

# A Modular 3D Holographic Interface

Design Document

Team 21

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# 1. Introduction

## 1.1 Objective

We live in a 3D world. The buildings we design, the art we create, and the objects we interact with on a daily basis are three-dimensional. Unfortunately our computer interfaces are not. Mouse devices, joysticks, monitors, screens and TVs provide a tremendously limited venue for interacting with three dimensions on modern devices. Almost ironically, despite technological advances in 3D sciences, the tools we use to design new objects and creations are centered primarily around 2D visualization. This is evident in design art computer apps like CorelDraw and Microsoft Paint which are essentially digital pencil and paper.

Imagine how much easier it would be to visualize and design 3D objects with a 3D tool and mechanism. With this project, you will not need to imagine. It would eliminate the need to muddle with multiple 2D perspectives in order to get a 3D perspective and give a realistic approach of how the items will be viewed in the real world. There is already a trend following the making of 3D software as seen in CAD (Computer Aided Design) software which still helps in designing objects however it's still two dimensional which is a huge limitation.

Out of the few methods of 3D display currently available, even fewer are affordable. Most forms of reliable 3D displays are expensive and at times even harmful for users. For example, 3D glasses can be harmful to glass wearers and even to most people when worn for an extended period of time. Specifically, they can be very tiring to the eye and lead to headaches since they distort images or the user's eye focus [2].

Our goal as a group is to provide a means of visualizing objects in a 3D space and to do so without the limitations of a 2D screen and interface while also avoiding eye fatigue. Providing such a solution at an affordable price while also preventing potential harm and risks to the users serves as a priority to us. 3D manipulation has started to trend in recent years and will only continue to do so in the future. Hence, the need and demand for such a method of display has never been more important than it is now.

This project's vision is to bring effective, accurate, beautiful three-dimensional I/O to modern devices. Instead of using clunky headwear, handhelds, or uncomfortable sensor gloves, we plan on using a dedicated 3D "hologram" display which can be viewed from four sides and a linked capacitive sensor array to detect hand motions around the 3D images. These sensors will function by leveraging the parasitic capacitance of the human body to detect how far away a given hand is from a metal plate without the need for touch. Our display will utilize the reflective properties of glass paneling and a standard, boring, 2D screen to project images back into a 3D space! Specifically this will feature a scaled up version of the popular phone-"hologram" devices [4]. From a user perspective, this device aims to be as simple as plug and play.

## 1.2 Background

Efforts are being made to transition from interacting with computers via screens to interacting with digital objects in the real world (3D space) through Google's AR project, Microsoft's HoloLens & Mixed Reality projects, Facebook's Oculus and more. All these companies realize the limitations of screens and are investing in breaking that limitation in the coming years. Currently the AR, and VR markets are valued at \$11 billion and \$8 billion respectively and are expected to grow to \$61 billion and \$34 billion respectively [1] showing the huge potential for holography in the future.

The biggest challenges with all three of these technologies is creating the depth in the image and keeping visual quality [8] while also doing so at a suitable price per device at scale. Our project would essentially aim to solve or satisfy those challenges, hence the difficulty of our project.

Traditionally, doctors have viewed medical scan data on computer screens in 2D slices. Medical hologram technology will allow a complete 3D visualisation of internal organs and body parts. This will allow doctors a greater ability to examine diseases and injuries in individual patients and will lead to more accurate diagnoses and surgeries [2].

Another application would be for live performances where the musicians are not physically present, instead transmitting their image to appear before the audience.

In the area of gaming, holographic display tables which allow real-time multiplayer games are already being tested. Manufacturers are also integrating this technology into the next generation of smartphone displays, which will allow portable 3D gaming.

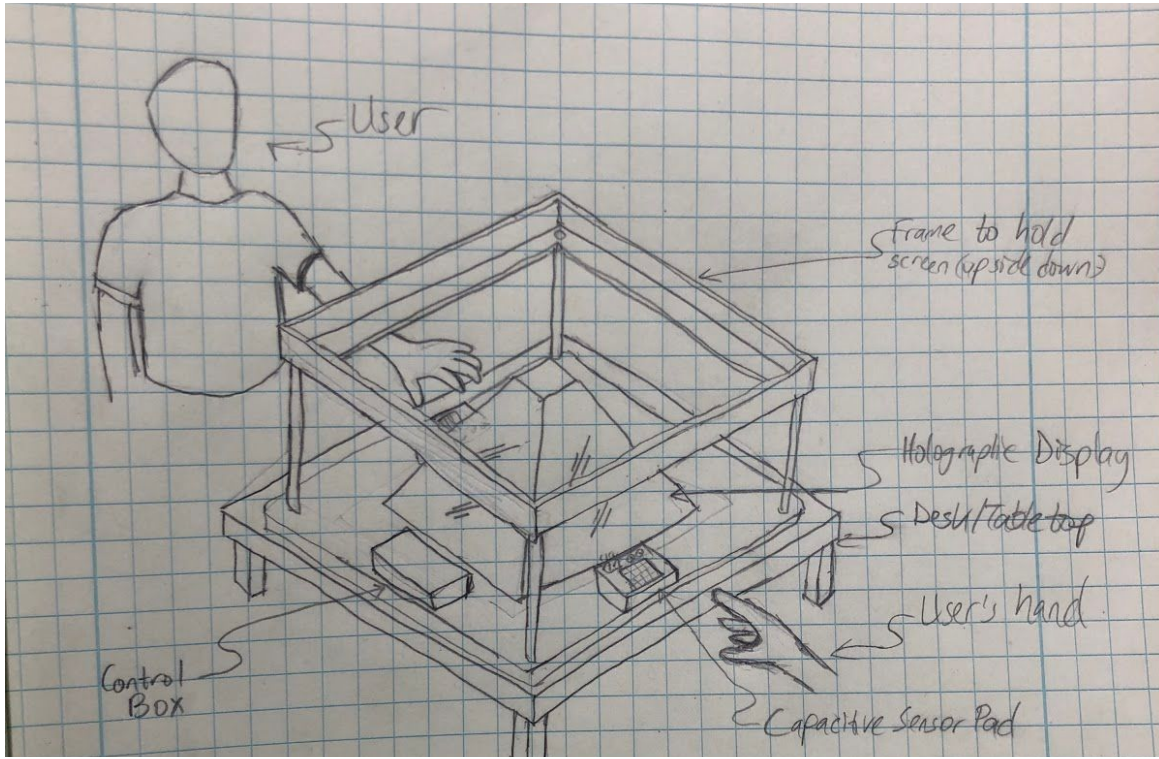
One of the most exciting applications of holograms is to the improvement of the educational experience. In order to engage students more fully, interactive digital lessons will be used in schools. This combination of digital and real-world information is known as mixed reality. Complex subjects can be taught using holographic images that students can interact with and examine. For example, pupils can virtually explore the ruins of ancient buildings during history lessons, or observe individual atomic particles and how they behave.

