# Automated indoor navigation control unit (Using raspberry pi)

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***Abstract*— With increase in the types of indoor positioning systems available and a growing demand for automated systems, our project tries to club the two together to make an automated navigation control system. This system helps in moving a prototype from one area to the next desired area automatically, without the need to drive the prototype manually. This is done by predefining the path in the user's database which is all controlled with the help of a Graphic Interface Unit (GUI).**

**Index Terms— indoor navigation, navigation control, automatic navigation, RFID control**

## I. Introduction

A key reason for the need of such a system is to eliminate the dependency on a joystick for manoeuvrability. For remote places, an automatic control system could help automate the system without the need of a skilled operator. And even though there are many forms of navigational system, most of them are only tasked with locating an object. Whereas the prototype mentioned in this paper is capable of being navigated and controlled around rather than just locating.

We first designed the system with the help of GPS modules but then realized the drawbacks it had due to its:-

- Inability to provide accurate values in certain places due to range or attenuation by building walls, tress, etc.
- When used in a small place such as an apartment, the location value from one end of the room to the next may end up to be the same, hence reducing accuracy and efficiency.

We next looked on the use of Wi-Fi signals in order to help with locating, but noticed that the module must always be in plain sight of the router and even then the RSS acquired happens to fluctuate which is undesired.

All this trial and error methods got us to our next idea of using RFID's. Despite some drawbacks, it is the only system so far that we made more positive progress.

The project is broken down to three parts:

- **Adding new Rooms**

The very first step when wanting to go to another room is knowing the different number of rooms available. Since a computer cannot just know how many rooms are present and where they are, we need to assist in doing so. For this we make use of RFID tags and sensors.

In this case the tags will be fastened to the floor by some means and will be a reference point corresponding to a room. As in the algorithm provided in Figure2, when adding a new room, the prototype must be over the tag in order to store the tag ID number as the room name.

- **Making links between rooms**

Once the different rooms are made, the computer must then figure out how to travel from one room to another. Rather than complicating things with machine learning, we have allowed for the path from this room to the next to be recorded and stored from the start RFID tag to the end RFID tag. Despite being hectic, it is a simple solution to lead with. In order to make sure the prototype heads in the right direction, a magnetometer is used in order to keep the orientation of the prototype in check at the start. The system is more clearly defined in the algorithm given in Figure3.

- **Going to a linked room**

Figure 4 gives the functioning of the navigation control process. Now since all the rooms and the paths between them are known, we tell the computer to take us to a certain room. Unfortunately the computer is still not smart enough to take us to the room from any given point, so we assist the computer by taking it over a known point (RFID of a room) and then from there the prototype takes over and controls the movement all the way till it reaches the intended destination.

## II. Literature survey

Few of the existing navigation control technology include:

- **Radio Frequency identification (RFID) reader and tags**,

[1][2][4] This is commonly used in places where there is no point to point satellite signalling possible. This module reads RFID tags which can be any material upon which an electromagnetic strip containing identification keys is attached on to.

- **Global Positioning System (GPS),**

[3][7] This system makes use of GPS satellites in order to track the prototype module's location. Done by connecting to more than three satellites and then triangulating its location with respect to the know position of the satellites.

- **Gesture control,**

[6][8] This method of control uses flex resistors added onto gloves. Different resistance readings of the sensor can correspond to different actions and in doing so can be programmed to control the device in particular manner.

- **Voice recognition,**

[7][9] Unlike the previous control method where we measure electronic signal, we check for sound signal. There are already ready-made Voice control device which just requires one to pre-program the module with their voice to do a certain task.

- **Wi-Fi or Bluetooth,**

[5] Rather than calculating the Received Signal Strength (RSS) from the satellites, we can follow the same approach with help of local signals, like those provided by routers. This can be expensive and a little complex as it will require 3 or more routers and they must all be in direct sight with the module. This is required as when signal passes through walls, it attenuates even more.

## III. Block diagrams

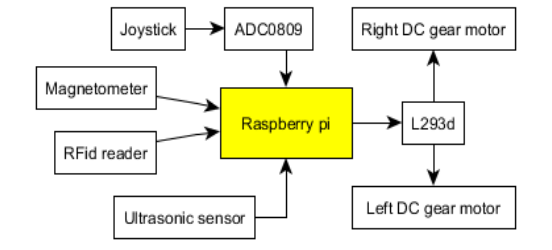


Figure 1: Modules incorporated

## IV. Hardware design

In this section we will discuss about the different modules involved as shown in Figure1 along with their respective functions.

