GNG1103

Design Project User and Product Manual

Hot Zone Havoc

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December 3rd, 2024

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Table 1. Acronyms

Acronym	Definition
BOM	Bill of Materials – The list of required materials and their costs
FOV	Field of View
FPV	First-Person View
HZH	Hot Zone Havoc – The name of the immersive game experience
LAWS	Lethal Autonomous Weapons Systems
UPM	User & Product Manual

Table 2. Glossary

Term	Acronym	Definition
DJI Education Hub	N/A	The software used to develop the code for the game experience
RoboMaster S1	N/A	The robot programmed and used in the game
Operating System	N/A	The software that supports the basic functions of a computer.

1 Introduction

This User and Product Manual (UPM) provides the information necessary for a diverse range of users to effectively use Hot Zone Havoc (HZH) and for prototype documentation. This document is meant to provide comprehensive information for using and understanding HZH. The manual does not require a technical background and is written to be applicable for all users. The primary objective of the UPM is to ensure HZH can be managed, operated, maintained, and, if needed, further developed. The overview describes the purpose behind and reason of importance of HZH, expanding on the user needs and the game's unique features that differentiate it from other products. Section 3 explains the software used to run the RoboMaster S1, DJI Education Hub. This section guides readers through the setup and understanding of the operations of DJI Education Hub, as well as connecting it to the RoboMaster S1 and how to start and exit the program. Section 4 describes the system's game mechanics in-depth, detailing each of the three parts of the program and their functionality. Section 5 provides troubleshooting and support details, explaining procedures in dealing with and preventing errors, maintenance and cleaning guidelines, and contacts for support and repair requests. Section 6 describes the development process, explaining each component used, its materials, total cost, and the instructions on how to recreate it. Section 7 summarizes the key lessons learned and challenges along development, as well as improvements for future iterations.

2 Overview

A need exists for Mines Action Canada to demonstrate the ethical concerns regarding LAWS through a simple, portable, and immersive experience with a RoboMaster S1, where players can grasp the severity of losing human control.

2.1 Reason of Importance

2.1.1 Human Control and Accountability

With the increasing autonomy of weapons systems, there is a pressing need to maintain human control over life-and-death decisions. The implications of losing this control are profound, affecting not only the principles of warfare but also the legal and moral accountability for actions taken by these systems.

2.1.2 Ethical Considerations

The ethical implications of using LAWS are vast, impacting international humanitarian law, human rights, and the potential for misuse or unintended consequences in conflict situations.

2.2 Fundamental User Needs

For the interactive experience HZH, fundamental user needs center on creating an engaging and impactful experience. Players require an experience that accommodates 3-5 participants and should allow for multiple playthroughs, which encourage player interaction. The game should be engaging, with a well-balanced pace that keeps participants invested without feeling rushed or over-extended. Therefore, the experience should last from 5-10 minutes total, in a round-based format. To illustrate the ethical concerns, players require immersion, to feel the severity of losing human control in warfare, without providing a sense of victory in the game. Clear instructions and rules are also a fundamental user need, to minimize player frustration due to dysfunctional game mechanics.

2.3 Unique Features

2.3.1 Interactive Experience

Rather than simply observing or digitally playing, participants must physically interact with the game and with the RoboMaster S1, which allows them to engage in a game that is both unpredictable and beyond their control. This interactive format makes the ethical impacts of the game more memorable and impactful, leaving a lasting impact on participants.

2.3.2 Compact, Portable, and Scalable

Since this experience is designed to fit in a carry-on suitcase and operate in a 20’x20’ space, the game is highly portable. It involves no physical set up on the ground aside from placing the RoboMaster S1 in the centre, and the physical props (player ID tags and cube) are simple and minimal. The play zone can also be scaled to be larger or smaller by adjusting the code.

2.3.3 Intuitive

Our game uses elements of well-known games to make it straightforward and easy to understand. The cube acts as a “hot potato” that players must constantly throw around to avoid being the ones to hold it when the robot enters the scanning phase. The scanning phase is like “red light, green light”, where participants must freeze in place.

Figure 1. Final prototype in use

2.4 Key Features

2.4.1 Ethical Concerns Demonstration

One key feature of HZH is its ability to strongly demonstrate necessary ethical concerns regarding the use of autonomous weapons in warfare, such as digital dehumanization or lack of human control.

2.4.2 Multiplayer Support

This experience can support gameplay for a variable number of players, encouraging co-operative and competitive dynamics. Players must work together to avoid the robot while also competing to survive, enhancing the interactive experience.

2.4.3 Easy Setup

The simple nature of the game allows for better accessibility in terms of set-up, with minimal physical props and straightforward connection methods. This ensures quick deployment and reduces barriers to entry for new users.

2.5 System Architecture

2.5.1 Visual Recognition System

The robot is equipped with visual marker recognition abilities and a built-in visual sensor, which are enabled during the scanning phase to allow the robot to identify and eliminate the players and the cube.

2.5.2 Random Movement and Targeting

The robot is programmed to randomly move within a defined 10’x10’ space and eliminate players based on a randomly selected number.

2.6 User Access Mode

2.6.1 Setup

The RoboMaster S1 is placed in the center of the play zone. Players wear an ID tag, and one player is given the cube.

2.6.2 Starting the game

Ensure Wi-Fi connection with RoboMaster S1. Upload correct game file to “DIY Programming” in DJI Education Hub and press the “start” button.

2.6.3 User Interaction During Game

User interaction consists of passing the cube, avoiding bumping into other players, working with teammates to avoid proximity to the robot, and freezing when the robot enters the scanning phase.

2.7 Cautions & Warnings

2.7.1 Eye and Face Protection

Users must take protective measures, especially for the eyes and face, when using the laser. They should take careful measures to avoid looking directly into the beam, as this can harm vision.

2.7.2 Avoidance of Water and Extreme Temperatures

The RoboMaster S1 and its components, especially the battery, should not come into contact with water or be used in extremely hot or cold environments. Should this occur, immediately power down the device and dry it as quickly as possible.

2.7.3 Maintenance and Care

Regular maintenance is required to ensure the RoboMaster S1 operates correctly and safely. This includes ensuring both battery packets are continually charged to full capacity and taking the appropriate measures to clean the exterior of the RoboMaster S1 depending on the environment it was used in.

2.7.4 Gimbal

When the gimbal is in use, do not touch the metal parts on the inner side of the pitch motor as it may become hot. When powering on the gimbal, do not touch the gimbal to avoid being injured

by the rotating shaft and avoid moving the chassis so that the self-test can be completed smoothly. Do not apply external force to the gimbal after the gimbal is powered on.

2.7.5 Cube

Handle with care as the cube may be fragile. Avoid removing the electrical tape on the corners of the cube, as this will expose the sharp edges, which can cause cuts or other injuries during handling, assembly, or cleaning. For your safety, please follow the following precautions:

1. Use protective equipment: It is recommended to wear gloves to protect your hands when handling or cleaning parts with sharp edges.
2. Avoid contact with sharp parts: during the operation, try to avoid direct contact with any sharp edges or points.

2.7.6 Child Monitoring

Do not allow children to touch or operate the RoboMaster S1 without adult supervision to prevent accidental injury. Additionally, ensure to store properly after use, out of reach of children and pets, ensuring that sharp parts are securely covered or wrapped.

3 Getting started

3.1 Using the RoboMaster App

If you have used a RoboMaster before, you may skip this step: (appendix RoboMaster S1 - Quick Start Guide v1.4 (EN))
Download the RoboMaster app: https://www.dji.com/cn/robomaster-s1/downloads

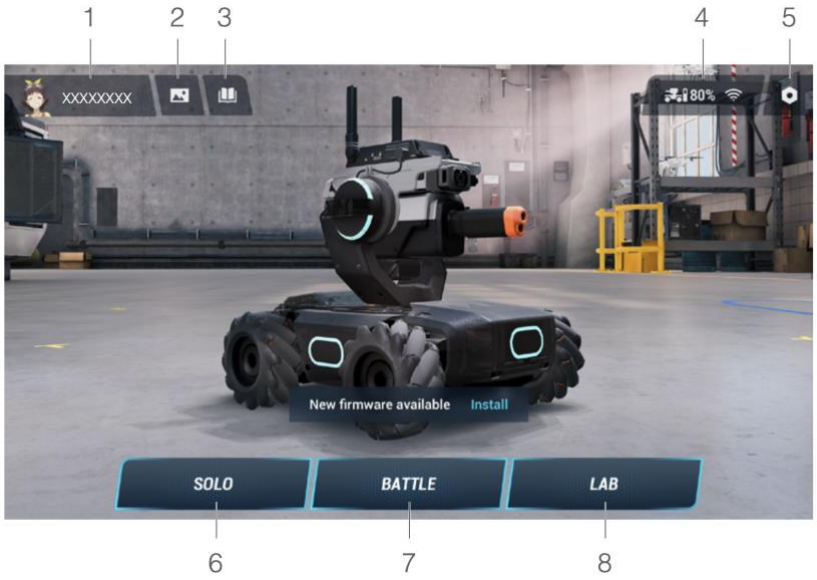

Figure 2. RoboMaster app main page[i]

1. Account: Tap to log in and log out of your account, modify your avatar, name, and gender information. An internet connection is required to log in.
2. Media library: click to view video and photos
3. Guide
    a. Product support
    b. Maintenance support
    c. DJI user manual download page
    d. Vision mark download page
    e. Online support
    f. Feedback
4. Connect: tap to see a guide how to connect via Wi-Fi or router
5. Setting: Robot, Connect, Display, Control, and System can be found in system
6. Solo: tap to enter solo mode
7. Battle: tap to enter battle mode
8. Lab: DIY Programming: Both Scratch and Python are available for programming

3.2 Connecting to the RoboMaster S1

Step 1: Set the **antennas to 90°**, then make sure the **battery** is **fully charged** and **properly inserted**.

