

## Design and Implementation of Wireless Mobile Robotic arm Controller based Smart phone and Embedded System via Bluetooth

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### Abstract

Embedded systems have received significant attention during the last decade mainly because of their numerous applications. They can be found in robotics, smart buildings, fabrication equipment, automation, industrial, commercial, military applications as well as medical. Most of the modern embedded systems are based on microcontrollers. The purpose of this research is to design and implement a pick and place objects mobile robotic arm based android controlling via Bluetooth by using Arduino microcontroller. 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, back ward and left or right etc. At the receiving end seven motors are interfaced to the microcontroller where five of them are used for arm and gripper movement of the robot while the other two are for the body movement of the vehicle.

**Key words:** robotic arm, android controlling, Bluetooth, Embedded system

### INTRODUCTION

Robots are smart machines that can be programmed and used in many areas such as manufacturing, industry, production lines, or health, etc (Prof. Ramesh kagalkar, 2016) These robots performs hard, dangerous, and accurate work to facilitate our life and to increase the production because they can work 24 hours without rest, and performs like human but more precisely and with less amount of time (Ph. D. Rahul Kumar, 2016). Assistive mobile robots that perform different kinds of work over everyday activities in many areas such as industry, product lines, manufacturing, or health, etc are very commonly used to improve our life. The idea behind this research is to exploit robotics usage in household work (Sentil Kumar, S., 2015).

A Smartphone is a mobile phone built on a mobile computing platform, which has more advanced connectivity and computing ability than what a feature phone has. (Priya Khachane, 2016). Nowadays, Modern smart phones are embedded with Bluetooth module, accelerometer sensor and are powered by different operating systems such as Symbian, Bada, and Android OS etc. Among all available mobile operating systems Android OS has gained significant popularity after being launched in 2008 (Piyush, V., 2015).

#### 2. Related Works:

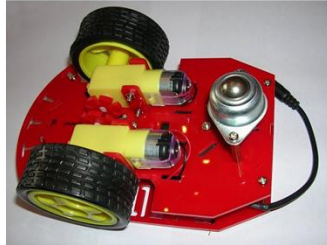
- M. A. K.Yusoff presented the development of a wireless mobile robot arm. A mobile robot that functional to do pick and place operation and be controlled by using wireless PS2 controller. It can move forward, reverse, turn right and left for a specific distance according to the controller specification. The development of this robot is based on Arduino Mega platform that interfaced with the wireless controller to the mobile robotic arm (Mohd Ashiq Kamaril Yusoff, 2012).
- M. J. Mohamed described the construction of a rover mobile robot which was used to follow the resultant optimal path from the global path planning technique. A remote computer is used to control the motion of the mobile robot and to upload the data of the path wirelessly. The control (positioning and directing) of the robot is based on the readings of two wheel encoders. The current direction and position of the robot are calculated relatively to its previous direction and position. The control algorithm is capable to move the mobile robot in order to follow a certain path (Dr. Mohamed Jasim Mohamed, Mustaffawaad Abbas, 2013).
- V. R. Kale presented a mechatronics color sorting system solution with the application of image processing. Image processing procedure senses the objects in an image captured in real-time by a webcam and then identifies color and information out of it. This information was processed by image processing for pick-and-place mechanism (Vishnu, R., 2013).
- P.Jain presented designing the RF based spy robot which involves wireless camera. So that from it can examine rivals when it required. This robot can quietly enter into enemy area and sends the information via wireless camera. On the other hand one more feature is added in this robot that is color sensor. Color sensor senses the color of surface and according to that robot will change its color. Because of this feature this robot can't easily detected by enemies. The movement of this robot is wirelessly controlled by a hand held RF transmitter to send commands to the RF receiver mounted on the moving robot (Prerna Jain, 2014).
- A. Ronank designed a prototype consists of robotic arm along with grippers capable of moving in the three axes and an ATMEGA 8 microcontroller. Software such as AVR Studio is used for programming, PROTESUS is used for simulation and PROGISP is used for dumping the program. RFID is used for identifying the books and it has two IR Sensors for detecting the path. This robot is about 4 kg in weight and it is capable of picking and placing a book of weight 1 kg (Anusha Ronanki and M. Kranthi, 2015).

#### 3. Robotic System Design:

The proposed hardware mobile robot consists of two parts the robotic arm and robot plate form. The robotic system is controlled with arduino microcontroller board which is the brain of the robot receive the data from smart phone via Bluetooth and send signals to the DC motors according to the received command. The direction rotation of DC motors controlled based H-bridge circuit.

### 3.1 Assembling the Chassis:

The chassis used for this thesis is known as Magician Chassis, which is widely used for robotics project. It is a very simple robot platform which consists of two gear motors and wheels as shown in figure 1.



