

# Android Phone controlled Bluetooth Robot

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**Abstract** – Robot is a reprogrammable, multifunctional device which is primarily designed to do work like human such as pick and place, loading and unloading, surveillance, health care, industrial, aerospace application. Robots can perform dangerous and accurate work to increase the productivity as they can work 24 hours without rest. This paper deals with the design and control of automated vehicle type robot which can move in desired direction and captures pictures and videos of required location. An android application has developed using MIT App inventor and a bluetooth communication is made with robot which interfaces with microcontroller to control its speed and direction. Aim of this work is to design and control the motion of robot using bluetooth device of an Android phone.

**Key Words:** Bluetooth device, GUI (Graphical User Interface), Android OS, Smartphone, Microcontroller.

## 1. INTRODUCTION

A robot is an electromechanical machine that is controlled by computer program to perform various operations. Industrial robots have designed to reduce human effort and time to improve productivity and to reduce manufacturing cost. Today human-machine interaction is moving away from mouse and pen and becoming much more pervasive and much more compatible with the physical world. Android app can control the robot motion from a long distance using Bluetooth communication to interface controller and android. Microcontroller ATMEGA328P-PU can be interfaced to the Bluetooth module though UART protocol and code is written in embedded C language.

As per the commands received from android app the robot motion can be controlled. The output motion of a robotic vehicle is accurate and repeatable. Pick and Place robots can be reprogrammable and tool can be interchanged to provide for multiple applications. The purpose of this work is to design and implement an Android Controlled Bluetooth Robot which is used for Surveillance, home automation, wheelchairs, military and hostages Rescue applications.

## 2. SYSTEM DESIGN AND ARCHITECTURE

### 2.1 Arduino Uno Board

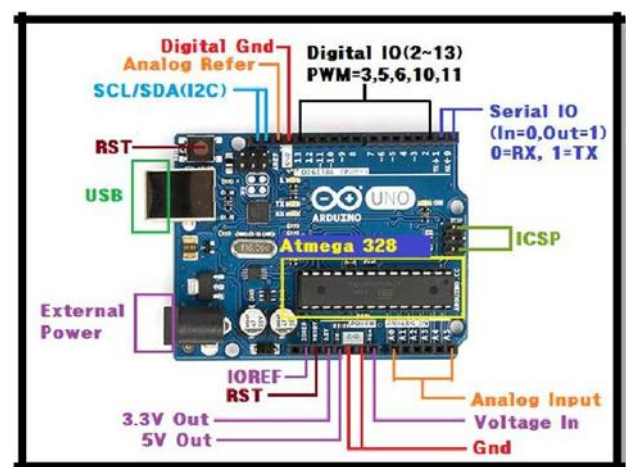


Fig.-1: Arduino Uno R3

This is the brain of robot loaded by a program written in embedded c language to do the required functioning and is interfaced with bluetooth module. The motor driver is used to make the system work as required.

### 2.2 DC Motor



Fig. -2: DC Motor

HC -05 Bluetooth module.D.C. motor is controlled by DC voltages and moves in forward, backward, left and right, direction according to the polarity of voltage applied. Mostly all mechanical movement which robot performs is accomplished by an electric motor. Electric machines are means of converting energy into mechanical energy. Electric motor is used to power devices. An example of small motor applications such as motors used in automobiles, robot, hand power tools and food blenders. Micro-machines are electric

machines with parts the size of red blood cells and find many applications in medicine.

### 2.3 Uart

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. 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.

### 2.4 L293D Motor Driver IC

Microcontroller cannot supply the current required to run DC motor. So satisfy this requirement IC's are used to drive the motor. The L293 and L293D are quadruple high-current half -H drivers. The L293D provides 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 bipolar 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. 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.

### 2.5 Working of L293D

The 4 input pins for this L293d, pin 2, 7 on the left and pin 15, 10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1. In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

### 2.6 L293D Logic Table

Consider a Motor connected on left side output pins (pin 3, 6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

Pin 2 = Logic 1 and Pin 7 = Logic 0 | Clockwise Direction

Pin 2 = Logic 0 and Pin 7 = Logic 1 | Anticlockwise Direction

Pin 2 = Logic 0 and Pin 7 = Logic 0 | Idle [No rotation]

Pin 2 = Logic 1 and Pin 7 = Logic 1 | Idle [No rotation]

In a very similar way the motor can also operated across input pin 15, 10 for motor on the right hand side.

