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An Intelligent Robotic Navigation Using Android Bluetooth Application for Structured Environments

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***Abstract*— In this paper, we present a smart navigation scheme using Bluetooth module. Two modules have been used at the transmitter and the receiver end resulting in a compact system. The Robot can be controlled by any android device having a Bluetooth application installed on it. An intuitive user interface has been design which ensures easy operation of the developed system. We have used open source environment for developing the entire algorithm which makes easy accessibility and widespread use of the system. The functionality has been tested multiple times to ensure its ruggedness in the given environment.**

***Index Terms*— Bluetooth Module, Navigation, Graphical user interface, Android Device.**

I. INTRODUCTION

Navigation based semi autonomous robot has been implemented by many of the researchers. The most commonly used technique is the traditionally used joystick based method [1]. In such systems user has to move the joystick in a particular direction, where he desires to move. These systems are useful for patients with their limbs working properly. In other words, these systems are not operable by a paralyzed person. The need for wireless based system with a simple touch based interface suits the best for such scenarios. The most commonly used wireless technique for navigation is Bluetooth technology.

Bluetooth is a wireless technology used for transferring data between electronic gadgets. The advantage of this technology is replacement of long cables as well as reduction in overall system cost. The best thing about this technique is requirement of minimal battery power. They can easily be extendible and they don't interfere with other sources.

Bluetooth based robot control has grabbed the attention of the researchers over the years. A variety of systems has been developed using Bluetooth devices [2, 3]. Such devices consist of a transmitter and receiver at either end or user provides control through a touch interface which guides the robot in different directions. A few implementations highlight the usage of android application [2]. These applications are basically a android Bluetooth application. Here certain digits and symbols are assigned for giving direction guidance to the robots. The main drawback associated with all such device is that they provide direct controls such as forward, backward, right, left and stop commands. They do not provide the entire navigation path.

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II. SYSTEM ARCHITECTURE

The system consist of an android device with Bluetooth application installed on it , an arduino uno microcontroller unit, HC-05 Bluetooth module, and ultrasonic sensors for obstacle detection. The HC-05 module is interfaced with the first microcontroller. The DC motor controls are interfaced with the second controller where various control algorithms are developed. The ultrasonic sensors are also interfaced with the same controller.

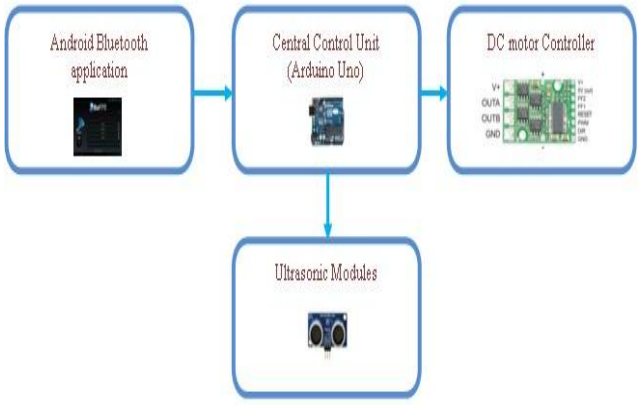


Figure 2.1 System interface

These two controllers work simultaneously and form a complete control unit. Certain sets of letters & alphabets are assigned for various movements of the robot on the given map. These letters are associated with various cases related to the main program that is written on the main control unit. Unlike, traditionally used methods where the numerals or alphabets are simply issue straightforward commands to the robot. Here in our case, we tested the robot in a known office environment on single floor consisting of four to six rooms; the robot has been initially assigned a reference position from where the user inputs various values from his device. Based on the values received through Bluetooth a certain case is executed, which consist of defined path for navigating a particular room. The entire algorithm is developed for a structured environment which consists of orthogonal walls and well structured corridors. So if a person has to move from one room to another he or she has to press a number and when the number is pressed, he is being directed to that particular room. The Robot while travelling may face certain obstacles for which we have employed ultrasonic sensors, it has been assumed that the robot has to move in structured environment, so these sensors work well in such cases.

