# Human Assistance Robot using Android Technology for Human Robot Interaction

Nupur Choudhury and Dr. Chintham Tejbanta Singh

**Abstract**--- This paper deals with the development of a Robot for elderly people. This robot guide will be controlled by a smart phone through which the user will send commands by using an android application that has been developed .The commands thus sent and received via Bluetooth are then processed and finally will control the robot. The route map of the destination will be fed in so that the robot can take the user to the target location avoiding the obstacles that might be there in the route. The application will be developed in such a way that it is compatible with any type of smart devices which can support an android operating system. Example: tablets, laptops, smartphones etc.

**Keywords**--- Android, Bluetooth, Route Map, Boebot, RFID etc

## I. INTRODUCTION

As many countries are rapidly stepping into the aging society a huge number of people are suffering from the lack of mobility functions or the disabilities related to the movement of limbs which are generally caused by lack of muscle strength or neurological problems. Moreover the increasing old aged population creates the limitation of people for nursing or assistance aiding activities. Therefore, there is an enormous need to develop assistance robots that can partially replace the therapists and the nurses. Presently, lot of researches on assistance and robots are being done, which includes various applications for the fore limbs, lower limbs, and for the assistance or training of the entire human body. In day todays life, walking or locomotion is one of the most vital human activities. For the improvement of the locomotion or walking ability of the aged society the walker type rehabilitation robot has dominated the research area related to human robot interaction domain over the last couple of years. At present various intelligent robots that have walker type abilities are implemented which have intelligent and efficient active or passive wheels in addition to a supporting frame. There are various robotic walkers for assistance purpose which provides the potential users with sufficient ambulatory capability in a cost effective and efficient way, for example JAIST(assistive robotic walker), JARoW (active robotic walker) etc. There are certain effective robotic systems that h as been proposed and are on its way for development. For example Hitomi system which will enable the blind to move freely in outdoor environment. The personal aid for mobility and monitoring (PAMM) is also being one such robotic system for human robot interaction which helps in mobility and also provides health status monitoring for the users. Moreover various researches are also in the execution process which are predominately working with passive robotics which deals with the development of intelligent walkers that would assist the elderly people. There are still various limitations in the present walker systems.

- Majority of the walkers are designed for the purpose of movement in the indoor environment. An indoor robot is often limited by the space of the indoor environment.
- The size of the robots are enormous in nature thereby restricting its maneuverability in narrow spaces due to its heavy weight.

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Hence, sufficient support in the form of small compatible and easy to handle devices are necessary to help the aged category to take a walk outside, which enables them to realize high quality lives or accelerate the rehabilitation. For this purpose a simple robotic guide has been proposed that will be able to guide the handicapped people to the pre specified target location avoiding all obstacles. The construction of the guide will be a BOEbot based robot(developed by Parrallax where the user or the person just needs to operate the BOEbot using an android application having left, right, up, down arrows which will be able to easily navigate through the route and the person would reach to his given location. The BOEbot is chosen explicitly for this purpose because it is capable of overcoming the above mentioned limitations. The robot is light and small in size which can follow any narrow path thus guiding the user to whichever location that he might want to reach to. Moreover it can efficiently relocate itself in the outdoor environment. The programming language that is being used that is BASIC STAMP 2.5 is one of the simplest programming language that any naïve programmer can try his hands on. Moreover the robot being operated with an android application makes it compatible with all the modern devices that surround human lives today and is efficiently user friendly for any naïve user to operate it for the first time.

## II. LITERATURE SURVEY

Human Robot Interaction (HRI) is a broad spectrum field of research or study which is dedicated to understanding, designing and evaluation of robotic systems for use of or with the human beings. Interaction as per the definition relates to the communication between humans and the robots. There might be several forms of communication between a human and a robot, however these forms are positively influenced by whether the human and the robot lies in close proximity to each other or not. Henceforth communication and therefore interaction can be separated into two primary categories:

- Remote interaction — In this mode of interaction the human and the robot are separated over space and time and are not collocated (for example, the Mars Rovers are separated from earth both temporally and spatially).
- Proximate interaction —In this mode of interaction the humans and the robots are in the same time and space that is both of them are collocated (for example, service robots may in the same time and space or in the same room as the user or the human being).Based on the mobility, physical manipulation or social interaction it is easier to distinguish within these general categories. Tele-operation or supervisory control are the operations that are referred as the remote interactions and the tele-manipulation is often referred as the remote interaction with a physical manipulator. Generally proximate interactions may be in the form of physical interaction and may take the form of a robot assistant. Social, emotive and cognitive aspects of interaction constitutes the social interaction domain. In the social interaction domain the robots and the users in the form of humans interact as peers and companions. In social interaction, the humans and robots interact as peers or companions. Most importantly, social interactions with the robots appear to be proximate rather than remote where both the teams are collocated.

