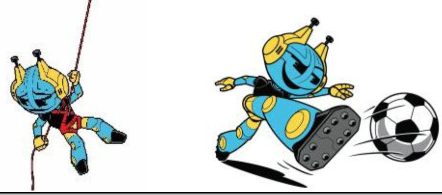


RCJA 2025 Rescue Line, Rescue Maze and Soccer Technical Description Paper

Team Information:

Challenge/Division: Lightweight Soccer

Team Name: Hyperion

School: Brisbane Boys' College

State/Territory: Queensland

Team Member Names:
If any team member had a specific role, please include this below.

Member 1: Matthew Adams (Hardware/Electrical)

Member 2: Sam Garg (Software)

Member 3: Thomas McCabe (Software)

Member 4: Luke Atherton (Hardware/Structural)

Robot Properties (200 words recommended maximum, plus components list (if applicable))
Please describe the software (e.g. EV3 Block Code, Python) and hardware (e.g. Spike Prime, EV3, Raspberry Pi) you have used for your robot.

For each piece of software/hardware used, please give it a star rating out of 5 (1=very bad, would not recommend to other teams, 5=very good, would strongly recommend to other teams).

If you have used custom electronics for your robot, please include specific model/part numbers or web links, and a star rating for each.

<u>Hardware:</u>

Our robots are custom-made with PCBs, PLA Printed Parts, and CNC-machined Aluminium plates. We use the CAD program Autodesk Fusion 360 to create 3D models of parts to test, then decide if they are applicable to implement into our final design. The main things considered when making the design were Size, weight, and easy access to important components, e.g., microcontroller, camera, fuses, battery.

Our robot uses 4 (DCX19 9v Maxon motors) motors for increased power and speed, and to improve balance and control for full 360-degree movement of the robot. For this 360-degree movement to occur, we made omnidirectional wheels, so the robot rolls flawlessly around the field. The wheel frame is made from ABS filament, while the rollers are made from silicone with a metal core. These wheels are positioned around a metal wire to keep them in place.

The vision system for our robot consists of adjustable 3d-printed PLA plates (allowing for image centring), an acrylic tube (ensuring no blind spots), a conical mirror (for long range, reliable, 360 goal vision), and the camera itself (OpenMV Cam H7 Plus).

Electrical:

We have 2 custom-made PCBs these are an Integrated main board and a Light sensor board.

The Main Board:

Our main board holds all our important components and the power supply circuit. Since our robot uses a 12.6V 1300mA battery for our motors and motor controllers, we use 2 regulators, which are 5V and 3.3V to power the rest of the board. The main microcontroller runs on 5V while all other components such as the (Camera) OpenMV-H7-plus-R4, (IR Sensors) TSSP58038, (Bluetooth) HC-05, (Compass) BNO005, and the Light sensor board via a FFC connector.

The Light Sensor Board:

This PCB contains 32 Red LEDs and 32 Photo transistors. Each LED and Photo transistor is accompanied by resistors and 0.1uf caps. The signals are transferred to 2 16-bit Multiplexers (MUX) 1 for the right side of the board and 1 for the left. These Multiplexers are used for easy reading of many sensors. The outputs from the Multiplexers are transferred through the FFC to the main board, then transferred to the Teensy.

Software:

In terms of software, we use Visual Studio Code as our primary code editor to write, maintain, and manage our projects. Alongside this, we utilise the PlatformIO extension, which provides powerful tools for compiling code, identifying errors efficiently, and uploading firmware seamlessly to our robot. This setup has proven to be both reliable and efficient. We highly recommend this combination (5/5) to other teams—provided they are using a PlatformIO-supported microcontroller, such as the Teensy 4.1, which we currently use in our system.

Component Ratings:

Maxon DCX 19 16:1 Motors x4 (Rating: 5/5) https://www.maxongroup.com/en-au/drives-and-systems/brushed-dc-motors

OpenMV H7 plus R4 (Rating: 5/5) https://openmv.io/products/openmv-cam-h7-plus?srsltid=AfmBOopUlx-O5g0kAdq29yPygN9NjdEHzttPajDnhGekYY7qRUs_2A8N

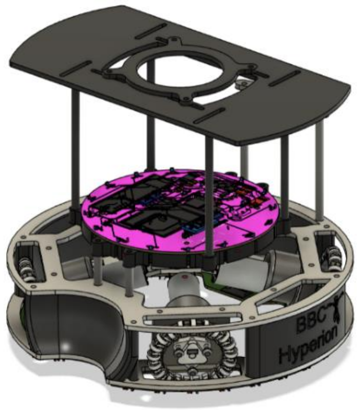
Teensy 4.1 (Rating: 4.5/5) https://core-electronics.com.au/teensy-4-1.html

