Prototype III

Team 2: 2ManyRobots

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1. Introduction

Identifying challenges within the project is a necessary and crucial step when designing a project for a client. It is extremely important to test multiple prototypes to ensure that the final project is functional, effective and efficient. This third prototype created by the group addresses the feasibility of the project design and tests to ensure all needs are met by the client. This solution combines multiple aspects of previous prototypes to ensure a user-friendly and impactful project is achieved. This prototype demonstrates the group's commitment to the final project and meeting the client needs. The following sections cover the functionality, purpose and applications of our prototype.

2. Final Prototype

As we approach the deadline for our design project, we need to finalize our design by conducting our final rounds of testing. Our final prototype will be designed in order to test the overall feasibility of our design, and that it satisfies all required criteria set by our client. To do this, we will need to develop a fully comprehensive, Hi-Fi, physical model that represents our finalized design. This prototype will be an exact representation of how our current design works. This final round of testing will allow us to either confirm that our design is successful, or if it requires slight changes to improve performance before submission.

2.1 Objectives

In our previous prototypes, we tested the portrayal of ethical concerns, and the functionality of our scanning function. The portrayal of ethical concerns surpassed our minimum requirement, allowing us to move forward in our design. After multiple rounds of iteration, our scanning function was successful in simulations. Keeping the results of previous prototypes in mind, we

can move forward to test how these aspects perform in real life conditions. In our last deliverable, we defined a testing plan for this prototype. Since this is our final prototype to be tested, we need to test all aspects of our design to check if it meets the required design criteria, or falls short. Our testing plan is as follows:

Test #	Reason for Prototype	Evaluation Criteria	Metrics	Test Description	Analysis Method	Why?	Stopping Criteria
1	Robot Functionality	If the robot can execute the implemented functions.	Pass/Fail	A full playthrough of our game will be run using the robomaster and test players. We will record if the robomaster executes the following functions: Translate in the correct direction, identify new cards, eliminate or pass each new card, perform all 3 rounds successfully, execute implemented lighting and auditory functions.	Each function will be given a pass or a fail. Our team will also observe the gameplay. After testing, any failed functions will be modified to eliminate any current errors. Our observations will be used to determine if any minor changes will be needed to maximize performance and the quality of our gameplay.	Testing has only been done in a simulated setting. Conducting tests with real conditions allow us to see how well the robomaster performs in varying conditions. One of our most important design criteria is to implement a smooth, error free code. This allows us to determine if our design functions properly in real life..	We will conduct 3 tests of full gameplay. If changes are required, the code will be modified then another 3 tests will be conducted. We will stop testing when our required criteria is met.
2	Ethical Message Clarity	If at least 3 ethical concerns are seen by potential users.	Survey	Peers will be asked to participate in, or watch a video playthrough of our prototype. They will then be asked to fill out a survey containing the 9 ethical concerns set by MAC.	Results will be analyzed to determine the percentage of each ethical concern seen by users. This will allow us to determine if our design meets the required minimum of 3	This will allow the group to verify if our design is successful or not. If required 3 ethical concerns are not met, design changes will be	Testing will conclude once a minimum of 15 potential users have been successfully surveyed.

				Each concern seen by the user will be recorded.	ethical concerns demonstrated.	required before final submission.	
3	Robot timing	If our game run time is within constraints. How the gameplay “feels”.	Pass/Fail	We will conduct a playthrough of our game. We will record the time of each round and of the entire game. Notes will be taken on how the game “feels” based on the timing such as if it feels rushed or too slow.	The recorded times will be compared against our time constraint of <10 minutes. Notes will be taken into consideration to determine if round length should be increased or decreased if constraints allow.	MAC stated that our design must be less than 10 minutes. We need to verify that our design meets this requirement as failure to do so would result in a failed design.	Full game playthroughs will be conducted. After each playthrough, the timing will be adjusted based on our results. Testing will conclude once both our time requirement is met, and the team is satisfied with the timing of each round.

