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# Pick and Place Robotic Arm utilizing Microcontroller and Wireless Communication

**Umar M. Pirjade [#1], Sahil R. Tonde[#2], Zia-Ur-Rehman Junnedi[#3], Shekhar S. Wankhede[#4], Prashant A. Kamble[#5], Amita N. Dubey[*6]**

*[#]Department of Electronic and Telecommunications, JSPMs RSCOE Polytechnic, Tathawade Pune*
**Head of Department, of Electronic and Telecommunications, JSPM's RSCOE, Polytechnic Tathawade Pune*

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**Abstract -** *The purpose of this study is to design a prototype of a robotic arm which can be controlled through wireless technology. In this scheme, robotic arm of 4 Degree of Freedom is manufactured and is controlled wirelessly through a mobile app developed using MIT inventor [1] which works on Bluetooth technology. Data from the app is sent serially via Bluetooth transmitter and thereby processed on the receiver which is then used as a reference to control the robotic movement. Successful tests on the linear movement of the robot were performed which results in elevation of robot deployment potentials.*

***Key Words***: Robotic arm 4 DOF, Robot remote control, Bluetooth Module HC-05

## 1.INTRODUCTION

The development of robotics technology basically aims to assist humans in performing a particular job, and it is a very fast evolving research field today. Some specific kinds of robots that can ease human task are arm robot (manipulator robot). Arm robots are designed to hold, lift, and move objects. Robotic Arm are mainly used due to their ability of higher precisions and accuracy which can result in constancy in greater production quality and less production time.

The Robotic Arm can be controlled wirelessly using the Bluetooth Technology, it is interfaced to the microcontroller using a Bluetooth module known as HC-05. An app is developed for the android platform, which communicates serially from the android smartphone to the HC-05 module, which then is processed and executed using microcontroller and the corresponding servos. Basic layout of the robotic arm is inspired by reference [1].

## 1.1 Background

A. Definition:

The term robot was first introduced in English in 1921 by a Czechoslovakian playwright named Karel Capek in his play titled R.U.R (Rossum's Universal Robots). Robots in the earlier sense are "forced labour" which means slave labour, but in the modern sense of the word, the robot has undergone extension of meaning [2]. A Robotic arm is basically a machine which is very similar to a human hand, it consists of a combination of links attached in series or parallel. It can be controlled by programming it to perform a specific task [3].

B. Arduino Uno R3:


Fig 1: Arduino Uno layout

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack [4]. Arduino Uno can be powered through a USB connection or by an external power supply, and the power source is selected automatically. It can be operated at a voltage of 7V to 12V.

C. HC-05 Bluetooth Wireless Module:

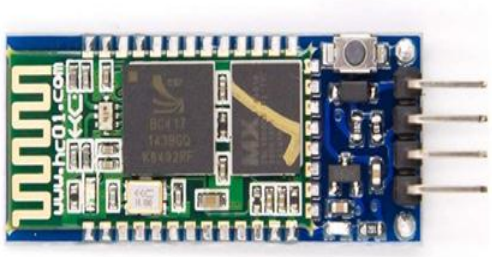

Fig 2: HC-05 Bluetooth Module

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. Bluetooth serial modules allow all serial enabled devices to communicate with each

other using Bluetooth. It works on the frequency of 2.4GHz ISM Band. It operates on 3.6V to 6V and its range is approximately 10 meters.

D. Servo Motor:

Fig 3: Servo motor

Servo motor is a DC motor with a closed feedback system in which the position of its rotor will be communicated back to the control circuit in the servo motor. This motor consists of a DC motor, a set of gear, potentiometer, and the control circuit. Potentiometer serves to define the limits of the angle of rotation servo. While the angle of the axis servo motors regulated by pulse width signal sent through the legs of servo motor cable [2].

### 1.2 Robotic arm Configuration:

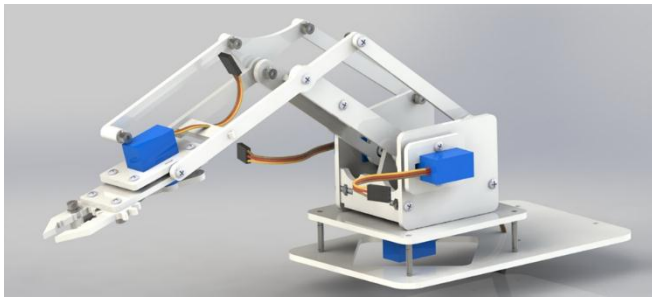

**Fig -4** Configuration of Robotic Arm

In our work the robotic arm we deigned is visualized in the picture above. In this configuration we have 4 Degrees of Freedom, named Base, Shoulder, Elbow and Gripper. Each joint is rotated or given an angular adjustment using servo motor, Servo Motors are electromechanical devices which converts the electrical energy into angular mechanical energy.

