



UNIVERSITY OF  
**ILLINOIS**  
URBANA-CHAMPAIGN

# Auto Cat Snack Dispenser/Exercise Machine

Team #39

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# Problems

## Currently on Market:

- 1). Auto feeders with scheduler or remote controls
- 2). Feeders with proximity sensor
- 3). Regular laser toys

## Problems:

- 1). Cats still get bored when owner's away
- 2). Cats gain unhealthy diet habits
- 3). Have to operate manually





# Solutions

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We Want a Product That Can:

- 1). Feed them automatically
- 2). Play with cats without the need of human operation
- 3). Dispense food according to the amount of exercise

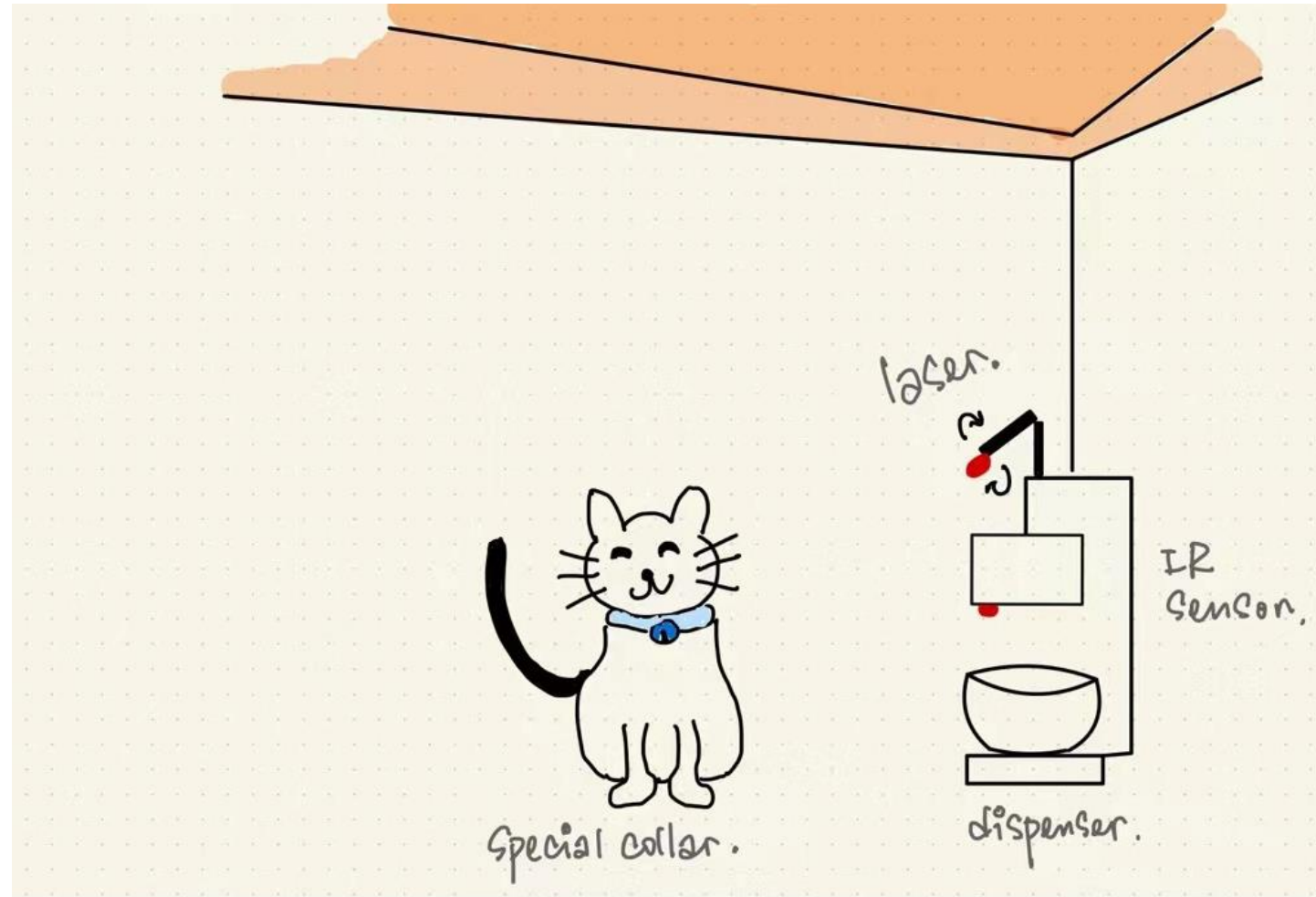
## Two PCBs

### Collar Part

- IMU: Sends acceleration data

### Base Part

- IR: Detects when cat approaches
- Laser Pointer: Pointing to the ground to play with the cat
- Dispenser



