**MIDDLE EAST TECHNICAL UNIVERSITY**

**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**





**TROY TECH**

**FINAL REPORT**

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1. **Introduction**

Members of our company, Troy Tech are interested in creating new approaches in robotic systems and especially tele-operated robots. Our aim is to pioneer the change in robotics industry. In the project called “*Devices trying to score in each other’s goals*”, we aimed to design and construct a robot that is able to score in opponent robots goal. Simplifying the players role and making the game enjoyable is crucial features of our robot. The robot does not have any self-operated or autonomous motion, an operator will control all the movements on the floor including the shooting of the ball. By producing the robot easily and accurately controllable by an operator (player) at a certain distance wirelessly, we aimed at accomplishing both performance criteria and entertainment purposes of the game.

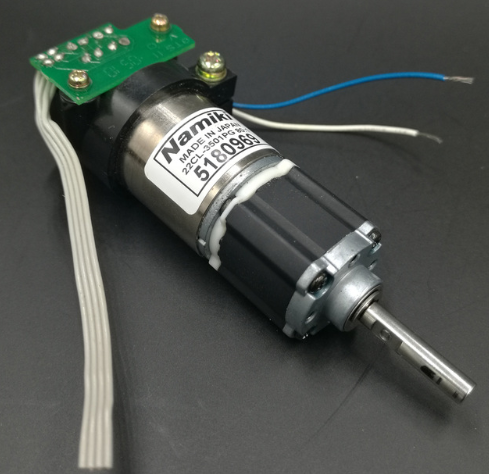
This project had several challenging ways such as the transfer of the video data and commands wirelessly at least 30 meters in closed area. This indoor range limit was our key concern during the design procedure. Another problem was to build a robust controlled device in a small playfield, and it was expected that it moves smoothly and invariant of time. For the purpose of meeting these requirements and challenges, we also had enhanced many design solutions that are feasible and reliable. These solution approaches were also planned efficient in terms of both budget and time. Because we have always been aware of the fact that the most important cost is ‘time’ in all engineering applications.

In this ‘Final Report’, we explain all the details of our overall system including every technical information. In the previous design steps, there were alternative solutions and plan-B’s. We took the advantage of following these operation principles, research and development steps, but here we include only the current parts of our end-product.

**3.4 Technical Specifications of Motor Drive Subsystem**

**3.4.1 Motors**

We chose “Namiki 22CL-3501PG” for our motor drive subsystem as shown in Fig.10. Its specifications are given in Table 1.

