BRO-NS

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Project Goals and Introduction

- Wanted to design and build a mounted turret that would automatically detect hostile targets.

- As an Alternative to the fully autonomous target detection and firing, we wanted to allow the user to manually aim and fire the turret if so desired.

- Focus on portability, deployability, and ease of use.
  - *Compact design*
  - *Tether free*
  - *Low power*

Project Goals and Introduction

- Cost and scale of current U.S military defense sentries

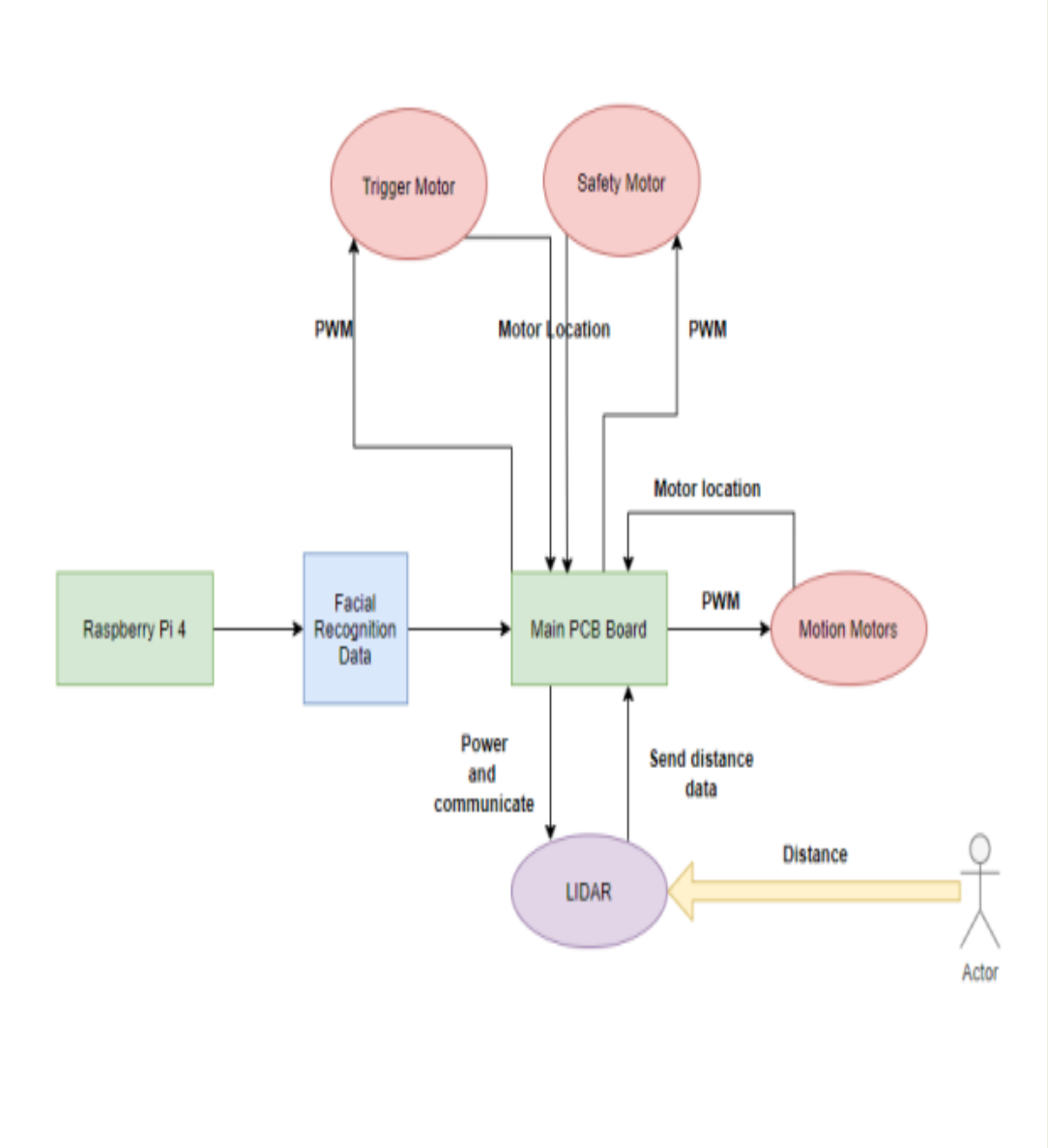
- Weapons documentary on U.S Navy Phalanx CIWS: Automated AA Sentry Turret

Design Specifications

- Wireless range of ~10m
- 80% accuracy within 5m
- 50% accuracy within 10m
- Target detection within 15m
- Can Identify a target in under 10 seconds
- Use less than 30W of power
- Ability to operate on a single battery pack for at least 10 minutes
- Deployable in under 3 minutes
- Weight < 10lbs

Project System: Primary System

- Custom PCB acting as Master Device
- In charge of running motors and LIDAR device for range detection
- Also responsible for all wireless communication



