Development of a remotely controlled video chat device that replicates the tilt of the phone

Connor Sullivan
Mentored by Mr. Christopher Rogers

Introduction

The COVID-19 pandemic has had lasting effects on many aspects of society, but few larger than its impact on the workplace. A Menoufia University study researched the effects of virtual work on a wide range of demographics and found overload and technostress to be significant consequences of virtual work (Gabr et al., 2021). These concerns came from a lack of professional relationships and experience in the new virtual environment. Other studies have shown an increased lack of interest and a decrease in productivity associated with the new virtual meeting model (Karl et al., 2022). This project aims to help address these concerns through the development of a video chat device in which a remote phone can control the video view of an onsite phone based on its tilt.

Materials and Methods

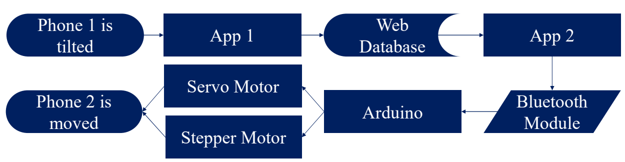


Figure 1 (above): Initial research led to the choice of using two different motors for movement, as the stepper motor allows the phone to make full yaw (horizontal) revolutions while the stepper motor limits the pitch (vertical) movements as the phone needs less range in that direction. The web database was the communication point between the apps (Figure 5) and the Bluetooth module between the second app and the Arduino.

Figure 2 (left): The project's first phase focused on creating the model based on existing research and preliminary drawings of the motors, which were incorporated into the design in Autodesk Fusion 360. A few considerations when designing the model included the room and needed positioning of the motors and the stability of the base during movement. A stepper motor was placed in the center of the base, directly next to the circuit, to place the center of gravity over the motor to reduce stress. A servo motor was used for vertical movement on the side of the model and connected to the circuit board in the base.

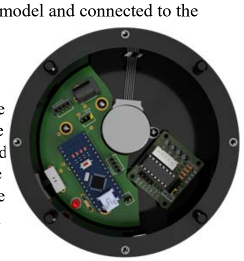


Figure 3 (right): The interior of the main base had three main components. The first component was the stepper motor which resided in the center of the base (Figure 2). The next component was the circuit board as shown in Figure 4. Lastly, the driver board for the stepper motor (1.06 in. diameter) was included in the interior as the four pins from the Arduino Nano with positive and ground passed through it.

Materials and Methods (continued)

Figure 4 (left): The printed circuit board (PCB) model which was designed in Autodesk Eagle before being imported and modeled in Autodesk Fusion 360. The board required ports for the 28BYJ-48 stepper motor and Arduino Nano as well as ports for the servo motor located on the side of the model (Figure 2). Additionally, a sliding power switch, an H-06 Bluetooth module, and a barrel port that supplied power directly to the board from a battery pack were added. The last major element of the board was an LED to indicate if the board is on. The final PCB is shown in Figure 7.

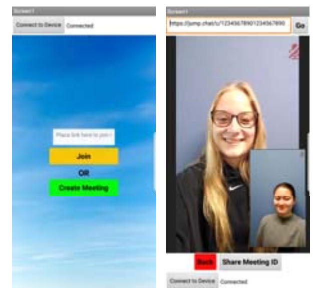


Figure 5 (right): The Massachusetts Institute of Technology (MIT) App Inventor program was used to design the apps from Figure 1. The first app was made for the remote user, recording and transmitting the phone's position to the web database in addition to the video call element. The second app (right) received the position data from the first phone by calling it from the database. The second app forwarded the data to the Bluetooth module which communicated the data to the Arduino code where the data was processed, and the motors were moved accordingly.

Results

Figure 6 (left): The final design from Fusion 360 (Figure 2) was assembled using 3-millimeter Baltic Birch wood components laser cut on a Full Spectrum Laser and 3D parts printed on a FlashForge 3D printer. One correction that was needed was filing the plastic holes in the PLA printed material down to the appropriate size. Other general design flaws included an insufficient number of holes in the lid for the wires below to pass through and an improper alignment of the mini-USB port of the Arduino Nano (Figure 4) and the access hole in the main base container.

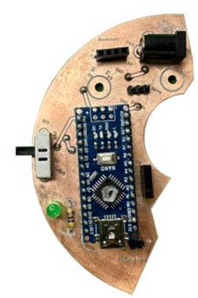
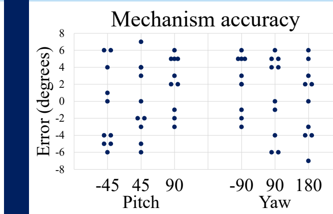
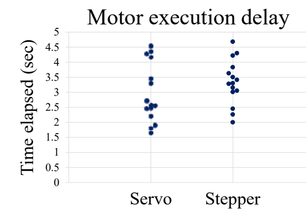


Figure 7 (right): The third and final PCB design (Figure 4) after being produced on a LPKF ProtoMat E44 and soldered. Though the fit of the PCB between the stepper motor and the walls was tight (Figure 3), the PCB did fit. This proper PCB fit allowed the base to stay compact and meant that the 3D printed base did not need to be reprinted. The final PCB worked as desired when soldered, as all electrical components functioned properly. Software serial was used to connect the Bluetooth module with the Arduino due to errors using the built in serial ports.

Results (continued)



Graph 1 (left): Displays the error of the mechanism's position from the remote phone. A positive error indicates an overshoot of the target angle while a negative error indicates an undershoot. The error of the yaw (stepper motor) position (*M* = 1.0˚, *SD* = 4.1˚) were slightly larger than the error of the pitch (servo motor) position (*M* = 0.5˚, *SD* = 4.2˚).



Graph 2 (right): The graph shows the distribution of the time between the phone being moved and the motor finishing its movement for 15 trials of each motor. The servomotor (*M* = 2.0 seconds, *SD* = 1.0 seconds) had a slightly smaller delay than the stepper motor (*M* = 3.3 seconds, *SD* = 0.8 seconds). Delay times ranged from 1.6 to 4.7 seconds.

Conclusions

The project was successful regarding the initial purpose of getting the remote phone to control the on-site phone's angle. While the remote phone was able to move the mechanism, there are still aspects of the design that need improvement. As found in Graph 1, there was still a difference between the intended and the actual position of the phone which shows a flaw in the ability of the code to read the position as well as the motor's accuracy. This has real-world implications as a few degrees could be the difference between looking at someone's full face and their ear. Another flaw in the current system, as seen in Graph 2, was the delay between phone movement and motor movement. This could result in a user missing important events of the meeting while waiting for the mechanism to move.

Other features that could improve the user experience are a reset button, a more compact design, and the ability of the mechanism to automatically adjust to look in the direction of the person speaking.

References

Gabr, H. M., Soliman, S. S., Allam, H. K., & Raouf, S. Y. A. (2021). Effects of remote virtual work environment during COVID-19 pandemic on technostress among Menoufia University Staff, Egypt: a cross-sectional study. *Environmental Science and Pollution Research, 28*(38), 53746–53753. https://doi.org/10.1007/s11356-021-14588-w

Karl, K. A., Peluchette, J. V., & Aghakhani, N. (2022). Virtual work meetings during the COVID-19 pandemic: The good, bad, and ugly. *Small Group Research, 53*(3), 343–365. https://doi.org/10.1177/10464964211015286