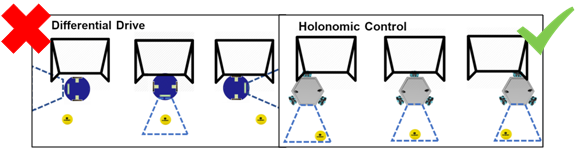


*Figure x. Namiki 22CL-3501PG*

*Table 1. specifications of Namiki 22CL-3501PG*

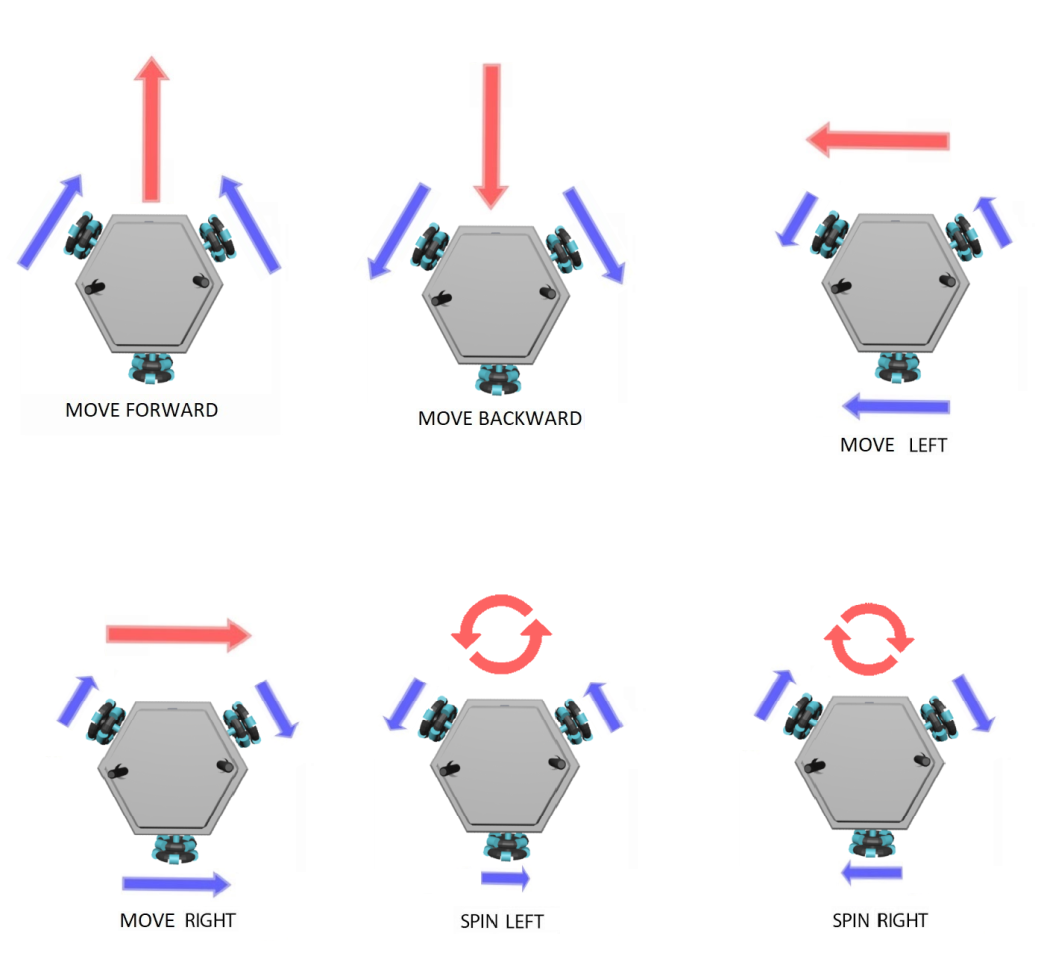
|  |  |
| --- | --- |
| **Brand** | Namiki Coreless Motor (Japan) |
| **Type** | Gear Motor |
| **Voltage** | 12V |
| **Rated power** | 15W |
| **Stall Torque** | 1.6Nm (16Kg · cm) |
| **Continuous torque** | 0.5Nm |
| **Output speed** | 120 r / min @ 12VDC |
| **Diameter** | 22 mm |
| **Length** | 65 mm |
| **Weight** | 140 g |

**3.4.2 Holonomic Control**

We chose holonomic control since its movement is better than the other options. Especially when defending, it is necessary to move left and right parallel to the goal line in order to be able to hold the ball. However, in differential drive method, the robot must turn in that direction in order to go to the right or left. Therefore, he can't see the ball while defending. However, in holonomic control method, the robot can easily go in all directions and defend his goal. The difference between two methods is shown in Fig. x.

*Figure x. The difference between holonomic control and differential drive*

As shown in Fig. x the robot can move multiple directions (i.e. moving forward, backward, left, right and spinning around it). It is based on three separately driven wheels placed on the robot body. The direction of the robot can be changed by varying the relative rate of rotation of its wheels. Therefore, it does not require an additional steering motion. Some example motions with varying speed of wheels are shown in Fig. x.