2.1 HC-05 Bluetooth module

HC-05 Bluetooth module Figure 2.2 has been used to navigate the wheelchair from one location to another. HC-05

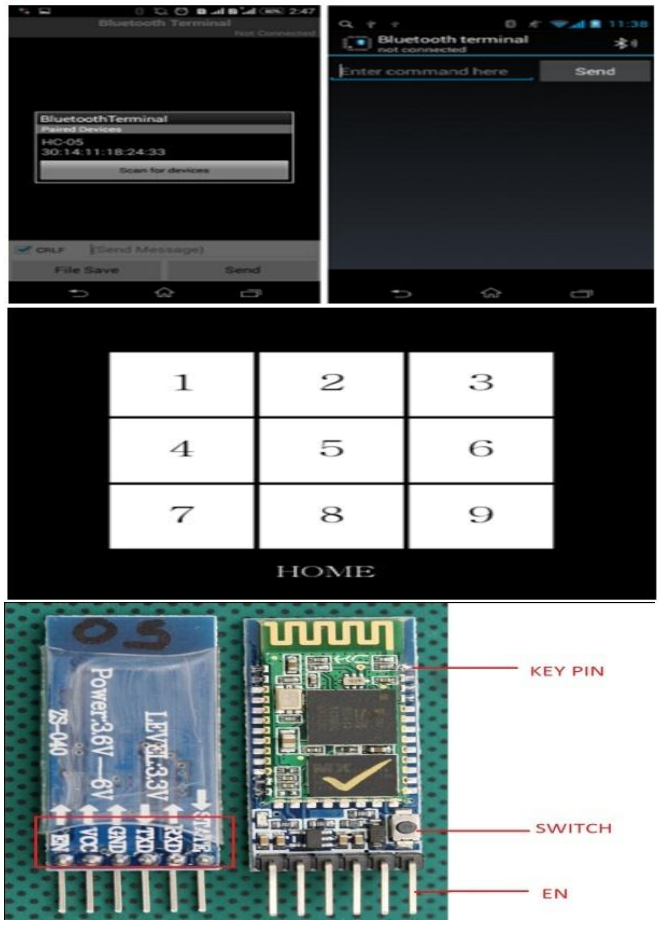
module is an easy to use Bluetooth SPP (Serial Port Protocol) module. The HC-05 has built in set of AT commands which enables us to change baud rate, name etc. It has a very wide baud rate but default one is 9600. The name can be changed or retained the same as desired by the user. The HC-05 is a 3.3V system but the breakout board offers current limiting resistors for some protection. While it's not advisable to keep the HC-05 connected to the 5V Arduino Uno pins, for this short exercise we decided to skip the voltage dividers which is used to drop 5V to 3.3V. Use of voltage dividers is done whenever we need to connect the HC-05 pins to 5V pins such as the Arduino Uno.

Fig 2.2 HC-05 Bluetooth module

Bluetooth TX -----> Arduino Uno RX (Pin 0)
Bluetooth RX -----> Arduino Uno TX (Pin 1) via the voltage divider!
Bluetooth GND -----> Arduino GND pin
Bluetooth Vcc -----> Arduino 3.3V pin but NOT the 5V pin.

2.2 Android Bluetooth Application

Our system utilizes the widely spread android application for sending data to the Bluetooth module. Any application which supports Bluetooth connectivity can be used for this purpose. We developed an intuitive user interface for easy handling. It consists of numbers which can be replaced by alphabets as desired by the user. Figure 2.3 depicts the typical application used in our system.



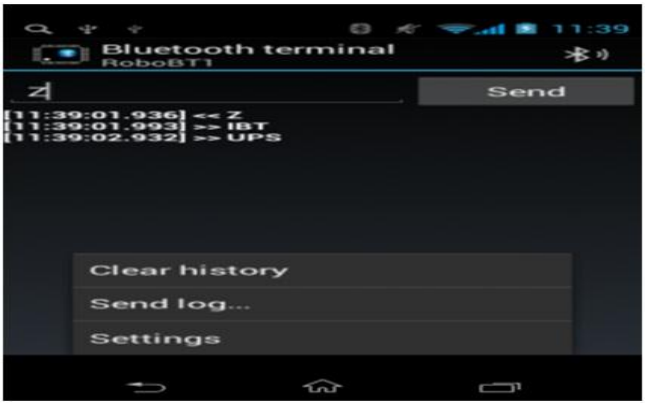
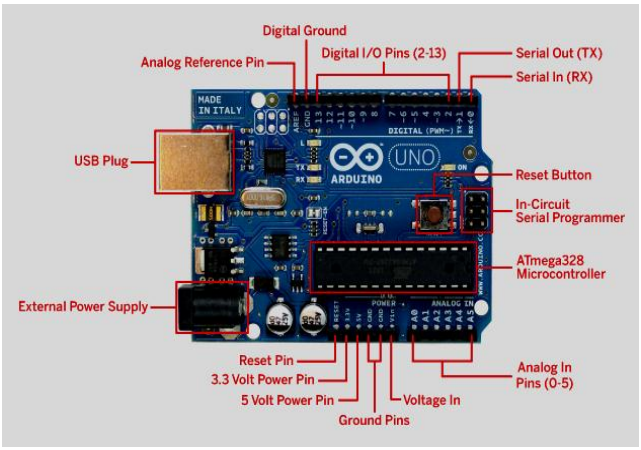


