Android App Controlled Bluetooth Robotic Vehicle

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The objective of the present work is to design and develop an android app based user interface to control a robotic vehicle using wireless bluetooth technology. The entire system consists of carefully selected replaceable low-cost components to meet the rugged industrial environment. The proposed single-board in-vehicle embedded system is equipped with the HC-05 bluetooth model to interact with microcontroller and android app, dc gear motor and L293D motor driver to control the kinetics of a robotic vehicle, and ATmega328P microcontroller as core processing unit fixed on self-designed chassis. The back-hand design for the android app is developed using open source called 'App Inventor' developed by MIT and suitable to develop app without Java platform. The in-vehicle electronics hardware is developed around the ATmega328P microcontroller and bluetooth module is interfaced with microcontroller through the UART protocol to exchange the data with android app. By pressing remote button developed in the android app the direction of the robotic vehicle can be decided. The major advantages of this proposed design is, minimum version of in-built bluetooth smartphone is used to install the developed app and wireless bluetooth technology offers zero communication cost. Moreover, this robotic vehicle can also be utilized other application such as, exploring the toxic area, detection of explosive landmines, multipurpose surveillance vehicle.

Keywords: ATmega328P microcontroller; Bluetooth technology; MIT App Inventor; Smartphone; Robotic Vehicle

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Introduction

Recent advancement in semiconductor material results smart devices such as smart phones and they becomes a basic need in day to day life with massive storage capacities, powerful with reinforced processors, richer entertainment function and vast communicating methodologies. Bluetooth technology, created by telecom vendor Ericsson in 1994, shows its advantage by integrating with smart phones. Bluetooth raised as one of the popular communication in which, the user can transfer files, commands etc. Utilizing its flexibility in communication, bluethooth controlled devices are start occupying its place in the market especially in controlling the robotic vehicle. Robots are electromechanical machine which can be controlled by artificial programming using high speed microcontroller [1]. They found in wide area of application such as industry, manufacturing, production lines, health, etc. The robot are preferred to work in rough industrial environment and designed to reduce human effort, to improve productivity and to reduce overall manufacturing cost. Bluetooth controlled robotic vehicle is one solution to design and develop the cheap and rugged robots to perform any task with safe distance operation. Bluetooth communication will enable us to control the robot up to 100 meters without the need for direct sight which means that the robot could be located behind a wall or some other object and the communication would not be lost.

In recent years, an open-source platform called android has been widely used in smart phones which the smart phones have gradually turned into an all-purpose portable device. Android has complete software package consisting of an operating system, middleware layer and core applications [2]. Using a Smartphone as the “brain” of a robot is already an active research field with several open opportunities and promising possibilities. This paper aims to describe the design and development of bluetooth controlled robotic which operated using android mobile application.

Hardware design

The main objective of the design is to overcome the traditional method of controlling the robotic vehicle usually wire or hand-held low range remote controller. The developed android app helps to move the robot at the desired direction which interns transfer the heavy weight material. By just bluetooth connectivity an android app can handle the movements of a robot and can move it in left, right, forward and backward directions.

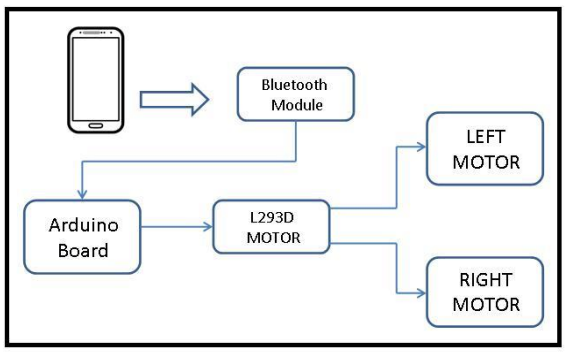

Figure 1. Block diagram of bluetooth controlled robotic vehicle

Arduino UNO is the latest version of the Arduino UNO board using the ATmega828 instead of the FTDI chip for faster transfer rate. It is

App Inventor for Android is an open-source web application provided by Google and now maintained by the Massachusetts Institute of Technology (MIT). It allows computer program to create software applications for the Android operating system (OS). MIT App Inventor is an innovative beginner's introduction to programming and app creation that transforms the complex language of text-based coding into visual, drag-and-drop building blocks. The simple graphical interface grants even an inexperienced person to create a basic, fully functional app within an hour or less.

