Robotics II Laboratory

Report on Task 04

Localization

SS 2020

Group-06_Task-03		**Matric.No**
Chaithanya Tenneti	-	1537943
Kaushik Goud Chandapet	-	1536199
Nishanth Iruthayaraj	-	1522044
Venkata Sai Tarak Padarthi	-	1536988

Date: 21.06.2020

TABLE OF CONTENTS

FIGURES

Introduction

Localization is the process of estimating the position of mobile robot with respect to the environment. Localization is used not only to estimate the robot's location but also used to measure the uncertainty in the location that is estimated [1].

The robot is constructed with sensors which is used to move by sensing the environment and also to monitor its own motion [2]. Localization also involves the robot, where a map is given and then identifying the robot where it is on the given map [3]. The map is normally expressed in the global coordinate frame and the robot in robot coordinate frame.

Task 1: Tracking and plotting position by wheel odometry

Wheel encoder in the given robot gives the angular position of motor of the left and right wheels. This is used to determine the distance that the robot has travelled. As we are not using any error correction for the given task, the error is getting accumulated. So the path tracked deviates from the actual path taken by the pioneer robot in the environment.

The following kinematic equation [4] is used to convert the angular position into transverse and rotational motion.

$$\Delta\theta = \frac{\Delta s_r - \Delta s_l}{2L}$$

$$\Delta s = \frac{\Delta s_r + \Delta s_l}{2}$$

$$\Delta x = \Delta s * \cos(\theta + \Delta\theta/2)$$

$$\Delta y = \Delta s * \sin(\theta + \Delta\theta/2)$$

$$X_t = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix} + \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta\theta \end{bmatrix}$$

Where,

Δs_r $= distance\ travelled\ by\ the\ right\ wheel.$

Δs_l $= distance\ travelled\ by\ the\ left\ wheel.$

Δs $= change\ in\ position\ of\ robot.$

$\Delta\theta$ $= change\ in\ orientation\ of\ robot.$

The above kinematic equation is used in our MATLAB code to track the robot position and plot it in the given environment. The following graph shows the path tracked in the given environment and the deviation in the path occurs due to the accumulation of error.

