2019 IEEE SoutheastCon Hardware Competition

First 50 … Next 50

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Introduction

The 2019 IEEE Southeast Con Hardware competition this year will be held at the Von Braun Center in Huntsville, Alabama, and is space themed. Teams will be awarded points based on the robot's ability to complete tasks including leaving home base, crossing the orbital line into Zone 2, completing multiple counter-clockwise orbits within Zone 2, removing debris from Zone 2, placing the debris in home base, placing color-matched debris in the appropriate color corner square, returning to home base, and raising the onboard flag. The team's will also lose points for every collision between their robot and the Spacetels. The objective is to receive enough points to make it into the top 8 competitors. After which, robots must compete one on one in a single elimination bracket with the team that scores more points moving on to the next round.

Problem Definition

The 2019 IEEE Southeast Con Hardware competition is an annual event for college students in the southeast region of the United States to compete in. Students must design and build a robot that meets several specifications and typically navigates around a themed course. This year the competition will be held at the Van Braun Center in Huntsville, Alabama [1].

This year's theme and course are both space themed, with the track representing an area holding Spacetels and floating debris. Figure 1 shows a top down view of the map, while Figure 2 shows the track from a side view. The robot will be designed to navigate counter-clockwise around the track and complete all assigned tasks in under three minutes. For every task that is successfully completed, the team will be awarded points by the judges, with the overall objective being to earn as many points possible as quickly as possible. The following shows a breakdown of all the tasks and the points associated with them [1].

