A Project Report on

# Kitchen Automation

Submitted in partial fulfillment of the requirements for the award of the degree of

**Bachelor of Engineering**

in

**Computer Engineering**

by


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# Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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# Contents


**1 Project Conception and Initiation** **1**
1.1 Research Paper Search . . . . . . . . . . . . . . . . . . . . . . . . . . . 1
1.1.1 Research Paper finalization . . . . . . . . . . . . . . . . . . . . 2
1.2 Project Title . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2
1.3 Abstract . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2
1.4 Objectives . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3
1.5 Literature Review . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3
1.6 Problem Definition . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4
1.7 Scope . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4
1.8 Technology Stack . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4
1.9 Benefits for Environment . . . . . . . . . . . . . . . . . . . . . . . . 6
1.10 Benefits for Society . . . . . . . . . . . . . . . . . . . . . . . . . . . 7
1.11 Applications . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

**2 Project Design** **9**
2.1 Proposed System . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9
2.2 Design (flow of modules) . . . . . . . . . . . . . . . . . . . . . . . . 10
2.3 Activity Diagram . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11
2.4 Use Case Diagram . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12
2.5 Description of use case diagram . . . . . . . . . . . . . . . . . . . . . 12
2.6 Project Modules . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 13
2.6.1 Module 1 - Robotic Arm . . . . . . . . . . . . . . . . . . . . . . 13
2.6.2 Module 2- Servo Motors . . . . . . . . . . . . . . . . . . . . . . 14
2.6.3 Module 3- Node MCU . . . . . . . . . . . . . . . . . . . . . . . 15
2.6.4 Module 4- Smart Phone Application . . . . . . . . . . . . . . . . 17

**3 Project Implementation** **19**
3.1 Module 1 - Robotic Arm . . . . . . . . . . . . . . . . . . . . . . . . . 19
3.1.1 The Robotic arm after full assembly . . . . . . . . . . . . . . . . 20
3.1.2 The 3D Models of each part of the robotic arm . . . . . . . . . . . 22
3.2 Module 2 - Servo Motors . . . . . . . . . . . . . . . . . . . . . . . . . 30
3.3 Module 3 - Node MCU . . . . . . . . . . . . . . . . . . . . . . . . . . 30
3.4 Module 4 - Smart Phone Application . . . . . . . . . . . . . . . . . . 34

**4 Testing** **35**
4.1 Design of Test Cases . . . . . . . . . . . . . . . . . . . . . . . . . . . 35
4.1.1 Flow of data from application to Node MCU . . . . . . . . . . . . 35

4.1.2 Flow of data from Node MCU to the Servo Motors and actions on the environment . . . 35
4.2 Testing . . . 35

**5 Results and Analysis** **36**
5.1 Analysis of results . . . 36

**6 Gantt Chart** **37**

**Bibliography** **39**
Appendix-A . . . 40
Appendix-B . . . 40
Appendix-c . . . 41

**Publication** **43**

# List of Abbreviations

| | |
|---|---|
| KAS: | Kitchen Automation System |
| FOM: | Flow Of Modules |

# Chapter 1

# Project Conception and Initiation

## 1.1 Research Paper Search

The papers which were referred were taken from IEEE Website and they are as follows. The idea was to implement a fully functional Home automation system. The idea was to go for a robotic arm which will be able to perform various household works such as cooking, picking up heavy stuff etc so these were the papers which were relevant to the topic

1) Low-cost home automation using Arduino and Modbus protocol

Authors : Vahid Hassanpour, Sedighe Rajabi, Zeinab Shayan, Zahra Hafezi

This paper gave an idea that Smart home creates the environment that maximizes the quality of life beside the efficient use of energy resources and provides the energy management systems (EMS). Since the energy crisis is a global problem, home automation should be pervasive all around the world as an important component in reducing energy and using renewable energy. One of the fundamental issues in home automation is the cost of automation. Thereby reducing the cost of automation is an important concern in the world. In this paper, a low-cost home automation system based on Arduino microcontroller has been introduced that works with Modbus protocol. 2) Design and implementation of a low-cost

Arduino-based smart home system

Authors : Souveer Gunputh, Anshu Prakash Murdan, Vishwamitra Oree

This paper gave the idea that smart home is the residential extension of building automation. It initially involved the control and automation of systems that ensure human comfort such as lighting, heating, ventilation, air conditioning and security. Recently, it has evolved to encompass most home appliances that use Wi-Fi for remote monitoring. Technological progress has enhanced the ubiquity of smart home systems resulting in improved standards of living. Commercial home automation systems are still unaffordable to a vast majority of the middle and lower class families. However, the emergence of cheap microcontrollers, like the Arduino, has enabled the implementation of low-cost smart home systems, incorporating the majority of features present in commercial systems. In this paper, they present a highly scalable, low-cost and multi-faceted home automation system based on Arduino microcontroller that is capable of integrating appliance and equipment automation, thermal comfort control and energy management.