Step 2: **Turn on** the RoboMaster **using** the **power button located at the bac**k. To turn on the RoboMaster press and hold the power button for **more than two seconds** to turn on or off

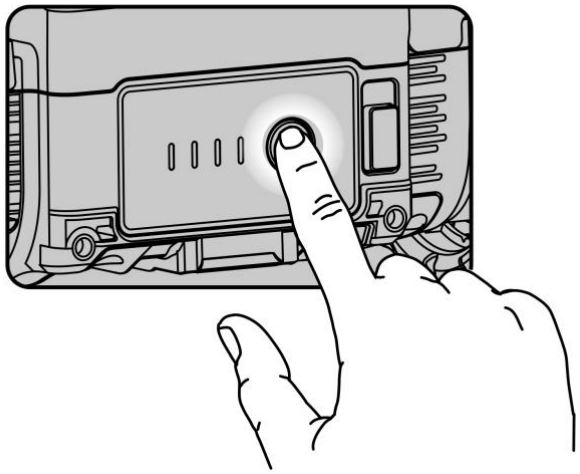

Figure 3. Power button on RoboMaster S1[i]

Step 3: On the **side of** the RoboMaster S1 **gimbal**, **slide the switch** to set the mode to intelligent.

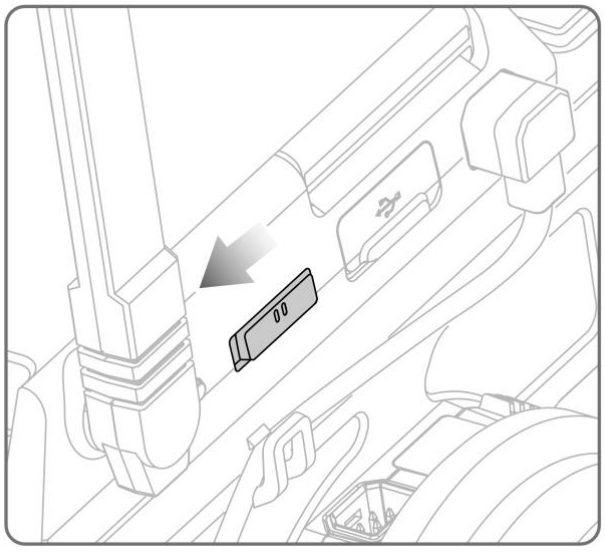

Figure 4. RoboMaster mode switch[i]

Step 4: **Connect** to the RoboMaster S1 **via Wi-Fi**, look for **RMS1-XXXXXX** (where XXXXXX is replaced by the number on the top of the gimbal). The default **password** is **12341234**, however this will also be shown on the top of the gimbal.

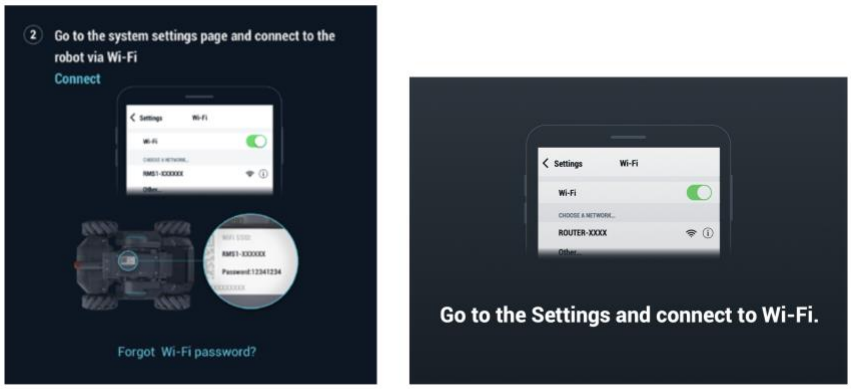

Figure 5. Wifi connection to the RoboMaster S1[i]

Step 5: In the RoboMaster app press Continue and then Next to get to the main page.

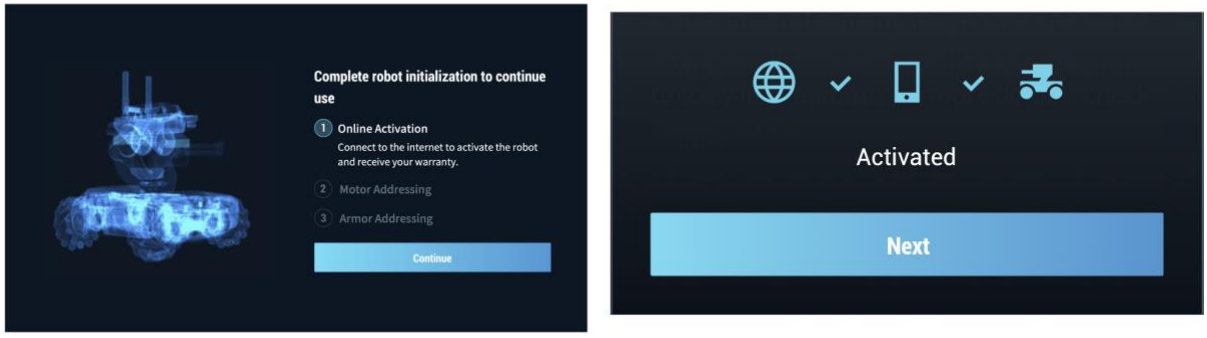

Figure 6. Completing the connection to RoboMaster S1[i]

3.3 Importing Code into DIY Programming

Step 1: On the main page select **Lab**
Step 2: Enter **DIY Programming** and select **DSP**+

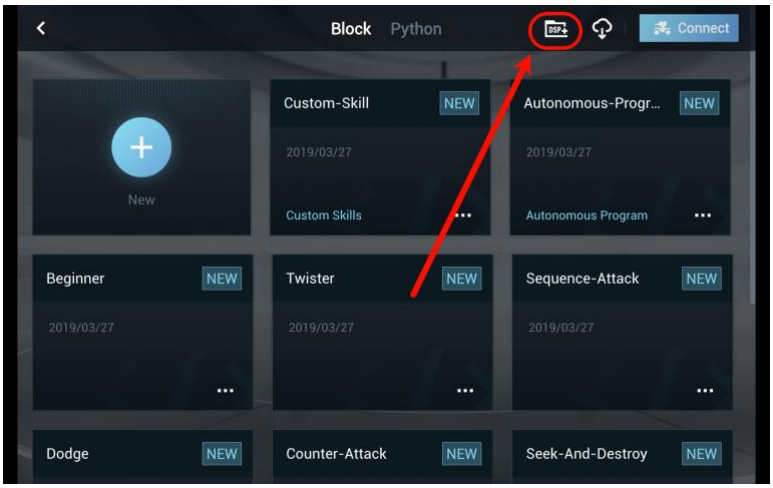

Figure 7. DIY Programming home page

Step 3: In the window that pops up you can **select the code files** you wish to import

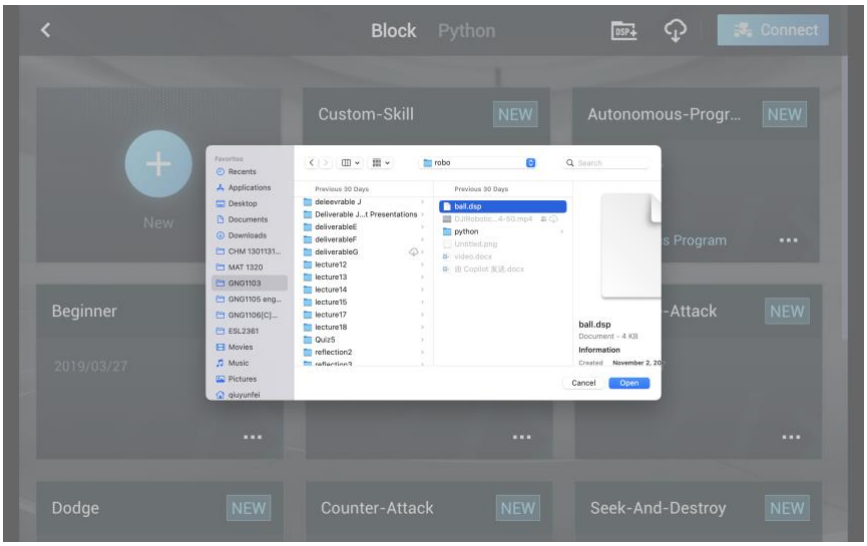

Figure 8. Import page

Step 4: To enter the code file that was just imported, **click directly on the newest file**.

