quebec), Pablo Piantanida, PI, \$100,000 per annum
2021-2028	FRQSC/ FRQNT	\$2,712,295	Regroupement Stratégique: <i>Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie</i> . (with I. Cossette and 52 others) \$276,000 per annum for 2 years and \$432,059 per annum for the remainder
2019-2025	FRQNT	\$2,160,000	Regroupement Stratégique pour <i>Systèmes cyberphysiques et intelligence machine matérialisée (REPARTI)</i> . (with C. Gosselin and 49 others) \$480,000 per annum.
2015	CFI	\$4,366,723	Innovation Fund: <i>Live Expression "in situ": Musical and Audiovisual Performance and Reception</i> (with M. Wanderley and 9 others)
2014-2021	FRQSC/ FRQNT	\$1,800,000	Regroupement Stratégique: <i>Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie</i> . (with M. Wanderley and 23 others)
2013-2019	FRQNT	\$2,160,000	Regroupement Stratégique pour <i>l'Étude des Environnements PARTagés Intelligents répartis (REPARTI)</i> . (with D. Laurendeau and 34 others) \$359,943 per annum.
2008-2014	FRQSC/ FRQNT	\$1,800,000	Regroupement Stratégique: <i>Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie</i> . (with S. McAdams and 23 others)
2007-2009	NSERC	\$57,630	Major Resources Support: <i>Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT)</i> . (with S. McAdams and 8 others)
2006-2013	FRQNT	\$1,530,000	Regroupement Stratégique pour <i>l'Étude des Environnements PARTagés Intelligents répartis (REPARTI)</i> . (with D. Laurendeau and 23 others) \$100,000 per annum allocated to CIM.
2002-2005	FCAR	\$720,000	Regroupement Stratégique: <i>Réseau Québécois de Recherche en Réalité Artificielle Distribuée (QUERRAnet)</i> . (with F. Ferrie, R. Bergevin, P. Cohen, and others)
2001	CFI	\$6,500,000	Major Facilities Award: <i>Centre for Integrated Research in Music Media and Technology</i> . (with W. Woszczyk and 11 others)
2000-2002	FCAR	\$113,500	Centre de Recherches. (with F. Ferrie and 17 others)

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Date	Source	Amount	Title/Description
2000	NSERC	\$275,000	<i>Information Systems in Support of Intelligent Machine Research.</i> (with F. Ferrie and 17 others)

TEACHING

COURSES TAUGHT

Course title and number	Description	Semester
ECSE-618 <i>Haptics</i>	Graduate course on haptic information design, co-taught with other instructors across Canada, under the informal designation of HAPTICS 501	Winter 2021–present
ECSE-421 <i>Embedded Systems</i>	Undergraduate course dealing with both the theory and practice of design for embedded systems	2018–present
ECSE-526 <i>Artificial Intelligence</i>	Graduate level course in artificial intelligence with emphasis on machine learning and autonomous agents	1998–present
*ECSE-683 <i>Topics in Vision and Robotics</i>	Graduate level laboratory course for RoboCup projects	Fall 2000 Fall 2002
*ECSE-424/542 <i>Human-Computer Interaction</i> [†]	Undergraduate (424) and graduate (542) course in human-computer interaction with emphasis on new interface paradigms	2000–present
ECSE-487 <i>Computer Architecture Laboratory</i>	Undergraduate laboratory course	1999–2018
ECSE-427 <i>Operating Systems</i>	Undergraduate course (core for Computer Engineering students)	1998
CSC-270 <i>Introduction to Modelling and Optimization</i>	Computer Science undergraduate course, University of Toronto	1993–1994
CEE 1714Y <i>Digital Systems and Computers</i>	Continuing Engineering Education course for the Association of Professional Engineers of Ontario	1993–1994
CSC-228 <i>File Structures and Data Management</i>	Computer Science undergraduate course, University of Toronto	1992–1995

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Course title and number	Description	Semester
COSC-3411	Computer Science undergraduate course,	1992
<i>File Structures and Data Management</i>	York University	

*Indicates new course that I created.

†In 2011, a project from this class placed third in the [Usability Professionals Association International Student Design Competition](#). Note that graduate students have also enrolled in this course under the designation of ECSE-681, *Colloquium in Electrical Engineering* or ECSE-689, *Recent Advances in Electrical Engineering*.