### 1.1.1 Research Paper finalization

The paper which seemed more relevant and useful was the 2nd paper (Ref. Section 1.1) as it gave a more clear idea of a Home/ Kitchen automation system and it's usage and future scope for it.

As we started to go further the main problem was the cost of the system. We needed a system which affordable to not only Upper class families but also common middle class families. This paper was relevant as it made sure the system has a minimum cost.

## 1.2 Project Title

The Title of the project was originally Home Automation but it was modified as ”Kitchen Automation ss this system is focused to make all the activities in the kitchen such as Cooking,turning gas on  off etc automated so that there is less stress on people who have to come home from a hectic day and have to cook and do the Kitchen chores on their own.

## 1.3 Abstract

Today's automation push complements efforts over the past decade to make kitchens more efficient. More computerization, more self directed controls, more graphical user interfaces to avoid language barrier issues may not seem like automation issues, but anything that speeds up the process, makes training easier, makes equipment easier to use and maintain is an element of automation. We thus intend to propose advancements in kitchen working environment for a comfortable human life. We would also like to point out that automation can also lead to a safer working environment with less potential burns or repetitive stress injuries. Commercial automation systems are still unaffordable to a vast majority of the middle and lower class families. However, the emergence of cheap microcontrollers, like the Arduino /NodeMCU, has enabled the implementation of low-cost smart home systems, incorporating the majority of features present in commercial systems. Automation creates the environment that maximizes the quality of life beside the efficient use of energy resources and provides the energy management systems. Automation will help a common man focus on his social life and relax for a bit by relying on technology to do it's work on their behalf and get benefited by it. Robotic process automation (or RPA) is a form of business process automation technology based on metaphorical software robots (bots) or on artificial intelligence (AI)/digital workers. It is sometimes referred to as software robotics (not to be confused with robot software). In traditional workflow automation tools, a software developer produces a list of actions to automate a task and interface to the back-end system using internal application programming interfaces (APIs) or dedicated scripting language. In contrast, RPA systems develop the action list by watching the user perform that task in the application's graphical user interface (GUI), and then perform the automation by repeating those tasks directly in the GUI. This can lower the barrier to use of automation in products that might not otherwise feature APIs for this purpose.RPA tools have strong technical similarities to graphical user interface testing tools. These tools also automate interactions with the GUI, and often do so by repeating a set of demonstration actions performed by a user. RPA tools differ from such systems that allow data to be handled in and between multiple

applications, for instance, receiving email containing an invoice, extracting the data, and then typing that into a bookkeeping system.

## 1.4 Objectives

The project has a wide scope in daily lives. They are as follows

- To reduce manpower by automated design.
- This automation will give various types of features in a single system i.e a single robotic arm can handle multiple features like Stirring, Turning gas on  off etc
- The user can relax after a hard day and rely on the system for the work as all the major things we do in kitchen can be done by the robotic arm.
- The arm will also be used to pick up heavy and hot stuff which is a risk for humans to do.
- The system should be made in such a way that people not having the idea of cooking can also take benefit from it.
- People suffering from physical or mental disabilities should also be able to use it.
- The application should be made in such a way that it should not occupy huge space in the users smart phone