2.2 Expected Outcomes

Before testing starts, it is expected that we will run into some errors. In terms of illustrating the ethical message, we are confident that this criteria will be satisfied as our prototype tested for this aspect provided excellent results. We do believe that the robot functionality and timing will result in some needed modifications. The simulations that were run in our second prototype allowed us to write the code in a way that reduced errors, but the real life application of the code has potential to reveal some unexpected areas of error. Mobility has been a concern of ours considering that the simulation provides perfect conditions. In reality, the surface that the RoboMaster is moving on will not be perfect. Conditions such as smooth or rough surfaces will determine the RoboMaster’s traction and overall distance traveled. Another aspect that is expected to run into error is the RoboMaster’s scanning ability. Since the RoboMaster uses a camera for all scanning functions, the light conditions play a huge part in how effective this will be. In terms of timing, we have designed our game with a theoretical run time. When actually

playing the game, how the players feel will determine how fast or slow our game should run. Players may feel rushed from quick play time, or bored from slow play time. This is something that requires the final comprehensive prototype to test as it is a qualitative measurement where immersion is needed to determine results.

2.3 Contingency Plans

There are 3 criteria that are being tested for this prototype. Therefore, we will set 3 contingency plans to account for failure in any aspect.

For the illustration of ethical concerns, if our success criteria is not met, our design will need extensive modifications. To deal with this, we will hold an emergency meeting where all group members will present potential ideas. Past concepts will be revisited, and all new concepts will be recorded. Due to time constraints, the new concepts will need to be somewhat similar to our current design as we will not have the time to start from scratch. A vote will take place to determine our new concept. Our respective roles will be used to determine workload. If one member feels that another member is better suited for the role based on skill set, potential role swaps will take place. A new test plan will be developed to test the new design.

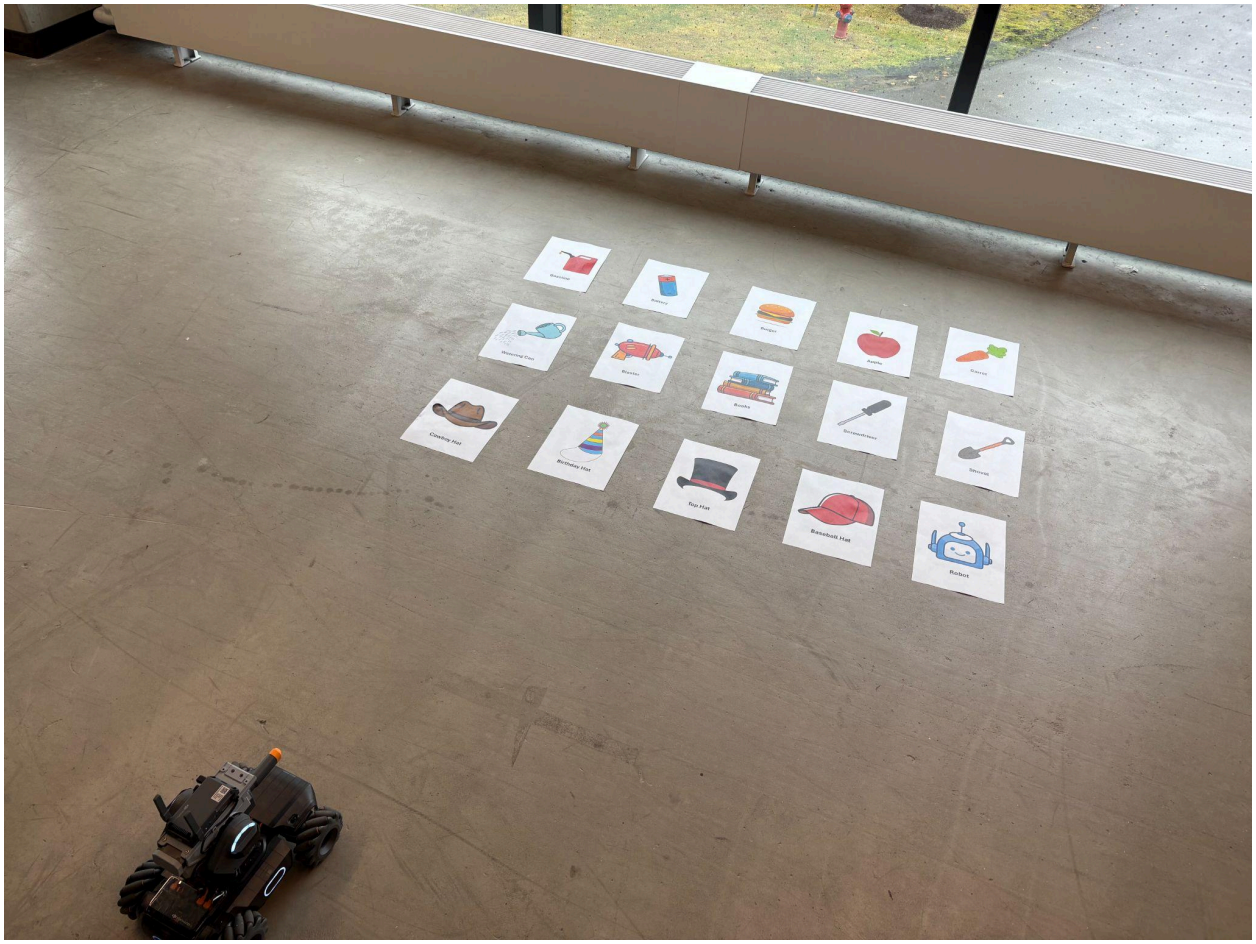
For robot functionality, there are multiple aspects to consider. If precision is below minimum requirements for the mobility functions, we have a fall back code that simplifies the robot movement. The fall back code consists of a “scanning area” where players will move into when