- **Raspberry pi**

This module is the heart of the project as it does all the processing work required. It requires knowledge in Python and in doing so can help control different actuators and also provide a user friendly GUI to allow better operation of the system.

- **Joystick**

It is the main controller that helps manually move the prototype around. It is also used in this case to record path from point A to B when required by the system.

- **ADC0809**

Since the signal output of the joystick module is analogues, we make use of this Analog to Digital Converter (ADC) in order to convert the analog value to digital 1's and 0's in order for the raspberry pi to understand.

- **Motor Driver**

We make use of the IC L293-d which consists of two H-bridge driver that help control and supply additional power required to drive the motors by use of a separate external battery.

- **DC Gear Motors and Chassis**

The Dc gear motor used came along with the chassis ordered. Dc motor used has a rating of 3-6VDC and 150RPM.

All the components shown as in figure1 are fastened over the chassis except the RFID reader module which is placed below in order to allow easy access to read the RFID tags that would be attached to the floor.

- **Magnetometer**

HMC5883L module is a three-axis magnetic field module which uses I2C Address for communication. This module is used in order to properly orient the prototype in the direction required before it can start to automatically manoeuvre to the destination.

- **RFID reader**

We make use of sensor RC522 which helps read RFID tags up to a distance 25mm. Due to this, we place the sensor under the chassis, low enough to detect a signal but not to low that it scrapes the ground. Unlike other methods, here we keep the tags stationary and move the sensor around instead.

- **Ultrasonic sensor**

This acts as an obstacle detection system, where if it detects an object at a distance closer than a given threshold, the system breaks and makes a beep noise in order to avoid any collision.

## V. Software implementation

- **PuTTY**

It is a software that helps support many variations on the secure remote terminal, and provides user control over the SSH encryption key and protocol version. . It also can emulate control sequences from xterm and allows local, remote, or dynamic port forwarding with SSH (including X11 forwarding). This allows the raspberry pi to be remotely accessed on a windows OS.

