OTU Engineering Robotics Competition Report

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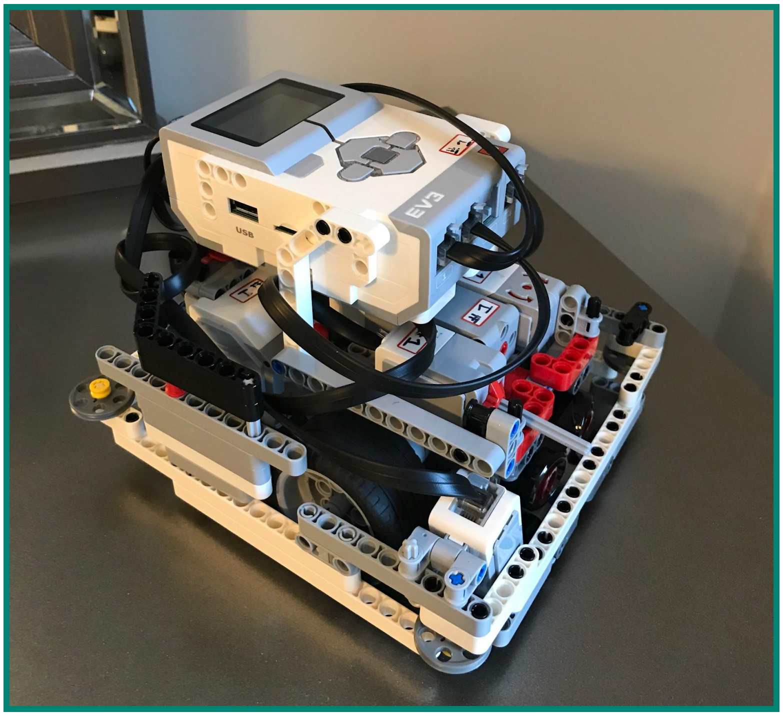
SYNOPSIS



Over the past month, our team set out to construct a fully autonomous Lego EV3 sumobot that was developed from a defensive standpoint. The possibility of a variety of issues and ways to prevent them throughout the building process was a significant factor in how we built our project. The robot had to be strong and durable enough to take numerous impacts and remain on the field. On top of that it had to be able to recognise its opponents and steer clear of them, as well as the field's perimeter. We continuously adjusted the software and robot design throughout testing to match the demands of the competition and maximize performance. The main components of our first concepts—stability, maneuverability, and sturdiness—were carefully considered throughout and ultimately displayed in our final result.

CHALLENGE STATEMENT

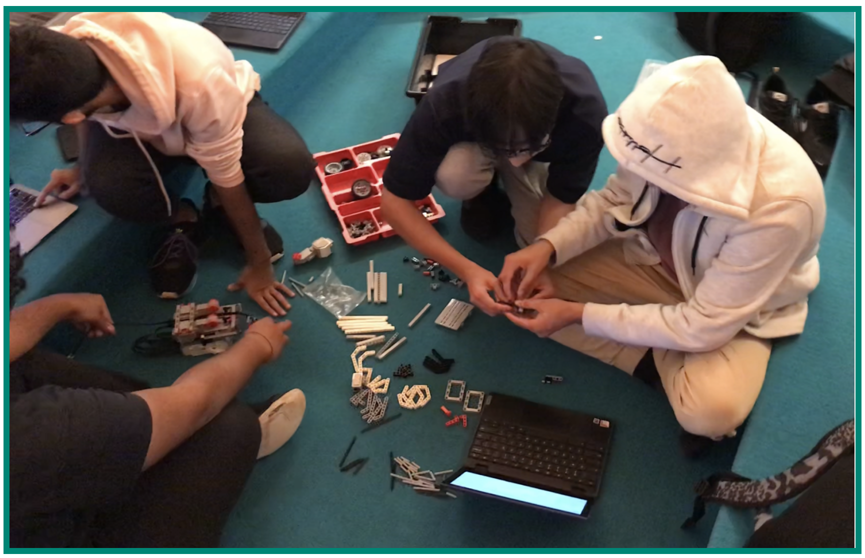
The main challenge of this robot project was to design and build a sumobot capable of adequate mobility, defense, and ability to attack other robots when needed, all while being constrained to 4 sensors, 3 motors, and a 20cmx20cm limit.

