TEACHING STATEMENT

MAURICIO SOUSA

I have worked with great students through mentorship and teaching, and I am excited to continue this as faculty. I believe that learning computer science can empower students to solve the challenging problems that matter most to them. With consolidated knowledge in computer science from lectures, group projects, and lab experimentation, students can apply their skills to improve and overcome challenges in the other knowledge domains of their future careers and lives. My formal education is in Software Engineering and Computer Science, and I have specialized in Human-Computer Interaction and 3D User Interfaces during my Master's and Doctorate studies. My background provides the tools to teach Human-Computer Interaction, Computer Graphics, and courses related to computer science. My experience has led me to believe that impactful and inspiring teaching practices are grounded in these five primary pedagogic principles: *Inspire and motivate; Hands-on learning; Discussion and critical thinking; Allowing for creativity; and Learning with each other.*

Inspire and motivate – Keeping students motivated can be a challenge. From my experience, I found that students are more likely to be inspired by research topics when presented with real-world applications such as the production of science fiction movies. Another approach is actively exposing students to state-of-the-art research related to the curriculum when possible by introducing in the classroom the latest developments and scientific papers that might interest them. Additionally, inviting students to participate in user studies to experience new technologies is a way to keep them engaged.

Hands-on learning – The main hardship I endured at the initial stages of my undergrad was an almost singular reliance on theoretical materials in the curriculum. This lack of direct hands-on experience hindered my knowledge consolidation. Therefore, combining teaching styles from lectures to hands-on sessions can keep students focused and motivated.

Collaboration and Discussion– Rather than a unidirectional flow of information, I consider learning a collaborative activity achieved by a group of people with shared goals. I believe that students should have the space to develop their values and their way of thinking. Yet, collaboration with my peers was integral to my Ph.D. experience. Through the intensive discussions and sharing of ideas, I gained confidence that I could achieve my research goals. Therefore, I intend always to create an environment that fosters collaboration and discussion to benefit the group.

Allowing for creativity – Fostering individual creativity facilitates students' ability to see problems differently, develop new approaches, and enrich their learning experience. As a teacher, I want to challenge my students to use their imagination, diverse experiences, and world views to guide their projects and research. And giving them the freedom to develop new creative ideas to overcome their challenges and apply the knowledge they acquire.

Learning with each other – A strong reason for choosing academia is to have the opportunity to collaborate with students from different backgrounds, teach them the technical skills they need to succeed, and, most importantly, learn from them. Teaching is learning as it requires instructors to always stay up-to-date with the curriculum; it is also learning as it constantly demands instructors to reassess their assumptions and understanding of the students. Most materials are new to students, and they perceive them with fresh eyes. Students' progress and feedback are always essential in how the materials should be adjusted and iterated.

Teaching Experience

During my Ph.D., I had the privilege to be a teaching assistant for the Human-computer Interaction course. The course was at the undergraduate level, and I was entrusted with two classes of 30 students per week. The lab classes had two main components: 1) I started each class by summarizing and recapping the lecture materials taught the previous week, and 2) providing mentoring and support for the students' term projects. Students were required to apply interface design methodologies taught in lectures to real-world scenarios. We employed an iterative approach for developing a user interface where students were required to perform design requirement analysis, prototyping, and several user interface evaluations. I found that providing a summary of the main concepts right before students put them into practice helped with knowledge retention and skill development. And with my guidance and feedback, groups of students were able to create impressive interactive prototypes of high quality.

