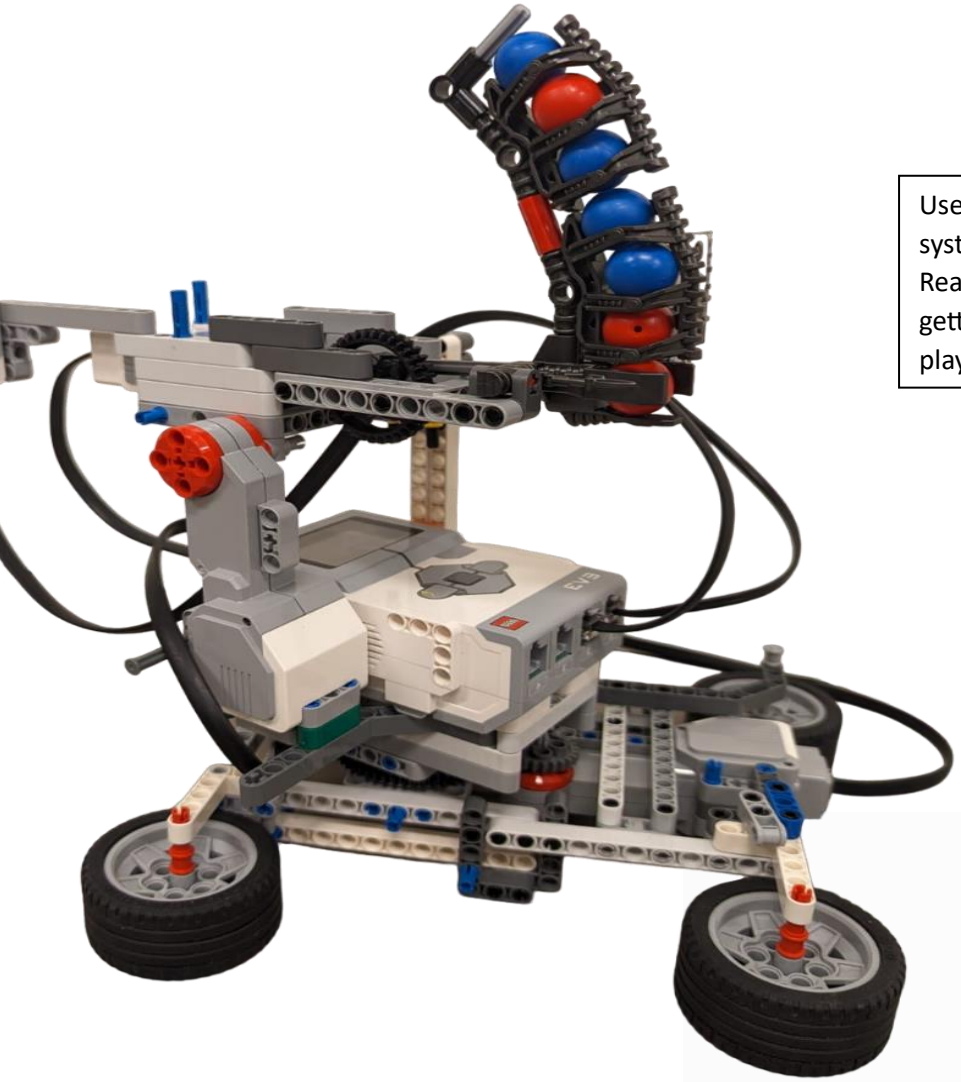
red ADS (Anti-Drone System)
Robot Manual

Group : Shola Alibi OLAYEMI, Ismael PADIOLLEAU, Banhui REN, Antoine Wilson, Sacha BLEICHER



User manual for the red ADS Anti Drone system. Table of content is on page 2. Read carefully of the instruction before getting started. We wish you an enjoyable play time with your new robot.

Table des matières

1. Introduction

1.1 Purpose of the Manual

The user manual for your anti-drone robot serves as a vital companion, providing clear and concise guidance for a safe and effective experience. It begins by outlining crucial safety measures, ensuring users navigate assembly, deployment, and operation without any mishaps. Step-by-step instructions using LEGO Mindstorms components enable a correct and efficient robot build.

