Deliverable H
Prototype III and Customer Feedback

Team: Five Alive

Zoe Saunders, Aurora Bedggood, Yunfei Qiu, Nada Abdelkader, Matthew Godreau
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1.0 Introduction

Lethal Autonomous Weapons Systems (LAWS) are a kind of autonomous system that can detect and apply force to targets based on sensor processing, instead of human approval. These systems are often referred to as ‘killer robots’ on account of their lack of human judgement and understanding, lack of accountability, algorithmic biases and more. Many organizations such as the United Nations, Red Cross and Mines Action Canada (MAC) are trying to raise awareness about these systems to stop their production before it’s too late. Our team has been tasked by MAC to create an immersive experience using a RoboMaster S1 robot to highlight the ethical concerns of LAWS raised by their organization. We have come up with a simple game concept that uses an unpredictable safe zone algorithm with the addition of a ‘live grenade’ objective. We are in the final stages of our prototyping stage and below is a comprehensive outline of what we have done so far as well as our final prototyping plans.

2.0 Prototype III

2.1 Prototype II Results

The second prototype consisted of several decomposed sections of code of the final game. The initial rendition was a very base level of development in order to test our most elementary features and functions, such as general movement and sound.In this prototype, we completed and tested the code for the 20'×20' boundary so that the robot does not cross the perimeter of the play zone, the random movement within the boundary, the 30-second timer for each round, the player identification and elimination system consisting of randomly selecting and identifying a player ID number then eliminating using sound and LED lights. We also created the physical components of the game, consisting of the wearable player ID tags with visual markers numbered 1-5 and the cube featuring visual markers on each face. All components of prototype II worked.

2.2 Prototype III test plan

A comprehensive prototype test plan can be found here:

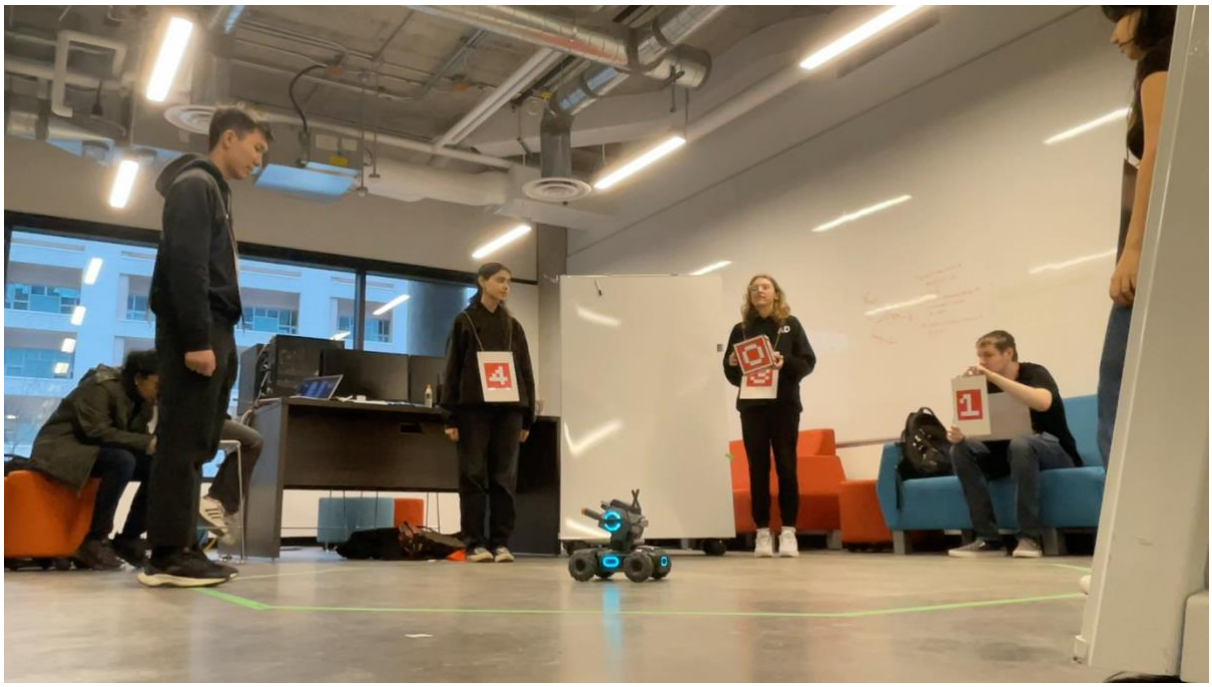
1	Communication	Visual Display	Lofi Focused	Physical	Funtionality	Measure whether the visual display works to displays the right player ID. Our hypothisis; if players are in the play area then their ID's should be identifiable	The robomaster will be connected to the DJI Hub code that, when the condition is met, connects with the laptop screen to show the ID of the eliminated player
2	Communication	LED lights	LoFi Focused	Physical	Functionality	Measure whether the LED lights turn on as programmed. Our hypothisis; if the LEDS follow the program then they should	The robomaster will be connected to the DJI Hub code that triggers the LED lights at a certain condition
3	Performance Measurement	Target and Symbol Recognition at Distances	HiFi Focused	Physical	The range at which the robot can identify targets or identifying markers	Measure the distances at which the robot can and can't recognize the symbols and targets. Our hypothisis; If the robot is too far away, then it will have trouble identifying targets	Using the robomaster application, we will test how far we can be away from the robot before it stops recognizing the symbol, then measure the effective distance
4	Communication	Laser Pointer	Lofi Focused	Physical	Functionality	Test if the laser is able to put a dot/'target' on the player or if it just emits a single light. Our hypothisis; if the robot emits a laser then the players will know they are eliminated	Using the DJI hub code we will test if a laser pointer can be projected onto players to simulated being targeted by LAWS
5	Learning/Understanding	Duration of elimination	HiFi Focused	Physical	Duratio of rounds	We will set a timer and see how long each round will take. Our hypothisis; if the code is correct then the robot should take around	Using our combined code we will test a round and time how long it takes to estimate the amount of round we should have in our