Power System Design

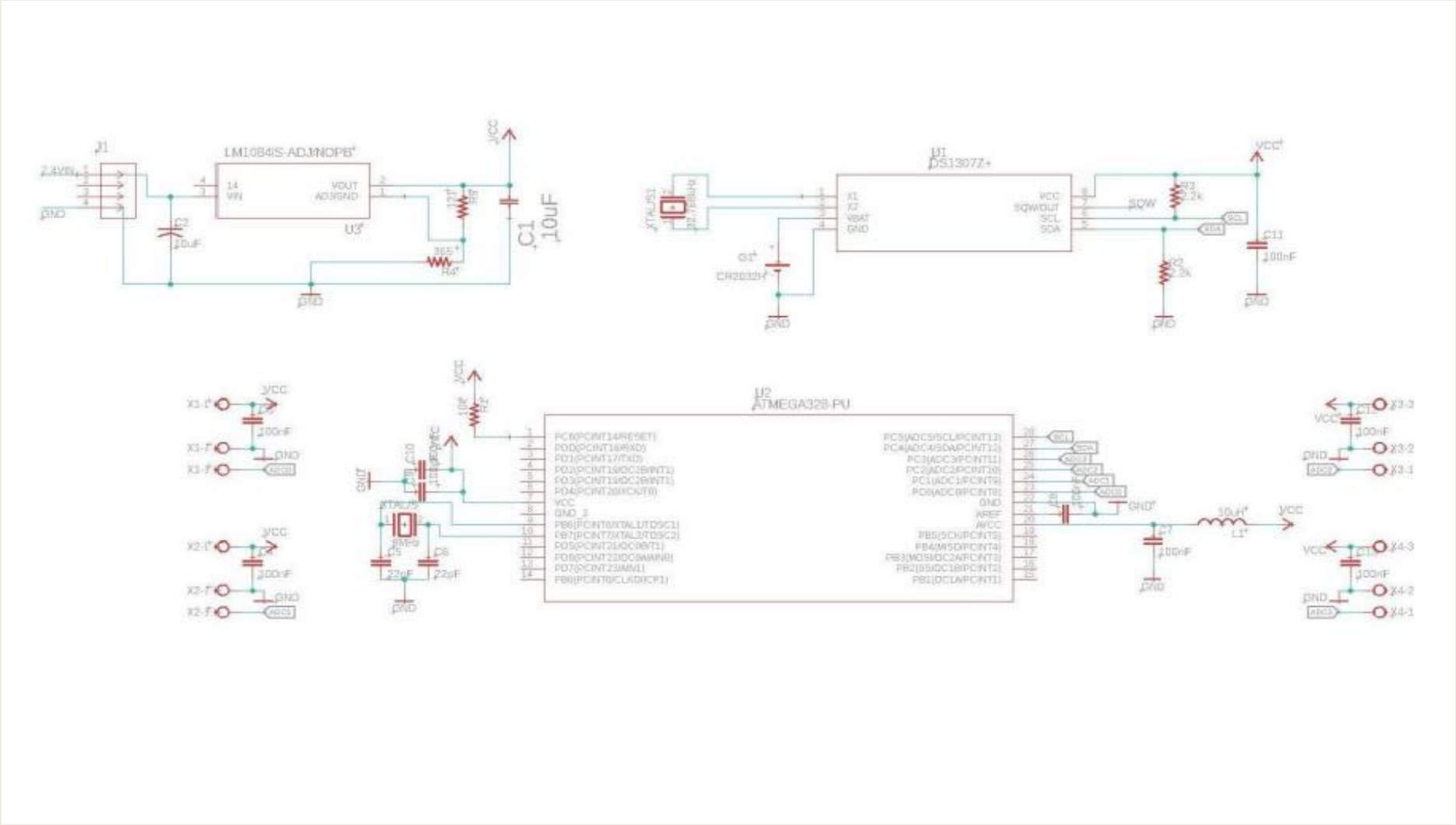
- We are utilizing two separate power supplies for our project
  - *Lithium Ion battery bank*
    - 10000mAh
    - 5v/4.8A rated output
    - Lower power draw from Pixy Cam 2.0
  - *High current RC battery*
    - 2100mAh
    - 7.2v/20C charge/discharge rate
    - Much higher power draw needed for the servos

Custom PCB MCU Specifications

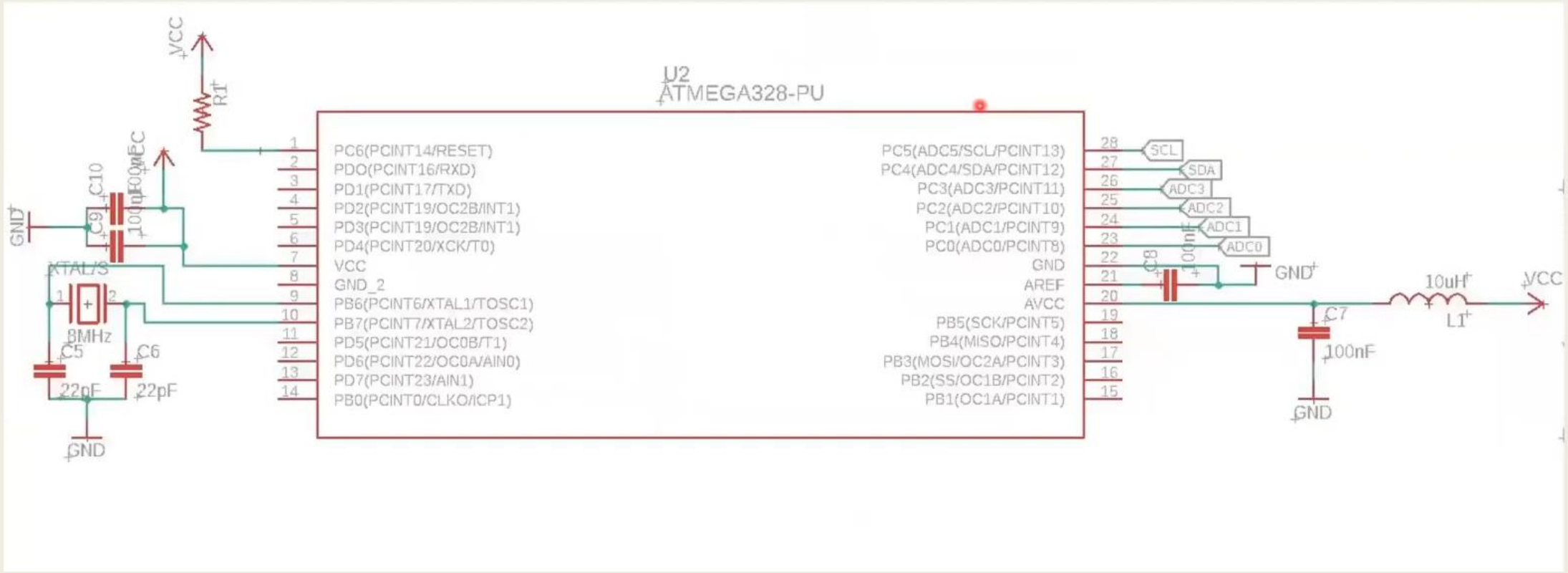
- Based on an Arduino Uno R3 reference design
- Using the Atmega328 because it was easy to obtain, and inexpensive
- Has enough resources for what we would need

