



# Machine On Demand Capstone 2.0 Project

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## BACKGROUND

### Problem Statement

- Creating an infrastructure to effectively serve natural disasters, accidents to effectively execute the required tasks such as putting out a fire or collect data in a radioactive environment.

### Constraints

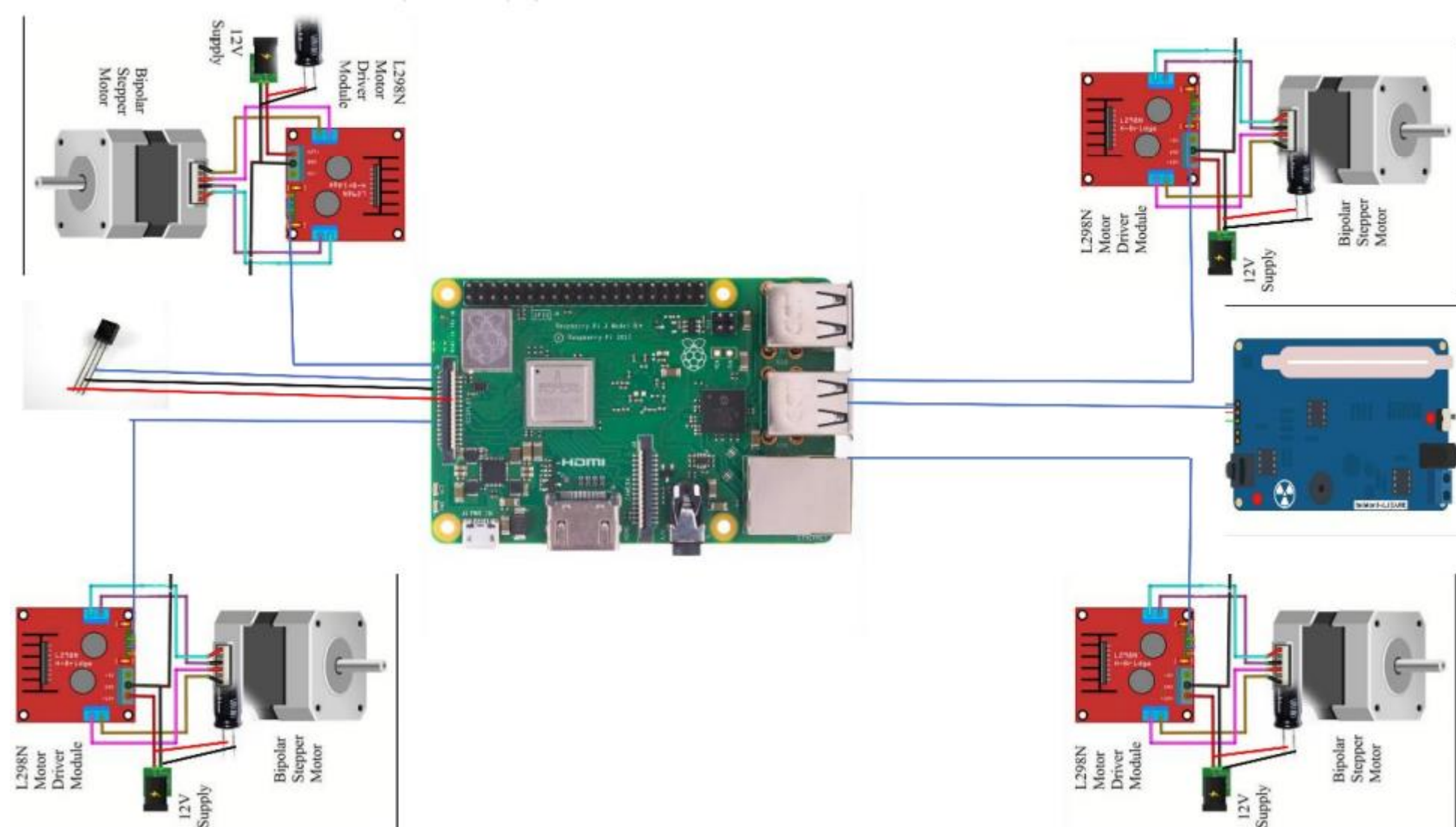
- Mecanum wheels having 3 degrees of freedom
- Lambda function in AWS has maximum of 15 minutes of run time per instance
- Lambda function in AWS has a maximum memory of 3GB and 6MB maximum function size
- AWS API gateway having a maximum of 128 KB per message
- GPIO Pins not exceeding \*to be assigned\*

