Terrain Mapping

Sanjukta Dutta, Divya D Kulkarni, Amar Vashishth and Bhawana Gupta,
Department of Computer Science and Engineering, CS 666 - Mobile Robotics
Indian Institute of Technology, Guwahati

***Abstract*—**This paper describes the mapping of an unexplored terrain using a mobile robot equipped with three ultrasonic sensors for perceiving the environment. And the robot has its GPS coordinates, which it gets via a camera overhead connected by a central server. This setup has been done for the indoor environment.

The implementation of his project has been done using Lego Mindstorms NXT kit, and the programming part has been done using Java and image processing or map formation part using Python.

I. Introduction

THERE are lots of places on earth which are still unexplored and dangerous for any human life. Our paper presents a technique using mobile robotics which can explore any unknown territory.

The terrain mapping was done in a 172x144 cm terrain, this small piece of terrain was mapped due to the limited range of the camera which was mounted on top of the room, which provided localization coordinates to the robot. The range of the camera used was 428x360. The orientation details of the robot were sent via the compass sensor.

In this paper, the localization and map construction of the mobile robot is done using the data received from the ultrasonic sensors and the coordinates obtained via the overhead camera which acts as the GPS device, sends the orientation coordinates. Hence, it is assumed that we don't have any prior knowledge of the environment and the robot autonomously constructs the map.

II. ALGORITHM

The algorithm used is as described below.

- Check whether the robot is inside the range of camera
  - Sense the front ultrasonic sensor value(F)

  - If the value is greater than 15(No object in the immediate front of the robot)
    {
    Then check the value of left and right ultrasonic sensor

    If(valueLeftUltrasonic and valueRightUltrasonic > 30)
      Move straight and maintain the direction according to the orientation
    }

    ElseIf(valueLeftUltrasonic < 30) //Wall or obstacle is to the left
      Contour the object by following the obstacle at the left and then again realign to the orientation it was before it encountered the obstacle to its left

    ElseIf(valueRightUltrasonic < 30) //Wall or obstacle is to the right
      Contour the object by following the object to the right and then again realign to the orientation it was before it encountered the obstacle to its right
  - Else
    Take a sharp 90° left turn so that the obstacle comes within the vicinity of the right sensor and then the obstacle can be contoured by the right ultrasonic sensor

- If the robot is not inside the range of the camera, move backward and take the respective U turn in the unexplored area

It is assumed that we know about the boundary coordinates of the arena. This assumption is taken into consideration as we are exploring the terrain in indoor scenario with the help of overhead camera for the localization of the robot.

III. EXPERIMENT AND RESULTS

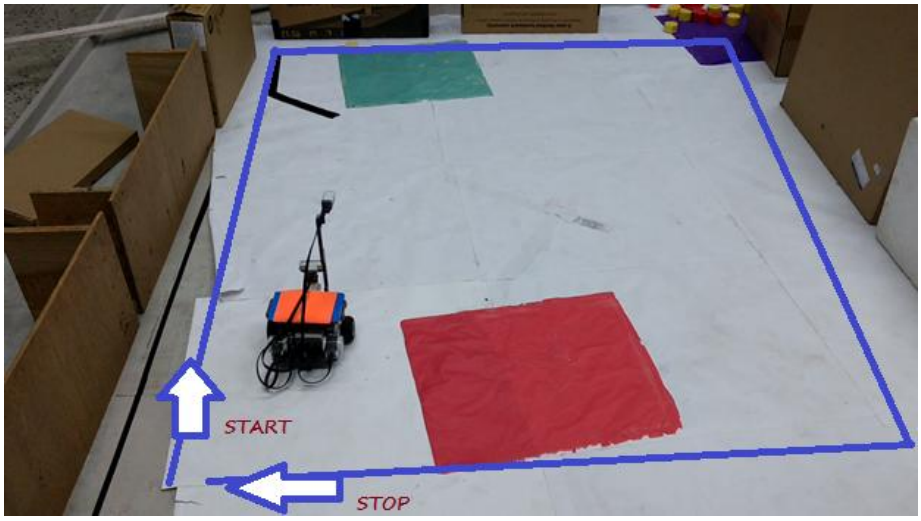


Fig.1: First Phase Robot Movement

Initially, we has made the algorithm, in which the mobile robot will only move in the perimeter of the terrain. The sensors that we used are three ultrasonic sensors, in which the left and right ultrasonic is immobile whereas the front ultrasonic sensor is movable. And instead of the compass sensors we used accelerometer to calculate the height of the inclination.

