APEX

Taipei, Taiwan,
Soccer lightweight


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Abstract

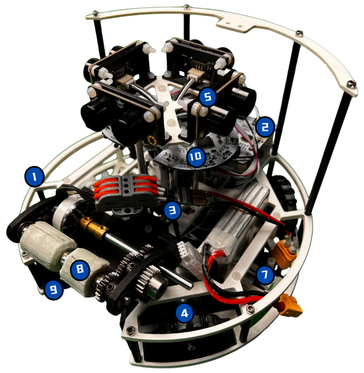
Team Apex have participated in RoboCup Junior Soccer Lightweight since 2019, we have won several international awards. This year with the past experience and the new recruits, team Apex aim for new fresh ideas and higher performance. We are determined to refining their robotics design, optimizing their programming algorithms, and strengthening teamwork for accomplishment for the upcoming competition. To achieve both good offense and defense, team Apex decides to assign one robot only focus on offense and another focus on defense. Additionally, we developed several diverse strategies to score and counter opponent's attack, including spin kick and cooperation between kicker and dribbler.

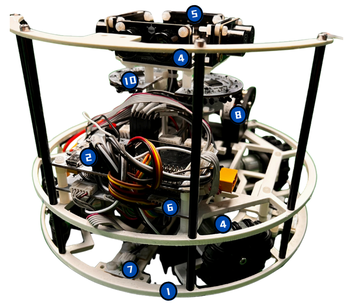
Design/Production

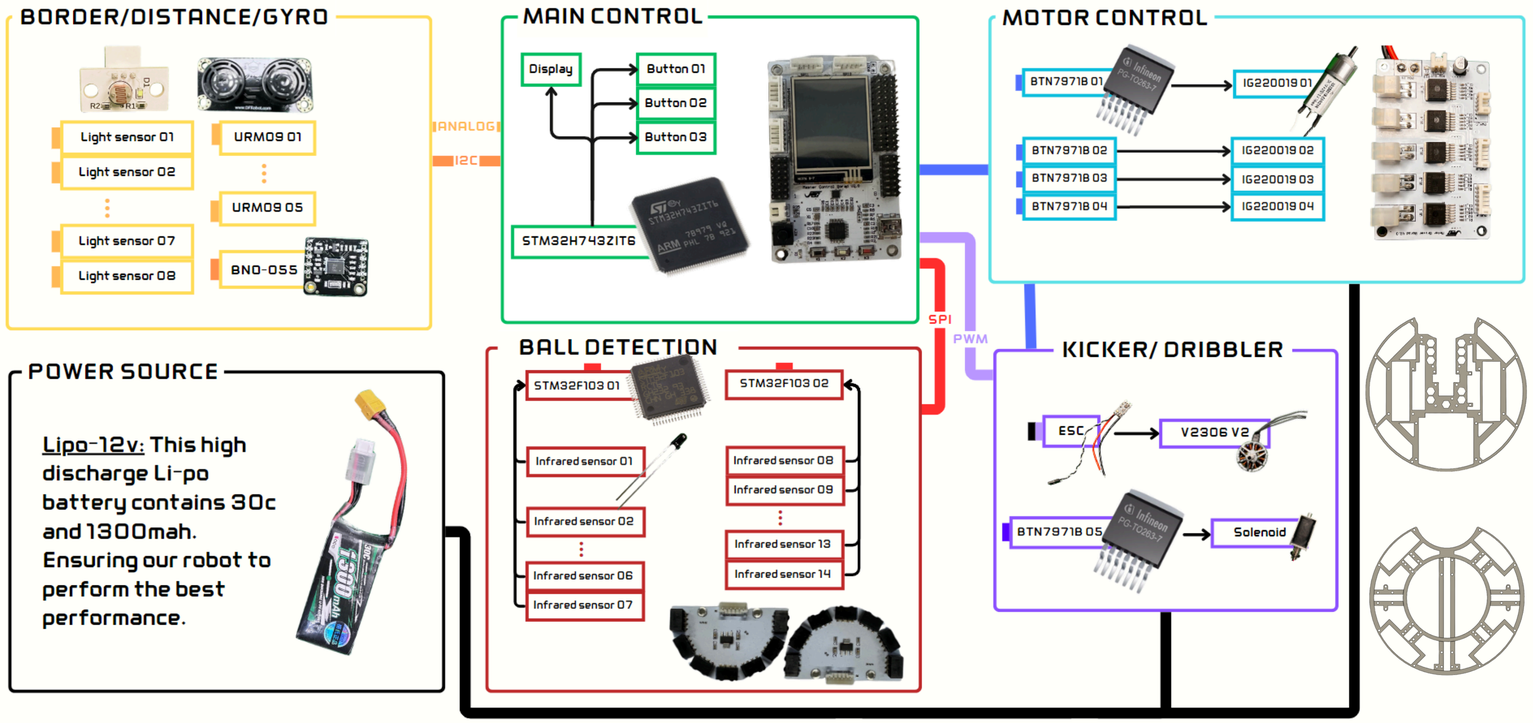
Team Apex expects the robot to obtain high durability, mobility, and accuracy to express the best performance throughout the competition, come along with diverse sophisticated strategies. To achieve this, we uses Fusion 360 and Inventor to design the chassis and 3D components. During this stage, we will brainstorm how the layout of the robot and components fulfill the requirement of specific strategies. We uses Snapmaker A250 to do both CNC carving and 3D printing. The finished chassis and 3D component will be assembled into a robot with suitable electronic equipment. Finally, we create the overall structure of the code and the basic functions using Keil Vision 5 and experiment various strategies to filter out the best.