UNDERGRADUATE SUPERVISION

ECE Honors Undergraduate Projects (2 semesters)

Name	Year	Research topic
Bu, Bruce	2020	360° Imaging for Navigation Assistance for the Visually Impaired
Akgul, Ahmet	2017-2018	Haptic Wearables
Bashar, Sharhad	2016-2017	Image-based environment description
Wu, Pei Yuan (Richard)	2016	Mixed-Reality Human-Machine Interaction
Gordon, Adam	2011-12	Virtual Presence
Warraich, Shahjahan	2010-11	Natural Interactive Walking
Lin, Nan	2008	Location sensing for mobile apps
Wang, Letao	2007	Interactive Agent
Charlebois, Pierre-Olivier	2004–2005	Sound Objects in a Soundscape
Myer, Sam	2003	Automated Music Transcription
El-Refaei, Sameh	1998–1999	Shared Reality simulator

ECE Undergraduate Design Projects (2 semesters)

Name	Year	Research topic
Ajji, Maya	2024	AI Digital Nurse Avatar (ADiNA)
Rahman, Nafis	2024	AI Digital Nurse Avatar (ADiNA)
Wang, Jingyi	2024	AI Digital Nurse Avatar (ADiNA)
Zhang, Rong Wei	2024	AI Digital Nurse Avatar (ADiNA)
Srivastava, Atreyi	2024	AI Digital Nurse Avatar (ADiNA)
Ktaily, Nour	2024	AI Digital Nurse Avatar (ADiNA)
Bansal, Pratham	2024	AI Digital Nurse Avatar (ADiNA)
Cattani, Alex	2024	AI Digital Nurse Avatar (ADiNA)
Wang, Bohan	2024	Cybersight
Feng, Shuzhao	2024	Cybersight
Tian, Steven	2024	Cybersight
Wang, Yiqiao	2024	Cybersight
Bebee, Lukas	2023-2024	Force-feedback experiences for IMAGE
Alexander Tsahageas	2023-2024	Force-feedback experiences for IMAGE
Emma Kawczynski	2023-2024	Force-feedback experiences for IMAGE
Massimo Rosati	2023-2024	Force-feedback experiences for IMAGE
Gurhan, Eren	2023-2024	Vision-guided Navigation Assistance
Yan, Ke	2023-2024	Vision-guided Navigation Assistance
Calitoiu, Mihail	2023-2024	Vision-guided Navigation Assistance
Park, John	2023-2024	Vision-guided Navigation Assistance
Hu, David	2023	Vision-guided Navigation Assistance

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Name	Year	Research topic
Gasmi Ilyes	2023	Vision-guided Navigation Assistance
Habelrih Edward	2023	Vision-guided Navigation Assistance
Arabian Ari	2023	Vision-guided Navigation Assistance
Fathi, Saab	2023	Avatar therapy for psychosis
Ham, Sia	2023	Avatar therapy for psychosis
Choi, Myunghoon	2023	Avatar therapy for psychosis
Kruchinski Almeida, Martin	2023	Avatar therapy for psychosis
Kabir, Anika	2023	Chatting with historical figures
Huynh, Vy-Kha	2023	Chatting with historical figures
Solaberrieta, Emilia	2023	Chatting with historical figures
Cui, Bowen	2022-2023	Immersive multimodal CAVE experience
El Haddad, Georges	2022-2023	Immersive multimodal CAVE experience
Fazal, Gohar Saqib	2022-2023	Immersive multimodal CAVE experience
Mahajan, Madhav	2022-2023	Immersive multimodal CAVE experience
Pan, Edwin	2022-2023	Touching faces in VR
Gosman, Mircea	2022-2023	Touching faces in VR
Justin, Legrand	2022	Vision-guided Navigation Assistance
Sen, Wang	2022	Vision-guided Navigation Assistance
Chamberland, Noah	2022	Vision-guided Navigation Assistance
Natchev Keanu	2022	Novel digital representation of sign language
Arabian Matthias	2022	Novel digital representation of sign language
Destiné, Maxens	2022	Novel digital representation of sign language
Jarvis, Thomas	2022	Natural Dialog Generation for Mental Health
Kong, Norman	2022	Natural Dialog Generation for Mental Health
MacNaughton, Ben	2021-2022	plots data parsing for IMAGE project
Williams, Aidan	2021-2022	plots data parsing for IMAGE project
Nunez, Matteo	2021-2022	Foot-fluid interaction simulation in mobile VR
Comeau, Francis	2021-2022	Foot-fluid interaction simulation in mobile VR
Gure, Kaan	2021-2022	Foot-fluid interaction simulation in mobile VR
Calin, Haluk	2021-2022	ML-based Navigation Assistance
Cano, Victor	2021-2022	ML-based Navigation Assistance
Das Sharma, Kaustav	2021-2022	ML-based Navigation Assistance
Dufault, Louca	2021-2022	ML-based Navigation Assistance
Simard, Felix	2021	detecting benevolent sexism in text
Watson, Tyler	2021	detecting benevolent sexism in text
Porporino, Anthony	2021	detecting benevolent sexism in text
Bourbeau, Charles	2021	detecting benevolent sexism in text
Ko, Neroli	2020-2021	haptic dance shoes
Zwack, Noah	2020-2021	haptic dance shoes
Zhang, Weijing	2020-2021	haptic dance shoes
Szwimer, Benjamin	2020-2021	visually impaired access to web graphics
Zoltak, Matthew	2020-2021	visually impaired access to web graphics
Itovitch, Ethan	2020-2021	visually impaired access to web graphics