### Target Specifications

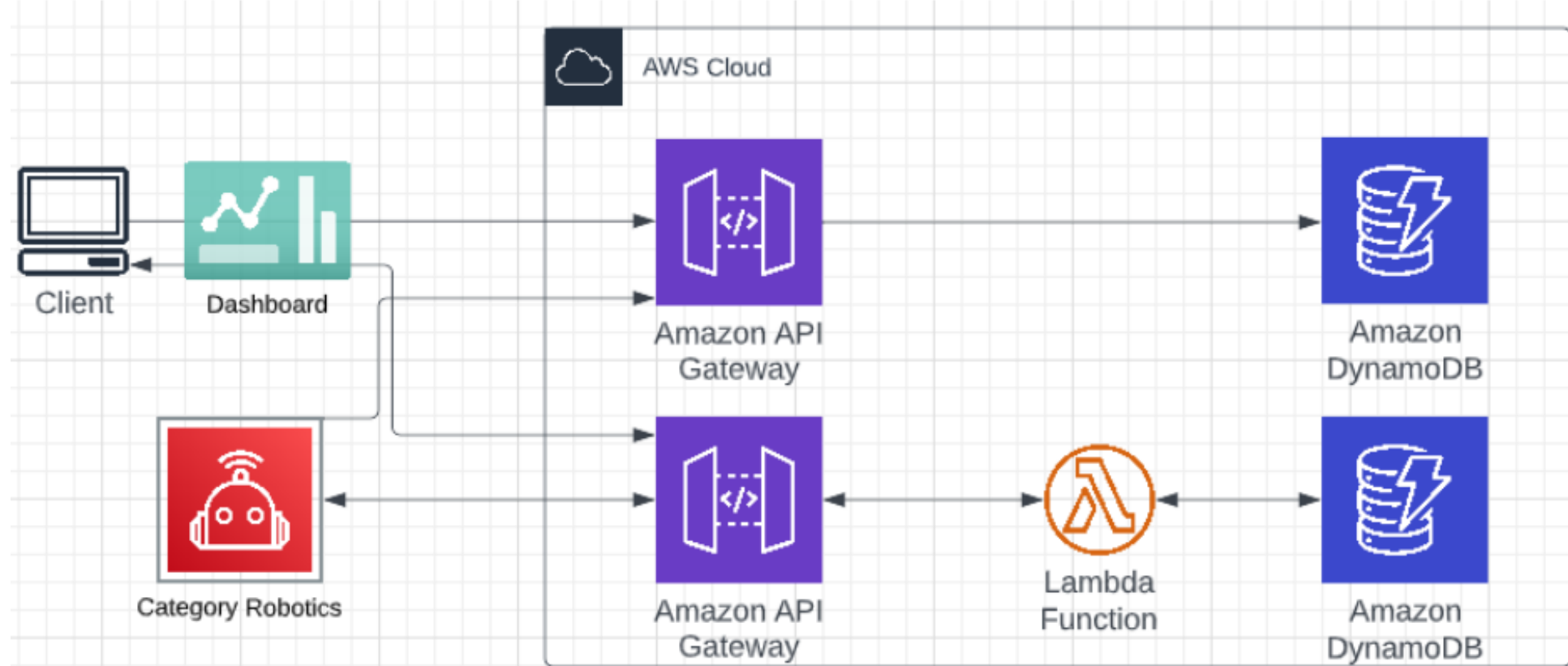
- Detecting radiation levels of at least 20 mSv
- Data rate not exceeding 5MB/s
- Detecting temperature levels of -55C to 125C
- Withstanding temperature of 60 C and above
- Mass of the prototype from 3 to 5 kg.
- Torque of the motors is 0.88 Nm