The practical uses of holographic technology have become a commonplace feature in our everyday lives. We are only seeing the beginning of the usefulness of holograms and as the innovators and developers continue to improve the technology, holograms will become an even larger part of society.

## 1.3 High-level Requirements

- Our device's display must be capable of both static and dynamic rendering of a 3D model with a decent frame rate of at least 24 frames per second (FPS). Here dynamic rendering refers to the requirement of real-time scene calculation.
- Further, our capacitive module must accurately sense positional data of appendages around the display with a height range of between 0 in to 8 in from each of the plates.

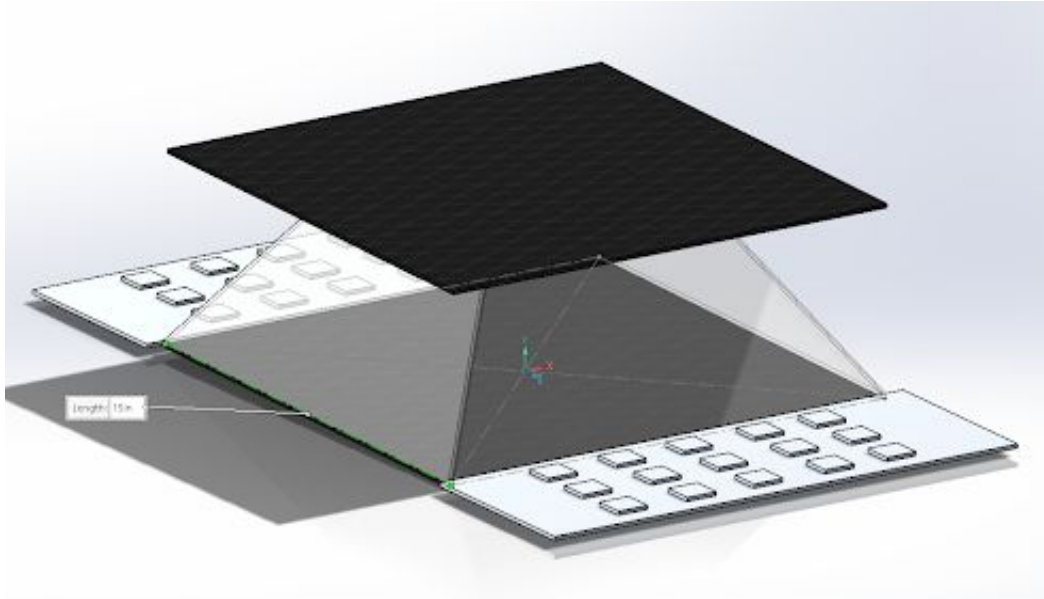
- Device should be able to read and take in .obj files and create four accurate perspective images of the object from the 3D model file.



**Figure 2: Visual Aid**

## 2. Design

### 2.1 Physical Design

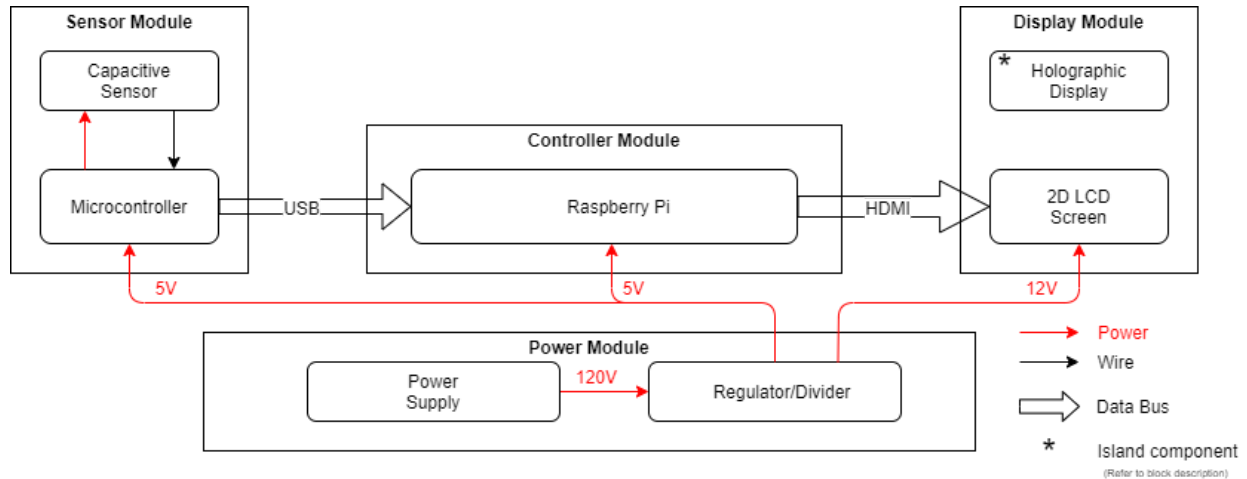


**Figure 2:** Physical Design

Pictured above (Fig. 2) is a mock-up featuring the physical aspects of our design. While the render above is somewhat lackluster, the finished product will radiate with a sleek acrylic-panel display centered between two 3D capacitive sensor arrays. Final dimensions may vary slightly, however as depicted, the display will be made to fit within a 12 in to 15 in square and the sensor arrays shall protrude from the display by up to 12 in.