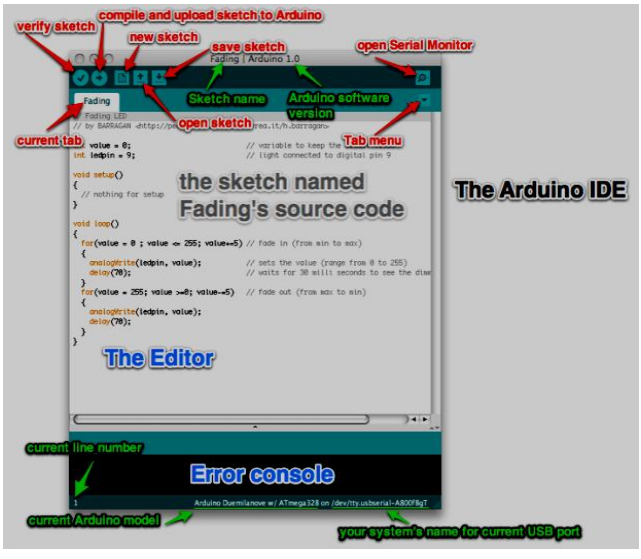
Figure 2.3 Bluetooth terminal application & User Interface

2.3 Arduino Microcontroller and IDE

Arduino is an open source prototyping platform for easy interface with a variety of sensors and actuators. We have interfaced the Bluetooth module in serial configuration to the controller. The ultrasonic sensors have also been connected to



the main controller, where the main code is written. The



software used is arduino integrated development environment which can easily be available as it is open source software. Figure 2.4 shows a typical Arduino microcontroller and its software environment.

Figure 2.4(a) Arduino Microcontroller

Figure 2.4(b) Arduino IDE

III. PROPOSED SYSTEM

The system consists of HC-05 Bluetooth module which is connected to the microcontroller unit. The application known as Bluetooth terminal has been used as a test platform. Initially, the user switches on the Bluetooth application and scans to see the list of available devices. The list of available devices consists of the desired Bluetooth device which we wish to connect. Now, when the user enters a certain text or number and sends to the Bluetooth module, the value is passed on to the central controller. This unique number is seen as interrupt and accordingly case structure is executed depending on room number selection. Figure 3.1 shows the navigation flow.

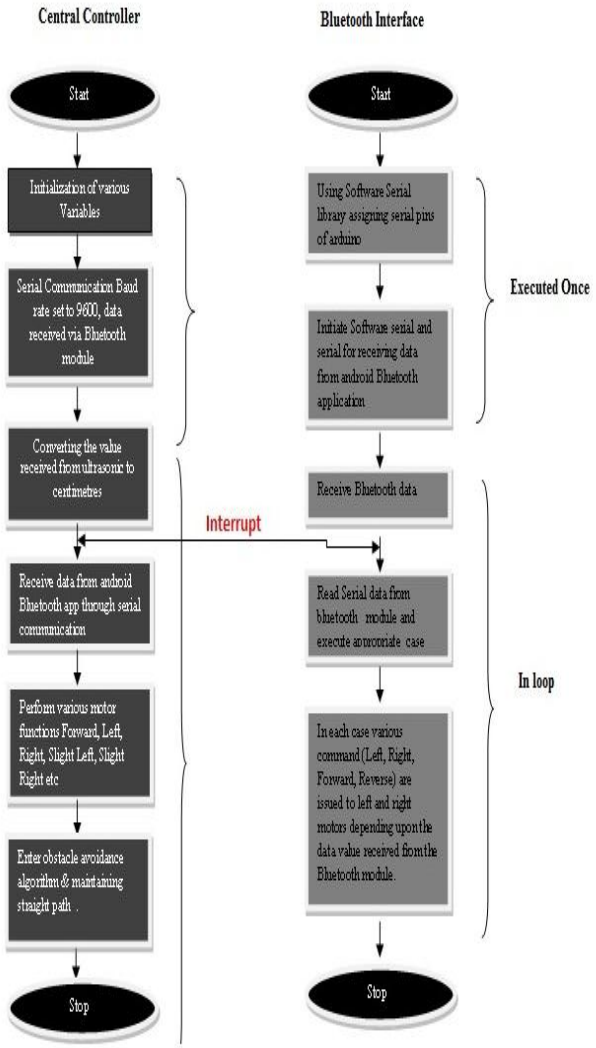


Figure 3.1 Flowchart Illustrating Navigation of Wheelchair

IV. RESULTS

We tested the designed algorithm for a given path and achieved near accurate results. Figure 4.1 shows the environment where the developed system has been tested. It consists of four room's diagonal to each other. The user inputs a value from the android application which is received by the controller via HC-05 module. Figure 4.2 shows the actual and real time navigation path followed by our robot.

