Rochester Institute of Technology

Principles of Robotics (EEEE-585/685)

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Subject: Lab #3: Introduction to mobile robots, the Hexapod Walking Robot and Ultrasonic Sensor

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Abstract:

This lab was done using a Hexapod Walking Robot. This is a six legged robot, such that each leg is independent of the other leg. Each leg consists of two servo motors which are responsible for a different way of motion either up-down or right-left. The robot was programmed using the Arduino Software. This robot has a PING))) sensor which is an Ultrasonic Sensor.

Theory:

The six-legged mobile robot configuration is useful due to its stable walking abilities. For the hexapod used in this experiment, each leg has two degrees of freedom.The servo motors allow the hexapod to move and there is a particular sequence which consists of lifting and striding each leg and therefore helps the robot to move forward. The forward motion of the hexapod is referred to as GAITS. In this experiment we would be showing three predefined GAITS i.e is the Tripod GAIT, Ripple GAIT and the Wave GAIT.

The hexapod controls each of the servos independently with a SSC-32 servo controller via serial data communication. The servo controller interprets the serial data into a series of PWM signals that determines the servo position. The SSC-32 servo controller is a very important feature of this robot.

For the hexapod to be stable it is very important that at any given time at least three of its legs must be on the ground. Each gait has its own advantage and disadvantage with respect to stability and speed

Following are the three basic gaits that were performed in the lab

Tripod GAIT

The movement of this gait is such that one middle leg of one side and the two extreme legs of the other two sides move forward at the same time. In the meantime, the other three legs remain on the ground. Thus, the stability criteria of the hexapod was maintained. This is the fastest of the three gait experiments so performed ut in terms of stability it is the least.

Wave GAIT

The movement of this gait is such that at a tme only a single leg moves and the other 5 legs are on the floor. Thus, we can say that this is the most stable of the three gaits but since only one leg moves at a time, in terms of speed this is the slowest. Due to its single leg movement this type of motion is useful in rough terrains.

Ripple Gait

The movement of this gait is very similar to wave gait. The only difference is that in the wave gait the movement was one leg at a time in the ripple gait its one side at a time. Its faster than the wave gait but not as fast as the tripod gait. In terms of stability it has 3 legs on the ground at the same time so kind off quiet stable.

Results:

1. Home Position

The hexapod's leg were made to look disoriented and then a program was written to get them to the home position. The home position refers to the position where all the legs are in the same alignment and the angle between the legs is 90^0.

2. a Tripod GAIT

As discussed above in the theory, the hexapod was made to come to its home position and then it was made to execute the Tripod gait by writing a program.

b. Ripple GAIT

As discussed above in the theory, the hexapod was made to come to its home position and then it was made to execute the Ripple gait by writing a program.

c. Wave GAIT

As discussed above in the theory, the hexapod was made to come to its home position and then it was made to execute the Wave gait by writing a program.

3. Own GAIT

In this experiment, we made a gait of our own such that the hexapod moves forward. The way it was done was that at first the two front legs lift up and stride themselves and then the last two legs lift up and stride and then all the legs are made to come to home position helping the hexapod to move forward.

4. Using PING))) ultrasonic sensor

We read the readings from the serial monitor and a table was made as provided below
The conversion formula is (recorded)/(29*2)

Distance (in cms)		
Actual	**Recorded**	**Adjusted**
2	191	2
3	192	3
4	265	4
5	299	5
6	352	6
7	402	7
8	470	8
9	470	8
10	523	9
15	839	14
20	1158	19
25	1377	23
40	2281	39
50	2851	49
60	3440	59

5. Object Detection and Avoidance

The idea was to make the hexapod walk until it finds an obstacle and then it turns in a desired direction and then again walks in that direction.

Discussion:

The gaits gave us an insight into how legged robots can walk and do other functionality. The ultrasonic sensors are better than the IR sensors that we used in the earlier experiment in terms of connectivity.

Conclusion:

The experiment that we had performed in the lab gives us the insight into a "Hexapod 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 functioning of the different servo motors of each leg 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.

Appendix:

1. Why must the servos of each leg be independent of each other?

There are two servos in each leg of the hexapod. Each responsible for a motion. One of the servo is responsible for lifting the leg while the other is responsible for the striding motion of the leg. Thus, they need to be independent of each other.

2. What are the advantages and disadvantages of legged robots?

The advantages are as follows:-

1. Legged robots or vehicles can navigate on any kind of surfaces which is inaccessible for robots with wheels. In the previous section, we discussed different kinds of wheels for different surfaces, but no standard works on all surfaces. Also, wheels are designed to work on prepared surfaces like smooth surfaces, roads, rails, etc.
2. Legged robots can jump or step over obstacles whereas wheels need to somehow travel over it, or take a different path
3. Wheels require a continuous path to travel whereas legs can step over isolated paths and move on. For example, if a particular city is hit by an earthquake, then the surface with a continuous path. This is where legged robots come into picture, although tracked wheels can manage up to a "certain" extent.

The disadvantages are as follows:-

1. These are very difficult to build as compared to wheeled robots
2. Wheeled Robots are faster than the legged robots and have better energy conservation
3. Legged robots require the system to generate an appropriate Gait to move, whereas wheels just need to roll.

3. Compare the three gaits

Every gait has its own advantage and disadvantage. Accordingly we can say that tripod gait is the fastest in terms of speed but lack in stability on the other hand we can say that the wave gait is the slowest but is the most stable. Ripple gait on the other hand is somewhat in between the two in terms of both speed and stability.

4. Utility of ultrasonic sensors in robotics.

The reason why Ultrasonic Sensors are better used for robotics is because of the following reasons

1. Better precision in terms of connectivity
2. Less sensitive to noise