Consider a Motor connected on right side output pins (pin 11, 14). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

Pin 15 = Logic 1 and Pin 10 = Logic 0 | Clockwise Direction

Pin 15 = Logic 0 and Pin 10 = Logic 1 | Anticlockwise Direction

Pin 15 = Logic 0 and Pin 10 = Logic 0 | Idle [No rotation]

Pin 15 = Logic 1 and Pin 10 = Logic 1 | Idle [No rotation]

### 2.7 Power adaptor

This is used to give appropriate DC power supply (9 V) to microcontroller, Driver IC sensors and other passive components of the Robot.



**Fig. -3:** Power adaptor with 9 V battery.

### 2.8 HC-05 Bluetooth module

This module is capable of communicating with pc, mobile phone or any other Bluetooth enabled device. It is interfaced with the microcontroller over the serial UART port of micro-controller. Bluetooth is a wireless communications protocol running at 2.4 GHz, with client-server architecture, suitable for forming personal area networks. Bluetooth is an extremely integral feature designed for low power devices. Bluetooth is a standardized feature or specification that is available in all Smartphone

running on android, laptops and

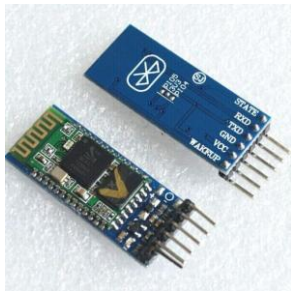


Fig. -4: HC -05 Bluetooth module.

computers. It is very handy as it can be easily fitted with a module to allow Bluetooth communication. Bluetooth is the only appropriate communications protocol that has no fear of getting the frequency interferences because it uses the MAC Address of the device i.e. Bluetooth allows the connectivity between two devices using their MAC Address.

HC-05 module shown in Figure-1 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). HC-05 module work on 3.0V low power operation and 3.0 to 4.2V I/O controls. It has integrated antenna, edge connector and UART interface with programmable baud rate. HC-05 module has default Baud rate: 38400, Data bits:8, Stop bit:1,Parity: No parity and supported baud rates are 9600, 19200, 38400, 57600, 115200, 230400, 460800.

3. SYSTEM ARCHITECTURE

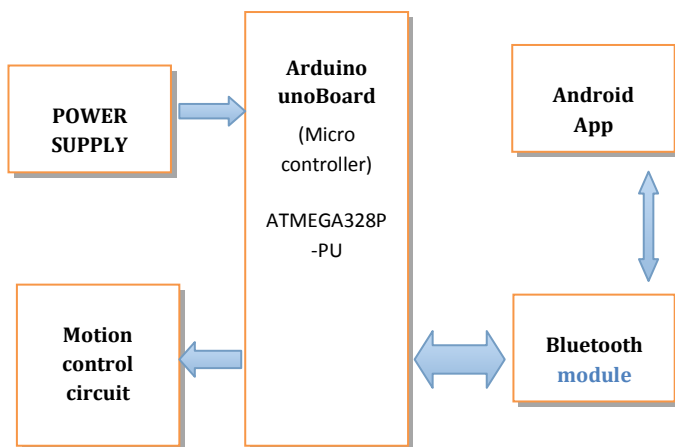


Fig. -6: System Architecture of proposed system

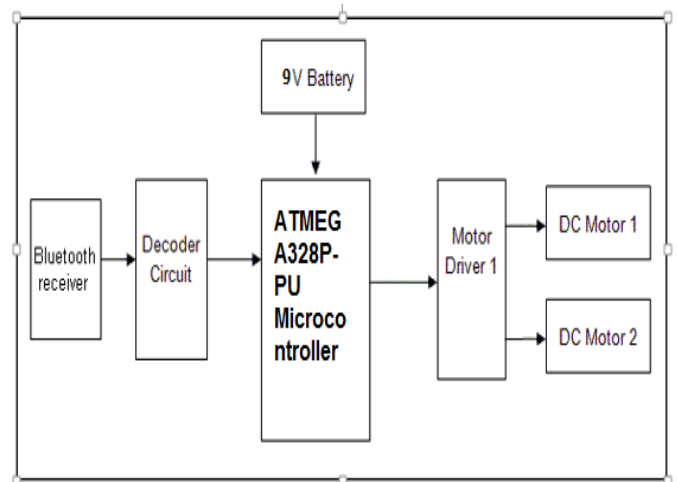


Fig. -5: Block diagram of proposed system

A robot can be controlled using Bluetooth module HC-05 and ATMEGA328P-PU microcontroller with android Smartphone device. The controlling devices of the whole system are a microcontroller. Bluetooth module, DC motors are interfaced to the microcontroller.