Operating the robot during anti-drone missions becomes intuitive with detailed insights provided. Maintenance tips and troubleshooting guidance are offered for consistent and optimal performance. Technical specifications, including power requirements and communication protocols, are explained to deepen the user's understanding. For those interested in customization, programming instructions are available.

The manual also equips users with emergency procedures to handle unexpected situations or malfunctions.

1.2 Overview of the Anti-Drone System Robot

The basic features of the anti-drone robot, constructed using LEGO Mindstorms, are focused on practical functionality. It is designed to identify and track drones with reasonable precision.

Its primary offensive capability involves a basic ball launcher, allowing the robot to attempt to disrupt or deter targeted drones. While the technology is limited by the constraints of LEGO Mindstorms, the robot serves as a cost-effective and accessible solution for understanding drone-related concerns in scenarios where more sophisticated systems would be necessary.

Applications include simulation of basic security measures, event monitoring, and the protection of restricted areas, providing a straightforward response to potential simulated drone threats.

2. Robot Overview

2.1 Components

1. 

2. 

3. 

Main components:

1. Lego Mindstorm Brick
2. Camera (Pixy 2)
3. 2 Large Motors
4. 1 Medium Motor
5. Pressure launcher

4. 
5. 

2.2 Features

RED ADS robot has drone detection features, including Real time tracking of drone movement, shooting system and audio warning system. It also has a system to computer console interface with clear reports and alerts on the drone threat and the response.

2.3 Technical Specifications

General:

- Dimensions: Width: 20 cm, Length: 23 cm, Height: 24 cm
- Weight: 600g
- Battery Capacity: 2200 mAh

Motor Types:

- Large Motors for pan and tilt motion.
- Medium Motors for shooting mechanism
- Limitation with the wires limiting the course (180° rotation is most cases)

Camera: Pixy 2 Camera

- Basic resolution suitable for object detection and recognition
- Capable of color detection and tracking
- Max target detection distance: 1500mm

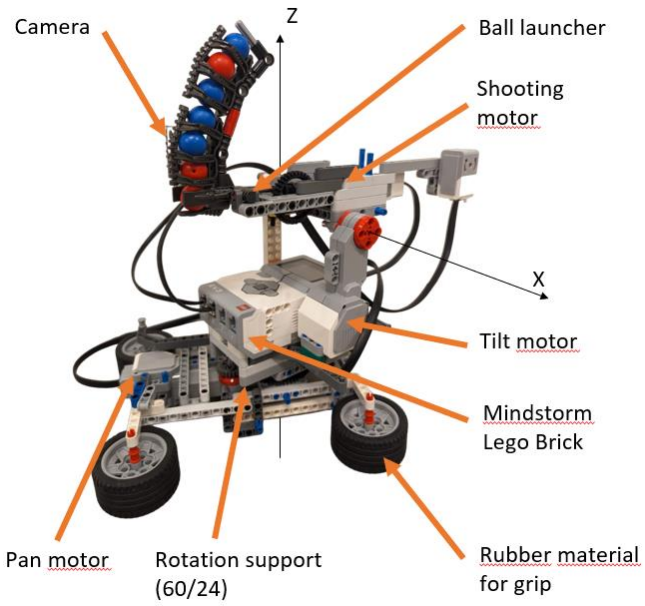
Shotting system:

- Shooting distance: up to 2000mm
- Max ammunitions capacity: 7 balls
- Automatic fire mode & manual one-way magazine

3. Getting Started

3.1 Unboxing and Assembly

Step-by-step instructions for unboxing and assembling the robot.



1. **Prepare Your Workspace**: Clear a flat and well-lit workspace to ensure you have enough room for the assembly process.

2. **Open the Box**: Carefully open the box by removing any tape or seals. Gently lift the lid to reveal the contents inside.