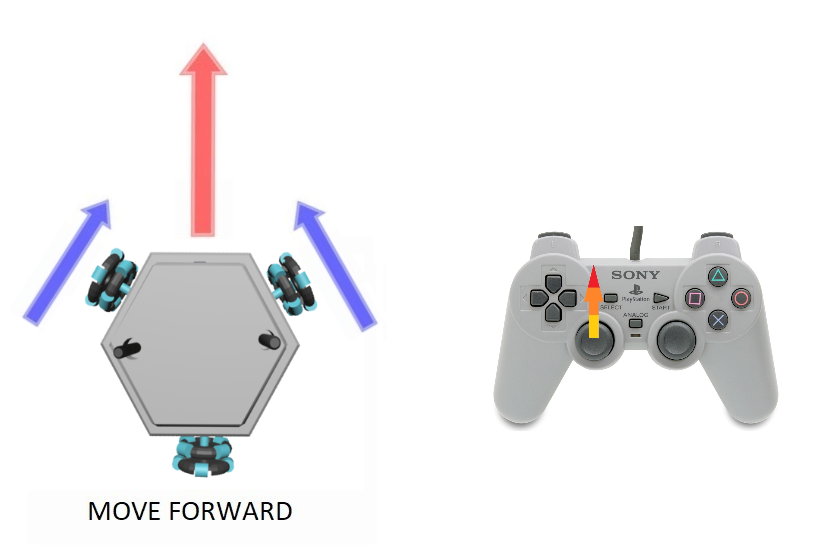


*Figure x. Holonomic drive*

**3.4.3 DC Motor Drive Movements**

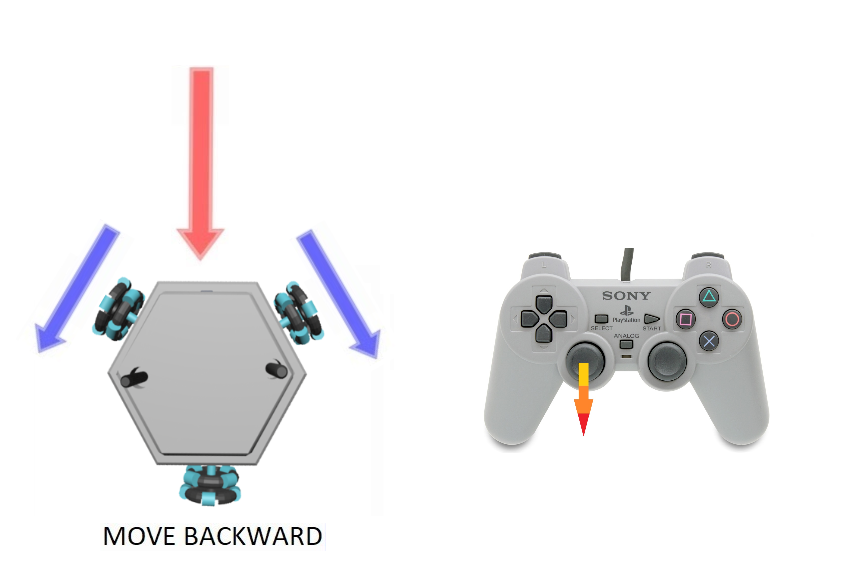
**i) Move Forward**

When user moves up the left analog of joystick, robot moves forward. For this operation, the two front DC motors should turn same speed and same rotation. This can be achieved with Arduino by setting the same PWM value to the both front motor pins. Note that different speeds can be obtained by changing the left analog position.



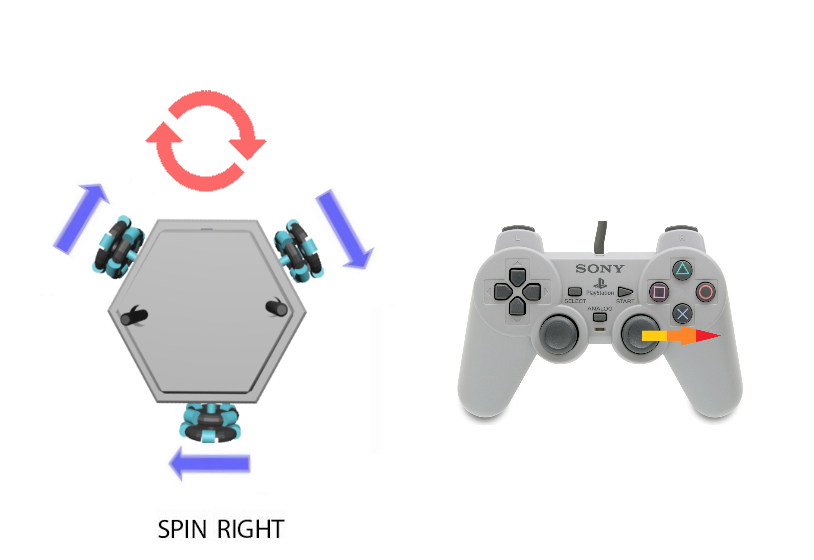
**ii) Move Backward**

When user moves down the left analog of joystick, robot moves backward. For this operation, the two front DC motors should turn same speed and same rotation. This can be achieved with Arduino by setting the same PWM value to the both front motor pins. Note that different speeds can be obtained by changing the left analog position.