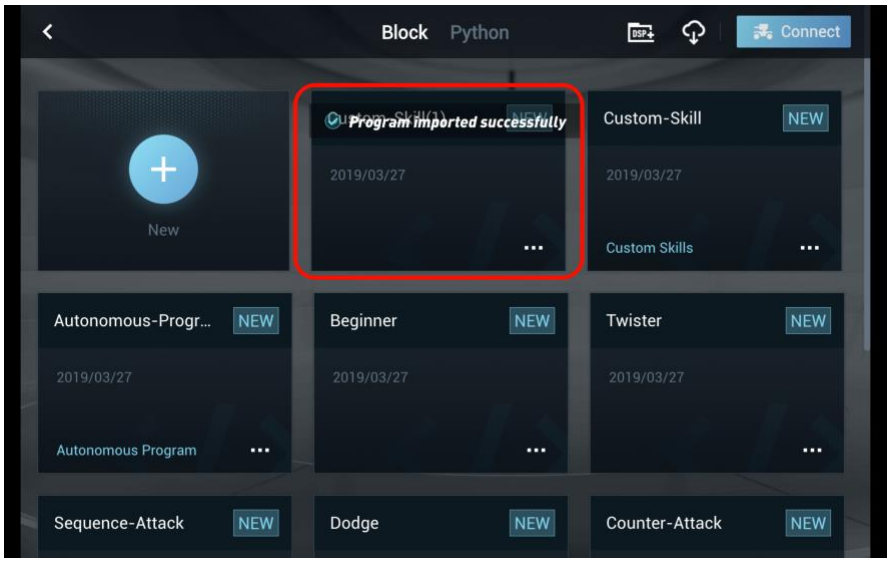

Figure 9. Updated homepage with imported code file

3.4 DJI Education Hub Interface

When a coding file is opened or created on the DIY Programming the following screen is shown. Familiarize yourself with the controls.

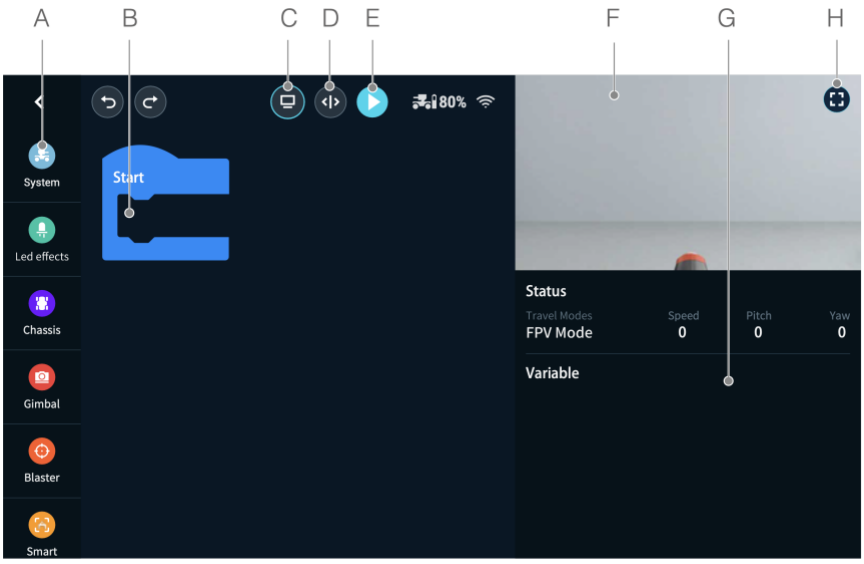

Figure 10. DJI education Hub coding screen[i]

A. Programming modules button: Tap the corresponding icon to program System, LED Effects,

Chassis, Gimbal, Blaster, Smart, Armor, Mobile Device, Media, Commands, Operators, and Data Objects.
B. Programming window button: Drag programming blocks into the window to create a program.
C. Display button: Tap to turn the FPV on or off.
D. Switch button: Tap to switch to view the programming block as Python code.
E. Run button: Tap to run the program.
F. FPV window: See the current FPV.
G. Status information: View the status information of the S1.
H. FPV button: Tap to enter the FPV in full screen

3.5 Exiting

To exit the program:

1. Pause the running code - In the RoboMaster app, click pause button above the code interface.
2. Disconnect link between app and RoboMaster by selecting a different Wi-Fi network.
3. Shut down the RoboMaster S1 by pressing and holding the battery power button for at least two seconds. This is located at the rear of the chassis.

3.6 Configuration Considerations

The chosen physical environment may be outdoor or indoor; however, ensure that terrain is not rough, as the RoboMaster S1 is susceptible to changes in direction which can alter the designated play area. The play area is intended to be 20'x20'; however, it can be adjusted to be smaller, as the default maximum distance that the robot is allowed to travel is set to 10'x10'.

To communicate the code file to run on the RoboMaster S1, alternative methods can be used; however, the most effective method is to connect a laptop with the appropriate program to the RoboMaster S1 via its local Wi-Fi. Other methods include a USB connection, a 3rd party Wi-Fi host, or a wired connection. As a wired connection is impractical for gameplay, avoid these methods.

To use the DJI Education Hub with the RoboMaster S1's local Wi-Fi, connect to the correct network and password as displayed on the top of the gimbal with your personal device.

3.7 User Access Considerations

This educational prototype has the potential to be used at schools, conferences, festivals, or otherwise popular events with the intention that people of all ages can participate. However, based on the content matter and nature of the gameplay, young users may face some restrictions. The

physical cube is 0.53 kg and thus may pose an issue for those without fully developed hand-eye coordination or mobility issues to throw with ease.

In terms of visibility, the RoboMaster S1 has limited target recognition capabilities; therefore, the vision sensor is preset to a default angle to ensure targets are identified as accurately as possible. This means young children may not be easily recognized, as they may not meet the minimum height requirement to be within the RoboMaster S1's FOV.

3.8 Accessing/setting up the System

To set up the physical play area, ensure that all ground obstacles are removed from the chosen 20'x20' space. Place the RoboMaster S1 in the center of the play area, facing the front, side, or back. Do not place the robot on an angle. Give each player one ID tag, ensuring that there is nothing obscuring the target, such as hair or accessories. Give one player the cube at the beginning of the game.

Open DJI education hub. Log into your account. If you do not have one, you may create one now. Once you are logged in, open DIY programming and upload HZH as a .dsp file. Once the code has uploaded, you can adjust the round timing, boundary settings, and number of players between 3 and 5. Then you can press start.

3.9 System Organization & Navigation

3.9.1 Player ID Tags

Each player will wear a tag with visual markers numbered 1 to 5. The tags allow the players to be identified and eliminated by the RoboMaster S1, as visual marker identification of numbers 1 to 5 is integrated into the code and enables the elimination mechanic, where the RoboMaster S1 stops rotating, turns its LEDs red, and plays a hit sound effect.

3.9.2 Cube

The cube to be thrown around has the visual marker "O" on each face to allow the RoboMaster S1 to identify the cube and eliminate the player holding it. The program is set to stop rotating once the visual marker is identified, then turn LEDs red and play a hit sound effect to display elimination.

3.9.3 Program

The program consists of three functions: the 30 second random movement phase, the cube identification and elimination in the scanning phase, and the player identification and elimination in the scanning phase. All functions are placed one after another in the listed order to create a loop that repeats the rounds. Details about each induvial function are under section 4.

3.10 Exiting the System

Once the game is over, players must take off and return the ID tags worn. The cube should also be returned. Return the RoboMaster S1 back to the center of the play zone. The game program is set to loop rounds, but it is not set to stop autonomously since number of rounds may differ between games. Once all players are eliminated, click on the blue “stop” button in the top left corner of DJI Education hub to stop the program.

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of HZH.

4.1 Random Movement.

The random movement phase marks the first half of the game, where the robot moves randomly within a pre-defined 10’x10’ space. The robot moves at 1.2 m/s, turns at 200°/s, and moves a random distance between 2’ and 4’. It works by selecting a random number 1-4, each corresponding to a direction, turning left or right to face that direction, and then translating forward. The random movement begins immediately after clicking “start” on DJI Education Hub.

4.1.1 Boundary

To stay within the boundary, the robot tracks and records coordinates after every move and is set to not go beyond 10’x10’.

4.1.2 Timer

The random movement is set to go on for 30 seconds, starting as soon as the program is run.

4.1.3 Avoiding proximity

The rules state that the players must constantly be moving around while the robot is in the random movement phase. However, this is for the purpose of adding an extra element that makes the game feel more threatening, and there is no code to detect the players' proximity to the robot.

4.2 Throwing the Cube

The cube is like a "hot potato", where players must constantly throw it to another player to avoid being the ones holding it when the 30 second random movement phase ends. There is no code to track the cube while it is being thrown, as the robot only starts looking for it during the scanning mode.