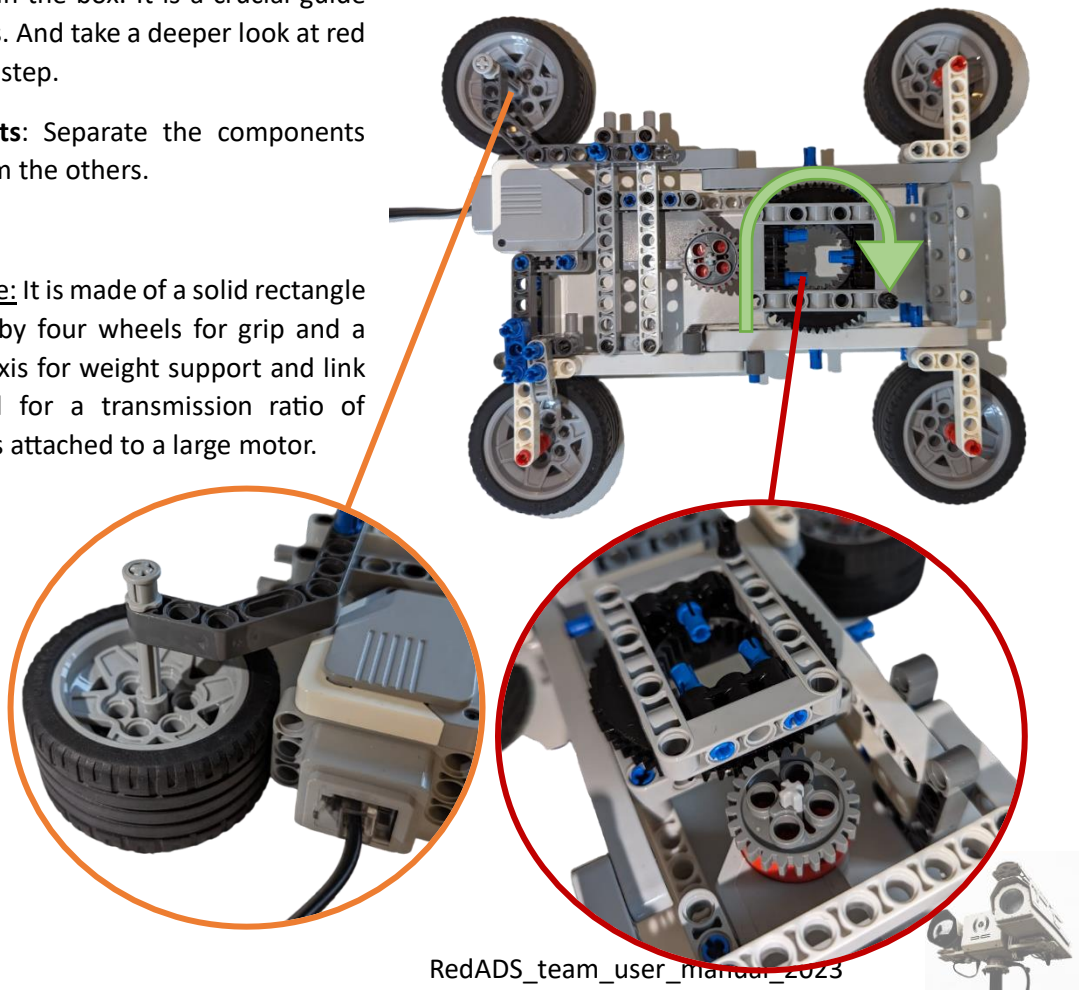
3. **Check the Contents**: Verify that all the components listed in the instruction manual are present. This includes LEGO bricks, motors, sensors, cables, and the control unit.

4. **Retrieve the Instruction Manual**: Locate the instruction manual within the box. It is a crucial guide for the assembly process. And take a deeper look at red ADS manual for the fifth step.