The data receive by the Bluetooth module from android smart phone is fed input to the controller. The controller acts accordingly on the DC motor of the robot. The robot can move to move in all the four directions using the android phone. The direction of the robot is indicators using LED indicators of the Robot system. In achieving the task the controller is loaded with program written using Embedded 'C' Languages. Android smart phone controller Bluetooth

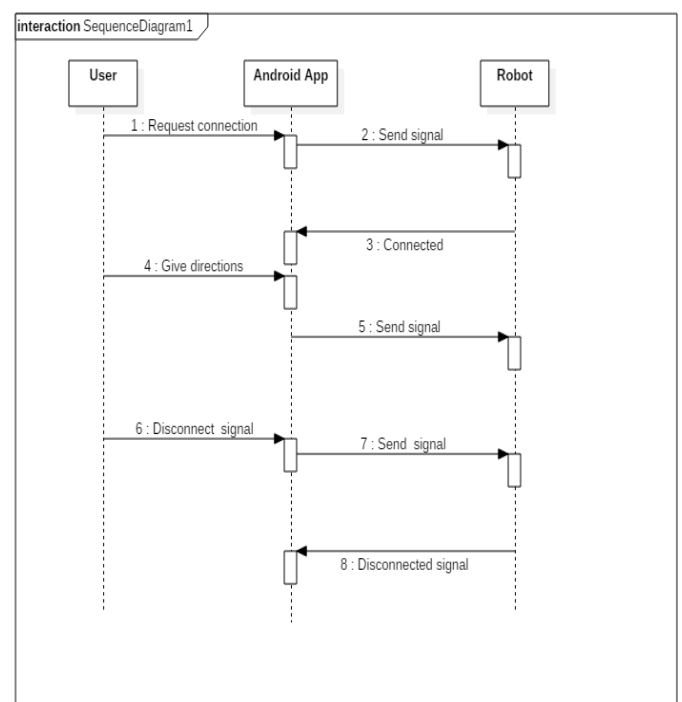


Fig. -7: Sequence Diagram1

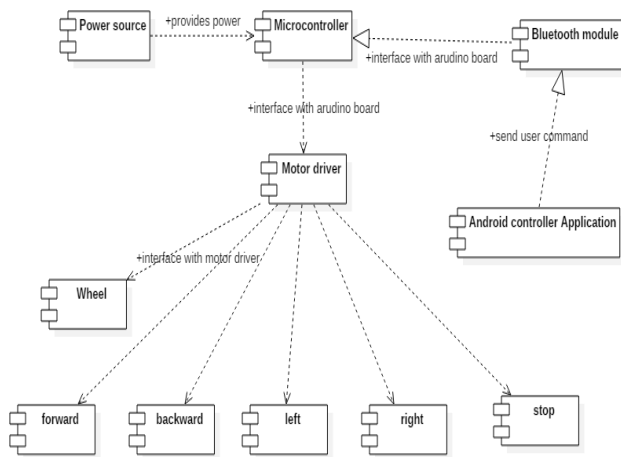


Fig. -8: Component Diagram

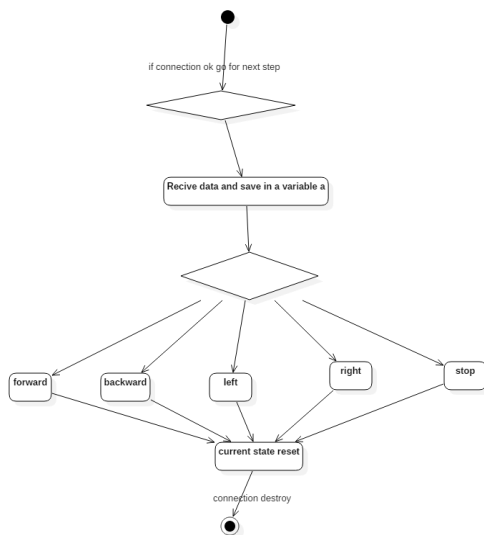