4.3 Scanning mode

Once the 30-second random movement phase ends, the robot enters a scanning mode, where it stops in place, moves the gimbal up 22° for a better view, and rotates to identify the cube and then a randomly selected player ID number.

4.3.1 Cube Identification and Elimination

Vision marker identification is enabled, and the robot is set to rotate in 15° increments for 3 rotations while looking for the visual marker on each face of the cube, the letter "O". If the cube is identified, the robot stops rotating, sets its LEDs to red and to blink three times, and plays a hit sound effect to show elimination. If the cube is not identified within three complete rotations, the robot moves on to the player identification and elimination.

4.3.2 Player Identification and Elimination

Vision marker identification is enabled, and the robot selects a random number from 1-5 and rotates in 15° increments while looking for the player ID with the visual marker of the random number selected. If the visual marker is identified, the robot stops rotating, sets its LEDs to red, and blinks three times, and plays a hit sound effect to show elimination. If the visual marker is not identified within three complete rotations, the robot selects a different random number, and this process repeats until a player is eliminated. This loop is there so that if a number corresponding to a player that is already eliminated gets selected, we can ensure another player that is currently in the game will get eliminated.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

5.1.1 Connection Error

Ensure the typed password for the RoboMaster S1 Wi-Fi is typed correctly. If you are still unable to connect, reset the RoboMaster S1 by turning it off and on again, then retry.

5.1.2 Visual Marker Identification Error

If the robot fails to identify the visual marker "O" on the cube within 3 rotations, it will autonomously move on to player identification and elimination. If the robot fails to identify the visual marker with the selected random number on the player ID tags, it will select a different number until a player is eliminated. To avoid such failures, while the robot is in scanning mode, the players are required to hold the cube straight and not move it and ensure nothing is obscuring the robot's view of their ID tags (i.e. hold the cube to the side instead of in front of their tag).

5.1.3 Battery Error

If the battery on the RoboMaster S1 runs out, replace it with a second battery while the dead one charges, or wait until the battery is charged again.

5.2 Special Considerations

Consider the lighting of a venue strongly, as strong lighting may interfere with the RoboMaster S1's ability to detect visual markers (player IDs and the cube).

5.3 Maintenance

5.3.1 Battery Maintenance

Regular charge and discharge: It is recommended to conduct a complete charge and discharge cycle of the battery every three months to maintain the battery activity. Charge within the temperature range of 5°C to 40°C. Use the DJI-recommended charger. Avoid storing in environments below -10°C (14°F) or above 40°C (104°F). A battery voltage below 1V may cause a safety hazard such as a fire when charged. To prevent this, the battery will not be able to charge if the voltage of a single battery cell is below 1 V. Avoid using any batteries matching this description. Always be alert to avoid over-discharging to prevent permanent battery damage.

5.3.2 Storage Environment

Avoid direct sunlight, and store the RoboMaster S1 in a dry, cool location. Keep it away from chemicals.

5.3.3 Firmware Update

Check LEDs and indicators to make sure all indicators are working properly and are not obstructed or damaged.

5.3.4 Cleaning

When cleaning the robot, avoid the use of corrosive cleaners. Clean the camera lens regularly to keep the image sharp.

5.4 Support

5.4.1 RoboMaster S1 Support

Online Customer Service:
Monday-Sunday 6:00-18:00 (PST/PDT)
Available as a live chat online on the DJI official website.

Hotline Service:
Monday-Sunday 6:00-18:00 (PST/PDT)
+1 778 588 9296

Service Request:
Request a repair service online on the DJI official website.

5.4.2 Game Support

613-562-5800 x1559
makerspace@uottawa.ca
ceed@uottawa.ca

6 Product Documentation

6.1 Cube

6.1.1 BOM (Bill of Materials)

Table 3. BOM for the cube

Item	Quantity	Cost ($)	Link
Electrical tape	1	1.69	General Purpose Electrical Tape at Canadian Tire
Shoe glue	1	13.99	Shoe Goo Original at Canadian Tire
MDF board (1/8" thick, 12" X 24")	2	2.50	MDF Board from MakerStore
White glue	1	1.99	Elmer's School Glue at Canadian Tire
Colour printed target symbol	6	0.25	uOttawa Printing Costs
Target symbol	1	0	RoboMaster S1 Target Identification Symbols
InkScape	1	0	Inkscape Download Page
Cube template	1	0	MakerCase Custom Basic Box Plan
Total Cost ($)		24.17	

6.1.2 Equipment list

1. Laser cutter
2. Coloured printer

6.1.3 Instructions

Step 1: Go to Inkscape and download the **Current Stable Version** for your **operation system**

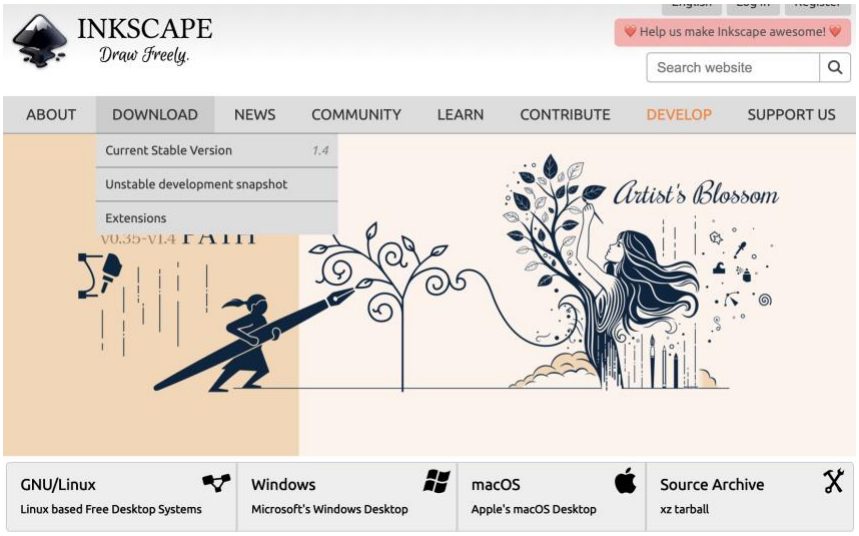

Figure 11. Inkscape current stable version download screen

Step 2: Go to the **MakerCase** website and select **Simple boxes**

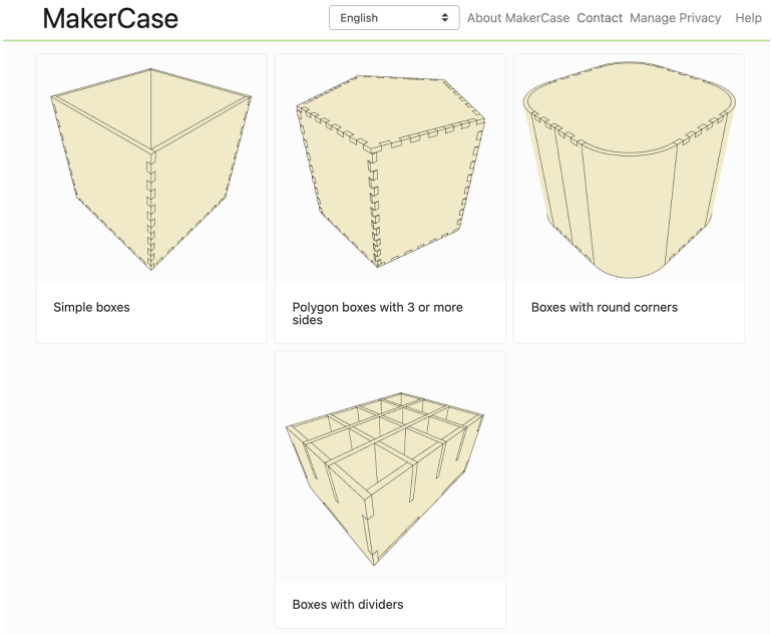

Figure 12. MakerCase homepage

Step 3: Adjust the box settings to match the following:

- Set the **Units** to **Inch**
- Set the **Width**, **Height**, and **Depth** as **7 inches** each.
- Select **Outside** for "Are these inside or outside dimensions?"
- **Material Thickness** set to **1/8in (0.118).**
- Select **Closed** under "Open or closed box?"
- Select **Finger** for "Edge Joints."
- Set the **Finger Size** slider to 0.708.