There are several researches that have been going on in the existing domain. O. Khatib et al., [1] have worked on the development of models, algorithms and strategies that are concerned with numerous autonomous capabilities that are essential for the robotic operations in human environments. These capabilities are related to the manipulation and integrated mobility, interaction efficiency with the humans, cooperative skills between multiple robots and efficient techniques for the real-time modification of collision free path. These studies were experimented on two

holonomic mobile platforms that were designed and developed in Stanford University in collaboration with Oak Ridge National Laboratories and Nomadic Technologies. Vladimir Kulyukin et al.,[3]. The project developed by them deals with the development of assisted indoor navigation system to be utilized by the blind people. The architecture consisted of a mobile robot that would be acting as a guide and small sensors that are embedded in the environment. The pilot study with several visually impaired participants reveals the various hardware and software components of the system and the various aspects of the human robot interaction that was observed in the initial stage. This work lacks in portability related factors as it cannot be mounted on devices that might be handy in case of easier locomotion and noisy environment too leads to ambiguity. Hyun Keun Park et al. [4] developed a robot system to be used for nursing for The Elderly and The Disabled. The scientists developed DO-U-MI a nursing robot which will behave as an aid to the elderly and disabled people. The robot will enable the aged society to move freely in the indoor environment for example a nursing home or a hospital. The man machine interface that has been developed is user friendly and also provides a number of entertainment services for humans such as music, movie etc. It can detect a human face and can localize a sound source. However manual control is a minor limitation in the project. Another significant experiment done by R. Rangarajan et al. [5], leads to the development of a robotic dog for the assistance of visually impaired people and can be controlled via voice commands. The primary purpose of this robotic dog is to assist the elderly or the blind people to a predefined location avoiding all kinds of traffic and obstacles that might be coming on the way. This robot system is operated using voice commands alone and thus proves to be an efficient Human Robot Interaction mechanism. Similarly, Arpit Sharma et al., [7] developed an arduino based robot sending keystrokes via Bluetooth from an android application and can control the robot wirelessly. In addition to it Abdel Ilah Nour Alshbatat [8], worked on automated mobility and orientation for blind or partially sighted people. This system works with the concept of GSM-GPS module to show the location of the visually impaired or partially sighted person. Moreover it provides the direction and location and the information related to any type of obstacles which are based on ultrasonic sensors. The system is small with a beeper, an ultrasonic sensor and a vibrator attached to it. The system depends on braille system for its operation and the results have shown that the blind can move freely, independently and safely in the environment. Joao Jose et al., [9], developed a navigation aid known as the smart vision prototype which smaller in size, cheaper and easily wearable for the user. The various functionalities that are addressed includes global navigation for guiding the user to destiny and can avoid static as well as dynamic obstacles. The camera is worn at the chest height and a computer is worn in a pouch and consists of a single earphone or speaker which enables efficient Human Robot Interaction. Brice Burger et al. [10]. has worked on human-robot-interaction in mutual assistance between speech and vision. The work deals with multimodal human robot interaction where a multiple object visual tracker which is interactively dedicated and distributed to two hand gestures and head location in 3 D is proposed. A speech understanding system is also developed in order to process deictic and anaphoric utterance in the form of speech. The field of Human Robot Interaction has led to several researches which has made life easy for the elderly people of the society, Chaitanya Gharpure et al.,[11], have worked on Shopping of the blind people that are assisted by robotic systems and has revealed several issues that might be there in the spatial cognition and product selection of the users in the supermarkets. In addition to it Songmin Jia et al.,[12] has worked on the development of a service robot system consisting of multiple human user interface where a multifunctional robotic system is created to improve the care ,cost and quality of life of the elderly people. RFID system is used here which is identified by a camera system and most of the obstacles can be avoided in this process in a

cost effective manner. Similarly Iwan Ulrich et al., [13], worked with the development of Guide cane which could apply the the robot technologies to assist the visually impaired or the elderly people. However dynamic obstacles are a limitation in this work.