While not illustrated above, the top plate will include a standard 2D LCD pointed downwards towards the glass to provide the desired 3D effect (a virtual image in the center of the display).

## 2.2 Block Diagram



**Figure 3:** A High-Level Function Block Diagram depicting power, data flows & connections

As shown in Figure 3, our project requires four modules for successful operation: a power supply, a controller unit, a sensor/input module and a display module. The power supply ensures that the system can be powered continuously all day and night with the proper voltage of 5 V and 12 V for the respective module voltage requirements. The controller unit consists of a Raspberry Pi, a microprocessor to run our 3D-to-2D algorithm as well as a USB port for taking in the 3D CAD file for processing then sending the final video/image to the holographic display via HDMI. The display unit comprises a 2D LCD screen that shows the four 2D perspectives of the holographic image and then is reflected onto glass pyramid structure which is the actual holographic display. Lastly, the input/sensor unit, takes in user input via a series of capacitive sensor plates that is then processed as input and sent to the Raspberry Pi to modify the final output hologram scene.

## 2.3 Functional Overview & Block Requirements

### 2.3.1 Display Module

The display module leverages the use of simple reflective technology, which consists of the two sub-modules below, to create a 3D image viewable to the user ([small-scale example](#) [4]). While this document will refer to the produced image as a hologram as is done colloquially, it is technically not a true hologram but rather a simple virtual image which appears 3D.

#### 2.3.1.1 Holographic Display

This component will be a Square Frustum (Base square and top square ratio of 3 : 4) and angled at  $45^\circ$  to effectively reflect the image from the screen. This unit is what creates the hologram image by reflecting the image from the screen to the viewer. Note that this component is NOT directly connected to the screen module because it only reflects the image from the

screen to create the hologram that the user sees. Thus the Holographic Display component is an island component.



**Figure 4:** A functional test of a holographic display reflecting the screen images

There is no need for it to be fixed permanently to the screen or connected in any way but we will fasten it with a frame or structure to prevent alignment issues. For the type of material, we will be using tinted acrylic to allow for best visibility and ease of cost/availability based off recommendations from ECE Machine shop. Alternative can be Glass, plexiglass or epoxy [5]. The material will be fully transparent and only reflective on the outer surface of the pyramid to prevent double imaging. It can be less transparent but for best user experience the thickness of the material ideally should be between 0.5mm-0.8mm to allow for best transparency.

Requirement	Verification
<ul style="list-style-type: none"> <li>Hologram image must display by visibly reflecting 2D LCD screen images to users point of view across all 4 sides of the device</li> </ul>	<p>A. Optical alignment tests: we plan to compare and match whether the reflected image matches the object file on the computer</p>



### 2.3.1.2 2D LCD Screen

This unit will render the hologram to be reflected off the “holographic” display (2.3.1.1) via a standard 2D screen. This subsystem will include any required video driver and 2D, LCD screen. It will take in video data via HDMI port from the Raspberry Pi which would be four live perspective views arranged in a way that when reflected to the holographic display it aligns to create the holographic image. The screen will be set to have the right brightness and resolution for the image to show clearly in lit environments.

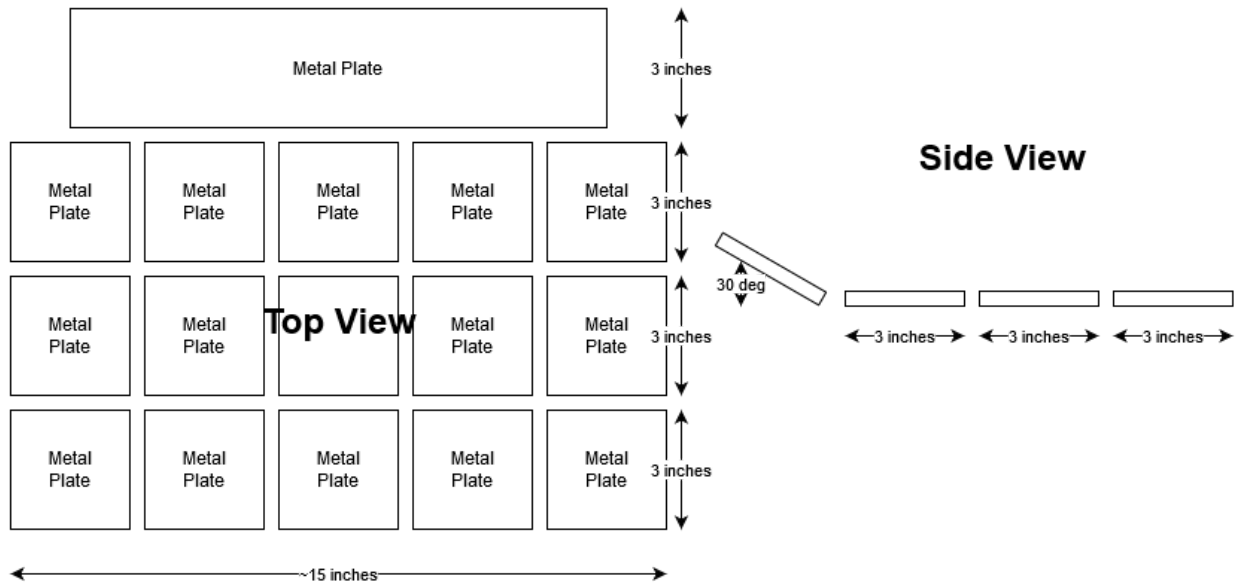
Requirement	Verification
<ul style="list-style-type: none"><li>LCD Screen should display the video data from Raspberry Pi showing the 4 perspectives of the object</li></ul>	A. Visual Inspection: by looking at the edges of the image in the visible space zone, we will be able to eyeball whether the images are being shown accurately and we can compare with the sizing of the actual object to ensure proportions and proper reflection of images. This will prevent double blur or glare effect

### 2.3.2 Sensor Module

A sensor module will handle the task of reading 3D positional data of a user’s hands above the module via parasitic capacitive coupling technology. This module will also handle processing to convert raw data into useful information.

