

Group 19

💢 Team Members 🛞



Ethan Hoang CPE



Jasper Steensma



Hussen Premier

CPE



Kevin Veciana

Background and Motivation



- Inspiration comes from the background laser tag
 - Late 1970's US Military creates first realistic laser tag system "MILES" allowing for a safe environment to create tactical training exercises
 - Ties to former UCF students/faculty and CREOL Department
- Motive behind this project
 - When deciding on a project to design we agreed as a team that it should focus on being enjoyable to build and entertaining to use
 - > Having a project we are passionate about increases productivity
 - > Easily testable as all the hardware parts can be tested separately
 - Changeable difficulty as we can always add upgrades to our system.



asper Steensma



Objective and Goals 💖



- Design Fully functional Laser Tag game
 - Replicate the dynamic experience of playing laser tag and make it as realistic as possible for enhanced gameplay
 - Utilizing infrared emitter and receivers we will be able to accurately detect "hits" between users and record the data

Specific Goals

- Less than a 1 second response time for emitter and receiver
- Maintain a minimum 80% hit register accuracy when aimed properly
- > Have a minimum of 1 hour play time
- Have 3 separate areas to register hits from different directions



Optics 🐵

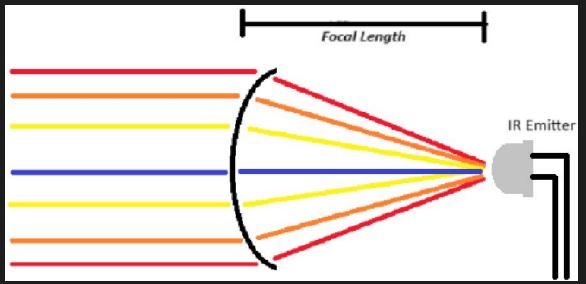
When you think of laser tag you imagine that it's done with actual lasers but this is far from the truth it's actually much more simple than you would think

Jasper Steensma

asper Steensma

Inside the barrel of the gun is an Infrared Emitter and it emits light in every direction so using a convex lense we can bend the light to make it go straight

The focal length depends on the curve of the lens and is changed throughout testing



Engineering Specifications

Vest Response Time	The response time from the sensor receiving the infrared light to the system outputting that it registered will be less than 1 second.	≤1 second
Trigger Response Time	The response time from the press of the trigger to the activation of the infrared laser will be less than 1 second.	≤1 second
Infrared Receiver Accuracy	The system will be able to accurately detect at least 80% of the hits that are aimed properly at the receiver	≥ 80%
Battery Life	The battery will allow at least 1 hour of playtime	≥1 hour
Areas of Receivers	The laser tag system will consist of at least 3 areas of hits per vest unit	≥ 3 areas of hits
Infrared Lights	The infrared lights are expected to emit light at a wavelength of 940 nm	940 nm



Jasper Steensma

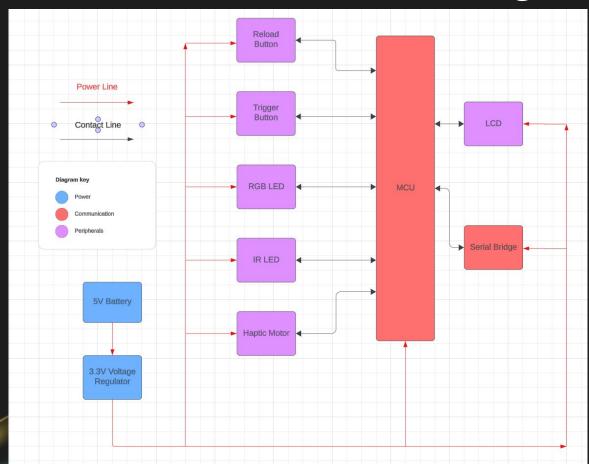
Design Software Comparison

Design Software	Efficiency	Features	Collaboration	cost
· · · ·	• • •	• •		
EagleCAD	Moderate (steeper learning curve)	Strong feature set, including schematic capture and PCB layout	Limited collaboration features	Moderate (affordable for small teams)
EasyEDA	Easy (beginner friendly)	Basic to moderate features, cloud-based	Excellent for collaboration (real-time cloud editing)	Free and paid versions available
Alitum Designer	Complex (professional grade)	Extensive, industry-leadin g tools for complex PCB designs	Advanced collaboration tools for teams	High (premium pricing for professionals)