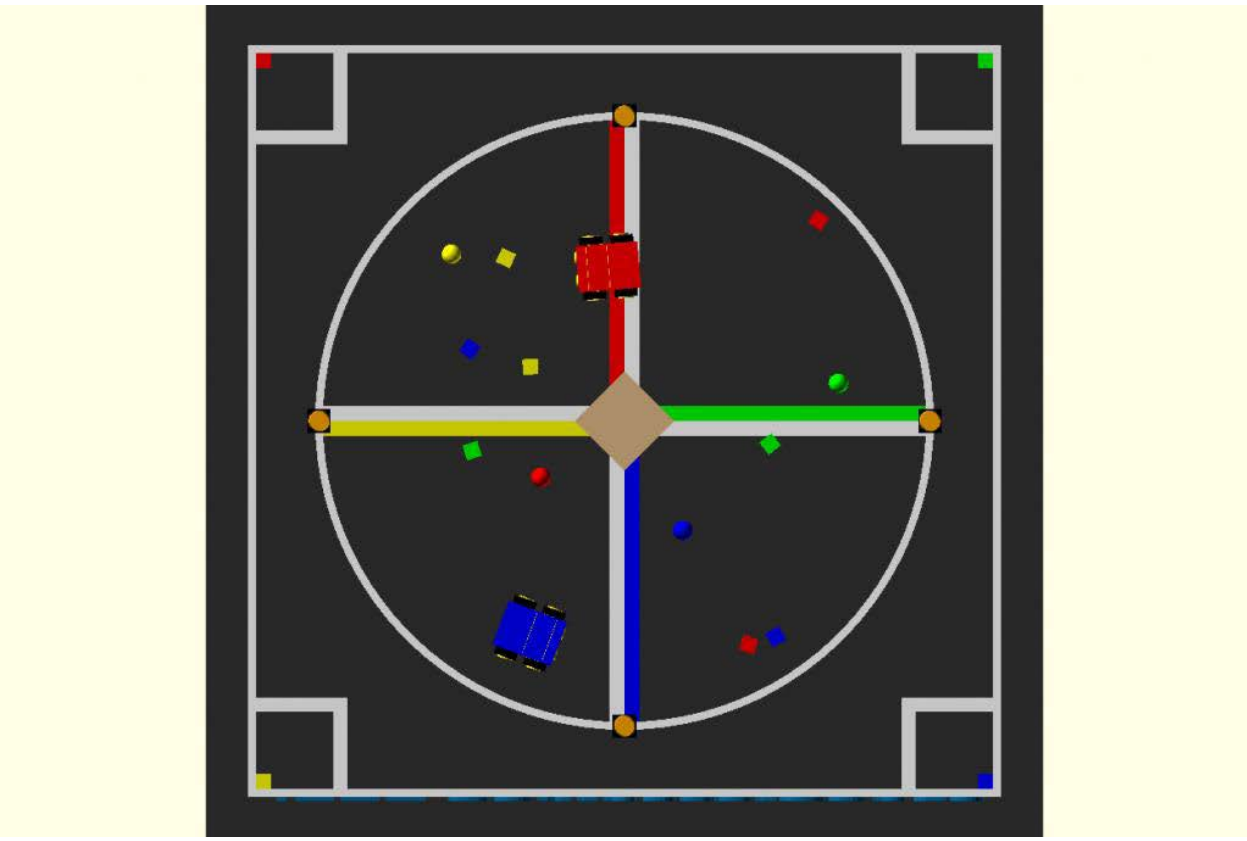

Figure 1: Top down view of track

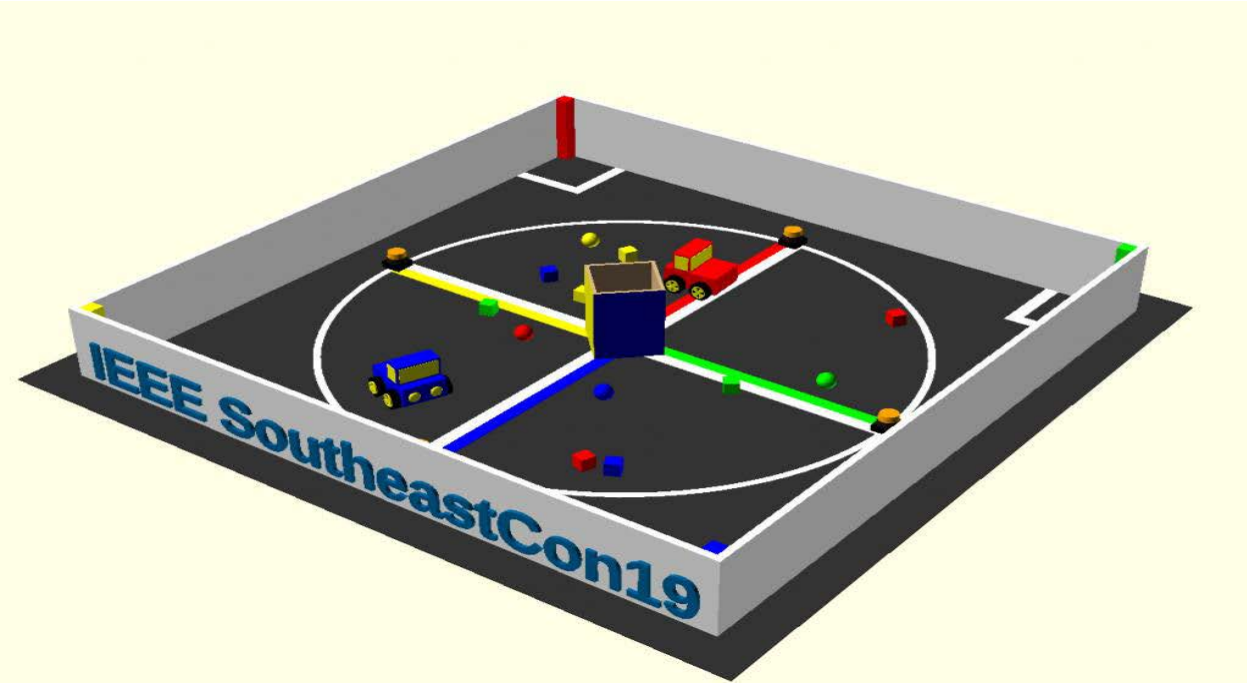

Figure 2: Side image of track

Points	Task
5 pts	Leave home base and enter Zone 1
5 pts	Cross the orbital line into Zone 2 (first time only)
5 pts	For each complete, counter-clockwise orbit within Zone 2, starting from the quadrant closest to designated corner square
10 pts	Debris removed from Zone 2 (each)
10 pts	Debris placed in home base (additional to removal)
10 pts	Color-matched debris placed in appropriate color corner square (bonus points)
10 pts	Finish in your home base
25 pts	At conclusion of debris removal, raise your onboard flag while in home base
-10 pts	Every collision with a Spacetel

Table 1: Breakdown of tasks and points for overall competition

The first task is to leave home base and enter Zone 1. Home base is one of the four corner squares, while Zone 1 is the area outside of the white circle. These 5 points can only be obtained once. The second task is to cross the orbital line into Zone 2, which is the white circle and where all the different pieces of debris are located. These 5 points are also only able to be obtained once. The robot must also only move around the track in a counter-clockwise orbit, but for every complete orbit that the robot completes, an additional 5 points are awarded. It is measured based on where the selected home base square is located[1].