**Fig. 1:** Magician Chassis (Robotic platform).

### 3.2 Robotic Arm:

Arms are types of jointed robot manipulator that allow robots to interact with their environment. Many have onboard controllers or translators to simplify communication, though they may be controlled directly or in any number of ways. Due to this fact, standalone arms are often classified as full robots. The robot used in this research is 4DOF (degree of freedom) as shown in figure 2.



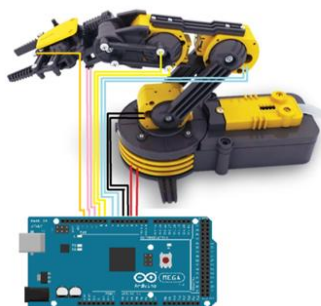
**Fig. 2:** 4DOF robotic arm.

### 3.3 Microcontroller Board:

The Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. In simple terms, the Arduino is a tiny computer system that can be programmed with your instructions to interact with various forms of input and output. The Arduino used in this research is Arduino Mega because it has 54 digital pins can be used as an input or output in addition it has four serial ports can be used for data interfacing with smart phone, as shown in figure 3. The robotic arm interfaced with Arduino as shown in figure 4.



**Fig. 3:** Microcontroller board (Arduino mega).



**Fig. 4:** Interfacing robotic arm with Arduino.

### 3.4 H-Bridge DC motor Driver circuit:

An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards. The term H-Bridge is derived from the typical graphical representation of such a circuit, as shown in figure 5. In this research seven H-Bridge circuit has been designed because there are seven DC motors in the robotic arm five for the arm and two DC motors for platform moving. The interfacing of H-Bridge with Arduino shown in figure 6.

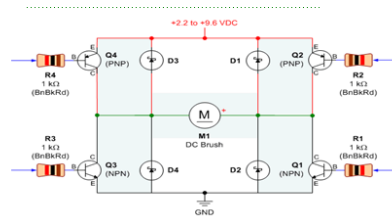


Fig. 5: H-bridge circuit for controlling the direction of rotation of DC motors.

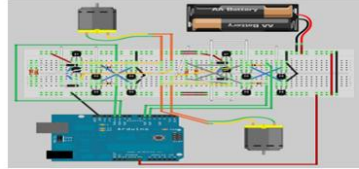


Fig. 6: Circuit diagram of interfacing DC motors of robotic arm with Arduino via H-bridge circuit.

### 3.4 Bluetooth interfacing Board:

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization. Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 20,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. Bluetooth was standardized as IEEE 802.15.1. HC-06 Bluetooth 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). It has the footprint as small as 12.7mmx27mm. The prototype implementation of robotic arm interfacing circuit with Arduino and Bluetooth shown in figure 7.

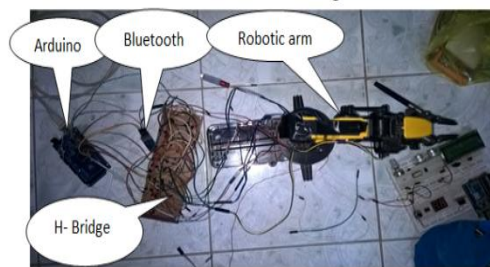


Fig. 7: Interfacing DC motors of robotic arm with Arduino via H-bridge and Bluetooth circuit.

### 4. Software system design:

There are two software used in this project one for Arduino by using C programming for controlling the robotic arm and interfacing with Bluetooth via serial port. A sample of instructions for controlling left motion of mobile robotic arm shown below.

```
void setup() {
  pinMode(2,OUTPUT); // set Arduino pin 2 as output
  pinMode(3,OUTPUT); // set Arduino pin 3 as output
  pinMode(4,OUTPUT); // set Arduino pin 4 as output
  pinMode(5,OUTPUT); // set Arduino pin 5 as output
  Serial.begin(9600); // enable Arduino serial port with baud rate 9600bps
}

void loop() {
  if(Serial.available()>0) // if serial data available from Bluetooth
  {state = Serial.read();} // store data in variable (state)
  if(state == 'LEFT'){
    digitalWrite(2,LOW);
    digitalWrite(3,HIGH); //if data= left then left DC motor rotate clockwise and right DC motor rotate counter clockwise
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);}
}
```

The another software is using an open-source Android Development Tools (ADT), Android SDK (Software Development Kit) and Java Development Kit (JDK), these open-source software packages Bluetooth server application is developed in Java using the Eclipse integrated development environment (IDE) which ensures the easy and quick development of the application. The proposed application on the Android phone is based on J2SE architecture and Bluetooth network technology.

