Wi-Fi Controlled Robotic Arm with Claw for Pick and Place Function

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Abstract: The Project is to develop a Wi-Fi controlled robotic arm for pick and place functions using a claw. Pick-and-place applications consist of 2 functions, first being, primary handling i.e. stacking each piece of a product into a tray or carton or perhaps another machine for further processes like capping or sealing and second, case packing. The work is designed in such a way so as to develop a pick and place robot with a gripping arm which is used to pick and place or palletize objects. There have been many advances in materials used for construction, controlling software and hardware and many more aspects has made robotic arms a very feasible and lucrative option for pick-and-place functions. This invention is controlled using a mobile phone connected using Wi-Fi, due to this, its mobility is maintained while a user can direct the arm to perform functions according to his needs.

Keywords: Robotic arm, Wi-Fi controlled Robotic arm, Blynk application, Pick and Place robotic arm

I. INTRODUCTION

Robotics can be called one of the core branches in Engineering & Technology. Robotics is related to the design, manufacture, applications and/or structural disposition of robots. No doubt that Robotics is also related to electronics, mechanics, and software. In this modern era, researchers not only focus on developing systems that exhibit modularity, flexibility, redundancy, fault-tolerance but also on a general and extensible software environment and seamless connectivity to other machines.

While there are certain researchers whose only focus is on automating a manufacturing process or a task completely this is done by providing intelligence of required sensors to the robotic unit, while others try in solidification of the analytical foundations which is a platform for many basic robotic concepts.

Time and man power are critical constraints in large scales, in this highly developing society. Automation plays a crucial role to save efforts made by humans in most of the regular and frequently carried works. Picking and placing of objects from a source to a destination is one of the most common and majorly performed works. Computer-based automation is getting rapidly increased in this present day robotic and automation industry mainly due to the need for increased productivity and delivery of end products with uniform quality.

Due to general high cost and inflexibility of automation systems which have already been used for automated manufacturing errands in the past, now leads to a broad interest in the usage of robots that can perform a variety of manufacturing functions at much lower costs in a tough and flexible environment.

The contemporary trends in automation of the manufacturing process are characterized by the usage of Industrial Robots. However, present day industrial robots also exhibit a monolithic mechanical

structure and closed-system software architecture. They usually not focus on those tasks which require high end precision.

Detection of the object can also be done by this pick and place robot as it a mechatronic based micro controller system. It also picks that object from source location and places at desired location. To detect an object, infrared sensors are used which detect presence of object as there is an interruption caused by the placed object in between the transmitting and receiving path.

Laws of Robotics:

Isaac Asimov introduced the three laws of Robotics in his short story "Runaround" in 1942. The three laws as stated by him are:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Later, a Fourth Law or commonly known as the Zeroth Law was introduced in the end of his book "Foundation and Earth". It is stated as follows:

A robot may not injure humanity, or, by inaction, allow humanity to come to harm.

II. PREVIOUS WORKS

The awareness of some device, which would help to serve humankind or work for humans by automation i.e. without any human interference, has been there and written of extensively in historic tales and documents, for example ideas like doors that open automatically. To buttress the idea of awareness since a long time, a book called "The Science of Ingenious Mechanisms" was written in the 9th Century by accumulating the ideas and texts preserved till then. This book caused some of the great minds (like Da Vinci) to come together and create objects that move without human help, just for the fun of it. With the invention of the NC (Numerically Controlled) machines, the popularity of the computer in the 1950s, and the integrated circuit in the 1970s together helped made it possible to develop the very first, yet very simple, industrial robot. The very first robots were invented to reduce heavy lifting tasks, as well as monotonous, redundant work in industries however they had no sensors and were simply used for pick and place purposes. In 1963 a robotic arm was invented to assist handicapped people, it was called "Rancho Arm" and was six jointed, this was then followed by a "tentacle arm" that had 12 joints and could even lift a person! Soon after in 1967 a robotic arm was developed for spray painting application