Fig. -10: State Chart Diagram

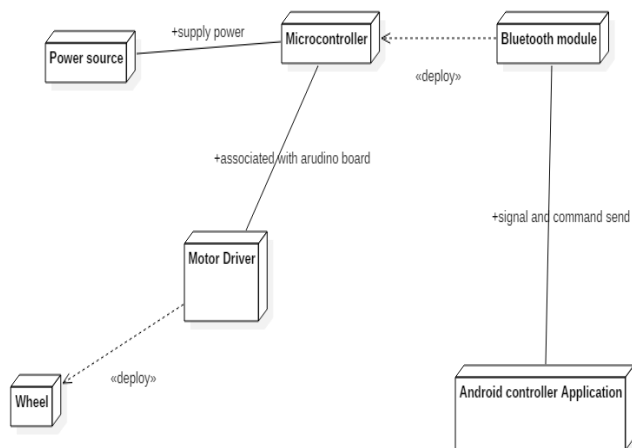


Fig. -11: Deployment Diagram

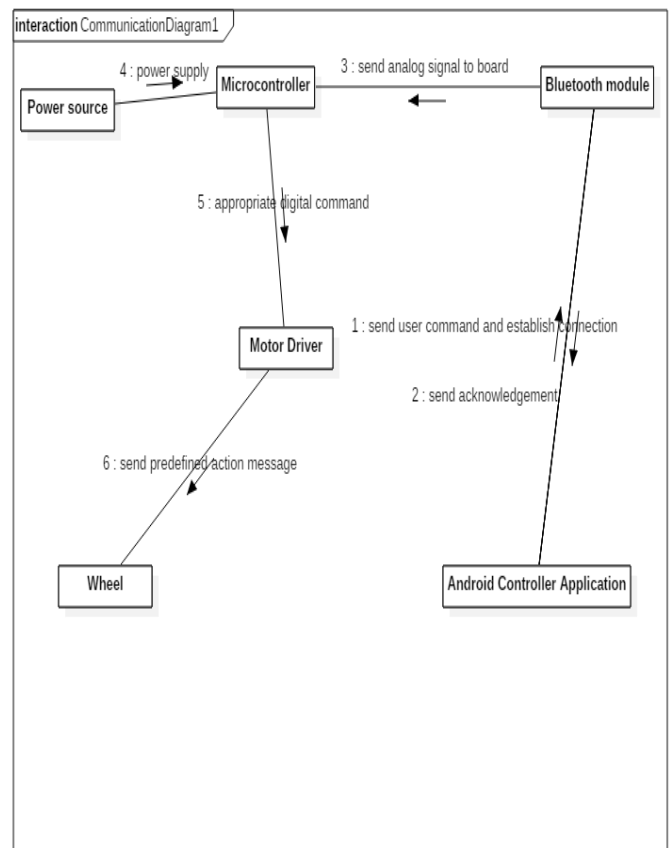


Fig. -9: Communication Diagram

## 4 SOFTWARE IMPLEMENT

### 4.1 MIT App Inventor (to build GUI for Android application)

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.

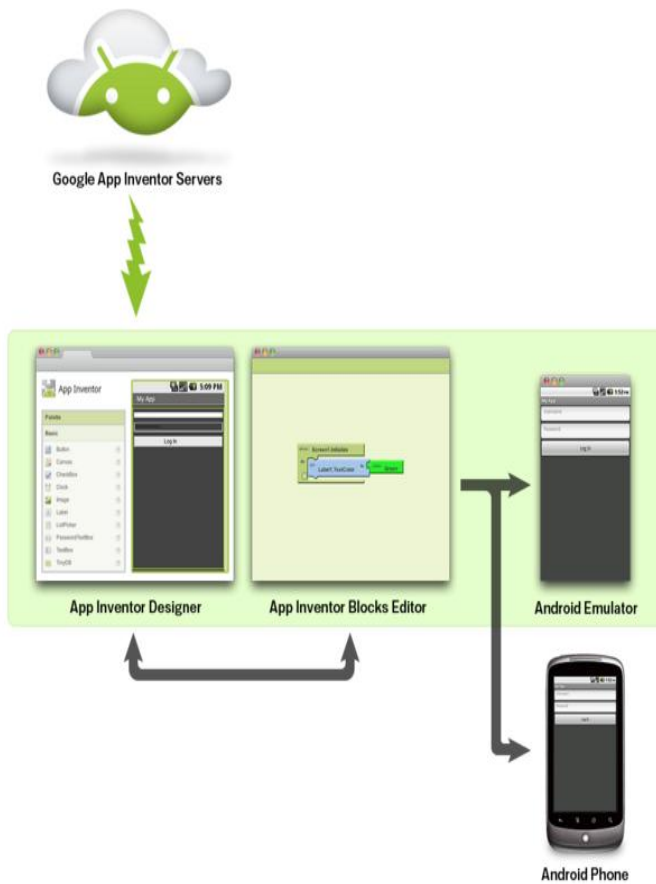


Fig. -12: Working of MIT APP Inventor

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)

### 4.2 App Inventor Designer

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 contain 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.