## PROTOTYPE DESIGN

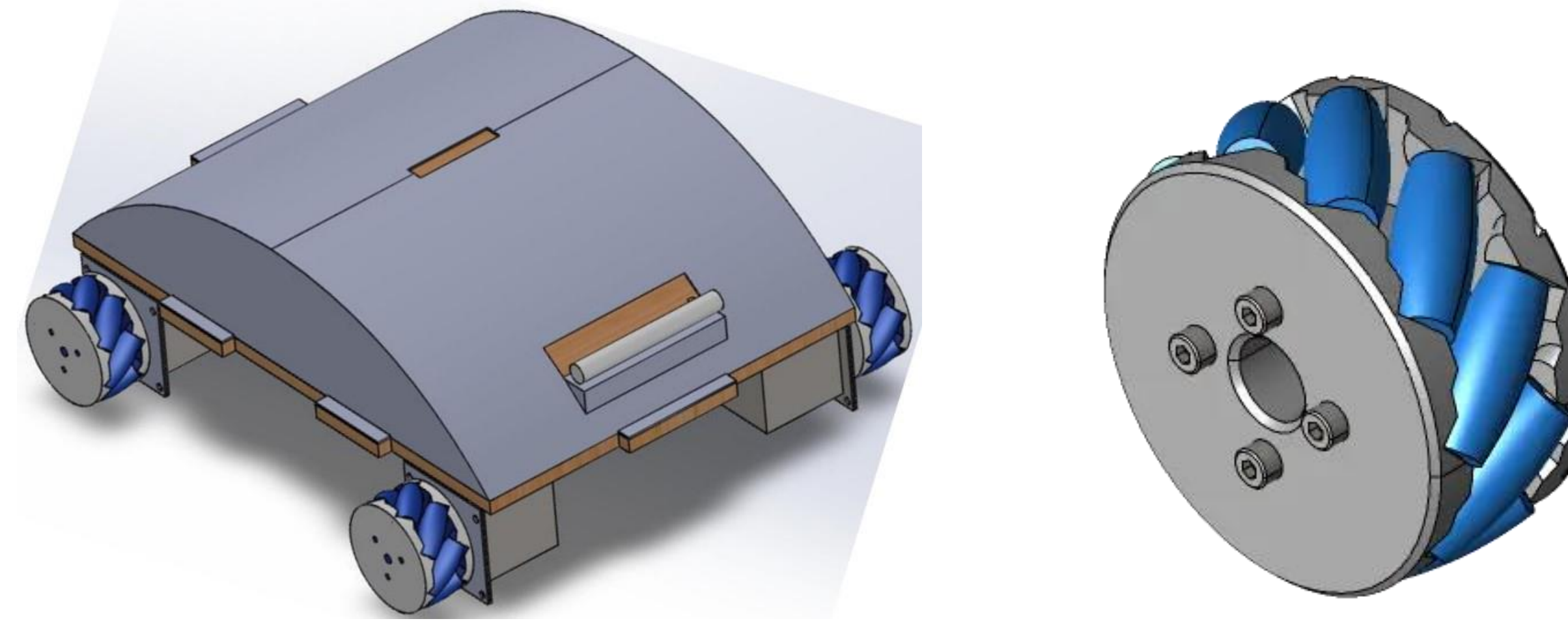
### Circuit Diagram:



### Cloud Architecture



- 3D model designs



## METHODS OF ANALYSIS

### Torque Analysis:

- To predict the torque required to move the robot, the following equations have been used to plot the relations between the torque, the wheels radius, and the mass, Figure [1]:

$$T = \mu \cdot F \cdot r \quad (1) \quad F = m \cdot g \quad (2)$$

### Speed Analysis:

- The following equations were used to predict the speed for different radius and RPM, and the results are presented in Figure [2]:

$$S = r\omega \quad (3) \quad \omega = \frac{2\pi n}{60} \quad (4)$$

### Radiation sensor testing:

- The radiation sensor, J305 Geiger Tube, was tested in the lab using different radioactive materials with different radioactivity and the results are shown in Table [1].