Kicker & Dribbler Mod: We uses V2306 V2 motor for the dribbler, due to its powerful torque, lightweight, ability to do precise control, and minimal size. By combining the powerful motor and silicon roll, the silicon roll can increase ball's friction and successfully capture the ball. Moreover, we also achieve powerful ball launching through hand craft solenoid, with 0.85mm copper coil. Most importantly, the kicker and dribbler system are all assemble in one 3D model to accomplish good organization.

Navigation System: We collaborates with 2 IR boards(each contains 7 infrared sensors) to efficiently track the ball. Furthermore, the utilization of light sensor, ultra sonic sensor and compass, the robot have the ability to ensure itself not to leave the court , while always facing the opponent side.







Components

1. **Chassis:** The design of the chassis are aim to reduce extra weight while holding every mechanical parts. Besides we chooses glass fiber chassis, due it powerful strength while being extremely light weight.
2. **Processor:** Our controller is based on STM32F7 and Arm® Cortex®-M processor. It has 14 analog pins, 4 12C pins, and 2 UART pins, which can support the robot with up to 8 light sensor and 4 ultrasonic while still maintaining high efficiency and capacity
3. **Compass:** By collaborating with compass to ensure the robot always face opponent side.
4. **Motor:** We use IG2200-19 as our motor for basic locomotion due to its fierce torque power, low voltage, and lightweight. Moreover, we place the 4 motors diagonal with omnidirectional-wheel to achieve smooth movement on both x and y axis .
5. **Ultra Sonic:** Can efficiently detects whether the robot reach the border of the soccer court
6. **Driver Board:** Our driver board has 5 BTN7971B and each with 2 PWM digital output pins on board. They control the speed and direction of our motors. The driver board is essential to the robot, because it prevents MCU from damaging and allows more precise motor control.
7. **Light Sensor:** Using the light sensor to detect the light's reflection ratio, to prevent the robot from venture out the court.
8. **Dribbler:** We use V2306 V2 motor for the dribbler, which it can use its powerful torque and precise control to efficiently capture the ball and develop certain offense strategy.
9. **Kicker:** The kicker is solenoid-based mechanism to perform powerful strength for ball ejection. Which the kicker serves most of the scoring and shooting.
10. **Infrared Sensor:** We have 2 Infrared receiver modules locating above the middle chassis. This is use to locate the ball, each of the sensor can scan 180 degree horizontally. The ball itself will emit its signal, as a receiver the IR can easily detect the location of the ball.

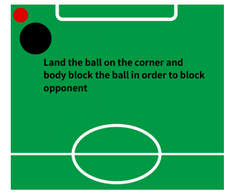
Strategy

For offense, the robots detect the ball's position using onboard sensors and strategically find the shortest path to reach the ball at full speed and dribble the ball to the goal with the kicker. Although the strategy might be simple and straightforward, we believes the offense side should require high mobility, strength, and accuracy. For defending, the robots detect the ball's position using onboard sensors and strategically move to the ball. They constantly monitor the ball to prevent it from crossing the field's white line, effectively maintaining control. By adjusting their position, the robots block opponents and reduce scoring opportunities, showing quick response times during defensive conditions.

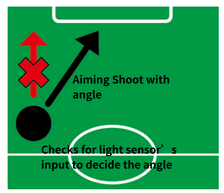
Corner play: According to the situation, we will choose to run the program the robot will launch the ball into the corner to derive corner attack strategy such as spin kick and corner kick.

Angled shooting: Because 4 of the neutral spots cannot be scored by only pushing the ball straight forward, our robot dribbles and shoots at an angle.

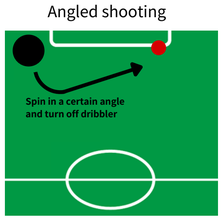
Spin kick: The robot will use the dribbler to carry the ball to the edge of the opponent's goal and spin in a particular angle while using the dribbler to make the ball rotate. Then release the ball and score in an **unexpected angle**.



Corner play



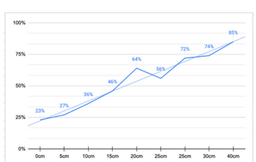
Angled shooting



Spin kick

Data

Moreover, we conduct several experiment on attacking strategy . For instance, we test spin kick probability of success from specific distance(Range from the edge of border to the border of penalty area horizontally). According to the experiment, we finds out **spin kick performs the best(85%) when it reaches to 40 cm**, which is also right on the border of the penalty area.



Facing enemies at different distances, the probability of scoring with a spinning kick varies.