Microcontrollers	MSP432P401R	Atmega2560	Atmega328
Operating Voltage Range	1.62-3.7V	1.8-5.5V	2.7-5.5V
PWM Channels	20	12	6
UART/USART	4	4	1
SPI	8	1	1
Flash Memory	256KB	256KB	32KB
SRAM	64KB	8KB	2KB
ROM/EEPROM	32KB(ROM)	4KB(EEPROM)	1KB(EEPROM)
Maximum Clock Speed	48MHz	16MHz	16MHz

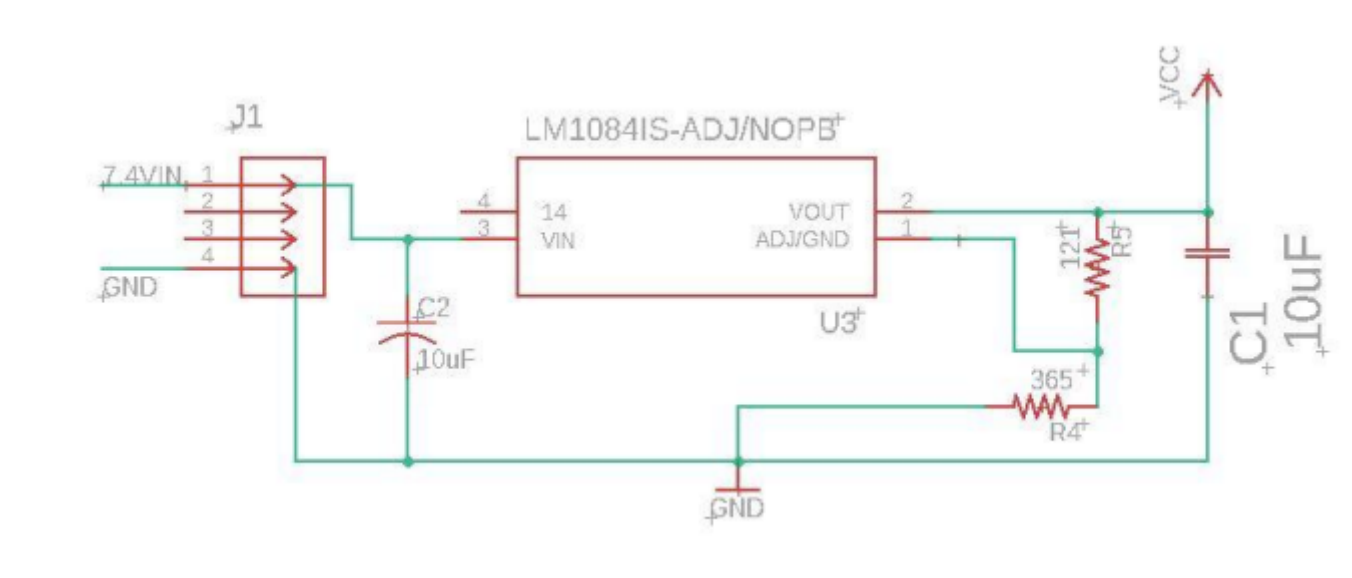
Custom PCB Schematic



