Deliverable E:

Project Plan and Cost

Daniella Centurione

Maddox Dansereau

David Maksuti

Vanya Micic

Jake Schindel

Faculty of Engineering, University of Ottawa

GNG 1103: Engineering Mechanics

Dr. Muslim Majeed

February 21, 2025

Table of Contents

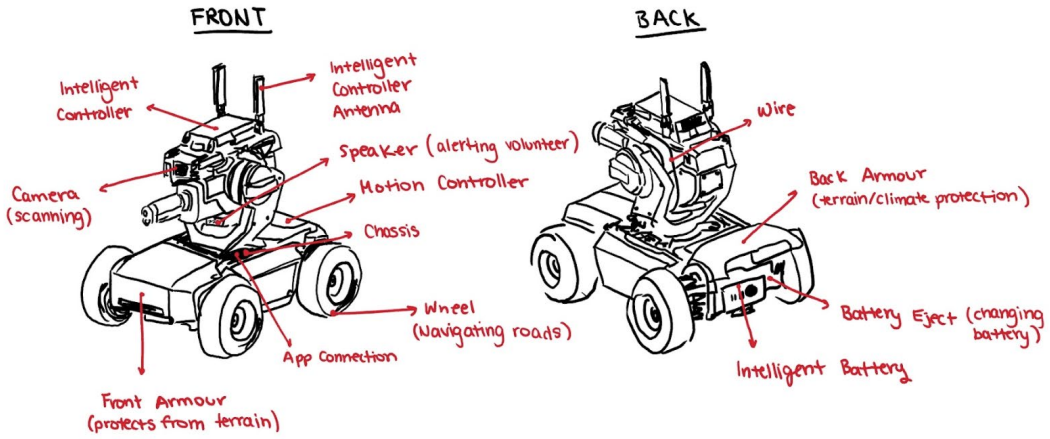
1. Introduction

Our team has a vision where we use AWS like the robomaster S1 and convert them into an aiding device that will play a key role in promoting community cleanliness, sustainability and community wellbeing, In this deliverable, our focus was to start to outline and perfect the design of a robot that aids in the management of waste in community spaces through trash detection and alert systems. In this deliverable we also work to design our robot, so it is visually appealing to members of a community and ensure the detection and interaction with the robot in its given surroundings is reliable and realistic for everyday recreation spaces. This ensures our robot is helping a community rather than being used for a violent and harmful manner.

