1. Introduction

To further explore the theme of communication and collaboration between people, our group focused on the human-computer interaction (HCI) technique of voice input. Users within this space work in an environment emphasizing communication and collaboration as well as using productivity and collaboration software tools to complete their tasks. This requires them to manually click, select, type, and perform many other actions which can be tedious especially when navigating and interacting with different productivity and collaboration software tools that serve different purposes. Users are required to remember the layout of the user interface for each different productivity and collaboration software tool in order to understand where each component is located, what each component does, and the sequence of steps to perform a specific action. With that being the case, the HCI technique of voice input would provide users with an intuitive, hands-free experience with minimal disruption when interacting and navigating, relieving them from the need to burden their memory, and allowing them to focus more on completing their tasks.

Thus, to facilitate the HCI technique of voice input, we incorporated it with smart glasses that enabled the users to provide hands-free voice commands to 1) conduct a live video meeting with other people, 2) send and view messages to other people, 3) view and manage their calendar schedule, and 4) change their settings to their preferences. A digital voice assistant of the user's choosing such as Alexa, Siri, and Google Assistant would reply to the user's voice commands, perform the necessary navigation and interaction, and display relevant information through a digital heads-up display using augmented reality elements. The smart glasses would incorporate the use of external cameras, built-in microphones and speakers, and sensors. To put our design into practice, we created a Figma prototype to demonstrate and showcase the user interface of our smart glasses and the user experience when interacting and navigating through the listed functionalities above.

2. Highlights of Research

Prior to finalizing our group effort and time on the HCI technique of voice input, additional HCI techniques we researched to support this project include eye-tracking and finger gesture controls. Though these HCI techniques would have also provided users with an intuitive, hands-free experience with minimal disruption when interacting and navigating with their productivity and collaboration software tools, contributing factors that finalize our decision on voice input include: 1) voice input being more relevant due to digital voice assistants, voice recognition and speech-to-text technologies, and many more, 2) eye-tracking would require additional hardware from the users as well as the productivity and collaboration software tools needing to integrate eye-tracking capabilities to perform different tasks, and 3) finger gesture controls requires the users to remember a set of unique gestures indicating a steep learning curve and can burden their memory. To better understand who our targeted users would be and the functionalities we would provide for our smart glasses Figma prototype, we dove into user scenarios, particularly 1) Rob, a project manager, 2) Dahlia, a part-time Costco worker and mathematics college student, and 3) Peter, a data analyst. With these user scenarios, we identified college students and office workers as our targeted users given that they use productivity and collaboration tools on a daily basis. In addition, identified that a video meeting application, a text messaging application, a calendar application to manage one's schedule, and a settings application are essential tools for our targeted users to complete their task.

When we conducted a usability test of version 1.1 of our smart glasses Figma prototype, we had a total of eight user studies. Half of these user studies were college students from CSS 480 who had a background in computer science or related fields while the other half were family members, friends, etc. The demographic of this user study group was meant to closely as possible reflect our targeted users which were college students and office workers. To simulate the hands-free environment we intended for our smart glasses with voice input, we utilized the Wizard-of-Oz technique in which the host would act as the digital voice assistant replying to the participant's voice commands and performing the necessary navigation and interactions on our smart glasses Figma prototype to fulfill the participant's desired task. Each participant followed an outline of predefined tasks for our video meeting, messages, calendar, and settings applications to serve as their input voice commands to the smart glasses. Upon completion, each participant was asked specific questions for each task to provide feedback on how their user experience went and what improvements could be made to improve our smart glasses Figma prototype.

Overall, the participants of our usability test noted they enjoyed the hands-free voice command environment when testing our smart glasses Figma prototype to complete a series of tasks. In addition, the participants noted that they could see how smart glasses would improve the productivity of college students and office workers working in an environment emphasizing communication and collaboration and using productivity and collaboration software tools. As for feedback on what could be improved, the participants noticed there was a limited demonstration of our video meeting application and expected additional functionalities for it. In addition, in each of our smart glasses applications, the process of navigating and interacting with it from start to finish caused the participants to notice that during the process, there was one step in which the user interface design could have been more intuitive with its layout with clearer prompts and indicators to help draw on where the users need to pay attention. With that being the case, in addressing these issues, and presenting version 2.0 of our smart glasses Figma prototype to the class, our classmates noted that the improvements made it clearer to navigate and interact through each application. Additional feedback they provided to consider included: 1) what alternative way would be provided for navigation and interaction if the user wasn't in a quiet environment to input voice commands? 2) consider having an active listening mode instead of the user having to prompt the digital voice assistant each time they provide a voice command, 3) how would we accommodate users who are blind and deaf? and 4) how would we accommodate users who want to use our technology with their existing prescriptive glasses without needing to have separate glasses?