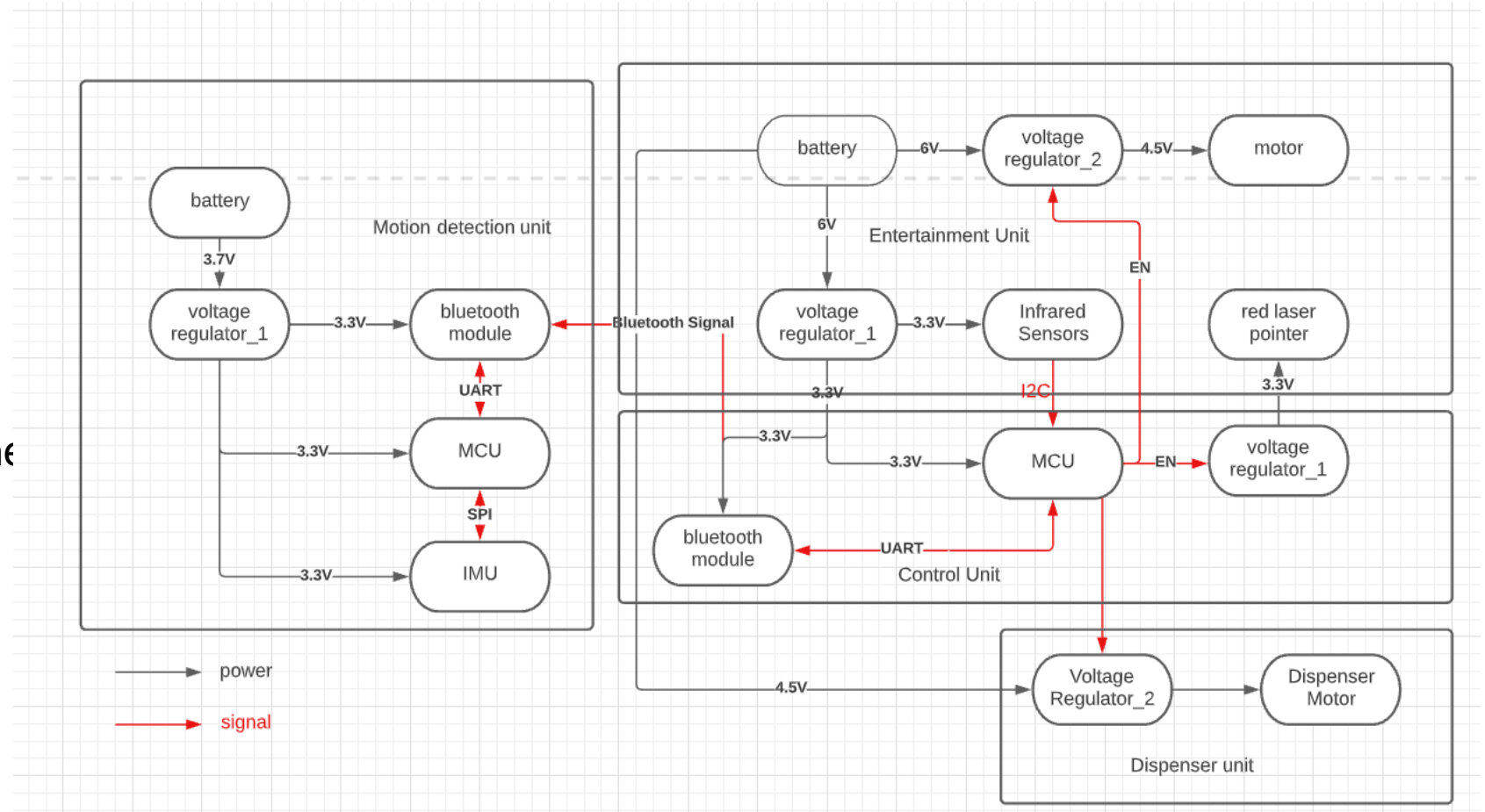
## Two PCBs

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## Parts We Changed:

- 1). IR sensor  
APDS9130 to APDS9960
- 2). BT modules  
RN42HID-I/RM to HC-05
- 3). The 6V battery for the Base Unit  
HR9-6-T2-ND to HR9-6-T1-ND
- 4). Changed collar to a coat

## The Reason for Changing Parts:

- 1). The original IR is too small to solder
- 2). Pairing two RN42 needs removing authentication through software
- 3). Out of stock  
The capacity drops from 8hA to 7hA
- 4). Parts are too big to fit on a collar



## Collar Part

IMU and a Bluetooth stabled in the coat

An LED blinks when acceleration threshold is reached

## Base Part

IR and a Bluetooth attached on the base

Dispenser and laser driven by two motors respectively



## High-Level Requirements

- The IMU needs to stay at low power consumption mode (0W power consumption) before the entertainment unit activates.
- The MCU in the motion detection unit should at least provide an output that achieves 80% accuracy. The accuracy is calculated by:  $\text{Accuracy} = \frac{|\text{recorded \# of times} - \text{actual \# of times}|}{\text{actual \# of times}}$ .
- The whole system needs to halt for at least three minutes to start the next activation



# Subsystems

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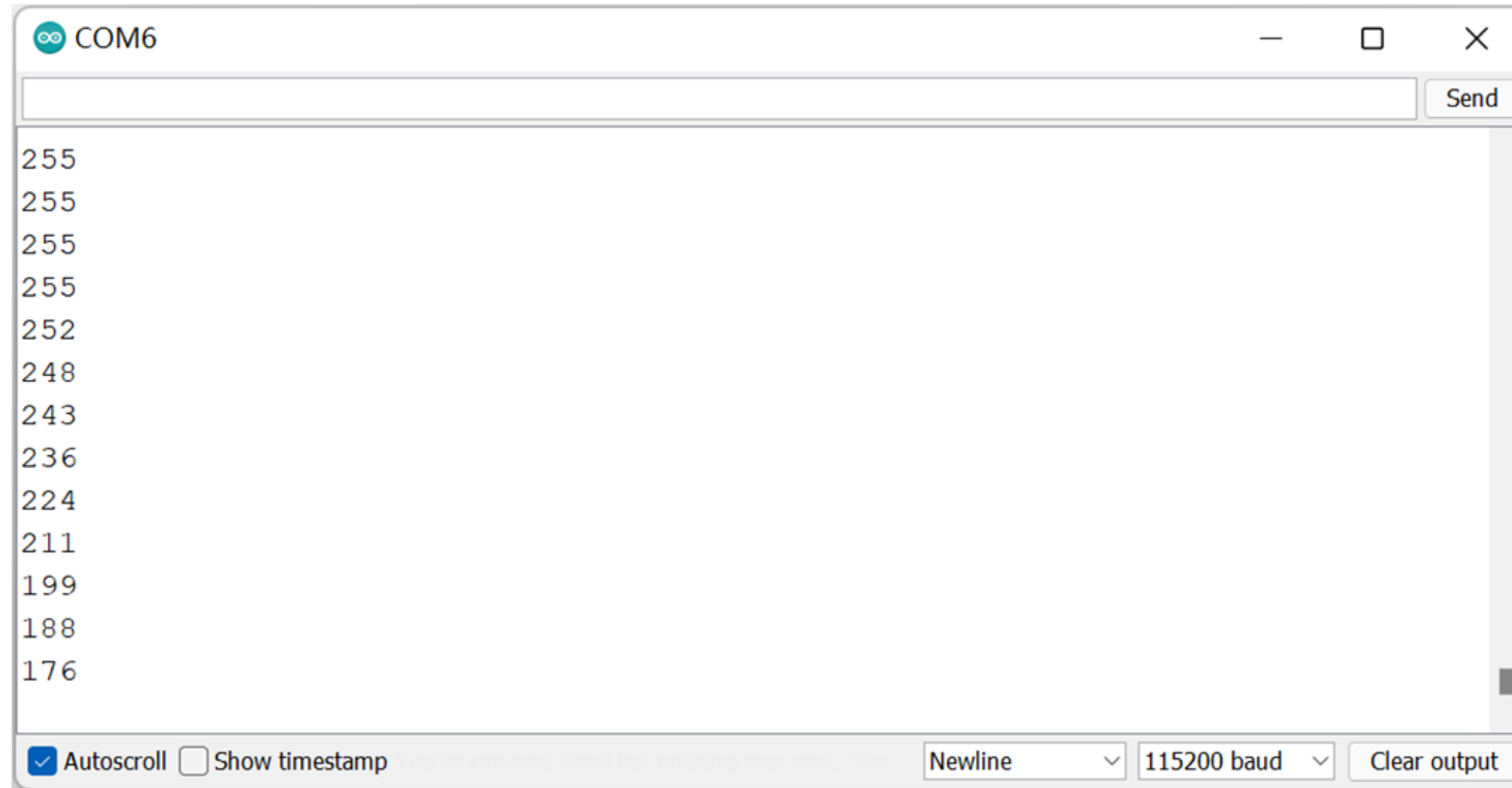
- 1). IR
- 2). IMU
- 3). Bluetooth
- 4). Dispenser