App Inventor involves three aspects: (i) App inventor designer, (ii) App Inventor Blocks editor, and (iii) An emulator or Android Phone. The set-up process for the software is very easy and system requirements are very basic. It is compatible with Mac OSX, Windows and Linux Operating systems. Browsers required for the software are Mozilla Firefox 3.6 or higher, Apple Safari 5.0 or higher, Google Chrome 4.0 or higher and Microsoft Internet Explorer 7.0 or higher. (App Inventor 2012).
The first phase of application design passes through App Inventor Designer. Designer is accessible through the web page and all the ingredients for the app are available on the left side of the window. The ingredients contains elements like a screen for the app, buttons for tapping, text boxes, images, labels, animations and many more. The right side of the designer allows users to view the screen and components added to the screen. Additionally, the properties section of the window allows users to modify the properties of components [3].

Microcontroller unit form the heart of robotic control unit, which acquires and process the information from the bluetooth module. Microcontroller have a CPU in addition to the fixed amount of RAM, ROM and I/O ports, which are embedded on a chip with support functions such as a crystal oscillator, timers and serial or analog input output (I/O). The MCUs are designed for embedded applications and can be used in remote controls, power tools, toys and other appliances. Invention of MCUs has reduced the size and cost of designs. MCUs are suitable where cost and space are critical [4].

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega328 programmed as a USB-to-serial converter.

a small form microcontroller board based on ATmega328. It is equipped with a USB connection, 32kBytes flash memory, 1 reset button, 14 digital input/output pins, 6 analog input pins and 1 power

jack. The recommended input voltage for this board is between 7 to 12 volts. Thus, an external power supply is needed. Power can supply to this board through the power jack. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started [5]. Besides that, Arduino UNO can communicate with a host PC by using a USB Type B cable. The user can write the program on the host PC and upload it to the board. After uploading the program, the USB Type B cable can be removed. The program will be stored in the Arduino board and it will still run each time the reset button is pushed. It also features the Atmega328 programmed as a USB-to-serial converter.

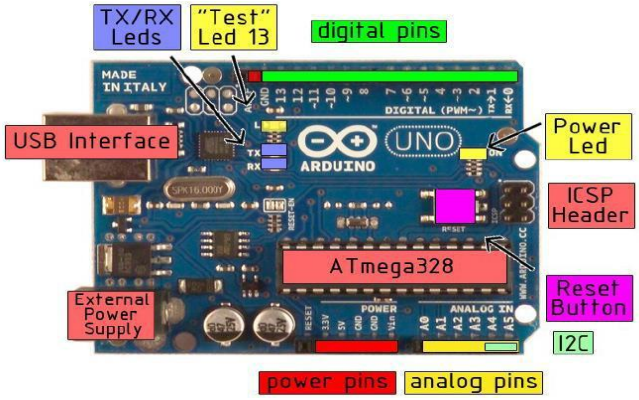

Figure 2. Arduino Uno Atmega328 microcontroller board

HC Serial Bluetooth product consists of Bluetooth serial interface module and Bluetooth adapter. Bluetooth serial module is used for converting serial port to Bluetooth. Bluetooth serial module's operation doesn't need drive, and can communicate with the other Bluetooth device [6]. But communication between two Bluetooth module require at two conditions: i) The communication must be between master and slave. ii) The password must be correct. A HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). Fig.2 shows the image of HC-05 bluetooth receiver and its pin description.

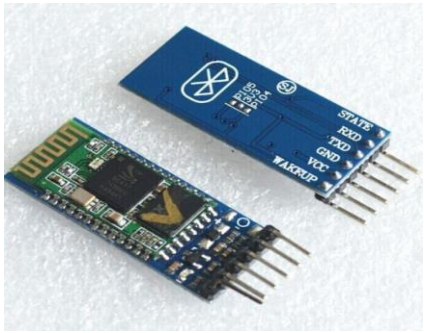

Figure 2. HC-05 bluetooth receiver and its pin description.

Universal asynchronous receiver/ transmitter is usually an individual integrated circuit used for serial communications for computer or peripheral device serial port. UART are now commonly used in microcontrollers. A dual UART combines two UARTS into a single chip. Many modern ICs come with a UART that can also communicate synchronously; these

devices are called UART. UARTs are commonly used in conjunction with communication standards such as TIA (formerly EIA) RS-232, RS-422 or RS- 485. The universal designation indicates that the data format and transmission speeds are configurable. The electric signaling levels and methods (such as differential signaling etc.) are handled by a driver circuit external to the UART. The UART takes bytes of data and transmits the individual bits in a sequence. At the destination, a second UART re-assembles the bits into complete bytes [7]. Each UART contains a shift register, which is the fundamental method of conversion between serial and parallel forms. Serial transmission of digital information (bits) through a single wire or other medium is less costly than parallel transmission through multiple wires.

