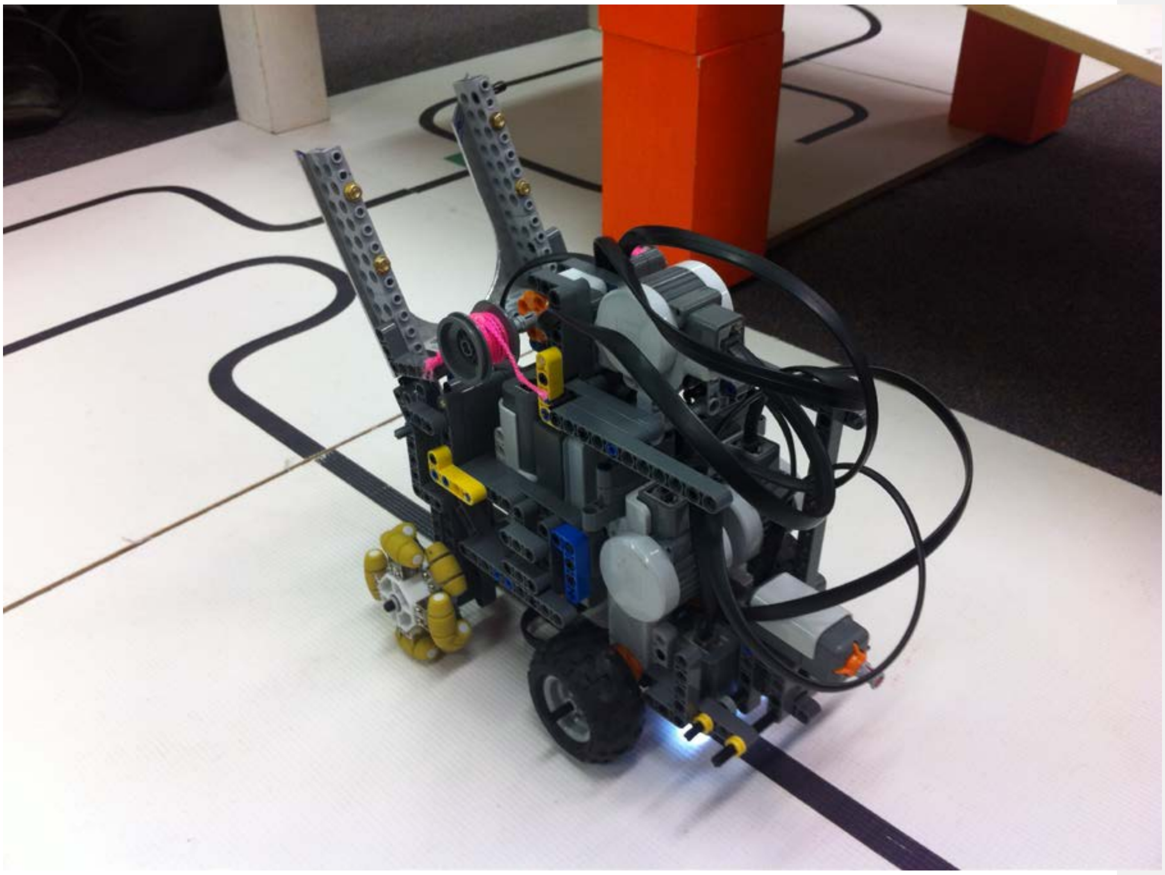
Fort Street High School

Team FSHS10 CHIMCHAR

Logbook



Problem

The Open Rescue challenge could be simply understood as following a line, turning at the green square, picking up the can and placing it on a block at the end. Firstly, it has to follow a black line course based on tiles in straight and loop formation. The robot also has to go through a doorway consisting of three 41mm × 41mm pieces of wood. A tile is in a see-saw format while one while another is angled on a platform leading to on top of the doorway. At the end of the course, is a 375ml can representing a victim, in which the robot must save by picking it up and placing it on an orange rescue platform at the end, which is 7cm high. Furthermore, the robot has to return to the "Spill Access Point", which is the aluminium strip at the start of the tile. Many designs and solutions were considered with two of them implemented and tested.

