Deliverable F

Prototype I and Customer Feedback

Team: Five Alive

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

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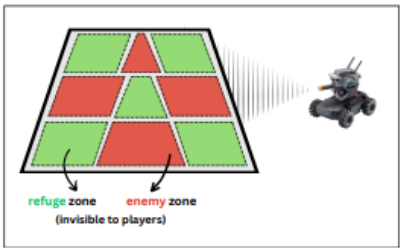
1.0 Introduction

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 ‘intruding enemy troops’ and a ‘live grenade’ objective.

2.0 Prototype I

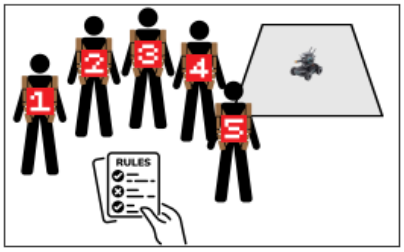
2.1 Storyboard

1: SETUP



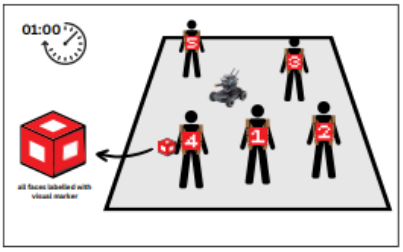
The Robomaster scans the space and determines refuge zones and enemy zones. The divided zones are invisible to players.

2: SETUP



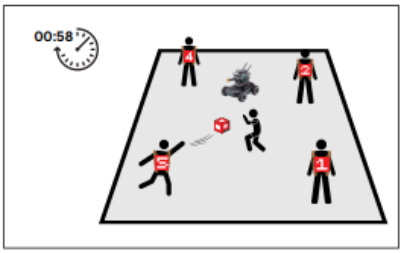
Players are given instructions and a player ID of a visual marker to wear.

3: LIVE GRENADE



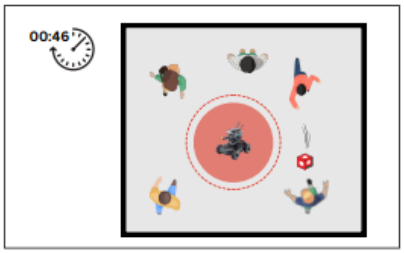
Players are given a grenade (cube) with all faces labelled with a visual marker.

4: LIVE GRENADE



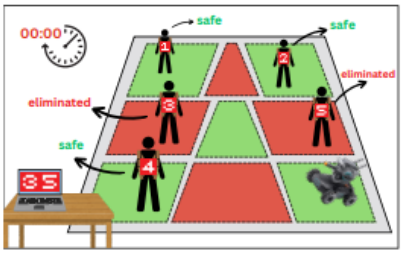
Once the timer begins, players must throw the grenade around.

5: PROXIMITY



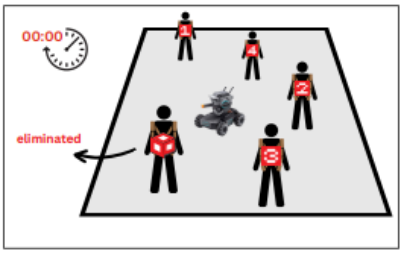
During the round, the Robomaster will randomely move to patrol the play zone. Players must avoid close proximity to the Robomaster.

6: ELIMINATION BASED ON ZONES



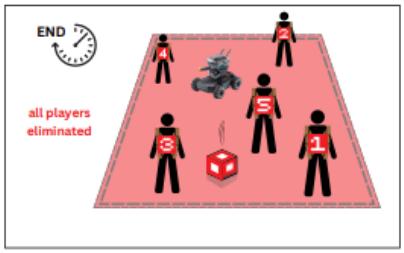
Once the timer ends, the Robomaster will identify and eliminate players in an enemy zone.

7: ELIMINATION BASED ON GRENADE



Once the timer ends, the Robomaster will identify and eliminate the player holding the grenade.

8: DROPPING THE GRENADE



If the grenade is dropped during the round, all players are eliminated and the round ends.

2.2 Feedback

Feedback	Design Updates
Player goal during gameplay is lacking – current design implies players would have no real objective/direction until the end of the round and be eliminated essentially by chance	Erratic movement patterns should be included in the robot's design, including chasing mechanism to scare participants

	Round times should be reduced from one minute and 30 seconds
Hot potato may be hard to configure – if identifying by the colour of the ball, the environment may also have that colour, or a player may be wearing a shirt with that same colour	Hot potato will only be tracked at the end of the round, and design will be updated to cube shape with similar visual marker to player IDs. It will be added to the rules that players must properly display the potato's vision marker at the end of a round.
Can be difficult to identify mass elimination when ball drops – hard to program that as well	Altering this feature so that the robot does not identify the ball drop immediately, but players are no longer allowed to pick up the cube during the round. The robot will determine instead if any players are holding it – if not, it is considered "on the ground" and thus mass elimination will occur
Might be hard to determine whether a player is in a safe/danger zone – what if they are in between?	Robot will physically approach all players at the end of the game and determine it based on its own coordinates
Instructions cannot be given/developers cannot interfere with the round after initial set up	Instructions will be adjusted to have some more detail at the beginning of the round