2.3 Prototype III testing

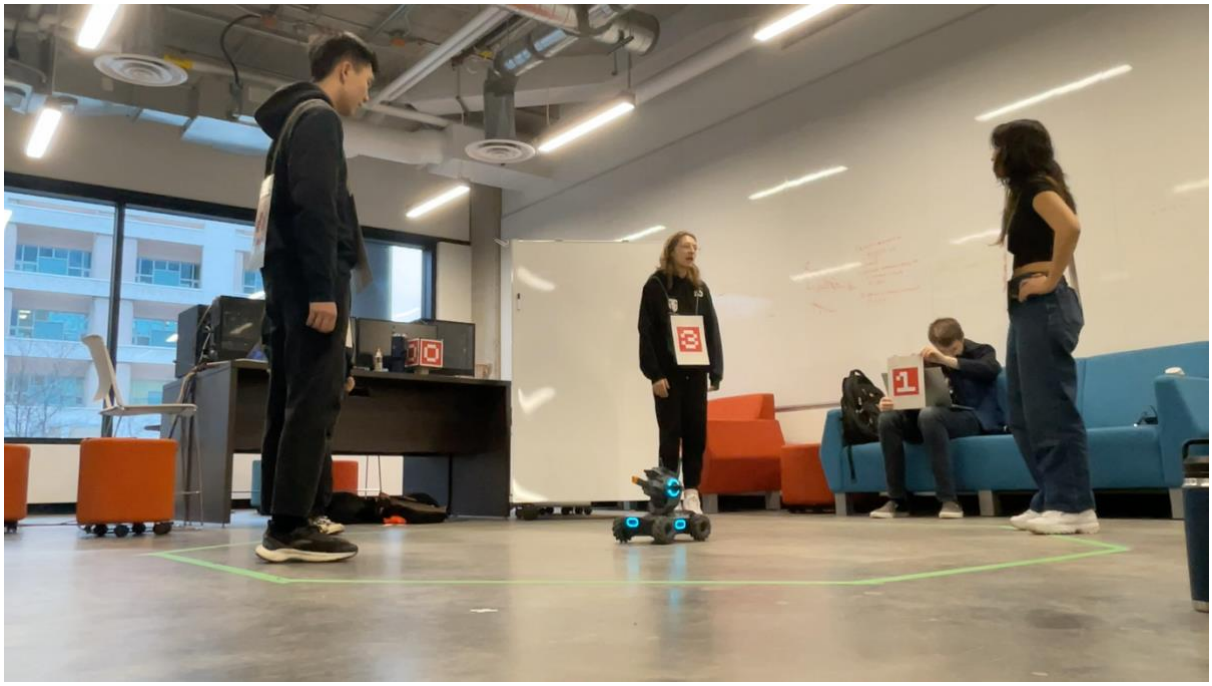
A major focus of our testing for prototype III was movement and targeting testing. From the initial testing in prototype II, one large issue was whether the RoboMaster S1 was capable of recognizing the number target IDs from a reasonable distance or not. Due to the

large size of our playing field, we tested the maximum range and height that the vision sensors could detect an ID at a certain angle of the gimbal. Upon testing ID detection, the response signal was also tested, represented by flashing LEDs, a laser pointer, and a sound effect. To test elimination duration, we conducted several tests in tandem with the target ID recognition code and timed each round to test the approximate length of elimination, and whether this length is incompatible with the original test time.

