ANDROID CONTROLLED PICK AND PLACE ROBOTIC ARM VEHICLE

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Abstract -

The design analysis of an Android Controlled "Pick and Place" Robotic vehicle has been presented in this paper. This work unravels the fact that man would always want to adhere to safety precautions at workplace and even in its environment, to be able to handle some specific tasks, like sending the robotic vehicle to hazardous environment to obtain samples for chemical analysis. It is a microcontroller based control system which works in alliance with Android Application. It can be accessed by android application and the application can control the movement of vehicle as well as its robotic arms.

This system comprises of a Bluetooth module which work as the receiver for vehicle. This sends commands to the microcontroller which execute according to the signals received by Bluetooth.

In this work, the design of a robot is presented which will move around in four directions and is equipped with gripper for pick and place operation. These operations will be controlled by a user friendly interface present on operator's mobile phone. Depending upon the button clicked on the application, proper motional commands are given to robot by microcontroller. This project is in aimed to design and develop a mobile robot which can move according to the button pressed on App. This prototype can be employed in chemical industry for handling of chemical materials of hazardous nature, or for movement of heavy objects in any industry.

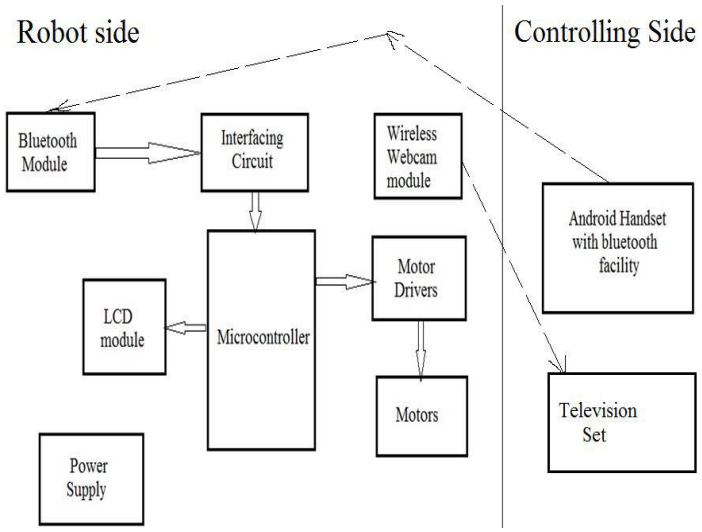
1. INTRODUCTION

The project is designed to develop a pick n place robotic vehicle with a soft catching gripper. The project is aimed to design and develop a pick and place robotic vehicle with a catching gripper. The project will include development of an android app and mobile robot which will be able to move objects from one place to another. Thus, controlling the vehicle remotely. Remote operation is achieved by any smart-phone/Tablet etc., with Android OS; upon a GUI (Graphical User Interface) based touch screen operation. This prototype will pave path for real life models using the same concept. [1]

The vehicle will be controlled by the android application device at the transmitting end, which will send signal i.e. ASCII code, to Bluetooth module (HC-05) which is employed as an interface between Mobile and vehicle (robot). The microcontroller is coded using AVR Studio for controlling of the motors, both to move the robotic vehicle and to control the gripping of the objects through the arm.

At the transmitting end using android application device, commands are sent to the receiver to control the movement of the robot either to move forward, backward and left or right etc. At the receiving end four motors are interfaced to the microcontroller where two for them are used for arm and gripper movement of the robot while the other two are for the body movement. The android application device transmitter acts as a remote control that has the advantage of adequate range, while the receiver end Bluetooth device is fed to the microcontroller to drive DC motors via motor driver IC for necessary work. Remote operation is achieved by any smart-phone/Tablet etc., with Android OS; upon a GUI (Graphical User Interface) based touch screen operation. The main advantage of this robot is its soft catching arm that is designed to avoid extra pressure on the suspected object for safety reasons.