Mentoring Experience

As a Ph.D. student, I mentored three master's students. As a postdoctoral fellow at the DGP lab, I supervised five undergrad researchers, one research assistant, and three graduate students. I am also co-supervising a Ph.D. student. Mentoring students is what I do best and it brings me great joy. My approach has always been combining hands-on advising and allowing students to develop and explore their ideas. I prefer to establish an open culture of communication and collaboration. And I frequently push for regular meetings to ensure that students feel they have support to succeed. At the same time, I try to keep students motivated and confident by offering them insightful descriptions of how I tackled similar technical challenges in the past. As a research assistant in four research projects in different domains (ex: Oil & Gas Industry, Architecture, Medical Imaging, and Surgery), I have an extensive background in prototype development and user evaluation design. I believe my diverse background has been instrumental in helping students overcome technical obstacles and expedite the tasks they had set up for their research. However, some projects can go beyond my expertise by encouraging students to follow their interests. I am always excited when this happens because it allows me to expand my knowledge and grow with them. There are a few examples I would like to share. My master's student, Carlos McGregor, was passionate about using psycho-physical indicators to predict when introductory computer science students struggled during programming exercises. His research was an excellent opportunity for us to learn more about cognitive theory and study the state-of-the-art taxonomies and strategies for CS1 education. Also, mentoring the Ph.D. students Jiannan Li and Karthik Mahadevan, made me gain a passion for Human-robot Interaction, electronics, and fabrication. These experiences expanded my interests and gave me the confidence to explore a broader range of approaches to solve the research problems I care about. My mentoring efforts have led to excellent outcomes; most students were able to publish their research in top-tier venues, and their success is something that fills me with pride.

Proposed Courses

My background in computer science prepares me well to teach fundamental topics in the field. I also hope to teach Human-Computer Interaction, Computer Graphics, and other related courses. Finally, I would be glad to establish new courses related to spatial computing, embodied interactions, and Artificial Intelligence with the "human-in-the-loop". Here are some possibilities:

- ***Introduction to Embodied Media Design***: This graduate course introduces the principles and practices of embodied interaction, exploring how the body, physical environment, and computational media interrelate. Students investigate tangible user interfaces, haptics, and embodied interaction with robots and artifacts through lectures and hands-on projects. The course emphasizes designing for the senses and crafting interfaces that extend and enhance human capabilities.
- ***Sketching Interactive Experiences***: A graduate course on sketching as a method for ideation, critique, and communication in interactive system design. Based on Buxton's *Sketching User Experiences*, students practice rapid sketching, storyboarding, and photo tracing alongside collaborative brainstorming, prototyping, and generative AI–assisted ideation. Through group exercises and critiques, they develop a visual vocabulary for expressing interaction concepts and communicating ideas effectively.
- ***Advanced Topics in Augmenting Humans***: A seminar examining how embodied media, AI, and augmented reality can extend and transform human capabilities. Students engage with research in HCI, human augmentation, and assistive technologies, reflecting critically on empowerment and accessibility. Readings, discussions, and design experiments explore sensory, cognitive, and physical augmentation, with focus on creative and inclusive applications.
- ***Advanced Topics on Interfaces for Creativity***: A graduate seminar on advanced user interfaces for creativity across domains such as drawing, painting, architecture, and engineering. Topics include creativity interfaces in interactive surfaces and spaces, air sketching and 3D modeling in mixed reality, and human–AI co-creation. The course combines lectures, paper discussions, and independent projects connecting these topics to students' research.

RESEARCH STATEMENT

MAURICIO SOUSA

My interests are in Human-Computer Interaction – at the intersection of Computer-supported Collaborative Work, 3D User Interfaces, and Mixed Reality. Through prototyping and user studies, I seek to contribute new research focused on making it easier for people to interact with each other and with their environment (physical, virtual, or a mix of both). I am also motivated to be part of the scientific community exploring new ways to bring remote people together as if they were in the same physical space. I firmly believe that for academia to create new impactful interactive technologies, it is vital to consider human factors and natural implicit and explicit communication.

My research aims to seamlessly bring together geographically distant people as if they share the same physical space. Physical distance should not be a contending factor prohibiting people from being together, sharing experiences, and transferring knowledge. I aim to contribute to a future where remote people can meet, experience each other's presence and environments, as well as use natural communication to socialize, collaborate, share resources, and help each other.