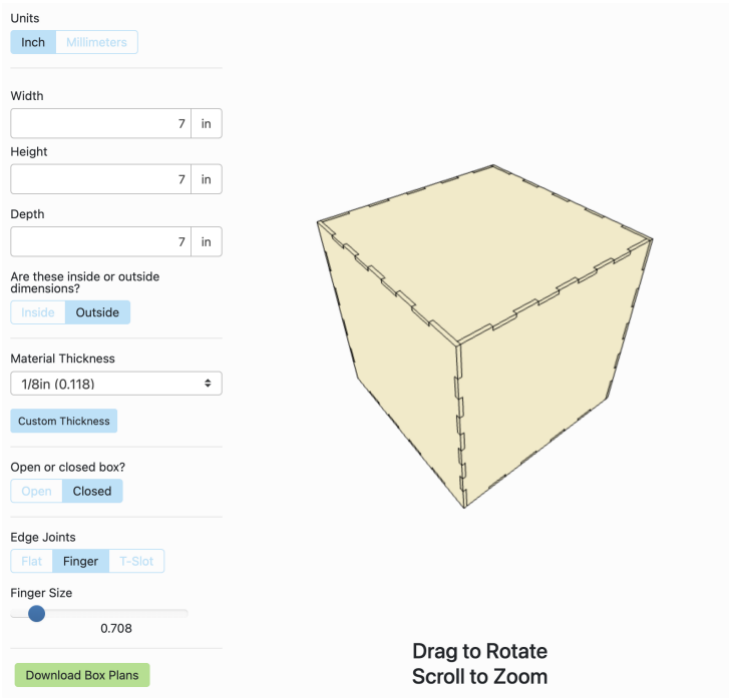

Figure 13. Custom box setting on MakerCase

Step 4: Click **Download Box Plans** to save the design as an **SVG file** for laser cutting

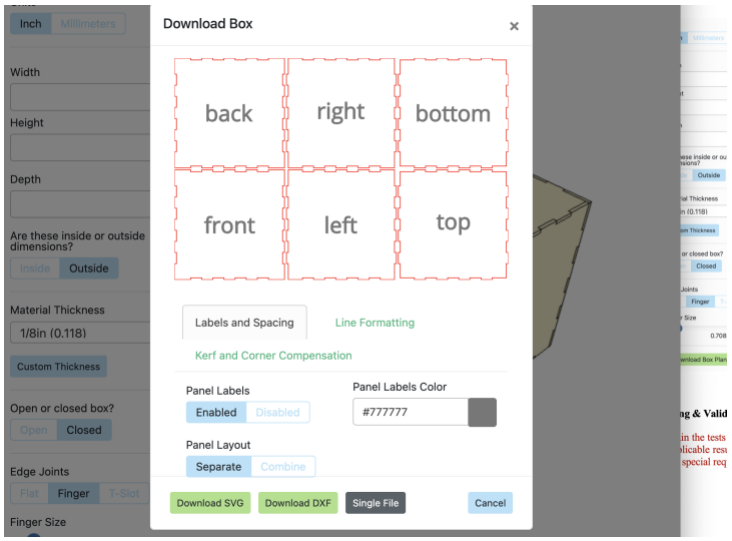

Figure 14. Download screen for custom box on MakerCase

Step 5: Open **Inkscape** and select **New Document**

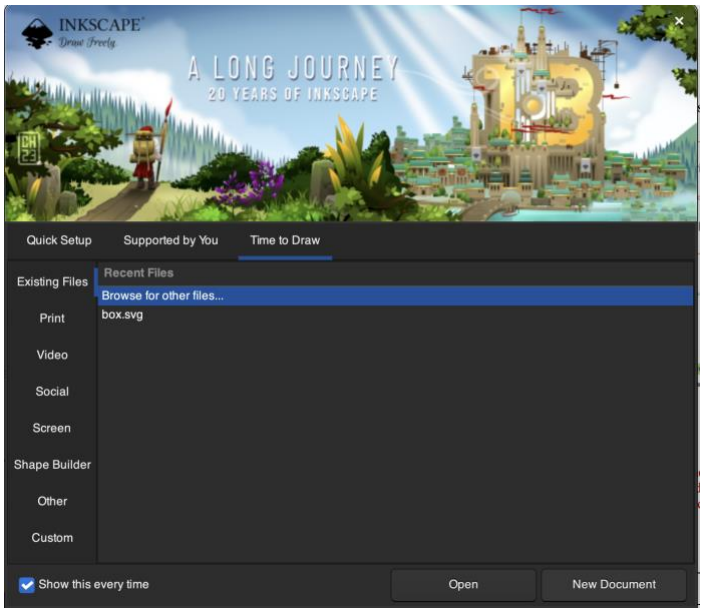

Figure 15. Opening window of Inkscape

Step 6: **Right-click** on the blank document and select **Document Properties**

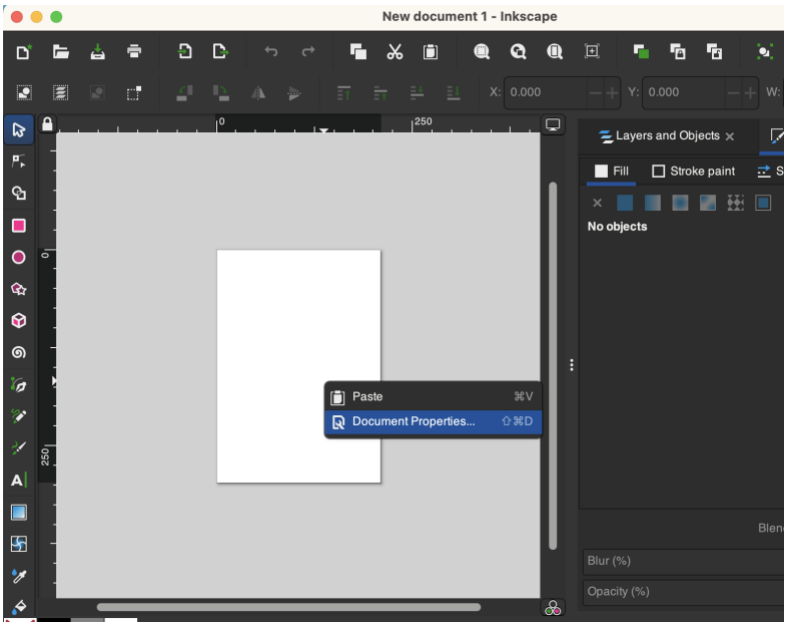

Figure 16. New blank document created on Inkscape

Step 7: Change the **Width** to **24 inches** and the **Height** to **12 inches**

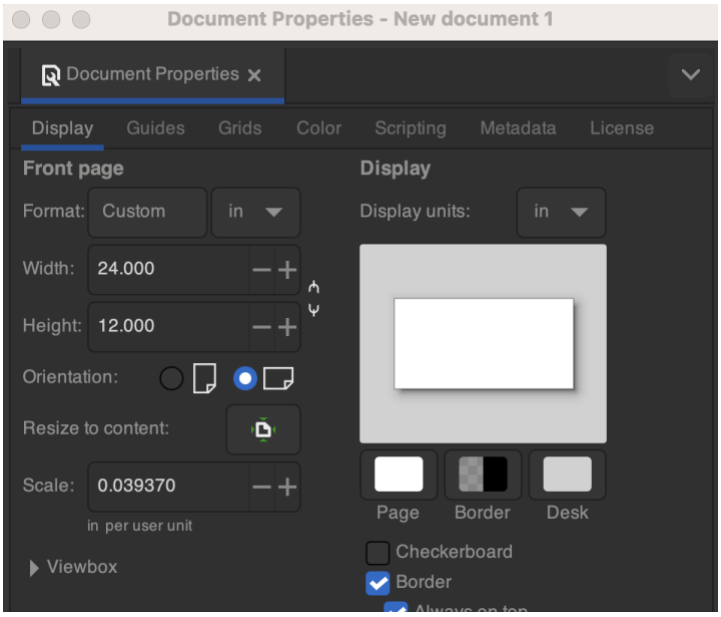

Figure 17. Document properties window in Inkscape

Step 8: Select **File** and in the drop-down menu select **Import.** Choose the file downloaded from MakerCase.

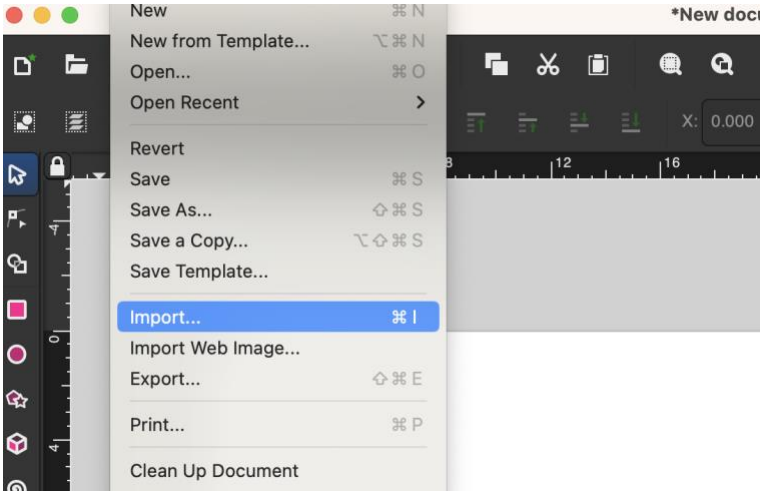

Figure 18. Importing a SVG file into Inkscape

Step 9: in the next window, set the **DPI for rendered SVG** to **600** and click **OK**