attempting to prove their status as a civilian. This removes the need for mobility as the RoboMaster will not need to move down a line to scan and can remain stationary. Since mobility is not a critical component in our design, this is something that can be interchanged without negative effects. To deal with error in sensing capabilities, the same fall back code simplifies the needed scanning capabilities. When switching to the stationary position for the RoboMaster, the RoboMaster will no longer need to keep track of previously scanned markers. The player identification function will replace this, simplifying the code to ignore the markers completely and randomly eliminating a preset percentage of players per round. For example, a 5 player game will eliminate 2/5ths of players in the first round chosen randomly, 2/3rds of players in the second, and the remaining player in the third. To accommodate for errors in lighting and auditory functions, these will be replaced with a higher involvement of the game master. The game master will narrate rounds, explaining to the players what exactly is happening.

Errors in run time will be easily fixed by extending or shortening wait times in the code, or by adding additional rounds. These both are not critical aspects and modification will not affect the overall effectiveness of our design.

2.4 Design

At this point in the project the RoboMaster is available for testing and use. A dry run of the experience was set up with prototype cards and the group members playing as the users and testing was conducted. See image on the following page.


Cowboy Hat
Birthday Hat
Top Hat
Baseball Hat
Robot

Initial setup of game area. Includes RoboMaster S1, 15 symbol cards laid out to be picked by players.

The team conducted a playthrough with 3 players. All players have selected their cards and are awaiting their results from the robomaster.

IMG_4364.MOV

The team conducts a modified playthrough with 5 cards (extra time given to users to pick cards was removed to test specifically how the RoboMaster is performing, 5 cards were held up to simulate 5 players).