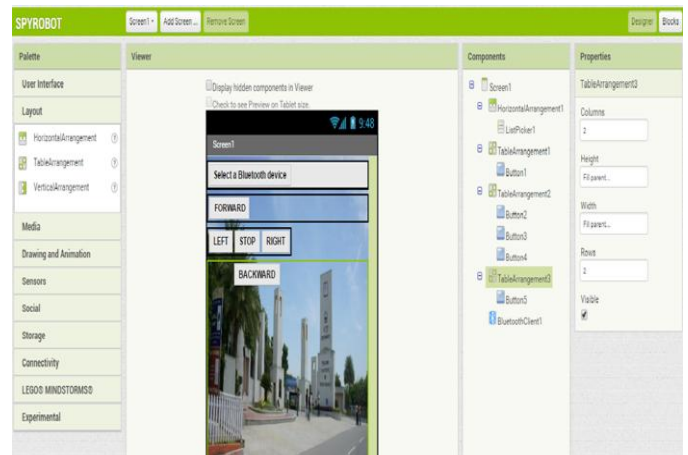


Fig. -13: App inventor Designer

Adding the components to the screen is a simple drag-and-drop process. The alignment of the components can be managed through alignment options. Several non-visible components are also added to the screen, which are explored later in the blocks editor. On the left of the screen is a list of the components which can be dragged and dropped onto the Android screen. To the immediate right of the Android screen is a list of the current screen components: a ListPicker, two Buttons in a Horizontal Arrangement and a “hidden” Label, hidden because it is initially blank. There is also a non-visible bluetooth client at the bottom of the screen. To the far right of the Android screen are the properties of the currently selected component - in this case the Label, Label1 is selected. If we click on the Blocks Tab and then click on the ListPicker1 component on the left hand side of the screen. A scrollable list of code blocks relevant to theListPicker1 appears. Click on “When ListPicker1 BeforePicking” and it will be placed onto the Blocks screen area.

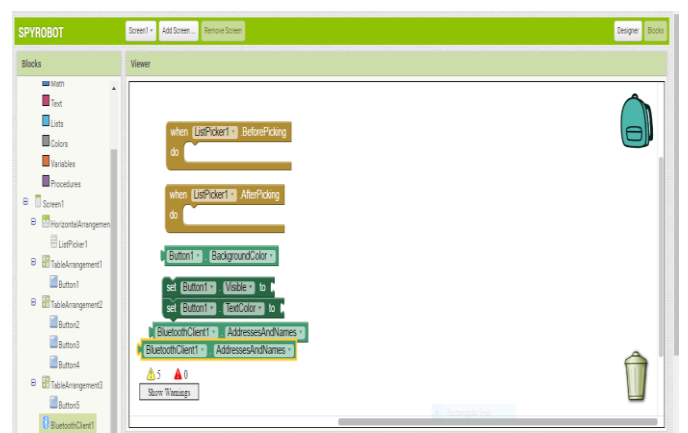


Fig. -14: Inventor App inventor Block Editor

We can now select further sub-Blocks to create the first full code Block, below. This allows List Picker1 to display the available (already paired) Bluetooth devices.

```

when ListPicker1 BeforePicking
do set ListPicker1 Elements to BluetoothClient1 AddressesAndNames
    
```

The next Block allows ListPicker1 to select and connect to the desired Bluetooth device and to set the “hidden” Label, Label1 to read “CONNECTED”

```

when ListPicker1 AfterPicking
do set ListPicker1 Selection to call BluetoothClient1 Connect
   address ListPicker1 Selection
   set Label1 TextColor to Green
   set Label1 Text to "CONNECTED"
    
```

Set the default Text of Label1 to be “NOT CONNECTED” and the colour of Label1 to be Red in the Design Screen; clearly, Label1 is now no longer “hidden”. Add a further component into the code Block, to set the Text colour of Label1 to be Green when the Bluetooth client is connected.