The map obtained after complete perimeter coverage is shown in Fig.2. and Fig.3.

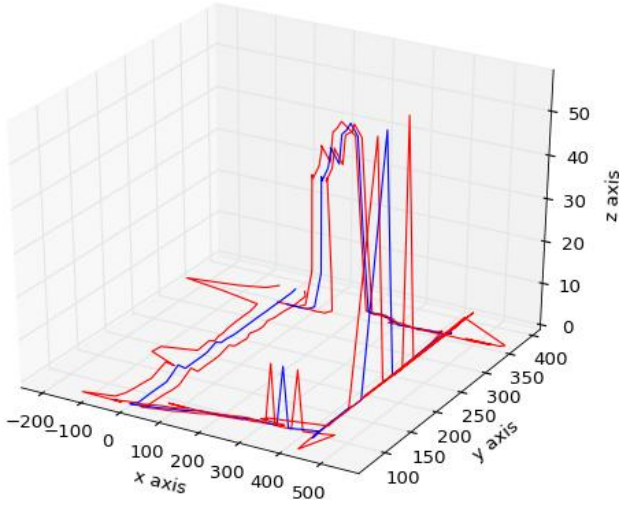


Fig.2: Line plot of 3D map

In Fig 2, the blue line drawn is the actual movement of the robot, whereas the red lines denote the

obstacles encountered during the run of the robot. This is the line plot of the map.

Whereas, Fig.3. shows the scattered plot of the terrain with the same data obtained used for the line plotting of above.

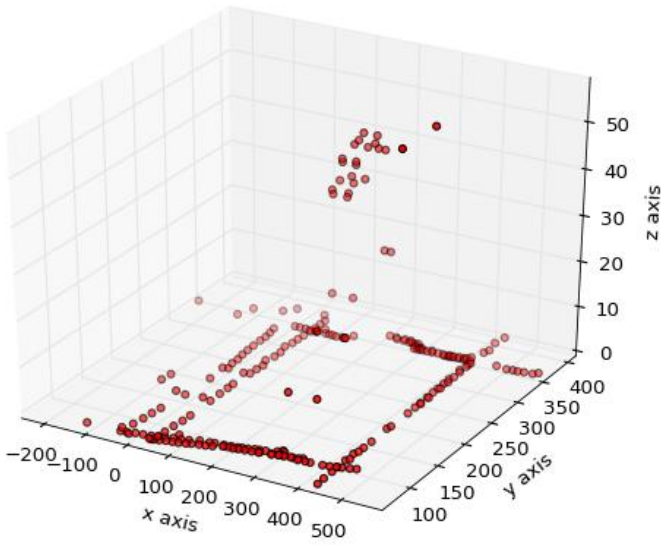
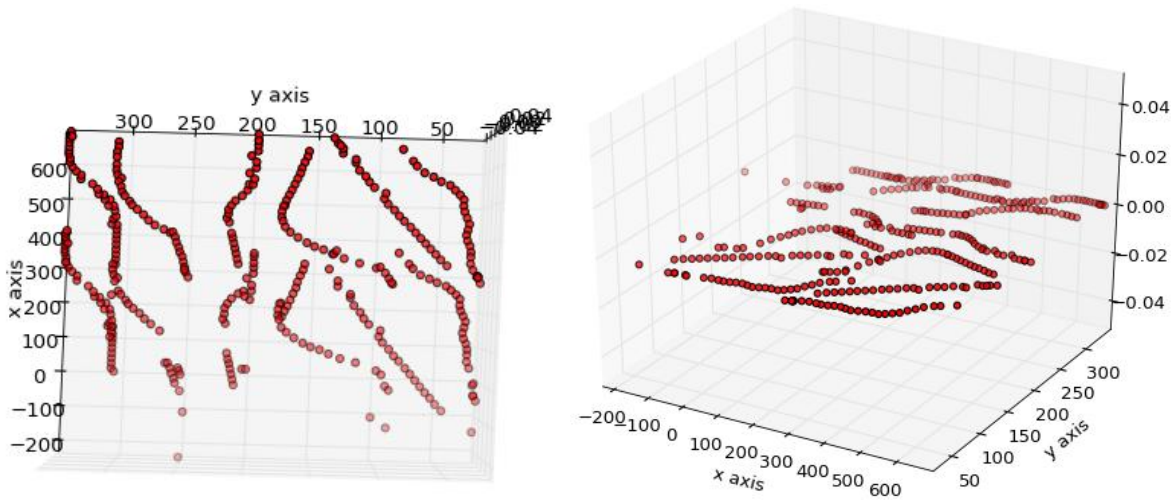


