Android Mobile Phone Controlled Bluetooth Robot using Arduino

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Abstract— A robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Designing of the latest invented ROBOT which can be controlling using an APP for android mobile. We are developing the remote buttons in the android app by which we can control the robot motion with them. And in which we use Bluetooth communication to interface controller and android. Arduino Controller can be interfaced to the Bluetooth module though UART (Universal Asynchronous Receiver and Transmitter) protocol.

Key words: Smart Phones, Bluetooth, Android OS, Robot, Motor

I. OBJECTIVE

Nowadays smart phones are becoming more powerful with reinforced processors, larger storage capacities, richer entertainment function and more communication methods. Bluetooth is mainly used for data exchange; add new features to smart phones. A host Bluetooth device is capable of communicating with up to seven Bluetooth modules at same time through one link. The purpose of our research is to provide simpler robot's hardware architecture but with powerful computational platforms so that robot's designer can focus on their research and tests instead of Bluetooth connection infrastructure. Also a wireless FPV (First Person View) camera is used to view where the status of robot.

II. INTRODUCTION

The very primitive concept of smart phones is believed to have been envisioned back in the mid- 1970s, but that vision didn't come into fruition until 1992 when IBM first showed its face. Nowadays they come with richer entertainment Function, efficient communication methods and reinforced Processors. As Bluetooth is used for Data Exchange, it is through this data exchange capability that through Bluetooth, Devices are now being controlled and monitored. Bluetooth technology was created in 1994 by the telecom dealer "Ericsson" for integrating with Smart phones. But through the years, with dramatic increase in smart phone Users, Bluetooth has turned them into all-purpose portable devices by redefining the world of data exchange and transferring wired devices into wireless devices; capable of efficient communication and the fact that host Bluetooth device is capable of communicating with as many as seven Bluetooth modules simultaneously through one link is proof enough. Android is wide spread and influential in today's scenario, that using a smart phone as the 'brain' of a robot is already an active research field, providing a number of opportunities and possibilities. In this paper, we present a review of current robots, which are controlled by mobile phones and tablets. Specifically speaking robots which on receiving the commands can perform simple actions like moving in all four directions, by an Android application. Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals – has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely opensource, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide. Arduino has been used in thousands of different projects and applications.

Fig. 1: Bluetooth Controlled Robot

The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to

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experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

Maximum of seven slaves can share a common master through a same link. Even several piconet can link together and form scatternet. It is useful in home environments, looking at its range or normal working area be 8 meters.

Bluetooth has gradually increased users to prosecute smart phones, which have gingerly turned into a multipurpose portable device and are accessible to people for their quotidian use.

Present day, android is widely accepted as an open source platform. Android consist of a complete package involving an operating system, middleware layer and core applications. A Smartphone is a cell phone built on a mobile computing platform, which has big number of boosted connectivity and computing ability than what a feature phone has.

In this paper, we are overcoming the problem of traditional robots, which are usually handled with any remote controller. Reducing the remote work we are making the robot move by just a click on the cell phone with android operating system. The basic problem was a remote controller and batteries for the remote, which will be replaced by an android app. And further we are minimizing the power required to transfer any object from one place to another which can easily be transferred by the robot. Even the robot will be able to avoid crashing with other hardware cause of a sensor build inside the system.

III. PURPOSE

The purpose behind this research is to design a robot for the transfer of data from one end to other in firms to make the information movement easier by just a tap on phone, with the help of an android application on one's cell phone. The android app will help the robot to move in different direction and transfer the material intended, in fact it will help the robot to not collide with any paraphernalia, as the distance of the obstacle will continuously get displayed on the screen of the app. 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.

IV. BACKGROUND

A. Motor Driver (L293D)

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).

This driver drives small as well as quite big motors, and it works on the concept of H-bridge circuit which allows the voltage to be flown in any direction. H-bridge is ideal for driving a DC motor as the voltage needs to change the direction of the motor to make it move it in either clockwise or anti-clockwise direction.

L293D pin diagram consist 4 input pins, 2, 7 are the left pins and 15, 10 are the right pins these pins regulate the rotation of the motor in either left side or right side. Inputs are given as Logic 0 (low) and Logic 1 (high), for rotating the motor the low and high signals are provided. It has Vcc pin where voltage required for internal operation is specified maximum of 5V supply can be provided. Vss or ground pin is there where we can apply voltage for driving the motor, maximum of 36 V supply can be applied. Maximum of 600mA current per channel can flow in the circuit.