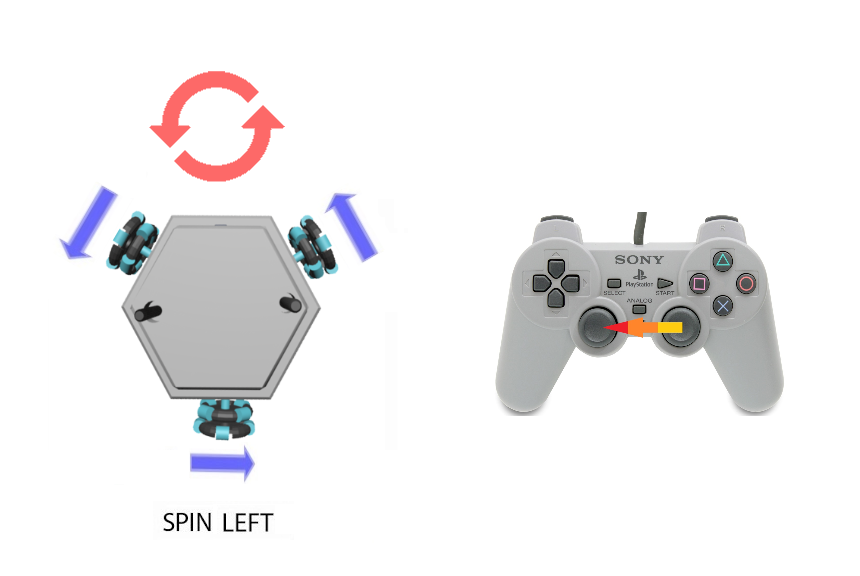
**iii) Spin Right**

When user moves right the right analog of joystick, robot spins right. For this operation, all three DC motors should turn at the same rotation and same speed. Note that different speeds can be obtained by changing the right analog position. This can be achieved by changing the PWM values for the motor pins.



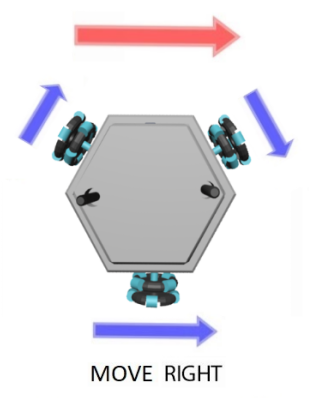
**iv. Spin Left**

When user moves left the right analog of joystick, robot spins left. For this operation, all three DC motors should turn at the same rotation and same speed. Note that different speeds can be obtained by changing the right analog position. This can be achieved by changing the PWM values for the motor pins.



**iv. Move Right**

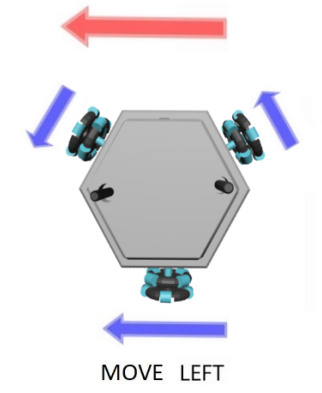
When user moves right the left analog of joystick, robot move right. For this operation, both front DC motors should rotate CCW direction and bottom DC motor should turn CW direction.



**iv. Move Left**

When user moves left the left analog of joystick, robot move left. For this operation, both front DC motors should rotate CW direction and bottom DC motor should turn CCW direction.