3.0 Updated test plan

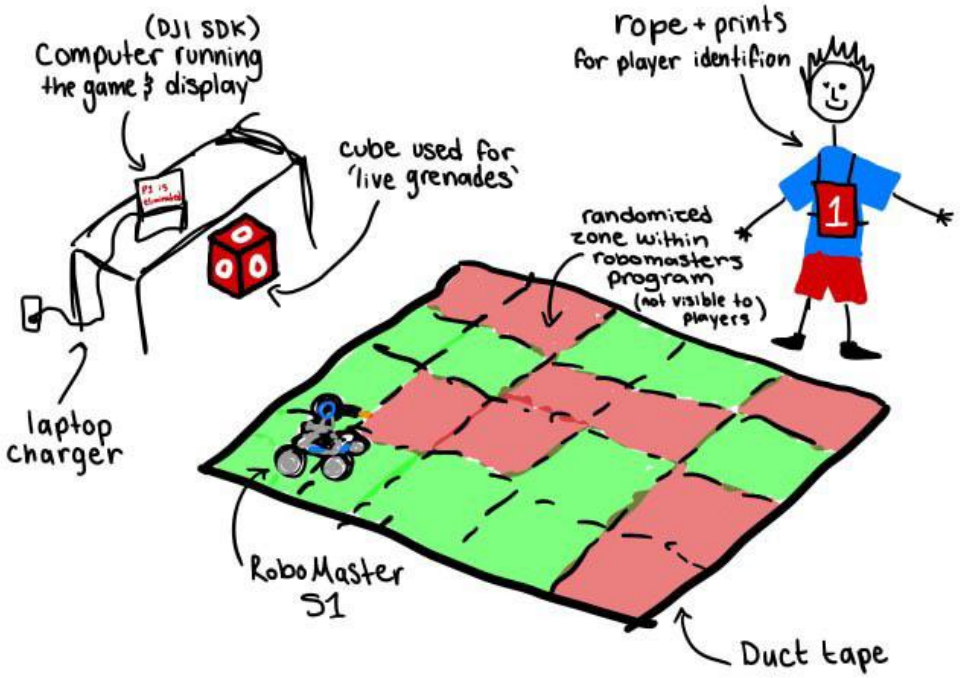
Updated Test Plan

Feature	Testing Method	Duration	Timing
General robot movement/behaviour during rounds (chasing, idling, etc)	Simulation in DJI	30s (length of round)	Begins: Nov 9th Ends: Nov 23rd
ID tracking (both player and cube)	Simulation in DJI	~1 minute	Begins: Nov 9th Ends: Nov 23rd
Display timer and elimination announcement	Running display program in tandem with simulation in DJI	~1 minute & 30 seconds (time for 3 rounds)	Begins: Nov 9th Ends: Nov 23rd
Determining zone type of player's location	Simulation	~30 seconds	Begins: Nov 9th Ends: Nov 23rd

Sound effect/LEDs	Simulation	~30 seconds (length of a round)	Begins: Nov 9th Ends: Nov 23rd

Some features are now recognized as difficult to test, as the team has limited to no access of the robot, and running tests in the simulation for a moving target requires extra programming of the target itself. The tests in the above table describe the updated testing plan based on feedback received, and the new testing circumstances regarding availability of the robot. It is also based on the updated design, as detailed in the following section (3.1).

3.1 Updated design drawing



3.2 Stop criteria

Test	**Stop Criteria**

Player Detection in Safe Zone	Stop test if detection accuracy reaches 90% across 10 trials. If accuracy is consistently below 70%, evaluate the detection approach.
Play zone Calibration for Accuracy	Stop test if the robot stays within boundaries in 90% of 10 trials. If issues persist, mark boundaries with tape and integrate line tracking.
Robot Movement for Accuracy	Stop test if movement accuracy deviation is less than 10% trials. If errors persist, adjust movement code.
Potential Collision Consequences	Stop test if the robot maintains safe distance from players in 90% of trials. Re-evaluate code if collisions happen.
LEDs (Delay, Contrast)	Stop test if LEDs react within 1 seconds and are visible in 90% of trials. If visibility is not available, test alternative LED displays.
Sound Loudness	Stop test if sound is clear from 10 feet away in 90% of cases.
Real-Time Sensor Data Relay	Stop test if sensor data syncs within 1 second margin in 90% of trials. If delays exist, try LED feedback or re-evaluate sensor setup.
Internal Timer for Accuracy	Stop test if internal timer deviation is less than 1 second over 10 trials. Try other timing systems if errors exceed what we expect.
Display Timer and Internal Timer Alignment	Stop test if timers align within a 1-second margin in 90% of trials. Input error value manually to decrease difference if delays are noticeable.