III. ADVANTAGES (HIGHLIGHTS OF THE PROJECT)

1. Accuracy: Robotic arms have slim arms and a wide reach, they are steady and precise because of which they very accurate. This is the reason they are perfect for pick and place applications
2. Flexibility: Robotic arms have huge amount of flexibility. robotic arms are more precise in performing tasks, these are connected to effective pcs or controlling devices, these consist of machine vision sub-systems that act as their visual sensors, hence, they are more flexible to the positioning of objects on which they can perform errands.
3. Consistency: The robotic arms can be customized to perform straightforward errands, they repeat these errands several times, and these robots work in the industrial facility with high level of precision at a consistent speed which leads to consistent performance at all times.

4. Longer Working Hours: The robotic arms help to increase the quantity of manufactured objects and also decrease the generation of deficient objects, these are able to deliver objects having same or similar quality during the production process, and these machines do not get exhausted and work for extremely long periods of time.
5. Safety Maximization: The robotic arms can carry out risky functions in perilous settings; they also decrease the material waste as well as spare the time and exertion. Moreover, their movements are exact or precise.
6. Profitability: The smart robotic arms help to increase the profitability in the industries, they also help companies to gain even more benefits, they can decrease the organizations losses, they can also be utilized in dangerously and harmfully polluted conditions, for example, the synthetic and radioactive in the atomic plants and can be utilized as a part of the radioactive waste cleaning.

IV. CIRCUIT DIAGRAM AND BLOCK DIAGRAM

A. Circuit Diagram

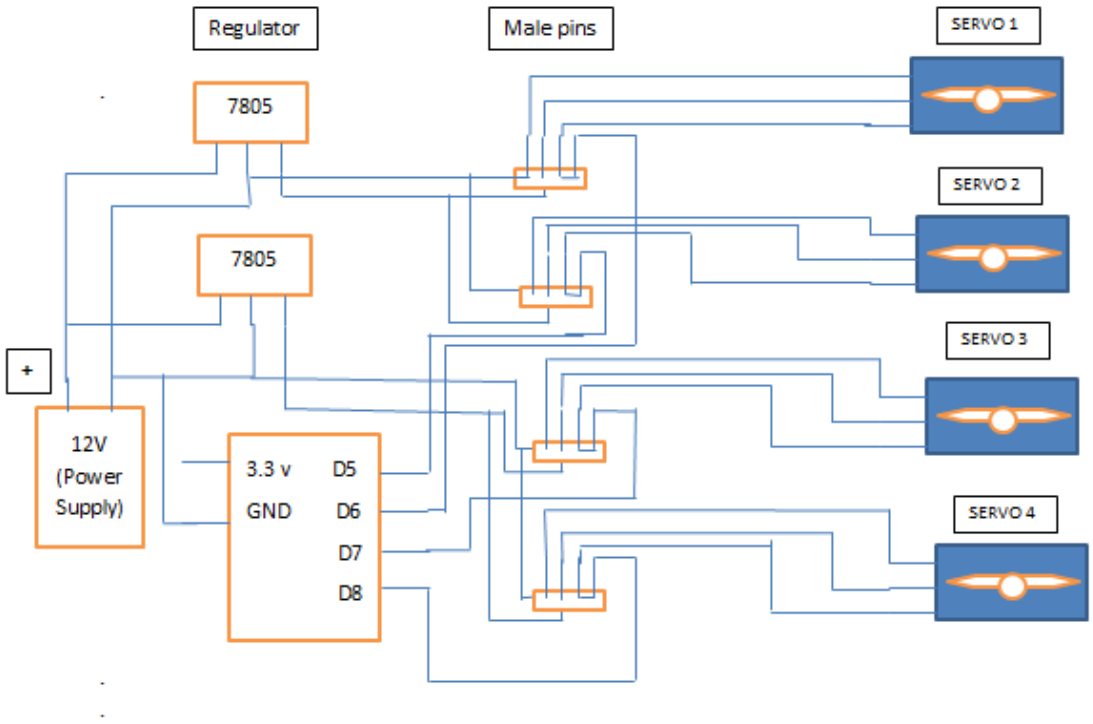

Figure 1. Circuit Diagram

A 12V DC power supply is used to give supply to the servo motors. This 12V Dc power supply is rechargeable, even though it can work constantly for 20 Hours, our servo motors require current, and hence, the battery is rechargeable so that after one use it can be recharged to its full potential for next use.