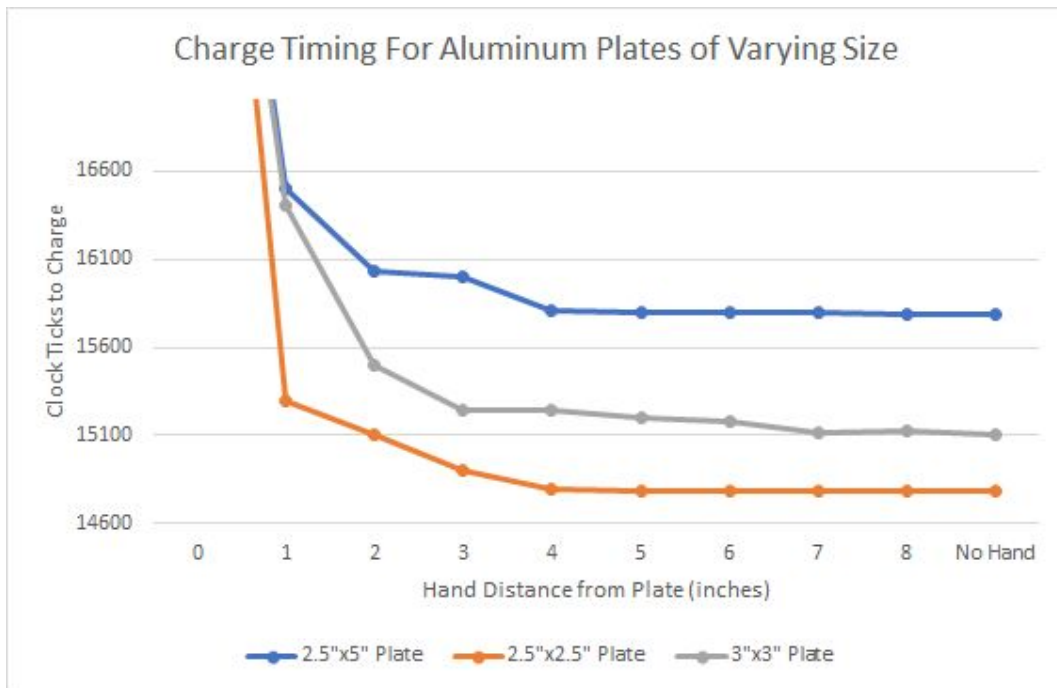
#### 2.3.2.1 Capacitive Plate Array

This unit would be an array of capacitive plates connected in parallel made out of a good conductor that will be charged and discharged repetitively in order to detect user proximity to plates.



**Figure 5:** Arrangement of a single capacitive array

While aluminum was originally considered, because soldering connectors onto aluminum is extremely difficult, the plates will likely be made of copper instead. As outlined in the controller section below (2.3.2.2), this system will include 32 metal plates. Specifically they will be arranged into two arrays, 16 plates each, where each array consists of plates in a three by five rectangle with a larger sixteenth plate placed higher, and at a slight angle from the rest (as depicted in Fig. 5). This arrangement allows for a large surface to be sensed and added redundancy (with the sixteenth plate) as a small form of error correction.



**Figure 6:** Time to Charge aluminum-hand plate capacitors of various sizes. The 0 in case has been cut on the Y-axis to provide more insight into charge timing at further distances.

As shown in Fig. 5, each individual smaller plate will be a 3 in by 3 in square. From preliminary testing with aluminum squares (Fig. 6), in order to detect hand motions at a distance of 8 in from the plate, the area must be roughly at least 9 in<sup>2</sup>. For the sake of tolerance these squares may be slightly enlarged.

Requirement	Verification
<ul style="list-style-type: none"> <li>Individual conductive plates should not have electrical contact between them</li> </ul>	A. With the circuit powered down, an Ohm-Meter with an electrode on each plate should read infinite resistance
<ul style="list-style-type: none"> <li>Plates should be properly insulated from all external points apart from their contact points</li> </ul>	A. With the circuit powered down, and protective insulator placed properly, an Ohm-Meter with an electrode on a metal plate and the second on the protective barrier should read infinite resistance
<ul style="list-style-type: none"> <li>When working in tandem with the microcontroller and transistor/resistor network, these plates should be able to detect a hand from 0 to 8" above each plate.</li> </ul>	A. A hand should be placed at 0 in up to 8 in in small increments B. At each of these steps, the metal plate should be charged and discharged by the microcontroller and circuit C. As the hand is raised, the microcontroller should register decreasing charge times. D. Similarly a difference in charge timing between no-hand and a hand at 8 in should be registered.

### 2.3.2.2 Microcontroller

The sensor controller (which will be PCB mounted) consists of supporting features required to make use of the conductive plates referenced in 2.3.2.1 - specifically a microprocessor and transistor/resistor network. It controls charge/discharge behavior of the plates, data collection and data processing.

#### 2.3.2.2a Microprocessor(s)

This unit will charge and discharge the transistor/resistor network (2.3.2.2b) and process the raw data from the capacitive plates. It will measure the time it takes for them to recharge then calculate the distances of user hands to the plates. This final positional data will be transferred off-board to a connected computer/linker for use as human-input (Raspberry Pi in this case, see 2.3.3.1).