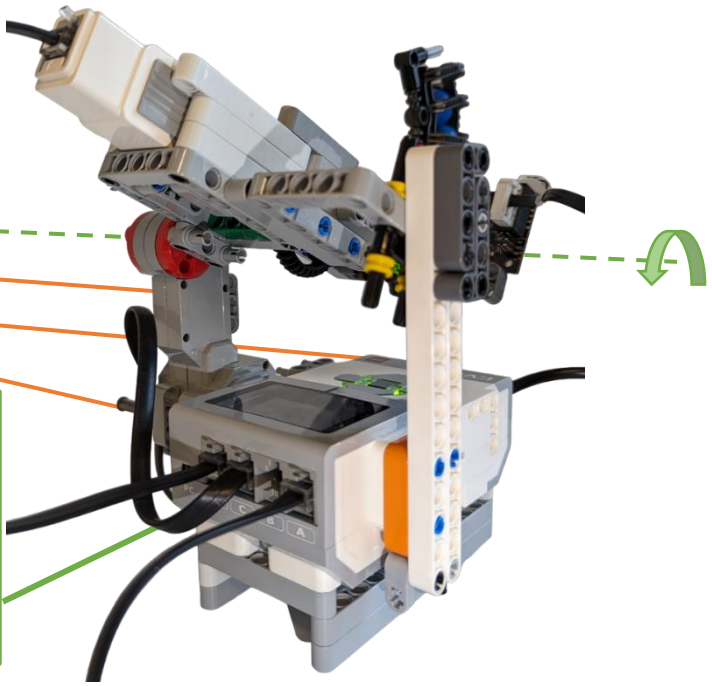
5. **Organize Components**: Separate the components you are going to use from the others.

6. **Start with the Base**:

6.1 Rotation base: It is made of a solid rectangle connected to the floor by four wheels for grip and a double wheel rotation axis for weight support and link with another cogwheel for a transmission ratio of (60/24). This cogwheel is attached to a large motor.



6.2 Camera and shooter moving platform: It is connected through the tilt motor plugged on the Lego Mindstorm Brick. Plug the Lego Brick first and then add the motor and a support on the other side to maintain the platform as steady as it can be.



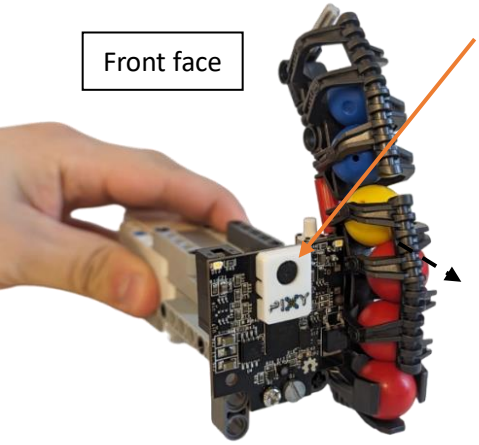
- Rotation axis for camera and shooter
- Tilt motor to rotate the platform
- Support for the axis
- Lego Mindstorm Brick as base

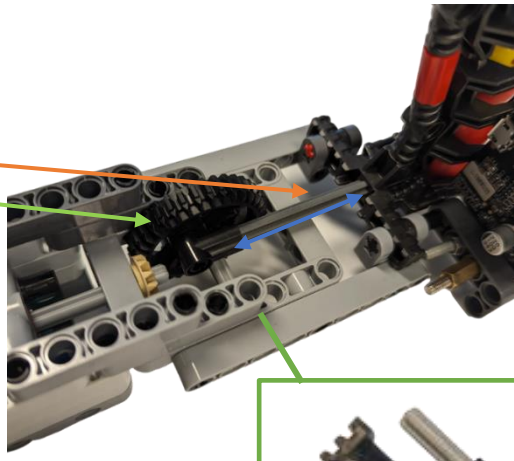
6.3 Shooting system uses a small motor. You can follow this tutorial to build it.

To make it:

1. Connect the camera to the shooter using the screws given with the camera.
2. Use a square LEGO piece, 2 axis and two cogwheels to create a 12/40 ratio transmission.
3. Evaluate the angle need for the axis linked with the launcher to fire the ball. For that put the axis at the "back" position and then "push" position to take the measure of the angle A_shoot.
4. Program the board to turn the motor by an angle A_shoot and then reload by turning the motor by the same angle the other way.

