Deliverable G

Prototype II and Customer Feedback

Team: Five Alive

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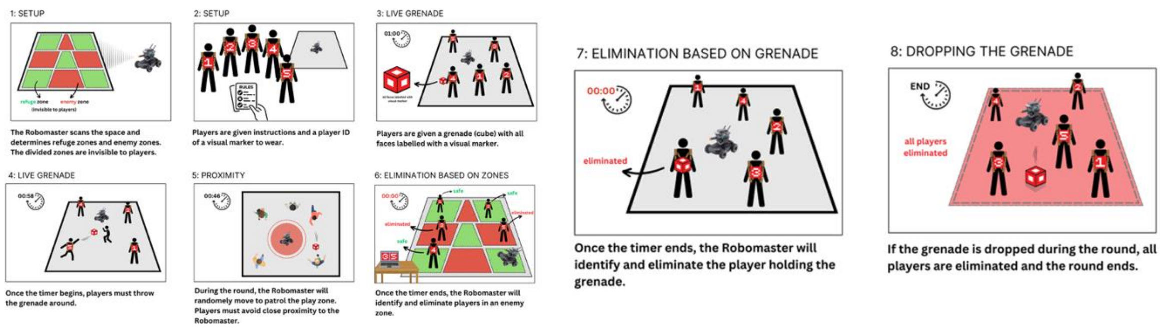
1.0 Introduction

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 II

Using our previous storyboard prototype, our team began to develop sections of coding that would be crucial in our game’s development.



Our ‘safe zones’, target identification, round timing and player interaction were determined to be the most important parts of our prototype. We broke these section into further tests such as random moveent, chasis/gimbal speed, collision avoidance, audio feedback and more that can be found below.

2.1 Prototype II test plan

For our second prototype we focused on the functionality of individual parts of the game. During the testing of this prototype, we experimented with the functionality of the game both in the simulation and with the RoboMaster S1 in our lab. We were able to use the successes and failures of this prototype to develop a plan for our third and final prototype.

1	Performance Measurement	Movement Within Given Parameters	HiFi Comprehensive	Physical	The range of the robots movements within the space	We will test wether the robot will stay within a 20' x 20' space. Our hypothisis; if the robot approches the boundry then it will turn around and continue	Using a simulation as a benchmark, we will test that the robot stays within its given parameters in a physical space	The robot sometimes went off course due to the flooring or drifting. Although it did stay within the programmed	Pass; by shortening the parameters to within a 20x20 space and making the robot return to its position we eliminated risk of		this is the best way to test this because our objective relies on the real life environment
2	Performance Measurement	Random Movement	HiFi Focused	Physical	functionality of the robots movement	Measure whether the robot movement follows a pattern or not; if the robot is not at a boundry or an obstacle, then it will continue to move as its coded. Our hypothisis; if the robot follows its coding it will stay	The robomaster will be connected to the DJI Hub code, and we will test if the random movement follows the coded behaviour	The robot moves in a random path that follows the code and stays withing the boundary	Pass; the robot continues movement as coded if no obstacles and stays within the boundary		this is the best way to test this because our objective relies on the real life environment
3	Performance Measurement	Gimbal and Chassis speed	LoFi Focused	Physical	The speed at which the gimbal can turn, and the speed that the chassis can move on an x-, y-axis	Measure the fastest speed that the gimbal can turn while still identifying a target, and the optimal speed of the chassis. Our hypothisis; if the robot moves too fast then our boundaries and movement	Create a small code to see which speed is best for our game, also experiment with speed settings in the app	If the robot is moving too fast it will drift and is at higher risk of missing targets or collision	Pass; we were able to determine that speeds over 1m/s and 100 degrees/s would be too fast for our main game		this is the best way to test this because our objective relies on the real life environment
4	Performance Measurement	Target identification while scanning	HiFi Focused	Physical	Distance between crosshair and target	A person will stand in the play area with the ID band to test if the robot will identify the ID while it is in motion. Our hypothisis; if the robot is in motion then it might have trouble identifying IDs	Using the Djl hub code we will test using our printed ID codes weher or not the robomaster can see them while scanning the area	The target recognition rate was lower than 90%	Fail; if the robot was moving it failed to identify anything. It breifly identified the 4 marker but it was unclear andn didn't identify anythign		This is the besy way to test for target identification because it allows us to see the capabilities and see what changes we need to make to our IDs or coding
5	Risk Management	Collision	LoFi Focused	Physical	Funcionality and ability to break	Will the robot recognize an obtacle and attempt to stop or avoid collision. Our hypothisis; if there is an obstacle in the robots path then it will not avoid or detect it	Using the robomaster app we will track a person through the room and see if the robomaster avoids stuff in its path	Speed affected the robots ability to stop. The floor was smooth which contributed to drifting	Fail; the robot isn't able to stop itself when its going fast, it doesn't detect and avoid obstacles		This is the best way too test for collision because there is little to no risk of damaging the robomaster and can help us predict faiures during our game
6	Learning/Understanding	Laser cut cube	LoFi Focused	Physical	the dimensions of the cube and line width in inkspace	We will test if the line width in inkspace will properly vector cut the cube sides and if the dimensions will be proper. Our hypothisis; if the scaled down version prints fine then the larger	Using the laser cut printer in the maskerspace we will print a miniture version of one of the cube sizes to ensure the larger print will work	The cut went well and printed very quickly and efficiently without any error in	Pass; everything went well and our real cube should print perfectly		This is the best way to test the box , it allows us to see if the print will work so we don't end up wasting material
7	Communication	Sounds	LoFi Focused	Physical	Functionality & loudness	Measure whether the sound functions as programmed and if it is loud enough for players to hear. Our hypothisis; if the players are within the play area then sound should be audiable	The robomaster will be connected to the DJI Hub code or robomaster appand we will play a sound, we will see if the sound plays and if it is hearable in a 20' range	the recording of audio on the app is extremly easy; we may be able to integrate it into DJI. Its also	Pass; the sound played clearly and loudly. In a simulation the sound was triggered by target ID		This is the best way to test for sound as its simple and effective, it allows us to see how players will feel during the game