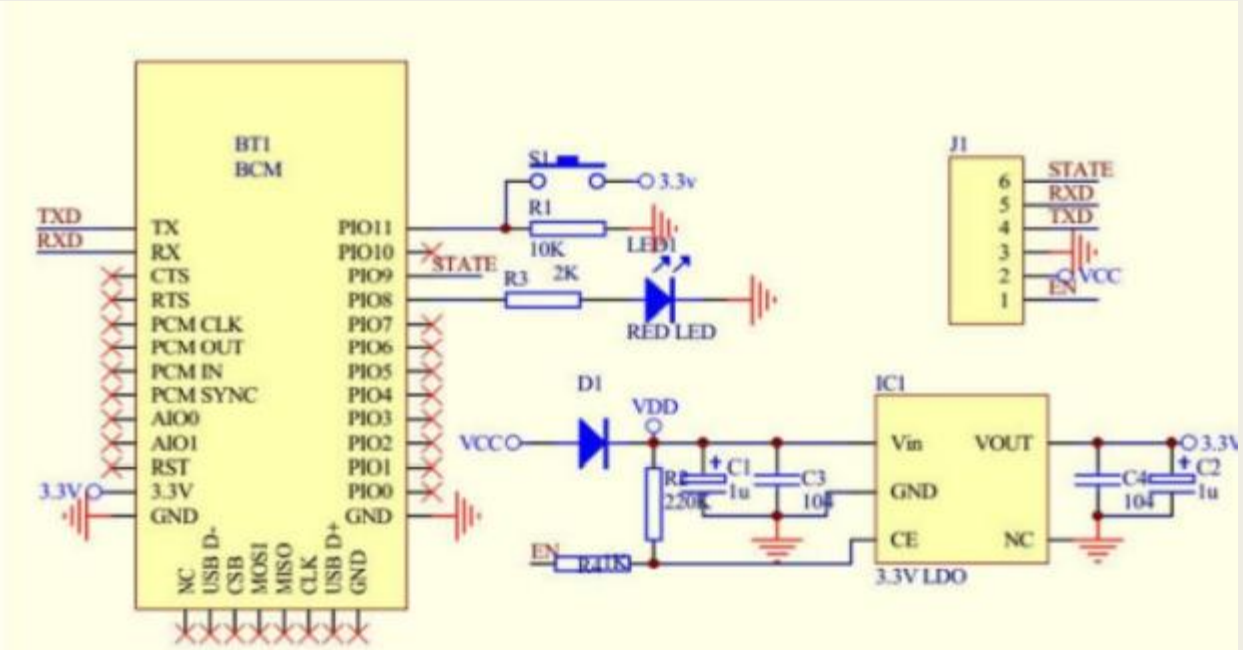
Custom PC: MCU



Custom PCB: Voltage Regulator

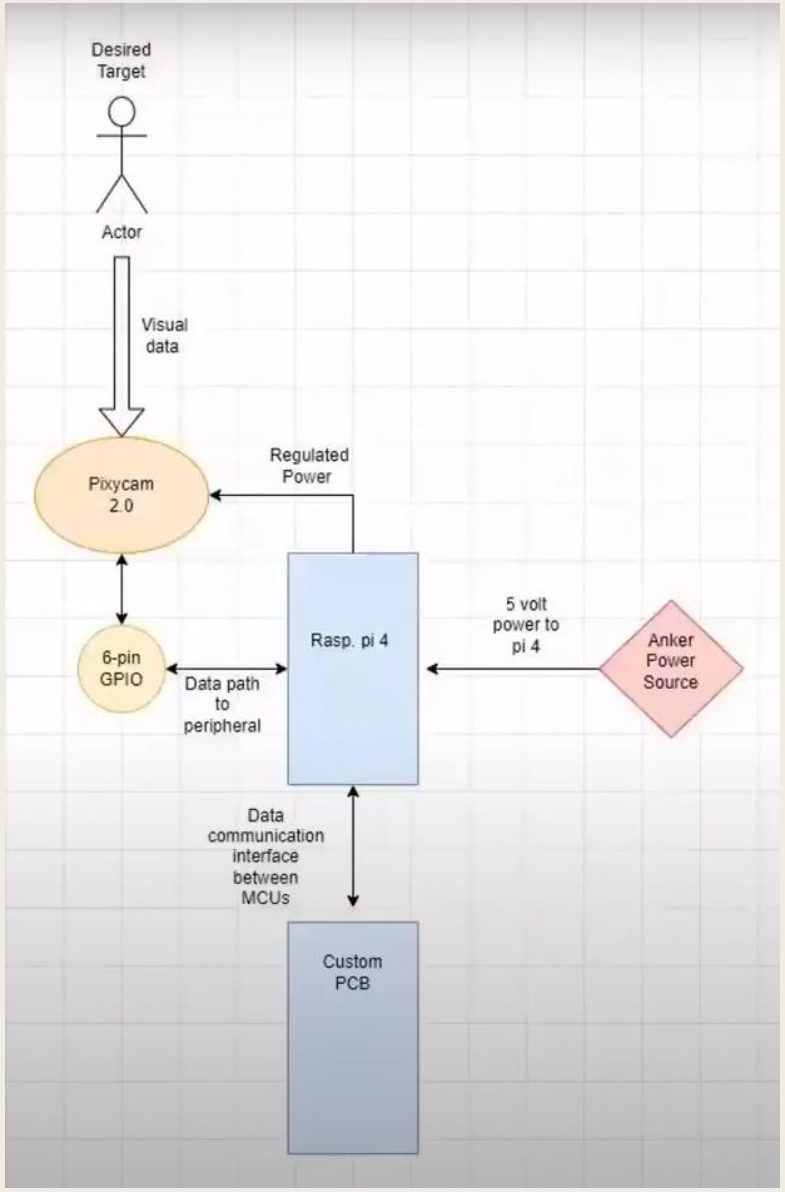


Custom PCB: Bluetooth module



Project System: Subsystem

- Subsystem handles all image processing data
- Camera being used is the Pixycam 2.0
  - *Customizable color detection*
  - *Machine learning facial recognition*