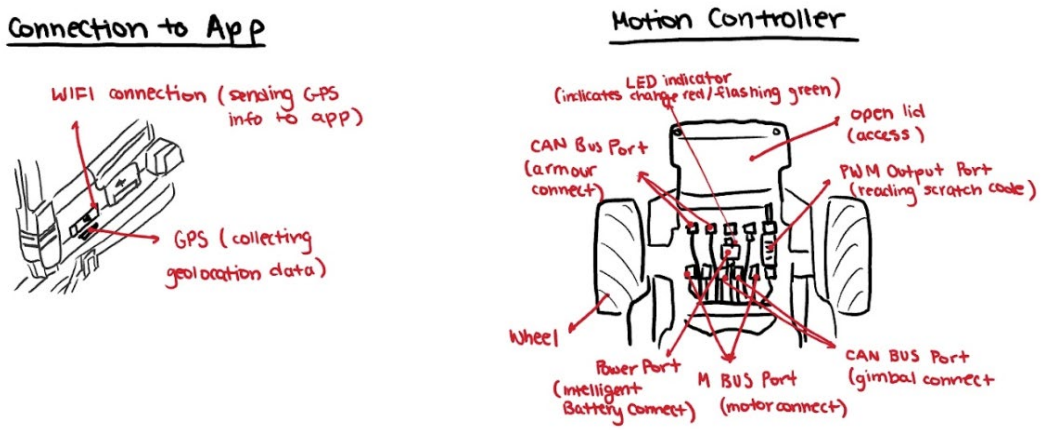
2. Design Drawing – Chosen Concept

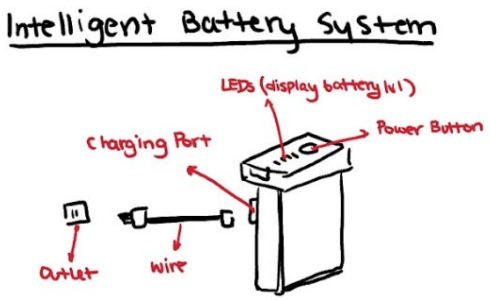
2.1. Detailed Design Drawing

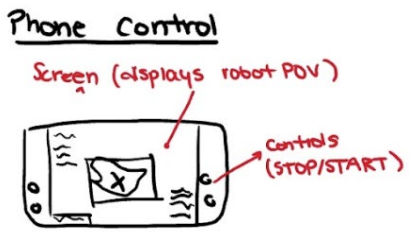
Full RoboMaster S1 – Important Features



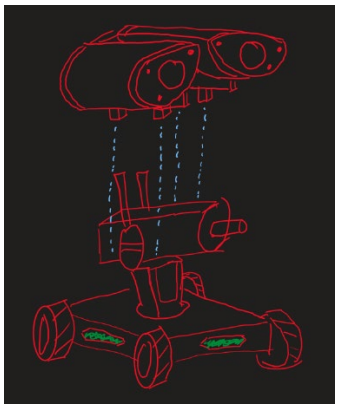
Sub-Features







Non-Functional Appearance


-> Cute eye-attachments

2.2. Trash Detection System

START
- Move Forward
- Stop every 2-3 seconds

→ **Scan for Objects**
- Process image to detech trash (symbols)
- Colour detection of plastic

→ **Trash detected?**
- Yes -> Start Alert volunteer sytem (2.2.)
- No -> Next

→ **Continue Scanning**

→ **STOP**
- Manual Stop on Robomaster S1 app
- Automatic stop after 2 hours -> return to start location

2.3. Alert Volunteer System

START

→ **Trash detected?**
- Yes -> Next step
- No -> Stop

→ **Tag location**
- Send GPS coodinates to volunteer network

→ **Change light chassis**
- Usually red
- When trash detected, change to flashing green

→ **STOP**

3. Project Task Plan

The following task list will be used to schedule the prototyping and testing stages as we work to create a solution for our clients' needs.

3.1. Detailed Task List

Task	Description	Estimated Duration	Deadline	Assigned Group Member
Prototype 1				
Low-Fidelity Robot Appearance	A low-fidelity prototype of the robot's headpiece will be constructed using cheap, readily available materials (paper, cardboard, glue, tape). This prototype will focus on being non-obstructive to the sensors and seeks to attach to the robot in a detachable/non-permanent manner. Code for a light pattern on the chassis will also be created.	1-3h	Feb. 27	Jake, Maddox
Create Robot Movement Code	A code that allows the robot to follow a predetermined path (line on the ground) will be developed.	1-3h	Feb. 26	Vanya
Create Vision Marker (Symbols) Detection Code	A code that allows the robot to detect a specific symbol (or set of symbols) will be developed.	1-2h	Feb. 27	Daniella
"Litter" Prop Creation	Small laser cut boxes will be created as props to represent litter. Based on the symbols chosen for the vision detection code, these symbols will be rastered on the boxes (alternatively; symbols printed on paper could be attached to empty soda cans, or similar objects).	1-3h	Feb. 27	David
Testing Prototype 1	The first prototype will be tested to confirm: -The robot movement code meets the selected criteria. -The headpiece is not obstructing the camera sensor. -The vision detection code allows the robot to successfully identify symbols at a specified distance.	1h-1h30	Feb. 28	All members
Prototype 2				
Improve Robot Appearance	Based on the observations made during testing, adjustments to the dimensions of the robot's headpiece will be made. Code for light pattern will be improved if necessary.	2h	Mar. 4	Jake, Maddox

Improve Robot Movement Code	Based on the observations made during testing, adjustments to the robot movement code will be made to ensure it drives along its intended path without error.	1-2h	Mar. 5	Vanya
Improve Vision Marker (Symbol) Detection Code	Based on the observations made during testing, adjustments will be made to the code so that the robot successfully detects symbols at the required distance.	1-2h	Mar. 5	Daniella
"Litter" Prop Interaction	Will implement a function that uses the vision detection code to stop/start the robot's movement along its path when it detects vision marker on "litter"; will also cue previously made chassis light pattern.	1-3h	Mar. 5	David
Testing Prototype 2	The second prototype will be tested to confirm: -The robots movement code meets the selected criteria. -The headpiece and chassis light pattern both respect the test criteria. -The vision detection code works as intended. -The robot's interaction with the litter prop works as intended.	1h-1h30	Mar. 7	All members
Prototype 3				
Final Adjustments to Appearance	Based on the previous testing, a final headpiece for the robot will be created considering what has been learned so far. The headpiece will aim to fix any remaining issues encountered during testing.	2h	Mar. 17	Jake, Maddox
Refine Movement Robot Movement Code	Based on the previous testing, a final code for the robot's movement will be created. Any issues encountered during the testing of prototype 2 will be addressed and resolved here.	1-3h	Mar. 18	Vanya
Refine Vision Marker (Symbol) Detection Code	Based on the previous testing, any final issues with the vision marker detection code will be fixed.	1-3h	Mar. 19	Daniella
Finalize "Litter" Prop Interaction	Based on the previous testing, any remaining issues pertaining to the robot-litter prop interaction will be addressed.	1-2h	Mar. 19	David
Testing Prototype 3	The third prototype will be tested to confirm that all functions/systems work as intended, and that the prototype is ready for design day.	1h-2h	Mar. 21	All members

