

Statement of Purpose

Pioneering advancements in Human-Computer Interaction (HCI) offer the potential to revolutionize the dynamics of human-technology interactions. My prior work at Microsoft Research along with my current graduate course at UW-Madison has given me the chance to delve into the intricacies of Human-Computer Interaction (HCI). Nurtured by a deeply personal experience of navigating a CNS (Central Nervous System) breakdown, my journey into technology and innovation has been more than a professional endeavor—it has been a lifeline. This profound personal connection has ignited an unwavering passion within me to dive deeply into the intersection of technology and health. It's not merely about creating innovative solutions but about using technology as a catalyst for healing. The desire to work in research originates from a genuine aspiration to contribute meaningfully to the lives of others who might be grappling with similar challenges. At its core, my journey from a personal struggle to the creation of transformative technology has illuminated the path forward. This has solidified my dedication and motivated me to pursue a Ph.D. in Computer Science, with a specialized emphasis on Human-Computer Interaction.

My work on the Human Emotion Analysis project provided an invaluable opportunity to collaborate with a diverse group of students from MIT and Harvard, bringing together interdisciplinary perspectives and expertise in the field of Human-Computer Interaction (HCI). This collaborative effort resulted in the creation of a startup BrainWave Health, where I proudly serve as one of the co-founders. Here we have explored the frontier of Brain-Computer Interface (BCI), creating innovative solutions that bridge the gap between human emotions and technological applications. Our proprietary software code, seamlessly integrated into Windows systems, captures users' emotions throughout the day, generating comprehensive graphs by day's end. This real-time emotional data is not only a technological marvel but also serves a crucial purpose in the healthcare sector. We have devised a system where the generated emotional graphs are directly shared with medical professionals. This innovative approach empowers doctors and medical representatives to make informed decisions and enables them to alter medication dosages remotely based on the user's emotional well-being. Supported by medical professionals, the significance of our work in BCI extends to the healthcare domain as our startup received funding from Harvard for its potential impact.

During my graduate course at UW Madison, I worked on a High-performance distributed file transfer system that achieved groundbreaking data transfer speeds. I strategically employed a combination of TCP/IP, UDP, and RDMA protocols to optimize data transfer, resulting in significant performance improvements over existing systems. In addition to enhancing performance, we implemented a proactive network security strategy that included a multi-layered defense mechanism against potential threats such as DDoS attacks and IP spoofing. A noteworthy aspect of this initiative was the addition of the novel Rootkit Sentinel, an innovative security measure designed to bolster the network's resilience and act as a formidable deterrent for potential intruders. In the event of an unauthorized access attempt, Rootkit Sentinel autonomously initiates a potent countermeasure, triggering a targeted wipe of critical data and discreetly embedding itself within the system's startup folder. This dual-pronged security approach not only showcases proficiency in network protocols and security but also underscores a dedication to advancing cutting-edge cybersecurity solutions.

Driven by a desire to improve the daily lives of visually impaired individuals, my project Assistive Technology for the Visually Impaired focused on developing assistive technology to address challenges in cooking and mobility. Hot surface identification and sharp edge detection were performed with Meta Quest Pro integrated with thermal sensors. The independence and safety of users were achieved by providing real-time feedback by utilizing Canny Edge Detection and Laplacian of Gaussian (LoG) algorithms for sharp edge detection and Blob Analysis and Adaptive Thresholding for thermal surface detection. Ethnography and user testing were integral components of the project, involving observing users in their natural environments and obtaining direct feedback through testing. As a result, alerts were incorporated in the form of voice and vibrations to notify unsafe areas to the users. This multifaceted approach not only addressed the technical aspects of the project but also ensured that the practical needs and preferences of visually impaired users were met. Being able to improve the lifestyle of people using technology has left me wanting to contribute further to this field.

Furthermore, I made significant contributions to the development of Green Corridors tailored to critical emergency vehicles including Ambulance and Fire Engines. The focal point of this work was architecting an IoT system characterized by both dependability and cost-effectiveness while upholding critical parameters including heat dissipation, power consumption, packet integrity, and transmission latency. We created a working model along with an intuitive online dashboard. Rigorous testing protocols and subsequent endorsement by the esteemed Indian Institute of Science (IISc) validated the robustness of our solution. Notably, our work garnered commendation at the International Conference on Ambient Systems, Networks, and Technologies, and further triumphed in distinguished hackathons including MIT Grand Hack. My project secured selection for presentation at the esteemed IoT World Congress in Fira de Barcelona. Subsequently, I had the privilege of presenting this work to Mr. Norm Judah, Chief Technology Officer of Microsoft Research, who appreciated our work and commended our concerted efforts.

This work coupled with my intrinsic drive led me to a pivotal six-month research internship at Microsoft Research. I made substantial contributions to the Massively Empowered Classroom (MEC) project—a flagship initiative within Microsoft Research. Beyond the automation of problem generation and solutions, I conceived and executed algorithms that not only produced but also assessed these questions based on automata state complexity. A noteworthy aspect of this algorithm lay in its ability to differentiate adept annotators from potential malicious users and spammers, a development that markedly amplified its effectiveness. This achievement prompted the project's integration onto Azure, broadening its accessibility. Subsequently, I undertook the task of transmuting this research into a cross-platform application compatible with both iOS and Android platforms. The successful implementation of this project in universities across India, coupled with its highly favorable reception underscored its pragmatic value. This endeavor also afforded me the opportunity to collaborate closely with eminent researchers from Microsoft Research and IISc.

Impressed by my contributions during my internship, Microsoft Research extended my tenure as a Research Fellow. In this capacity, I embarked on research endeavors for the BlendNet project, an end-to-end last-mile infrastructure project, that entailed the deployment of a scalable, location-based contentsharing network. This pioneering innovation empowered users to access content either from nearby kiosks or through other seeders via local Wi-Fi. Although initially met with a modest 8% success rate, a rigorous process of debugging, coupled with comprehensive analysis increased the success rate to 98% and made the system robust. Data was meticulously collected for ethnography through numerous pilot studies involving college students and farmers. My contributions merited me the privilege of

presenting Blendnet at the Technical Advisory Board (TAB), an esteemed event at Microsoft Research where noteworthy projects are showcased to dignitaries from Microsoft Research worldwide, as well as esteemed Professors from elite universities. The project further culminated in a successful collaboration with a prominent media house, resulting in its deployment in the market and reaching over 10 million active users.

Recent research has brought to light notable distinctions in language usage between the Dark Web and the Surface Web. This divergence prompts the need for specialized language models to cater to the unique demands of Dark Web investigations, requiring domain-specific textual analysis that can provide valuable insights to researchers. I worked on Samaritan, an innovative language model pre-trained on Dark Web data, equipped with advanced capabilities in voice input and output. The meticulous methodology employed in curating and refining Samaritan's training data considers the heightened lexical and structural diversity inherent in the Dark Web. Qualitative analysis, encompassing factors such as the date of data and data quality, reveals the advantages of Samaritan over its baseline counterpart and other widely adopted language models. Specifically, Samaritan's superiority is evident across diverse use cases, establishing it as a pivotal resource for future research within the Dark Web domain. The assessment of Samaritan's effectiveness in tasks related to detecting underground activities further underscores its potential in addressing cyber threats within the unique landscape of the Dark Web.