Kevin Veciana

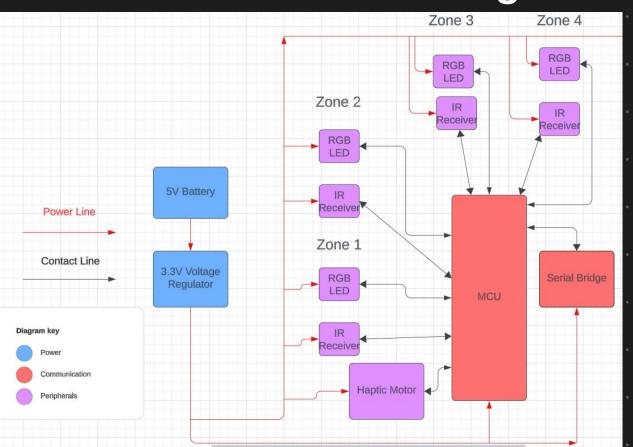
Hardware Phasor Block Diagram





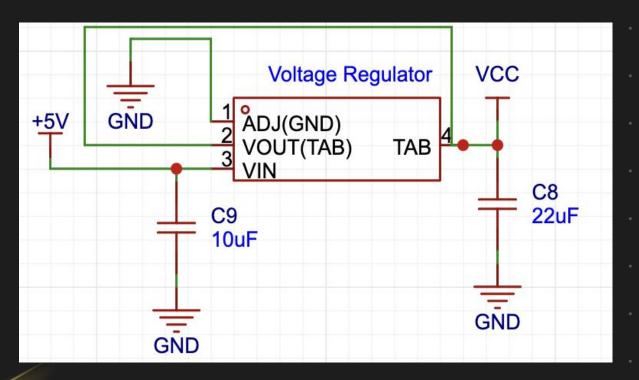
Kevin Veciana

Hardware Vest Block Diagram



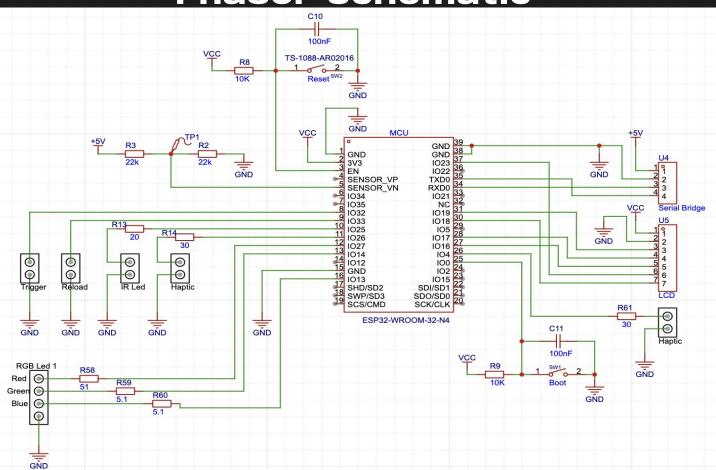


Voltage Regulator Schematic



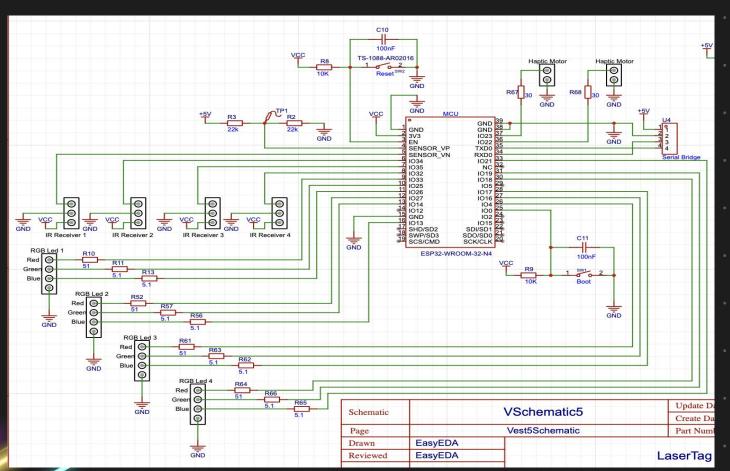


Phasor Schematic





Vest Schematic





Power Supply Comparison

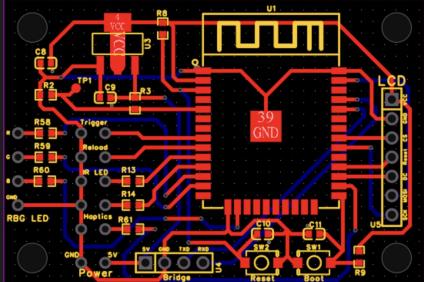


Power Supply	Capacity	Rechargeability	Portability	Cost
Option				
USB Power Bank	High (5,000mAh - 20,000mAh)	Rechargeable (hundreds of cycles)	Bulkier than other options	Medium/High initial cost (based on capacity)
AA Batteries	AA Batteries	Non-rechargeable	Small, high accommodation	Low initial cost, more over time
Li-ion AA Rechargeable Batteries	Medium (2,000mAh per battery)	Rechargeable (hundreds of cycles)	Same as standard AA	Medium initial cost, low long-term cost

Voltage Regulator Comparison



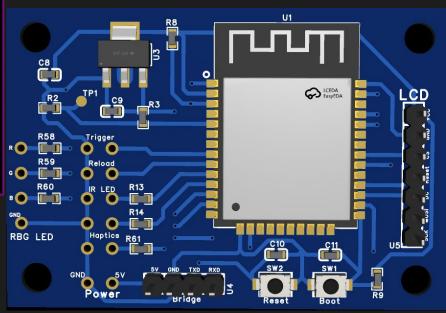
Voltage Regulator	Efficiency	Heat Generation	Complexity	Cost	Noise
Linear Voltage Regulator	Low (around 40-60%)	High (excess energy dissipated as heat)	Simple, easy to design	Low	Low (cleaner output)
Switching Regulator	High (up to 90% or more)	Low (less heat generation)	More complex (requires inductors, capacitors)	Medium initial cost, low long-term cost	Higher (produces electrical noise)