Regulator IC 7805 is being used to convert 12V to 5V as servo motors can sustain maximum 5V supply. A 7805 regulator IC has 3 pins, Input, Ground and Output. The Input is connected with the 12V DC power supply and the output pin is connected with capacitors to keep power constant by charging and discharging controlling the supply. The output is then connected to the input pin of servo motors using male to female jumper wires. Two Regulator IC's are being used to control 4 servo

motors, one IC controlling 2 motors. These are connected in parallel so that all 4 servos get equal voltage. The supply Circuit has 4 pins each for each servo, 3 corresponding to the wires on the servo motor and one to send the signal, the signal pin and output pin (of servo) and connected through soldering. The signal pins on the other hand are connected to GPIO pins of the Nodemcu. All GPIO pins on Nodemcu are PWM pins thus can be used to operate servo motors. Servo motor 1 is connected to D5, Servo motor 2 is connected to D6, Servo motor 3 is connected to D7 and finally Servo motor 4 is connected to D7. The Nodemcu receives 3.3 V supply using a USB cable connected to the Laptop. A 12V supply can also be used to provide supply to the Nodemcu.

B. Block diagram

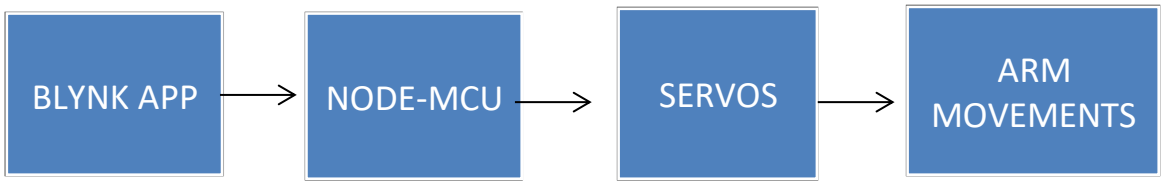

Figure 2. Working Mechanism Block Diagram

The Blynk app is connected to the Node MCU. Blynk app provides us with an Auth token which is fed to the Node MCU as the address to which it needs to connect. Auth Token is basically a unique id that acts as an identifier to connect the hardware (Node MCU in our case) and the smartphone. This token is included in the code to be uploaded on Node MCU. Blynk app and Node MCU are connected over a Blynk server.

The app has various widgets to control various hardware but as we are controlling servo motors, which needs degrees as input hence we chose slider as a widget to control all our servos. The slider provides us with the flexibility to rotate and stop our servo motor at any degree of our choice. It sends a command as soon as the slider is released. These commands are sent over the Blynk cloud/server to the Node MCU which provides input command to the servo motor.

In total there are 4 servo motors connected to Node MCU –

1) Base servo- to rotate the base to a full 180 degree
2) Forearm- to bend the arm up and down (less than 180 degree)
3) Elbow- to reach far or nearby objects (90 degree)
4) Claw- to pick, hold and drop the object (less than 180 degree)

The servo motors are connected to the general input output pins of Node MCU.

The blynk app hence has four sliders to operate four different servo motors. The work of this arm is not fixed or limited to positions; its working is rather in the hands of the user which is done using these sliders. The arm can be used to pick object at any position within a range and drop it at the desired position with the only limitation being the range up to which the arm can extend itself.

V. METHODOLOGY

The first thing to be kept in mind was to decide its mobility criteria which made us decide to make it wireless. Making it wireless will enhance its mobility as there will be no actual physical connection between our remote (which is our mobile phone) and our robot and hence there will be no path or say connection hindrance/difficulties.

