# Accessible analogue inputs for those with limited mobility

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***Abstract*— This prototype is designed to address the problem that users with limited mobility face when trying to play games. This controller mainly addresses the inability to move fingers or limbs when playing games. Many controllers nowadays require the user to have full range of motion of their hands and to be able to make small, precise movements with their hands. This controller seeks to allow users with limited mobility a way to provide an analogue input in order to play games on their PC. Applications of this controller include any application where a single-axis analogue input is required, such as racing games.**

## I. Introduction

The problem with most popular controllers is that they require the user to make precise inputs by pushing or moving joysticks or buttons. This can be difficult for someone with limited mobility or someone who does not have full range of motion of their hands. Another problem is the lack of alternative controllers that do not require the use of hands. There are few controllers that allow the user to use their feet to send inputs to the game. Alternative solutions are also relatively expensive when compared to traditional controllers. The way this controller addresses the problem is by using an ultrasonic sensor as the method of input. The analogue input sent to the computer is the distance between the ultrasonic sensor and whatever object is in front of it. This controller is designed for those with limited mobility and for users who are missing limbs. Due to the fact that the method of input is moving a part of the users body closer or farther to the ultrasonic sensor, there is nothing for the player needs to act upon. There are no buttons to push, joysticks to move, or triggers to pull. As such, this controller will be able to help users with joint pain such as arthritis, as the user does not need to apply force to the controller in order to use it. This controller can also help those with a limited range of motion, as the controller can be positioned and calibrated in a way where the user can comfortably move part of their body. This controller can also help those who are missing limbs. The majority of controllers require the use of both the player's hands. If a player is missing fingers or a hand, they cannot play using a traditional controller. This controller allows players to substitute use of their hand with any other part of their body. This means that players can use their hands, feet, and head as ways to manipulate the input of the ultrasonic sensor. This document will present the design philosophy and iteration process for this controller.

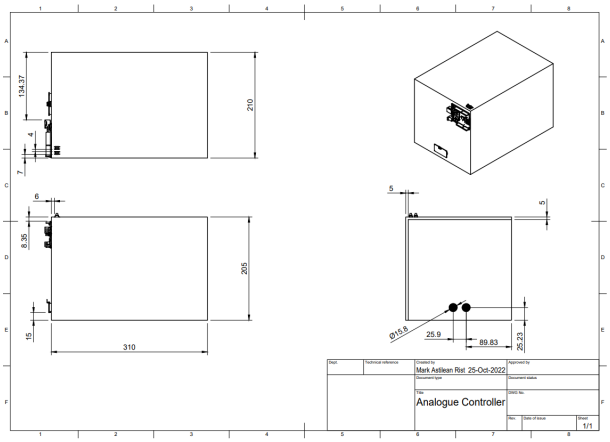


Fig. 1. Controller design

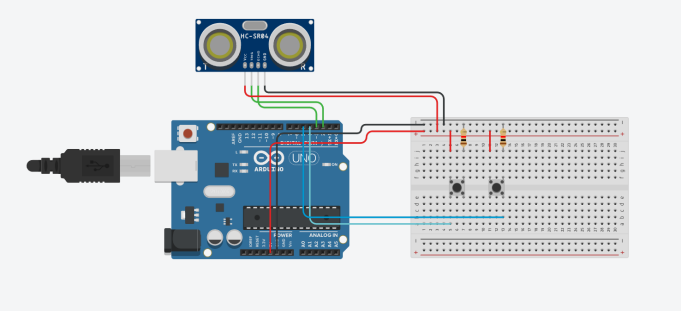

Fig. 2. Circuit diagram

## II. Literature Review

The state of video games today is one of inaccessibility [1]. Many of today's games have little support for accessible input methods, and have few input rebinding options. This can negatively impact gamers with disabilities. Given the many different inputs on modern day controllers, developers are creating their games without much regard about input type, or the number of inputs required to play the game. This has led to many disabled gamers feeling left out [2] and needing to return games as they are not able to control or play these games due to their disability [1]. More effort needs to be made in order to help accommodate gamers with disabilities. Gaming companies need to focus more time and resources towards creating accessible ways to playing their games. Modern day controllers have dozens of inputs and require the use of both of the user's hands in order to operate [3] [4]. This includes the creation of accessible controllers for those who cannot use traditional input methods. For example, there is still no accessible alternative to racing

wheel controllers. While controllers like the Xbox Adaptive Controller are positive steps in the right direction [5], there needs to be more alternatives for those who are not part of the Microsoft ecosystem, or have a disability to which the Xbox Adaptive Controller cannot be used for.

