Project 1 -- Sensing and Movement

Introduction:

Aim of this assignment is to build a robot using particular hardware and software environment (Interactive C) i.e. sensors, actuators and connectors between them. This project is used to work out the team structure and method of operation which should be carried out for optimum performance.

Purpose of this project is to design, build, program and demonstrate an autonomous robot that carries out the following simple task:

- **To move around a square three times.**

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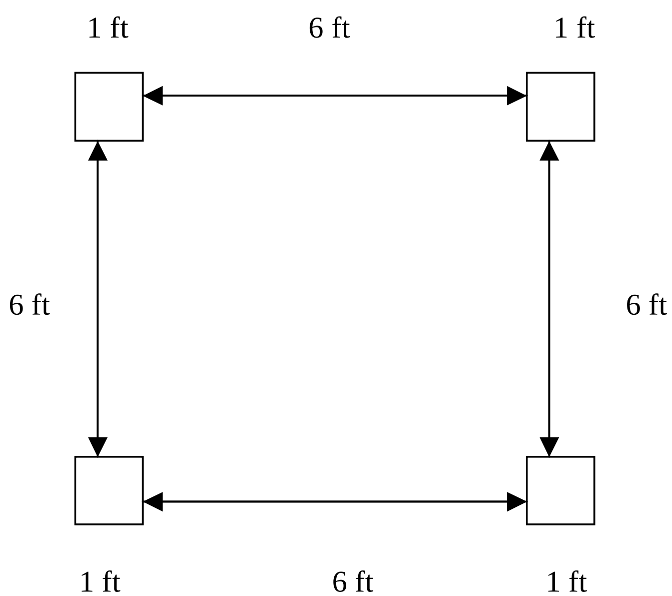

Hardware:

Our robot was built with a 4-wheel tank design. The basic input/output (sense and act) primitives of the robot consisted of the motors, encoders, and reflectivity sensors:

1. **Motors (Act)**
   The robot had two motors, each connected to the rear wheels in a 1:1 gear ratio. The 1:1 gear ratio was achieved using the 16 tooth gears. The motors were mounted directly on top of the beam where the wheels were mounted.

2. **Encoders (Sense)**

   Each front wheel each had its own encoder attached to it in a 1:9 gear ratio, so that the encoder discs would spin 9 times as fast as the wheels. And since each encoder disc has 6 holes, the encoder would read either 54 ticks or 108 ticks, depending on the way the handy board software library is set up.There were around 2500 ticks for 6 feet. Each encoder disc was attached to its target wheel axis by a large 24-tooth gear on the wheel axle, to a small 8-tooth gear on a middle axle, to another large 24-tooth gear on the middle axle, to a small 8-tooth gear on the encoder disc axle.

3. **Reflectivity Sensors (Sense)**

   The robot was equipped with two Omron EE-SB5 Reflectivity sensors. These sensors were used to detect the black tape, and to align with the black tape. Since these sensors operate best at about 5 millimeters from the target surface, they were mounted at about 5 millimeters from the floor that the robot is resting on. Our controller program counted the read value from the handy board reflectivity port of greater than or equal to 150/255 as black. The reflectivity sensors were mounted by encasing them inside of legos. A 1x2 lego spacing was left open for the reflectivity sensor to look outside of its encasing. The encasing space was 1x4x2 lego spacings. And the encasing space was covered again with another 1x2 window to accommodate the rest of the sensor and its wires.

The body of the robot was held together with beams and pins very tightly, which was tight.

Demonstration:

Demonstration aspects:

Expected results from demonstration:

The robot must start completely within one of the tape square and must move within.one inch of a second tape square ,then the third,then the fourth and back to first,completing one circuit.The robot must then complete this circuit two times.

- The robot must stop after completing the three circuits.
- Team members must not modify environment prior to demonstration.

Results obtained from the demonstration:

Robot completed the circuit which it was to complete 3 times.The software used the encoder to detect when it had gone past the next phase and if it had then it stops moving forward, turns left 90 degrees and veers for the black tape. This was a stopgap arrangement done because it was a known fact that the robot veered right a little, as the weight on the robot was not evenly balanced and traction on both sides was not the same.

Construction process and Actual testing:

The robot used in the demonstration was the third one actually built. The first two robots were both front wheel drive, 2-wheeled, caster robots.

1. Robot One:Crude Prototype
   The first robot, as mentioned above, was built with two front drive-wheels, and had a caster on the back.It was designed so that the caster would slide smoothly over the floor, so that the robot would be able to make turns around the center of the two drive-wheels. Encoders were also attached directly to each drive-wheel axle so that the robot could go straight. To reflectivity sensors were mounted directly beneath the drive-wheels, to detect the black tape. However, even though encoders were being used to detect the course correction needed, it seemed as though they were not accurate enough. Testing showed that it could not stay on course within 1 foot of the target square at 6 feet away.The first robot was scrapped.Actually, it was later found that the failure of the robot to go straight was caused by using a compound caster, made up of 3 smaller casters. But this was not found to be the problem until after the construction of the second robot, as described below.

2. Robot Two:Refined Prototype
   The second robot was nearly identical to the first robot above.It used the same two front drive-wheels, and had the same messed up compound caster on the back. In addition, the second robot was constructed more solidly than the first, since it was nearly the same. It could be dropped from about 6 feet in the air and its body would remain perfectly intact. Of course, it was never dropped while the handy board was mounted on it though. With the compound caster on the back, it was still not going straight, so all of the compound caster except for one single caster were removed. After it was tested with only one single caster, it turned out that the encoders were correcting the course well enough to stay within 1 foot at 6 feet away. This testing was done on both a carpet floor and a linoleum floor.It turned out that the caster being used retarded the motion of the robot. Not only that, it caused the wheels to slip. This is because most of the weight of the handy board was resting on the back caster.But the cellophane plastic quickly scraped away on the tile floor as the robot went forward. So after the end of about one round there would be a large hole in the cellophane, and it would no longer slide well enough. After testing this robot it was decided the robot needed further redesign.

3.Robot Three:Final Design

The third robot was the final design, a tank design.The encoders on this robot were going 9 times the speed of the wheels, the reflectivity sensors were positioned at the front of the robot for detecting the tape. Most of this robot is described above in the hardware section of this report. There were problems with this robot however. After testing it on the classroom at Sarkey's it made more than four rounds around the square successfully. It was reconstructed and the beams were made to hold together better, and it was made stronger.Finally, we just tilted the handy board in it's mount to try to keep the right wheels from slipping. It did work.The robot worked fine during the final test.

Programming :

There are different methods which are used

- **goStraight()**:Causes the robot to go as straight as it can.It takes speed,acceleration,correctionAccelaration as the input parameters

- **align()**:Causes the robot to align with the edge of black tape in front of it. The maxForwardSpeed,maxBackwardSpeed and incrementFactor are input parameters.

- **enable_encoder(),reset_encoder(),motor(),analog()**are the inbuilt functions in Interactive C which are used to carry on different functions.