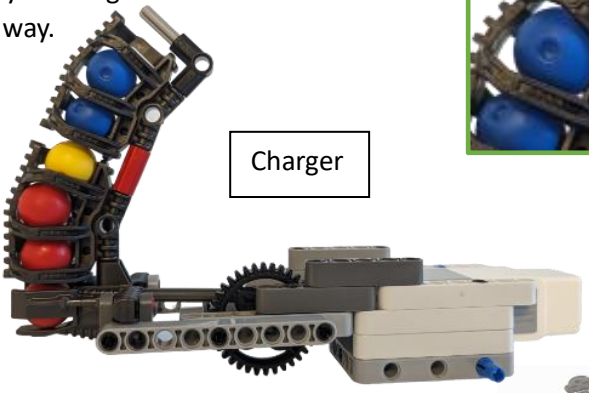
Front face



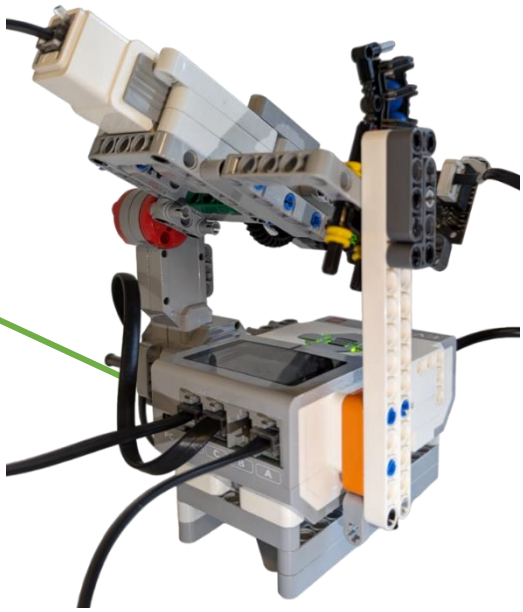


Back face

Charger

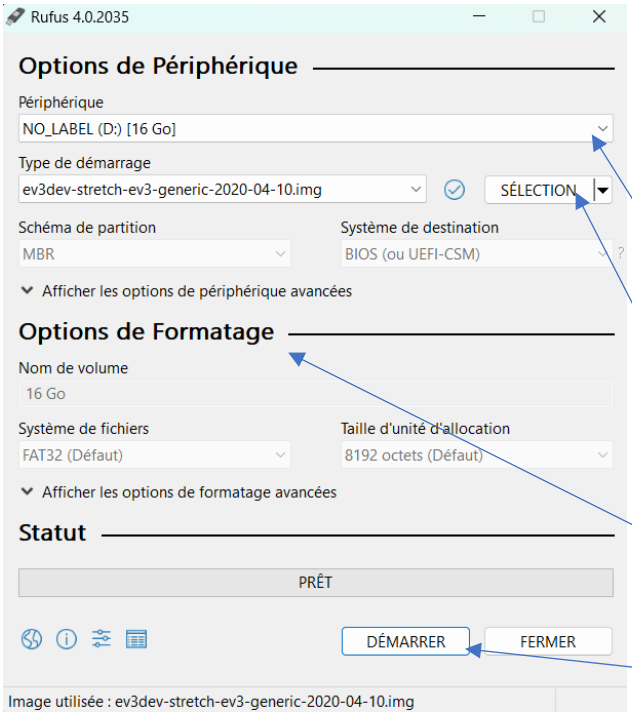


Add Motors and Sensors: Attach the motors and sensors according to the manual's guidance. Ensure that they are securely connected to the base.



8. **Connect the Control Unit**: Integrate the control unit as instructed, linking it to the motors and sensors using the provided cables. Be mindful of the correct ports.

Motors	**Port**
Pan Large Motor	A
Tilt Large Motor	C
Shooter Medium Motor	D
Sensor	
Pixi2 Camera	1



3.2 Powering On/Off and first boot

Instructions on how to power the robot on and off safely.

You will first need to flash a micro-SD card with the ev3d Stretch image using a burning software like Rufus or balenaEtcher.