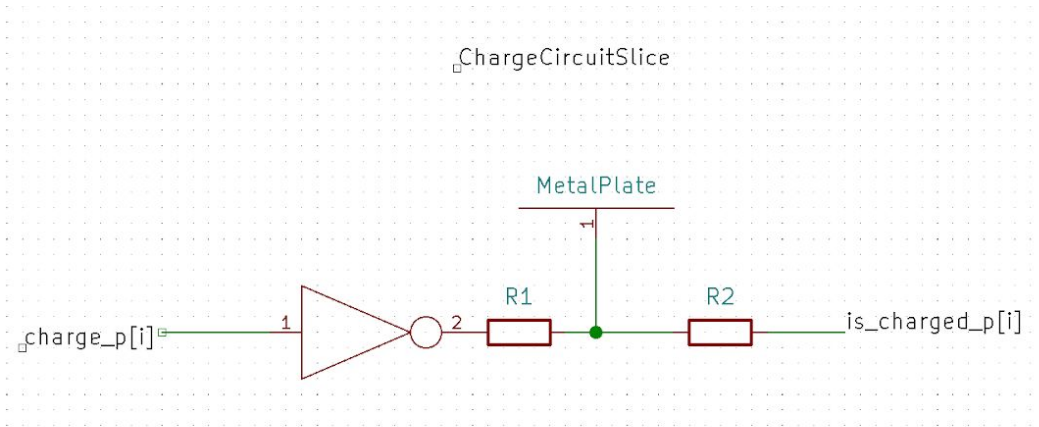
This design will feature the use of an ATmega328 series, 8 bit, AVR microcontroller. While there are many other microprocessor options, the ATmega328 is low power, capable of running with a 4 MHz system clock when using an external 16 MHz crystal oscillator. While a faster clock is not necessary, the faster the clock, the higher the resolution capable on each plate and the faster each plate can be allowed to charge. Further, the ATmega328 supports UART serial communication, SPI and I2C protocols. Converting this to USB is relatively trivial with the appropriate hardware. The ATmega328 also can be programmed via the aforementioned interfaces easily once a bootloader is burned into its Flash memory (feasible through the assistance of an Arduino board).

Unfortunately the ATmega328 has a limited number of IO ports (23 or less depending on processor configuration). In order to decrease the port usage this design will feature a 32:1 Multiplexer and 1:32 decoder which results in only seven pins used (five for address/plate select, one to serve as a charge signal, one to test whether the plate is charged). Extra pins can now be used for push button input or LED output to control functions like recalibration. This will only allow a single plate to be charged at a time, however this is virtually already a requirement since the CPU runs sequentially regardless.

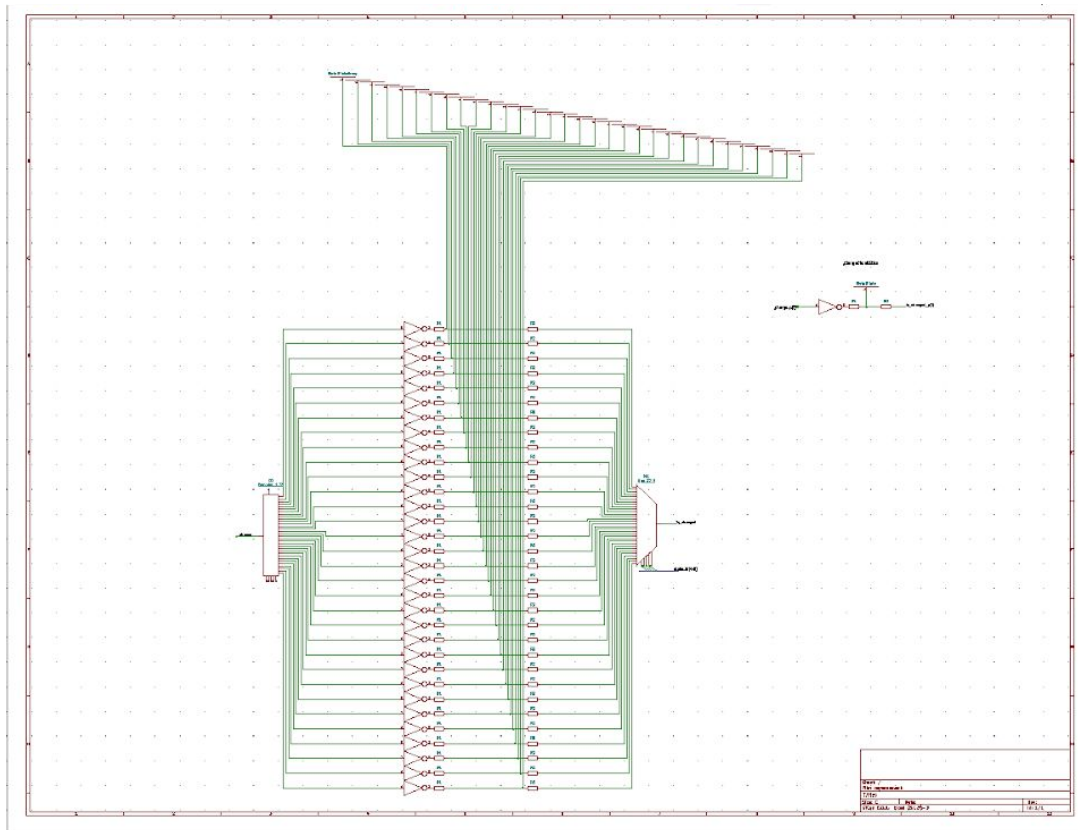
### **2.3.2.2b Transistor/Resistor Charge Circuit for Capacitive Sensor**

Given digital signals from the microprocessor(s), this unit will charge and discharge the thirty-two conductive plates used for capacitive sensing. As input the circuit will take a 5-bit plate select signal (`plate_id[4:0]`), an active-low charge signal which triggers charging of a plate (`charge_n`), and an output active-high signal `is_charged`.