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Name	Year	Research topic
Weiss, Ben	2020-2021	mixed-reality for schizophrenia treatment
Bieber, Nicolas	2020-2021	mixed-reality for schizophrenia treatment
Khan, Marwan	2020-2021	360° imaging for navigation assistance
Johansen, Anthony	2020-2021	360° imaging for navigation assistance
Gurkan, Mert	2020-2021	360° imaging for navigation assistance
Warsi, Osman	2020-2021	360° imaging for navigation assistance
Lague, Ethan	2019-2020	AR firefighter situational awareness tools
Masciotra, Alex	2019-2020	AR firefighter situational awareness tools
Philippon, Thomas	2019-2020	AR firefighter situational awareness tools
Bouchard, Tristan	2019-2020	AR firefighter situational awareness tools
Smith, Babette	2019-2020	AR and 360: camera-mediated future
Smith, Lilith	2019-2020	AR and 360: camera-mediated future
Chen, Jennie	2019-2020	Foot-fluid interaction simulation in mobile VR
Servera, Ryan	2019-2020	Foot-fluid interaction simulation in mobile VR
Wong, Tyrone	2019-2020	Foot-fluid interaction simulation in mobile VR
Bluethner, Lucas	2019-2020	Foot-fluid interaction simulation in mobile VR
Volodina, Yuliya	2019	360° camera scene understanding
Ritch, David	2019	360° camera scene understanding
Lam, Guillaume	2019	360° camera scene understanding
Nasseem, Veronica	2019	360° camera scene understanding
Amjad, Adeeb Ibne	2019	360° camera supported intersection-crossing
Amarouche, Hakim	2019	360° camera supported intersection-crossing
Tang, James	2019	360° camera supported intersection-crossing
Commodari, Stefano	2019	360° camera supported intersection-crossing
Regimbal, Juliette	2019	Haptic Wearables
Radi, Nusaiba	2019	Haptic Wearables
Berman, Isaac	2018	Vision-based crossing assistance
Mashaal, Stuart	2018	Vision-based crossing assistance
Liu, Shi Yu	2018	Vision-based crossing assistance
Legrand, Augustin	2018	Force Feedback for VR and AR
Fournier, Clément	2018	Force Feedback for VR and AR
Nith, Romain	2018	Force Feedback for VR and AR
Malik, Numan	2017-2018	Variable-Friction Surface Mechanism
Eshaq, Yousef	2017-2018	Variable-Friction Surface Mechanism
Alalawi, Beshr	2017-2018	Variable-Friction Surface Mechanism
Ahmed, Ridwan	2017-2018	Variable-Friction Surface Mechanism
Nichyporuk, Brennan	2017-2018	AI/vision-based Q&A Dialogue
Benseler, Nick	2017-2018	AI/vision-based Q&A Dialogue
Karatzas, Thomas	2017-2018	Wine recommendation engine
Zhilin, Oleg	2017-2018	Wine recommendation engine
Simard-Morissette, Olivier	2017-2018	Wine recommendation engine
Mirfallah Liarestani, N.	2017	Autour
Kim, Yong Beom	2017	Autour

