SHOUN

League :
Soccer Open

From :
Japan

Hyogo Prefectural
Sanda Shounkan High School

About us

We are the robotics team from the Science Club of Sanda Shounkan High School. We will be participating in RoboCup Eindhoven 2024 as players in the Junior Soccer Open competition. This season is the first time for all of us to take part in the RCJ Soccer Open competition, and we are excited to be able to stand on the stage of this world championship about a year after we started participating in RCJ.

Maruoka Yuya Captain,Software Developer
Developed programs for UART communication, motor control, and other programs

Yamamoto Tatsuki Hardware Engineer
Designed and built robots

Furuichi Haru Software Developer
Developed algorithm for chasing ball and micro python code for OpenMV

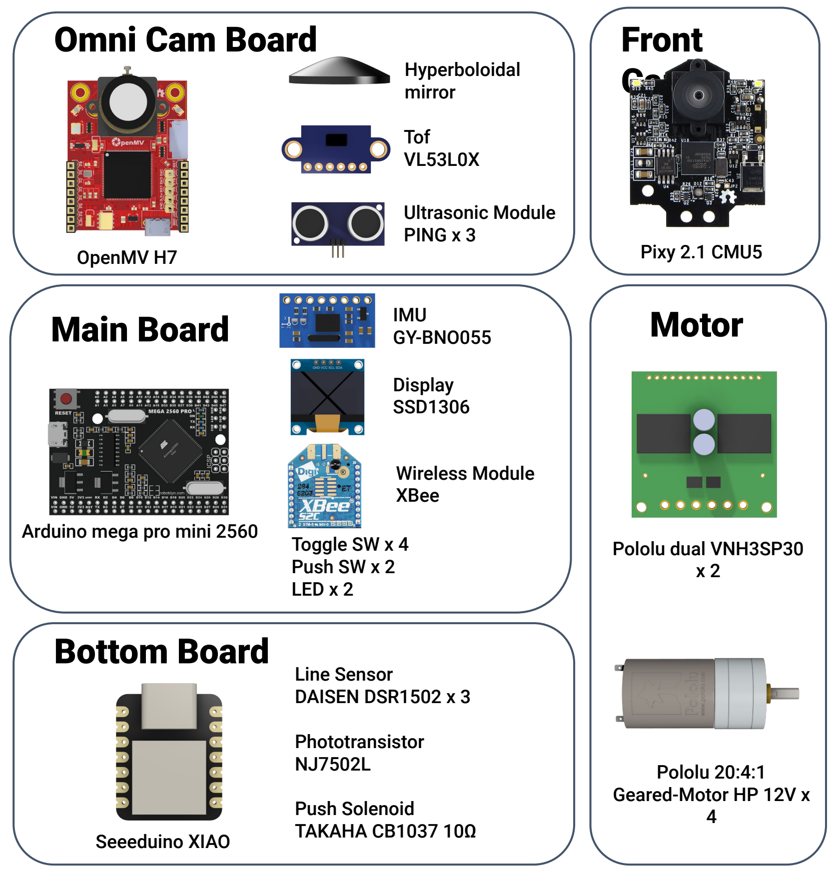
Award

2nd place at RoboCupJunior JapanOpen2024

Development software

- Arduino IDE
- Visual Studio Code
- OpenMV IDE
- Autodesk Fusion

HARDWARE



Omni camera

To improve the accuracy of ball recognition, we changed the omnidirectional camera from Pixy to OpenMV. As a result, the accuracy of recognizing the distant ball which is seen small on the camera has improved. Additionally, as a result of switching from CNC to 3D printers to produce the mirror molds for the Omni Camera, we discovered that 3D printers can also produce molds with sufficiently high precision.

Ping and Tof distance sensor

When the robot cannot find the ball, we think that there is a higher chance of finding the ball by moving towards the center of the court. By measuring the distance to the walls in four directions using Ping and Tof, it is possible to move toward the center of the court.