As seen below in Figure 8, each of the 32 circuits is connected to a metal plate, the multiplexer and decoder. Specifically the circuit functions by charging the metal plate via an inverter/buffer and resistor R1. Generally R1 is large enough to lengthen charge times to detectable ranges (testing as seen in Figure 7 uses the circuit below with  $R1 = 1M\Omega$ ). During this testing the CD40106B Hex Schmitt-Trigger inverter proved practical so the final design will likely feature six of these ICs (the four extra inverters will either be grounded or used for any required multiplexer/decoder inputs). Resistor R2 is added to limit maximum current input to the multiplexer and is not meant to source much power.



**Figure 7:** Blit-Slice Schematic View of Capacitive Charge Circuit



**Figure 8:** Schematic View of Capacitive Charge Circuit

Requirement	Verification
<ul style="list-style-type: none"> <li>When a conductive plate is neither being charged nor discharged, large</li> </ul>	<p>A. After charging a plate and holding it at a charged level, a voltmeter can be placed across various resistors (R1 in</p>

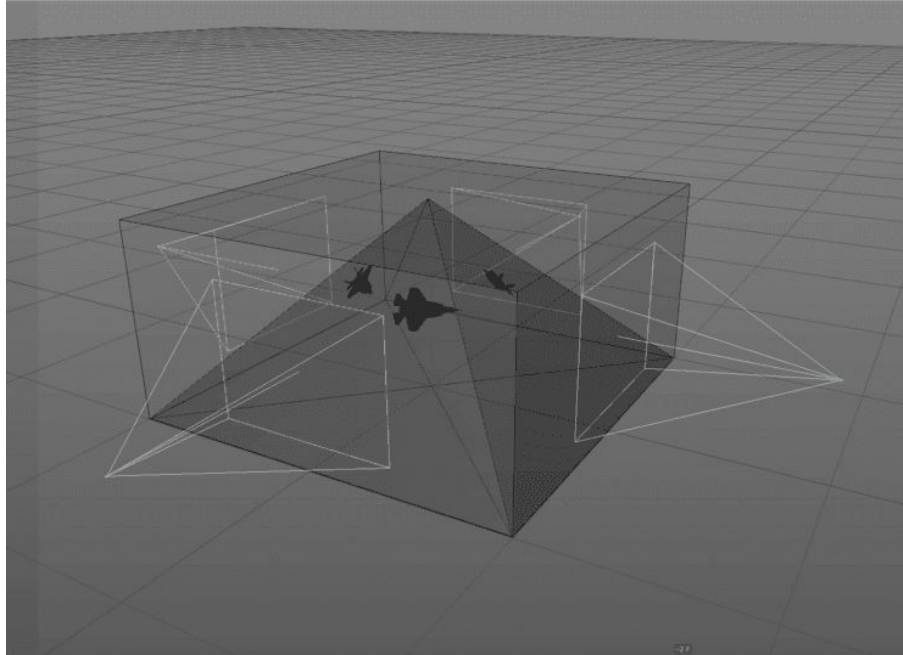
current should not flow ( $< 1 \text{ mA}$ - to account for possible leakage current)	Figure 7) to check for zero voltage drops
<ul style="list-style-type: none"> <li>Should be able to source enough power through inverters to charge metal plates to a nominal HIGH voltage (<math>\sim 4.7 \text{ V}</math>)</li> </ul>	A. An oscilloscope or voltmeter can be user to verify the maximum voltage the metal plates can be charged triggers a logic 1 on multiplexer TTLs (Figure 8)
<ul style="list-style-type: none"> <li>External signal contacts (i.e. wires to capacitive plates) must be shielded to decrease parasitic capacitances/interference.</li> </ul>	A. Shielding wire may be checked for appropriate voltage bias with a volt-meter

### 2.3.3 Control Module

This unit links the 3D HID input with the display module. This will handle arbitrary program execution/logic (e.g. a game of 3D Pong) which makes use of the sensor output, calculate appropriate rendering (3D to 2D) for the holographic display and forward these renders to the display module to be projected back into 3D space.

#### 2.3.3.1 Raspberry Pi/Computer

A Computer, chosen to be a Raspberry Pi handles the positional input from the capacitive sensor array (treating it like a HID and reading through a USB serial port) and will map appropriate 3D object projections to the 2D, LCD screen. The aforementioned conversion will be done via standard graphics libraries (i.e. OpenGL ES) onboard. This will also be running basic program logic.



**Figure 9:** Simulation of how the Raspberry Pi Code creating the 4 perspective views

Requirement	Verification
<ul style="list-style-type: none"> <li>Should be able to properly interface with Sensor Module and Display Module and take in directional input from the capacitive sensor PCB</li> </ul>	A. Test function that displays on screen what the general direction and velocity value of the users' gestures are
<ul style="list-style-type: none"> <li>Should be able to manipulate the 3D cad object</li> </ul>	A. CAD software window: have an open window that shows whether the directional input is actually 3D cad object in the cad software space
<ul style="list-style-type: none"> <li>Should be able to continuously grab four views/perspectives from the cad file</li> </ul>	A. Saving pictures of the perspective views will allow us to know what the code is observing from the cad file
<ul style="list-style-type: none"> <li>Should be able to merge the the 4 perspectives into a live video of the object</li> </ul>	A. Connecting the screen to the raspberry pi will allow us to see the final video being streamed from the code

### 2.3.4 Power Module

This route appropriate power to each submodule.

### 2.3.4.1 Wall-Adapter/Power Supply

A power supply is required to keep the system up continually. Power from a wall outlet, which is then regulated to 120Volts for the rest of the system. Used to power components from other systems reliably. This may include AC/DC converters, wall adapters.