Projectile Launcher

- NERF Doomlands Desolator Blaster
- Provided easy means to fire multiple shots without having to engineer a feed and prime mechanism
- Inexpensive and met our requirements for range (27.342 meters) and accuracy
- Lightweight (2lbs or 0.907kg)
- Manual reload with a clip size of 10 Nerf darts
- No modification

Motor Specifications: Trigger Motor

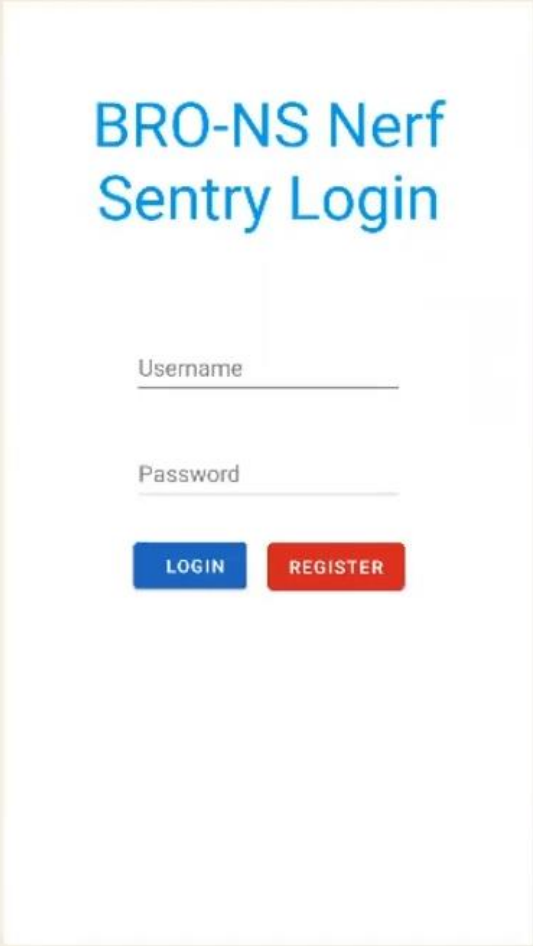
Servo	Stall Torque	Price	Weight	Dimensions
MG90D	2.1kg-cm at 4.8V 2.4kg-cm at 6V	$9.95	13.4 grams	22.8x12.2x28.5 mm
MG92B	3.1kg-cm at 4.8V 3.5kg-cm at 6V	$11.95	14 grams	22.8x12x31 mm
SG92R	2.5kg-cm at 4.8V	$5.95	9 grams	23x12.2x27 mm

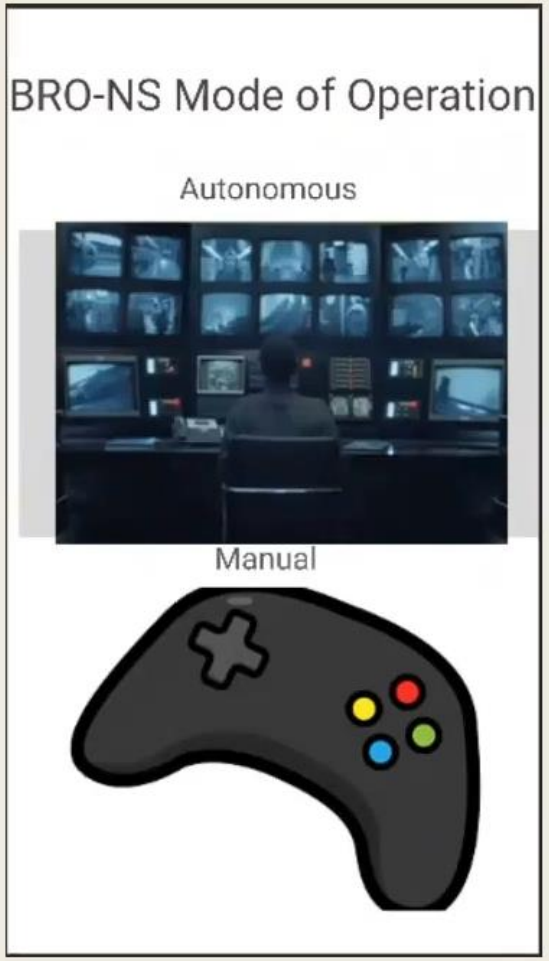
Motor Specifications: Pan and Tilt

Servo Motors	MG995R	MG996R	DS3218MG
Operating Voltage Range	4.8-6.6V	4.8-6.6V	4.8-6.8V
Speed	0.2-0.16s/60deg	0.17-0.13s/60deg	0.16-0.14s/60deg
Stall Torque	9.4-11kg-cm	9.4-11kg-cm	19-21.5kg-cm
Stall Current	1200mA	1400mA	Not found
Size	40.7x19.7x42.9mm	40.7x19.7x42.9mm	40x20x40.5mm
Price	$19.95	$20.99	$15.99

Android App

- Used Android Studios
- Programmed in Kotlin, interoperable with Java
- Reason for choosing Android:
  - *The creation of UI*
  - *Interest in android development*
  - *Access to android devices*
- Functionality
  - *Login*
  - *Mode of Operation*
  - *Manual Control Image upload and deletion*