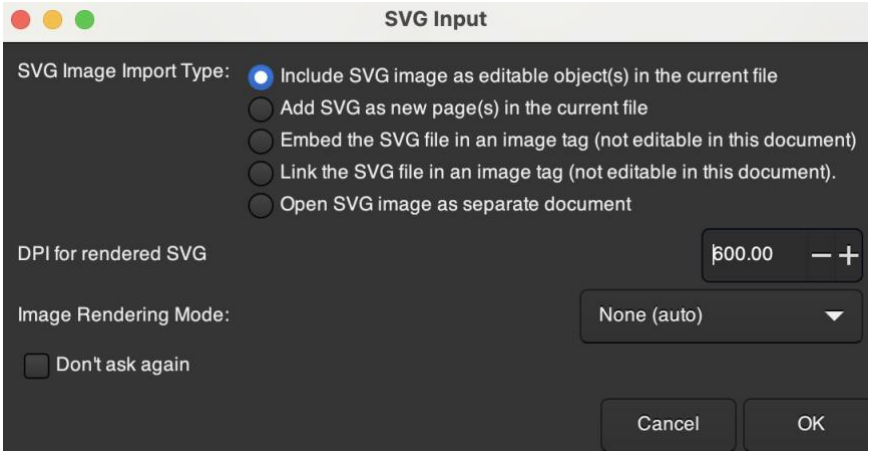

Figure 19. SVG Input pop-up window

Step 10: **Delete** the bottom three sides and rearrange as desired

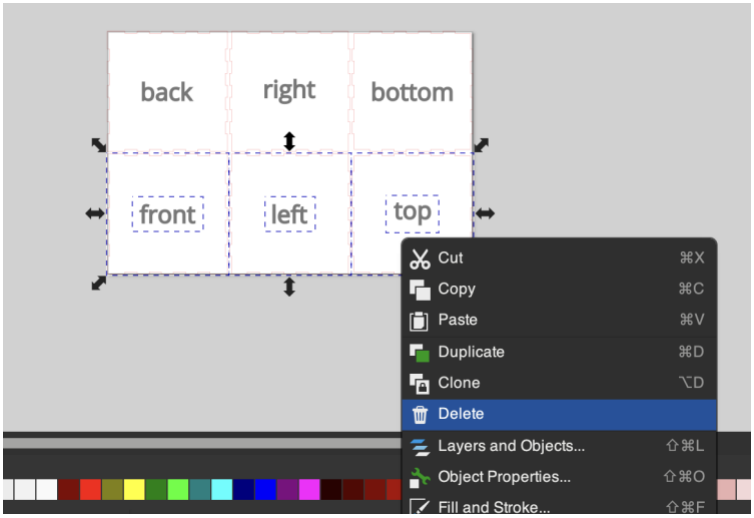

Figure 20. Deleting shapes in Inkscape

Step 11: **Delete** the text from the squares

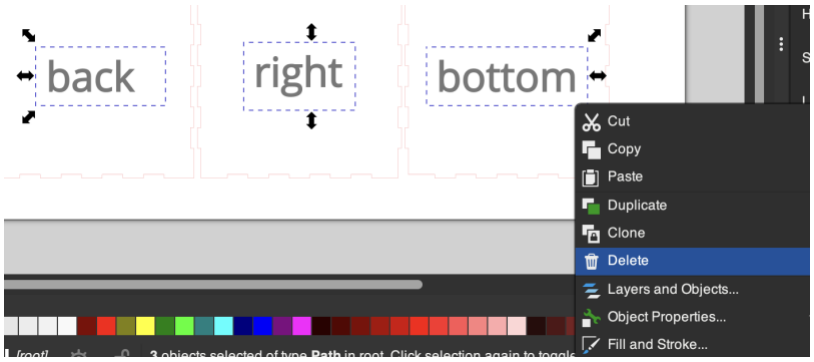

Figure 21. Deleting text in Inkscape

Step 12: Select **Fill and Stroke**, then select **Stroke style** and set the **Width** to **0.001 inches**

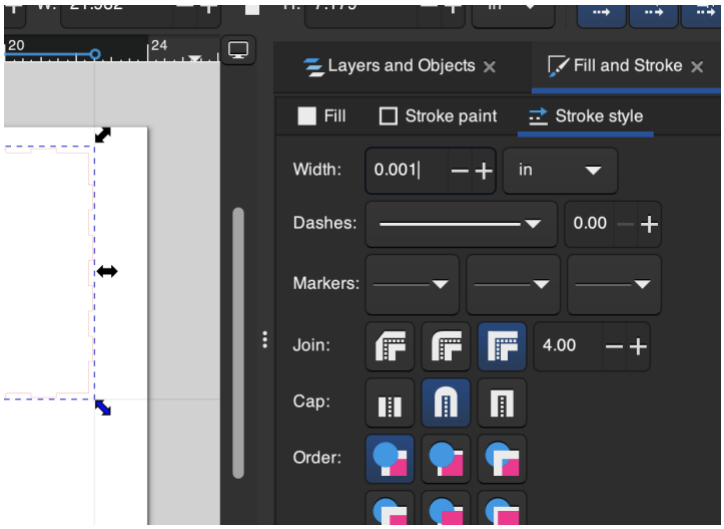

Figure 22. Line width for shapes in Inkscape

Step 13: Select **File** and then **Save As…**

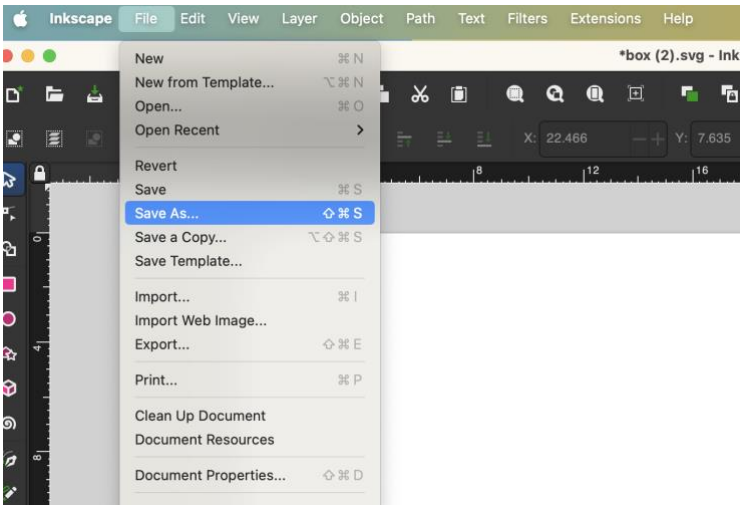

Figure 23. How to save file on Inkscape

Step 14: Save the file as a **PDF** and ensure the **Resolution for rasterization (dpi)** is set to **600**

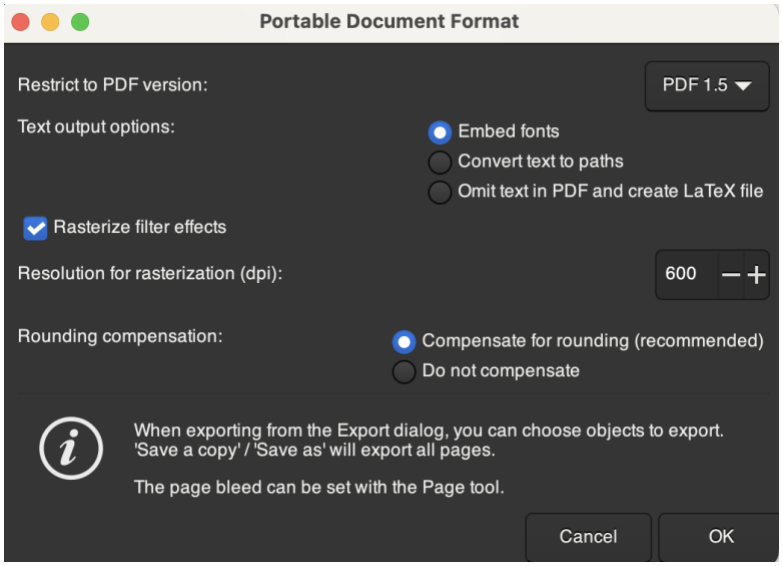

Figure 24. PDF export window in Inkscape

Step 15: Repeat **steps 5 to 14** to print the **front, left and top** of the cube

Step 16: Save **both PDFs** onto a **USB drive**

Step 17: **Input** these files into a **laser cutting machine**. Use **1/8" MDF** board as the material and proceed to cut the design. You can use the steps outlines in **APPENDIX 10.1.**

Step 18: **Connect the sides** of the cube to create a box. **Secure** the sides **using shoe glue**.

Step 19: **Cover** each **edge** with **two pieces of electrical tape** to ensure all edges and corners are covered.