## 2. Design Methods

A. Material and tools:

Materials used in the design of hardware, among others:

1)Arduino Uno R3 Microcontroller as a data processor.

2)Wireless communications module HC-05 as sender and recipient of the data instructions.

3)Motor servo actuator 180 degrees as robot arms.

4)Barrel Jack adapter for external power supply for Arduino and peripherals.

5)Android Supported Smartphone to transmit data for control of arm.

6)Sensor Shield V5.0 for Servo motors convenience.

7)The components of electronics, cables, PCB (Printing Circuit Board), lead and connectors.

B. Software:

The supporting software's used in our work are:

1)The Arduino IDE is used to create the program in the microcontroller.

2)MIT app inventor

3)Blender for Model visualization

C. Hardware Design:

The general description of the system can be observed on block diagram below:

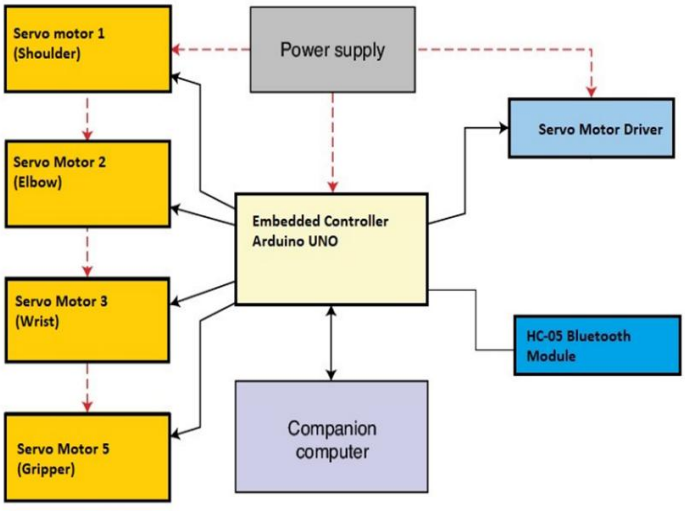


**Fig -5** Block Diagram of Pick and Place Robotic Arm

**Fig -6**. Actual Robotic Arm Produced

## 2. RESULTS AND DISCUSSION

Table 1: The Robot Specifications

| No. | Specifications | Value |
|---|---|---|
| 1 | Height | 166mm |
| 2 | Width | 165mm |
| 3 | Length | 247mm |
| 4 | Weight | 350gm |

A. Design realization:

Robotic arm of 4 Degrees of freedom, despite of its limited joints of axes it can still carry out multiple tasks carried out in three dimensions, such as pick and place, pull, and push test subjects which weigh up to approximately 150gms

B. Testing Microcontroller and Sensor Shield V5.0:

To test the microcontroller and the sensor shield, a single servo motor is connected, and sample sketches or programs were run in order to confirm the functionality of the hardware beforehand.

Checked uploading the test codes from Arduino IDE to the microcontroller as shown in Fig.7

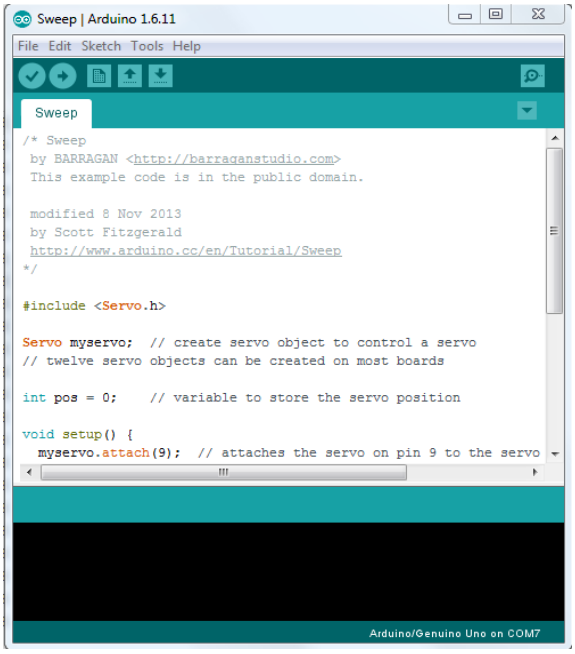


**Fig -7** Uploading Test Sketch

C. Bluetooth Module Testing:

Bluetooth Module is tested by connecting the smartphone to the HC-05 Bluetooth Module and monitoring output on the serial monitor which is integrated in Arduino IDE as shown in Fig.7 and Fig.8