Roles

Originally, there were two members of the group. We were assigned roles at the beginning of the design process. Michael was elected as the core builder of the robot since Kevin could only make it to half of the weekly courses. Kevin was more of a computer person so he programmed the robot. When the robot was halfway through the building process, a new member, Alex Guan, joined the team since his partner left the course. Since he was code illiterate, he planned was fit to the role of assistant builder.

Kevin Zhu, Year 9

As well as doing 100% of the programming, Kevin also acquired a non-contact sensor. He created a reliable claw that uses Lego drilled and nailed to a piece of U-shaped metal. This mechanism is very reliable because it holds the can exactly and does not tilt forward to drop the can.

Michael Cam, Year 9

Michael is the lead builder of the robot. Before Alex joined the team, he built the base of the robot and finished attaching the wheels to the NXT brick. When Alex joined, the body was altered so the light sensors could be evenly spaced

Alex Guan, Year 8

Originally, in Team 7, he joined Team 2 after Team partner had left the project. Since only attending half the programming courses last year, he did not know how to program the robot. He was part of the building process, in which he aided Michael in attaching the light and touch sensors. In addition, he was also a part in building the claw mechanism and writing the logbook for the team.

Planning

There were many possible combinations with the design of the robot. First, we decided to have the NX brick to be horizontal, as designing the robot around it would be more efficient and seemed easier. Other possibilities that could have been part of our robot are the:

- Placement of light sensors
- Placement of touch sensor

- Arrangements of distance sensors and touch sensor
- The placement of the pick-up mechanism

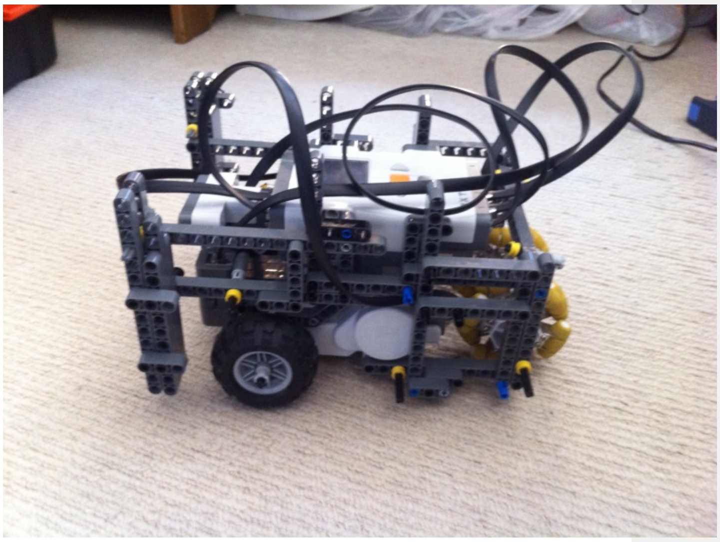
For these possibilities, we had to consider:

- The distance of the light sensors from the ground
- The placement of the touch sensor (to make sure that it is in the front-most part of the robot)
- The arrangement of the light and distance sensors to make it as efficient as possible
- The amount of space required to have a fully functioning pick-up mechanism.

We planned to have the pick-up mechanism done last, as it was the most complicated part. Another decision was to have the touch sensor placed between the two light sensors to separate them enough to make it function properly. All of this had to be connected to the NXT brick, and placed at the front. The pick-up mechanism was then planned to be placed over these sensors, reaching to the very front, and thus pick up the can.

Designs

Design 1



The brick was designed to be horizontal across the robot due to height limitations (we were too scared that the robot will be too tall if it was placed vertically). In addition, the holes in the brick were better aligned to have beams going down vertically, which could later then be connected to the motors. This was another core part of our design, having the brick on top of the motors. The motors would act as a “seat” for the brick to rest on, and it was simple to align both of these using the beams and some calculations. The brick had to be on top so we would be able to press the buttons, and the motors underneath so the wheels could function (robots will not move if the wheels are spinning mid-air). However, the biggest reason it was designed like this is due to the centre of gravity. If the brick were to be vertical, then the height will be too extreme to place the motors underneath it. This would mean that the motors would have to be placed towards the front, which is not that big of a problem. However, the biggest problem with this was balancing the centre of gravity so it would be close to the centre. By having the brick and motor on top of each other near the middle of the robot, we completely eliminate this problem as the weight of these two combined is enough to keep the centre of gravity close to the middle, so the whole robot wouldn't tip over.