### 4.3 An emulator or Android phone

The final part of the application design is testing the application. Thus, for the users without the android handsets. App Inventor gives the option of testing the application in an emulator which is very similar to the real device but with some limitations. From the Blocks Editor, the user can connect the application to the emulator available via the connect option and test how the application functions in real world. Apart from the emulator, the user can also directly connect the android phone to the computer via USB connector and test the application. Real time testing is definitely the best option for monitoring the application function.



Fig. -16: Android Emulator

## 5. ANDROID APPLICATION

Spy Robot is the name of the android application designed for this project. It was designed through App Inventor. The basic function of the application is to control the robot (created with Arduino and Chassis). It has different buttons integrated to it and each button has different functions.

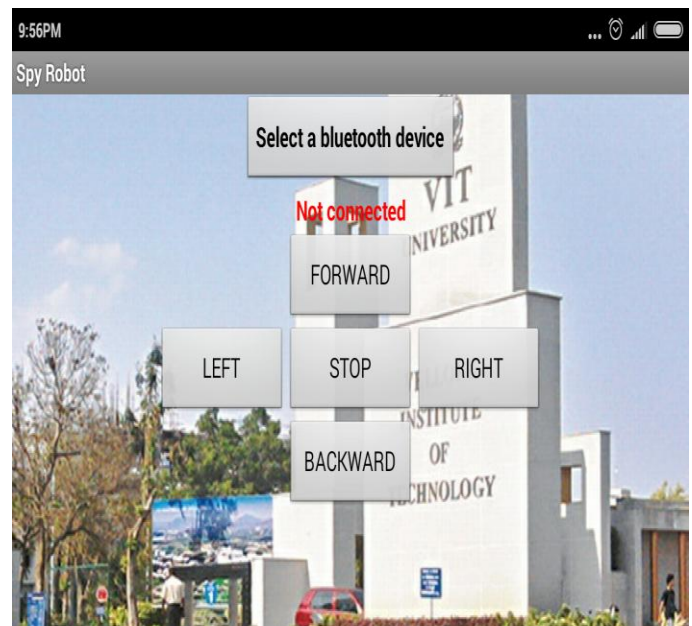


Fig. -15: Spy Robot application layout

### 5.1 Buttons

There is a total of six buttons in the application. One of them are for preparing the device to communicate with the robot. Four of them are for commanding the directions. One is for stopping the motion of robot

### 5.2 Set Device and Connect Buttons

The first button is the set device button. When the button is tapped the application takes the user to a window with the list of Bluetooth devices available. Tapping the right device allows the user to come back to the main window which awaits the user with the activated connect button which when clicked connects the application to the robot allowing the user to use other buttons available.

### 5.3 Software Tools: Arduino

For writing code in assembly and simulation of code, Arduino software plug-in to write code in C. Compilers: IAR, Image Craft. Code Vision Arduino Program type: Application Clock frequency: 7.372800 MHz Memory model: Small



**Programming Digital I/O pins of Arduino UNO board:**

- Each pin is controlled by three commands associated with it which are designated as:

pinMode()

digitalWrite()

digitalRead()

- pinMode()

This configures the specified pin to behave either as an input or an output.

Syntax

pinMode(pin, mode)

Parameters

pin: the number of the pin whose mode you wish to set

mode: INPUT, OUTPUT.

Returns

None

Example

```
int ledPin = 13; // LED connected to digital pin 13
void setup()
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}
```

```
void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000); // waits for a second
  digitalWrite(ledPin, LOW); // sets the LED off
  delay(1000); // waits for a second
}
```

- digitalWrite()

Write a HIGH or a LOW value to a digital pin.

If the pin has been configured as an OUTPUT with pinMode(), its voltage will be set to the corresponding value: 5V (or 3.3V on 3.3V boards) for HIGH, 0V (ground) for LOW.

Syntax

digitalWrite(pin, value)

Parameters

pin: the pin number

value: HIGH or LOW

Returns

None

Example

Sets pin 13 to HIGH, makes a one-second-long delay, and sets the pin back to LOW.

```
int ledPin = 13; // LED connected to digital pin 13
void setup()
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}
void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000); // waits for a second
  digitalWrite(ledPin, LOW); // sets the LED off
```

```
delay(1000); // waits for a second
```

}

- digitalRead()

Reads the value from a specified digital pin, either HIGH or LOW.

