Designing Accessible Computer Peripherals: An Ergonomic Approach to In-Bed Device Usage

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***Abstract*—The increasing use of computers in non-traditional environments like beds has created new ergonomic challenges for users. Standard computer peripherals are made for desk use and can cause health problems when used in these environments, demonstrating a need for different novel input devices. This project aims to develop an ergonomic input device optimized for in-bed usage. The design process involved clay prototyping for ergonomic optimization, followed by CAD modelling and integration of Arduino-based controls. Through the iterative process, it was revealed that the housing of internal components would require modifications to the scale of the controller. In other words, the keypad and joystick would need to be larger to accommodate the internal components and wiring. Lastly, creating a controller for bed use requires careful consideration of internal spacing, cable routing, and user comfort to achieve optimal functionality.**

***Index Terms*—Ergonomic design, Computer peripherals, Human-computer interaction, Bedbound computing, Arduino controllers, Accessibility design**

I. Introduction

There has been a rise in using computers and mobile devices outside of their normal environment, particularly in bed [2]. Most modern keyboards and mice are designed specifically for desk use, where users are seated in chairs [3], when used in less-than-ideal settings, such as lying down, these devices can cause extremity disorders like carpal tunnel syndrome, thoracic outlet syndrome, and myofascial pain syndrome [4]. This project addresses the gap in the computer peripherals space by developing a keyboard and mouse alternative optimized for use in bed.

This solution consists of a joystick which will take the place of the mouse and a mini keyboard that will replace the full-size keyboard. We developed the joystick using clay models so we could shape the handgrip according to natural hand positioning to make it ergonomically optimized [1], we then digitized it into a CAD model. For the mini keyboard, we used the Razer Tartarus [5], as a template and then iterated on it by changing the design to make it more vertical to ensure it was usable in bed comfortably.

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II. Results

We should look at each controller component separately to address the issue regarding loose cables and how they'll be handled. The keypad has enough space to house all the wires that it will need. To ensure they won't unplug or move around, we'll use tape to secure them in place along the surfaces of the keypad's interior. Additionally, the wires will be cut to the minimum length required, with some leeway as a mechanical precaution. The joystick has less volume to

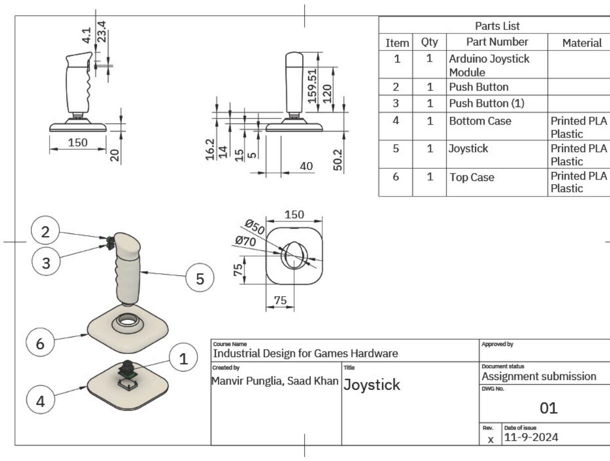

Fig. 1. Technical Drawing of Joystick

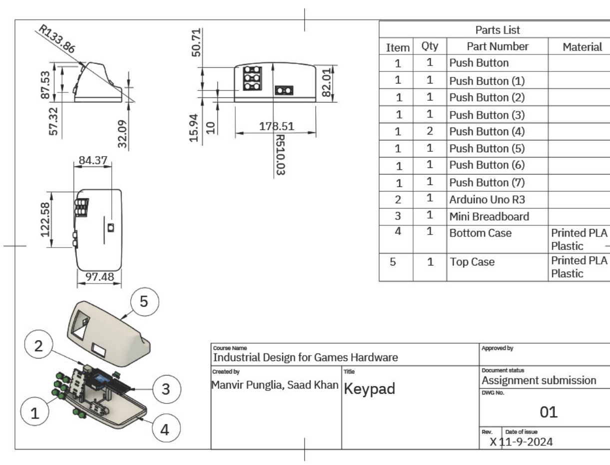

Fig. 2. Technical Drawing of Keypad

work with, however, the number of wires will also decrease. Near the top of the joystick houses two buttons that will require wiring, this wiring will extend down toward the base, passing through the housing unit for the joystick module, leading outside to connect to the Arduino module located in the keypad. Similarly to the keypad, the cables will be secured down to the interior of the joystick.

The mechanical solutions are simple as the model doesn't require complex mechanisms to secure the internal components. For both the keypad and joystick, I've noticed that the Arduino Uno R3 and Joystick module contain holes on the sides and corners of the PCB. To utilize the holes, I digitally secured the two components by creating pins that pass through those holes as a way to seat them in place. For the internal components that don't have holes, we'll use glue to secure them into place upon construction and assembly.

There are two openings across the two devices. The first slot on the keypad will serve as a way to connect the Arduino module to a computer. The next opening is on the joystick, this opening will act as a pass-through for cables that need to travel from the joystick into the keypad to connect to the Arduino module.

Our ergonomic design was inspired by three devices that follow ergonomic philosophy in their design. The first two pieces of inspiration relate to our keypad. The first is the Razer Tartarus, its compact design allows the user to single-handily use a mini keyboard [5]. The second is the Logitech vertical mouse, its innovative design allows the user to rest their hand on the mouse naturally and comfortably when lying down [6]. The design for our keypad follows a similar ergonomic design and is a combination of the two aforementioned devices. The last piece of inspiration is any commercially available PC-based joystick, specifically the ones built to look similar to pilot joysticks. We've decided to create a joystick rather than a mouse because it's more ergonomic and natural for the user to use when they're in a reclined position or bed.

III. Conclusion

Our main takeaway from this assignment is taking into consideration the space required for internal components to be seated properly within our controller. The measurements and dimensions are very important when creating a model that will be 3D-printed later and when creating a physical product in general. Additionally, there were a lot of aspects to keep in mind as we were constructing the model such as spacing between internal components, spacing for cable management, and comfortability. Additionally, our design philosophy followed in the footsteps of Logitech with their vertical mouse by creating a similarly vertical and ergonomic design [5], and Razer with their Tartarus mouse that inspired our button layout [6]. As we were building our model, the dimensions were changing from what we initially thought when creating the clay prototype for assignment one. In conclusion, the controller became larger than the original prototype, this may be due to the consideration that internal components would need to be placed within the final product.

Fig. 3. Project Progression Gantt Chart

Appendix A
Contributions

A. *Manvir Punglia - 100828507*

Wrote Introduction, made the push button component in fusion 360, made technical drawings and wrote abstract

B. *Saad Khan - 100829159*

Wrote Results and Conclusion, made the joystick and keypad model in fusion 360 and wrote abstract

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