IR

	Requirements	Verifications
1	IR sensors can send a signal to turn on the laser when cat approaches.	We set the proximity data threshold to 200 (0-255) so that the IR sends signal when detects obstacles within 5cm.





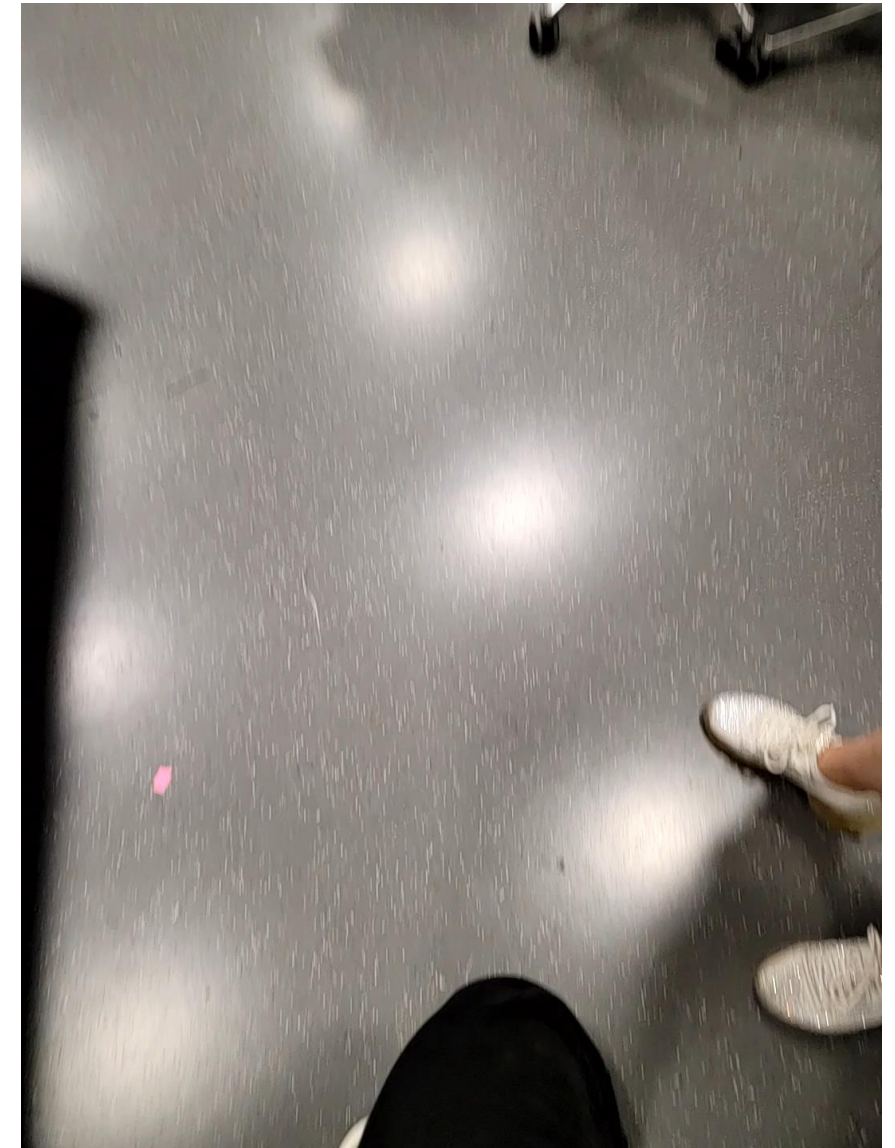
- Raw data given by the IR sensor.
- The IR sends data from 1 (farthest it can detect) to 255 (contact with the sensor).
  - We set the threshold to be 175, which is about 5cm from the sensor.