DC motor is one type of rotary actuator which is having number of application in industry. DC motor is specified by its RPM and torque (kg/cm). For the robotic system, 300 RPM and 3kg/cm torque motor is used to bear load. DC motor works on direct current

The L293 and L293D are quadruple high-current half –H drivers. The L293 IS designed to provide bidirectional drive currents of up to 1A at voltage from 4.5V to 36V. The L293D is designed to provide bidirectional drive currents of up to 600-MA at voltages from 4.5V to 36V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolor stepping motors, as well as other high-current/high voltage loads in positive-supply applications. On the L293D, external high-speed output clamp diodes should be used for inductive transient suppression [8]. A Vcc1 terminal, separate from Vcc2, is provided for the logic inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0°C to 70°C. Table 1 shows the controlling sequence of dc motor using L293D.

Table 1. Controlling sequence of dc motor using L293D

S1	S2	S3	S4	Motor direction
1	0	1	0	Clockwise
0	1	0	1	Anticlockwise
1	1	1	1	No effect
0	0	0	0	No effect

Arduino IDE is an environment that consists of a message area, a simple text editor and menus. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. It allows the user to create the "sketches" in order to let the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package [9].

Arduino board interaction with the device which connected to it. The sketches that written by the user can be stored in sketchbook. Besides writing the program, it also allows user to compile and upload the sketches to the Arduino board. Furthermore, Arduino IDE has its own software library which called "Wiring". This library makes the common input output operation become easier. It uses the tool chain and AVR library to compile the program and uses the avrdude to upload the program to the Arduino board.

Arduino programming language is a simplified version of C or C++ programming language. It is encompasses strong typing, imperative, declarative, functional, generic, object-oriented and component-oriented programming disciplines. This programming language does not need to include the header file at the beginning of the coding. Besides that, there are only two functions are needed in order to make a cyclic executive program. Those functions are setup () and loop (). Setup () is the function that is used to initialize the settings and only runs once at the beginning of the program. While the loop () is the function that is called continuously.

Result

The Android app is generally developed using JAVA language but this Android app can also be build without knowing the Java language. This app was developed in "App Inventor" developed by MIT. This app inventor is designed specifically for Non – Computer Science students those who don't know the JAVA language. The figure shown below is the block diagram back- hand design for the application. The app shown below has 5 buttons and all the buttons gives 5 different bytes in the output that has to be fed to the Microcontroller to process. For eg. if we press forward button ,the Bluetooth Module will give 1 byte at its output as shown in the figure. The app consists of the option in the main screen whether to use the accelerometer of the phone or to use the buttons to control the Robot. This app inventor brings out the revolution in the Embedded Systems & Robotics. The app invented by this searches for the Bluetooth devices along with their MAC addresses. The user just has to select the particular MAC Address. When a particular MAC is selected, the status shown on the screen is "Connected". Now all the buttons are active and the app is now connected with the robot and mobile phone can control the robot. Fig. 3 shows the developed android frontend design.

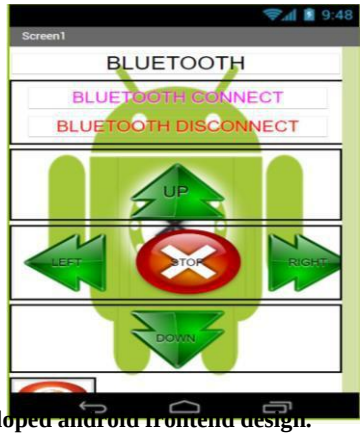

Figure 3. Developed android frontend design.

The next Block allows ListPicker1 to select and connect to the desired Bluetooth device and to set the "hidden" Label, Label1 to read "CONNECT BLUETOOTH". Fig. 4 shows MIT app inventor design to scan and pair the bluetooth device

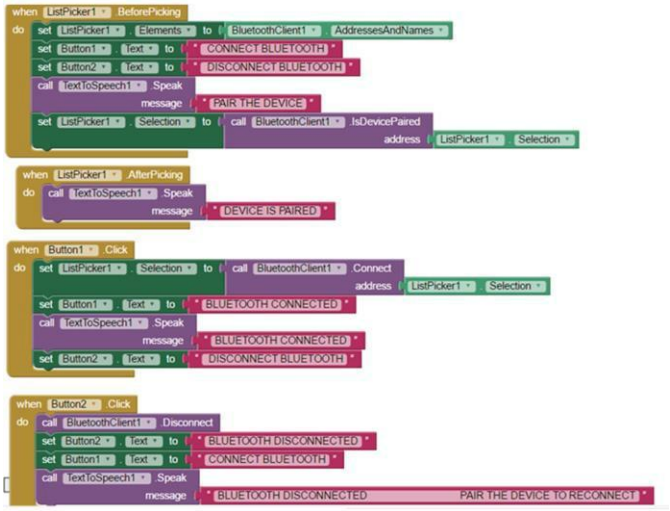

Figure 4. MIT app inventor design to scan and pair the bluetooth device of Label1 to be Green when the Bluetooth client is connected.