Fig.3: Scattered plot of the 3D map

Since, we had used an inclined plank for the collection of above data, therefore we have obtained some values at the z-axis. In Fig 3, its only the , mapping of the obstacles present and not the movement of the robot.



(a) 2D Map (b) 3D Map

Fig.4: Final Map

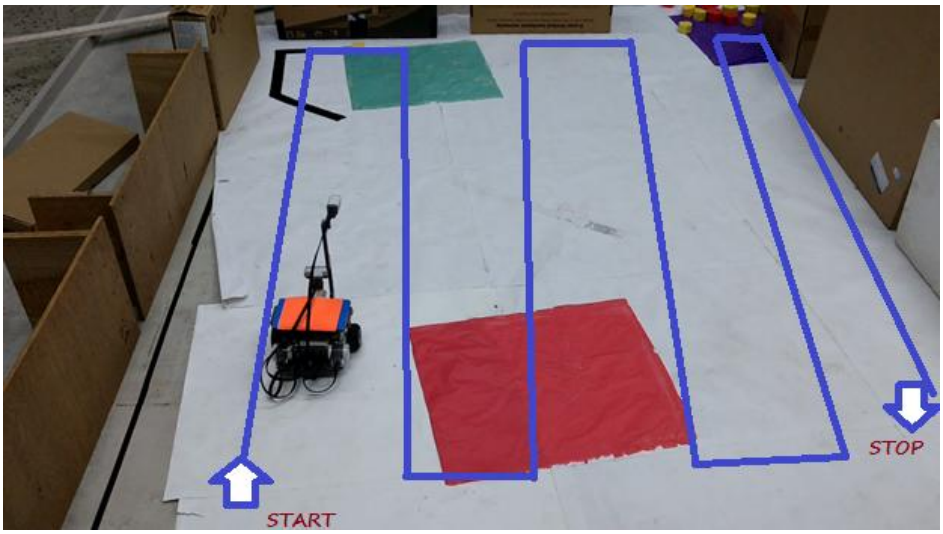


Fig.5: Final robot movement

Fig 5 is the movement for the robot for which we obtained the map in Fig 4. For this we had used three ultrasonic sensors with the front sensor which can rotate and the magnetic compass sensor in place of the accelerometer for the movement of the robot in right direction and orientation.

Since, we had placed lots of obstacles on the terrain, hence we obtained the map as shown in Fig.4.

IV. LIMITATIONS

The limitation that can be there in our project is that since we have used only the ultrasonic sensors hence we cannot differentiate between a regular object and an irregular object, which may cause problem with the mapping of the terrain.

If we could have used laser sensors then we could have formed the exact map of the environment.

And we have used the indoor based GPS by exploiting the camera mounted overhead. Instead if we could have used some GPS sensor then our robot could have been deployed into outdoor scenario for mapping of the environment or terrain.

We could have equipped our robot with some automatic or non conventional source of power and could have also mounted our robot with lots of sensors for getting the physical data of the environment also.

V. CONCLUSION

Terrain mapping of an unknown terrain and environment is very challenging problem and we have tried to implement the solution to this problem for an indoor scenario. If we could have been equipped with some more sensors and interfaces and some automatic charging facility we could have deployed our robot to outside world and could have made it completely autonomous.

VI. REFERENCES

[1]. http://www.lejos.org/nxt/nxj/tutorial/index.htm

[2]. Stackoverflow for resolving of menial errors