2. Block Diagram



The project contain 2 sections

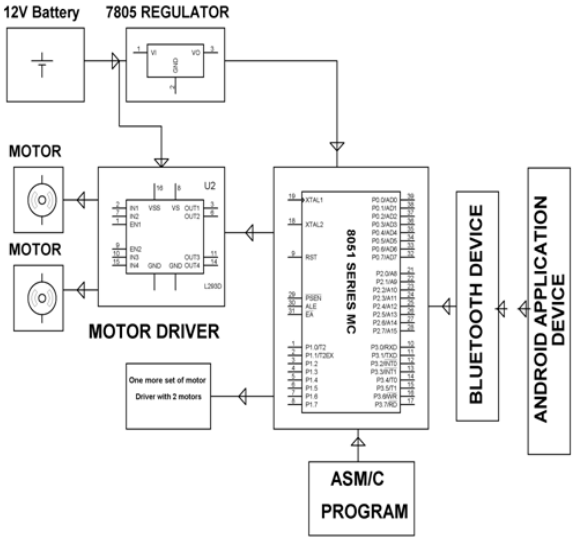
1. Robot (Receiver end)

2. Control section (Transmitting end)

The control section will be an Android cell phone which is having Bluetooth facility. The data to control the robot will be transmitted through the cell phone Bluetooth

There will be a Bluetooth module at the receiver end also. Both the Bluetooth should be paired each other. As soon as the data sent from the Bluetooth module at the transmitting end, it will receive at the receiver end. The microcontrollers compares the incoming data with the pre stored data and do the corresponding actions.

3. CIRCUIT DIAGRAM



It consists of an Atmega16 Micro controller IC, Bluetooth module, four DC Motors with driver IC and power supply. The pick and place robotic arm consists of a robotic arm placed on a moving vehicle. The vehicle is able to move along any type of surfaces irrespective of its smoothness or roughness. It uses two motors for the operation and a belt type tyre is attached to the vehicle like in the tanks, for the smooth and reliable operation. The pick and place robot uses four motors for the operation of the system, two for the operation of moving vehicle and two for the pick and place operation. The pick and place arm consists of an arm assembly with a jaw, which is only able to move in up and down direction. There are two motors for the arm assembly, one for the up and down motion and other for jaw opening and closing. The maximum upward and downward motion is limited by a mechanical push button type switches. It breaks the motor circuit when the arm is at its maximum position beyond which the motor does not rotate.

For the controlling of motor, motor driver IC and Atmega328 micro controller is used. The input signal or controlling signal is given from an android device, which is interfaced with the microcontroller by a blue tooth module. L293D has 2 set of arrangements where one set has input 1, input 2, output 1 and output 2 and other set has input 3, input 4, output 3 and output 4.

The program is so written i.e., while executed it sends commands to the motor driver IC as per its requirement for running the motor for the movement of the robot as explained in the subject above in L293D. The android phone screen is used for sending commands for left, right, forward and backward and centre is for stop through its inbuilt Bluetooth system.

12V battery powers the circuit in series with a diode D2 that nearly provides 5 through regulator IC LM 7805 for the microcontroller which has standard connections like crystal, reset arrangement indication LED etc. A blue tooth device being powered from a reversed biased Zener diode D1, is interfaced to the microcontroller that after being paired with any smart phone communicates with this Bluetooth device for taking appropriate action as per the touch operation made on the smart phone.

The work uses another motor driver IC working on similar technology for the arm up and down / open and close duly interfaced to the microcontroller with duly pulled up resistors. The program is so written that for touch screen operation from the smart phone results in command being sent through the Bluetooth module, on A=open, B=close, C=up and D=down number upon MC developing appropriate rotation of the motor.

Now we consider the operation of the ***soft catching arm.*** It senses pressure in the arm by measuring current. The motors used for an operation up and down and gripper operation open and closed pass through series resistor of 10 ohms/ 2 watt from the output of the second motor driver IC L293D.While motor is operating the returning current from Driver IC is grounded through this resistance. And the voltage across it is proportional to the current owing through it and this current is proportional to the load at the motor or pressure in the arm jaws. Thus by measuring the voltage we can measure the amount of pressure. The inbuilt ADC in the Atmega328 continuously measuring this voltage.

Thus, while motor operates in normal condition the running current results normal voltage drop across the 10R/2W ohm resistor as the motor can run in clockwise (or)anti-clockwise. When load increases the voltage across resistor get increased and is continuously monitored by micro controller. When it increases above a certain value, interrupt is produced thus stopping the motor. The program is so written that once interrupt zero occurs low, no such command would generate any input to the motor driver IC for any direction for that motor movement. Only

the other direction rotation is possible from the command. This helps in soft catching arrangement of the arm gripper.