## III. RESEARCH GAPS

The various researches that were done in this field involved a lot of limitations primarily due to the following reasons:

### *A. Portability Issues*

The portability issues that were present involved large equipment especially laptops or other devices that need to be carried around for smooth locomotion. The proposed robotic guide is composed of a small BOEbot which will be controlled via a smartphone or a tablet so that the user need not carry heavy equipment around. Moreover since the entire system is based on Android application, it can be easily mounted on any device which can support an android operating system

### *B. Lack of Route Decision System*

The current available systems lack in the routes decision systems as the predefined targets cannot be achieved or the guide will not be able to reach the target system. The proposed system will be integrated with a suitable decision system so that the guide can reach the target avoiding all obstacles.

### *C. Complex Operation Systems*

The existing systems involve complex operation systems like involvement of a large number of sensors and Radio Frequency Identification Tags which makes the entire environment a complex framework for the robot to navigate

### *D. Dynamic obstacles*

There are various problems related to dynamic obstacles i.e. fast moving humans or animals that might come on the path of navigation which creates dynamic obstacles that might lead to sudden obstacles which might lead the whole system to fail.

The analysis of the research gaps leads to a requirement for the development of a robotic guide which is simple in operational activities as well as leads the user to the specified target avoiding all obstacles. Hence the problem statement can be defined as development of a robotic guide which can be controlled via a smart phone or a tablet and has built in efficient route decision system so that the robot can take the user to the target location avoiding obstacles.

## IV. METHODOLOGY

### *A. Module: Android Application Controlled BOEbot*

The initial development is composed of development of an android application which will be able to control a BOEbot (robot) and can maneuver the BOEbot in 4 directions which includes ‘left’, ’right’, ’forward’ and ‘backward’. It consists of a BOEbot module which will be connected with the user interface in the smart phone through which the activity will be accomplished. The application is designed in such a way that the BOEbot can maneuver to the predefined destination location simply by sending a keystroke a communication to the BOEbot.

A smart phone is a device built with advanced computation and connectivity on a mobile computing platform than an ordinary feature phone. It is easily affordable and efficient to handle for support regarding the collaborative activities in a community as a result of the tremendous advancements in the mobile phones technology. Today scientists are eagerly working and discovering new avenues of communicating with the machines where a major discovery was identified when gestures were an option for this type of interactions where a nonverbal form of communication in which physical actions can generate

specific messages which might constitute light variations, sounds or any type of physical movements. Based on the different type of gestures and Motion Technology via still camera, data glove, Bluetooth infrared beams etc. has been able to draw significant interest among scientist all over the planet upon whether the gestures are Bionic, optical, tactile etc. Today Human robot interaction has faced a huge revolution and is changing at a speedy rate because of a small yet powerful device which is known as a smart phone. Present day smart devices have built in accelerometer sensors, Bluetooth etc. and are equipped with efficient operating systems like Symbian, Android OS, Bada etc. out of which the Android operating system has gained significant popularity after its launch in 2008 surpassing all other competitors due to its open architecture. A new revolution has been created in the field of application development for mobile phones creating new domains for technical exploration. The smartphone or device can be rotated freely in space, temporarily the phone's 3-axis acceleration sensor provides 3-dimensional signal data from This data is transmitted using an android application to a robot via Bluetooth module of smartphone. Later, it is processed by a microcontroller embedded on the robot for its desirable motions. In this context, a robot is an analogy for any machine that is controlled by man which might from a simple toy to heavy machinery. Robots are used to replace humans in performing various tasks that they are unable to perform due to physical limitations, size discrepancies or differential and extreme environments. For past few decades, scientists from the entire globe are showing exclusive interest in gesture technology making it a powerful tool for mankind by exploring the various possibilities in different domains. Smartphones are more an assistance aid rather than simply a tool for making calls and has led to the whole world merge into the palms in the form of a smart phone. A great number of researches have been done in this field and our project being one such medium.

### *B. Architecture*

The architecture of the existing module is as shown in Fig:1, where an android application will be developed that would be connected to the BOEbot via a Bluetooth. The user would simply send signals from the android application from the smartphone and finally it would make the robot move to the desired location.