Current predominant computing technologies are effective in establishing communication channels between people. Still, they add unproductive protocol layers to the flow of communication between remote people, rendering interactions far from seamless. Although widely adopted, traditional video conferencing approaches still uphold partial viewing or down-scaled representations of remote people that curb the sense of "being there." Modern advances in Mixed Reality technologies have ignited hope of bringing remote people closer together. Yet, people are resistant to adopting these technologies compared to others, such as videoconferencing on smartphones or desktop computers. I believe there are three reasons for this. First, Mixed Reality still does not significantly improve communication over conventional technologies. Current approaches promise remote encounters in immersive virtual realities that detach people from their reality and environment. For virtual encounters to be practical, we must embrace how people naturally interact in their physical world. Second, technology is still cumbersome and requires people always to wear head-mounted displays. We must look for solutions to equip the physical environment with augmentations instead of solely resorting to user instrumentation. Lastly, the Metaverse promises virtual encounters in a separate alternative reality that requires an overwhelming disconnection from actual reality. Despite the benefits of entertainment and escapism, people want to be aware of their surroundings and who surrounds them in most scenarios.

To achieve this vision, I create software and hardware technologies that unite people by leveraging their context and natural communication. And I focus on improving how people communicate and collaborate, perceive each other's actions, and have a tangible impact on remote physical environments.

Research Contributions

My research follows these four related areas: studying perception manipulation techniques to improve remote interactions, improving user interactions within immersive environments, contributing novel medical interfaces for rehabilitation, medical imaging, and surgery, and advanced technology for learning physical skills.

Perception Manipulation to Improve Remote Collaboration

I hypothesized that perception manipulations could increase workspace awareness and improve remote face-to-face collaborative work in shared 3D workspaces. By perception manipulations, I mean to purposefully change the properties of how a workspace and remote people are presented to a local observer using geometrical transformations, reshaping gestures, and warping and repositioning devices. I focused on leveraging the sense of "being there" using full-body virtual representations of people and enhancing the visibility of nonverbal communication.

I contributed the open-source Creepy Tracker Toolkit [11], a set of tools for rapid-prototyping context-aware applications that incorporates body tracking, interactive surfaces, and point-cloud representation of people. The Creepy Tracker toolkit served as the technological foundation for all my prototypes related to body representation

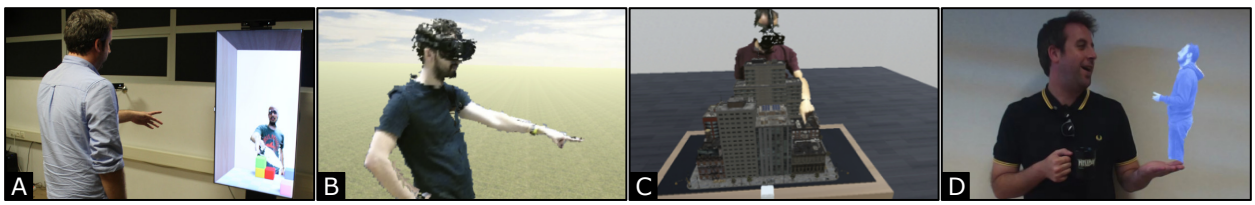

Figure 1: I proposed four concepts to improve remote telepresence and collaboration.

and remote telepresence.

I designed an assessment of different manipulation techniques to improve workspace awareness in a face-to-face remote collaborative 3D. And I proposed a new shared virtual workspace, called Negative Space [10] (Figure 1A), connecting two remote physical spaces while providing a sandbox for interacting with 3D content. From this research, I found that Mixed Reality technologies interfere with the ability of people to perceive deictic gestures. Therefore, I proposed Warping Deixis [9] (Figure 1B), a novel body warping technique to improve how deictic gestures to distance targets are interpreted in mixed-reality environments. Warping Deixis can significantly reduce misunderstandings when people collaborate in immersive environments. Finally, I contributed Altered Presence (Figure 1C), an interactive approach that uses body warping to ensure that opposing participants share the same understanding of the workspace.