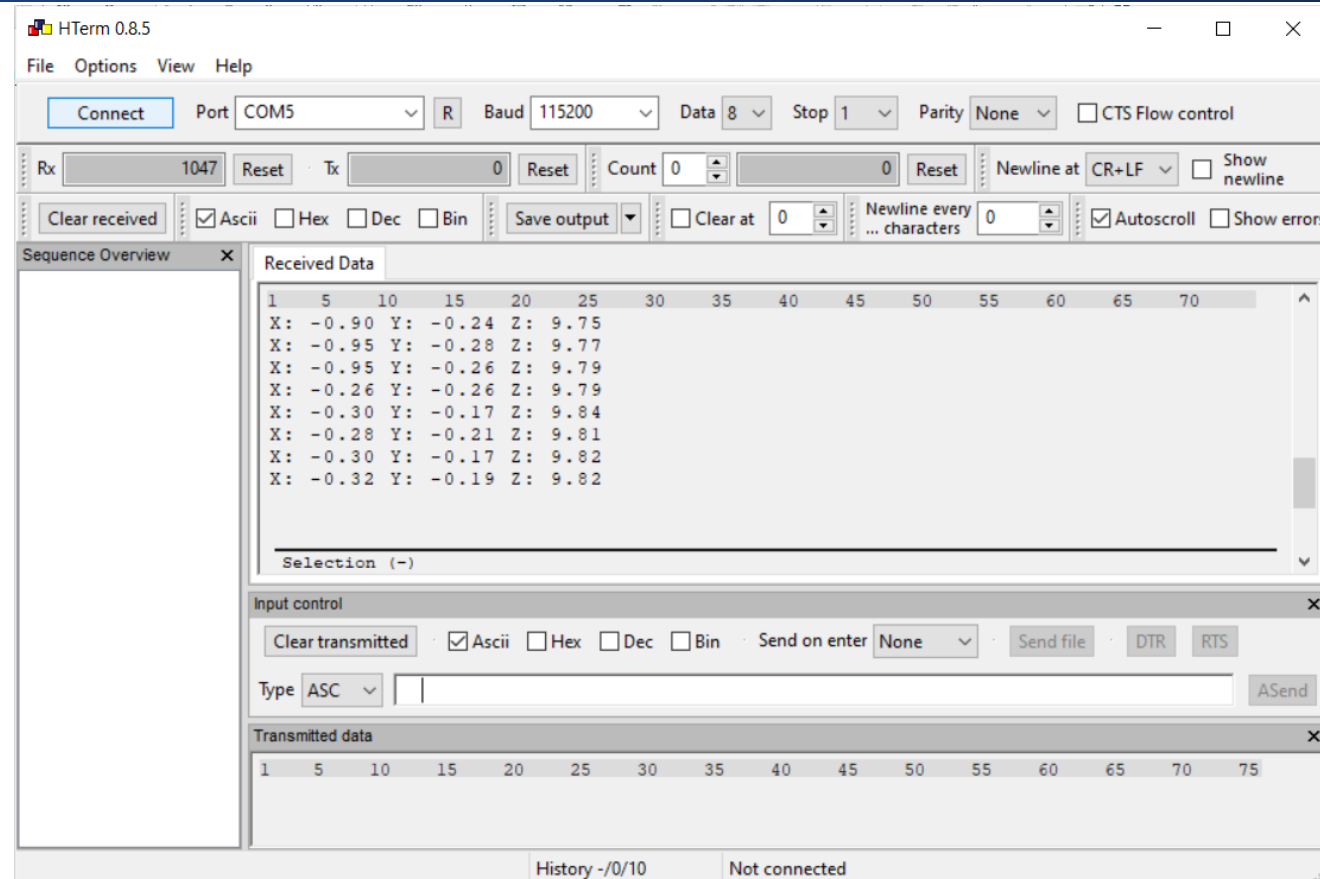




# IMU

	Requirements	Verifications
1	The time cats' acceleration reaches the threshold needs to be at least 80% accuracy.	We've connected a LED that blinks every time the threshold value is reached. The accuracy is shown to be 100%.
2	When cats are shaking their hair, check if the count number increases accordingly.	We retrieve data from the IMU every 2 seconds, so that we can eliminate the noises from shaking.





- Acceleration data given by the IMU.
  - It has three directions, X, Y, Z.