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Name	Year	Research topic
Gibeault-Girard, Gabriel	2017	AR firefighter display
Velastegui, Nicolas	2017	AR firefighter display
V Cama, Carmen Aimee	2017	AR firefighter display
Dermont, Daniel	2016-2017	Haptic shoes
Makriogiorgos, A.	2016-2017	Haptic shoes
Rohlicek, Greg	2015-2016	Mobile telepresence
Carter, Stephen	2015-2016	Mobile telepresence
Zhang, Zhaowei	2015-2016	Haptic shoes
Huynh, Alex	2015-2016	Haptic shoes
Guzman, Juan	2015-2016	Video analytics
Ali, Hassan	2015-2016	Video analytics
Macario, Daniel	2015-2016	Automated event detection
Arané, Yarden	2015-2016	Automated event detection
Leighton, Brett	2015-2016	Automated event detection
Aird, Nicholas	2015-2016	AR firefighter display
Chen, Yuechuan	2015-2016	AR firefighter display
Lei, Simon	2015-2016	AR firefighter display
Mendonca, Justin	2015-2016	Firefighter IPS
Asfour, Justin	2015-2016	Firefighter IPS
Ward, Thomas	2015-2016	Firefighter IPS
Laramée, Alexandre	2015-2016	Firefighter IPS
Sahib, Shivan	2015-2016	Biosignal wearables
Nath, Saptaparna	2015-2016	Biosignal wearables
Bramson, Shawn	2013–2014	Mobile Telepresence
Larose, Andrew	2013–2014	Mobile Telepresence
Dirik, Alize	2013–2014	Mobile Telepresence
Mansour, Rita	2013–2014	Walking Straight
Elkerdi, Ghalia	2013–2014	Walking Straight
Redel, Josh	2012	Augmented Meeting Collaboration
Savchenko, Eugene	2010	3D interaction

ECE Undergraduate Design Projects (1 semester)

Name	Year	Name	Year	Name	Year
Himmelman, Tristan	2009	Glass, Emily	2001	Li, (Shao-Gi) Chris	1999
Ephraim, Theo	2009	Asselin, Ramy	2001	El-Sharif, Osama	1999
Peck, Benjamin†	2008	Sud, Daniel	2001	Nasereddin, Hazem	1999
Mankarios, Daniel	2007	Gapakov, Timofei	2001	Virdi, Gurpratap	1999
Konstantinidis, Alex	2007	Rosenblatt, Avi	2001	Shah, Ali	1999
Pufahl, David	2005	Pekofsky, Gregory	2001	Djihanian, Sylvie	1999
Zhu, Ming-Zhang	2005	Kitisa, Anousack	2000	Moussaoui, Khaled	1999
Chan, Keng Chi	2005	Vial, Thibaut	2000	Dib Youssef	1999
Phan, Andrew	2004	Bernier, Martin	2000	Tam, H.	1999
Saiffee, Ali-Akber	2004	Agha, Khurram Z.	2000	Gagnon, Gabriel	1999
Shield, Robert	2004	Bhattacharya S.	2000	Tjhin, P.	1999
Aubé, Francois	2004	Lavery, William	2000	Luong, Mai	1999
Rudzicz, Frank	2003	Yeung, Jason	2000	Lau, Sau	1999
Sarikaya, Deniz	2002	Liao, Yuan Mei	1999	Tsai, Wanti	1999
Vallianatos, K.	2002	Yee, Amy	1999	Lerner, Sorin*	1999
Hassaine, Sofiane	2002	Pereira, David	1999	Hochstein, Lorin*	1999
Wyse, Marisa	2001	Ciambella, Gary	1999	Pollack, Jonathan	1998
Bancroft, David	2001	Kassouf, Nadim	1999	Nguyen, Bau	1998
		Lee, Garvin	1999		

*Co-supervised with James Clark

†Co-supervised with Paul Kry

Computer Science Undergraduate Projects (1 semesters)

Kandlikar-Bloch, Mira	Jun–Aug 2024	AI Digital Nurse Avatar
Gostovic, Lilith	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Newman, James	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Song, Juyeon Olivia	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Chowdhury, Shadman	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Liang, Tina	Jan– Apr 2024	AI Digital Nurse Avatar (ADiNA)
Nejad, Namdar	2022	Improving Accessible Representations of Web Graphics
Li, Dailun	2022	Training and Testing an Open-Source French TTS Model

Mechanical Engineering Undergraduate Design Projects (2 semesters)

Sadaqa, Abdel-Rahman	2020-2021	Haptic illusions
Waite, Emilie	2020-2021	Haptic illusions
Shi, Rock	2020-2021	Haptic illusions
Fitz-Gerald, Thomas	2020-2021	Haptic illusions
Pollet, Nathan	2020-2021	Multimodal haptic armrest
Uzan, Emanuel	2020-2021	Multimodal haptic armrest
Ruivo Patricia	2020-2021	Multimodal haptic armrest
Abravanel Tal	2020-2021	Multimodal haptic armrest
Fowo, Clovis	2017-2018	Haptic interface for the feet
Robert, Gabrielle	2015-2016	Variable friction shoe
King, Michael	2013-2014	Variable Friction Foot-Ground Contact