Step 20: Download the RoboMaster S1 Target Identification Symbols and **print six** of the **'o'** symbol **in colour**

Step 21: **Cut** and **glue each symbol** to a side of the cube **until all faces** are **covered**

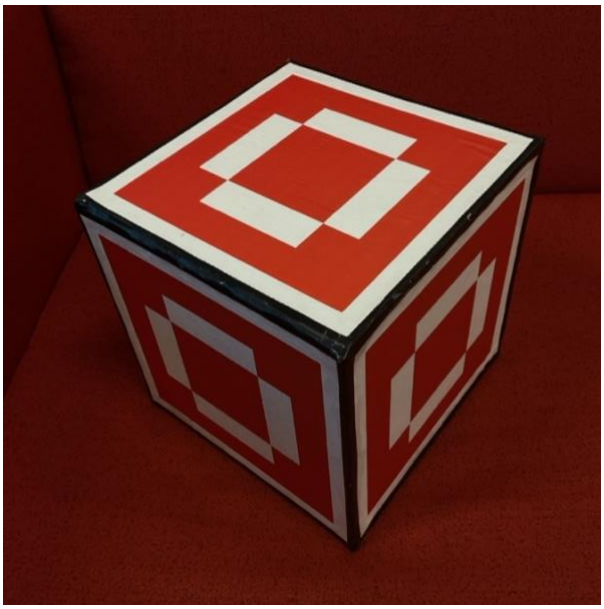

Figure 25. Final prototype of the cube

6.1.4 Testing & Validation

The robot's ability to recognize each face of the cube was tested at various distances ranging from 1ft to 5ft away. We found the robot was able to identify the cube from various distances but wasn't successful 100% of the time. The durability of the cube was also tested by tossing it back and forth as well as onto a carpet over concrete. The cube was able to withstand all the testing with little to no damage. Force applied during testing was minimal so users may want to conduct further testing.

6.2 Player ID's

6.2.1 BOM

Table 4. BOM for the player IDs

Item	Quantity	Cost ($)	Link
Colour printed target symbol	10	0.25	uOttawa Printing Costs
Target symbol	1	0	RoboMaster S1 Target Identification Symbols

Pack of cardstock	1	19.09	100Pcs White Cardstock Paper at Walmart
Twine	1	3.99	Multi-Purpose Medium Jute Rope at Canadian Tire
Clear packing tape	1	2.43	Packing Tape at Walmart
Total Cost ($)		28.01	

6.2.2 Equipment list

1. Coloured printer

6.2.3 Instructions

Step 1: Download the RoboMaster S1 Target Identification Symbols and print 2 of each of the visual marker symbols numbered 1 to 5, in colour.

Step 2: Cut the printed papers along the marked cut line so that each symbol is a square

Step 3: Tape each symbol to cardstock paper

Step 4: Cut 10 pieces of twine to about 1 m each

Step 5: Attach the pairs (i.e. the two symbols with a “5”) by taping the twine to the back of their cardstocks using clear packing tape

Figure 26. Finished prototype of the player IDs

6.2.4 Testing & validation

The robot's visual recognition ability of the player ID tags was tested to determine if it was able to identify the numbers, the distance at which it can identify them, and other variables such as lighting or contrast. We found that the robot's recognition ability was reasonably consistent, but not always, so we made the player identification during the scanning phase last three rotations to give the robot multiple tries. We also tested the ID tags themselves and found that they are durable for the purposes of the game.

6.3 Program

6.3.1 BOM

Table 5. BOM for HZH Program

Item	Quantity	Cost ($)	Link
DJI Education Hub	1	0	DJI Education Hub Download Page
Total Cost ($)		0	

6.3.2 Equipment list

1. RoboMaster S1
2. Computer

6.3.3 Instructions

Step 1: Open **DJI Education Hu**b
Step 2: Under **DIY Programming**, click on **Create**

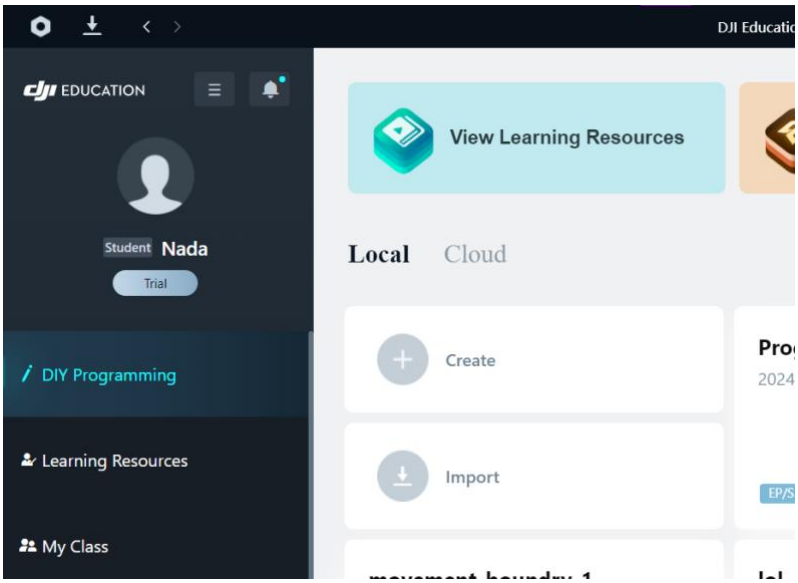

Figure 27. DIY programming DJI Education Hub homepage

Step 3: Use the categories on the left side to select the type of block you want to add

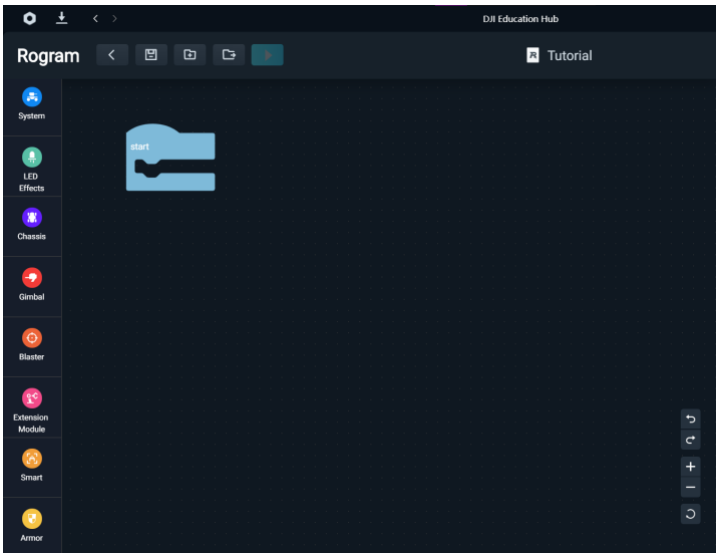

Figure 28. New code file in DJI Education Hub

Step 4: Drag the block under the start block. Drag more blocks until the program is complete

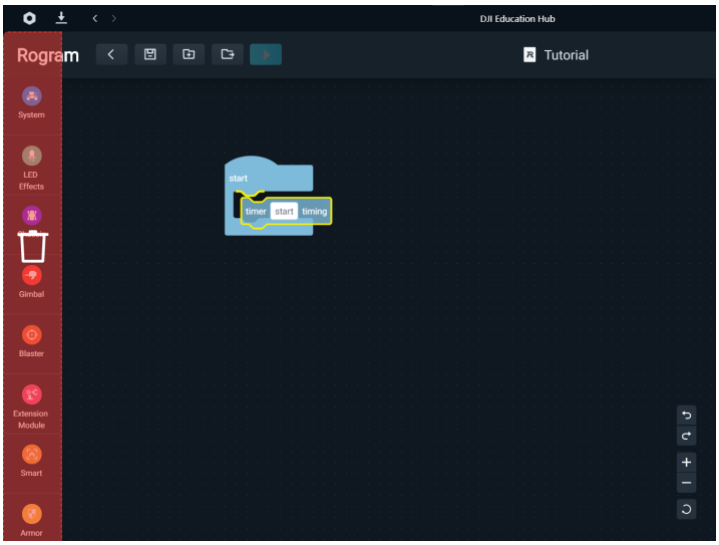

Figure 29. Example of how to block code in DJI Education Hub

Step 5: Create 3 programs under 3 functions: a random movement function, a cube identification and elimination function, and a player identification and elimination function.

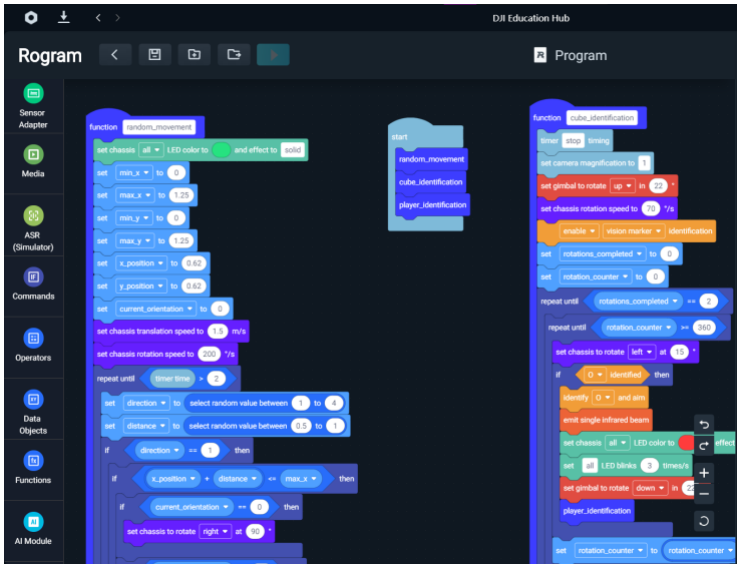

Figure 30. Clip of code from final prototype

6.3.4 Testing & validation

Each separate function of the program was tested individually until they were all functioning and then combined and tested comprehensively. We had issues creating a loop that goes through all functions repeatedly without having to manually press play after each round but managed to integrate all aspects together by placing the functions within each other. Multiple comprehensive tests were done, and the program is functioning.