- We wrote a function to calculate the absolute value of acceleration and set threshold to 20 to compensate the constant acceleration in Z direction.
  - $ABS = (X^2 + Y^2 + Z^2)^{0.5}$



# Bluetooth



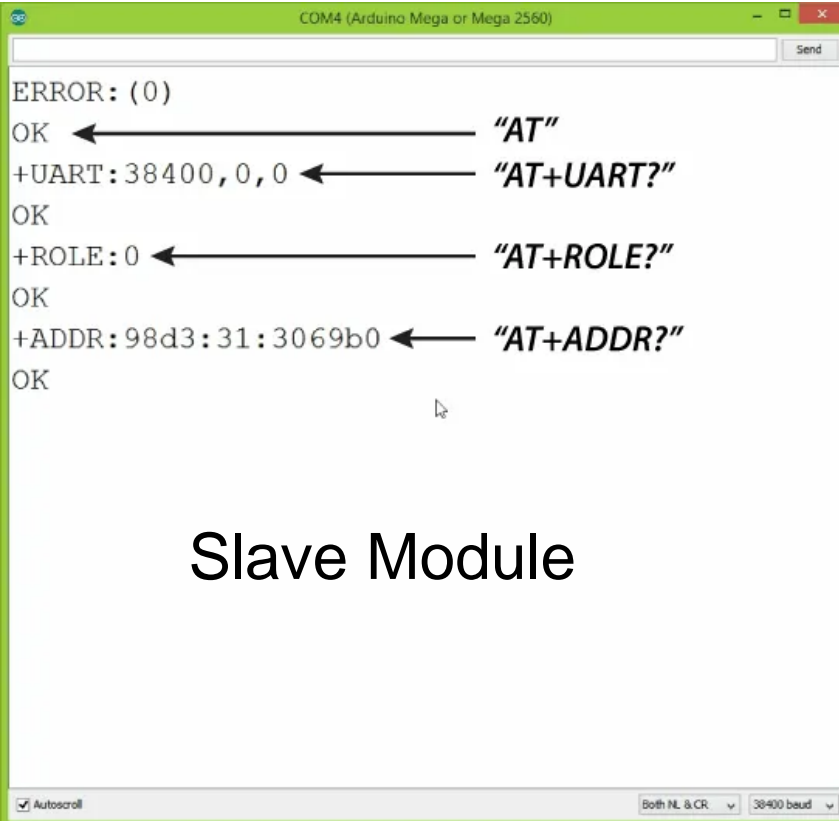
	Requirements	Verifications
1	The Bluetooth module of the collar needs to be paired with the other Bluetooth module of the base unit.	The LED on each module flashes every two seconds indicating that they paired successfully.
2	The two Bluetooth modules can transmit serial data with each other and send to the MCU in UART form.	Tested with Serial.write() and Serial.read() functions on the development board.