Next the robot must begin removing the debris from Zone 2, and for each piece of debris removed, 10 points are awarded. The next task is for the robot to place2 the debris in the

appropriately colored corner square for 10 points, or if this is during the playoff rounds placing the debris back into your home base for 10 points. Next, 10 points are awarded if your robot can navigate back to your home base and end the round there. Lastly once all the debris has been removed, if your robot raises an onboard University flag 25 points are awarded. Unlike in the past, it is possible to lose points in this competition as your team loses 10 points for every collision your robot makes with one of the blinking LED's that are located on the orbital line. These are referred to as Spacetels[1].

In addition to completing the tasks, the robot must meet a set of specific requirements to compete. This includes the robot being completely autonomous once started as well as being entirely self-contained. The robot is restricted to a maximum size of 9"x9"x11" but may also extend an additional 3"x3" when not in motion. The robot may not include any detachable or remote extensions and the onboard flag must contain the school logo, State, territory or US flag. In addition, the robot must have a bumper that surrounds 80% of its perimeter in a continuous stretch and the robot may not damage the playing field or require repair of the field in between competitions[1].

The way that the tournament works is as follows. There will be two qualifying rounds of play for all robots, and playoff rounds for the eight highest scoring robots. During the qualifying rounds there will only be one robot on the playing field at a time. The scores of both qualifying rounds will be summed and the 8 teams with the most points will move on to the quarterfinals. During these rounds teams will face off head-to-head in a single elimination competition where there are two robots competing for objects on the same playing field[1].

To graduate, several requirements must be met including building a robot that completes the following tasks:

- Leave home base and enter Zone 1
- Cross the orbital line into Zone 2
- Remove debris from Zone 2
- Avoid Spacetels

III. Project Design

A. Hardware Design

To complete the tasks for this competition, beginning with navigation, the Pololu 12V 131:1 Metal Gear Motor (figure 3a [2]) is used These motors allow the use of the wheels chosen, which are the Andy Mark 4” Mecanum Wheels (figure 3b [10]). Both the wheels and the motors are attached to the 3D printed body of the robot. A bumper that is added that cover around 80% of the robot’s perimeter. This bumper is approximately 1” high and should sufficiently cover the wheels and other components to prevent damage from being inflicted by other robots or the course itself.

The robot knows where it is using The TeraRanger One ToF Rangefinder Type B a distance sensor on the front and the right sides of the robot to assist in collision avoidance with the wall, as well as to help guide the robot between zones (figure 3e [6]).

To locate the cubes and the spheres, the TeraRanger Multiflex 8 Sensor Kit (figure 3f [7]) is used because it allows for the configuration of up to 8 separate sensors organized in an array. To stay within the boundaries of our robot specifications, only three of these sensors will be used. The TeraRanger Multiflex 8 Sensor Kit is going to be attached to an gate in front of the robot aiming forward to detect the cubes and the spheres. After guiding the robot to collect the object

through an opening in the front,. Once the robot has an object in its possession and knows it is in the properly quadrant it exits Zone 2 and head towards the proper delivery square. After the debris is within the lines of the square, the robot will back up until it is back in Zone 2, turn 90 degrees, and continue traversing the zone in a counter clockwise fashion.

The microcontroller that is used is a Nucleo STM32F446RE ARM development board (figure 3g [9]), as it has the processing power, as well as the proper amount of Analog to Digital Converters, Universally Asynchronous Receivers/Transmitters, and driver positions required for this project.