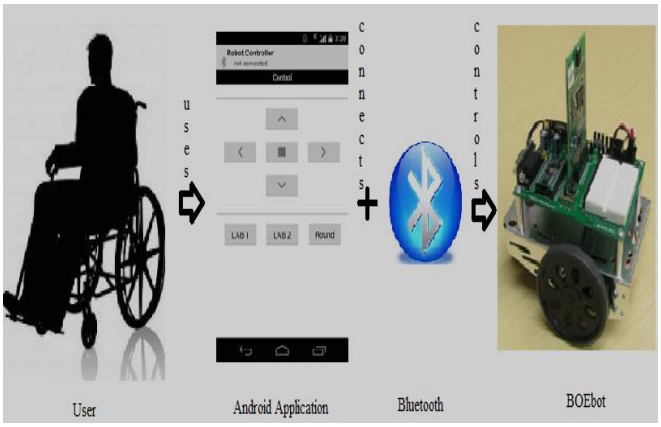


Fig. 1: System Architecture

## V. REQUIREMENT SPECIFICATION

The various system requirements for the proposed system has the following set of hardware and software requirements for its initial stage i.e module 1

### *A. Software Requirements*

- The Java Development Kit (JDK)
- Eclipse IDE-Juno (Java Developers version) with the Android plugin.
- Android SDK and add-ons
- Basic Stamp 2( Parralax Inc).

### *B. Hardware Requirements*

- RAM 3 Gb and above
- BOEbot (Parallax Inc)
- EasyBlue 500 SER Bluetooth module
- Smart phone or a tablet which supports android operating system.

The development process needs an mobile phone that is equipped with an android operating system as a primary hardware requirement. The android based development is highly utilized by software developers because of its open architecture and platform independent nature as it is based on java programming language and getting started with the API is very easy as it is open source and provides a number of communication interfaces like Bluetooth, USB, WiFi etc. that can be used to communicate with the robot which makes it cheaper and more useful than any other ARM-based processing unit. The robot used here is BOEbot developed by Parallax Inc. which consists of a basic stamp 2 microcontroller brain where the program could simply be fed in from the basic stamp 2 editor. It is cheap and is easily available. For communication of the robot with the smartphone A Bluetooth device is used to communicate with the android application where the Bluetooth device EasyBlue 500 SER module is used for the communication where it is attached with the BOEbot that receives the signals from the android application. And works accordingly. It is designed for low power devices such as mobile phones. As Bluetooth connectivity is based on the MAC address of the device the connectivity of the devices is flawless with minimum error involved. The Easy Blue 500 SER Bluetooth module looks like figure 2 a shown below. This Bluetooth module is then attached with the BOEbot and is used for communication.


Fig. 2: Easy Blue 500 SER Module

The android application is developed using the Java programming language and using Android SDK and add-ons. The Java Development Kit (JDK) along with the composition of Eclipse IDE with android plugin is utilized for the application development. However for the microcontroller programming Basic stamp 2-2.5 is used to write into it. The application thus developed has taken the shape of the figure 3 thus shown below.

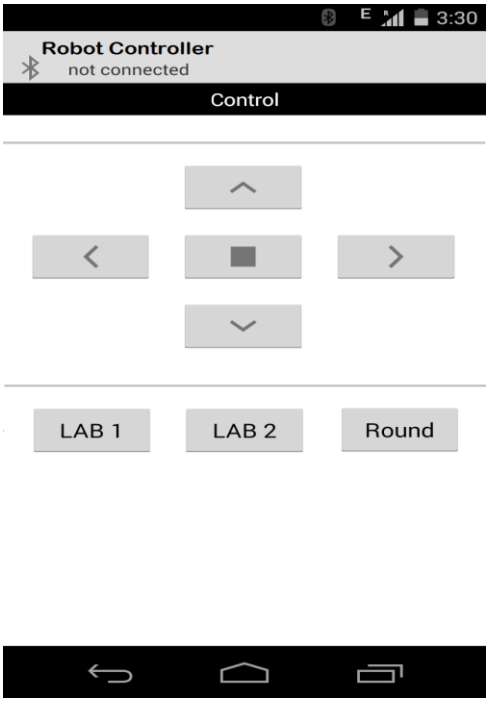


Fig. 3: Android Application

The first keys shown in the application is used to navigate the BOEbot in 4 different directions which includes left, right, front and backwards. The keystrokes on being pressed will make the robot move in that particular direction until and unless the key is being released. Buttons on the bottom panel represents the various predefined locations that the user wants the BOEbot to lead him/her to. The entire application is developed using java programming language and the apk can be mounted on any smart device may it be a smart phone or a tablet or any other device that might support an android operating system.

## VI. SYSTEM DESIGN

The complete design of the project is divided into 2 sub-designs

- Initial System design.
- Final System design.