Related to this topic, I realized that interacting with full-size representations of people may not be desirable. Using miniature versions of remote people can create an eye-gaze matching problem that hinders communication. Therefore, I collaborated to realize a design space [1] (Figure 1D) for interacting with volumetric representations of people and presented an approach for dynamically manipulating scale, orientation, and the position of holograms to improve communication.

Improving Interactions in Mixed Reality Environments

I also contributed to improving the user experience in immersive and semi-immersive environments. One of the current drawbacks of current technologies and approaches is the still existing gap between the interaction techniques and the natural way people interact with the physical world. Therefore, I collaborated and contributed to several techniques for selection [7, 16], manipulation [8], perception of virtual objects [6], and interactive surfaces [15]. Furthermore, immersive technologies isolate users entirely from the outside world and can place them in unsafe situations. Two this end, I was invested in creating methods to make virtual reality users aware of their surroundings [5] and investigating ways to safely warn bystanders if they invade dangerous situations near users engage in virtual reality experiences [14]

3D User Interfaces for Rehabilitation, Medical Imaging, and Surgery

I believe that Mixed Reality technologies are reaching a level of maturity that can positively impact healthcare. In the future, Mixed Reality could provide patients and medical practitioners with lifesaving information. Indeed, the U.S. Food and Drug Administration Federal Agency approved the first augmented reality app for surgical use not long ago.

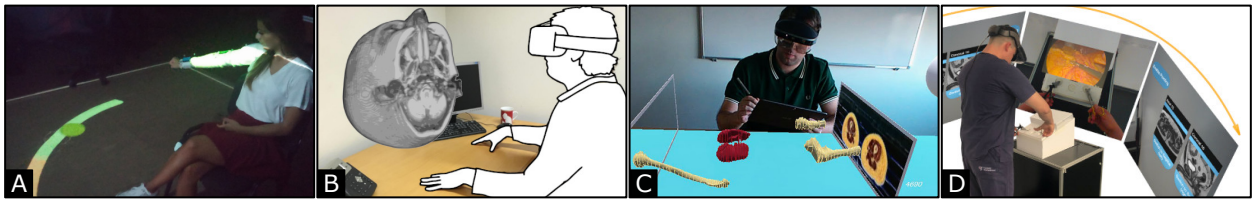

Figure 2: Contributions to Rehabilitation, Medical Imaging, and Surgery.

In this space, I proposed SleeveAR [13] (see Figure 2A), a projected Mixed Reality user interface that allows people to perform rehabilitation exercises by themselves under the offline supervision of a therapist. SleeveAR showed a robust approach to guiding people through prescribed exercises and demonstrated performance improvements between consecutive exercise executions. I proposed VRRRRoom [12] (Figure 2B), an interactive visualization approach to help radiologists analyze and interpret medical images in hopes of avoiding severe diagnostic errors. And I collaborated in a collaborative 3D reconstruction approach for anatomists, called Anatomy Studio [17] (Figure 2B). Yet, my significant contribution to this area is a collaboration that enabled the steps for Mixed Reality to be used in minimally invasive laparoscopic surgery [18]. In this work, I contributed to the design of a method that improves surgeons' comfort by keeping the laparoscopic video in their viewing area regardless of neck posture and an interface that makes it possible to access patient imaging data without interrupting the operation.