Undergraduate Internships

Name	Year	Research project
Mandampully, Samyuktha,	2024	(Mitacs Globalink) Internet Multimodal Access to Graphical Exploration (IMAGE)
Lu, Calla	Jan–Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Sarellano, Andrés	Sep– Dec 2023	(Tec de Monterrey Undergraduate Research Trainee) Social Telepresence
Moreno Piedra, Balthazar	Sep– Dec 2023	(Tec de Monterrey Undergraduate Research Trainee) Social Telepresence
Tomiuk, Emma	2023	(ARIA Intern) Musical Telepresence
Gunatilaka, Movinya	2023	(Mitacs Globalink) Musical Telepresence
Lavoie, Gabrielle	2023	(research trainee) Internet Multimodal Access to Graphical Exploration (IMAGE)
Bessonov, Vladimir	2023	(research trainee)
Phan Antoine	2023	(SURE student) Internet Multimodal Access to Graphical Exploration (IMAGE)
MacInnes, Gabrielle	2023	(SURE student) Internet Multimodal Access to Graphical Exploration (IMAGE)
Abderrahim, Ons	2023	(Mitacs Globalink) Autour
Glavas, Theodore	2023	(NSERC USRA) ChatGPT-based health assistants
Li, Hanzi	2022	(CS Intern) Internet Multimodal Access to Graphical Exploration (IMAGE)
Gutiérrez, Diego Macias	2023	(Mitacs Globalink) Haptic dance shoes
Cortes, Dafne Peña	2023	(Tec de Monterrey Undergraduate Research Trainee) Internet Multimodal Access to Graphical Exploration (IMAGE)
Shen, Xing	2022	(ECE Intern) Vision-Guided Navigation Assistance
Dutta, Riana	2022	(NSERC USRA) Internet Multimodal Access to Graphical Exploration (IMAGE)
Pan, Edwin	2022	(SURE Student) Touching Face in VR
Chen, Hongye	2022	(ECE Intern) Internet Multimodal Access to Graphical Exploration (IMAGE)
Behal, Rahul	2021-2022	ML-based Navigation Assistance for the Visually Impaired
Rao Appala, Siddharth	2021	(Mitacs Globalink) Making internet graphics accessible through rich audio and touch
Contreras, Luis F. H.	2021	(Mitacs Globalink) Haptic device for sensory re-education application

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Name	Year	Research project
Bhayana, Rachit	2021	(NSERC USRA) Conveying Paralinguistic and Non-Verbal Cues in Teleconferencing
Reszetnik, Grace	2021	(NSERC USRA) Avatar therapy for psychosis
Jiang, Cecilia	2021	(NSERC USRA) Avatar therapy for psychosis
Radi, Rakshitha	2021	(ECE Intern) Assistive Technology Project
Marshall, Kenji	2020-21	(ECE Intern) Avatar therapy for psychosis
Pollet, Nathan	2020	(SURE Student) 360° camera imaging
Bu, Bruce	2019	(SURE Student) Haptic Wearables
Chen, Jennie	2019	(SURE Student) Haptic Wearables
Zhang, Yukai	2019	(SURE Student) Haptic Wearables
Ratnakirti, Navneet	2019	(SURE Student) Sweatsponse
Al Taha, Feras	2018-2019	(NSERC USRA) Haptic Wearables
Nunez, Matteo	2018	(SURE Student) Haptic Wearables
Huang, Yixiang	2018	(SURE Student) Non-Intrusive Mobile Experience Sampling
Li, Zihang	2018	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array
Kaoubi, Hadir	2018	(Mitacs Globalink) Autour: “What’s around me?”
Ma, Jiantong	2018	Haptic Zoom
Tran, Jessica	2017	Social Media Monitoring
Xing, Emily	2017	Attention Switching Protocols in Family Conversations
Hao, Ju	2017	(Mitacs Globalink research intern) Haptic shoes
Lisus, Daniil	2017	(NSERC USRA) Natural Interactive Walking
Tran, Andrew	2016-2017	Multimodal CAVE integration
Sun, Nan Jin (Kelly)	2016-2017	Multimodal CAVE integration
Liu, Yufei (Kevin)	2016	Flexible graphical display of foot-ground interactions
Kashyap, Sumeha	2016	(Summer Intern from Indian Institute of Technology Guwahati) Walking Straight Project
Hamed-Baghi, Bobak	2016	(SURE Student) Game Interaction for Haptic Shoes
Dubé, Felix	2016	(SURE Student) Haptic Shoes
Yang, Yanzhe	2015	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array