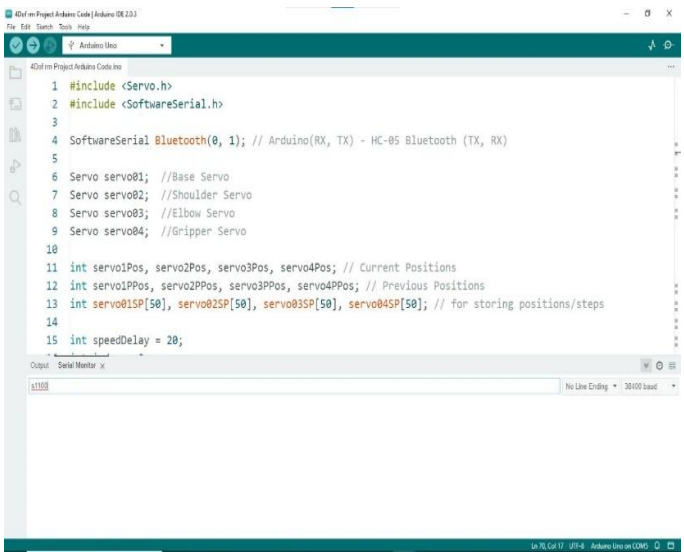


**Fig -8**: Serial Monitor

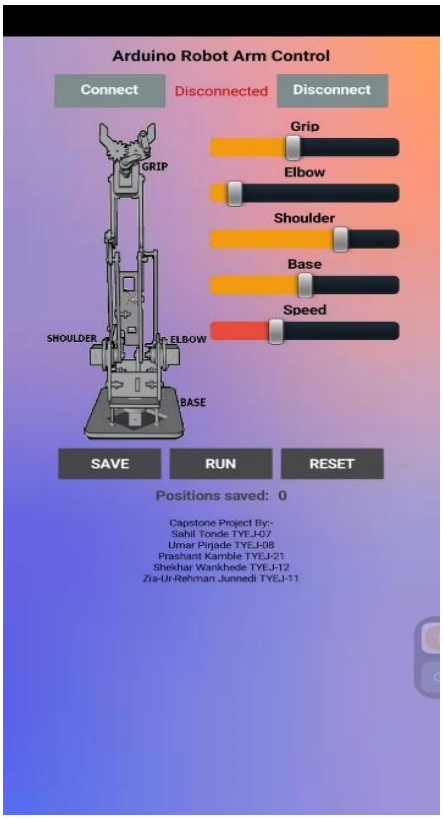


**Fig -9**: Control App Bluetooth Integrated

D. Running the robotic arm with complete configurations: -

App developed using MIT App inventor is installed on smartphone and all the required connections are made properly according to the block diagram and schematics.

As the mechanical aspects were inspired by the reference [6], assembly and modifications to the gripper were made to achieve our particular goal.

App contains sliders to adjust robotic arm's joints as shown in Fig.9. The Robotic arm moves according to the values and limits implemented in the app.

Arm jitters due to a continuous stream of data from android app to the serial of HC-05 Bluetooth Module as shown in Fig.8. Continuous stream of data fed to the Arduino microcontroller makes it an invalid data string which is the main reason behind the jitters.

This can be resolved by sending data from the app if and only if the slider is adjusted and the finger is lifted off from the slider. This will cause the slider to send only one data string, which in return will make processing function as expected.

## 3. CONCLUSIONS

1)The Four Degree of Freedom (4DOF) has enabled the robotic arm to perform the designed movements very well. Furthermore, the mobile robot successfully follows the command from each input variable slider from the app to move the robotic arm.

2)Even though the robotic arm has only 4DOF it can still perform crucial tasks accurately and precisely if the jitter problem is solved.

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## BIOGRAPHIES

Umar Murtuza Pirjade,
Pursuing Diploma of Three years in Electronics and Telecommunication, JSPM's RSCOE, Polytechnic, Tathawade Pune.

Zia-Ur-Rehman Mohammed Rafique Junnedi,
Pursuing Diploma of Three years in Electronics and Telecommunication, JSPM's RSCOE, Polytechnic, Tathawade Pune.

Sahil Rohidas Tonde,
Pursuing Diploma of Three years in Electronics and Telecommunication, JSPM's RSCOE, Polytechnic, Tathawade Pune.

Shekhar Sandeep Wankhede,
Pursuing Diploma of Three years in Electronics and Telecommunication, JSPM's RSCOE, Polytechnic, Tathawade Pune.

Prashant Ashok Kamble,
Pursuing Diploma of Three years in Electronics and Telecommunication, JSPM's RSCOE, Polytechnic, Tathawade Pune.

Amita N. Dubey,
Head of Department, of Electronic and Telecommunications, JSPM's RSCOE, Polytechnic Tathawade Pune