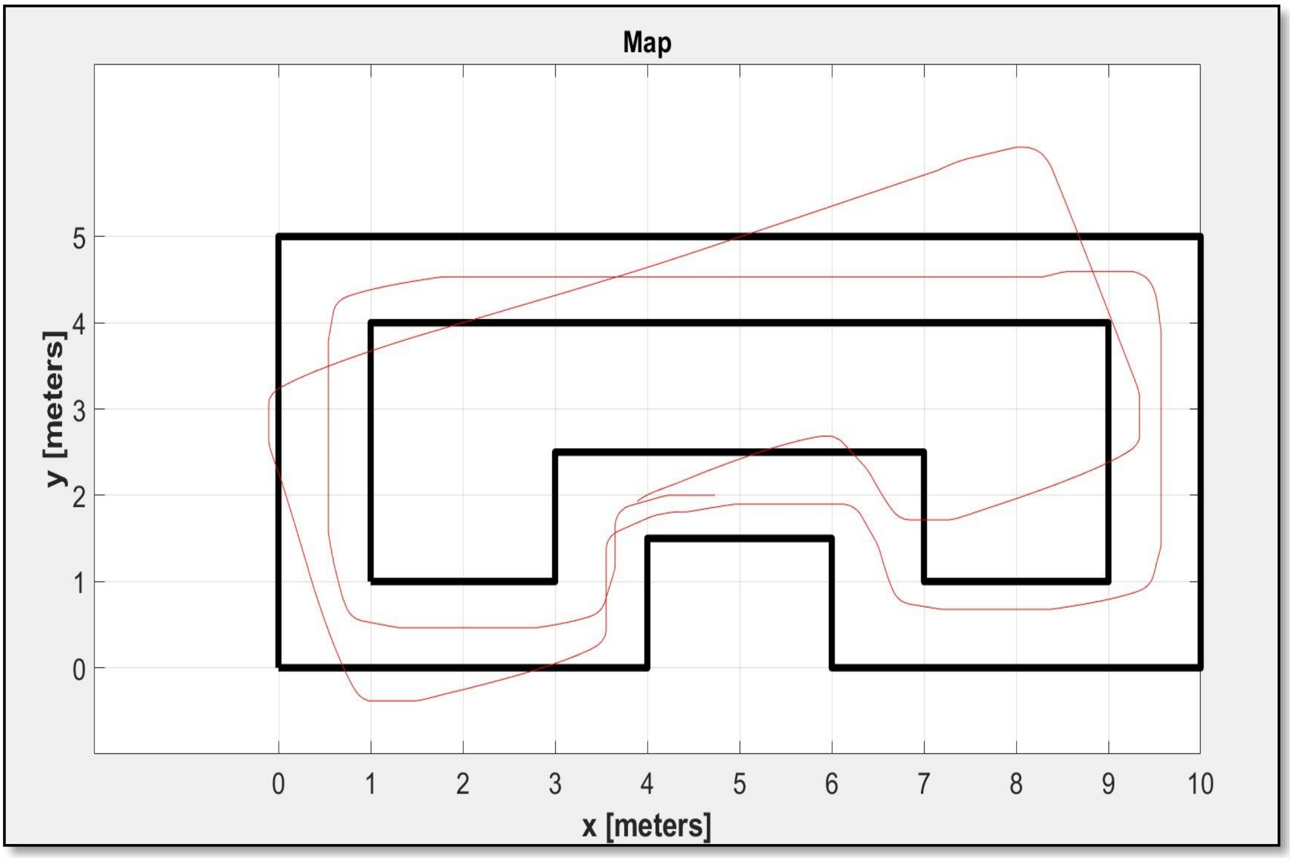

Fig 1: Path tracked using wheel odometry

Task 2: Tracking and plotting position by GPS sensor

The Global Positioning System (GPS) sensor used in the robot receives the signal from the satellite and determine its location in the environment with good accuracy. As the starting point of path tracked is different from the actual point from the environment, the error is obtained and is nullified by adding that to the obtained position.

The following graph shows the path tracked by using GPS sensor.

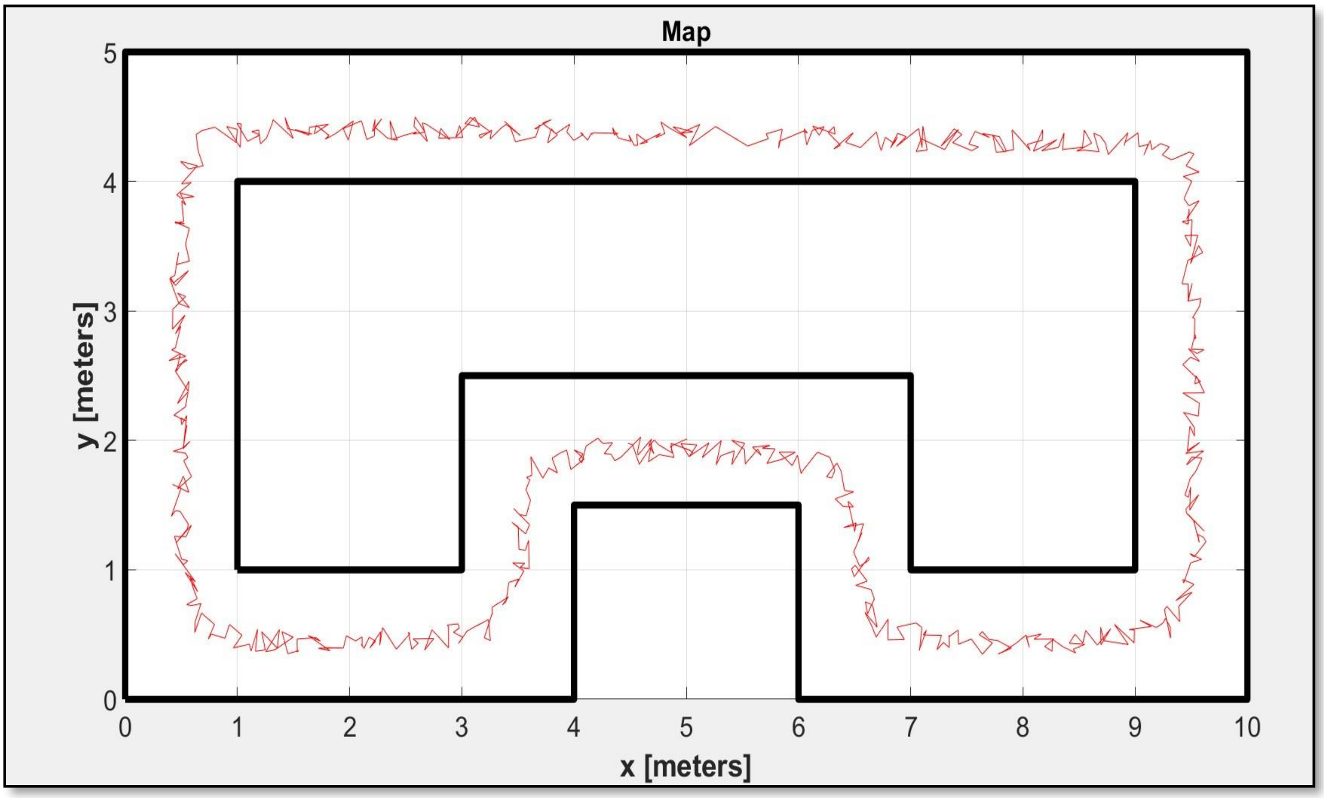

Fig 2: Path tracked using GPS sensor

Task 3: Tracking and plotting position by IMU sensor

The Inertial Measurement Unit (IMU) sensor consists of gyroscope and accelerometer, where the gyroscope provides the angular rate and the accelerometer provides the acceleration of robot.