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Name	Year	Research project
Morency-Trudel, Juan	2015	(NSERC USRA) Spatialized audio for environmental awareness for the visually impaired
Liu, Bei Chen	2015	(SURE Student) Haptic in-sole design and implementation
Liu, Shuxuan (Dennis)	2015	Multimodal CAVE integration
Chaudhary, Yetesh	2014	Communication in Emergency and Crisis Response
Pavlassek, Jana	2014	(NSERC USRA) Natural Interactive Walking
Jiang, Mike	2014	(IAESTE student trainee) Graphics Rendering for Multimodal CAVE
Yin, Guofan	2014	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array
Murgai, Prateek	2014	Acoustic Signal Processing
Sharma, Alok	2013-14	(BITS India Student) rt Emergency Response
Gupta, Sakshi	2013	(SURE Student from Indian Institute of Information Technology, Jabalpur) In-Situ Audio Services
Brais, Robert	2013	(NSERC USRA) Natural Interactive Walking
Gourdy, Oriane	2013	(Grenoble INP Student) 3DUI Interaction
Jain, Nehil	2011-12	(BITS India Student) In-Situ Audio Services
Sutcliffe, Andrew	2011	Haptically Augmented Steering Wheel
Greencorn, Dan	2011	Food Analysis Simulation
Redel, Josh	2011	Open Orchestra
Varenne, Dylan	2011	(Polytech Nice-Sophia), In-Situ Audio Services
Tomiyoshi, Marcio	2011	(ELAP Scholarship Student) Open Orchestra
Beniak, Stephane	2010	(NSERC USRA) Natural Interactive Walking
Salenikovich, Stepan	2010	Natural Interactive Walking
Chaw, Gary	2010	Natural Interactive Walking
Redel, Josh	2010	Health Services Virtual Organization
Smith, Severin	2009-11	Natural Interactive Walking
Rajalingham, Rishi	2009	(NSERC USRA) Natural Interactive Walking
Renner, Farid	2009	(SURE Student) Natural Interactive Walking
Bae, Sung	2009	Optical Tracking for Audio Graffiti

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Name	Year	Research project
Jathal, Kunal	2007	Haptic and auditory perception in human walking
Lin, Nan*	2006	(NSERC USRA) Interactive navigational control of robotic wheelchair
Reiter, Philippe	2005	(VP USRA Student) Distributed Video Rendering
Ariane Chan-You	2003	Region-of-Interest Control in Videoconferencing
Ariane Chan-You	2002	Videoconferencing Data Reduction
Gupta, Greeshma	2000	(NSERC Student) Automated slide converter
Cote, Christian	2000	(NSERC Student) Video transformations
Ayatizadeh, Negah	2000	Network communication daemons
Swartz, Tanya	2000	Speech-based TV-tuner interface
Cohen, Ouri	2000	Classroom 2000 access control
Yeong, Jason Aw	1999	(Work Study) Previously Asked Questions system
Agha, Khurram Zubair	1999	(Work Study) URL access tracking
Lim, Weoi Peng	1999	(Work Study) Graffiti board
Agha, Haroon Ali	1999	(Work Study) Classroom 2000 minipres. system
Klinger, Zamir	2000	(NSERC Student) Automated Door Attendant
Hooshangi, Sara	2000	(NSERC Student) Intelligent Classroom
Liao, Yuan Mei	1999	Electronic Classroom control interfaces
Luo, Jiexin	1999	PowerPoint C2000 interface and image libraries
Zhao, Changpeng	1998-99	Seamless PowerPoint upload for Classroom 2000
Lakdawalla, Azeem	1998-99	Real-time conjugate-gradient based head-tracking

*Co-supervised with Joelle Pineau

SERVICE

UNIVERSITY SERVICE

Department Committees

2020-2022	ECE Unit Lab Access Committee
2017-2018	Undergraduate Recruitment Committee, Chair
2017-2020	Search Committee (Software Engineering, Artificial Intelligence)
2017-2018	Tenure Committee
2015-2023	Safety Committee (Chair in 2015-2017)
2014-2016	Grant Application Support Committee
2012-2024	Graduate Committee
2008-2012	Undergraduate Recruitment Committee
2005-2011	Scholarships/Graduate Student Financing Committee
2002	Ad hoc Committee on Computing Infrastructure for ECE/SOCS
2000-2008	College Liaison Committee
2001-2004	Information Technologies & Undergraduate Lab
2000-2002	Curriculum Committee
2000	Software Engineering subcommittee
2000-2007	Undergraduate Student Advisor