3.1. COMPONENTS REQUIRED

(1) ATMEGA16A Microcontroller : To define the task of the four motors. To start or stop a motor according to the commands obtained from the android application device using a bluetooth module. [2]

(2) Bluetooth Module (HC-05) : To establish a connection between the android application device and the circuit. It basically incorporates a serial communication between the android application device and the circuit.

(3) L293D motor driver IC : It is a motor driving IC. We are using two L293D which can inculcate the working of two motors each. Since we need three motors, we are using two motor driving ICs.

(4) 7805,5V regulator IC : The various components used in the circuit operate at a voltage 5V but the input supply may be of either 12V or 9V. hence, we use a 7805 voltage regulator IC to convert the input voltage into desired voltage.

(5) Resistors 10-kilo-ohm

(6) Capacitors - 0.1µF , 33pF

(7) 16.0MHz Crystal Oscillator : It provides oscillation frequency to the microcontroller.

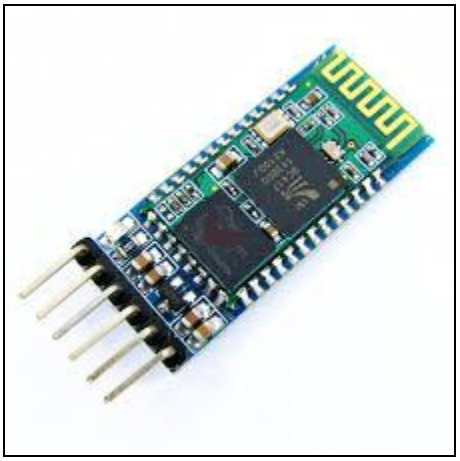
(8) 100 rpm DC Motor : This is a high torque motor which is basically being used here for the weight lifting purpose.

(9) 45 rpm DC Motor

3.2 BLUETOOTH MODULE HC05

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 Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm.



Bluetooth Module(HC-05)

Some of the features of the Bluetooth module HC 05 are :

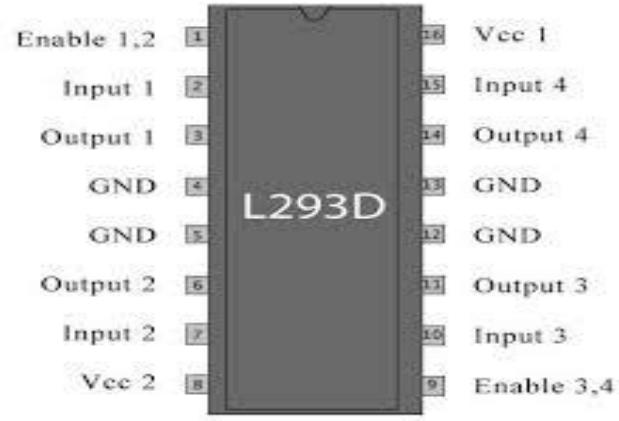
(1) Typical -80dBm sensitivity
(2) Up to +4dBm RF transmit power
(3) Low Power 1.8V Operation ,1.8 to 3.6V I/O
(4) PIO control
(5) UART interface with programmable baud rate
(6) With integrated antenna
(7)With edge connector

3.3 L293D MOTOR DRIVER IC

(1) L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

(2) L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

(3) Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.



Pin Diagram of L293D IC

4. INTRODUCTION TO ANDROID

Android is a mobile operating system (OS) currently developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smart phones and tablets. Android's user interface is based on direct manipulation, using touch gestures that loosely correspond to real-world actions, such as swiping, tapping and pinching, to manipulate on-screen objects, along with a virtual keyboard for text input. In addition to touchscreen devices, Google has further developed Android TV for televisions, Android Auto for cars, and Android Wear for wrist watches, each with a specialized user interface. Variants of Android are also used on notebooks, game consoles, digital cameras, and other electronics. As of 2015, Android has the largest installed base of all operating systems. It is the second most commonly used mobile operating system in the United States, while iOS is the first.

4.1 ANDROID APPLICATIONS

Applications ("apps"), which extend the functionality of devices, are written using the Android software development kit (SDK) and, often, the Java programming language that has complete access to the Android APIs. Java may be combined with C/C++, together with a choice of non-default runtimes that allow better C++ support; the Go programming language is also supported since its version 1.4, which can also be used exclusively although with a restricted set of Android APIs. The SDK includes a comprehensive set of development tools, including a debugger, software libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. Initially, Google's supported integrated development environment (IDE) was Eclipse using the Android Development Tools (ADT) plugin; in December 2014, Google released Android Studio, based on IntelliJ IDEA, as its primary IDE for Android application development. Other development tools are available, including a native development kit (NDK) for applications or extensions in C or C++, Google App Inventor, a visual environment for novice programmers, and various cross platform mobile web applications frameworks. In January 2014, Google unveiled an framework based on Apache Cordova for porting Chrome HTML 5 web applications to Android, wrapped in a native application shell.