B. Arduino Uno

UNO is a microcontroller based on ATmega328P. It has 14 digital input-output pins; 6 pins are for PWM outputs, 6 pins act as analog input pins. 16 MHz crystal USB connector power jack is attached, consist of LCSP header and reset button. UNO contains everything needed to support any normal microcontroller (µC). In UNO connections can be established by connecting Arduino to personal computer with a USB cable, power with AC to DC adapter can be provided or battery to get started. Arduino is a firm which design hardware, µC based kits for building digital devices and interactive objects that can percept and control physical devices. It establish a serial communication interface for loading programs from PC through USB.

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring) and the Arduino Software (IDE) based on Processing.

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C. DC Motor

DC motors are part of the electric motors using DC power as energy source. These devices transform electrical energy into mechanical energy. The basic principle of DC motors is same

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as electric motors in general, the magnetic interaction between the rotor and the stator that will generate spin.

Electric Motors produce Mechanical movements by taking in the electrical energy and producing equivalent mechanical energy. Hundreds and thousands of devices are powered by electrical motors- from small pick-and-place robots to big turbines- motors find applications in every industry.

D. Bluetooth Module (HC-05)

This is used for establishing Bluetooth connectivity, it is easy to use Bluetooth SPP (special pot protocol) module. It setup a transparent wireless serial connection. HC-05 is a fully qualified Bluetooth supporting V2.0+EDR(enhanced data rate), 3Mbps modulation, 2.4 GHz baseband and use CSR Blue core 04- External single chip Bluetooth system. Its footprint is very small limiting up to 12.7 mm X 27 mm, its default baud rate is 38400. It underpin master and slave concept, and if the master and slave are paired then red and blue LEDs on the module blinks at 1 time per 2 seconds in interval and if disconnected blue LED blinks for 2 times per second. Its auto pairing pin code is "0000" as default and it automatically reconnect in 30 min when disconnected because of exciding the range of connection.

It is a Bluetooth Serial Module which converts Serial port to Bluetooth and works in either of the two modes: Master and Slave. The device named after even number can operate in slave mode and this configuration can't be changed. But for the device named after odd number, the users can set the work mode (master or slave) of the device by AT commands, as an example, between two Arduino boards, one acts as the Master, the other is the Slave. It is a Bluetooth SSP (Serial Port Protocol) module which communicates with Arduino via Serial communication. It needs a power supply of 3.6V to 6V. Bluetooth Serial Module is primarily used for replacing the serial port line. This can be achieved when the Bluetooth master device is connected to the Slave device, resulting in the formation of a pair. It is through this Bluetooth connection that the RXD and TXD signals are sent and received. To communicate with the Bluetooth adapter of other computers and smart phones, the MCU has to be in the Bluetooth slave module, the conditions being:

- The communication must be between Master and Slave.
- The password must be correct.

E. Arduino IDE

IDE is an integrated development environment based on programming language named as Processing, it also support C and C++. It basically is a cross-platform application written in JAVA. IDE is basically for software programming of any hardware board or IC. This code editor have following features: Syntax highlighting, brace matching, automatic indentation, one-click mechanism for loading and compiling of the programs on the Arduino board. In IDE program written is known as Sketch. C/C++ sketch consist of two functions which are compiled and amalgamate with a program stub main ().

- Setup (): this function runs at the beginning or starts of the program and even initializes the settings.
- Loop (): this function is called repeatedly until the board power is cut-off.

F. Android Platform

Android is a mobile operating system developed by Google based on Linus Kernel and is mostly wield with touch screen smart phones .Android platform is reliable for building an android application, android is a common choice of people while they buy any cell phone. Android provides easy accessibility and understandability of different aspects for daily use. They are widely known as mobile computers and are expanding the sale of smartphones worldwide. They are widely accepted as they provide open architecture, platform independent and enormous capabilities. It is built from JAVA programming language and as android uses JAVA, android API provides easy access for hardware components. Android may use USB, Wi-Fi and Bluetooth for connecting with the robot.

Android Studio: For building an android app android studio is looked for, android studio is an Integrated Development Environment (IDE) for android app development. The first stable build was released in December 2014, starting from version 1.0, based on JetBrains IntelliJ IDEA software, Android Studio is designed specifically for Android app development. It can be downloaded at Windows, Mac and Linux smoothly, and replaced Eclipse Android Development Tools (ADT) which is Google's primary IDE for indigene application development. It has Gradle based build support, Lint tools to catch performance and version compatibility. Android studio is a well-to-do layout editor which allows users to drag-and-drop UI components, and even provide user with option to preview layouts on multiple screens.

G. Wireless Camera

Wireless security cameras are closed-circuit television cameras that transmit a video and audio signal to a wireless receiver through a radio band. Many wireless security cameras require at least one cable or wire for power "wireless" refers to the transmission of video/audio. However, some wireless security cameras are battery-powered, making the cameras truly wireless from top to bottom.