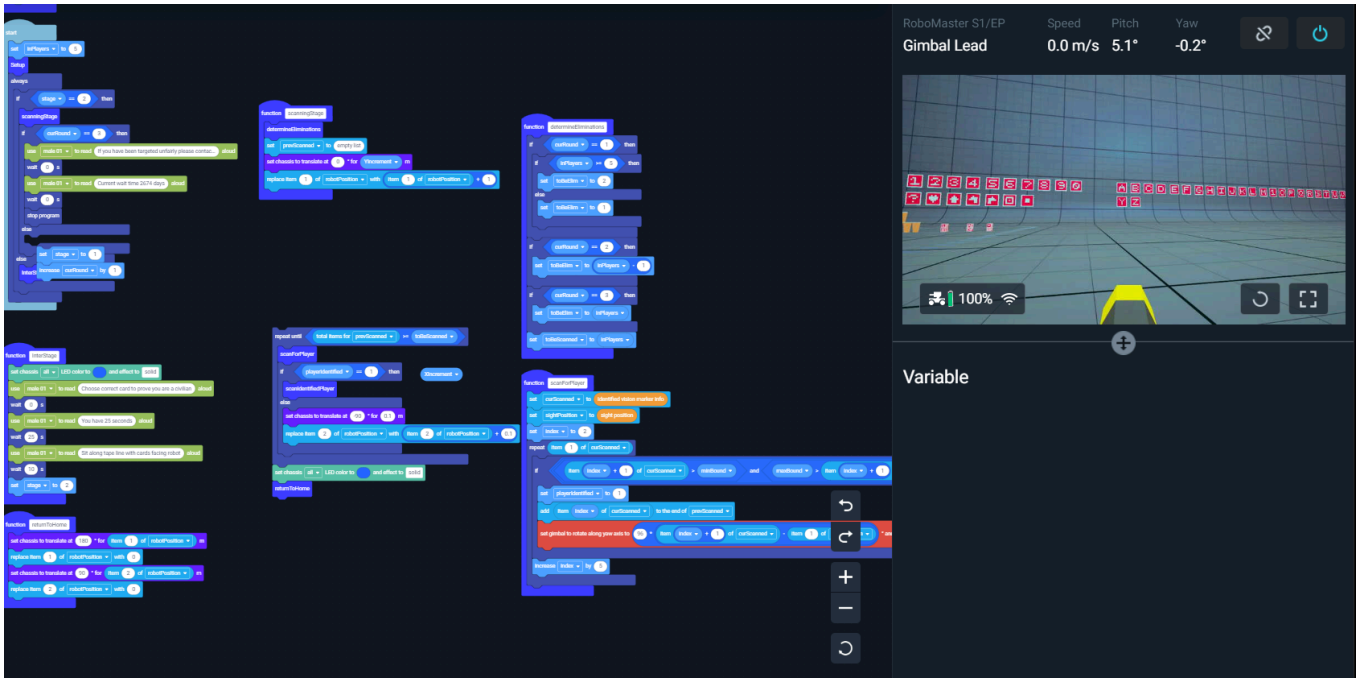
3. Testing

3.1 Functionality Testing

Basic functionality was achieved readily in the DJI education hub, with some adjustments made to improve readability of code. However, several problems were quickly encountered in real world testing. The voice lines feature was unexpectedly non-functional, despite software previously indicating otherwise. Movement precision was abysmal, especially with the smaller wheels that allow omnidirectional travel. Several game constants needed to be adjusted, such as the distance the robot travels before checking if a new target is within view. At the end of the trial period, full functionality was achieved, with the exception of voice lines.

3.2 Potential user feedback

Improvement to the prototype requires feedback. Surveys are a simple way to achieve this. In testing we displayed video of the robot, then asked potential users to rate the prototype on the following categories: Ease of use, Understandability of robot instructions, Ethical messages clarity. These categories are ranked from 1 to 5 (5 being great). With the prototype in place, we will observe how users interact with it, and it will give ideas about how it does or does not work. Detailed questions about their experience in the interviews. Feedback from them was recorded and will be used to improve the prototype.



3.3 Results

Test	Name	Test results	Score (1-5)	Comments
Robot Functionality	Marcel Ocampo	Pass	**5**	Subsystems worked perfectly under stress tests.
Ethical Message Clarity	Joey Darwish	Pass	**5**	Message delivery was clear to users.
Timing Adjustments	Mark Leah	Pass	**4**	Timing matches user interaction well, maybe slightly long.
User Perceptions	Joey Abbas	Pass	**5**	Users understood the robot actions.
Symbol Readability	Elie Khoury	Pass	**5**	Recognized symbols in various light conditions, and height of the card

3.4 Changes Made

Several changes to the finalized code were made. The movement was adjusted such that the robot only moves in one direction, reducing position tracking error, and allowing exclusive use of the more reliable larger wheels. The position increment before scanning was increased, and the scanning window was enlarged to compensate. This also increased position tracking precision. The code structure was also altered significantly, with more functions used, increasing readability. These modifications were made in a series of Iterations.

Iteration	Adjustments made
1	Basic functionality achieved.
2	Formatted so adjustable constants (position increment before scanning, scanning window size) are separated, timings added without value.
3	Code structure overhauled for readability.
4	Voice lines removed due to failure.
5	Movement simplified to 1D.
6	Positions, gimballing adjusted to make use of larger wheels, default gimbal angle increased in pitch.
7	Timings set, constants adjusted.

Additionally, due to detection issues with cards, the blank borders were enlarged, to allow users to hold them properly, without causing scanning issues.

Voice line functionality is still being investigated, however the contingency plan of using staff to organize the game is viable.

4.1 Prototype Justification

The prototype II was important as it dealt with improving RoboMaster to read and scan symbols during gameplay. Key functions such as scanning visual markers; identifying if it was a new one or an old one already scanned; and pointing and firing accurately were all tested. This was essential for the robot to work reasonably well in real world situations. In fact, for Prototype III, we are working to build on the success of our Prototype II, making the system even better. The main thing it will do is to eliminate errors, increase clarity, and make sure the robot fits the needs of the user. Combined with earlier designs the prototype in the new will be easier to use and more effective. Prototype III is the best solution because it solves problems for users and continues to rise to meet their needs as more functionality and clarity is added.