3. Recommendations

The design and research process of empathize, define, ideate, prototype, and test is often a process that goes through multiple iterations in a continuous loop. Though version 2.0 of our smart glasses Figma prototype addresses the issues of version 1.1, there is still room to expand on new opportunities and address additional concerns that were not highlighted in previous versions further indicating that the design and research process never stops. One of the feedback mentioned earlier for version 2.0 is to consider having an active listening mode instead of the user having to prompt the digital voice assistant each time they provide a voice command. This would indeed remove a tedious step especially when the user is providing multiple voice commands in sequence with one another. However, this can come at the cost of draining the battery of the smart glasses at a faster rate, and how some users may not be comfortable with an active microphone at all times due to privacy. With that being the case, we think providing users the option to pick between the two choices within the settings application would accommodate this.

Additional feedback we received earlier for version 2.0 included: 1) what would be alternative ways for navigation and interaction, 2) how would we accommodate users who are blind and deaf? and 3) how would we accommodate users who want to use our technology with their existing prescription glasses? These are areas that require additional research, new designs to be mock-up, and further usability testing to be conducted in order to collect new data and feedback. With new data and additional feedback for these specific areas, we can further enhance the smart glasses' uses in the communication and collaboration space by identifying what additional applications to provide, how to offer more personalization for the users, how to improve the user interface and experience for users, how to encourage positive and healthy uses of the technology, and many more. For instance, one particular screen could appear after a certain time period to remind users to take a break with the smart glasses and get up to avoid sitting for extended hours. This facilitates more self-awareness and positive behaviors related to technology use. Moreover, making the smart glasses more personalized and tailored would indicate we understand the needs, wants, and pain points of different types of users which would expand the targeted users of the smart glasses and their functionality such as science lab workers using the smart glasses to help them conduct tests, and analyze their research and data.

Although the smart glasses provide beneficial features to assist those who are working in a communication and collaborative environment with their everyday tasks, particularly college students, and office workers, there are also concerns to address alongside the new potential opportunities to explore. One concern is regarding its feasibility due to the fact that the technology is costly and incorporating external cameras, built-in microphones and speakers, and sensors. It would be in the best interest to lower expenses and promote a market strategy to showcase the smart glasses' uses at an affordable price. Moreover, another concern would be the user training and learning curve that is required with the smart glasses if users want to use them to their full potential. Many users today are looking for simplicity and don't have the time to invest in learning new products and applications especially if their existing products and applications already help them complete their tasks. Perhaps the most significant concern is how their data is stored and how privacy management is ensured for the smart glasses. With the recent court cases and lawsuits of data breaches and the selling of data advocating for greater data privacy, security, and control, people are becoming more aware of how their data is collected and used, and want to have more personal control over their data. The software for the smart glasses could integrate clear mechanisms for opting in or out of data collection, and it would help the integrity of the technology be more transparent with its users.

4. Group Reflection

Given that the design and research process of empathize, define, ideate, prototype, and test involving multiple iterations in a continuous loop was used in the course for the group project, we as a group recommend this process of design and research for future explorations of HCI especially relating to communication and collaboration. It was extremely helpful for our group to complete our project in a series of multiple steps which involved: 1) researching various HCI techniques, 2) developing user scenarios, 3) creating multiple sketches, 4) creating flipbooks, 5) creating an initial prototype, 6) usability test of the initial prototype, and 7) improving and finalizing our prototype. The initial steps helped our group view our project through a big-picture lens by brainstorming and exploring different HCI techniques, what problems to address and solutions to implement in the communication and collaboration space, and many more. As our group progressed toward the final steps, this helped our group narrow down to the small details of smart glasses with hands-free voice commands such as the user interface design and functionalities to provide. Adding on to the usability test of the initial prototype step, this helped our group identify the strengths, weaknesses, and improvements needed for our smart glasses Figma prototype based on the participants' reactions, questions, and feedback they provided when navigating and interacting with it. Lastly, conducting the Wizard-of-Oz technique both in the usability test and final demo for the class helped our group visualize and hear how our smart glasses would function in practice.

5. Appendix

Link to smart glasses Figma prototype:
https://www.figma.com/proto/oiD2u1FB8lNUUCGCxhkZxe/Smart-Glasses-HUD%2FUI?page-id=1%3A2&node-id=10-26&viewport=-10766%2C-215%2C0.19&t=s5qDYdnva0aauh2v-1&scaling=scale-down&starting-point-node-id=10%3A26

Link to Kanban board:
https://trello.com/invite/b/Og7gQglG/ATTIaf6fa24dc2d6973cd6513fc564bf627a9F698B6E/kanban-css480-project

Table 5.1: List of group materials submitted and their status update.

Material	Status Update
Design sketches and early design concept descriptions.	No changes since its last submission to Canvas.
Flipbook designs with descriptions.	No changes since its last submission to Canvas.
Prototype and instructions for viewing, running, and/or using (if additional emulation software is required to run the prototype, include this software or easy download links & instructions).	No changes since its last submission to Canvas.
User test method and results.	No changes since its last submission to Canvas.
Slide deck used in the final presentation.	No changes since its last submission to Canvas.