Wireless cameras are proving very popular among modern security consumers due to their low installation costs, there is no need to run expensive video extension cables and flexible mounting options wireless cameras can be mounted/installed in locations previously unavailable to standard wired cameras. In addition to the ease of use and convenience of access, wireless security camera allows users to leverage broadband wireless internet to provide seamless video streaming over-internet. Wireless cameras are also ideal for people renting homes or apartments. Since there is no need to run video extension cables from the camera to the receiver or recording device through walls or ceilings one does not need approval of a landlord to install a wireless security camera system.

Analog wireless is the transmission of audio and video signals using radio frequencies. Typically, in analog the wireless has a transmission range of around 300 feet (91 meters) in open space; walls, doors, and furniture will reduce

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this range. Analog wireless is found in three frequencies: 900 MHz, 2.4 GHz, and 5.8 GHz. Currently, the majority of wireless security cameras operates on the 2.4 GHz frequency. Most household routers, cordless phones, video game controllers, and microwaves operate on the 2.4 GHz frequency and may cause interference with your wireless security camera. 900 MHz is known as Wi-Fi Friendly because it will not interfere with the Internet signal of your wireless network. Wi-Fi is a wireless local area network that enables portable computing devices to connect easily to the Internet.

Wireless Range: Wireless security cameras function best when there is a clear line of sight between the cameras and the receiver. Outdoors, and with clear line of sight, digital wireless cameras typically have a range between 250 to 450 feet. Indoors, the range can be limited to 100 to 150 feet. The signal range varies depending on the type of building materials and or objects the wireless signal must pass through.

H. TFT-LCD Display

An LCD is made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time.

Full TFT-LCD Device Characterization: Non-destructive characterization of the different parts of the TFT-LCD device was successfully carried out by Spectroscopic Ellipsometry (SE). The ellipsometric data were collected at an angle of incidence of 70° using the Jobin Yvon UVISEL NIR (260-1700 nm).

The UVISEL Spectroscopic Phase Modulated Ellipsometer is a unique instrument that provides significant advantages for display applications when compared to conventional ellipsometers. Its technology is the most suitable for accurate thin film measurement on transparent substrates as the software includes advanced capabilities for automatic correction of backside reflections.

TFT Device Design: The most common TFT design called inverse staggered structure is presented below. This structure presents the advantages of a simple fabrication process and high electron mobility. In the TFT array fabrication process the first step consists of gate and storage-capacitor electrodes construction with 2000-3000 A of a metal such as aluminum, chromium, tantalum or tungsten layer deposition. Then a triple layer of silicon nitride and amorphous silicon is deposited using PECVD. The 1st part of the device consists of a glass substrate covered with an ITO layer and a polymer layer. ITO is a semi-transparent conducting material which exhibits absorption in the FUV and NIR and is known to be inhomogeneous due to the deposition method or post-treatments. A graded layer model has to be taken into account in the model. Refractive index and thickness of each layer were accurately characterized from 0.75 to 4.5 eV.

V. DESIGN AND IMPLEMENTATION

The robot is made up of an Arduino board, motor driver, 2 DC motors, Bluetooth module HC-05 & wireless camera. Firstly the data from the android app is sent as an input to the Bluetooth module which further gives it to the Arduino Uno, Uno is a controller which controls the signals and performs the assigned functions it understands which signals have to be forwarded to the motor driver so that it moves in particular order. Like in if the users have tapped the left button on the app the Arduino will send the signal to the motor driver to activate the left pins and accordingly move the motors so that the wheels can follow the direction.

As shown in the block diagram, User give directions through the app to the microcontroller with the help of Bluetooth module, then Arduino handles the motor driver which further supports the dc motors and enable the high signal at specific motor pins. The motor driver has several pins and those pins are for power supply, ground, and each dc motor have its own respective pins which when gets a high signal activates the dc motor, like pins 5,6 for the left motor and 9,10 for the right motor.

A. Controller Code

The Arduino Uno board works according to the code burnt on it, code is burnt on the board with the help of software. In code we specify maximum and minimum range of the sensor, input is taken from the Echo pin while output is sent to Trigger pin which is tied to the ping sensor or echo pin.

- In code we specify maximum and minimum range of the sensor, input is taken from the Echo pin while output is sent to Trigger pin which is tied to the ping sensor or echo pin.
- Now with digital Write(pin, signal); command we give signals to the pin mentioned. For e.g.: digital Write (5,HIGH); will produce a high signal on pin number 5.
- A series of "IF" conditions is given for different directions: if(input ==''f"); this will put a case when the f key is pressed the code will execute this if statement.

The high low signal works like if the high signal is given it moves the wheel in front and if low then backwards. Pins 5 of left motor & 10 of right motor are responsible for moving in forward while pins 6 of left motor & 9 of right motor are responsible for moving backward.