4.2 Creating of Test Plan

For Prototype III, the test plan has been designed to ensure the robot works as expected and is easy for users to use. The first test will be to see if all the pieces of the robot function correctly. If the robot has no problems with completing its tasks, this will be judged successful. The second test will test the ethical message. Surveys will be used so that users will be asked to rate the message according to how clear and very effective it was. A second test will confirm that the robot’s actions occur in a way that complements those of the users. Based on feedback, adjustments will be made to the timing necessary. Then, the robot will be tested in qualifying for next lighting and angles symbols. The robot can function well in real world situations. The last test will be how the users understand the robots instructions. Users will rate how clear it is when the robot uses lights, lasers and audio to communicate. Importance for each test is because it

plays a role in helping the robot reach its goals. The team can then test specific features and then test feedback to get an improved and more functional and user friendly design.

5. Finalized Design

Now that our prototyping and testing phase has concluded, we have defined what our final design will be. Multiple rounds of testing and iteration has led our team to produce a high quality product for our client Mines Action Canada. We have designed our product to satisfy all set requirements and fit within the given constraints.

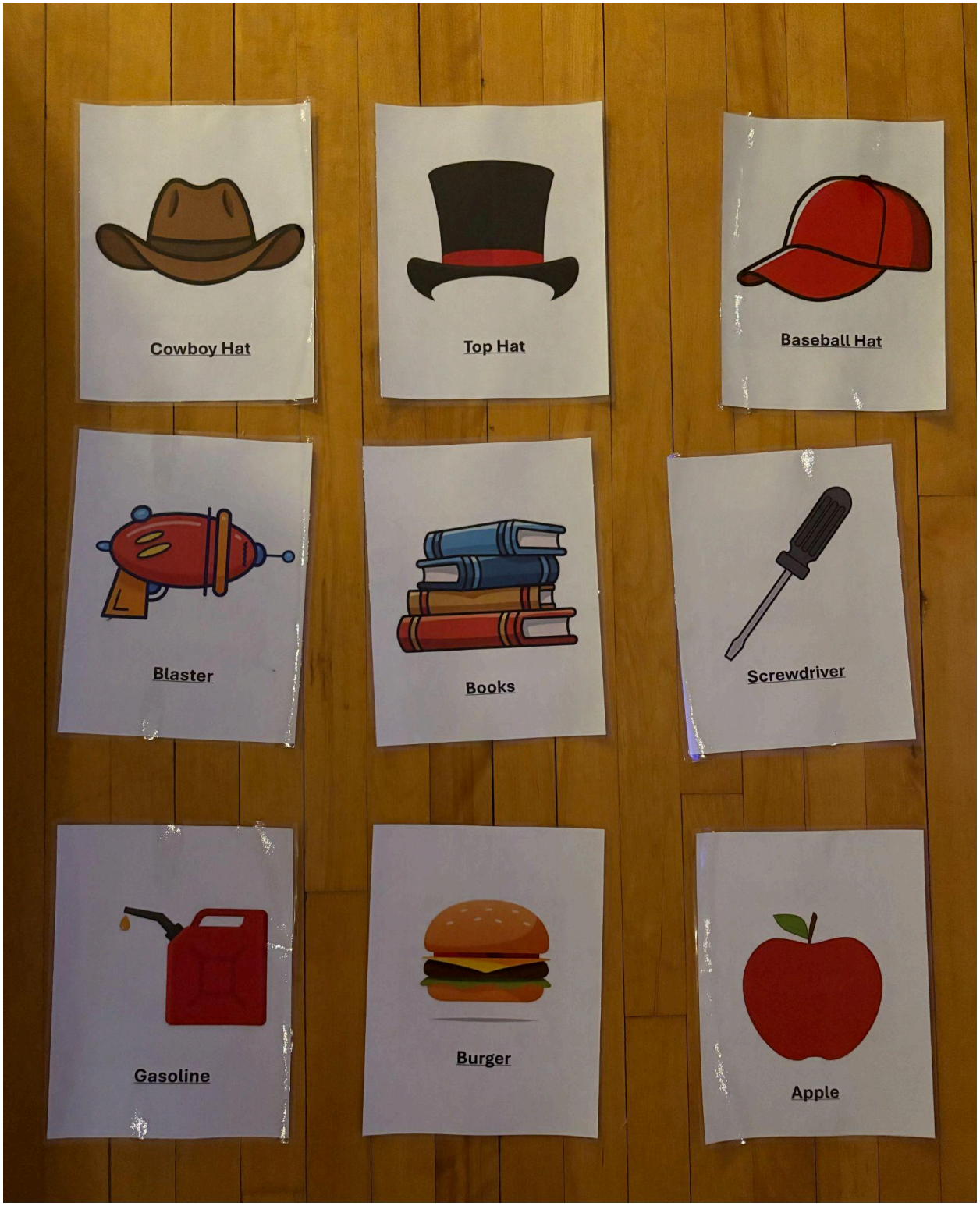
5.1 Gameplay

Our developed immersive experience consists of players choosing symbol cards to prove to the RoboMaster that they are a civilian. There will be 3 rounds of gameplay where players will attempt to problem solve to avoid elimination by figuring out what cards will successfully prove that they are a civilian. Once a card is chosen, players will sit in a line and hold their chosen card in front of them. The RoboMaster will move down the line, scanning each player and their card to determine if they are eliminated or not.