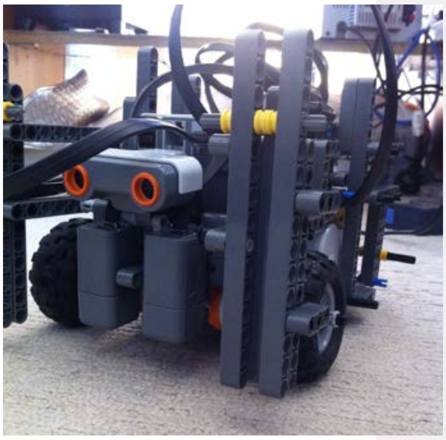
The Sensors

We used two main types of sensors in our first design. These were the reflected light sensors and the ultrasonic sensor.

The Light Sensors

We used two light sensors and they were crucial for the robot to navigate the course as it detected the percentage of light reflected off the tile. For example, the light sensor would detect a black line if the values returned were lower, and would be higher if it was a white surface. Furthermore, the value returned on the green square would be between the black and white value while the aluminium foil would return most of the light (i.e. higher than white). The light sensors would also need to be spaced apart as on a straight line, the robot needs to account for the line in the middle to navigate stably through the course. Hence, the rule of thumb is to space the light sensors with one LEGO piece. This was where our first problem started, deciding on how to separate them. At first, we decided to separate it by placing a beam between it, but the beam was unstable. The piece was not secure and did not adequately perform its role of separating the two light sensors. We then had to add more beams inside the robot's structure to hold that beam up, and it worked quite well.

The Ultrasonic Sensor

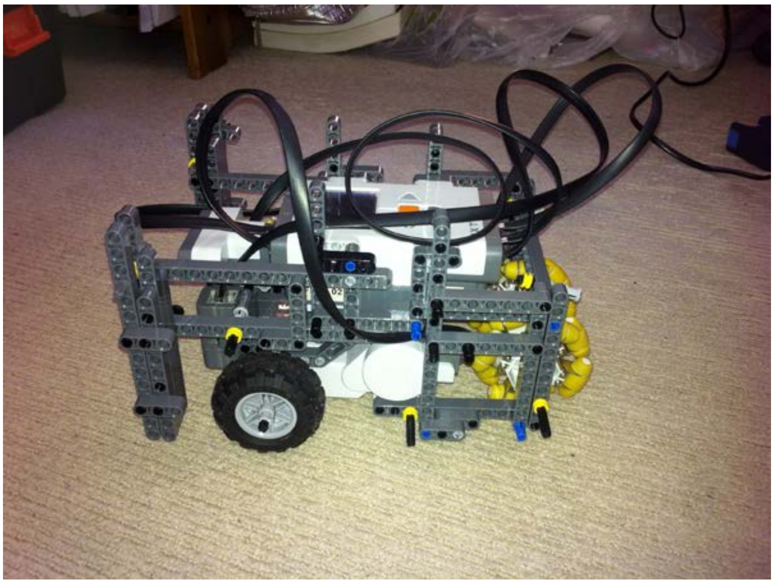


We were originally going to use the touch sensor and the ultrasonic sensor to detect the water bottle tower and to detect the can, respectively. However, as we developed the idea of using a forklift, we decided to combine them and only use the ultrasonic sensor. This would accurately determine the distance between the robot and the water bottle tower as it uses sonar technology to detect it, returning the distance in centimetres. Furthermore, it would also detect the can, once it reaches the final tile. Moreover, there was a perfect place to mount it – right above the two light sensors.

The Structure

The structure was rigid, and there was very little room for adjustments. This was to ensure that the robot was adequately reinforced, and made sure the parts (motor, brick, sensors) wouldn't break off if force was applied. This was something that worked well when the robot was moving around, but was disadvantageous when the drop test was done.