Syntax

```
digitalRead(pin)
```

Parameters

pin: the number of the digital pin you want to read (int)

Returns

HIGH or LOW

Example

```
int ledPin = 13; // LED connected to digital pin 13
```

```
int val = 0; // variable to store the read value
```

```
void setup()
```

```
{
```

```
pinMode(ledPin, OUTPUT); // sets the digital pin 13 as output
```

```
}
```

```
void loop()
```

```
{
```

```
val = digitalRead(inPin); // read the input pin
```

```
digitalWrite(ledPin, val); // sets the LED to the button's value
```

```
}
```

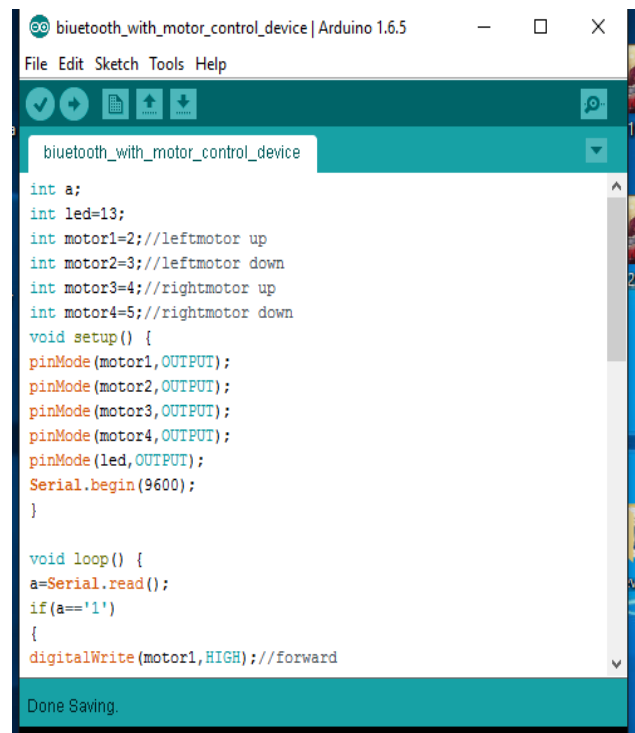


Fig.-18:Bluetooth with motor control device

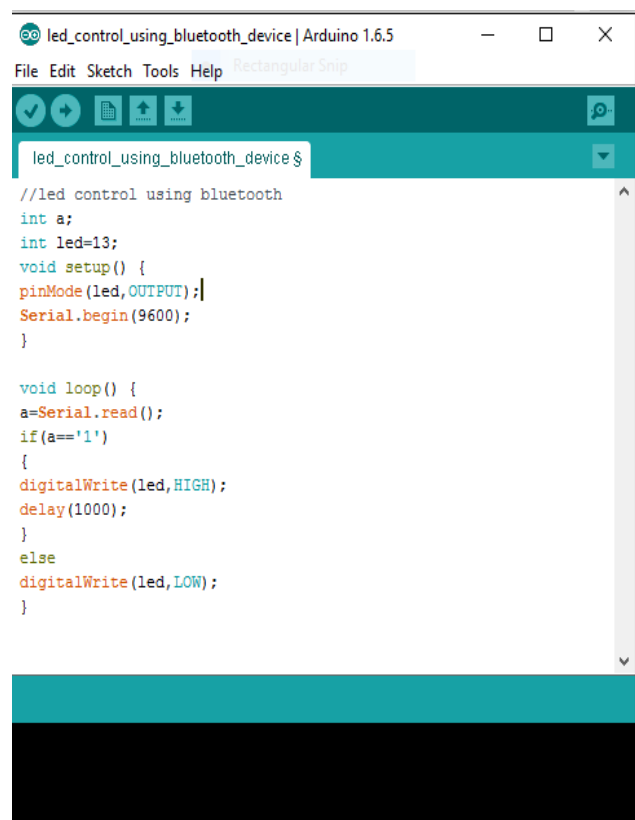


Fig.-19: led control using Bluetooth

## 6. IMPLEMENTATION SOURCE CODE

### Motor Driver Control Using Bluetooth



```
int a;
int led=13;
int motor1=2; //leftmotor up
int motor2=3; //leftmotor down
int motor3=4; //rightmotor up
int motor4=5 ; //rightmotor down
void setup() {
pinMode(motor1,OUTPUT);
pinMode(motor2,OUTPUT);
pinMode(motor3,OUTPUT);
pinMode(motor4,OUTPUT);
pinMode(led,OUTPUT);
Serial.begin(9600);
}

void loop() {
a=Serial.read();
if(a=='1')
{
digitalWrite(motor1,HIGH);//forward
digitalWrite(motor2,LOW);
digitalWrite(motor3,HIGH);
digitalWrite(motor4,LOW);
}
if(a=='2')
{
digitalWrite(motor1,LOW);
digitalWrite(motor2,HIGH);
digitalWrite(motor3,LOW);//backward
digitalWrite(motor4,HIGH);
}

if(a=='3')
{
digitalWrite(motor2,LOW);//right
digitalWrite(motor1,HIGH);
digitalWrite(motor3,LOW);
digitalWrite(motor4,LOW);
}
if(a=='4')
{
digitalWrite(motor1,LOW);
digitalWrite(motor2,LOW);
digitalWrite(motor4,LOW);//left
digitalWrite(motor3,HIGH);
}
if(a=='5')
{
digitalWrite(motor1,LOW);//stop
digitalWrite(motor2,LOW);
digitalWrite(motor3,LOW);
digitalWrite(motor4,LOW);
}
}
}

LED Control Using Bluetooth
int a;
int led=13;
void setup() {
pinMode(led,OUTPUT);
Serial.begin(9600);
}
```

```

void loop() {
a=Serial.read();

if(a=='1')
{
digitalWrite(led,HIGH);
delay(1000);
}
else
digitalWrite(led,LOW);
}

```

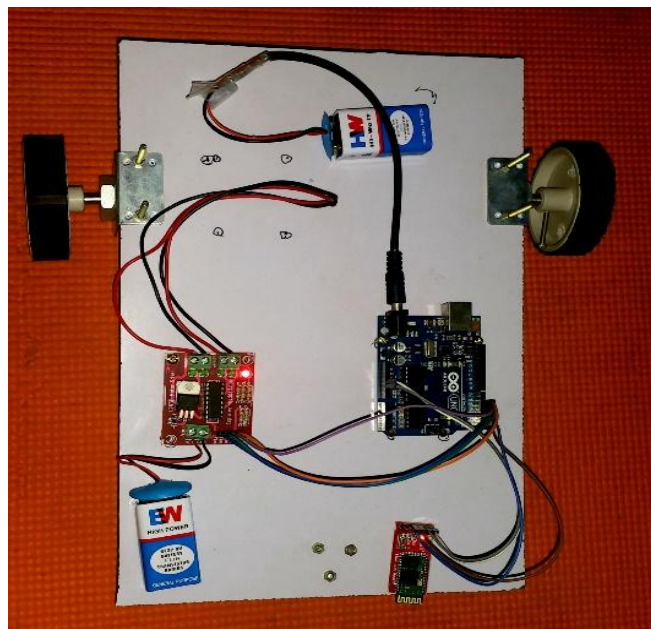


Fig. -20: Android phone controlled bluetooth robot

## 7. APPLICATIONS

- **In Domestic Use:** This project can be used at homes for many purposes like picking up and placing some objects from one to other.