Find the SD card

2. Find the ev3d stretch image (.iso file extension)

You can leave this as is

3. Press Start

3.3 Uploading code on LEGO EV3

1. First initialisation : You must follow each step described in the ev3dev website : https://www.ev3dev.org/docs/getting-started/

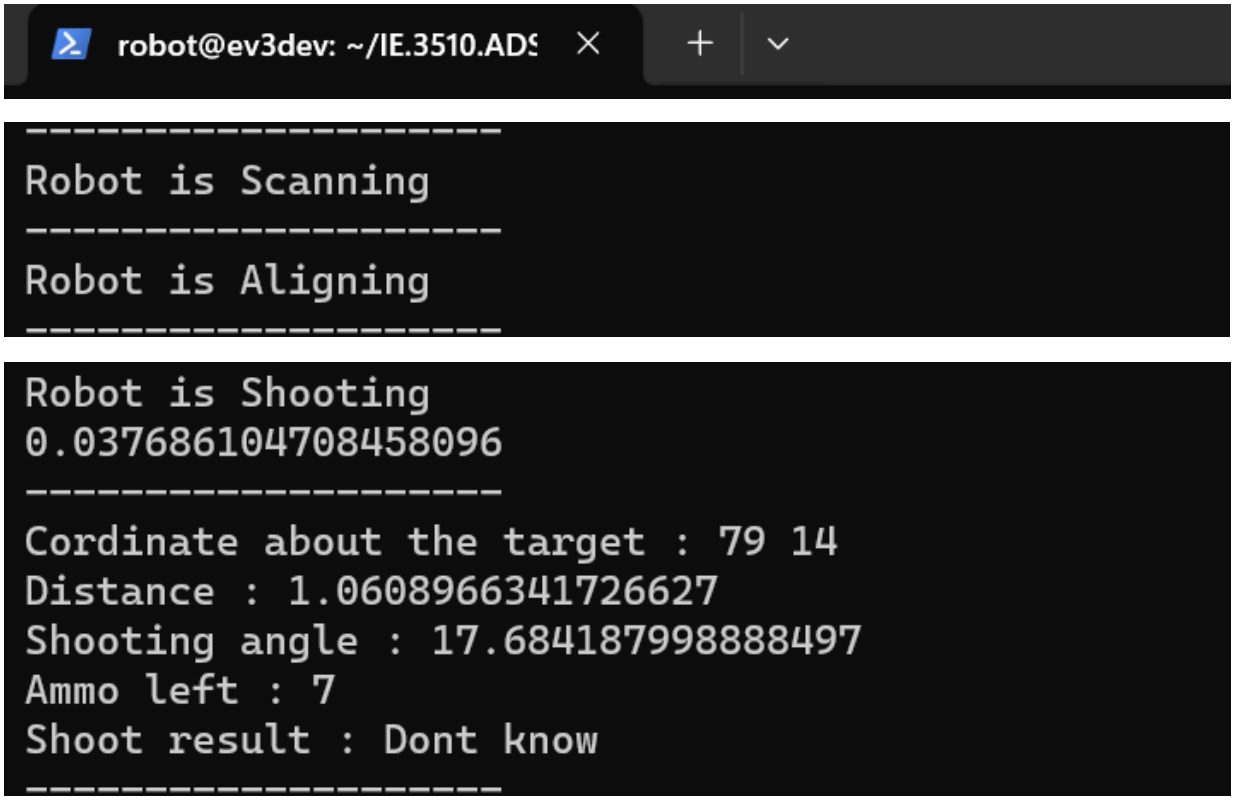
The code is available here : https://github.com/i-padiolleau/IE.3510.ADSRED

2. To send the program to the robot, use git pull to download the last version of your code :

/SSH key : git@github.com:i-padiolleau/IE.3510.ADSRED.git

/git pull

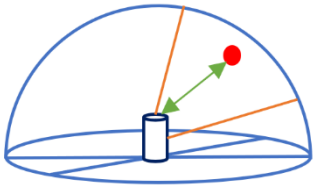
/python main.py



4. Robot Operation

4.1 Initialization

The first step is to set up the environment. Start with setting a 1.5-meter wide semi-cercle area in front of the robot camera axis and make sure that no obstacles or chosen-color objects are in the way.