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**3.6 Technical Specifications of Power Supply Subsystem**

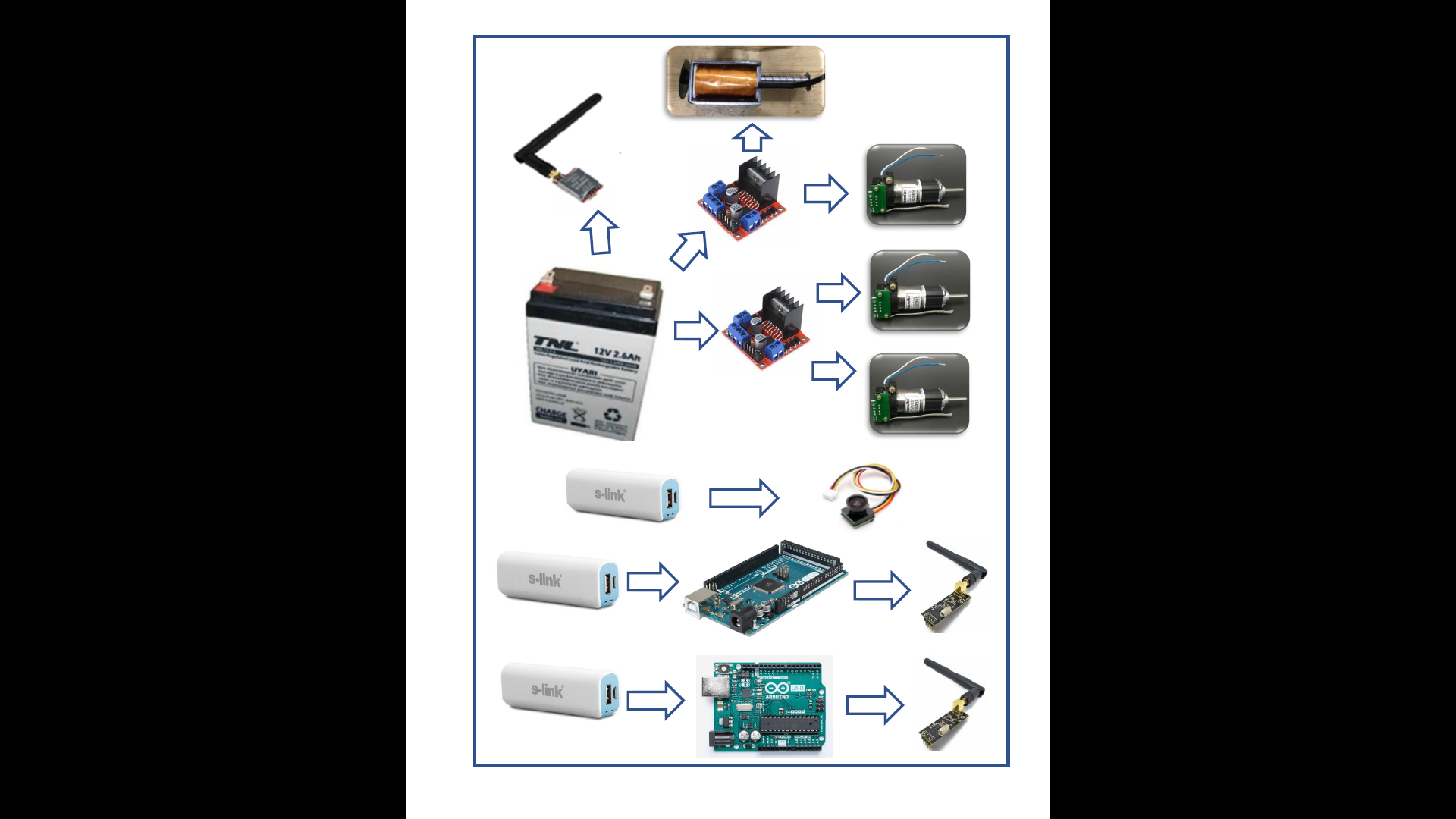


Figure x : Overall power supply subsystem schematic.

**7. Conclusion**

Troy Tech delivers a properly designed product which is compatible with the requirements, within a limited timeframe and economic budget constraints. Our main desire as a company is to provide unique and affordable products with significant functions, durability and performance. In this project, we present a perfectly working robot including unique design marks and precious engineering labor.

The product of our company “Helen V” is designed for a specific project which is briefly described as “designing and constructing one of the two teleoperated robots trying to shoot and score in opponent’s goal”. In this ‘Final Report’, we have explained the final steps of our design journey.