## 1.5 Literature Review

Originally, The idea was to implement a smart home system or home automation system but as we all know kitchen has the most important and the most hectic work at home so the automation of kitchen would be more reliable and efficient. The idea of Kitchen automation had various modules like Egg Tray Automation, Jar Automation etc in Which the eggs were to be placed on a tray which had weight sensors which notified the user that there's a shortage of egg and it needs to be refilled. Instead of Weight sensors we also could've done Image Processing but it would cost more so to reduce the cost we were gonna use weight sensors. The Jar automation was similar to egg tray automation which would give a notification to the user that the Jar needs to be refilled. The application was to be designed in a way that it would add all the notified items into an e-shopping cart and ask the user the duration of refill to order it. The technology stack used in this was chosen by taking into consideration that the cost of the whole system should be minimum and affordable to everyone. For automation, the right type of hardware was needed to be found as it has to deal with an extremely high temperature and the hardware should have the capacity to sustain that amount of heat so Robotic arm can be covered with insulating material. This project can also be further extended to operate various other kitchen appliances like refrigerators, mixer grinders etc. The robotic arm was designed on solid works website and it was 3D printed instead of actually buying metal parts so as to reduce the cost of the system. The 3D printing machine took more than 24 hours to print all the parts and then it was binded together with the use of nut bolts.

## 1.6 Problem Definition

The goal of this project is to successfully configure implement Kitchen Automation system to reduce human labour and attain safety from tasks that are risky to be done by humans. The user must successfully be able to interact with the system using his smart phone so an application must be built for the communication between the user and the automation system. There must be constant updating of data and user must be notified every time a certain small level goal is achieved. The robotic arm must be made in a way that humans should totally rely on it and it should require minimum human assistance and should be easy to use by anyone.

## 1.7 Scope

The kitchen is the heart of the house. The demand for automated kitchens is growing particularly for branded quality products. As the demand for apartments grows and lifestyles change, style, convenience and efficient use of space drives the demand for prefabricated kitchens. A modular kitchen is no longer just about maximising use of a small space, it has also become about maximising comfort for the users for our generation trying to keep up with their hectic life and schedules. The ability to supplement or replace human labour with automated solutions is fast becoming a lifeline for the upcoming future. These solu- tions would help a lot of people who already struggle to cope up with the fast moving life making it and convenient for them.

Future homes will be able to offer almost all required services, e.g, Communication, Medical, Energy, Utility, Entertainment and security. As we move into the next generation more and more devices will begin to connect to one another. The dream is a future in which data is communicated between devices and humans without relying on manual input of individual bytes. Computers can automatically mine data and then use that data to change aspects of the home environment is the future. These are all goals that the engineers are working towards and pert is the next generation home automation innovation, that let's you control,monitor and secure your home with your smart phone. As technologies continue to advance,you can expect the house of tomorrow to be even more automated than that of today.

## 1.8 Technology Stack

- NodeMCU (acting as central processing unit)

  NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board.

- Robotic Arm A robotic arm (not robotic hand) is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effector and it is analogous to the human hand.

- Servo Motors

  We need 6 servo motors of 2 types. MG996R SG90 micro. A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

  The MG996R is essentially an upgraded version of the famous MG995 servo, and features upgraded shock-proofing and a redesigned PCB and IC control system that make it much more accurate than its predecessor. This high-torque standard servo can rotate approximately 120 degrees.

  SERVO MOTOR SG90.. Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos

  Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

  Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

- User Interface for controlling Automation System (Android/iOS application operable on mobile devices)

  Various softwares like Android stduo, firebase etc can be used to create an application which can be supported on both android and iOS

- 3D solid modeling software.

  SOLIDWORKS is used to develop mechatronics systems from beginning to end. At the initial stage, the software is used for planning, visual ideation, modeling, feasibility assessment, prototyping, and project management. The software is then used for design and building of mechanical, electrical, and software elements.

- 3D printer

  3D printing is a blend of software and hardware. The 3D printing process starts with a computer aided (CAD) file. CAD 3D software allows for the rapid creation of a drawing of an object in 3D. Computer aided manufacturing (CAM) uses computer software in tandem with machinery to improve and improve the manufacturing process. 3D Printers use a laser or extruder (the material output part of the printer), that move along an X, Y and Z axis to build an object in three dimensions, wherein successive layers of material are laid down in different shapes. These layers can be only a few microns thick at a time. This is an advantage over traditional method which uses subtractive method where materials are cut or drilled from mould. Using the additive process, layers of materials in liquid, solid or material form are fused together. 3D printers thus use additive manufacturing or direct digital manufacturing technology to produce proto type of a product. 3D printers use CAD software like PTC Creo to create a digital blue print first. The object is then built layer by layer. Using this new technology, a manufacturer can develop a working prototype in just a few hours compared to traditional prototyping. The 3D printers developed by companies like Stratasys allow vivid visualization with realistic 3D models. Ultimately, this results in saving time and cost. Especially since the additive manufacturing process also minimizes waste.