Android has a growing selection of third-party applications, which can be acquired by users by downloading and installing the application's APK (Android application package) file, or by downloading them using an application store program that allows users to install, update, and remove applications from their devices. Google Play Store is the primary application store installed on Android devices that comply with Google's compatibility requirements and license the Google Mobile Services software.

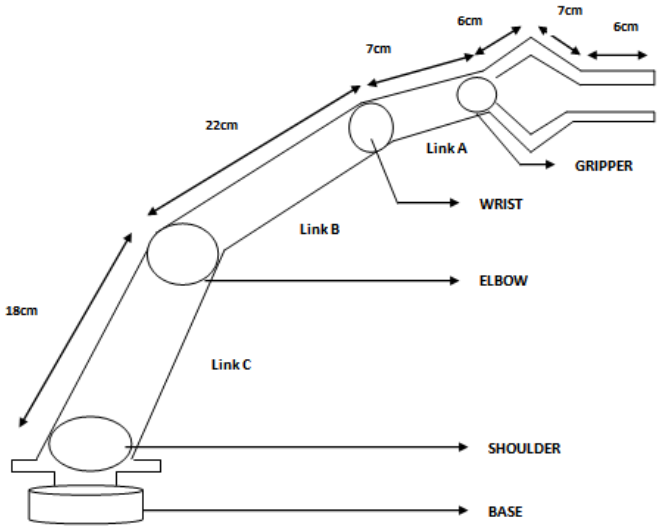
We in this project are developing the software in the Eclipse Software. The development of the app is divided into three parts :

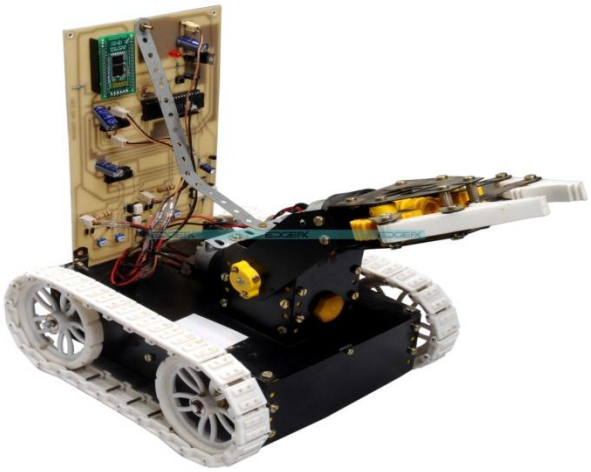
(1) Android Manifest : This section of the code deals with the permissions that the application has to take from the android application device or the mobile phone. Since, the application is using the Bluetooth feature of the device, it takes permission for the usage.

(2) XML File : This section of the code deals with the layout design of the application. For example, the position of the buttons and their function is incorporated in this section of the application coding.

(3) JAVA File : This section of the code incorporates main function of the application. This section deals with the main functions being performed by the application i.e. sending of ASCII codes to the Bluetooth module connected in the circuit. The communication is carried out using the UART feature of the Bluetooth module. Hence, the mode of communication is serial communication. [3]

5. Diagram of Robotic Arm





Prototype of Pick and Place robot

5. CONCLUSION

The project or the robot been made is a working prototype of the pick and place robotic arm vehicle. The prototype presently cannot handle much weight but after further developments and introduction of high torque motor in the circuit will help in picking up large weights, for e.g. , bombs.

Further developments like, introducing a wireless camera to the circuit may also lead to addition of various applications of the pick and place robot like, it can pick a bomb from a crowded place and place it at a place where least damage will occur to human life and property.

Even the usage of Bluetooth can be modified by using other connections like GSM or Zigbee which will be advantageous in the respect of range. Since, the range of Bluetooth is limited, it is now the limitation of out project which can be removed by using Zigbee which is efficient in terms of range.

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[3] Richard E. Pattis. Karel the Robot: A Gentle Introduction to the Art of Programming. John Wiley &Sons, 1981.