The angular rate obtained from the gyroscope is used to calculate the angular position of the robot. The following equation gives the angular position of robot,

$$\omega = \frac{\Delta\theta}{t}$$

$$\Delta\theta = \omega * t$$

The acceleration is obtained from the accelerometer and the following equation is used further to calculate position of robot.

$$\Delta s = u * t + a * t^2$$

Using the above equations, we also calculate Δs, $\Delta\theta$ and they are used in the following equations to find the exact position at each time in x and y direction.

$$x = x + \Delta s * \cos\,(\theta + \Delta\theta)$$

$$y = y + \Delta s * \sin\,(\theta + \Delta\theta)$$

We use the above equations to plot the path tracked by the robot as shown below.

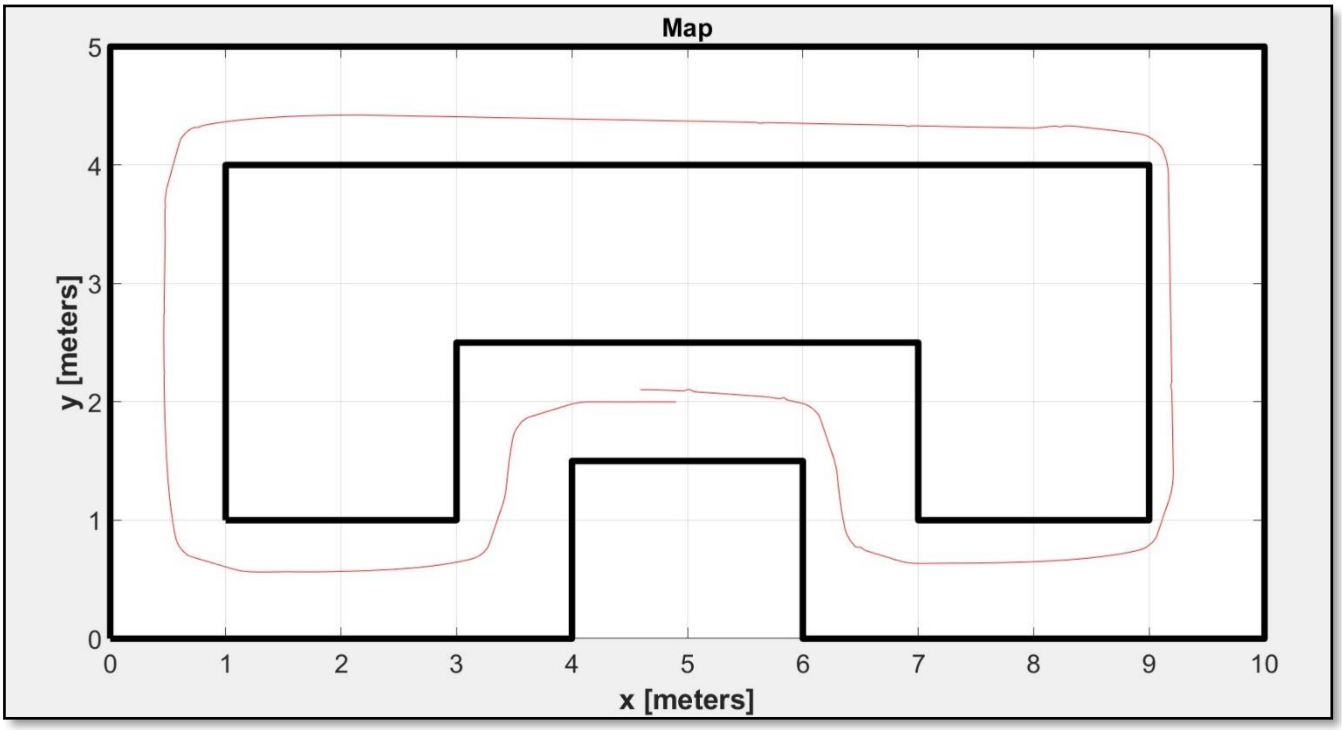

Fig 3: Path tracked using IMU sensor

References

1. https://www.researchgate.net/publication/306117685_Robot_Localization_An_Introduction
2. https://onlinelibrary.wiley.com/doi/full/10.1002/047134608X.W8318#:~:text=Robot%20localization%20is%20the%20process,making%20decisions%20about%20future%20actions.
3. https://www.robotshop.com/community/blog/show/robot-localization-so-a-robot-really-knows-where-it-is
4. http://www.hmc.edu/lair/ARW/ARW-Lecture01-Odometry.pdf