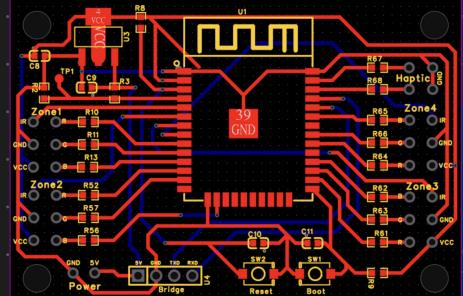
Phasor PCB Layout



Phasor 3D Model





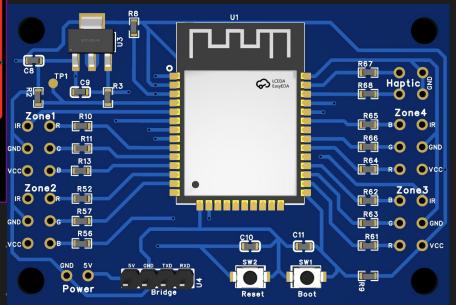


Vest PCB Layout



Kevin Veciana

Vest 3D Model





Microcontroller Comparison

	ESP32	MSP430	Raspberry pi	Arduino
Price	\$3.80	\$10.77	\$10.00 - \$80.00	\$9.00
Wireless Connectivity	Wifi, Bluetooth, and ESP-NOW	None ° ° °	Wifi and Bluetooth	None (available with add-ons)
Languages	C,C++,MicroPython	C and C++	Python	°C, C++
Number of Cors	2 cores	1 core	4 cores	1 core
Use Case	Great for home automation projects due to its connectivity features	Suitable for low-power applications and embedded systems	Acts as a full-fledged computer, suitable for multimedia, automation, and complex software applications	Excellent for beginners and simple projects, with a vast community and extensive documentation



Hussen Premier CPE

Display Comparison

Parts	Resolution	Interface	Driver	Price
1.4 inch TFT LCD Display	128x128	SPI	ST7735	\$7.89
2.0 inch OLED Display Module	128x64	12C	SSD1306	\$8.99
2.8 inch Capacitive Touch LCD Display	240x320	Parallel	HX8357	\$12.99
2.2 inch TFT LCD Display Module	240x320	SPI	ILI9341	\$10.49



Hussen Premie CPE



Emitters and Receivers

The **TSAL6200** is a high-power infrared LED that emits at 940 nm; providing a narrow and intense IR beam.