Physical Skills Demonstration and Remote Teaching

Online synchronous and asynchronous tutoring with an instructor is a powerful method for people to learn new physical skills. However, online videos and telepresence approaches do not allow adequate spatial awareness or viewpoint control of the demonstration activities scattered across a physical workspace. Even online synchronous tutoring using video conferencing, instructors are not sufficiently aware of the audience's progress and understand-

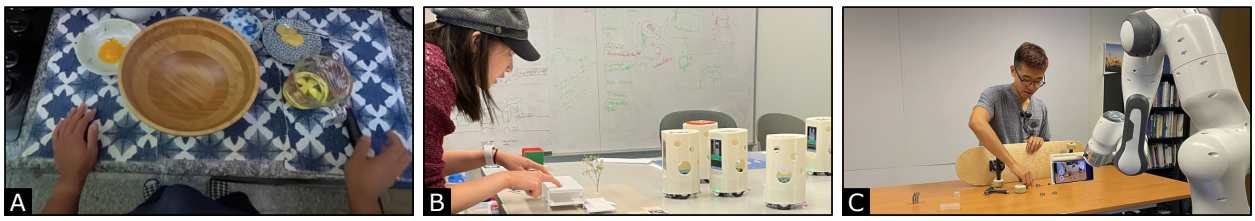

Figure 3: I proposed three approaches for learning technical skills by demonstration.

ing. I believe that online tutoring and remote teaching can bring direct knowledge to those who need it. And help people who do not have access to formal education in the subjects they need. As a mentor and scientific advisor, I have been engaged in research to improve physical skills demonstration and remote teaching.

I contributed to presenting immersivePOV [2] (Figure 3A), an approach to create how-to videos from an immersive first-person perspective using a head-mounted 360° action camera. We found that our approach reduces perceived cognitive load and facilitates task learning. Also, I contributed Asteroids [3] (Figure 3B), a novel approach for tangible robotic telepresence, to enable workbench-scale physical embodiments of remote people and tangible interactions by the instructor. With Asteroids, the audience can actively control a swarm of mini-telepresence robots, change camera positions, and switch to other robots' viewpoints for a better sense of presence and understanding. Finally, more recently, I contributed Stargazer [4] (Figure 3C), a novel approach for assisting with tutorial content creation with a camera robot that autonomously tracks regions of interest based on instructor actions. Instructors can fluidly control camera behaviors by integrating subtle nonverbal communication into instructional activities.

Future Research Agenda

I choose an academic career to pursue my vision and contribute meaningful and impactful research. Below, I describe some of the challenges I hope to study:

Tangible Remote Telepresence – In 1998, Scott Brave, Hiroshi Ishii, and Andrew Dahley proposed the concept of real-time, distributed, collaboration-based Tangible User Interfaces. While there is a large body of work on collaborative methods and tangible interactions, little is known about how remote collaborators can manipulate local physical environments. This challenge is also aggravated by the lack of research on how local people can have sufficient awareness of the remote person's actions. I believe this line of research is important and can lead to advances in remote assistance and teaching. I aim to focus on technology that allows remote influence on physical objects and study spatial, social, and workspace awareness techniques to improve collaboration in this space.

Cross-reality Remote Collaboration – I helped organize the first workshop on *Enhancing cross-reality applications and user experiences* (AVI 2022). Our objective was to discuss the benefits and challenges of interacting in cross-reality environments. In cross-reality, people transition between different points on the reality-virtuality continuum according to their context and the technology they can access at any given time. However, it is challenging to maintain awareness and communicate when everyone has varying degrees of presence and different abilities to interact. My goal is to perform studies on awareness and explore ways to improve an equal standing between all collaborators.

Remote Expert Assistance – I want to continue my research on physical skills demonstration and remote teaching. I believe that having access to knowledge is a matter of human rights. And I believe that the contribution of an experienced instructor or expert can make a difference in the learning process. There are significant opportunities to explore how remote experts can use novel technologies to guide and coordinate physical actions and collaborate in real time. There is also an opportunity to allow remote medical specialists to be called into a surgical room to guide and perform assistance anywhere and anytime. I aim to develop technologies further and study new approaches to democratize access to knowledge, focusing on communication, demonstration, and interaction with the audience.

I believe these challenges are exciting, and to research them will require lessons from various disciplines of Human-computer Interaction, computer graphics, computer science, and cognitive psychology. I look forward to collaborating inside and outside the department to further my research.

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