4. Bill of Materials and Budgeting

BOM		
Product	Cost Estimate	Link
Robomaster S1	0$	https://www.dji.com/ca/support/product/robomaster-s1
Robot Décor	10$	Designed and printed in MakerLab or Affordable pre-fab décor
Film Camera	0$	(previously owned) https://www.canon.ca/en/products/Video-Cameras---PRO
CapCut Editing App	0$	(previously owned) https://www.capcut.com/
Green Screen		
Litter Prop	0$	Made from recycled and previously owned materials
OnShape software	0$	(Free with tuition) https://www.onshape.com/en/
DJI Scratch software	0$	(Free with tuition) https://scratch3-tello.app/
Presentation board	13$	https://www.staples.ca/collections/presentation-poster-boards-10217

TA Approval		
Name	Approval	Initial
	✓	

5. Project Risks and Contingency Plans

5.1. Task Completion Delays

It will be necessary to consider delays in task completion due to unforeseen complexities; this includes issues with team members' availabilities or technical difficulties. To plan around this, buffer time should be included in the schedule to accommodate for possible delays. Also, if a group member is having difficulties completing a task, other members could help so that the task gets finished on time. Team meetings could also be used to check in and track individual members' progress so that delays can be anticipated.

5.2. Staying Within the Allocated Budget

Respecting the project budget of $50 is important; if the wrong materials or components are chosen, their cost may exceed the allocated budget. To respect the project budget, our team should plan our expenses in advance whenever possible to know if we will be within the budget. When purchases are made, a record of what was purchased and how much should be made to track expenses. Also, choosing cost-effective alternatives for materials and components will help reduce expenses. Similarly, sharing resources with other teams will also help stay within budget.

5.3. Insufficient/Improper Testing Methods

Insufficient or improper testing could negatively impact the quality of our final prototype, since issues with our earlier prototypes risk going undetected until it is too late for them to be fixed. To mitigate this potential issue, a comprehensive test plan that covers all the necessary systems of our prototype will be developed. Also, team members should review each other's observations/data collected during the testing stages to identify any potential issues. Testing should also be done iteratively, to ensure that issues are caught as soon as they arise.

6. List of Equipment

6.1. Hardware

-DJI RoboMaster S1- Base component for movement of the device.

-Vision Sensors- This allows the RoboMaster to "see" the world. It will act as a depth sensor, to distinguish far objects from close objects, which will keep it from crashing. It will also act as the main method for detecting "garbage" for the user.

-Lighting system- A lighting system to alert the user of "garbage" when it detects it.

-Decorative items- To give the RoboMaster a friendly, more approachable look, one main decorative item is the headpiece, which will be made to emulate the likeness of Wall-E. Other additions may be added where it is seen fit.

-Laser cutter- We will use the laser cutter supplied to us at STEM to create parts as needed.

-Laser cutting supplies- Things like MDF board will be used in with the laser cutters to make more intricate parts needed for attachments on the robomaster.

-Microcontroller- Raspberry Pi or Arduino Uno R3 could be used for more complex processing if needed.

-Breadboard- Used with Arduino Uno R3.

6.2. Software

-InkScape- InkScape will be used to create images to feed into the laser cutter for parts.

-CAD Software- Either SolidWorks or Onshape will be used to develop ideas for certain designs, such as the design of the headpiece.

-Arduino IDE- To develop and upload for the Arduino Uno R3.

-DJI Scratch- For testing/development of detection/movement of the RoboMaster.