The **TSOP4838** is an IR receiver commonly used in remote control systems. It's designed to filter out ambient IR noise like sunlight and artificial lighting, while only responding to IR signals modulated at 38 khz



Hussen Premie



RGB LEDS

The **10mm RGB LEDs** allowed for a greater brightness for outdoor use and the diffused lens provide a more even light output for our laser tag system



Hussen Premie CPF



LCD Display

This **1.44-inch TFT LCD** display is an excellent choice for a wireless laser tag project, offering numerous advantages in terms of functionality, visual appeal, and interactivity.

It is energy efficient which is critical since our system is battery powered and the TFT technology ensures good viewing angles.

Easy to implement with adafruit GFX library.



Hussen Premiei



Vibration Motors

Vibration motors are a fantastic addition to a wireless laser tag system, providing immersive haptic feedback that complements the visual cues offered by RGB LEDs.



Hussen Premie



Wireless Communication Protocols

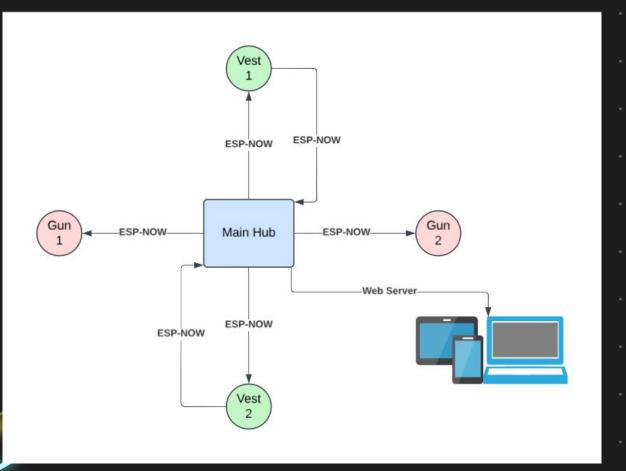


	ESP-NOW	Wi-Fi	Hussen Premier CPE Bluetooth
Range	~220 meters	100 meters	60 meters
Delay	Low latency for local communication	Low latency for local communication	Low latency for local communication
Data Size	250 Bytes	1460 Bytes	251 Bytes
Power Consumption	Known for low power consumption	Moderate power consumption (depends on usage)	Low power consumption (especially BLE)
Use Cases	Applications needing low-latency, local communication.	Web servers, data logging, remote control, etc.	Short-range communication, wearable devices, remote control, etc.

Communication Protocols

• • • • •	UART	I2C	SPI Hussen P
Communication Type	Asynchronous	Synchronous	Synchronous CPE
Number of Wires	2 (TX, RX)	2 (SDA, SCL)	4 (MISO, MOSI, SCK, SS)
Data Transmission	Full-Duplex	Half-Duplex	Full-Duplex
Speed	Moderate	Slow to Moderate	Fast
Complexity	Low	Moderate	High
Number of Devices	Point-to-point	Multiple, with unique addresses	Multiple, with individual chip select
Use Cases	Long distance, low speed data transfer	Short distance, low-speed data transfer between ICs	Short distance, high speed data transfer between ICs