Other University Service

2024	Chair's representative, Biomedical Engineering PhD Committee meeting
2024	Faculty Mentor, McGill Biomechanics Club
2022-2024	Research Axis Co-lead and Member of CIRMMT Executive Committee
2014-2016	Elected Member of Council, McGill Association of University Teachers
2009-2013	Research Axis Co-lead and Member of CIRMMT Executive Committee
2007-2013	Co-chair, Multimodal Immersive Systems research axis, CIRMMT
2006-2008	Member, CIRMMT Board of Directors
2006	Advisory Committee for Dean of Music
2004	Tomlinson University Science Teaching Project adjudication
2003-2004	Royal Bank Teaching and Learning Innovation Fund adjudication
2003	Groupe de travail sur les normes et standards de la formation en ligne. Conférence des recteurs et des principaux des universités du Québec (CREPUQ), McGill University Representative
2002-2003	SC-IST Workgroup on Research Computing
2000-2003	SC-IST Workgroup on Classroom Design
1999-2004	Engineering Committee on Teaching and Learning
1999	SC-IST McGill Machine Project
1998	Workgroup on Educational Technology

Fundraising Activities

2002	RoboCup demonstration at McCord museum for Dean's Circle
2002	Corporate fundraising for McGill RoboCup team
2001-2002	Intelligent Classroom promotion with the Engineering Class of '50; helped raise \$274,000
2001	Trottier Building research promotion

Other Activities

2007-2010	Promotion of Academic Integrity
2001-2002	Design of new Intelligent Classroom systems for ENGMC 304
1999-2002	Maintenance of the Intelligent Classrooms, training other faculty in use of the technology
1999	Curriculum development of three new courses in software engineering

PROFESSIONAL ACTIVITIES

Service to the Community

2023-2024	Local Events Organizer, 2024 IEEE Cognitive and Computational Aspects of Situation Management (CogSIMA)
2023	Sponsorship and Exhibits Co-Chair, 2024 IEEE Haptics Symposium
2019	Government of Canada, Network of Canadian Experts on Virtual Reality
2018	Consulted by Ordre des ingénieurs du Québec regarding the OIQ's position on AI
2018	Invited Member, Fonds de recherche, Chantier sur l'intersectorialité et la créativité
2018	Co-chair, ACM SIGCHI Demonstrations
2017	External member of academic selection committee, École de technologie supérieure
2016	Organizing Committee, IEEE International Workshop on Multimedia Signal Processing, Special Session on Multimodal Interaction with Digital Information in Smart Cities
2016,2019	Selection Committee, Bill Buxton HCI Thesis Award
2016	Digital Media Program Review, York University
2016	Critique of TCPS CORE Tutorial on Research Ethics (Secretariat agreed to remove problematic question associated with the Zimbardo study)
2010-2015	Theme Leader, Enabling Technologies, Graphics Animation and New Media (GRAND) Networks of Centres of Excellence
2010-ongoing	Voting Member, IEEE Communication Society Multimedia Communications Technical Committee (IEEE MMTC)
2009	Organizer and Chair, AES Workshop on Network Technologies for Audio over IP
2008	Tenure Portfolio evaluation, York University
2005-2006	Organizer, AES Tutorial and Workshop on Human Factors in Audio
2004	Founder, AES Technical Committee for Human Factors in Audio Systems
2003	Organizer, Workshop on LAN Delivery of Audio for AES
2002-2003	Comité Scientifique de Robofolies, Centre Science de Montreal
2001	Local Events Organizer, Autonomous Agents Conference, Montreal
2001-2009	Chair, AES Technical Committee for Network Audio Systems
2000-2004	Scientific Organizer, RoboCup Junior, Montreal
2000-2001	Organizing Committee, Robofesta International Robot Games Festival, Japan
1999-2000	Member and Webmaster, Canadian Virtualized Reality Working Group
1998	Co-organizer, AAAI Symposium on Intelligent Environments

Editorial Service

2021-ongoing	Associate Editor, IEEE Transactions on Haptics
2021	Senior Program Committee, International Conference on Multimodal Interaction
2021	Guest Editor, IEEE Transactions on Haptics (WHC track)
2020-ongoing	Associate Editor, Frontiers in Virtual Reality
2019	Associate Editor, World Haptics Conference
2019	Guest Editor, Multimodal Technologies and Interaction, Special Issue on Multimodal Medical Alarms
2018-2022	Associate Editor, Program Committee member, Haptics Symposium
2013	Guest Editor, Journal of the Audio Engineering Society, Special Issue on Audio Networking
2008-2022	Associate Editor, Journal of the Audio Engineering Society