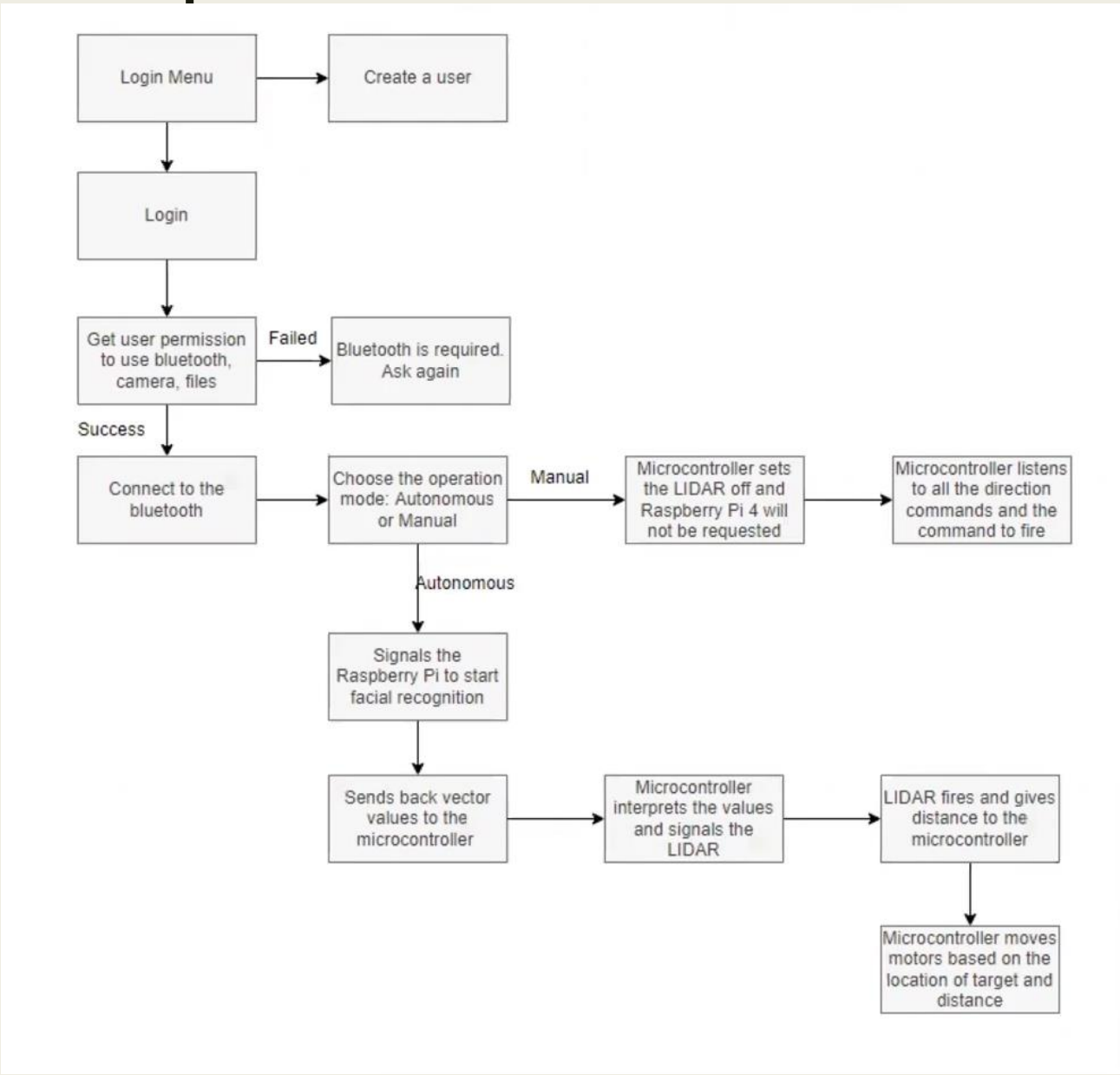




Backend Service

- The user authentication will use Firebase as there is a dedicated guide for android programming with both Java and Kotlin and can be installed into android studio.
- Built in libraries and services that allow access to android authentication
- Ease of creating authentication over other backend hosting services
- 10k/month free authentication on Spark Plan

Operation of BRO-NS



Camera and Sensors

- *Camera comparison*

Devices	Power usage	Software / hardware	Programming language	I/O ports
OpenMV M7/H7	200 mA (max)	hardware	micropython	SPI bus, I2C bus, Async serial bus (RX /TX), ADC, DAC
Pixycam 2	140mA (5V)	hardware	Not programmable	I/O connectors and usb
Jevois	800mA (4w total)	hardware	python	usb