As of today, there are four distinct types of technologies used in 3D printers: Material extrusion based 3D printers, Photo polymer, Selective Deposition Lamination and Binding 3D printers.

## 1.9 Benefits for Environment

Kitchen automation has a large effect on environment.Measuring this impact isn't straight forward and simple.Many emerging technologies offer the potential to reduce emissions.The Earth's climate has changed throughout history. Just in the last more than half a million years, there have been seven cycles of glacial advance and retreat. According to NASA and Vostok Ice Core, Petit et al (Nature, vol. 399) the current warming trend is of particular significance because of the fact most of it is likely to be the result of human activity since the first industrial revolution. Consequently, researchers have even been looking for ways of modifying the Earth's environment to control global climate. Using advanced technology when building or upgrading infrastructure can help reduce climate-related risks. The climate-resilient technology is already being incorporated, not only into the construction industry but also into business processes of many different industry sectors. According to The Guardian, if every new building for the next 30 years was made with a material which absorbs carbon dioxide, humans could eliminate the globe warming pollution but the key is automation and robotics. It can have a huge footprint to enhance the resilience of business to the climate variability of a warming planet. Rapid advances in robotics are proving to be a key driver of the current explosion in technological innovations created by both corporations and early-stage startups. Robotics is already a multibillion-dollar industry with its core in manufacturing automation. The market for robots that can perform basic chores such as cleaning, mowing, and vacuuming is already significant. Yet robotic driving will transform means of transport or factories reducing energy consumption and pollution emissions. The link between energy efficiency, renewable energy sources, and climate change is clear however the path of how automation can help is not obvious. It is in relation to combining climate change in particular where robots can provide some benefits. Preventing pollution and emissions through monitoring the release of harmful greenhouse gasses or optimizing the manufacturing processes are the forces which can definitely change ways how the current world works. With regard to the latter, robots are rising to tackle the dullest, most dangerous and possibly the dirtiest jobs like sorting garbage for instance. In recent years, the waste industry has begun deploying new software and mechatronic innovations to bring down the operating costs and reduce the negative impacts of waste on the environment. According to Science, there are numerous benefits of using robots in waste treatment and recycling. Processes which have been automated can reduce the amount of CO2 emissions as a result of final waste incineration reducing its quantity or increase the number of materials which can be captured during the sorting processes and as a result bring them back on the market

## 1.10 Benefits for Society

This system will ensure that anyone who uses it can benefited by it to reduce the stress of the people who come home tired and have to cook food. Automation in the workforce requires an initial investment. However, the increased profits are proving a fantastic return on investment. Improved Safety and Security In a factory setting, robots are taking over dangerous jobs involving blades, welding, chemical exposure, and more. It's obvious why human error can have huge consequences in this setting, especially after workers have been on the line for long hours. In an office setting, automation also reduces human error. For example, automation can help monitor unusual cyber activity. This helps to keep your sensitive information safe. Better Product Quality One of the great benefits of automation is freedom from fatigue. Plus, robots don't need bathroom breaks or sick days. They can produce the same product the same way as long as you need them to, with virtually no variation in quality. Automation ensures better product quality in an office setting too. An automated personal assistant, such as Sally, can schedule your meetings for you. By syncing up with your calendar, Sally won't forget about your dentist appointment and double book. Higher Product Output While automation has the potential to replace jobs, it also has the potential to create higher profits, allowing businesses to expand. For example, the rise of ATMs may have decreased bank teller employment, but because ATMs made it cheaper to operate each branch, the number of branches increased. In turn, bank teller employment overall increased because of the ability to serve more customers during more hours at a lower cost. Higher Employee Value Productivity and profits have a clear link. That's probably why people today are working more hours than ever. In fact, it is estimated that in the United States, 85.8Automating aspects of your business allows your employees to have higher value and be more productive. Plus, it will likely lead to more enjoyable jobs. Freedom From the Mundane Automation allows employees to focus on the jobs that require critical thinking and free them from busy work. Speaking of busy work, automation eliminates the horribly boring tasks that no one wants to do. For example, applying hundreds of labels a day gets old quickly and requires minimal skill. The same goes for exchanging a long chain of emails to try and coordinate a meeting time. Automating systems like this saves time and money, and is likely to increase worker morale as well!