Journal Referee

2022	IEEE Multimedia
2021	ACM Transactions on Human-Computer Interaction
2020-21	ACM Transactions on Applied Perception
2020	ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
2019	Frontiers in Neurobotics
2018	Peer J–Journal of Life & Environmental Sciences
2017	Sensor Review
2015	Ambient Intelligence and Smart Environments
2010-20	IEEE Transactions on Haptics
2012	International Journal on Acoustics
2011	BMC Medical Informatics and Decision Making
2011	IEEE Software
2010	IEEE Transactions on Affective Computing
2010	IEEE Transactions on Robotics
2010	IEEE Signal Processing Magazine
2009	IEEE Transactions on Robotics
2008	EURASIP Advances in Signal Processing
2008	EURASIP Image and Video Processing
2008-ongoing	Audio Engineering Society
2007	IEEE Transactions on Systems, Man, and Cybernetics
2006	International Journal of Human-Computer Interaction
2006	Springer Virtual Reality
2005	Elsevier: Computers and Education
2005	Elsevier: Image and Vision Computing
2004, 2019	IEEE Pervasive Computing
2000, 2003	Wiley Journal of Robotic Systems
1999	ACM Transactions on Computer-Human Interaction
1999	IEEE Transactions on Robotics and Automation
1998	IEEE Personal Communications

Conference Review

2024	IEEE Conference on Cognitive and Computational Aspects of Situation Management (CogSIMA)
2023	ACM/IEEE Human-Robot Interaction
2020	IEEE Virtual Reality
2018, 2020, 2024	ACM SIGCHI User Interface Systems and Techniques
2018	Workshop on Assistive Computer Vision and Robotics
2018	Eurohaptics
2017	International Conference on Auditory Display
2017	Mobile HCI
2017-19	IEEE World Haptics
2016	IEEE International Workshop on Multimedia Signal Processing
2015	ACM Multimedia
2015	INTERACT
2014	ACM SIGGRAPH
2012, 2013	Workshop on Context Based Affect Recognition
2012, 2013	International Society for Presence Research
2012	IEEE Canadian Conference on Electrical and Computer Engineering
2011	AES Conference on Audio Networking
2011	Intelligent Robots and Systems
2011	VRIC Wkshop on Haptics for Telepresence, Teleoperation & Collab. Environments
2009	IEEE Haptics Symposium
2009	International Computer Music Conference
2009	Stereoscopic Displays and Applications
2008-19	ACM SIGCHI Human Factors in Computing
2008	Immersive Medical Telepresence
2006	International Conference on Digital Audio Effects
2006, 2007	IEEE Workshop on Projector-Camera Systems (part of CVPR)
2005-2009	Canadian Conference on Computer and Robot Vision
2004, 2009-14, 2016	Graphics Interface
2003, 2006	Audio Engineering Society
2003	New Interfaces for Musical Expression
2002	RoboCup International Symposium
2002, 2015	IEEE International Conference on Robotics and Automation
2001	ACM UbiComp
2001	IEEE International Conference on Computer Vision

Grant Review

2017	NSERC Strategic Project Grants
2017	Member of Expert Committee, CFI Innovation Fund
2016	L'Agence Nationale de la Recherche (France)
2011	NSERC Collaborative Research and Training Experience Program (CREATE)
2009, 2011	Mathematics of Information Technology and Complex Systems (MITACS)
2009	NSERC Strategic Networks (Site Visit Chair)
2008, 2015, 2017	Peer review, NSERC Collaborative Research and Development Grants
2007-2008	NSERC Industrial Research Chair (Site Visit)
2007-2020	Research Grants Council, Hong Kong
2005	NSERC Steacie Memorial Fellowship
2002, 2005-2008	Panel member, NSERC/Canada Council, New Media Initiative
2001-2017	Peer review, NSERC Discovery Grants
2001, 2008	Peer review, CFI (Canada Foundation for Innovation)

Participation in Academic Fora

2019	San Diego Opera – Opera Hack, July 27-28
2019	Dagstuhl Seminar on Ubiquitous Computing Education, June 2-7
2010	Participant, NSF/CCC Workshop on Ultra-Large Scale Interaction

CONSUMER ADVOCACY

2013	brought successful appeal (2013 QCCA 1670) before Quebec Court of Appeal regarding anti-SLAPP legislation
2013	initiated petition to improve rights of Canadian airline passengers
2010	advocating for reliable public transportation in Montreal
1997-2019	created and maintained passenger rights website