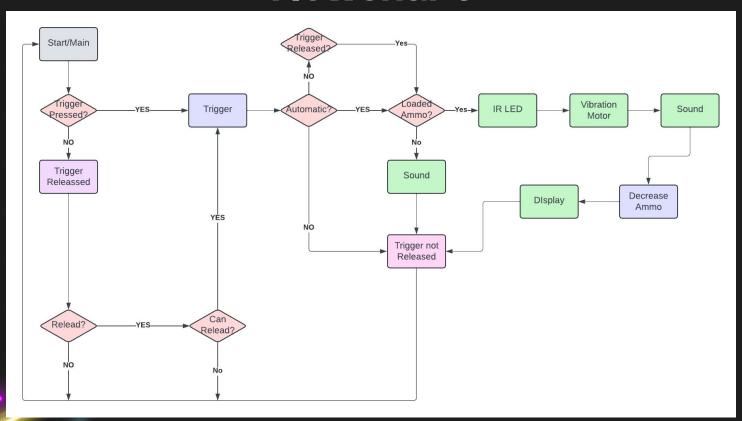
Wireless Communication Flowchart





Hussen Premier CPE

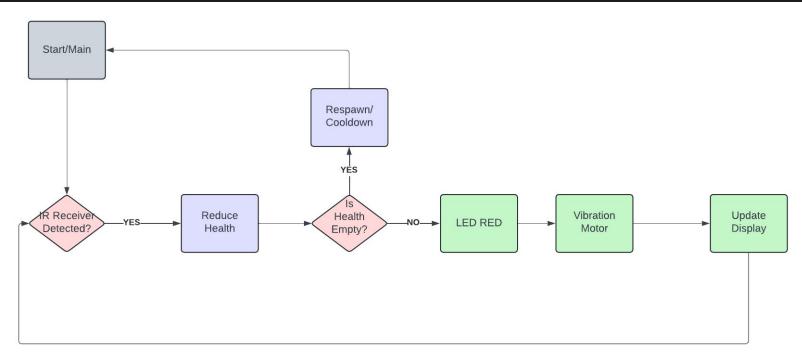
Laser Gun Gameplay Software Flowchart





Hussen Premier CPE

Vest Gameplay Software Flowchart





lussen Premier CPE

Main Housing Cad Prototype

- Designed using Onshape which is a browser hosted CAD program allowing cloud storage
- The model was designed to be 3D printed and the slicer to easily format to print
- Modular design so users can attach or detach different components to their choosing
- Main housing incorporates ample space for hardware and wiring to different components

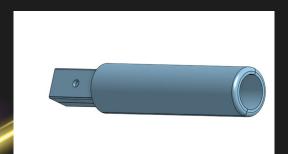


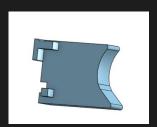
Ethan Hoang

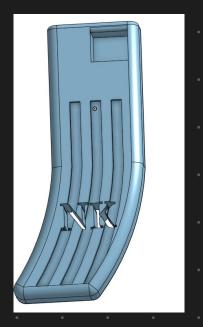


Modular Cad Components

- Modular components designed for easy connection to the main housing so users can choose attachments they want
- Some attachments could include sights, stocks, extended barrels, grips, magazines, and more
- These are the final prototypes that were printed and used on the final guns and vests

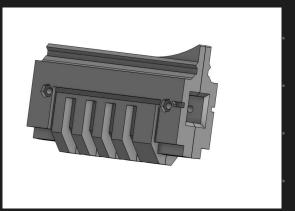








Ethan Hoang CPE



3D Printing Materials

		2
VE	76	
1		
M.	2.0	

CPE

Material ·	Cost	Strength	Post Processing	Printing Temp Eth
PLA-CF	\$20 - \$30 \$25 - \$35	45.5 to 57 MPa	Difficult and requires extra post processing	200 to 230 Celsius
ABS	\$15 - \$25	29.6 to 48 MPa	Requires acetone to glue together	220 to 250 Celsius
PLA	\$20 - \$30	39.9 to 52.5 MPa	Very little	180 to 220 Celsius

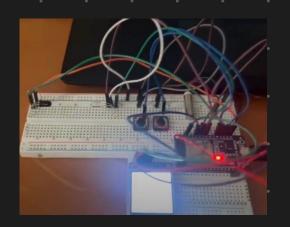
Important aspects - Durability, easy to obtain, ease of printing, and easy post processing

Prototype and Testing

Each component was first tested individually including lens, haptic feedback motors, buttons, infrared leds, and lcd display

We were able to successfully get the infrared emitter and receiver to communicate with each other using different boards and also allow the haptic feedback motors to react whenever the sensor detects IR

The lens was able to focus the light to condense it into a single straight line





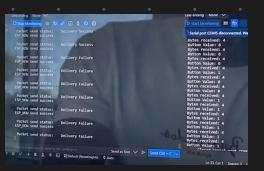
Ethan Hoan



Red LED was used for demo because Infrared light is invisible to the naked eye

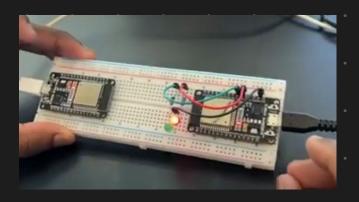
Esp-Now Communication prototype

- Test prototype for esp-now using different development boards
- This prototype tests the software and hardware interaction to prove that esp-now communication between two disconnected boards works
- The final goal is to allow the vest, gun, and main hub to communicate with each other and allow a smooth communication between users.