Link: [Deliverable G - Prototype Test Plan]

2.2 Creating and testing critical components

Using the DJI education hub, the RoboMaster app and multiple recording devices the results of our tests were recorded. We created the code for each part of the game (random movement, player identification, boundary, etc.) individually using blocks in DJI Education Hub. We then did a physical prototype test on either the individual parts or multiple parts combined by connecting the programming platform to the RoboMaster S1 and running the programs, and the observed results and analysis were recorded in the prototype test plan table under section 2.1.

2.2.1 Random movement with boundary & timer

Link to in person testing: randommovement.MOV

Link to simulation: https://drive.google.com/file/d/1GZlB-gMaMnMysbMeDLzyDHKVrCyyn7I/view?usp=sharing

Code dsp file: https://drive.google.com/file/d/15-PY-ecdhHnDE84AlNPAm3yzi_ZlJVWz/view?usp=sharing

Block code from DJI Education Hub:

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2.2.2 Simulation: Boundary Line Detection

Link: Boundary Line Detection video. This program uses line tracking and is based on the assumption that the 20’×20’ perimeter would be represented physically by blue tape, and the RoboMaster S1, following random movement inside the perimeter, would turn around once the blue tape line is detected. It was discarded because integrating the code with the random movement code was too complicated, the boundary detection based on coordinates was a simpler idea, and a risk that the robot fails to identify the physical tape line.

2.2.3 More Functionality Tests

1) People tracking, speed and collision test:

Link: collisionspeedtracking.MOV This test was not directly related to our game but was conducted to experiment with the RoboMaster limitations and features. Using the tracking feature on the RoboMaster app we tested the speed and tracking limitations. This resulted in the collision avoidance to be tested as well, we discovered that although the RoboMaster may maintain distance from the person it’s tracking it doesn’t consider other obstacles.

2) Complete functionality test using RoboMaster app:

Link: speedfunctionality.MOV. This test was not related to our game and was not run on a program, but was instead a test of the RoboMaster S1’s capabilities, including movement speed, ability to turn, rotation speed, speaker, etc. We did benefit from the speaker as testing speaker loudness was part of the prototype II test plan.

3.0 Feedback

Some constructive feedback we received included suggestions to test our separate code components altogether to work out inconsistencies or overlap in the code. We also discussed the logistics of running multiple files or running the functions of a separate block code file in one main master file, to make the code cleaner and easier to run. In terms of physical testing, we received a suggestion to further adjust our program to identify the targets better, which has since been effectively completed. Given that the display of our game is written in python and the intended plan was to translate the code, another suggestion was given to attempt to run the display file at the same time as the block code on the RoboMaster S1.

4.0 Prototype III

After completing our testing for prototype II, it is clear where we need to improve and what our next steps are. The key component to our next testing is combining our code to run one round.

Our testing for prototype two was very successful and gave our team plenty of insight into what prototype III will look like. The insights were found through the prototype II test plan, and the insights allowed us to create another test plan for prototype III, which can be found in the prototype test plan table under section 4.1.

4.1 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 displayworks to displays the right player ID. Our hypothisis; if players are in the playarea 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 theyshould	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 theyare 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

Link: [Deliverable G - Prototype Test Plan]

5.0 Conclusion

In prototype II, we started developing the game program based on our storyboard. We programmed the random movement the robot will follow, the 30 second timer of each round, the boundary of the 20’×20’ perimeter so that the robot does not cross it, the robot’s detection of the visual markers the players are wearing and its response of eliminating a player based on ID number. In a table, we tested HiFi, LoFi, comprehensive, and focused aspects of the prototype, and interpreted our results to shape our plan for prototype III. This table gave us insight on what works and what needs improvement, which will be fixed in the next prototype. Our main goal for prototype III is to combine all the individual codes into one that runs the game start to finish with no error.