The drop test is a test where a robot is held upright at a height of approximately 30 centimetres and released so it falls to the ground. This tests if the robot is sturdy enough to survive the force should the code malfunction and cause the robot to fall to the ground. This would ensure that not only does the robot not become an embarrassment, but also so that the robot only requires minor repair should such a catastrophe occur. In numerous occasions, the connecter that joined the beam to the brick and other parts of the robot came loose. The theory was that the robot was too rigid, and the impact from the robot landing and the "bounce" of the wheels was too much, thus the connectors came loose. It failed almost every time, but putting the robot back to normal was simple. All we had to do was press the robot in from the sides, and the beams would come back on.



The Can Pickup Mechanism

Although this design differs from the images above, the can pickup mechanism, originally, was essentially two gears with approximately a quarter of it cut off, wrapped in a rubber band for grip. Many contestants used this design last year, and it seemed like a classical design, despite failing for ~60% of the time. We learnt from last year's faults that the rubber gears could not hold up the entire can, as either it will slip out due to the lack of grip, or because the cogs bent out too much, which caused the gears to misalign and hence, not spin. Therefore, for this method of lifting to work, either the cogs had to be perfectly spaced out, or it will not pick the can up, as many teams have experienced in the past.

Design 2

The Sensors

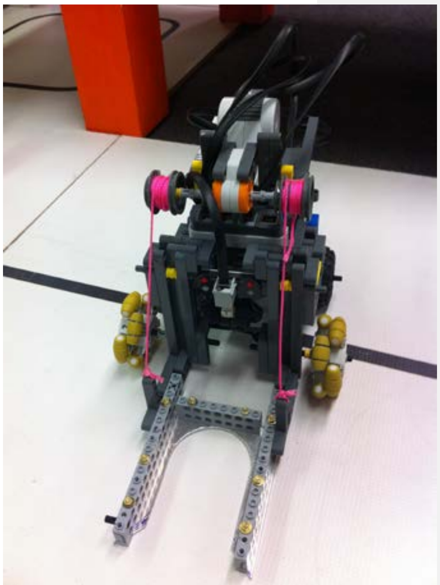
In the second design for the robot, the sensors were drastically changed. Essentially, we now decided to use four sensors instead of three. These are the two light sensors, one touch sensor and one infrared distance sensor. The two light sensors are essentially follow the same rule applied to the first design – spaced with one Lego piece, as it has proven to work flawlessly, if calibrated correctly.

The Touch Sensor

After numerous tests, the ultrasonic sensor has proven that it cannot detect the water bottle tower properly, as it sometimes detects the tile as the water bottle tower. A simple shift to the touch sensor proved to work.

The Infrared Distance Sensor

It was recommended by multiple sources on the internet to use the infrared distance sensor (medium range) to detect the soft drink can more accurately than the sonar sensors. Hence, we decided to use the "***High Precision Short Range Infrared distance sensor for NXT or EV3***" created by mindsensors. This worked quite well with the code and hence, it was effective for the task.



The Forklift

Inspired by one team last year, the group made a decision to build a forklift in order to lift the can up, instead of using the geared design in Design 1. Once the sensor finds the can, it is almost certain to lift up the can since it will not slip out or cause gears to misalign, if designed properly. We built this forklift out of a variety of Lego pieces, screwed onto an aluminium base plate. Then, a multitude of Lego pieces would be joined to the structure in order to follow the forklift track properly and act as for the string to pull on the Lego pieces. In the end, we designed it to lift up the can on an angle so that the can cannot fall out the front. This was done by tying the string to Lego piece and applying hot melt glue to it in order to secure the connection. Moreover, placing the connection exactly 4 connector joints away from the edge of the base-plate enables the forklift precisely in the way that is expected. If it were too far forward, the lifting angle would be too high. On the other hand, if the L-connecter were too far backwards, the can would fall out.

During the course, the forklift would also stow in a lifted position to ensure it does not bump into the tunnel and knock the course over.