While talking about making it wireless, a suitable and feasible platform was needed. Wi-Fi connectivity was preferred over Bluetooth connectivity because Wi-Fi has a longer range and the corresponding hardware used to maintain a Wi-Fi connection was much easily available and easy to work with.

Instead of making our own app, we thought of using an app called "BLYNK". The basic work of this app is that it gets connected to our Node-MCU (Wi-Fi module) and can command it accordingly. There are many other apps to do so but this app has got slider-controls because of which we can control our robot in more efficient way as our robot can move at any degree with the help of our slider.

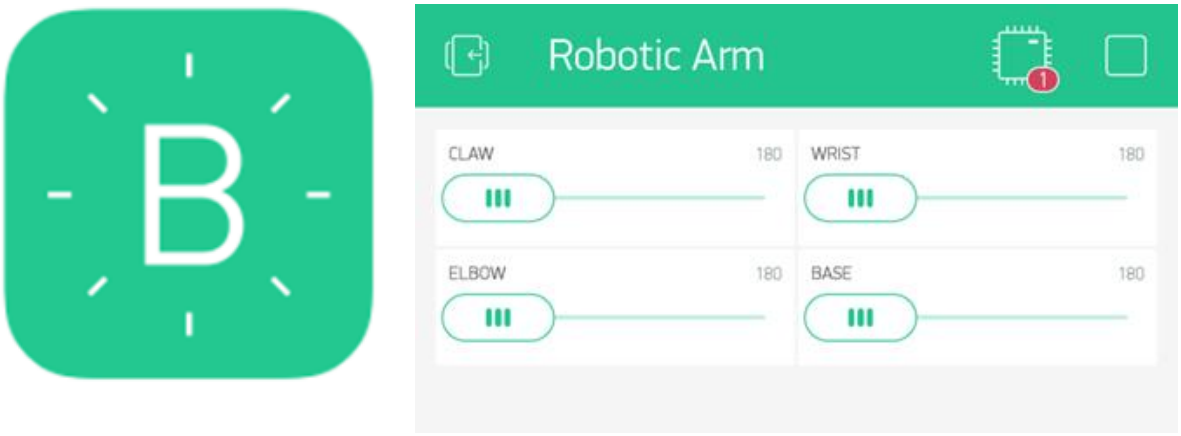

Figure 3. Blynk App interface with sliders to control the servo motors

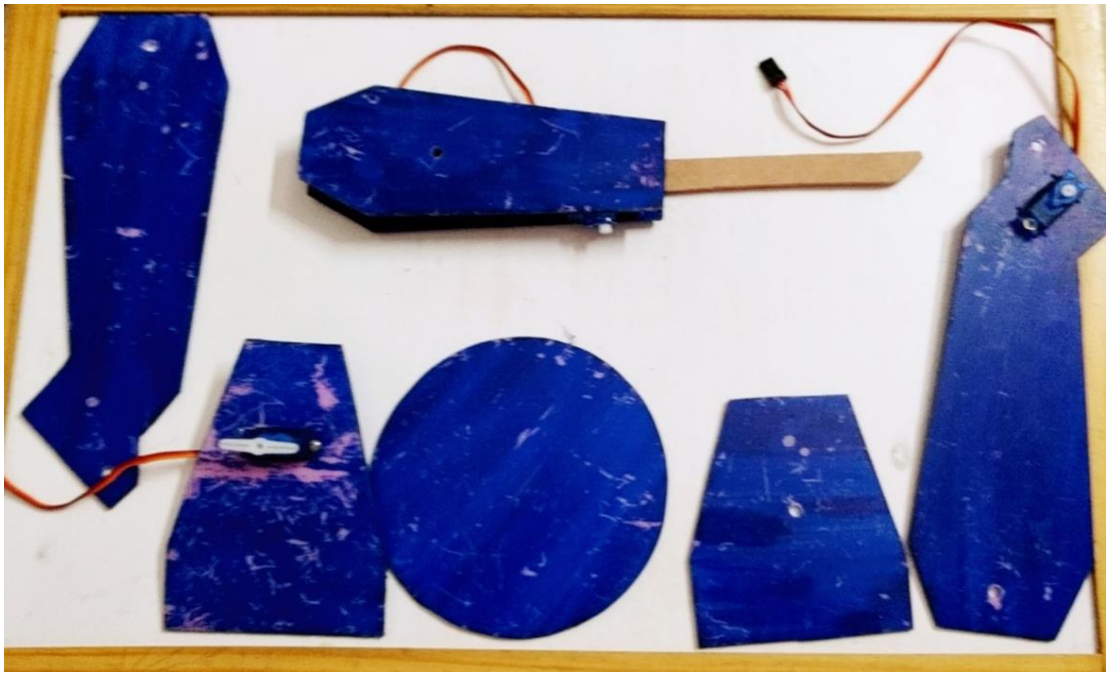

Figure 4. Components of Robotic Arm

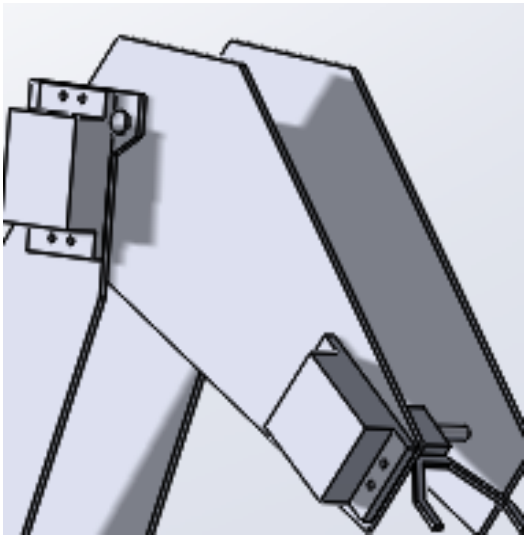

Fig. 5: (a) Forearm structure in Solidworks

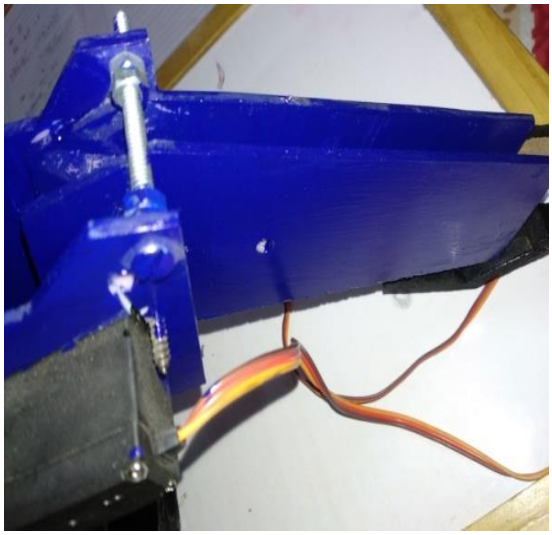

Fig. 5: (b) Realized forearm structure

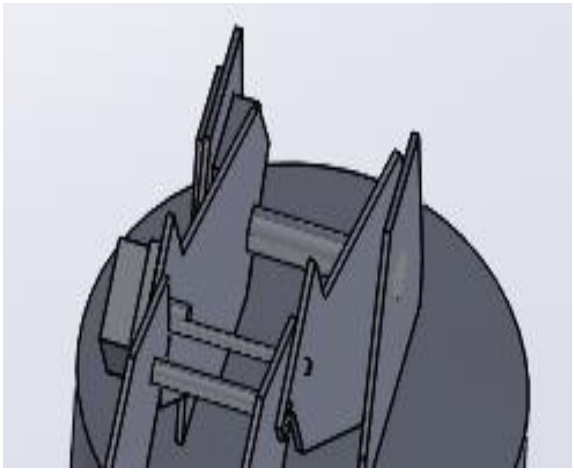

Fig 5: (c) Structure of elbow using Solidworks

Fig 5: (d) Realized elbow structure

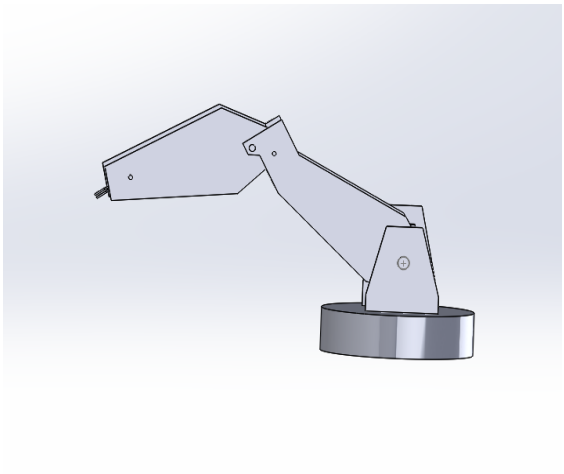