First make sure your HC-06 Bluetooth module is paired with your mobile. The default password for pairing is "1234" or "0000". Click on "BLUETOOTH" icon to select MAC address of the bluetooth module to be paired. The "CONNECT BLUETOOTH" button pair the selected bluetooth MAC address.

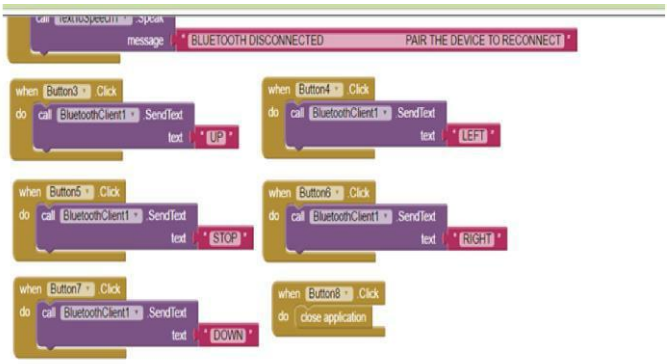

Figure 5. Character string send to bluetooth receiver by pressing the buttons

Fig. 5 shows the character string send to bluetooth receiver by pressing the buttons. When press "up arrow" it sends the data "UP" to Bluetooth module connected with the circuit. When microcontroller detects "UP" the robot/robot car moves FORWORD. When press "DOWN ARROW" it sends the data "DOWN" to Bluetooth module connected with the circuit. When microcontroller

detects “DOWN” the robot/robot car moves REVERSE. When press “LEFT ARROW” it sends the data “LEFT” to Bluetooth module connected with the circuit. When microcontroller defects “LEFT” the robot/robot car turns LEFT. When press “RIGHT ARROW” it sends the data “RIGHT” to Bluetooth module connected with the circuit. When microcontroller defects “RIGHT” the robot/robot car turns RIGHT. When press “STOP” button which is in the centre of remote it sends the data “STOP” to the Bluetooth module connected with the circuit. When microcontroller defects “STOP” the robot/robot car gets stopped. Click on “EXIT” icon to disconnect paired bluetooth and exit from the application.

First of all we give instruction from mobile phone. Then the Bluetooth modules will receive these instructions, the TX and Rx pins of Bluetooth modules are directly connected with Rx and TX pins of microcontroller and also Vcc and ground of Bluetooth modules will be connected to the 5V and ground of microcontroller. Motor driver connected to microcontroller to run the car, motor driver pins 2,7,10 and 15 will connected to digital pins 11,10,9 and 8 of microcontroller, we use two dc motor to drive the car one of it driver 6 and3 pins of motor driver and another connected to pins 11 and 14 of motor driver. Microcontroller receive the instruction from bluetooth inside the microcontroller there is CPU it has memory which understand only machine language so should convert analog signal into digital data then store inside the memory. Fig. 6 shows the proteus simulation of the developed system

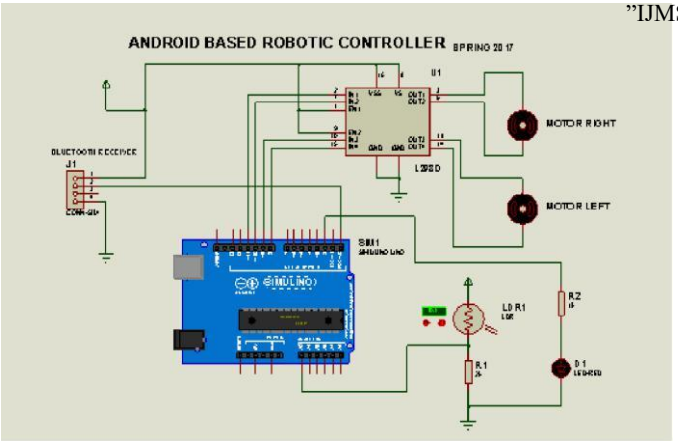

Figure 6. Proteus simulation of the developed system

Conclusion

The proposed system shows how the android smartphone can be used as remote controller for robot and various embedded technologies with the help of the Bluetooth technology. The proposed system also shows that how a robot can be used for travelling purpose. The operating system of smartphone is Android, and it can develop effective remote control program and by using WiFi wireless network, the communication between smartphone and robot can be realized, which makes it simple and convenient to control robot.

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