4.0 Potential failures

Mode/Effect	PFME number	Whys	Answers
2/4	PFME 1; not staying within or calibrating to the play area	Why would the play area not be registered by the robot?	The code may not correctly identify the size or set parameters of the play area.
		Why would the code be unable to recognize the size or parameters of the play area?	The programmed dimensions may have been incorrectly entered or the code may have translated differently from a virtual testing environment to a physical one.
		Why would the dimensions be entered in correctly or be translated poorly to a physical environment?	The code may have been written incorrectly, the measures of units may have been incorrect, and the digital environment could prove difficult to scale into a physical one.
		Why would the code be written incorrectly and/or have difficulty translating to a physical environment?	The software and testing environment used may not accurately represent the environments the experience would be used in, and the code may translate differently from a flawless virtual environment to a possibly flawed physical one.
		Why could the code and robot have difficulty translating themselves from a simulated environment into reality?	Without physical testing, the robot may incorrectly register the play area's size or scale depending on the environment it is used within.
3/2	PFME 2; misidentifying players as targets	Why would the robots misidentify a player as hostile when its target is another?	The robot's recognition systems may be unable to distinguish one player from another at a glance, unless a form of identification is used.

		Why would a form of identification aid the RoboMaster S1 in discerning one player from another?	The RoboMaster S1 can recognize certain patterns, such as numbers or letters, and associate them with individual players.
		Why would patterns or symbols be easier and better for the RoboMaster S1 to identify than colours?	Players could be wearing certain colours that could confuse the RoboMaster S1's sensors if colours were used for identification, and colours in the environment could disrupt the sensors.
		Why would the environment affect the RoboMaster S1's sensors if colours were used?	If colours were used, the RoboMaster could misidentify colours in the environment around it (such as the blue of the sky and the green of the grass) as a player.
		Why would misidentifying one player for another because of the environment hinder the experience?	If the RoboMaster S1 has a focus on the environment surrounding it as opposed to the players in the play area, the experience won't run as intended.
4/3	PFME 3; missing object (grenade) in play or general	Why is the target out of sight?	It moves to the area which is hard to be recognized.
		Why not try again to get back on track?	The object moves very fast, so the camera cannot catch it. Also, the color may be similar to the environment.
		Why may the camera not track the target firmly?	Object may be very close to camera.
		Why are targets typically recognized when they fall within a specific range of distances?	The camera lacks optical zoom capabilities, and there's a limit to its rotational speed.
		Why is the target color not significantly different from the surrounding environment color?	The outdoor light is intense, and the background is complex.
1/3	PFME 4; errors or delays in		

	timing (no chosen)		
3/4	PFME 5; display not working properly	Why isn't the information on the screen displayed correctly?	The screen is unable to receive a strong signal from the robomaster.
		Why is the signal weak?	We use wireless to connect, so there might be a loose connection due to interference from other wireless signal or physical obstruction.
		Why could it lose connection?	The device might have sustained physical damage or experienced wear and tear over time.
1/2	PFME 6; sound not working or being too quiet (no chosen)		
1/1	PFME 7; LEDs not working or being visible	Why would the LEDs not be visible?	The lighting inside or outside could be too bright
		Why would brightness be an issue?	Lighting affects the way our eyes perceive each colour
		Why would the lighting be changing?	Our clients intend to use this game inside at conferences and outside at fests
		Why could outdoor lighting pose more of an issue?	Outdoor lighting often has more direct white light which makes some things harder to see
		Why might more vibrant LED colours be used?	Vibrant light colours like blue, red and purple have more contrast and ability to catch your eye in any lighting
3/3	PFME 8; RoboMaster getting too close to players	Why is the distance decreasing?	The device does not maintain the appropriate distance.
		Why is the robomaster not maintaining a safe distance from the target?	Proximity sensors detection doesn't work well

		Why can't proximity sensors detect exactly?	It may be disturbed by other players or other factors like leaves. The safe value setting may not be suitable.
		Why is it easily disturbed by other things?	The proximity sensor detection interval was short
		Why is the proximity detection interval short?	Determine the exact distance.

5.0 Conclusion

In this testing and prototyping stage, we determined many flaws and project risks in our original design. To minimize risk, we created several contingency plans and altered many features for simplicity while maintaining the original intention of the design and integral components. Our first prototype is a simple proof of concept, consisting of a storyboard to showcase the design fully. We ran into several logistical issues, including complications with the "hot potato" features, but successfully altered the plan to account for these logistical issues. Our next prototype is aimed to be an initial rendition of the full game, with fully functional code. This will include the fundamentals of the game, with less focus on appeal and more on basic functionality. The final prototype will include necessary adjustments for the code, as well as emphasis on improving user experience.