As we mentioned in previous reports, we know our responsibilities and requirements for the design procedure. We made enough progress in the first semester. In the second semester we finalized our product by choosing proper components and required improvements. We built our shooting system and modified movement system after lots of researches and comparisons between different alternatives. We tried to implement the most efficient components to our products. Also, we improved our already-working video transmission system and aimed to obtain one beyond the requirements. In addition, we focused on appearance of our “Helen V”. We did our best while designing our product and locating the components to create an eye-pleasing appearance. Neatness was important in terms of both compact sizes and robust character of the robot.

At the end of this eight-month adventure, we feel gratified after proceeding carefully on track of the project to fit the time schedule of the project as planned and launching a successful product. We really believe that the experience of this capstone project is of great value in our engineering careers.

**Appendix A-User Manual**



USER MANUAL



HELEN-V

*May 10, 2019*

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1. **What’s inside the box**

Your shipping box contains Helen-V (Fig. 1), Eachine ROTG02 FPV Receiver (Fig. 2), a command transmitter module with PS1 joystick (Fig. 3), Artengo beach volley ball (Fig. 4) and charging cables. Remove all items carefully and do not discard your shipping box.

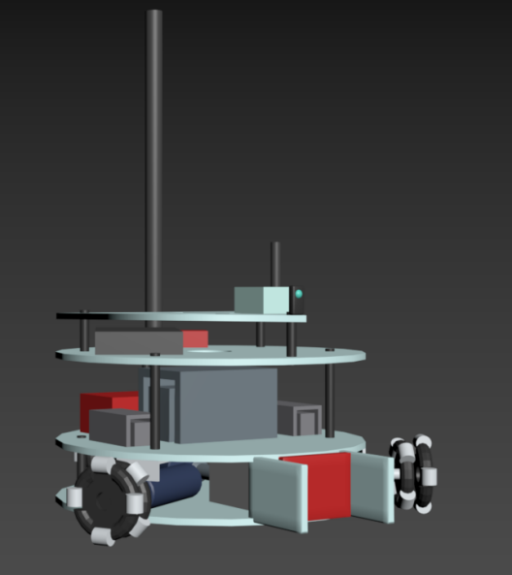


Figure 1. HELEN-V

Figure 2. Eachine ROTG02 FPV Receiver





*Figure 4 . Artengo beach volley ball*

*Figure 3. Command Transmitter Module*

1. **Quick Start Guide**



**1**



**2**



****

**5**

**3**

**4**





**5.8 GHz**

1. Install any FPV receiver app to your smartphone /tablet/PC (“GoFPV” is recommended.).
2. Connect “ROTG02 FPV Receiver” to your smartphone /tablet/PC..
3. Turn on HELEN-V and command transmission unit
4. Adjust the channel of “ROTG02 FPV Receiver” by pressing the adjust buttons. If you press any of these buttons 2 seconds, it will automatically set the channel.
5. You can start playing the game!
6. **Controls**





1. **Charging**



Helen-V includes 2 power-banks and a 12V (2.8Ah) accumulator battery. Moreover, command transmission system has a power bank. You can charge the power-banks with a simple micro-usb cable. You can charge 12V battery using DC supply or a 12 V battery charging adaptor.

**WARNING:**

- While charging the 12 V accumulator battery, make sure that other power-banks are switched off.

- Reverse charging is prohibited! Do not reverse the positive (+) and negative (-) terminals when charging the 12V accumulator battery.



1. **Care and Maintenance**

🡪Recharge the batteries after each use. Only an adult can handle the battery. Recharge the battery at least once a month when the robot is not being used.

🡪Store the robot where the temperature is between -20º and 45º C (-4º to 113º F). Don’t leave it in your car, because temperatures in parked cars can exceed this range.

🡪It does not have a waterproof function, so keep the robot out of water.

🡪Do not use the robot in loose dirt, sand or fine gravel which could damage moving parts, motors or the electric system.

🡪 When not using, all the electrical source should be turn off.

🡪In case of a technical problem, please contact Troy Tech, please do not try to fix the problem by yourself

**Appendix B**