Requirement	Verification
<ul style="list-style-type: none"><li>• Should provide steady power throughout duration of device use</li></ul>	A. Measuring the input and output voltage with a multimeter at the input pin and the negative probe and positive probe
<ul style="list-style-type: none"><li>• Should provide surge protection to prevent explosions</li></ul>	A. Check Voltage threshold of device and ensure the accurate voltage tolerance to go to ground in case of spike

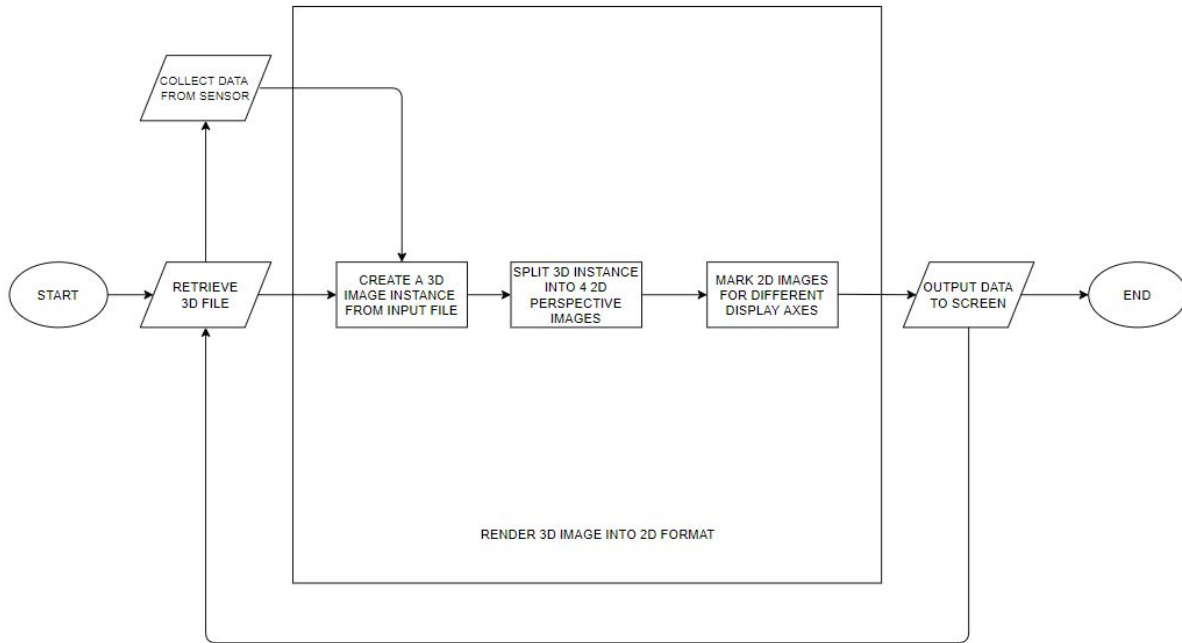
### 2.3.4.2 Voltage Regulator(s)

This integrated circuit supplies the required 5 V and 12 V to the respective modules. This component must be able to handle the peak input from the power supply

Requirement	Verification
<ul style="list-style-type: none"><li>• Must convert DC output from wall adapter to steady 5 V and 12 V (+/- 5%) supplies</li></ul>	A. Measuring the input and output voltage with a multimeter at the input pin and the negative probe and positive probe

## 2.4 Software





**Figure 10:** Raspberry Pi Software Flow

The software algorithm starts off with retrieving the input 3D format file. Ideally this could be done by either having a pre-loaded file inside there thus making it a stand-off mode version or retrieving the input from a USB I/O such as a computer. With this retrieved input, the program then collects movement data from the capacitive sensor array via a USB serial port.

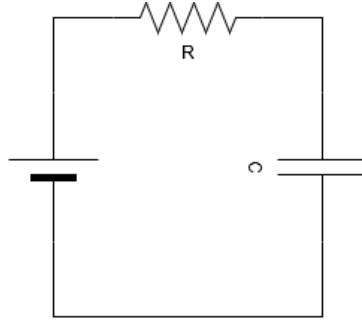
When all data is collected, the Raspberry Pi proceeds to render the 3D image into a 2D format. It starts by creating a single instance from the 3D file, this is particularly in cases for more video-like formats. This process also includes combining the data obtained from the sensors to recreate a new 3D instance. From here, the processor splits the instance into four different 2D images based on unique perspectives. In a nutshell, the front, left, right and back views of an object. The different perspective images is what would make the holographic display. Once the images are created, they will be marked in order to be displayed simultaneously in the output. The images will be collated and formed into an output package which in turns will be sent to the screen via HDMI. From this point the process ends or continues if more instances are to be made from the input file or sensor.

## 2.5 Tolerance Analysis

The block which poses the highest risk towards the successful completion of this project is the capacitive sensor module (2.3.2). As outlined earlier, the sensor array is required to sense hand-positions above each plate from a range of 0 in to 8 in. While higher resolution may be achieved, a resolution of 0.5 in in the z-axis is desired with a significantly lower resolution along the x-axis and y-axis.

Meeting these requirements involves three main components: the resistance of R1 in Figure 7, the plate sizing, and the sampling rate of the microprocessor (i.e. the system clock speed). The charge circuit depicted in Figure 7 can be seen in a simplified into a simple RC circuit (Figure 11 below) whose charge at the capacitor can be modeled by Eq. (1).

$$V_c = V_{dd}(1 - e^{-t/(RC)}) \quad (1)$$



**Figure 11:** A Simplified RC Charge Circuit

R is a fixed value of the circuit, however C, the capacitance of varies based on the position of a hand over the metal plate. Further, the based capacitance of each metal plate greatly varies based on the environment around the sensor - placing the device on a wooden versus metal table will yield dramatically different capacitance. To maintain resolution there are three main options, increasing R to decrease the charge time at a given capacitance, increasing the area of the plate, or increasing the sampling rate to detect changes quicker.