While brainstorming, we decided on constructing a defensive robot rather than an offensive robot. To achieve a defensive sumobot, we decided to use 2 motors to power rubber wheels as it creates more friction between the robot and the ground, protected the sides of our wheels and the inside of our robot with Technic pieces, and chose our sensors with defense in mind. These include a colour sensor for getting off the edge, a gyro sensor to turn towards the middle of the platform, an ultrasonic sensor to sense other robots, and a touch sensor to push back other sumobots if needed.

The constraints from the rules however, led to some deficiencies in our sumobot which includes having blindspots, only being able to have the colour sensor on one side, and the touch sensor not extending as long as we wanted as it had to be less than 20cm.

MECHANICAL ANALYSIS AND DESIGN

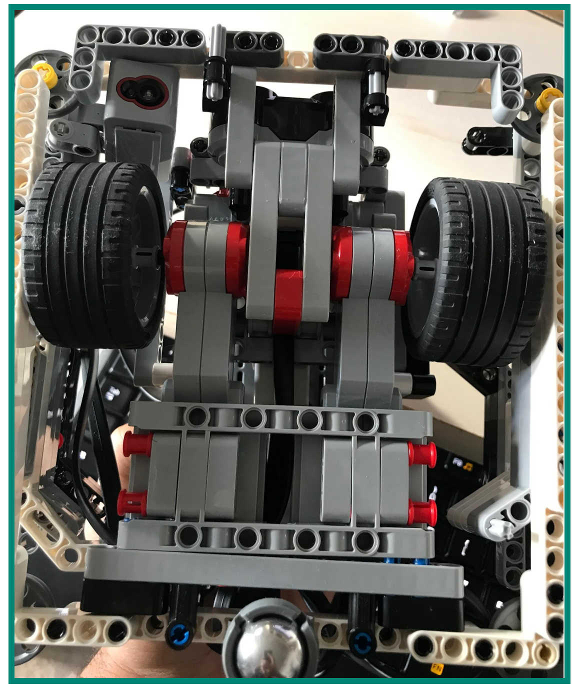
When the robot challenge was first introduced, our group immediately began conducting in-depth research to determine the most efficient mechanical strategies for a sumobot. We collected a number of ideas and started planning the skeleton of our robot upon looking through previous competitions, tutorials, and community videos.