- **In Spying Operations:** This robot can help in spying operations. The object recognition and android control makes it Hi-Fi.
- **For Handicapped People:** This project can help the handicapped people especially those who had lost their feet unfortunately.
- **Robo Races:** The tilt control of robots can be used in robo races which will be revolutionary.
- **Military Application and Hostage Rescue**

## 8. CONCLUSIONS

The operating system of smart phone is android which can develop effective remote control program. At the same time, this program uses blue-tooth connection to communicate with robot. It has proven to allow for meaningful two-way communication between the Android phone and the robot which would allow a non-expert to interact with and adjust the functionality of a system which uses ATmega328 controller, a single board micro-controller intended to make the application of interactive objects or environments more accessible. The surveillance is always has been a quite sensitive task. And it includes so many risks. So it's better to use robot for this job instead of people. And if you are able to control the robots with efficiency and accuracy then you can guarantee yourself with good results and success. This system is a good step for secure surveillance using robots.

Wireless control is one of the most important basic needs for all the people all over the world. But unfortunately the technology is not fully utilized due to a huge amount of data and communication overheads. Generally many of the wireless-controlled robots use RF modules. But our project for robotic control make use of Android mobile phone which is very cheap and easily available. The available control commands are more than RF modules. For this purpose the android mobile user has to install a designed application on her/his mobile.

## 9. FUTURE SCOPE

A wireless camera is mounted on the robot vehicle for spying and surveillance purpose even in night time by using infrared lighting. Future modifications can be made to perform different tasks with precise control such as:

- A Robot Mounted with camera
- A headset, with a full-color display
- A mission control centre

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## BIOGRAPHIES



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