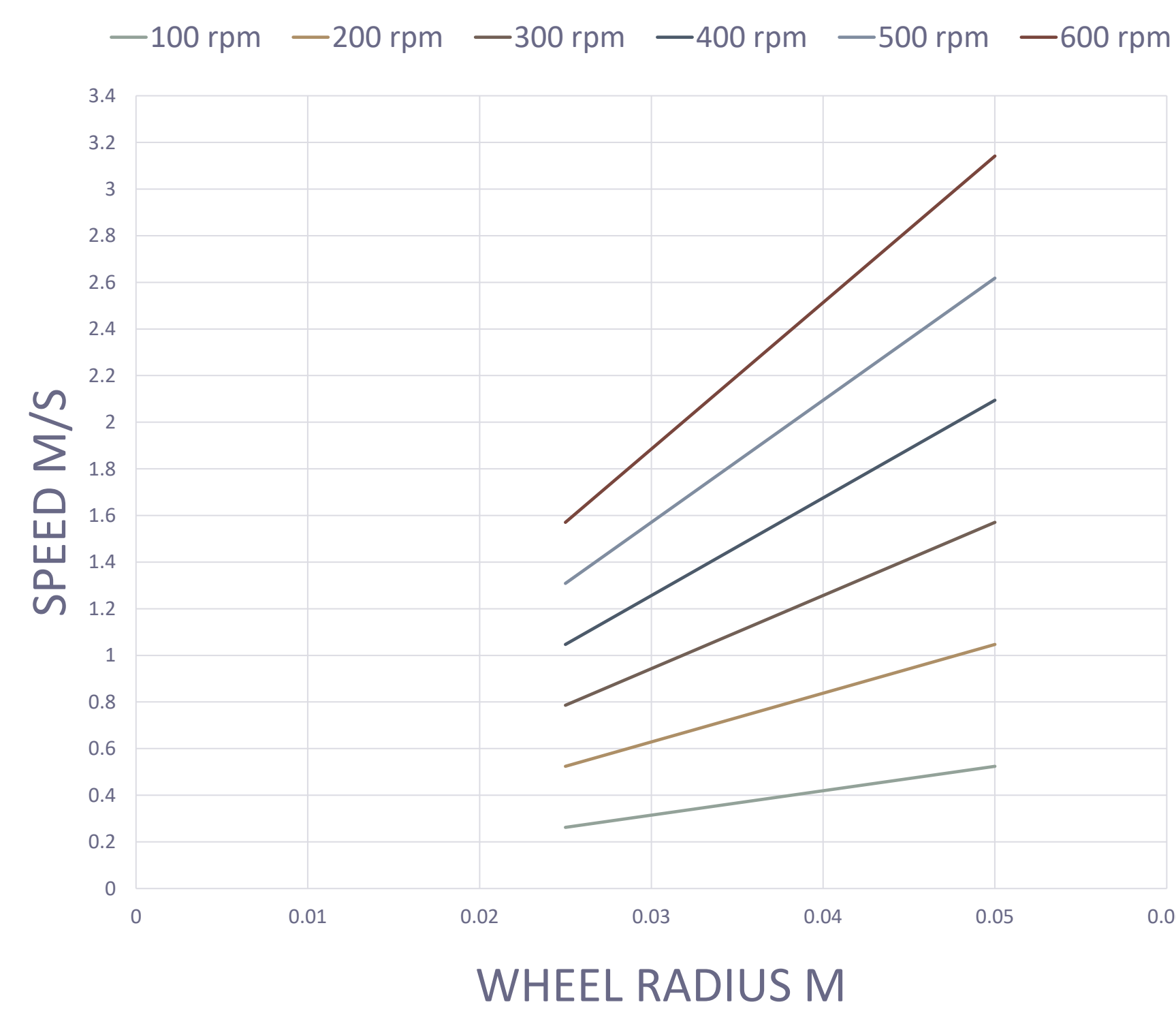


Figure [2]