Early stages of mechanical planning and assembly

Motors

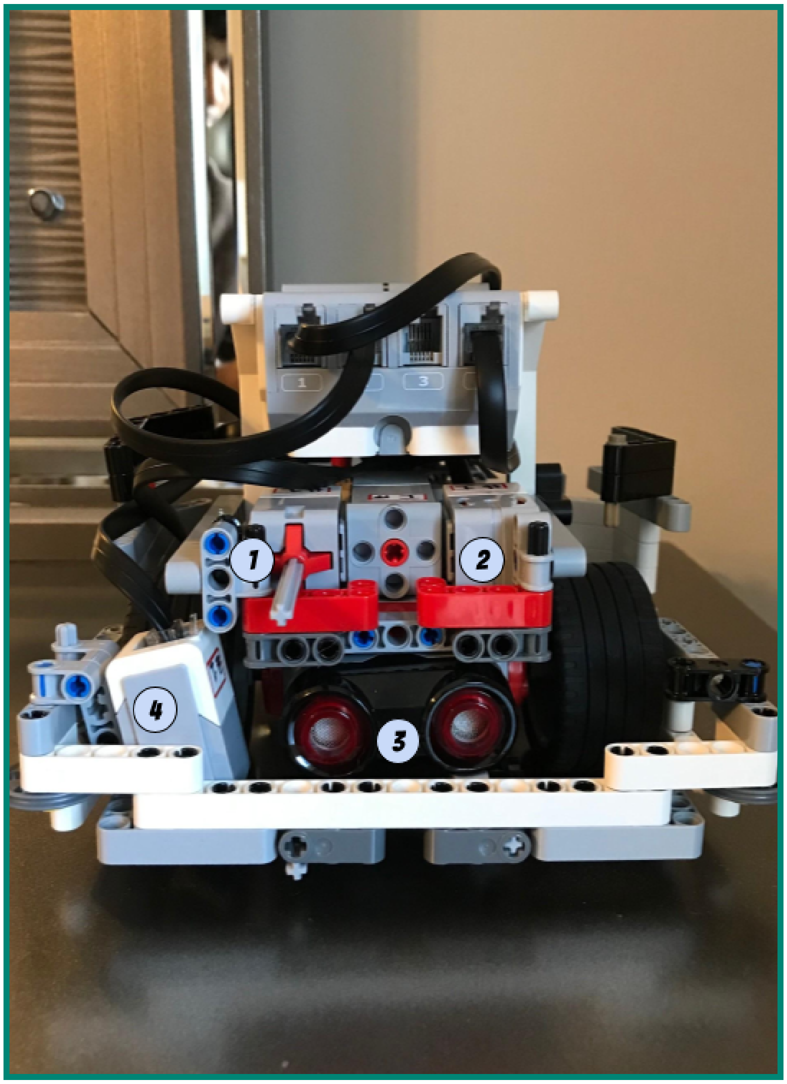
We decided as a group to have the two main motors be symmetrical, giving the robot's motion on two substantial wheels a stable foundation. The rubber wheels included in the EV3 kit were ideal for our design, as they had enough mass to support the robot and offered enough floor friction. We added the Technic ball pivot at the back to add stability since we only had 2 wheels. Since there was still a motor remaining (2/3), we added a medium motor at the front to control a spinning weapon as a line of offense.



Sensors

The robot's sensors are an essential component because it will be completely autonomous in combat. There were a total of 4 sensors used, each serving a distinct function.

1: The EV3 touch sensor was added to the front of our robot, extended with a rod with the purpose of detecting any head-on collisions that may happen in battle. Since we are designing a defensive sumobot, this sensor allows it to back away from a detected collision to try and stay upright.



Labeled front view of sumobot

2: The next sensor added was the gyro sensor, capable of tracking angles of rotation for more precise turns.

3: An ultrasonic sensor was also added to detect the front of our robot's proximity to any other objects in the ring.

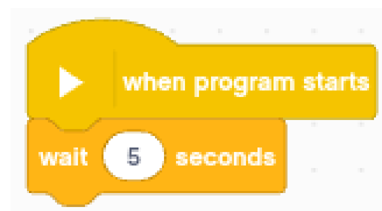
4: The colour sensor was a crucial addition. Pointed at the floor, this sensor allows the robot to stay within the boundaries of the ring, as if it goes out of bounds, it will detect the colour of the floor changing.

SOFTWARE ANALYSIS AND DESIGN

The software component of our robot is like the brains of the system, it is necessary for how it will perform based on the changing environmental scenarios during the competition. All software for the robot was designed in EV3 Classroom. The programming language is very simple to follow and understand, allowing this process to be smooth sailing.

Wait command:

For the competition it is required that the robot starts moving 5 seconds after the EV3 button is pressed, therefore this was the first line of code added.



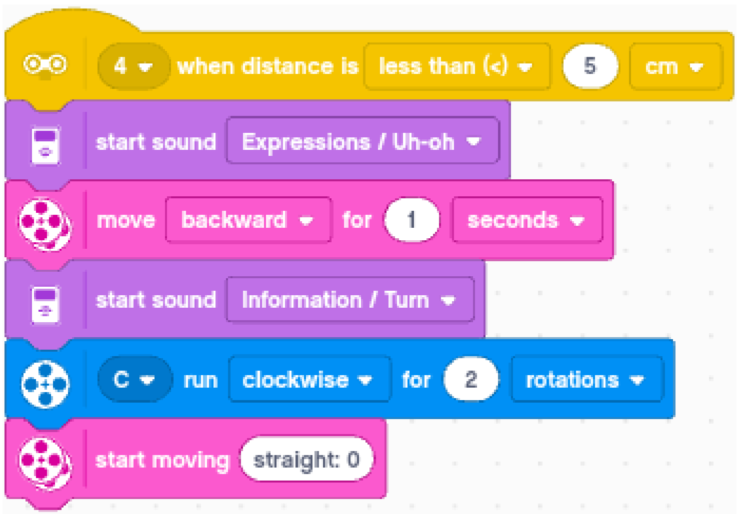
Staying inbounds:

As mentioned, the colour sensor allows the robot to detect when it’s out of bounds, and come back into play. Again, the EV3 programming language made this very simple to code:

turns robot around 180°

Proximity:

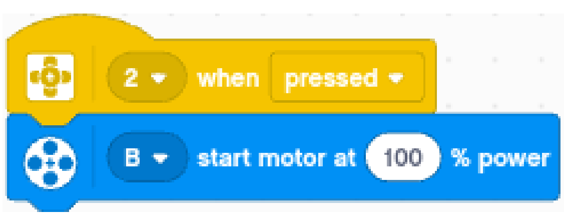
This block of code detects nearby objects, and essentially makes our robot run away from them, sticking with our defensive tactic.



sound effects also added

Spinning sword:

This code is run when a robot makes a collision with the front of our robot, via the touch sensor. It results in the start of the medium motor which will have an offensive weapon attached to it, to hopefully damage the competitor.



These are a few of our programming components, tactically chosen to improve our robot's chances at surviving the competition. All the code was tested by simply running it with the robot on my hardwood floor, and making slight tweaks when it would not perform how we wanted it to.

INTEGRATION AND TESTING

1. After completing our team's integration and testing, we were able to produce a well-built system with many excellent functional components. As our team was aiming for a defensive build, the finished product was surprisingly small and had a lot of survival-enhancing features. For starters, the robot's inner core, which houses all of our sensors, is well-maintained, while the outside is supported by larger pieces. Also, most of the kit had to be used for this robot because many lego pieces were put together for the rigidness. Upon assembling the software components, we knew that we needed to add wall blockages on each side of the robot; while doing so, the robot endured larger impacts. Additionally, the robot benefits from the sensors because, when turned on, it will attempt to distance itself from its adversaries. The system also required the two wheels on the bottom with the Technic ball pivot; they were placed very closely together with two motors to minimize surface area for it to function more quicker.

2. While being very simple, the software components work together with the mechanical parts because we strategically coded our sensors to act during specific circumstances (like explained above). For example, our EV3 touch sensor only works upon impact, but if that doesn't happen (as we hope), we have our ultrasonic sensor that will try to detect a robot before it attacks. Then, that will activate the mechanical motors as well as the gyro sensor to leave the situation.

3. Finally, we chose this overall design because we assumed that many other groups were probably going for an offensive strategy. That's why we went for a simple build that can be defensive and can quickly escape from dangerous situations. Even though we decided to make a robot with not too many external components, the plan was to make it smaller and focus heavily on the coding aspect to win.

4. We also tested it by simple trial and error. After building the robot "prototype", we just tried running the robot and seeing the mistakes in the process. If we saw a mechanical mistake, we would simply alter the arrangement of pieces and add more so it works more seamlessly. For coding errors, our group just added more precise code. It took several group sessions to get the testing perfect.

CONCLUSION

Throughout the process of building our robot, we learned new building techniques, and enhanced our knowledge about engineering processes. From the brainstorming/research period, to the design process, then finally building and coding our robot, we learned about what it takes to become engineers. From our experience, we understand the design of sumobots needs a lot more study the next time around. As it was our first time tackling a challenge like this, we went in blindly not knowing how difficult it would be from both a mechanical as well as a software perspective. We would definitely look to attend more workshops to get a better understanding of how to better design our sumobot. Whether our sumobot wins or loses, what matters the most was the experience and fun we had throughout the whole project.