## III. Methods

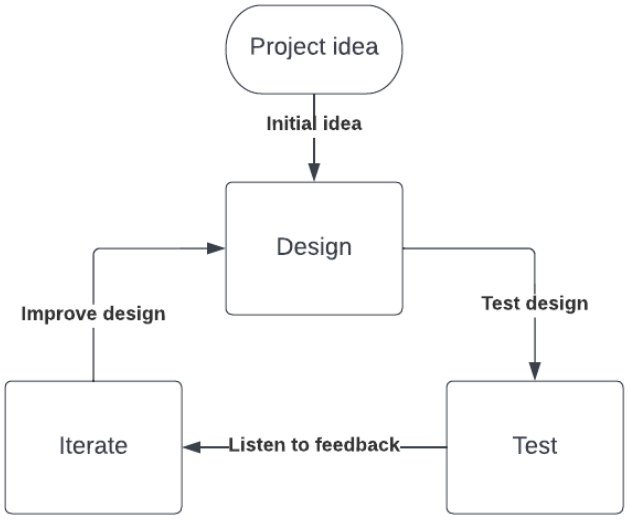


Fig. 3. Iterative design process

The iterative design process used to make this prototype started with an initial idea. Once the initial idea was conceived, the design process begins. The design process consists of visualizing what the new iteration will look like and how it will behave. This step of the process provides the testing process with all the documents and information it needs to conduct its test and review of the design. During the testing process, the iteration is shown to potential users for feedback. The feedback received during the testing phase is then used to modify the design. The testing process is done in order to get feedback from the product's userbase as to create a product that will be well received by the those who will use it. After the testing phase, the iteration phase begins. In the iteration phase, the ideas and revisions from the testing phase are applied to the product. After the iteration phase, the design phase begins again. This is where the revisions from the iteration phase are further built upon and integrated into the design. This cycle repeats until the project meets the requirements of the feedback team.

## IV. Results

The Quality Function Deployment (QFD) chart above compares this product against Logitech racing wheels and keyboards and mice. This QFD chart shows that this product has distinct benefits and drawbacks when compared against more traditional methods of input. For example, this product is easier to calibrate and more comfortable than both the Logitech steering wheels, and keyboards

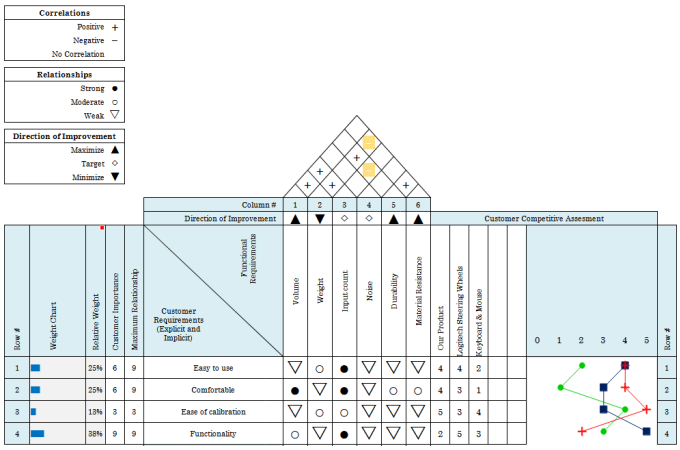


Fig. 4. Quality Function Deployment chart

and mice. However, this product is not as functional as both of the compared products, which customers rated as being the most important factor in a controller. This means that this product will not be able the entirety of a customer's input methods. However, this product will be able to assist consumers with inputting certain inputs instead.

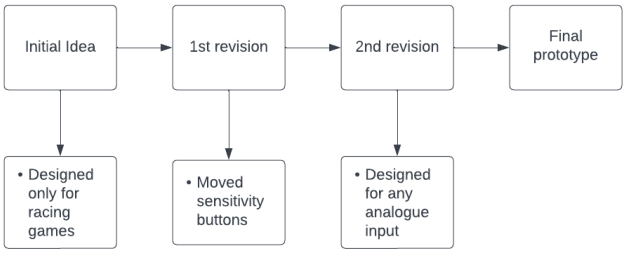


Fig. 5. Prototype progression

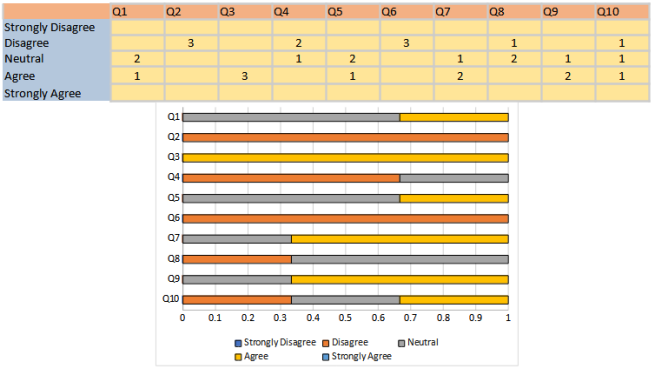


Fig. 6. System Usability Scale

This QFD also shows that consumers are pleased with the ease of calibration this product demonstrates. As such, in future versions of this product, the ease of calibration will be taken into account, and will be left alone if possible. The

design and method if input will also not be changed, as consumers thought the design of the product was comfortable. As such, the ultrasonic sensor and the square shell its housed in will continue to be used as is. However, in future iterations of this product, additional functionality will be added in order to help justify this product to future customers.

## V. Conclusion

Through working on this project, I learned a lot about the design process and what kind of considerations goes into the products I use everyday. I learned that there is a lot to consider when designing a product. For example, QFD charts and interviews with potential customers is paramount to creating a well-designed product. In future iterations of this project, I would enforce the structural integrity of the cardboard with 3D printed supports. Cardboard alone is too light and easily prone to bending. In future iterations, I would also like to improve upon the wiring by using regular wire as opposed to jumper cables. As well as building the sensitivity buttons into the frame of the build instead of holding them in place with a breadboard. I also learned how to make and produce engineering diagrams, which will help me further understand the products around me.

## References


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