Smartphone IMU Based Indoor Mapping Robot To Follow User Position and Movement

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*Abstract* — Information on movement is a helpful data for a broad spectrum of applications, including monitoring, support, automation, etc. There are a number of techniques that can be used for the assignment of placement. With the popularity of smartphones and tablets in everyday life, the job of discovering the movement of customers through their phones is gaining a lot of attention from both the groups of studies and business. Integrated technologies such as GPS, Wi-Fi, Bluetooth and camera in smartphones are all capable of creating a positioning system. GPS methods have become a standard among these techniques and have accomplished a great deal of achievement for the outdoor setting. Meanwhile, for positioning tasks in indoor environments, Wi-Fi, inertial sensors and Bluetooth are preferred. In our work, we are studying the efficiency of the inertial sensors to position the robot in the indoor environment through the user’s smartphones. the paper's main goal is to provide a fresh technique for monitoring people based on their IMU smartphone sensors.

Keywords—IMU, Movement detection, Wi-Fi, smartphone-based tracking, Inertial sensors

# Introduction

There are many following systems out there in the real world but most of them use the Wi-Fi range Bluetooth range to move but none of these methods use IMU based following due to the belief that IMU position tracking will add up the errors but with our tracking system we are using the rotational vector and the linear acceleration for heading and movement tracking of the human in the forward motion most people disregarded using IMU due to the error caused by double integration when converting from acceleration to velocity to distance but in our proposed idea we are eliminating one axis and thus reducing the error of the robots movement as compared to the traditional position estimation. So the proposed idea basically eliminates the unused axis of motion so that the double accumulated error is reduced to only the error accumulation for single integration. And thus getting a bit more accurate than the original way but still there is error this can be adjusted by using the SLAM algorithm which can be used to not collide with any type of objects near it, rather just continue in its path following the user. The following system in this paper have their applications in different set of areas for example , It could be used in different settings like industrial robots that could be used to follow the user’s motion gestures from hand.

# Contents/Overview

## Materials used

The Materials that were used In the project for making the Robotic Agent.

## About The Expected Results

## The expected outcome of the project is explained as how the robot will detect the human movement through phone

## Working of the Model/Project

## Explains the complete project and how it was implemented and future modifications that could be done

## Results/Output

Screenshots and images of the implemented project and also a brief explanation of the topics

## 

# Materials used

We used a raspberry Pi which connects to the laptop via Wi-Fi and a smartphone Xiaomi Note 5 pro for sending data to the raspberry pi and a motor controller with dc motors and a raspberry pi camera a power bank for powering the pi’s system.

# About The Expected Results

The results that are expected are that the robot moves along with the human’s phone and basically tilts itself when the phone tilts and moves forward when there is a linear acceleration detected.

# Working Of The Model/Project

The robot’s heading estimation has different working parts but the two main ones are the forward motion detection and rotational motion detection.

## Forward Movement of the Designed model/Bot

The Forward movement of the bot is achieved by-

#### Using the accelerometer value from the smartphone.

#### Changing the accelerometer value to linear acceleration value for getting values on a single axis by subtracting the gravity accelration.

#### Applying the linear acceleration value to the velocity equation to find the velocity.

#### The velocity value is then applied to the distance equation along with a constant time value to find the distance travelled by the User/Smartphone.

#### The length of the tyres of the bot is noted and is then rotated according to the value of distance we got from the distance equation.

#### Equations Used In the Process-

1. Velocity - Acceleration equation-



1. Distance – Velocity equation- 

## Rotation Of The Designed Model/Bot

The Rotation of the bot is achieved by-

#### The rotational vector value from the smartphone is retreived by using the rotational vector component across the z-axis called as the yaw value in android .

#### The degree value is retreived so these degree values are sent to the robot which turns the robot along with the phone

#### The sending of the value is in real time so when the values reaches the robot and based on the next upcoming value it moves itself.

**For Future Implementation**

## Simultaneous Localization And Mapping Implementation

#### Simultaneous localization and Mapping using monocular visual data is performed offline due to raspberry pi constraints in running ORB\_SLAM2.As in the beginning it was performed on the raspberry pi but due to getting a lower fps in processing it had to be done offline in a more powerful system.

#### In this the video is recorded from the raspberry pi camera and then the visual monocular SLAM is run on a more powerful computer .

#### It detects the object around it. But can be used for future implementation where it would be a good addition to the IMU for a perfect positional tracking and to adjust itself if its moving astray.

## Object Detection Implementation

#### Object is detected based on the the YOLO Library which is also performed offline because of Raspberry pi’s constraints in running the object detection.

b)The video from the raspberry pi is use in a more

powerful computer to perform object detection

c)this can be used as a future implementation wherein

we can do this along with the SLAM for avoiding or moving towards a certain object.

# Results/Outputs

Here are the results and outputs of each of the different process used

## Heading estimation app view :

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As you can see in the app we have to provide the IP address and it would send the Rotation angle and the linear acceleration values to the IP.

## SLAM implementation :

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Here is the screenshot of the Slam Implementation and the path shown of the robot moved.

## Object Detection :

##### Conclusion

There are a lot of different implementation of IMU based following but our proposed method could also be better in certain scenarios , because as compared to other implementations they either use Wi-Fi based tracking while others use the position data but in our is more better than other implementations because they are implemented in real time along with the user movement , this type of system could be used in systems which need Human computer interaction for example to control assembly line robots in factories where the robots are running in their own associated path.

The Results which we got were achieved as expected.

For future implementation if the SLAM and Object detection are integrated for the robot then it could be a good addition to the following system.

##### References

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