Working under the assumption that the sensor should output data at roughly 100 Hz, this leaves 10 ms to poll each capacitive plate, extrapolate distances from charge timing data then transmit the data over USB. The ATmega328P can be configured to run at a 4 MHz system clock (a sampling rate of roughly 250 ns). If half of this time is spent polling then each plate is allowed, on average,  $\sim 150 \mu s$  to charge. Further empirical testing is required to determine exact resistance values needed however as tested (see Figure 6) a plate sizing of 3 in by 3 in paired with a 1 M $\Omega$  resistor is able to distinguish a hand anywhere from 0 in to 8 in above the plate.

As a result of the environmental factors a software-based recalibration will be required when moving the sensor array regardless of other hyperparameters changed.

## 3. Cost & Schedule

### 3.1 Cost Analysis

Fixed costs for designing this project include a roughly \$40 / hour salary paid to each of three partners payable for approximately 60% of the length of this course (16 week). Assuming a 15 hr per week schedule, the labour cost can be estimated by Eq. (2) to be \$42,300.

$$\text{Labour Cost} = 2.5 \times \frac{\$40}{\text{hour}} \times \frac{15 \text{ hours}}{\text{week}} \times 16 \text{ weeks} \times 60\% \times 3 \text{ people} = \$42,300 \quad (2)$$

Part #	Source	Description	Unit Cost	Quantity
LCD Screen	Vision/LG	Standard LCD screen with HDMI input	\$100	1
Frame	ECE Machine Shop	Simple frame to support frustum and screen	\$50	1
Glass Frustum	ECE Machine Shop	Four tinted trapezoidal acrylic pieces	\$37	1
Raspberry Pi	Premier Farnell	Model 3B with serial, hdmi and usb input	\$42	1
ATMega328P	ECE Supply Shop	Microcontroller with	\$10	2
PCBs	PCBWay	Made to order capacitive sensor PCB	\$25	2
Assorted electrical components	ECE Supply Shop	resistors, capacitors, ICs, crystals, sockets (Digikey; est.)	\$25	~
Total	-	-	\$314	-

**Table 2:** A Summary of Costs

### 3.2 Schedule

Week	Pavan	Taofik	Charles
2/17	-Start Design for Capacitive Sensor Network -Look into Microprocessor for sensing -Serial communication between sensor and linker	-Complete design for display module -Reach out to machine shop	-Look into Open source libraries for basis of raspberry pi algorithm -Set up virtual machine to write code for raspberry pi
2/24	-Complete Design of Capacitive Sensor Network	-Follow up machine shop -Complete design for Power Module	-Begin preliminary coding
3/2	-Start testing capacitive sensor prototype -Start PCB Design	-Submit final design and specs to machine shop -Order parts	-Start testing with 3d files -Start testing with raspberry Pi
3/9	-Place/submit PCB design order	-Test display setup and acquire screen, and holding components	-Test directional input with capacitive sensor and code
3/16	SPRING BREAK		
3/23	-Assemble capacitive sensor pad/box	-Revise Machine shop design -Complete power module design	-Test code that loads 3d cad file perspective
3/30	-Final PCB order	-Assemble and test power module	-Test code that exports video to screen
4/6	-Assemble full setup	-Assemble full setup	-Test code on full setup
4/13	-Test Demo of individual modules	-Test Demo of individual modules	-Test Demo of individual modules
4/20	-Complete final documentation	-Complete final documentation	-Complete final documentation
4/27	-Complete final demo	-Complete final demo	-Complete final demo
5/4	Prepare Final Presentation & Begin Final Report		

**Table 3:** Estimated Design and Build Schedule

## 4. Ethics and Safety

We recognise that as interesting and exciting as this project sounds there are some potential concerns in regards to safety and ethics that could be involved. We consider these and hold this important when designing, developing, and presenting this project. In order to elaborate more on our ethics and safety regulations, we touch on more specific concerns in detail.

We understand that dealing with electric components can be harmful to users, so we decided to lower the power voltages to feasible values that would prevent harm to the human body. In accordance with Article 1 of IEEE Ethics code [9], which highlights the priority of public safety, we go through great measures to guarantee the safety of those around the area and the environment in general when building and using the holographic interface. In reference to the capacitive sensor, we are going to reduce the charges and exposure of the electric field to the users by insulating the capacitive sensor with glass or plastic. By taking these measures, we help to prevent any shock risks involved with coming in close proximity with the capacitive sensors and mitigate the human exposure to electric fields. This will ensure that we are prioritizing the safety of user interaction with the project making it safe to use.

We noticed that our project appeals to a large audience so it is necessary to clarify any considerable misleading information regarding the display. For the sake of those unaware, we will explain and perhaps even put out a notice that the 3D projection of our project isn't necessarily physical but in fact a reflection of images. It is paramount we do this in order to uphold Article 3 of the IEEE Code of Ethics which asserts the realistic claims based on available data[9]. Furthermore, it is absolutely prohibited for users to reach towards the glass prisms where the projections reside. This acts as a precautionary measure to ensure that no injuries are sustained by possibly breaking through the glass for any reason whatsoever.

Looking into more of the ergonomic issues that may occur, there's a possibility for anybody to develop strains in their arms and hands when working with them over long periods of time. Similar to choir conductors or juggling performers, our project users exhibit the same range of motion. Consequently, we recommend using the project in ample time intervals and taking breaks between them. Stretching the affected areas before and after use will also help prevent such wear and tear or strain from occurring.

Overall the aim of our project aligns greatly with Article 5 of IEEE Code of Ethics [9]. To improve the understanding of individuals in our society through the use of our projects in order to help visualize, plan, design and build with less restrictions and more creativity is a goal our projects strives to deliver. Conclusively, we have considered a great amount of scenarios that could fall under safety and ethics speculations. All of the guidelines we have provided are in line with the code of conducts from IEEE and ACM. We adhere to these standards and strive to use our project for the better good of enhancing and promoting productivity of our user's works.

## References

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