Android provides Bluetooth Adapter class to communicate with Bluetooth. Create an object of this calling by calling the static method *get Default Adapter()*. Its syntax is given below.

```
Private Bluetooth Adapter BA;
BA = Bluetooth Adapter.get Default Adapter();
```

In order to enable the Bluetooth of your device, call the intent with the following Bluetooth constant *ACTION\_REQUEST\_ENABLE*. Its syntax is given below.

```
Intent turnOn = new Intent(BluetoothAdapter.ACTION_REQUEST_ENABLE);
Start Activity For Result(turnOn,0);
```

Once you enable the Bluetooth, you can get a list of paired devices by calling *get Bonded Devices()* method. It returns a set of bluetooth devices. Its syntax is given below.

```
private Set<Bluetooth Device>paired Devices;
paired Devices = BA.get Bonded Devices();
```

In order to control the robotic arm action with button touching the following codes for each action.

```
b1=(Button)findViewById(R.id.button);
b1.setOnClickListener(new View.OnClickListener(){
@Override
public void onClick(View v){
TextView txtView=(TextView)findViewById(R.id.textView);
txtView.setTextSize(25);}});
<Button
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:text="LEFT"
android:id="@+id/button"
android:layout_below="@+id/imageButton"
android:layout_centerHorizontal="true"/>
```

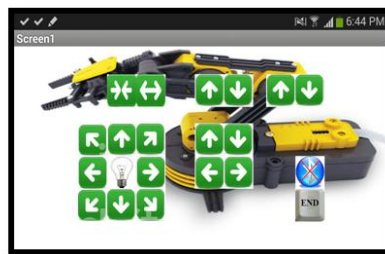
Followings are the steps to build the application:

- Set up Bluetooth adapter.
- Find surrounding Bluetooth devices in the range.
- Connect to the Bluetooth devices.
- Exchange data between the master and the slave devices.

The Android Bluetooth APIs are available in Java SDK *Android Bluetooth* package.

The android software for controlling robotic arm shown in figure 8, and the interfacing of robotic arm with android application shown in figure 9.

The final system design of the project shown in figure 10.



**Fig. 8:** Android software for controlling robotic arm.



**Fig. 9:** Interfacing smart phone with Arduino via Bluetooth.



**Fig. 10:** Final system design of mobile robotic arm.

#### Conclusions:

A Pick and place robot controlled by an Android application has been designed and implemented. The Android operating system as well as Arduino software are open source software. The Pick and place robot is controlled wirelessly by an Android application through a Bluetooth module with flexible and easy to control. The main feature of this pick and place robot is the soft catching arm or soft catching Gripper. This robot can handle the object up to 100gm and can be developed to handle explosive items like a bomb; it should be handled carefully by adding higher sensitivity than mechanical pressure sensors and suitable DC motors.

#### REFERENCES

- Prof. Ramesh kagalkar, 2016." A survey on new approach for robotic arm functioning using android mobile",International Journal of Emerging Technology and Computer Science, 1-4.
- Ph. D. Rahul Kumar, 2016." Android Phone controlled Bluetooth Robot", International Research Journal of Engineering and Technology (IRJET), 03-04.
- Sentil Kumar, S., 2015." Robotic Arm Control through Internet/LAN for Patient Operation", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 4(7): 6289- 6296.
- Priya Khachane, Anuradha Nair and Prof. Sanchali Kshirsagar, 2016. "Improved Efficiency in Agriculture with Smartphone Operated Robot", International Journal of Innovative Research in Computer and Communication Engineering, 4(1): 251- 258.
- Piyush, V., Savaliya, Sunil B. Somani and Virendra V. Shete, 2015. " FPGA Based Real Time Bluetooth Communication for Tele health, Household Security and Industry Safety", International Journal of Innovative Research in Computer and Communication Engineering, 3(8): 7209- 7215 .
- Mohd Ashiq Kamaril Yusoff, 2012. Reza EzuanSamin, and Babul Salam Kader Ibrahim, "Wireless Mobile Robotic Arm", International Symposium on Robotics and Intelligent Sensors, 41: 1072-1078, (IRIS 2012).
- Dr. Mohamed Jasim Mohamed, Mustaffawaad Abbas, 2013. "Practical Application and Construction for Mobile Robot", Eng. &Tech. Journal, 31, Part (A), No.14.
- Vishnu, R., Kale, and V.A. Kulkarni, 2013. "Object sorting system using robotic arm", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2-7.
- Prerna Jain, Pallavi N. Firke, Kalyanee N. Kapadnis, Trupti S. Patil and Sonali S. Rode, 2014. "RF Based Spy Robot",Journal of Engineering Research and Applications, ISSN : 2248-9622, 4-4( Version 2): 06-09.
- Anusha Ronanki and M. Kranthi, 2015. "Design and Fabrication of Pick and Place Robot to Be Used in Library", International Journal of Innovative Research in Science, Engineering and Technology, 4-6.