## 1.11 Applications

The System contains a Robotic arm which can do various tasks in the kitchen like Stirring food, Turning gas on  off, turning mixer grinder on  off etc. The best part about is that you can configure it to run on it's own by making it remember the co-ordinates. Perhaps the most cited advantage of automation in industry is that it is associated with faster production and cheaper labor costs. Another benefit could be that it replaces hard, physical, or monotonous work. Additionally, tasks that take place in hazardous environments or that are otherwise beyond human capabilities can be done by machines, as machines can operate even under extreme temperatures or in atmospheres that are radioactive or toxic. They can also be maintained with simple quality checks. However, at the time being, not all tasks can be automated, and some tasks are more expensive to automate than others. Initial costs of installing the machinery in factory settings are high, and failure to maintain a system could result in the loss of the product itself.

Moreover, some studies seem to indicate that industrial automation could impose ill effects beyond operational concerns, including worker displacement due to systemic loss of employment and compounded environmental damage; however, these findings are both convoluted and controversial in nature, and could potentially be circumvented.

The main advantages of automation are Increased throughput or productivity. Improved quality or increased predictability of quality. Improved robustness (consistency), of processes or product. Increased consistency of output. Reduced direct human labor costs and expenses. Installation in operations reduces cycle time. Can complete tasks where a high degree of accuracy is required. Replaces human operators in tasks that involve hard physical or monotonous work (e.g., using one forklift with a single driver instead of a team of multiple workers to lift a heavy object)[49] Reduces some occupational injuries (e.g., fewer strained backs from lifting heavy objects) Replaces humans in tasks done in dangerous environments (i.e. fire, space, volcanoes, nuclear facilities, underwater, etc.) Performs tasks that are beyond human capabilities of size, weight, speed, endurance, etc. Reduces operation time and work handling time significantly. Frees up workers to take on other roles. Provides higher level jobs in the development, deployment, maintenance and running of the automated processes. The main disadvantages of automation are: Possible security threats/vulnerability due to increased relative susceptibility for committing errors. Unpredictable or excessive development costs. High initial cost. Displaces workers due to job replacement.

# Chapter 2

# Project Design

graphics

## 2.1 Proposed System

The proposed system should have the following features. The required automation tools should be efficiently and safely placed in the environment(Kitchen). The placed tools shouldn't impose any inconvenience to the user or to the environment i.e they shouldn't have any effects on the surrounding that could alter environmental conditions in a negative way, and only the input and output of the information should be done. The data of the environment is to be collected at all the required instances of time and shouldn't affect the on going process at all. This program would define the limits of data fluctuations which will be analysed via a set of logical functions and operations performed on the data gathered and pre-defined actions will be stored here as triggers or functions. These predefined actions will be recorded movements of the Robotic Arm around it's various axes that will be performing those actions directly on the environment as it will be placed in it too. This Robotic Arm will be controlled by the user via an User Interface which will be an Application handled by the user to define the co-ordinates and positions of the concerned object to be used from a fixed position of the Arm itself. The actions to be performed by the Arm will be stored and defined in the Node MCU itself and the Application will also be configured with it via a wireless network over WiFi. Hence, the Node MCU will act as the bridge between the User Interface and the Arm and will perform all the necessary processing of data, requesting data, timing actions and decision making of the entire Automation use case. The transfer of data should be over a secure network and a wireless medium of transfer wherever possible so as to avoid the hassle of wires which would only pollute the environment unnecessarily. Hence, to sum it up, the central processing system i.e the Node MCU will be configured with the Sensors,The Robotic Arm, and the User Interface. The User Interface i.e Application will be sending data to the Node MCU to forward to the Robotic Arm for performance. This is the proposed system for our Kitchen Automation Project.