### *A. Initial System Design*

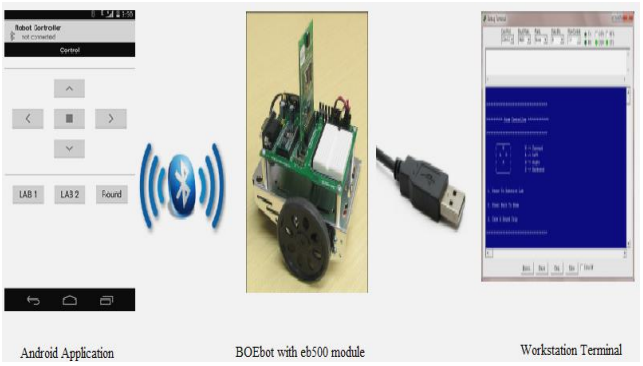


Fig. 4: Initial System Design

The initial architecture involves a BOEbot to be connected with the Laptop which supports a Basic Stamp editor (version 2.5) via a USB cable. The EasyBlue 500 SER Bluetooth module is mounted on the BOEbot and is connected to the laptop. The communication port for the Bluetooth module is noted as COM8 and the Bluetooth module communicates via that port. On the other hand, the android application is linked with the robot through Bluetooth connectivity between the module and the application. Once the connection is established, the keystrokes that are sent from the application are received in the debug terminal of the basic stamp editor.

### *B. Final System Design*


Fig. 5: Final System Design

The Final system architecture involves the removal of the USB cable from the robot and downloading the program into the microcontroller of the BOEbot from the BS2 editor. The application will pass on the keystrokes and it will make the robot perform the predefined functionalities thus making tit completely controlled wirelessly through the android application.

## VII. ACHIEVED GOAL

The project done is capable of the following activities: The BOEbot can be controlled via Bluetooth with the Laptop keystrokes and accomplishes all the activities that are to be supported by the application.

The various functions that can be executed by the robot is as follows:

- Forward, Backward, Left, Right.
- Steer to Lab 1
- Steer to Lab 2
- Steer to Home
- Make a round trip.

The Forward function enables the robot to move forward until the W key is released from the pressed condition. Similarly Backward, Left and Right functionalities enables the robot to move backwards, left and right respectively by pressing S, A and D keys. The Steer to Lab 1 function makes the robot to move 22 seconds forward and then take a left turn and move 15 seconds to the destination which has been set as Lab 1. The Steer to Lab 2 function makes the robot to move 22 seconds forward and then take a right turn and move 15 seconds to the destination which has been set as Lab 2. Similarly Steer to Home allows the robot to move back to the home position and Make a round trip option allows it to make a rounded trip from the destination to the home location. The similar functionality has also been achieved through the smart phone application and the BOEbot can be controlled wirelessly through the android application on any android device.

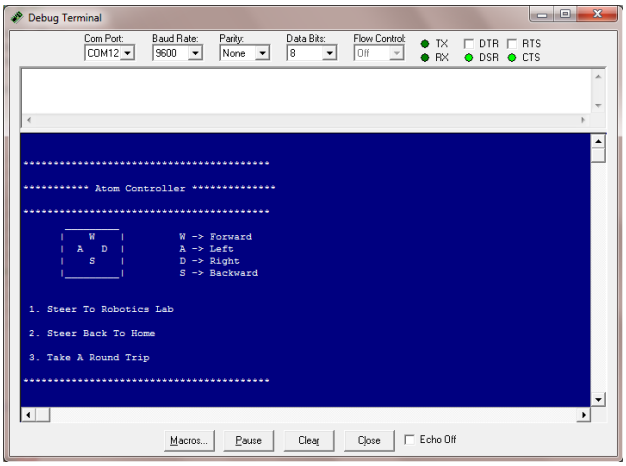


Fig. 6: Implementation Window Which Enable the BOEbot to be Controlled via Keyboard

## VIII. CONCLUSION

The methodology will serve as an addition to the Human Robot Interaction field. With the aid of the BOEbot the elderly people and the visually impaired or any other person who might need assistance in locomotion can easily move and reach to their pre specified target location avoiding all obstacles. Since the development of the application is based on the latest technology that is available, it is compatible with any kind of existing modern devices for example smart phones, tablets etc. It proves to be more user friendly with the visually impaired people because it will have functionalities that would reduce manual effort to a great extent as the existing braille applications can be replaced with voice command controlling operations. Moreover no prior training is required to operate on the application thus making it simple for handling. The android technology thus used makes it compatible to all types of modern devices creating a revolution in today day to day affairs. The application being compatible in all modern smart devices makes it easier for carrying and transportation. Hence this application is anticipated to be a boon to mankind and help people in making their life simpler.

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