Front camera

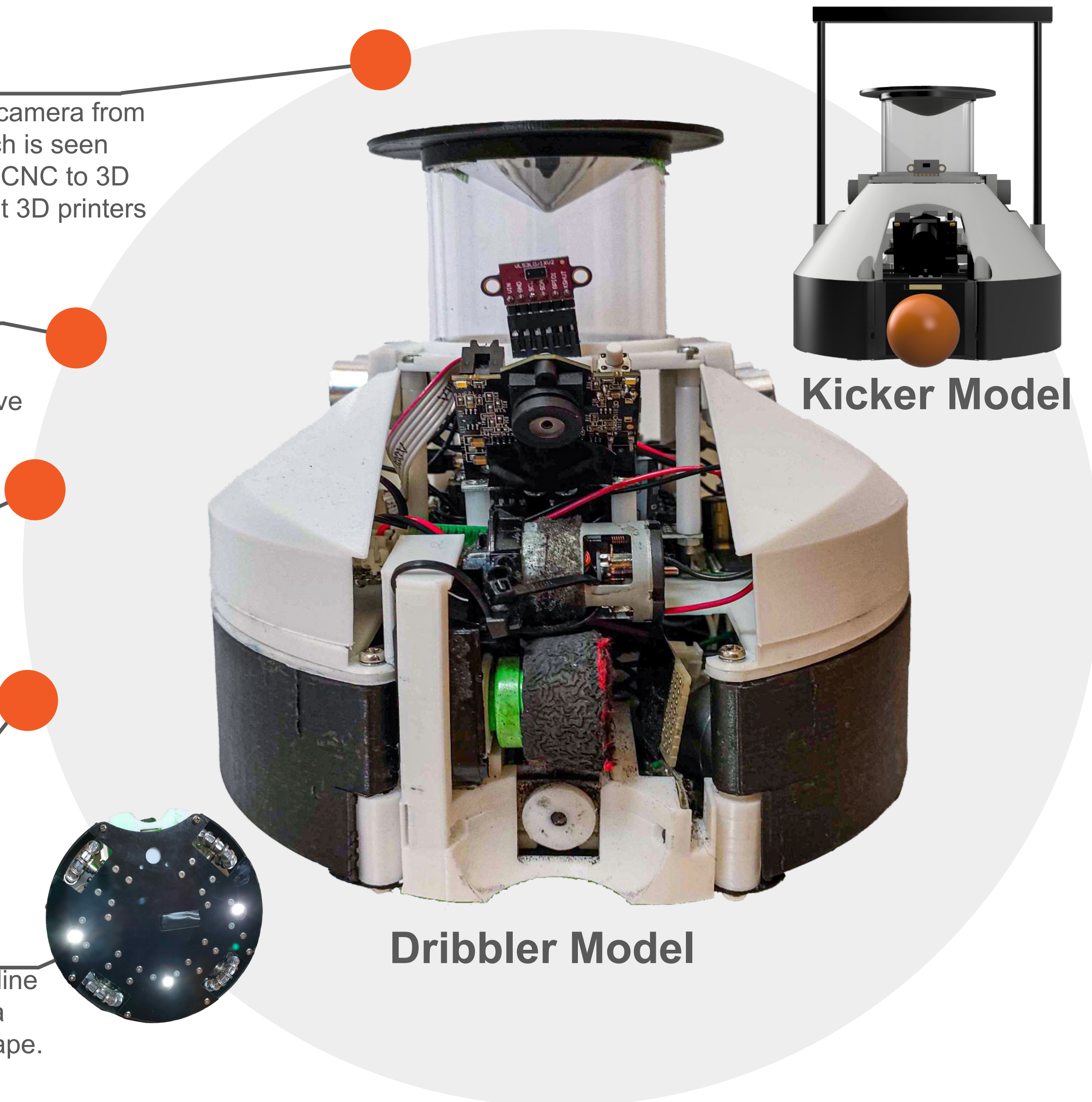
We think that it is important to recognize the ball in the opponent's territory faster and more accurately than the opponents do, in order to go forward in the game more advantageously. By using a front camera, robots can recognize the ball that is in longer distance in front of the robot than using only an omni camera more accurately.

Dribbler

The production of the dribbler started after the Japan Open in March. It was made by taking out the motor and other parts from the power head of a vacuum cleaner. A rubber part of a glove was cut and pasted on the rotating part to pick up the ball. As a result, it was able to grip the ball firmly.

Line sensor

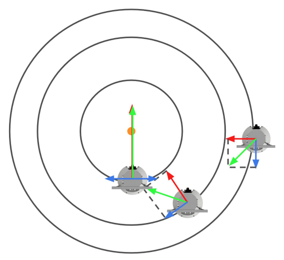
Our robots have only 3 line sensors.We use Seeeduino XIAO exclusively for line processing, and output a signal to the main board via UART when detecting a line. When the main board detects the UART from XIAO, it executes line escape.



SOFTWARE

Ball Chasing with Calculation Formulas

The conventional ball chasing using conditional branching has been improved to ball chasing using calculation formulas that allows smooth movement of the ball. At the beginning of development, it was not seen so strong, but as the program was optimized and the loop frequency increased, it began to show its true potential.