Fig 5: (e) Structure of arm using Solidworks

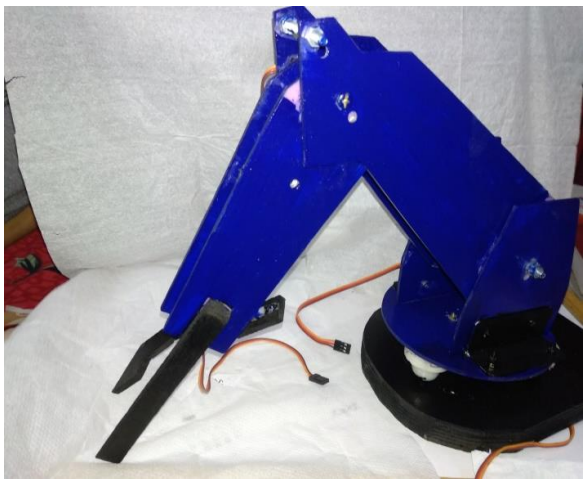

Fig 5: (f) Realized structure of arm

The most important step was that of designing. Robot was supposed to be designed in such a way that it has a whole hundred and eighty-degree hemi-spherical coverage despite being small in size. Our design resembles a working human arm which consisted of a hundred and eighty-degree rotating base serving as a firm platform as well. Base is connected to a forearm, forearm to palm region, palm region to claw, which is used to pick and place or palletize.

After this, dimensions of robot were supposed to be taken care of. Dimensions were chosen in such a way that it isn't too big so that it isn't possible to carry that robot and it isn't compatible enough to work in congested areas. Also, the robot shouldn't be that much small that it isn't possible for it to perform its function on comparatively heavier objects or say it shouldn't be underpowered.

The next thing which should be kept in mind is the material of which our robot's infrastructure should be made of. If the material is too hard and heavy like steel, we will require much powerful and expensive servos and corresponding heavy power sources as well. If the material is too light and flexible, it won't be able to pick up objects and might bend down. Thus, thinking of a material which is strong and light at the same time was a challenge. Plastic Acrylic sheets were the best option available which met our requirements.

The model should be weigh balanced. If servos are attached irrespective of the weigh balance and force balance diagram, either the entire structure will topple, or it won't be able to pick up objects. We can hit and trial at different axes at which our servos should be connected so that they give their most efficient performance.

VI. CONCLUSION

The implementation of pick and place robot is being done by using android application which successfully works in all environments. For the completion we have used various software applications like Blynk and Arduino version 1.8.2. The final output of the system is a robotic arm controlled by Wi-Fi.

Conflict of interest: The corresponding author declares that there is no conflict of interest.

Ethical statement: It is also declared that ethical responsibilities are completely followed.

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This volume is dedicated to Late Sh. Ram Singh Phanden, father of Dr. Rakesh Kumar Phanden.