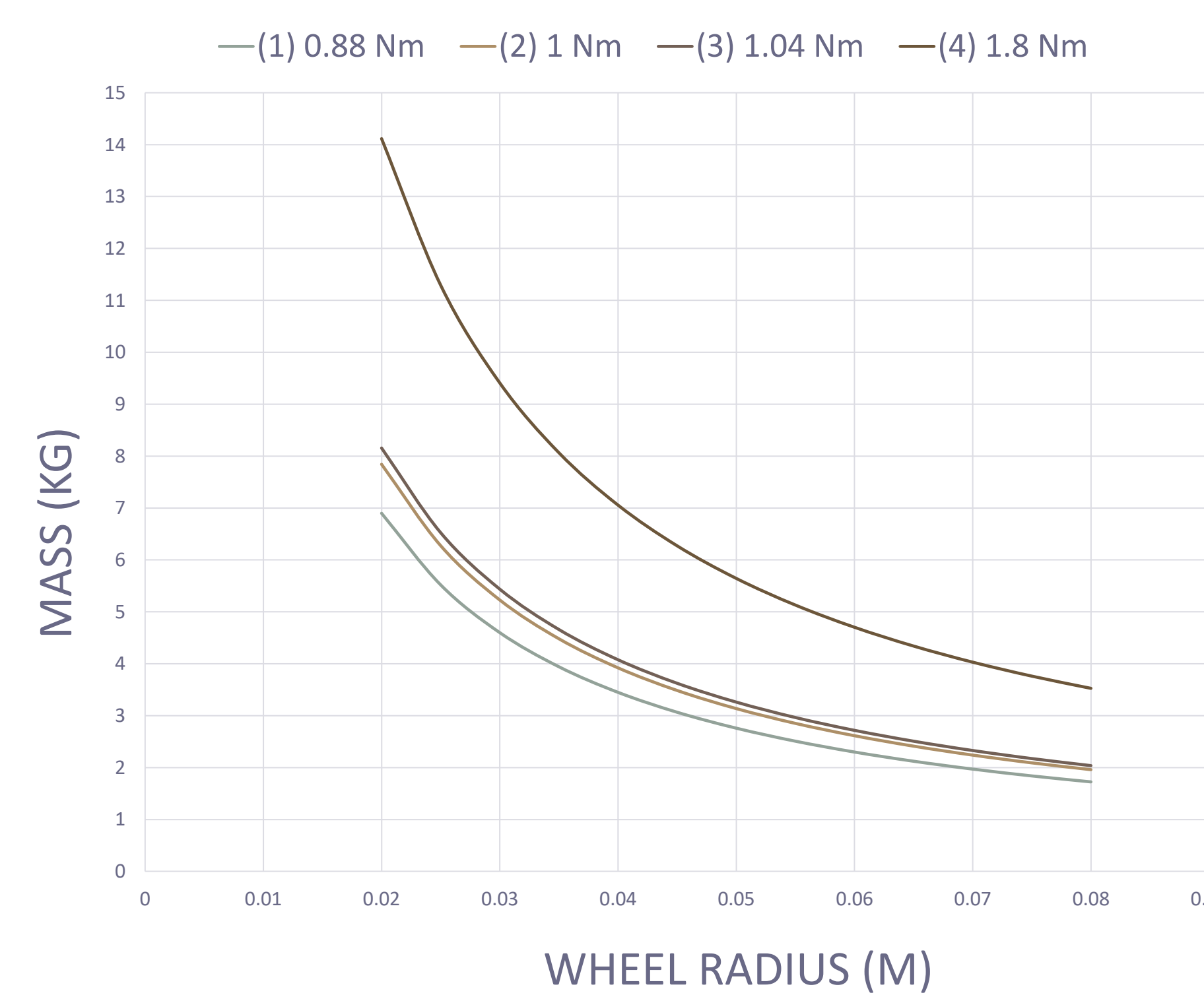


Figure [1]

Eu-152c	25cm	0.5 uCl	Cs-137	25cm	0.1 uCl	Na-22	25cm	1 uCl
	reading1 CPM	28		reading1 CPM	25		reading1 CPM	55
	reading2 CPM	29		reading2 CPM	29		reading2 CPM	57
	reading3 CPM	35		reading3 CPM	20		reading3 CPM	46
	reading4 CPM	44		reading4 CPM	18		reading4 CPM	61
	reading5 CPM	39		reading5 CPM	31		reading5 CPM	59
8 pices	25cm	6.6 uCl	3 pices	25cm	3 uCi			
	reading1 CPM	129		reading1 CPM	58			
	reading2 CPM	133		reading2 CPM	54			
	reading3 CPM	124		reading3 CPM	42			
	reading4 CPM	116		reading4 CPM	61			
	reading5 CPM	134		reading5 CPM	58			

Table [1]

## VALIDATION

- Total weight of the robot combining all the parts equated to 3.89KG
- Stainless steel 304 and lead glass can withstand temperatures up to 800C
- Given the wheel radius of 0.0375m and the mass close to 4 Kg, the torque required to move the robot is 0.88 N.m
- An uncompressed video feed with a quality of 480p results into 9.2MB/s and after compression and processing it reaches to 2.3MB/s
- Given a 12v battery and 2.3mAh, it was able to power all the motors and raspberry pi properly
- The radiation sensor was able to detect material of activity 6.6uCl correctly and converted into uSv/h

## CONCLUSIONS

- We have concluded that connectivity between robots is an essential requirement in the modern industry. Ranging from observability to human-aid tasks.
- We learned how to coordinate between different disciplines, explore fields and getting out of our comfort zone for example; applying robotics principles into a raspberry pi.

## FUTURE IMPROVEMENT

- How the robot can improve
- Use a robot operating system (ROS)
- Adding a localization mechanism
- Transforming the cloud architecture into microservice based architecture
- Use KVS service to transmit live video feed to the cloud
- Create a robust application and host it in AWS amplify
- Add authentication using AWS Cognito
- Research for materials that can resist higher radiation level to handle more sever scenarios.
- Design the cover to be more aerodynamic.
- Design a locking mechanism for the cover to the bed for easier accessibility.