- For moving forward both motors receive high signal on pins 5, 10 and low signal on pins 6, 9.
- For moving backward both motors receive high signal on pins 6, 9 and low signal on pins 5, 10.
- For moving in the right direction we need left motor to move in forward direction & right motor to move in backward direction, so we will enable high signal at pins 5&9 and low signal at pins 6&10.
- For moving in the left direction we need right motor to move in forward direction & left motor to move in backward direction, so we will enable high signal at pins 6&10 and low signal at pins 5&9.

For stop we will give low signal to all the pins.

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B. Arduino Code Implementation

```
/*
Project: Control RC Car via Bluetooth with Android Smartphone
More information at www.ardumotive.com
//L293 Connection
const int motorA1 = 5; // Pin 2 of L293 const int motorA2 = 6; // Pin 7 of L293 const int motorB1 = 10; // Pin 10 of L293 const int motorB2 = 9;
// Pin 14 of L293
//Leds connected to Arduino UNO Pin 12 const int lights = 12;
//Buzzer / Speaker to Arduino UNO Pin 3 const int buzzer = 3 ;
//Bluetooth (HC-06 JY-MCU) State pin on pin 2 of Arduino const int BTState = 2;
//Calculate Battery Level
const float maxBattery = 8.0;
// Change value to your max battery voltage level!
int perVolt;          // Percentage variable
float voltage = 0.0;          // Read battery voltage
int level;
// Use it to make a delay... without delay() function!
long previousMillis = -1000*10;
// -1000*10=-10sec. to read the first value. If you use 0 then you will take the first value after 10sec.
long interval = 1000*10;   // interval at which to read battery voltage, change it if you want! (10*1000=10sec)
unsigned long currentMillis;          //unsigned long currentMillis;
//Useful Variables
int i=0;
int j=0;
int state;
int vSpeed=200; // Default speed, from 0 to 255 void setup()
 {
Set pins as outputs: pinMode(motorA1,OUTPU);
pinMode(motorA2,OUTPUT);          pinMode(motorB1, OUTPUT);
pinMode(motorB2,OUTPUT);
pinMode(lights, OUTPUT); pinMode(BTState, INPUT);
Initialize serial communication at 9600 bits per second: Serial.begin(9600);
}
void loop()
 {
//Stop car when connection lost or bluetooth disconnected
if(digitalRead(BTState)==LOW) { state='S'; }
//Save income data to variable 'state' if(Serial.available() > 0)
{ state = Serial.read();
}
```

Fig. 2: Interfacing Mobile and Bluetooth

C. Application Instructions

- The application is generated through android studio. Just after getting started, app asks to enable the Bluetooth unless and until the Bluetooth module HC-05 is not connected, the app will not be able to move the robot.
- Console page consist of 5 buttons named as LEFT, RIGHT, FORWARD, BACKWARD & STOP. On pressing these buttons one can move the robot in the specified direction, for example on pressing Right the app will send an R output to the controller which will then process the signal and give the input to motor driver. While pressing the stop button the robot will stop its movements.
- Lastly, an OK button is provided so once the robot stops and there are no further directions to be given user can click the button which will disconnect paired Bluetooth module.

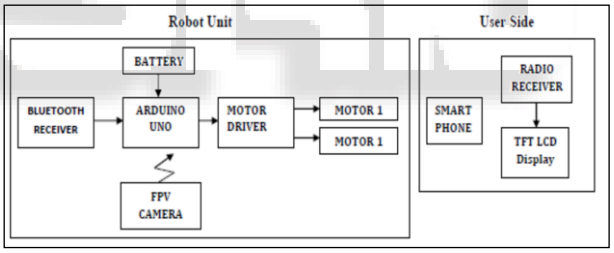

Fig. 3: Block Diagram

VI. CONCLUSION

The purpose of writing this paper is to introduce a hardware system which can transfer small requirements from a room to another by just tapping on one's mobile screen. The hardware here introduced is a compound robot which is handled by an android application, the connectivity between the robot and the app is done by HC-05 Bluetooth module, which provides 5 meters range from its current position. Completion of this project will bring a new product to the world to increase speed and efficiency. Thus it is concluded as by introduction of any such robot will enhance smart work and one can control their task remotely and wirelessly.

VII. FUTURE ENHANCEMENT

Range of connectivity can be increased by using Wi-Fi. As of now we are using Bluetooth module which can be replaced by Wi-Fi module. And can extend range by installing routers on short distances. Additional features can be added like to

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handle robot by voice commands, this is achieved by adding speech recognition module.

Movements and features of robot can be increased, by rotating it, and providing it diagonal movements. Camera can be attached and robot can be utilized in order to be used like a spy. More type of information and data can be transferred, head count in a room can be established, face recognition can be made, and by removing user id and password, login can be performed by checking finger prints.

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