7. Prototype 1 Test Plan

7.1. Prototyping and Test Plan Table

Tests					Prototypes			
N°	**Objective (Why)**	**Test Method (What)**	**Usage of Results (How)**	**Test Duration (When)**	**Type (What)**	**Objective (Why)**	**Fidelity**	**When to realise**
1	Testing robots' movement	The purpose of obstacle-lined path movement is to test and evaluate the robot's capacity to navigate and adapt to different types of terrains. This is important because this robot is supposed to work independently in unpredictable environments, striking a balance between safe and efficient movement. If it does not offer reliable movement, it meets with its first failure.	Use the results to modify movement control and traction settings to optimize accuracy in riding, thereby allowing robot movements with a high degree of energy and safety.	1-1.5 hours (Feb 28)	Focused physical	Ensure smooth and smooth path following by the robot without any errors.	low	Feb 26
2	Checking symbol detection	The robot must accurately identify symbols for communication with its environment. Without this ability, we cannot make appropriate judgements based on these decisions, such as stopping at designated points or maneuvering around terrains. This is highly critical in the proper application in practical scenarios.	Optimizing camera settings and enhance detection software to improve reliability, ensuring that the robot's visual data interpretation is consistent.	1-1.5 hours (Feb 28)	Focused analytical	Ensure correct identification and interpretation of symbols by the robot as these are crucial for autonomous decision-making.	medium	Feb 27
3	Evaluating headpiece impact	We will concern ourselves that putting a headpiece would not interfere with the robot's vision system.	If the headpiece obstructs the camera, or the detection accuracy is	1-1.5 hours (Feb 28)	Focused physical	Ensure that the headpiece does not obstruct the vision	low	Feb 27

		Otherwise, the robot may later have difficulties in adjusting objects or recognizing certain symbols, which may result in mis navigation. The design should ensure that all components are functioned properly.	affected, the design should be modified to the necessary need.			of the robot on which it can rely for proper navigation.		
4	Testing the chassis light pattern	The light of the robot is very important in the communication process of actions to its users. Anything that goes wrong with them could lead to confusion or safety problems in its operating environment, especially in low visibility.	Optimal lighting patterns need to be installed and response timing to ensure clear real-time feedback, when the lights are fulfilling their purpose.	1-1.5 hours (Mar 7)	Focused physical	Make sure the function of the lights is visually available so that the robot knows it has detected an object.	low	Mar 4
5	Testing the response to the litter	To detect and react to objects in the way, such as the litter, the robot should avoid all accidents or incorrect activities. If not, it will effectively undermine its functional safety and stop the operation of the robot.	Enhance the object detection sensitivity and the response time to allow for effective avoidance or braking for the robot.	1-1.5 hours (Mar 7)	Focused physical	The obstacle detection and avoidance capability of the robot must be valid in a way that no unintended collision occurs.	medium	Mar 5
6	Improving movement stability	Variations in robot mobility could render any kind of reliable functioning under given conditions. Testing on different terrains assures adaptability thus keeping it from failing unexpectedly in real-time applications.	Calibrating motion algorithms and sensor feedback to provide the best smooth and predictable motion.	1-1.5 hours (Mar 7)	Focused analytical	Ensure predictability of the robots' behaviours on different terrains, preventing any erratic actions.	medium	Mar 5
7	Optimizing the	To detect the symbols from the	Adjust camera focus,	1-1.5 hours	Focused analytical	Make sure the robot	medium	Mar 5

	detection range	right distance so the robot could react instantly. Otherwise, if the distance is too short, it would not be quick enough and might miss essential signs used for navigation.	software settings, and lighting compensations to achieve maximum detection consistency to improve the detection range.	(Mar 7)		can identify markers at some working distance, preventing any delays.		
8	Finalizing the robots' headpiece design	A perfectly designed headpiece must be visually appealing with a proper concept for usefulness. Contrarily, its sensorial duties may be impaired, making the very presence of a robot less effective and less enjoyable.	A particular sensor ensuring the powerful connection of the headpiece design element naturally seem more favourable.	1-2 hours (Mar 21)	Focused physical	Develop a final headpiece that is aesthetically appealing and functionality without interference.	High	Mar 17
9	Improving the robots' movements	In order for a planned maneuver to be executed properly, the robot must follow paths with a high precision. A higher inaccuracy may mean failed operations by having one miss a stop point or turn in the wrong direction.	Make some refinements, tuning, and speed adjustments to our motor control and path-maintain algorithms in order to optimize movement accuracy.	1-2 hours (Mar 21)	Focused physical	Ensure that the robot has smooth movements without turning errors during navigation.	High	Mar 19
10	Validate the whole systems' integration	Alongside, let every piece of the robot component that we incorporated to work perfectly. The malfunction of just one section brings system malfunction about, which results into unpredictable or unsafe behaviours from the robot.	Test that the movement, detection, and response functions are working in conjunction as it would in the real world.	1-2 hours (Mar 21)	Focused physical	Confirm all subsystems of the robot work the way it needs to work.	High	Mar 21

8. Conclusion

In conclusion, our chosen design for the RoboMaster S1 includes a trash detection and alert system that will be used alongside volunteers, city workers, and community members to more effectively keep public spaces litter free. Our next steps towards perfecting our design will be doing tests to ensure the RoboMaster can reliably recognize garbage in public spaces, and alert those working alongside it. Ultimately finishing our design that CRAiEDL and Mines Action Canada can use and implement to convince others of the benefits of using autonomous weapons for a humanitarian purpose.