Set the robot on the floor, ideally facing a white wall with lots of lighting. Then make sure that all the wires are correctly connected.

Change the configuration into the config file and select the mode for the robot to operate : Manual or automatic

4.4 Vision Processing with Pixy2 Camera

Pixy2 is a compact camera system compatible with LEGO Mindstorms, enhancing robotics projects with efficient vision capabilities. This intelligent camera uses color-based recognition, detecting and tracking objects with its built-in algorithms. Its integration is user-friendly, featuring a simplified setup process and communication through the I2C interface. The Pixy2 camera allows for seamless interaction with the LEGO Mindstorms EV3, enabling robots to identify and respond to visual stimuli. This opens possibilities for creative applications, from following colored lines to recognizing specific objects.

How to set up color targeting on the Pixy2 camera for LEGO Mindstorms. Follow these four steps:

1. **Connect Pixy2 to LEGO Mindstorms**: Ensure the Pixy2 camera is correctly connected to the LEGO Mindstorms system using the compatible interface, usually the I2C.

2. **Install Pixy2 Software**: Download and install the Pixy2 software on your computer. This software allows you to configure the camera settings and define color targets.

3. **Configure Color Targets**: Open the Pixy2 software and navigate to the color configuration section. Specify the color or colors you want the camera to target. Adjust settings such as hue, saturation, and brightness to fine-tune detection parameters.

4. **Upload Configuration to Pixy2**: Once satisfied with the color target settings, upload the configuration to the Pixy2 camera. This ensures that the camera is now programmed to recognize and track the specified color targets.

4.5 Scanning Sequence, detection and Target Following

Now your robot is all set, using the given program will start the robot scanning sequence. Make sure you uploaded the code to the robot and clear the area. Start your program from the computer and observe.

For the first test, try this:

- Let the robot proceed to a full scan of its environment without presenting in any target.
- On the second scan, present to him a target, wait for the signal “target detected” and move the target to make sure it moves and adjusts to the new coordinates.
- Then stop moving the target and wait for the “Ready to fire” signal and the shoot.

4.7 Shooting Mechanism reload

To run a complete sequence of test, present to the robot 7 consecutive target. The system will inform you when ready to shoot, keep the target steady, and tell the robot if the target has been hit. The shooting mechanism need you to manually reload after every 7 shoots on a target. Wait that the system is not moving to do so.

If the shooting system get stuck, simply remove the ball stuck in the claws.

4.8 Report of mission

If order to help you improve the design or test different configuration, the red ADS anti-drone system comes with mission report feature telling you what happened over the 7 presented targets. The mission report will appear after 7 target were presented :

	Coordinates	Distance	Balistic angle	Time to answer	Hit/Miss
Target 1	θz: 14°; θx: 45°	1,45m	+30°	3.02s	Hit
Target 2	θz: 40°; θx: 90°	0,34m	+45°	DNS	DNS
…					

5. Safety Guidelines and Maintenance

5.1 General Safety Precautions

The recommended age range for the use of the product is 11 years and above. Younger users must be supervised during assembly and operation to ensure they follow safety guidelines.

Assemble the Red ADS robot by following the manual guide and ensure all components are securely attached and correctly positioned. Operate it in a suitable environment, away from obstacles and potential hazards. Replace worn-out parts or components.

5.2 Emergency Procedures

Release Stuck Cable: If a cable is stuck, carefully release it to avoid damage. Ensure that all cables are free and not entangled.
Disconnect Batteries: If applicable, disconnect the batteries to ensure complete power isolation.
Check for Damage: Inspect the robot for any damage or loose components. Address any visible issues before attempting to restart.
Verify Programming: Check the robot's programming for errors or unexpected behaviors. Debug the code if necessary.
Regular Maintenance: Implement a regular monthly maintenance schedule to prevent potential issues. Check components, cables, and batteries regularly.