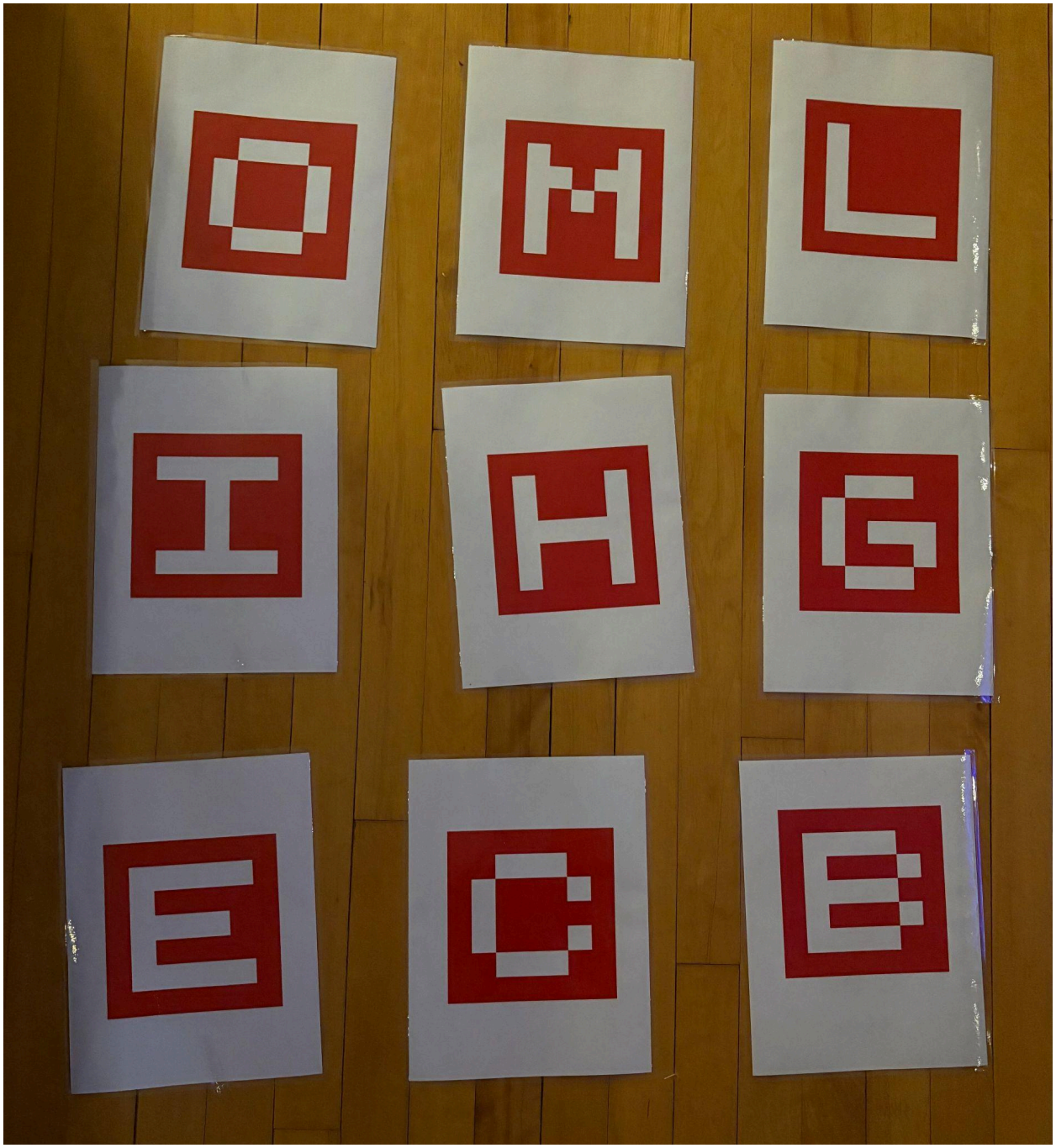
5.2 Symbol Cards

15 laminated symbol cards have been chosen. The cards were designed to have certain symbols that seem to be a good choice when proving they are a civilian, and some that seem

like it would result in elimination. On the back of the card, there is a RoboMaster recognized symbol that we have incorporated into our code to allow a proper functioning scanning process. Our cards are as follows:

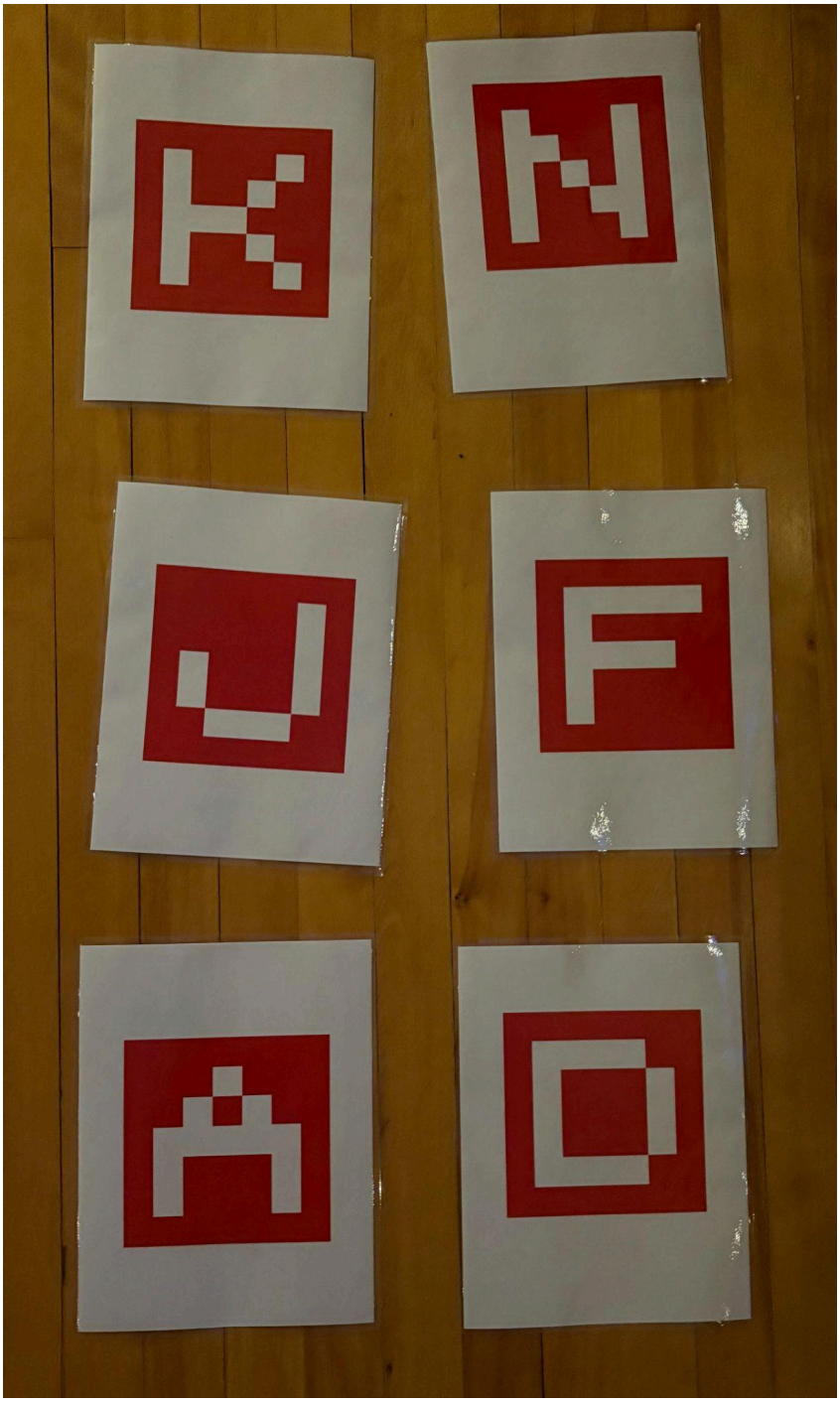


Front of the first 9 cards displaying the symbols for players.



Back of the first 9 cards showing the RoboMaster recognized symbols.

Front of the remaining 6 cards showing the symbols for players.



Back of the remaining 6 cards showing the RoboMaster recognized symbols.

5.3 Connection to Ethical Concerns

Our team has aimed to display the following ethical concerns: Digital dehumanization, algorithmic biases, loss of meaningful human control, lack of human judgment and understanding, lack of accountability, inability to explain what happened or why, impact on our relationship with technology

Digital Dehumanization

In our design, the RoboMaster does not process the players as humans, but as an input of data. This is demonstrated through the scanning process. The players present themselves to the RoboMaster with the hope of proving that they are a civilian. Regardless of the fact that all players are technically civilians, the RoboMaster does not perceive them as so.

Algorithmic Biases

In our code, the decisions of the RoboMaster are purely based on a predetermined data set. In each round, the RoboMaster takes the input of a player and determines elimination or not based on the implemented algorithm. The fact that the RoboMaster makes a decision based on the program, displays how a potential lethal autonomous weapon would eliminate an actual civilian based on a predetermined data set.

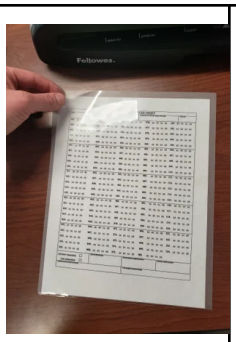
Loss of Meaningful Human Control

In our design, the game master only has control over the amount of players. The game master will have no control over how the RoboMaster will make decisions. All the game master does is start the RoboMaster. Relating this to the real world, a lethal autonomous weapon would be set out by someone, but once they set the lethal autonomous weapon, they will no longer have any control over it.