# Challenges of Pairing Two Bluetooth Modules

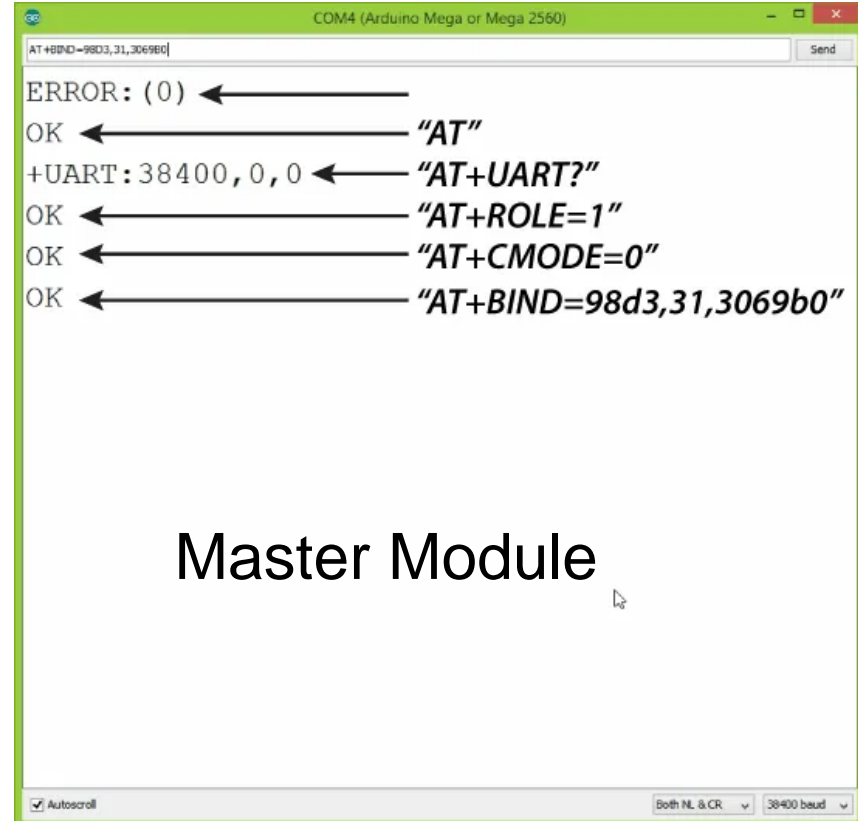


- We had to disable authentication for pairing in the Bluetooth's command mode.
- Set master/slave roles and store slave module's address in the master module.
- This requires jumper wires, development board, and computer software.



```
COM4 (Arduino Mega or Mega 2560)
ERROR: (0)
OK ← "AT"
+UART:38400,0,0 ← "AT+UART?"
OK
+ROLE:0 ← "AT+ROLE?"
OK
+ADDR:98d3:31:3069b0 ← "AT+ADDR?"
OK
```

Slave Module

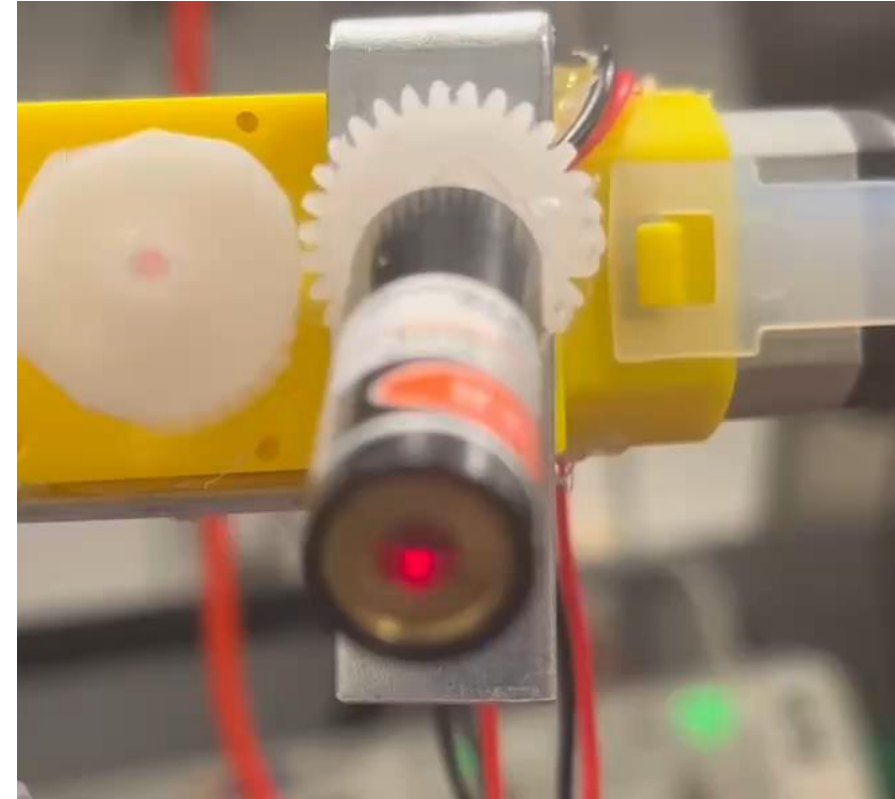


```
COM4 (Arduino Mega or Mega 2560)
AT+BIND=98d3,31,3069b0
ERROR: (0) ←
OK ← "AT"
+UART:38400,0,0 ← "AT+UART?"
OK ← "AT+ROLE=1"
OK ← "AT+CMODE=0"
OK ← "AT+BIND=98d3,31,3069b0"
```