First, consider circular motion centered on the ball.
To find the angle the robot should move in this circular motion, consider a circle with the ball as its center and the distance between the ball and the robot as its radius, and a line tangent to the robot's position.
The further behind the ball the robot is, the stronger the force directing in the direction of the ball will be combined with this circular motion, and it will go around the ball and ultimately capture the ball in the forward direction of the robot.

Variable Center Coordinate

The setting value of the center coordinate of the omni camera greatly affects the movement during the chase. When capturing the ball, if the center coordinates for using in ball chasing with calculation formulas is completely in the center of the robot, the center of the robot will move to touch the ball, and it will push the ball at a position that is off from the kicker. However, if the center coordinate is placed at the kicker's position, trajectory of chasing the ball will make a larger circle excessively when going around. Therefore, the program is devised so that the center coordinate setting value is changed based on the y coordinate of the ball that is seen by the omni camera, making a small circle and capturing the ball at the kicker's position.

←This video will help you understand the result of this algorithm.

Dribbler Strategy

We came up with a strategy using a dribbler. When the robot finds the ball, it faces the direction of the ball and holds the ball with the dribbler. When the robot holds the ball with the dribbler, it moves straight toward the goal. Finally, when the robot gets close to the goal, it faces the goal and shoots.

Goal correction by P control

Controlling the robots to face the goal direction is important for them to reliably score the ball in the goal. Therefore, we decided to use P control to perform gentle turning to point the robots in the angular direction of the goal obtained using the vision system while chasing the ball. First, we created the following code to perform gentle turning using four omni wheels.

```
void moveThetaWithTurning(int speed, int move_theta, int TurnPower) {
  while (move_theta > 360 | move_theta < 0) {
    if (move_theta > 360) {
      move_theta -= 360;
    } else {
      move_theta += 360;
    }
  }
  powerx = move_theta % 90;
  powerx = abs(powerx - 45);
  speed = speed + (0.25 * (45 - powerx));

  a = speed * (cos((move_theta) * (PI / 180)) + sin((move_theta) * (PI / 180))) / sqrt(2);
  b = speed * (cos((move_theta) * (PI / 180)) - sin((move_theta) * (PI / 180))) / sqrt(2);
  move(a + (TurnPower * -1), b + TurnPower, b + (TurnPower * -1), a + TurnPower);
}
```

This code allows the robot to move in any directions while making gentle turns. The strength of the gentle turns is determined by P control based on the difference in angle between the robot's front and the goal direction. As a result, the robot was able to chase the ball while facing the goal, as shown in the video below.

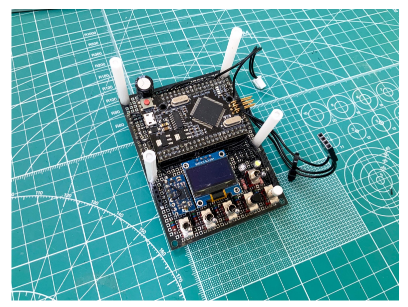
Robot-to-Robot Communication

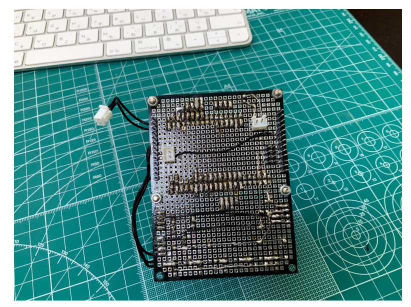
Our two robots do not have a clear distinction between offense and defense. So,if there is no distinction between offense and defense, if both robots recognize the ball, they will chase after it, and as a result, they may interfere with each other. We thought it would be effective to solve this problem by having the robots share the location of the ball through wireless communication. Our robots use XBee for wireless communication, which is easy for us to use because it uses UART.

NEXTSTEP

Designing the PCB

As we are not yet proficient in software for designing PCBs, such as KiCad, all the circuit boards installed on the robots are built by hand. This has become a big burden in building the robots, so we are considering installing PCBs designed by ourselves on the robots for the next season. We are currently studying KiCad in preparation for this.





↑This is hand-made main board

Omni Wheel improvements

The omni wheels we use on our robots are made of aluminum, so they are very slippery. We are considering working on creating an omniwheel that improves this issue.

More advanced vision systems

This season, we developed robots using two cameras. We'll use the experience we gained from developing robots that can perfectly recognize the ball on the entire court using more cameras next season. We also plan to work on recognizing opponents using cameras.

More Line Sensors

Each of our robots has only 3 line sensors, which is very few among the RCJ Soccer team. We are considering putting more line sensors on our robots for next season to recognize the lines more accurately.