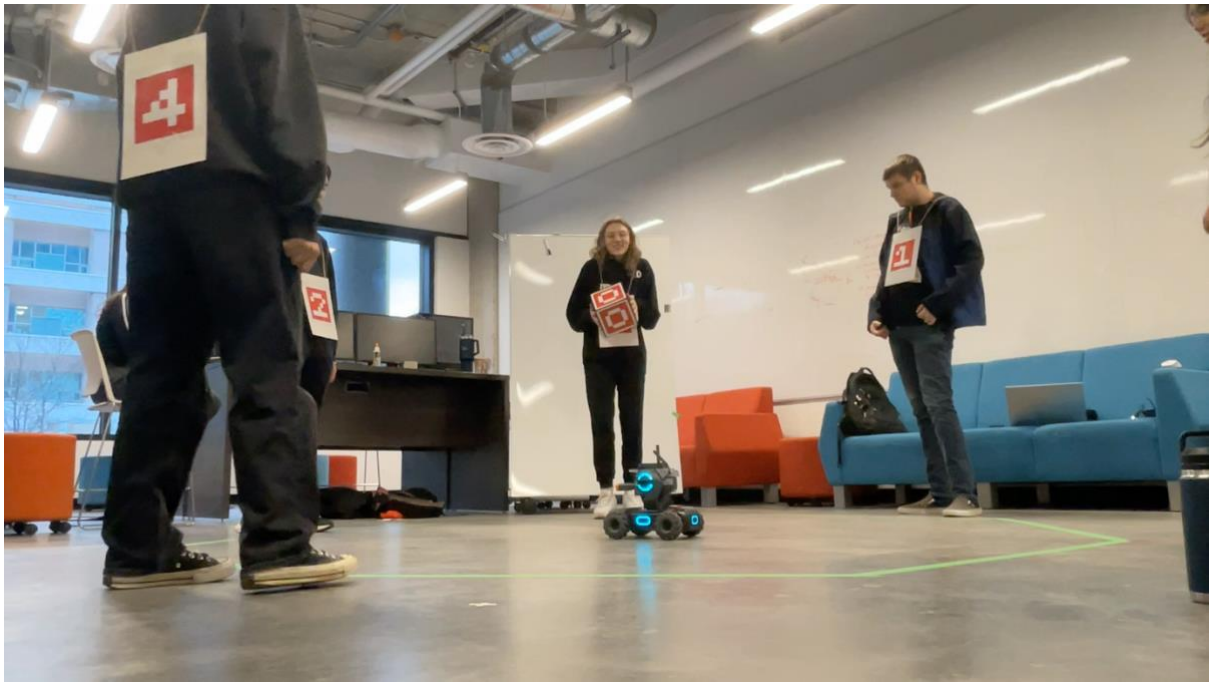
2.3.1 Target & symbol recognition at distances