Master Module



# Mechanical Part



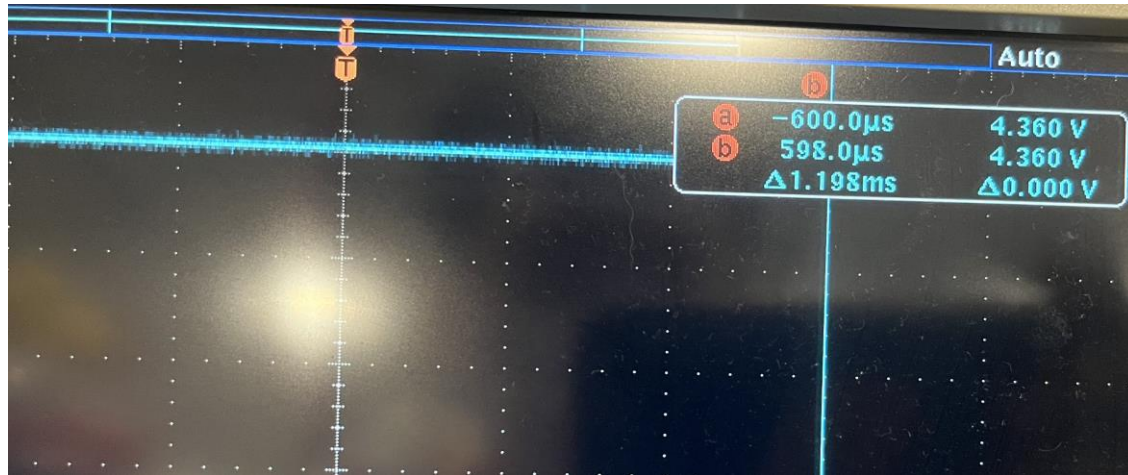
Laser attached with motor

Dispenser attached with motor



	Requirements	Verification
1	Once the motor receives the signal from the microcontroller, the dispenser only drops a few snacks every time.	1). We designed to drop one snack each time as shown in previous videos. (success)
2	The system should be able to at least operate 8 hours under an average current drain of 833 mA under 6V.	1). Use an oscilloscope to find the current 2). Do calculations based on the current measured to check if it meets the requirements. (partially) Our design has changed the laser part powered by 3.7V battery with 400mAh

# Mechanical Part Working Characteristics



Dispenser Motor Voltage & Resistance

$$I = 4.36/5.20 = 838\text{mA}$$

$$\text{Battery operating hours} = 7\text{Ah}/838\text{mA} = 8.35\text{hr}$$



Laser & Motor Voltage & Resistance

$$I = 1.96/5.17 = 379\text{mA}$$

$$\text{Battery operating hours} = 400\text{mAh}/379\text{mA} = 1.06\text{hr}$$



# Summary

## What we learned:

- 1). PCB designs
- 2). Data communication protocols
- 3). Integrating different parts in one project
- 4). Creating libraries for hardware components in C
- 5). Writing formal design documents

## What we would do differently:

- 1). Thoroughly testing all components before designing PCBs
- 2). Leaving more testing headers on PCB
- 3). Keeping modular design in mind, designing smaller PCBs for each part first
- 4). Making better schedules
- 5). Finding more tutorials before choosing parts



# Further Works

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- Making the PCB and battery of collar part smaller/lighter.
- Adding two switches for convenience.
- Developing a software to monitor cat's activities.



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# Thank You!



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