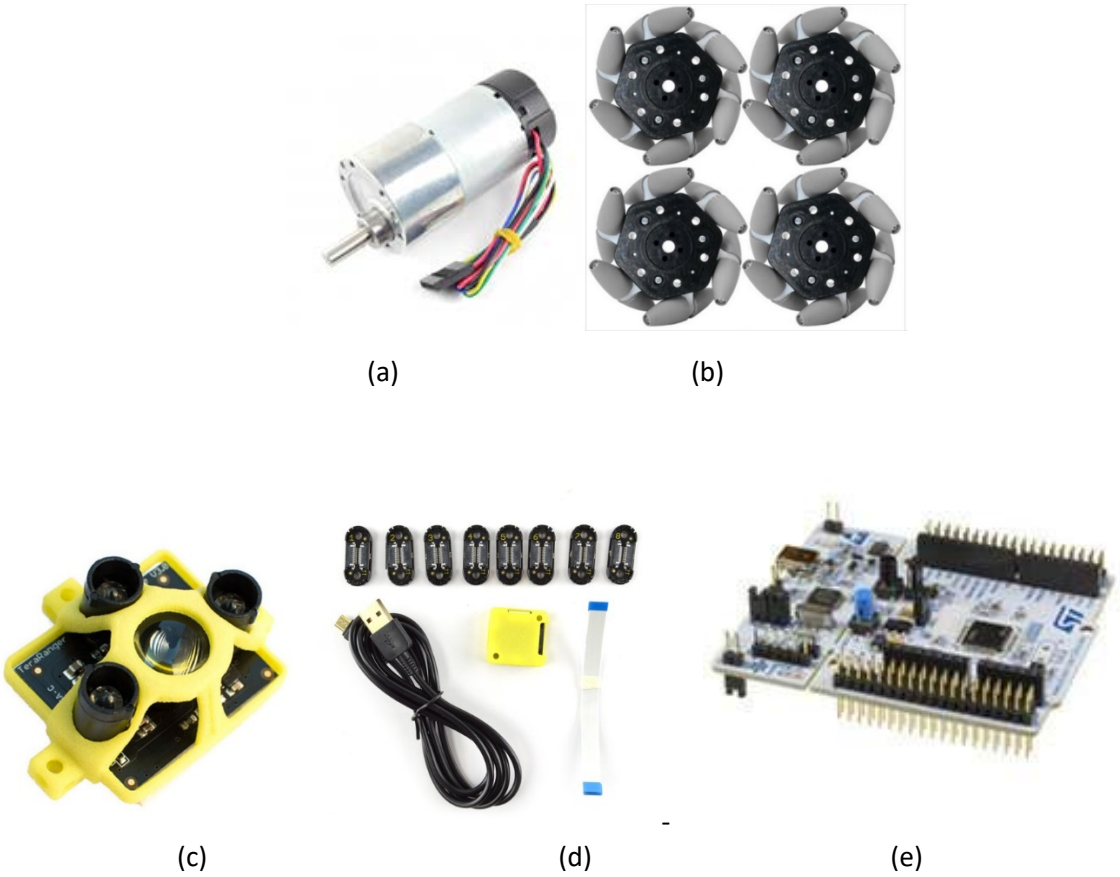

Figure 3: Images of parts selected (a) Pololu 12V 131:1 Metal Gear Motor, (b) Any Mark 4" Mecanum Wheel Set, (c) TeraRanger One ToF Rangefinder Type B, (d) TeraRanger Multiflex 8 Sensor Kit, (e) Nucleo STM32F446RE ARM development board,

B. Software Design

The software used to develop the program that loaded onto the ARM development board and control the robot developed in Keil uVision 5 and will be primarily in C. The following is a pseudocode that will be used when programming the robot:

Robot begins in the starting square

Equal power to all wheels, after 40cm it turns 90 degrees

The bot will go forward until the array sensors find object or it is about to exit zone 2

> If array sensors pick up object will use PD controller to properly align open the gate and pick up it up then it will start heading to the wall until it is 10cm away from it turn 90 degrees heading to the corner then it opens the gate and backs up returuning zone 2 using the same way.
>
> Otherwise it will turn 90dgreeas when it is about to leave zone 2.
>
> Will continuously run while loop using color sensor (ADC) to make sure it's picking up a color
>
> Once color is detected will use other color sensor (ADC) to continuously check if color matches.
>
> > If color matches will turn right 90 degrees and head straight.
> >
> > Will use line sensor to detect when zone 2 is left, and will head straight until line sensor detects a new line.
> >
> > At this point robot will back up for X seconds and turn 180 degrees and once line sensor detects zone 2 will turn 90 degrees to the right
> >
> > > While doing this a distance sensor in the front will make sure that the robot doesn't get too close to the wall

With all these components working together in both the software and the hardware, the previous design is successfully built.

IV. Costs

Table 2 shows the costs of the project . the team received $1,990.00 from the EECS department to purchase the parts for the track and robot.

Product/Reason	**Cost**
Robot Costs	
Track Materials	$300.00
Arm Processors	$50.00
Proximity Sensor (2)	$135.00 each
Sensor Array	$100.00
Rapid Prototype plastic	$150.00
Motors	$350.00
Motor Drivers	$100.00
Wheels	$200.00
	= $1570.00 Robot Total

V. Results

Overall, the main purpose of this project was to build a robot that was capable of competing in the track clearing it.The robot build was able to compete all the tasks .

VI. Conclusion and Recommendations

In the end, the robot was able to successfully navigate the course.
If this robot would be built

again, the team would recommend using a color sensor. The team would also recommend utilizing different cheaper distance sensors.

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