Ethan Hoang



Final Vest and Gun

- Final Vest using the Vulcan Paintball vest
 - Contains all the infrared sensors and RGB led representing zones
- Gun Housing made with 3D Printed PLA
 - Contains the TFT lcd, trigger, reload switch, infrared emitter, and multiple haptic feedback motors







Ethan Hoang CPE



Difficulties and Solutions 🔣



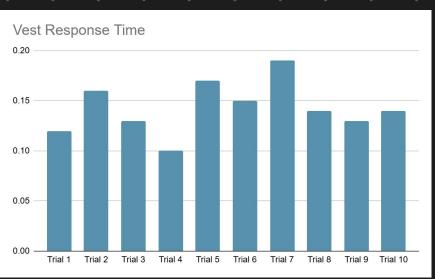


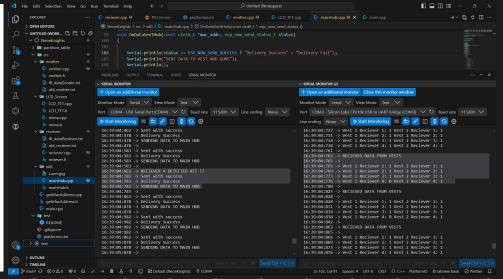
Problems	Solutions Ethan I
The components and parts must be lightweight, durable, and secured correctly so they don't break while playing	We research and utilized small components and also utilized lightweight materials for the housing and made sure to design the housing to secure them properly
LCD display	We learned and research ways to code and utilized the LCD display as to better understand how to use the display in our project
Constant updates and changes to CAD designs	We practiced better communications as to prevent constant small updates to the CAD before printing as to prevent any mistakes in the design
Wireless communication and distance	Thoroughly tested wireless communication devices at distances as to prevent any future issues

Engineering Specification #1



Ethan Hoang CPE

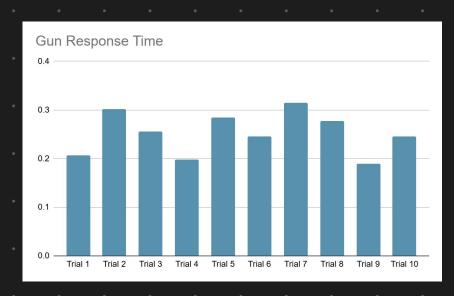


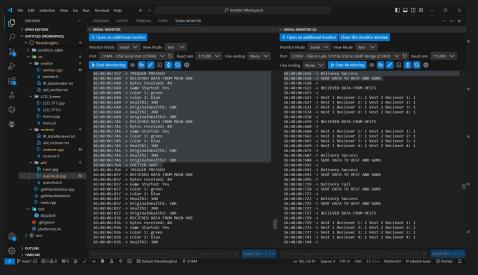


Engineering Specification #2



Ethan Hoang ____ CPE

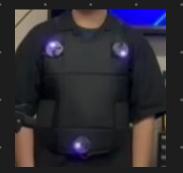




Engineering Specification #3

Through testing and multiple trials we discovered that it registers almost 100% of the hits shot by the gun when the directed correctly by the user.

All possible trials that has a "missed shot" and not registered by the vest is discovered to be the result of user error in which they missed a shot at the zones on the vest.