## VI. Algorithms

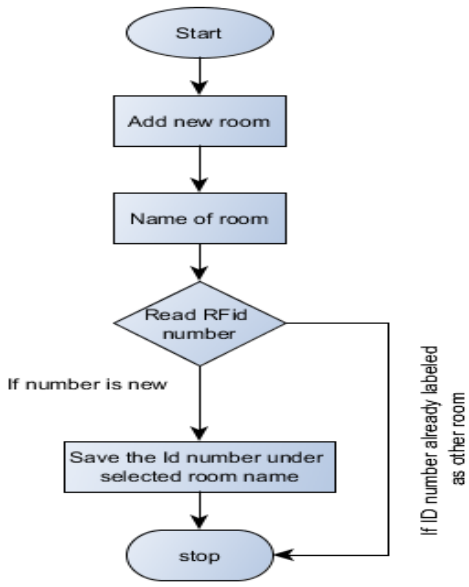


Figure 2: Adding a new room

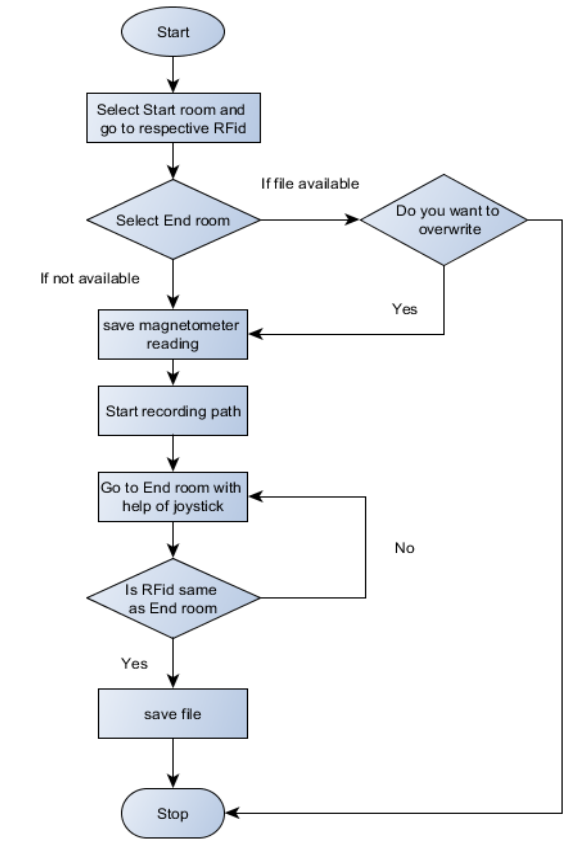


Figure 3: Making a link between two rooms

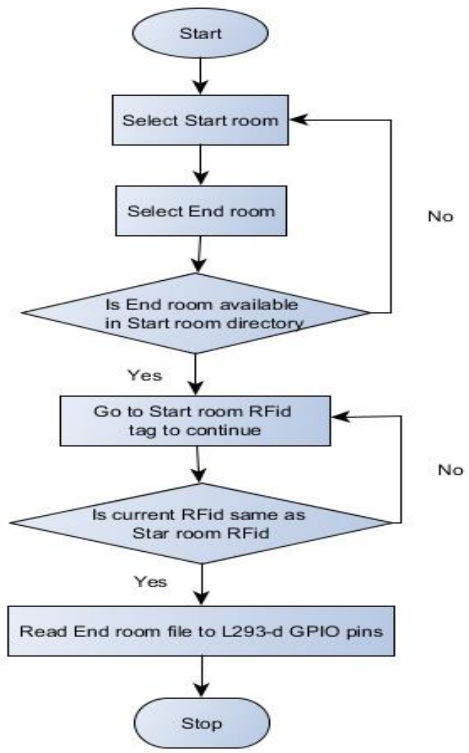


Figure 4: Navigation GO

## VII. Result and discussions

In completion of all the above, we now have a prototype model that is capable of basic level automated navigation control

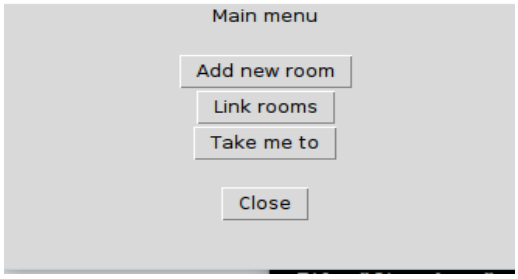


Figure 5: GUI main menu

In Figure5, the main menu of the system is displayed which provides all the main functions accessible to users like Adding new rooms, Linking different rooms or automatic control to an already linked room.

## VIII. Applications

Such a system can be used for a variety of applications some of which being:

- **Hospitals**, in beds and wheelchair which can help transport of patients from their room to the required lab and so on
- **Industries**, as an automated frequent goods transporter or an automated lift service vehicle to transport employee to a point saved on the system
- **Personal home use**, this is in the case of wheelchair users. Its simplicity allows it to be usable and friendly to the elderly, people suffering from paralysis or other physical disabilities.

## IX. Limitations and advantages

- RFID tags acting as the room locations have to be **manually fastened** to the floor and must not be tampered or moved when accidentally bumped into.
- If the **prototype is bumped** and happens to be pushed off course the system would not know and would continue in the wrong path and so there is a need for a closed loop feedback system.
- The **magnetometer isn't reliable** in all cases and so a better substitute must be explored to fix the orientation before automatic motor control.
- The more the number of rooms available, the **more number of paths** will have to be created. For example, for 4 rooms, in order for all rooms to be linked to one another, there must be 12 paths defined and stored.

## X. Conclusion

Such a system is handy in places where there is no direct range for satellite connectivity (like in case of gps) or UWF band of frequencies to assist in the navigation process. This makes it possible for the system to work in places with poor satellite connection and inside buildings where such signal happens to be weak, thus making it a good approach for an automatic indoor navigation control system.

## XI. Future work

There is a great amount of scope for future improvements to our current implementation that can enhance both the performance and the user experience of the application, some of which include:

- **Voice recognition** or voice commands can be used for control of GUI options.
- **Eye movement** control for the GUI, to help provide and easy platform for disabled people to move around.
- **Obstacle** avoidance so that the prototype can navigate around an obstacle and towards the intended destination without the need of a user taking charge of control.

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