Rochester Institute of Technology

Principles of Robotics (EEEE-585/685)

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Subject: Lab #2: [Four Wheel Differential Drive Robot and Analog Distance Measuring Sensor]

Abstract:

- **Configuration** – We had used a Four Wheel Differential Drive Robot.
- **Locomotion** – It has four wheels as the name suggests and each side of the robot is independent of the other side. This independence allows the robot to rotate about its center axis and increases its maneuverability.
- **Programming** – Programming was done on Arduino board using the Arduino Software.
- **Control** – We have used an Arduino board for controlling which we have programmed as per the required lab tasks to make the robot perform them.
- **Sensors** – A sharp GP2D12 analog distance sensor which is basically an Infrared sensor.
- **Behaviour(s)** – Obstacle avoidance and moving the robot in different directions as per the task assigned

Theory:

Wheeled Robots, in general are considered to be more stable than their legged counterparts. Normally at least three wheels of a wheeled robot are designed to be in contact with the ground at all times. Three wheels in contact with the ground guarantees a stable balance and allows for more focus to be placed on the maneuverability, traction and control.

The type of wheeled robot that we are using for this lab is the Four Wheel Differential Drive Robot. In differential drive each side of the robot is independent of the other. This independence allows the robot to rotate about its center axis and increase its maneuverability.

Motors

In this robot two motors are used. Each motor is connected to the wheels of each side. The motors operate in such a way that both wheels of one side rotate together at the same speed and the other two wheels of the other side rotate together at their respective speeds.

In this experiment we had to make the robot move in a square so in order to make the robot move in a square the two motors move the wheels of each side in the opposite direction. This means the wheels of one side move in the forward direction and the wheels of the other side move in the opposite direction. This action of the motors move the robot turn in a direction.

The speed of the motor s controlled using the voltage sent to it and the direction is controlled using an H-Bridge. A simple H-bridge consists of 4 transistors using which we could decide the direction of flow of current of the motor and thereby decide the direction in which the motor should run.

Sensors

The sensors used for this experiment is the Infrared Sensor. As per the required tasks that are to be performed we are supposed to find the

distance of an obstacle and then perform a certain task. An IR sensor would do the best.

The IR transmitter emits continuous IR signals; when an obstacle is encountered these signals get reflected from the surface of the obstacle which are received by the IR receiver. Then depending on the amplitude of the received signals the distance is calculated. The IR module so used in this experiment is GD2D12 an analog distance measuring sensor that uses infrared to detect objects. Its working range is with 10-80 cm and output ranges from 0- 25 volt. The module produces only analog values thus an internal A2D converter in UNO converts these signals into 8bit digital signals ranging from 0 to 255

Polling IO

The Arduino uses a sequential programming software ie it cannot execute two commands at the same time. Polling is sequentially executed condition unlike interrupts, which stops the current execution.
The advantage of Polling I/O is that is simple and fast to implement. However some disadvantages are that it may waste precious clock cycles (CPUs) , and an I/O change may occur while the CPU is processing other software instructions

Results:

1. Sweep Motors (Acceleration/Deceleration):

The bot was successfully accelerated from rest to a certain speed and then it was deaccelerated back to rest after some time of acceleration.

2. Implement a drive for time:

The bot was accelerated up to a certain speed and a separate timer function was called to make it run for desired time and then it stopped.

3. Linear Error Test:

The bot was made to go to and fro a certain distance certain amount of times (in the experiment the bot was made to move 5 to 6 times) and the displacement from the initial position was noted

Displacement in forward direction [X]	Displacement in forward direction [Y]
0.8 inches	1 inch to the left

4. Square Error Test:

The bot was made to move forward for suppose X distance ad then it was made to turn 90 degrees to its left and then the same procedure as carried four times until the bot made a square and then the process of making a square by the bot was repeated for 5 to 6 times. After that the displacement from the initial position was calculated

Displacement in Forward Direction [X]	Displacement in Lateral Direction [Y]
2.0 inches	2.5 inches

5. Raw IR Reading:

The IR signals response was serially transmitted to the computer and was displaced on the Serial Monitor

6. Wander/ Obstacle Avoidance:

With the help of the IR sensor the bot was able to sense the presence of an obstacle. A polling condition continuously checks the IR sensor value. Whenever the value of the sensor reaches a threshold value it calls a

function named as changeDirection which changes the direction of the bot. The threshold value is set in such a way that whenever the analog signal reaches 250 it changes the direction of the bot

Discussion:

1. The linear motion has a deviation in the X-axis and as well as in the Y-axis. The x-axis deviation may be due to reasons like varying frictional force. The y-axis deviation may be due to reasons like varying load on each wheel/

2. Adding additional sensors may enhance the intelligence of the bot.

3. The turns taken by the bot are very sharp. If the bot has separate axial motors then it could have a parabola path in terms of turn and that might help in building non driver cars and other useful things.

Conclusion

The experiment that we had performed in the lab gives us the insight into a "Four wheel Differential Drive Robot". The locomotion and various ways in which the robot can move and the other tasks that could be done using the robot would help us during the project work.
While doing this experiment it was important to understand the motor functioning without which it would have been difficult in understanding the maneuvering capabilities of the robot. The maneuvering capabilities of the robot was the main objective of the experiment.

Theoretically the robot while in the third task that is the "Linear Error Test" was supposed to come back to the original position after 5 to 6 linear forward and backward movement but practically it did not happen. Same was the case with the fourth task that is the "Square Error Test". In both the case there were deviations which have discussed in the discussion section above.

Appendix:

1. The bot used was manufactured by Lynxmotion with a microcontroller from Arduino

2. The software soused can be downloaded from Arduino.cc

3. A sharp GP2D12 analog distance measuring sensor was used and its manual can be found at the link
http://www.parallax.com/dl/docs/prod/acc/SharpGP2D12Snrs.pdf

4. I would like to thank my Friend Man for helping me with in understanding the Arduino programming and the various components required in doing this experiment.