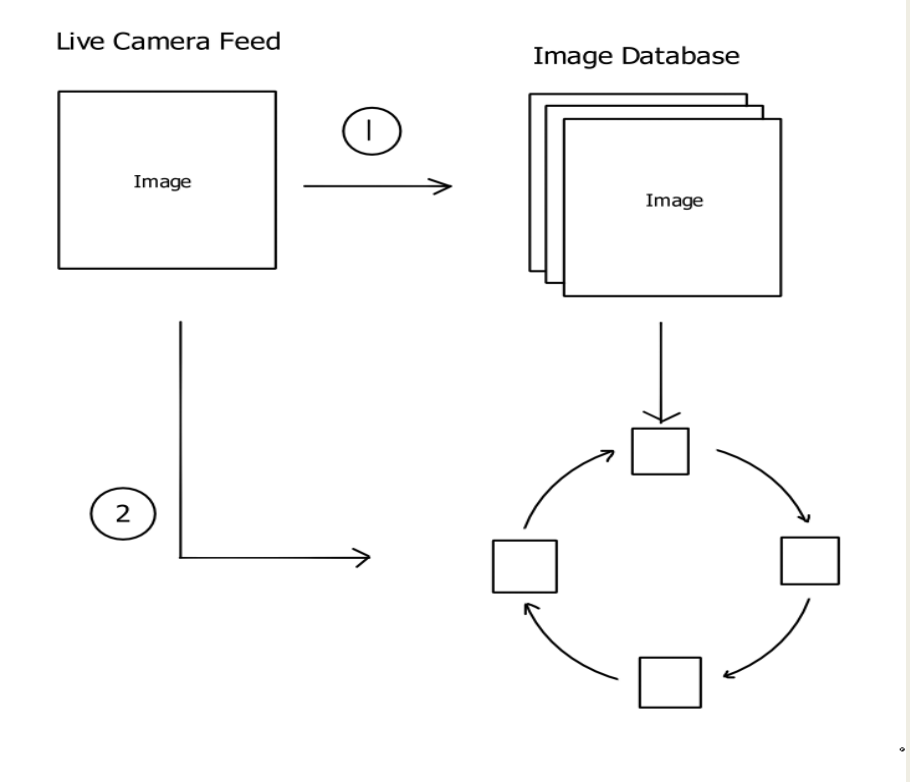
Camera and Sensors

- *Range detection tech comparison*

Distance Sensors	Approximate Range	3D Mapping	Complex Structure Mapping
Ultrasonic Sensor	2cm - 500cm	no	no
IR sensor	100cm - 500cm	no	yes
LIDAR	Around 10m	Yes (if using multiple)	yes
LED Time-of-Flight	Around 4m	yes	yes

Computer Vision

- *Why we chose the Raspberry pi4 (2gb)*
  - *Portable*
  - *great software support*
- *What limitations might we have*
  - *Memory*
  - *Speed of tracking*
- OpenCV
- Coding in python



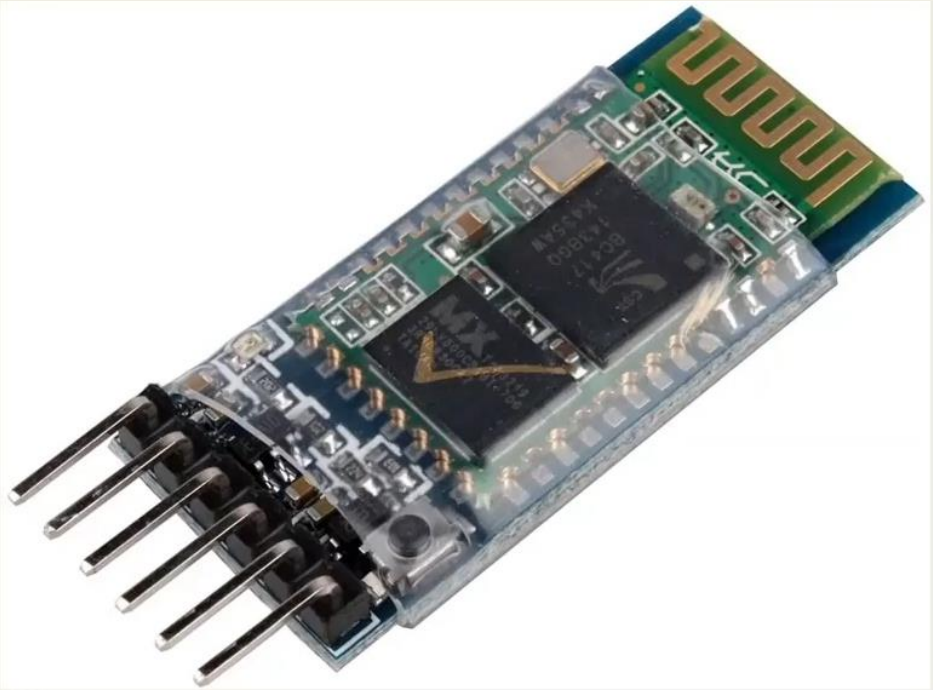
Chassis Design

- The cassis prototype mockup will first be constructed of wood. We will take our design and 3D print the final product.
- The microcontroller boards will be holstered securely since the turret will be capable of being mobilized between different locations.
- The microcontrollers will be housed with the horizontal motor, allowing access to peripherals while protected from hazardous weather conditions.
- Mounted to the chassis, the firing mechanism will comprise of a slider crank mechanism to pull the trigger repeatedly.