7 Conclusions and Recommendations for Future Work

7.1 Conclusions

Throughout the development of HZH, we learned several key lessons. Iterative design is crucial, as testing and refining the prototype based on user feedback greatly improved the functionality and user experience of HZH. This also helped us to refine our early concepts to align with our project goals as much as possible. Balancing technical, ethical, and user experience considerations was also a challenge, which required us to thoroughly consider many different avenues of design for our concepts. This challenge prepared us to navigate the considerations we must take to integrate multiple different subsystems together, which required careful coordination from all members of our team.

7.2 Recommendations

The initial concepts for HZH included a grid-style layout of the zones, where safe zones and danger zones were randomized and stored in the RoboMaster S1's program. Then, it would detect player location, go up to a player, and determine elimination based on its own geolocation within the grid. This avenue would allow for more interesting and engaging elimination rounds and could be explored in more depth if given the time. Rather than scrapped, the concept of mass elimination was simply just not thoroughly developed. This was a feature that rendered all players eliminated if the cube representing a grenade was dropped. If given a few more months, this would have been a useful feature for increasing engagement and adding initiative to the hot potato game. Some discussed design concepts included padding the insides and securing an Arduino model with pressure/ball drop sensors or increasing the FOV of the RoboMaster S1 to detect the cube on the ground first. Another interesting concept that was scrapped included the digital display, which communicated to players the round timer, as well as which player ID was eliminated, and whether mass elimination occurred. Due to a lack of time and resources, this was necessary to be scrapped as it would have entailed rewriting the entire program in Python, which had proved unreliable in

connection with the RoboMaster S1 in testing. However, should this avenue be more consistent in further testing, using Python as opposed to block code would be highly beneficial, as this allows for more customization and interesting methods of using the RoboMaster S1.

8 Bibliography

GNG1103 - Five Alive | MakerRepo. (2024, November 2). https://makerepo.com/NadaAbdelkader/2140.gng1103-five-alive

RoboMaster S1 Quick Start Guide v1.4. (2019, October 30).

RoboMaster S1 User Manual v1.8. (2020, February 14).

Laser Cutting Lab Manual (GNG 1103 – Engineering Design)

APPENDICES

9 APPENDIX I: Design Files

Table 6. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
RoboMaster S1 - Quick Start Guide v1.4 (EN)	https://dl.djicdn.com/downloads/robomaster-s1/20191030/RoboMaster_S1_Quick_Start_Guide_v1.4_EN.pdf	2019-10-30
RoboMaster S1 - User Manual v1.8	https://dl.djicdn.com/downloads/robomaster-s1/20220429UM/RoboMaster_S1_User_Manual_v1.8_EN.pdf	2020-02-14
MakerRepo	https://makerepo.com/NadaAbdelkader/2140.gng1103-five-alive	2024-11-02
Laser Cutting Laboratory	https://uottawa.brightspace.com/d2l/le/dropbox/457641/320544/DownloadAttachment?fid=18355800	2024-11-02

10 APPENDIX II: Other Appendices

10.1 Laser Cutting

For this project the Epilog Laser Mini was used to laser cut the sides of the cube. Before you start laser cutting familiarize yourself with the machine and its controls.

Figure 31. Epilog Laser Mini[ii]

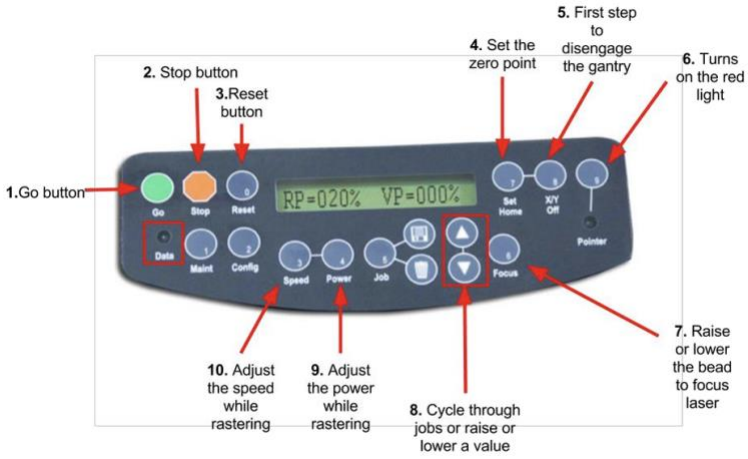

Figure 32. Control panel of the Epilog Laser Mini[ii]

Step 1: Open the **PDF files** saved on the USB drive in Adobe and click **Print.**
Step 2: Select **Epilog Engraver Win32** as your printer and she **Page Sizing** option to **Actual Size**
Step 3: Click on **Properties** and in the Epilog software, adjust the settings to the following:

- Resolution: 600 DPI
- Speed: 20
- Power: 100
- Frequency: 500 Hz

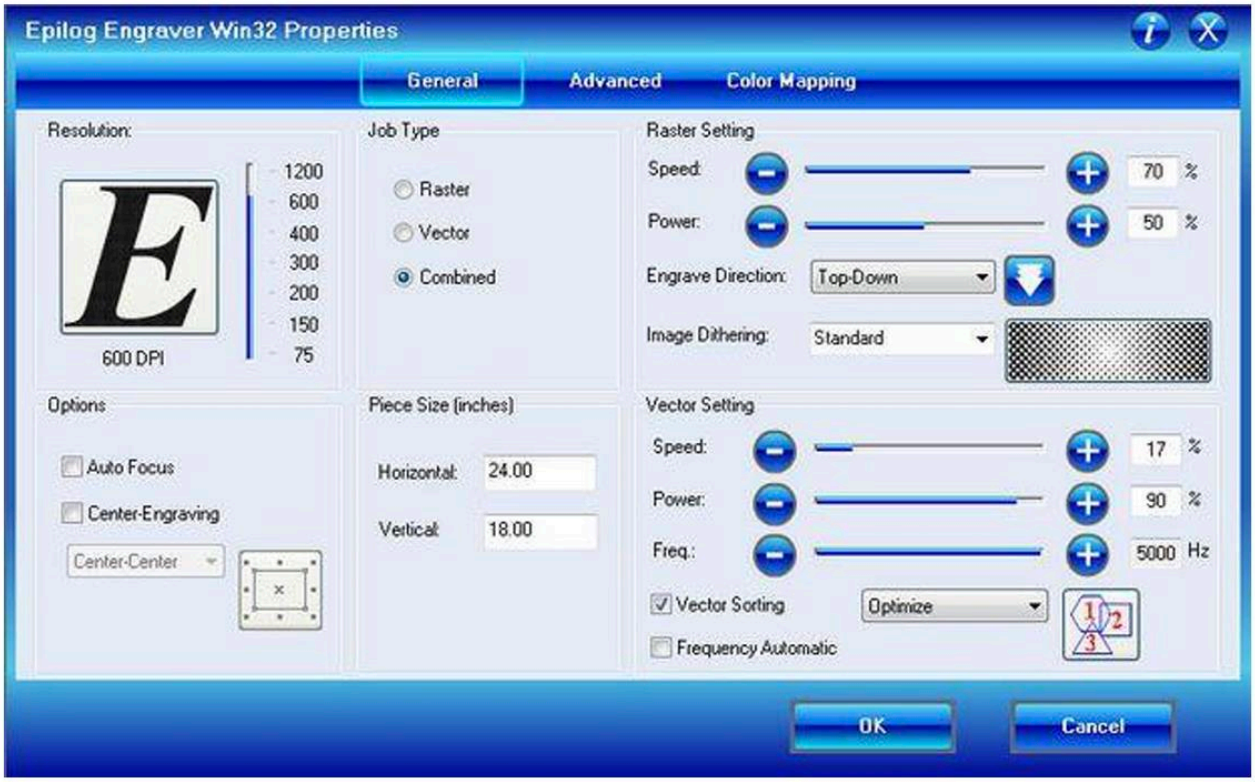

Figure 31.Epilog Laser software[ii]

Step 4: Click **OK** and then send the file to the laser by clicking **print**
Step 5: Place the **MDF board** into the laser cutter
Step 6: Put the **focusing tool** on the laser head. Press **Focus** and **adjust the bed**, by pressing the **up/down arrows**, until the material is **just touching** the focus tool
Step 7: Press X/**Y off?** then **Go**. You can now **freely move** the laser about the **X and Y axis with** your **hands**. Press **pointer for** a **guide** to where the laser will start. Once the laser is in the starting position you wish, press **Set home**.
Step 8: Press **Job** and select your job name. Press **Go** to start.

[i] RoboMaster S1 User Manual v1.8. (2020, February 14).
[ii] Laser Cutting Lab Manual (GNG 1103 – Engineering Design)