6. Costs

6.1 Final Prototype BOM

Part Name	Description	Quantity	Units	Part Image	Unit Cost (CAD)	Amount (CAD)	Supplier
3M™ Multi-Purpose Duct Tape, 3920-YL, Yellow, 1.88 in x 20 yd	A role of Yellow tape. Used to mark boundaries .	1	Roll		$6.37	$7.30	Walmart
Colour, 1 sided printed page,8.5 x 11 inches	Custom colour printed page. Used for game cards.	30	Pages		$0.25	$7.50	University of Ottawa

Laminated paper, 8.5 x 11 inches	Laminated letter sized papers to create game cards.	15	Pages		$2	$30	Staples
Total						$44.80	

7. Conclusion

It is extremely important to create and test various prototypes before the final project has been decided and submitted. These prototypes help to identify the challenges within the project and areas of improvement or areas that meet the needs of the client. The tests conducted by the group ensures that the final project is functional, effective and efficient. Feasibility, functionality, purpose, application, and fulfillment of the client needs were most recently tested and covered in the third prototype above. The most recent and past prototypes will be taken and combined to ensure a memorable and meaningful experience is created for the users.

8. References

1. *RoboMaster S1 - DJI*. DJI Official. (n.d.). https://www.dji.com/ca/robomaster-s1
2. *3MTM multi-purpose duct tape, 3920-yl, yellow, 1.88 in x 20 yd, 1 per pack*. Walmart.ca. (n.d.). https://www.walmart.ca/en/ip/3m-multi-purpose-duct-tape-3920-yl-yellow-yellow/6000197362032
3. *Lamination services. Staples.com. (n.d.). https://www.staples.com/services/printing/in-store-printing/laminating/*
4. *Print, copy, Scan*. Library. (n.d.). https://www.uottawa.ca/library/services/print-copy-scan