Statement of Purpose

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The emergence of novel computing platforms, such as AR/VR, offers new ways for us to visualize and externalize information; what is still missing is a thorough theoretical framework to underlie it, and techniques that can augment humans based on proprioception when interacting with digital pieces. To fill this gap, my research focuses on (1) understanding the partnership between the human bodies and the digital environments more intuitively and (2) creating new systems that augment a wide range of senses, for example, bodily perception, to enable realistic and natural interactions, which are especially important for the success of the Human-Computer Integration.

In the Summer of 2019, I joined the X-CHI Lab at Xi'an Jiaotong-Liverpool University through our Summer Undergraduate Research Fellowship Program, under the supervision of Prof. **Hai-Ning Liang** and Prof. **Wenge Xu**. My first HCI project explored boundary-awareness techniques for AR. As current AR headsets have a limited area for mid-air hand-based interactions, users may easily move their hands outside this tracked area during the interaction, especially in dynamic tasks. To identify users' challenges when interacting with Magic Leap without any boundary awareness information, I conducted a formative study to categorize the user demands. Based on the findings, I then proposed four methods to highlight boundary awareness (i.e. static & dynamic surfaces, static coordinate & dynamic coordinate lines) and evaluated them against the benchmark (a condition without any boundary information) to make users aware of the tracked interaction area. This work was accepted by IEEE VR 2020 and received a Best Conference Paper Award Nomination. It was also my first time giving a presentation to over 100 attendees at an academic conference. After this project, I continued to work as a research assistant, collaborating with other researchers in our lab and gaining a broader understanding of exertion games and hands-free text entry techniques, which led to a demonstration paper at CHI PLAY 2020, a journal paper at JMIR Serious Games, and a conference paper at IEEE ISMAR 2020.

Having investigated human perception and on-body interaction, I became curious if we could create novel interaction experiences by directly actuating bodily interfaces. In the Spring of 2020, I was accepted as a research intern at the Exertion Games Lab (Monash University), working with Prof. **Florian 'Floyd' Mueller** and **Rakesh Patibanda**. We started with the idea of using Electrical Muscle Stimulation (EMS), a technology that can actuate muscles, to offer an opportunity for novel play experiences. Inspired by traditional two-player hand games (e.g. Rock Paper Scissors), we implemented a custom prototype with a wearable EMS device to make it possible for players to experience our hand games alone. This work was accepted by CHI PLAY 2021 as a Work-in-Progress paper, and we are planning to submit a full paper to IMWUT. While working at the Exertion Games Lab, I also led a proof-of-concept project to investigate body-movement CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) designs to protect potential access risks in VR. This work was accepted by CHI 2021 Interactivity. In addition, I also actively collaborated with other members of the lab to explore bodily interfaces, which led to three conference papers at CHI 2021 and 2022.

To further strengthen my research skills in mixed reality, I joined Institut Polytechnique de Paris (Télécom Paris) and Carnegie Mellon University as a research intern in the Summer of 2021, co-advised by Prof. **Jan Gugenheimer** and Prof. **David Lindlbauer**. I led an independent research project towards understanding how to best create an on-body menu in VR. I explored the design of creating a connection between virtual information and bodily landmarks and proposed three on-body mapping techniques, i.e. first-person perspective grasp, third-person perspective avatar, and hybrid perspective mirror. I also conducted a user study to assess the performance of these three systems on the creation and post-establishment recall tests. During the six months of weekly project updates with David and Jan, I learned about independent research, thinking about the feasibility of a research project or idea, experimental design, qualitative and quantitative analysis, and user research. This internship eventually led to a first-author conference submission to IEEE VR 2022.

While it is important to understand how people interact with digital information in virtual environments, I am also interested in investigating how robotics can enrich human perception through discrete Swarm UI. I joined the Information Somatics Lab at the University of Tokyo this November as a research intern, working with Prof. **Masahiko Inami**, Prof. **Shigeo Yoshida**, and Prof. **Zendai Kashino**. Like swarms of ants and shoals of fish, collectives can change form at will, continue to function despite losing members, and merge with other superorganisms to grow larger. Inspired by the collectives, we are building a swarm of robots that will enable humans to attain the properties of swarms, e.g. flexibility, resilience, and scalability. I use such a robotic swarm to promote the understanding of body ownership and augment bodily perception and cognition in both real and virtual worlds. Currently, we are preparing papers for IEEE IROS 2022 and Science Robotics.

I am also committed to using my expertise to substantially promote empathy for vulnerable populations in order to improve the lives of others. After a panel discussion in the Spring of 2021, I realized that despite the negative effects of myopia (nearsightedness) on patients' quality of life, many non-myopic people still have misconceptions about it. Thus, I designed and developed two VR myopic games to provide a means for the non-myopic population to experience the difficulties of myopic people. These two games simulate two inconvenient daily life scenarios (riding a bicycle and greeting friends on the street) that myopic people encounter when not wearing glasses. The goal is to facilitate empathy in people with non-myopia for those who suffer from myopia. I evaluate myopic game experiences through questionnaires and semi-structured interviews. Overall, the results showed that these two games could create an engaging and nonjudgmental experience for non-myopic people that has the potential to facilitate empathizing with the myopic. This work was accepted by CHI PLAY 2021 and was nominated for the Student Game Design Competition Award.

Doing lasting-impact work to push the frontiers of HCI is just one aspect of what I hope to accomplish during my future career - I would also expand the impact of my work through service and outreach. In the last two years, I have served as a reviewer for over 30 papers at CHI, CHI PLAY, IMWUT, IEEE TVCG, IEEE ISMAR, IEEE VR, IUI, and VRST. I have received 2x Special Recognition for Outstanding Reviews (IEEE ISMAR) and been marked as 1x Highly Useful Quality (IEEE TVCG). I have also worked as a student volunteer for CHI, CHI PLAY, TEI, DIS, MobileHCI, IEEE AIVR, IEEE ISMAR, and received many Scholarships from UIST, NIME, IEEE ISMAR, and IEEE VR. At Xi'an Jiaotong-Liverpool University, I was voted in as the student representative on the Academic Practice Subcommittee (only one position for undergrads). Two proposals I wrote were approved by the leadership, which helped thousands of students be assigned with their external mentors and access remote research programs during the pandemic.

Personally, I am determined to devote my life to research, with the goal of either a tenure-track position at a university or a scientist job in an industrial research lab. I am looking forward to a chance to further discuss how my skills, interests, and passion fit into their groups. If you need any other details, please refer to my CV, Recommendation Letters, and homepage: https://dynasty-li.github.io.