5.3 Handling and Storage

Power Off: Always turn off the robot when not in use. This helps conserve battery power and prevents accidental activations.
Secure Cables: Ensure that all cables are neatly secured and do not obstruct moving parts. Loose cables can get entangled and affect the robot's operation.
Handle with Care: Lift and handle the robot with care and avoid dropping or rough handling.
Avoid Obstacles: Operate the robot in an environment free of obstacles and hazards.
Clean Environment: Avoid operating the robot in dusty or wet environments. Dust and moisture can damage sensitive components.
Temperature Considerations: Operate the robot within the recommended temperature range. Extreme temperatures can affect battery performance and electronic components.
Power Down: Turn off the robot and disconnect the power source before storing it. This prevents unnecessary battery drain.
Secure Storage Area: Store the robot in a secure, dry, and dust-free area. Use a protective cover if available.
Avoid Direct Sunlight: Avoid exposing the robot to direct sunlight for extended periods, as it can lead to overheating.
Battery Removal: If storing the robot for an extended period, consider removing the batteries to prevent leakage or corrosion.

6.1 Regular Checks

Routine maintenance checks are essential for optimal RED ADS robot performance. Regularly inspect the following:
Cable Integrity: Check the robot's cable for any signs of wear, fraying, or damage. Ensuring the cable's integrity is crucial for a stable power supply and efficient data transmission.
Lighting Conditions: Assess the lighting in the robot's operational area. Proper lighting is vital, especially because of the visual sensor for targeting or navigation. Consistency in lighting helps in accurate task performance.
Obstacle-Free Area: Scan the environment for any obstacles that could hinder the robot's movement or functionality. Keeping the operating area clear of clutter and obstructions prevents accidents and operational errors, allowing the robot to function smoothly.

6.3 Battery Maintenance

Charge Before Use: Ensure that batteries are fully charged before each use to maximize runtime. Follow the charging instructions provided in the user manual.
Monitor Battery Levels: Keep an eye on the battery levels during operation. If the robot exhibits reduced performance, recharge or replace the batteries.
Regular Charging: Charge the batteries regularly, especially if the robots are not in use for an extended period. Follow the recommended charging schedule to maintain battery health.
Avoid Overcharging: Do not leave the batteries on the charger for longer than necessary. Overcharging can reduce battery life. Use a charger with automatic shutoff or a timer if available.
Cooling Period: Allow batteries to cool down before recharging if they become warm during use. This helps prevent overheating.
Alternatively, use two Mindstorm bricks in case one gets faulty, or the battery gets weak or bad.

7. Troubleshooting

7.1 Common Issues and Solutions

Common Issues and Solutions for RED Anti-Drone Robots:
Robot Not Responding: Check the battery levels and connections. Ensure that the batteries are correctly inserted with the correct polarity.
Inconsistent Movements: Inspect the motors and joints for debris or obstructions. Clean the robot's moving parts and retest.
Failure to Detect Drones: Verify that the Pixy2 camera is properly connected and calibrated. Adjust the camera angle for optimal drone detection.
Camera Calibration Issues: Follow the camera calibration procedure in the user manual. Ensure proper lighting conditions during calibration.
Stuck or Jammed Parts: Turn off the robot and carefully inspect for any stuck or jammed parts. Clear obstructions and ensure smooth movement.
Unintended Shutdowns: Check for loose wires or connections.
Overheating: Allow the robot to cool down. Check if the motors are straining or if the environment is too hot. Consider reducing the workload or improving ventilation.
False Positives in Drone Detection: Adjust the camera settings and thresholds for object detection. Ensure that the detection algorithm is tuned to minimize false positives.
Unexpected Behavior during Scanning: Review the scanning sequence code. Ensure that angles and distances are set correctly. Verify that the robot's starting position is consistent.
Difficulty Following Targets: Fine-tune the follow target algorithm. Adjust parameters based on the size and characteristics of the detected target.
Failure to Reboot: Check the reboot function in the code. Ensure that the motors return to their starting positions as intended.
Pixy2 Connection Issues: Verify the Pixy2 camera's connection to the robot's control unit. Recheck wiring and address any loose connections.

7.2 Contact Information for Support

Contact Red ADS customer support for technical assistance via email customersupport@redads.fr.