2.3.2 LED and laser pointer



2.3.3 Duration of rounds

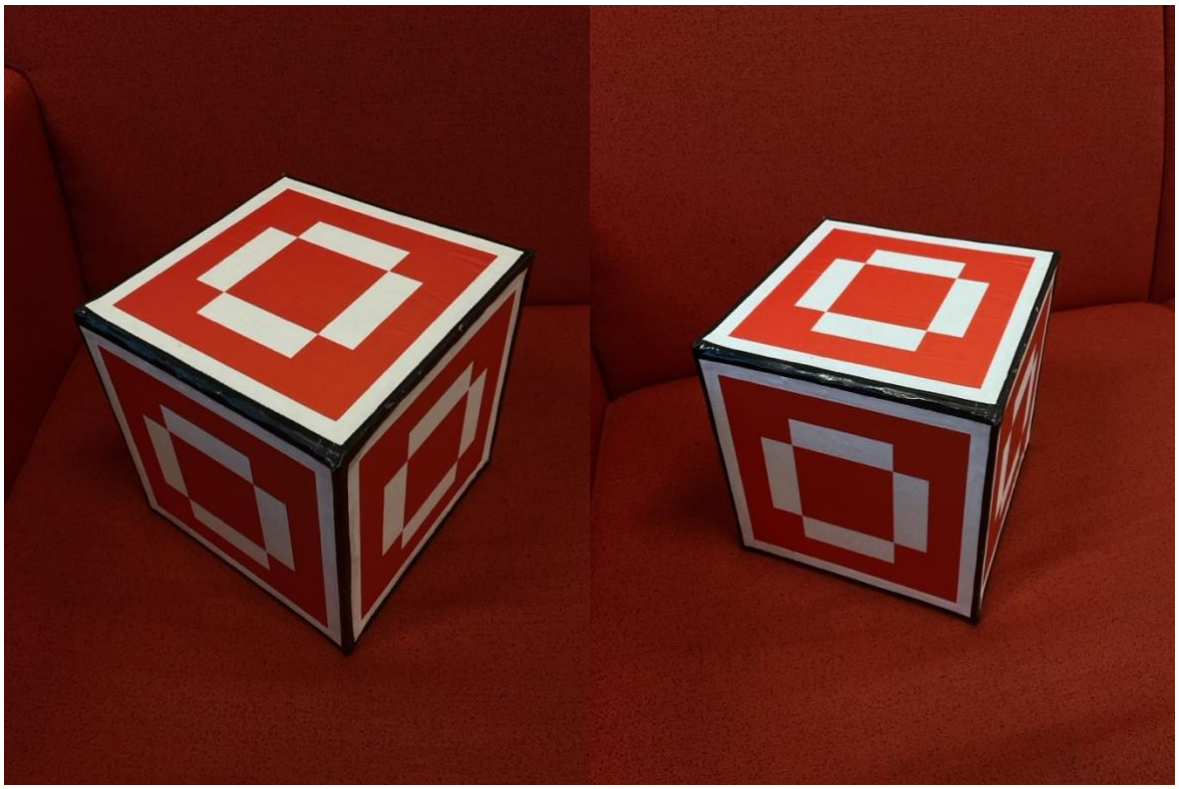


2.4 Prototype III results

Results from testing include safe randomized movement within a 20’x20’ space to be unsuccessful, due to small obstacles in the flooring adjusting the orientation of the chassis, causing it to go off course to a certain degree. To compensate for this, we have changed the

boundaries of the chassis movement to be within a smaller distance (10’x10’). In terms of target recognition, with a gimbal angle of 0°, the vision sensors were not able to consistently recognize target IDs at a certain distance or height. To fix this issue, we changed the angle of the gimbal, and max distance that players should be from the robot at the end of gameplay. There were also discrepancies between cube recognition and player recognition, as IDs were slightly different. During testing, the RoboMaster S1 was able to recognize players much more effectively and consistently than the cube. This is likely due to certain angles or heights that it was being held at. In future testing, we aim to determine the true root cause of this and resolve any discrepancy. In terms of elimination, upon recognizing a target, LEDs, sound effects, and the laser beam were very successful indicators of elimination, and were highly consistent. However, the testing of the display was unsuccessful due to connectivity issues with the RoboMaster S1’s local WiFi hosting system. As the display will no longer be used, higher emphasis will be placed on other indicators of elimination, such as the LEDs and sound system.

2.4.1 Cube or ‘bomb’ design



3.0 Updated BOM

Item	Type (software/tangible)	Cost
Printing (visual markers)	Tangible	$4
String (player ID)	Tangible	$4
Laser cutting (cube)	Tangible	$5
DJI Education Hub	Software	$0
Robomaster S1 app	Software	$0
Python	Software	$0

4.0 Feedback

We received feedback from our TA, PM, and other teams regarding our third and final prototype. Upon struggling with connecting our code in Python to the RoboMaster S1, it was recommended by our TA that we rework our elimination announcement system.

5.0 Next Steps

For our next steps, we intend to continue refining our product and to continue structuring our rounds to improve the player experience. We are also preparing for our final design day presentation as we now have a fully developed game. To be ready for design day we just need to print our material for the final board as well as fine tune our pitch. Final steps include completing the user manual and submitting our design day material.

6.0 Conclusion

Overall, our third and final prototype was very successful even with our display becoming obsolete. Our player recognition is reliable, and the random movement code stays within the given parameters. We have successfully run through our game and recorded a backup demonstration for design day. We are on track to complete our design day board along with our pitch presentation.