BNO005 (Rating: 4/5) https://www.amazon.com.au/Precision-Acceleration-Gyroscope-Geomagnetic-Smartphones/dp/B0FD8P7FWX **HC-05 (Rating: 4/5)** https://www.amazon.com.au/Bluetooth-Pass-Through-Wireless-Communication-Arduino/dp/B01G9KSAF6 **TSSP58038 (Rating: 4/5)** https://www.digikey.com.au/en/products/detail/vishay-semiconductor-opto-division/TSSP58038/4695717?srsltid=AfmBOopEVuwf_liw91CwBaYATAahxA23xp6aBPaJavajmFHZMRfkdnSS
Collaboration **(100 words recommended maximum)** Please describe if your team has used any methodologies, software or systems to aid collaboration (working together). This could be related to the design, construction or programming of the robot(s). It is the overall desire of RoboCup Junior events that any technological and curricular developments will be shared with other participants after the event. Any developments including new technology and software examples, may be published on the RoboCup Junior website after the event, furthering the mission of RoboCup Junior as an educational initiative.
In terms of collaboration the main ways we managed to work together was through the use of GitHub, Email, Team and Whatsapp. We used GitHub to share and edit each other's code as well as for easy access to prior versions. We used Email to communicate our absents from sessions as well as sharing word docs like this one. We used Team to post notices, and we used What's app to plan and update people on what we need to do next.
Key Achievement & Area for Improvement **(300 words recommended maximum)** Please describe one aspect of your robot your team is particularly proud of, and one aspect you would like to further improve.
From a hardware perspective, a key achievement would be the design of the vision system. Utilising adjustable plates (ensuring the camera's vision was centered in OpenMV), an acrylic tube as opposed to standoffs (removing blind spots and allowing for constant, reliable 360-degree goal vision), as well as a conical mirror shape with specifically calculated dimensions (allowing for a theoretical 31m of goal vision with seeing above perpendicular, in all directions), all allowed for a successful vision system from a hardware perspective. An area for improvement would include the addition of more complex components in future competitions. While refining the basics was beneficial this year, without more complex components such as a kicker, we often found our robot missing goal opportunities, with the ball often getting stuck within the goal box. Furthermore, when experiencing electrical issues, requiring changes to components on our main PCB we often had to largely disassemble our robot, wasting large amounts of time. To improve this in the future we aim to make our design in a way such that our main PCB is more accessible, so changes can be made more efficiently.

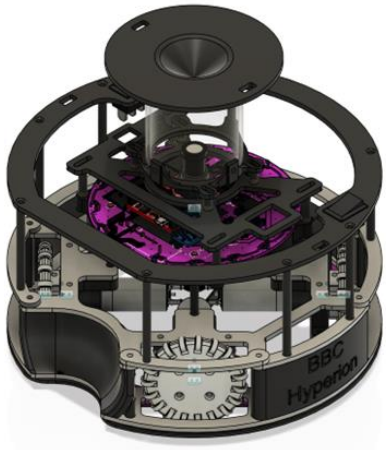
One of the innovations we are most proud of is the integration of the camera into our main.cpp, which plays a vital role in our robot's performance. This system allows us to track the goal with high precision, significantly improving our attacker's accuracy when aiming shots. For the defender, the camera ensures the robot can correctly orient itself away from the goal while maintaining an optimal distance to block incoming shots effectively. Additionally, the camera helps us determine our position on the field, which enables us to implement more advanced strategies.

The parts of our electronics that we are proud of are the design of the PCB. For example, the routing for the motor controllers was difficult and time-consuming because we needed to try and fit 100 mil width traces to reduce resistance in the circuit and have the motor controllers be in an easy-to-access position for easy repair if the motors come unplugged or damaged. Additionally, the motor controllers had to connect to the teensy so space for all the traces had to be considered.

Photos and Design Documentation **(100 words recommended maximum, plus images)**
If there is a design drawing of the robot or if you have photos or notes of the development process, please provide these as proof of your team's learning.

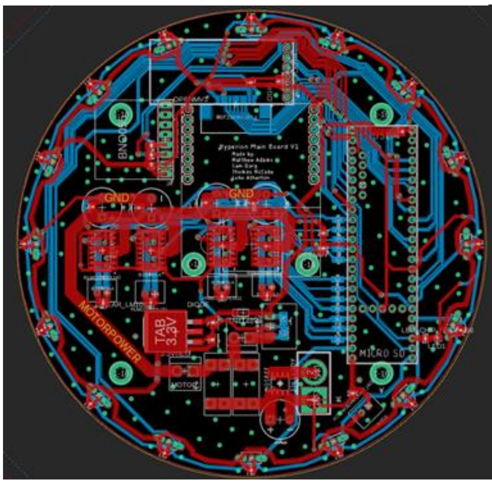


Original Robot CAD Design

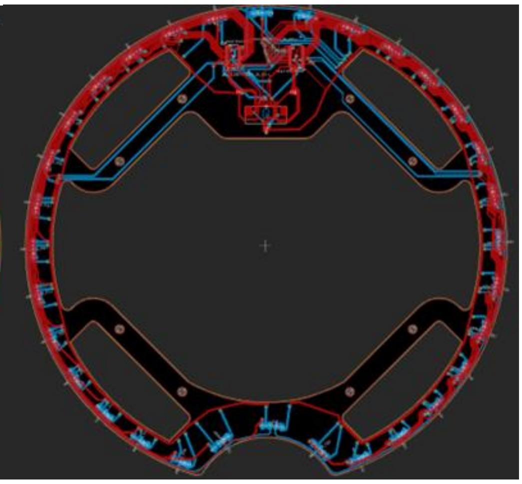


Final Robot CAD Design

From a hardware design perspective, for the development of the robot the general proccess started with the designing of the major plates of the design (base and middle plates), then focusing on the drive system components (motor brackets, and wheels), then other major components such as the tssp ring, and capture zone. Then working up, the vision system components and top plate were designed (however a 2nd version of the vision system was later used replacing the original). After such, more minor parts were designed including the battery holder and guard, side guards and LSB protector.



Main Board Design



Light Sensor Board Design

All of our code developments can be seen in our previous commits inside our GitHub here: https://github.com/SamGargRobotics/Hyperion-BBC-Robotics.