Wireless Connectivity

JBTek HC-05 Bluetooth Module

- Cost and availability is similar to that of other units
- Easy to setup and least amount of time to start using
- An operating voltage of 4V to 6V with a range up to 100m



Budget

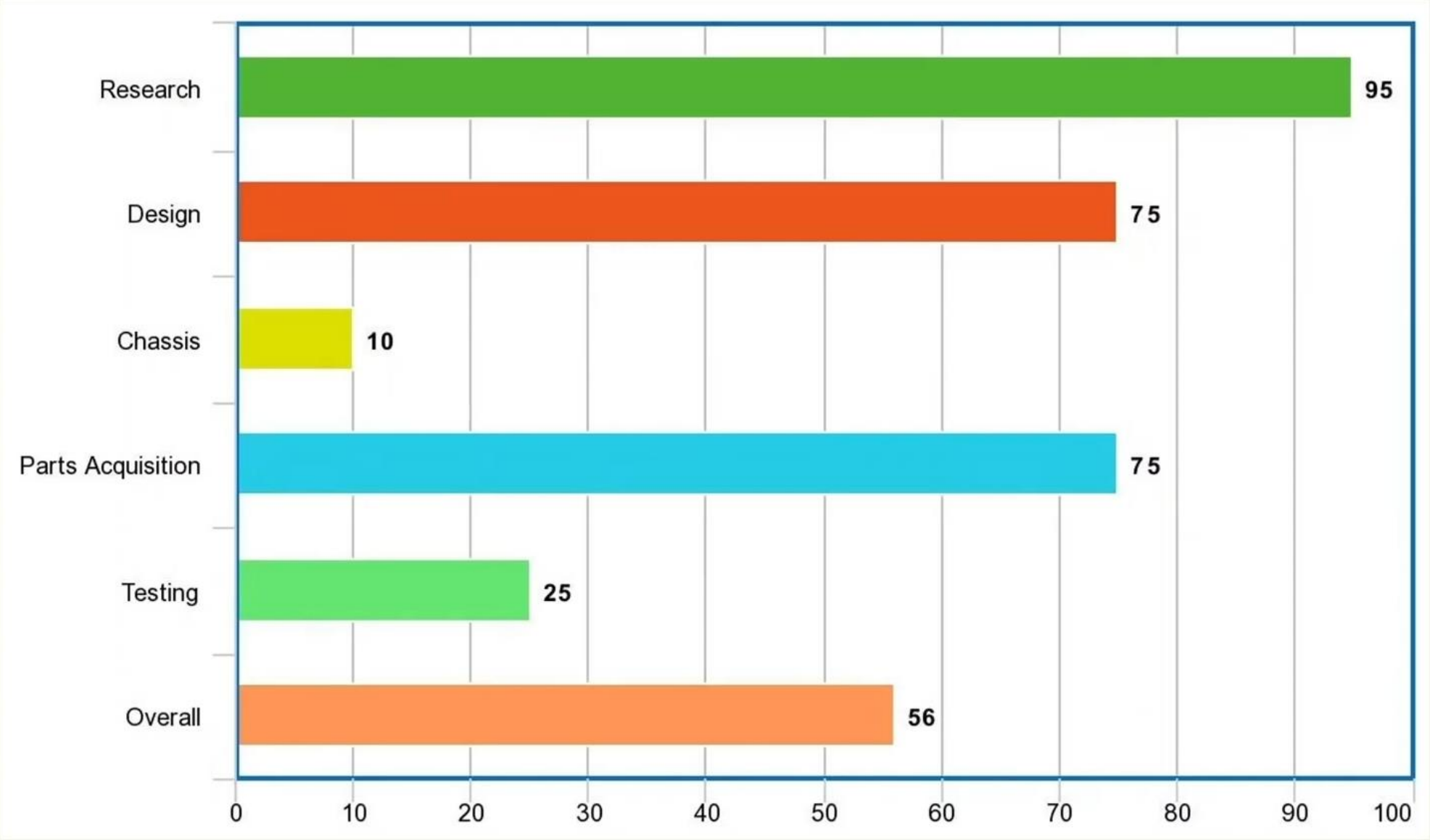
Quantity	Component	Value	Manufacturer	Price (from)
3	Battery Housing	CR2032H	FDK	1.39
3	XT60 Connector	PRT-12638		3.23
3	Timing Device	DS1307Z+	MAXIM INTEGRATED PRODUCTS	2.45
3	MCU	ATMEGA328-PU	MICROCHIP	2.37
3	Voltage Regulator	LM1084IS-ADJ/NOPB	TEXAS INSTRUMENTS	3.53
12	3 pin Analog Header			1.26
3	Crystal Oscillator	8MHz	TXC	0.36
3	Crystal Oscillator	32.768kHz	ABRACON	0.16
3	PCB from Oshpark			50.41
1	Nerf Blaster			20.84
1	LIDAR			27.68
2	Arduino Unos			20
1	Pixycam			60
1	7.4V LIPO Battery			29.9
1	LiPO charger			24.95
2	SG92R Servo			5.95
1	MG995R Servo			13
1	JBtek HC-05			11.99
			Total:	326.93

Testing Approach

- Building the two systems (primary and secondary) individually, then bringing the two together to test functionality

- We are coding and developing the primary system with an Arduino uno dev. Board so that we can progress while we wait on the custom PCB
  - *Because they share the same MCU, we hope we can then rapidly program the custom board from our already written code without many issues*

Progress


Research
95
Design
75
Chassis
10
Parts Acquisition
75
Testing
25
Overall
56
0
10
20
30
40
50
60
70
80
90
100

Progress Cont.

- Custom PCB
  - *Currently being manufactured*
  - *We have roughly 75% of our total parts needed for the PCB*
- Programming
  - *Currently experimenting on how the MCUs will communicate*
  - *Working out kinks in facial recognition software*
- Chassis
  - *Paper sketches completed, AutoCAD files will be drawn within a few weeks*

Tasks left to complete

- Integration of Primary MCU and motors with secondary MCU and camera system
- CAD designs of chassis
  - *Decision to build with raw materials, or 3-D print*
- Assemble, Solder, and test of custom PCB