Ethan Hoang CPE





💢 Stretch Goals and Results

Project Objectives	Stretch Goals	Super Stretch Goals
Build a working Phasor/Gun that emits IR light	Connect all the systems wirelessly so that there is no need for any wires between the Phasor and vest	Transmit and record wireless data to a central computer displaying a scoreboard web application
Build a working Vest that can detect IR light	Add Multiple Game modes	Adjustable fire rate for single fire, burst, semi auto, and full auto
Combine everything to have a fully functional laser tag system	Add a reloadable magazine feature that resets bullets on the user	Add a Recoil System that replicates firing a real gun
Have fully functional Phasor and Vest PCBs	Interactive LCD Screen showing users their health and ammo	Radar on the LCD that can show enemy opponents relative to you
Contain all of our parts in proper housing to keep them secure	3D Print custom housing for aesthetics and modular design	Motor to widen or tighten the laser width for custom difficulty
Detection Range of 10-20ft	Detection Range of 20-40ft	Detection Range of 40+ ft



Bill of Materials

	Part	Part number or description	Quant ity	Unit Cost	Total Cost
	Elegoo Uno R3 Project Super Starter kit	N/A	2	~\$45	\$90
	1kg Black PLA filament[25]	2.85mm PLA Filament	2	~\$25	\$50
	Infrared Emitters and Receivers[21]	5mm 940nm	1	~\$5	\$5
•	4pcs Breadboard Kit	2pcs 830 point 2pcs 400 point	• 1	~\$9	\$9
	LED lights	Multicolor 5mm	1	\$6.75	\$6.75
	MSP-EXP430FR6989	MSP-EXP430FR6989	1	~\$53	\$53
	ESP32-WROOM	ESP-WROOOM-32 CP2012 USBC	1 (Pack of 3)	\$19.99	\$19.99
•	Coreless Vibration Motors	7x25mm Vibrating Motors 1-6V 8000-200000 RPM	1 (Pack of 6)	\$6.99	\$6.99
•	Plastic Lens	Plastic Lens	• 6	~ \$0.45	\$2.70
	MIsc.	N/A	N/A	N/A	~\$50
	Combined Total				~\$293. 43

Estimated

Actual

		· <u> </u>	r	•	
Part	Part number or description	Quantity	Unit Cost	Total Cost	
2kg Black PLA filament[25]	2.85mm PLA Filament	4	\$29.94	\$119.76	
Infrared Emitters and Receivers[21]	TSAL6200 5mm 940nm	2	\$7.27	\$14.54	
LED lights + LED resistors	10mm RGB multicolor	1	\$19.88	\$19.88	
PCB	PCB designed by Neon Knights three iterations	3 Different iterations 2 Fast Shipping	\$19.77 x2 \$2.68 x1	\$42.22	Jasper Steensm CPE
ESP32-WROOM	ESP-WROOOM-32 CP2012 USBC	2 (Pack of 5)	\$17.99	\$35.98	
TFT LCD screen 128x128	FTVOGUE 1.44 Inch Display Module LCD Display Screen 128x128	2	\$9.00	\$18.00	_
Vest	Valken Paintball Chest Protector	2	\$25.75	\$51.50	
Coreless Vibration Motors	7x25mm Vibrating Motors 1-6V 8000-200000 RPM	1 (Pack of 10)	\$12.99	\$12.99	
Plastic Lens x 2	Plastic Lens	6	\$11.18 +	\$11.18	
Battery Holder	4 AA battery holder	2 (Pack of 2)	\$5.98	\$11.96	_
Reed Switches	Reed Switch	1 (Pack of 10)	\$9.62	\$9.62	
Round Rocker Switches	20mm Mini 12 Volt Dc Circle Switch	1 (Pack of 6)	\$6.99	\$6.99	
Magnets	50 Pcs 10x3mm	1 (Pack of 50)	\$5.13	\$5.13	• •
Misc. and Tools	Heat shrinks, screws, heat gun, magnets, and Veclro	N/A	N/A	~\$100	
Combined Total		•		~\$459.75	

Work Distributions 🙏



Ethan Hoang

- Primary CAD design
- Primary Trigger and Magazine control
- Primary Housing design
- Secondary Wireless connection

Hussen Premier

- Software development
- Internal components
- Primary Wireless connection
- Secondary Wiring and Soldering

Jasper Steensma

- Secondary Software development
- **Primary Optics**
- Primary Wiring and Soldering
- Secondary PCB design
- Primary Web application design

- Primary PCB design
- Primary Power management
- Secondary Wiring and Soldering