The graph clearly shows the error between the two paths.

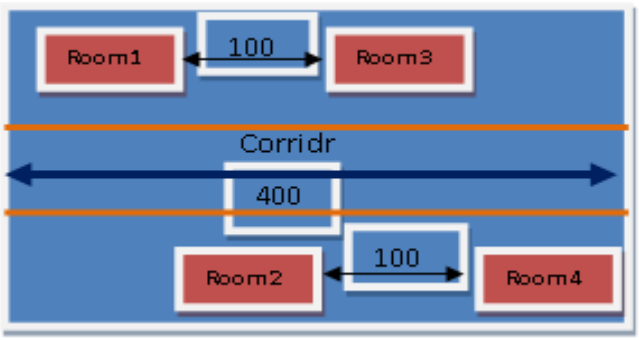


Figure 4.1 Floor Plan

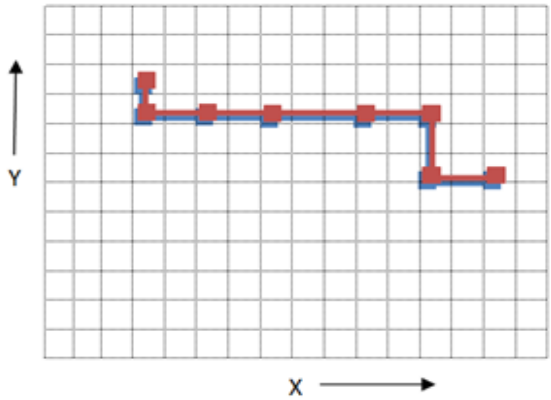


Figure 4.2(a) Actual Navigation

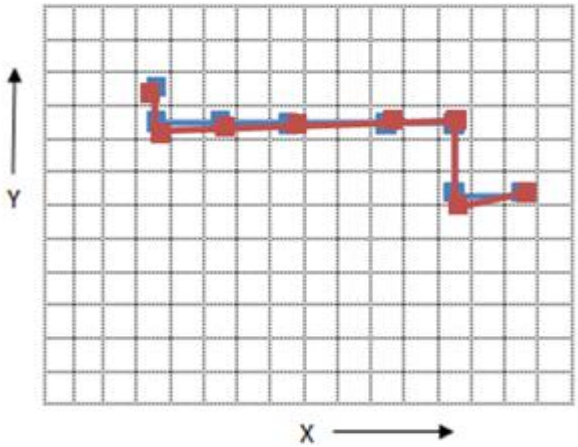


Figure 4.2(b) Real time Navigation

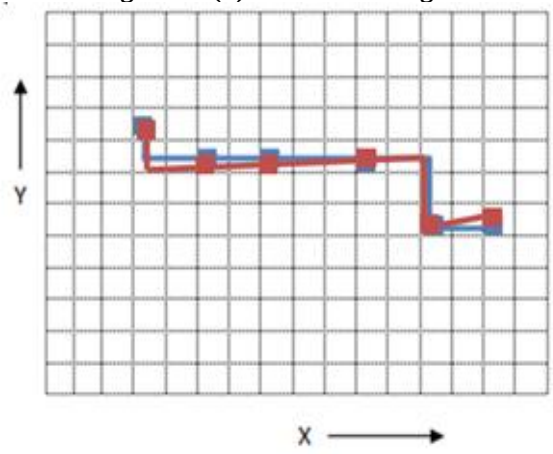


Figure 4.2(c) Real time navigation

Actual Path **Desired Path**

V. CONCLUSION

Bluetooth based Robot navigation is a widely used method. Many researchers have employed android devices to transmit control texts or digits. Most of the systems issue direct commands to the motor and lack a complete navigation algorithm. Here, with each digit or numeral we associated a complete path from a certain location to some other location. This path defines all the commands such as moving left or right, forward or backward in single case structures. In this way we have made possible cases for a set of predefined rooms. An easy touch interface further makes the system intuitive and interactive.

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