## 2.2 Design (flow of modules)

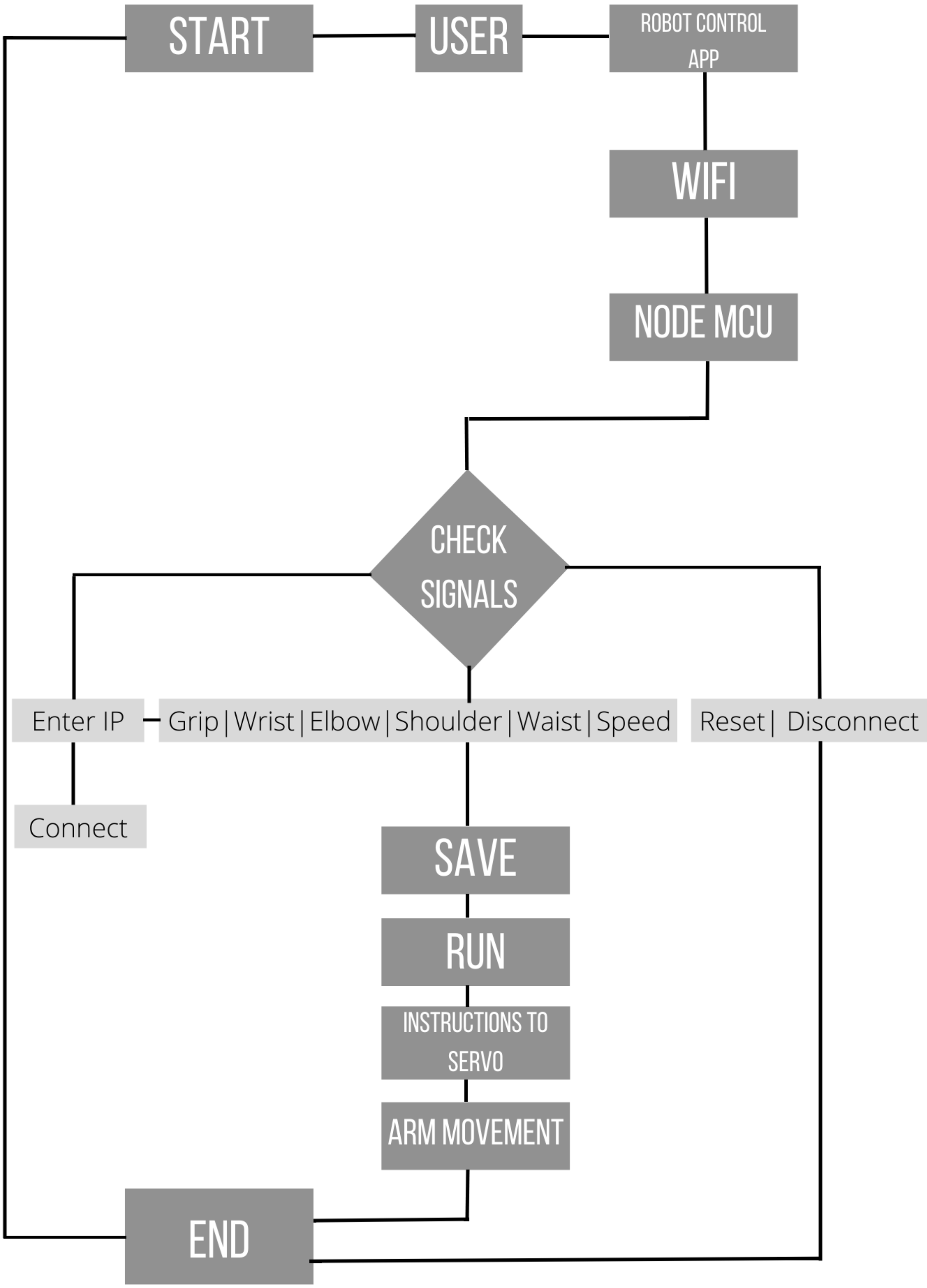



Fig. 2.2 Flow of Modules

The basic FOM of the KAS will be as given above. The user can run, reset and save the programs given to the robotic arm via Node MCU and the changes would be done on the environment.The positions of the arm will be constantly notified to the user via node mcu in the application.

The flow will be as follows

The user will install the application which is to be used to control the robotic arm. Once the application is installed then we need to configure it with the node mcu. So for doing that we must ensure that both the devices are connected to the same WiFi network. After that the application gives data to node mcu and the node mcu acknowledges that the data is received by glowing the LED attached to it. Then after the 2 are on same network we enter the commands to make a movement in the arm i.e the grip, elbow, shoulder, waist, speed, reset, disconnect and then save that path for future use. Then once the node mcu receives the signal it then passes it to the servo motors to make the arm move. This is done via wired communication. When the motors receive the input they move and perform the changes in the environment. The current co-ordinates are them sent back to node mcu. The reset button will stop the working and the arm will return to it's origin co-ordinates. and the disconnect button will disconnect it from the WiFi network.

## 2.3 Activity Diagram

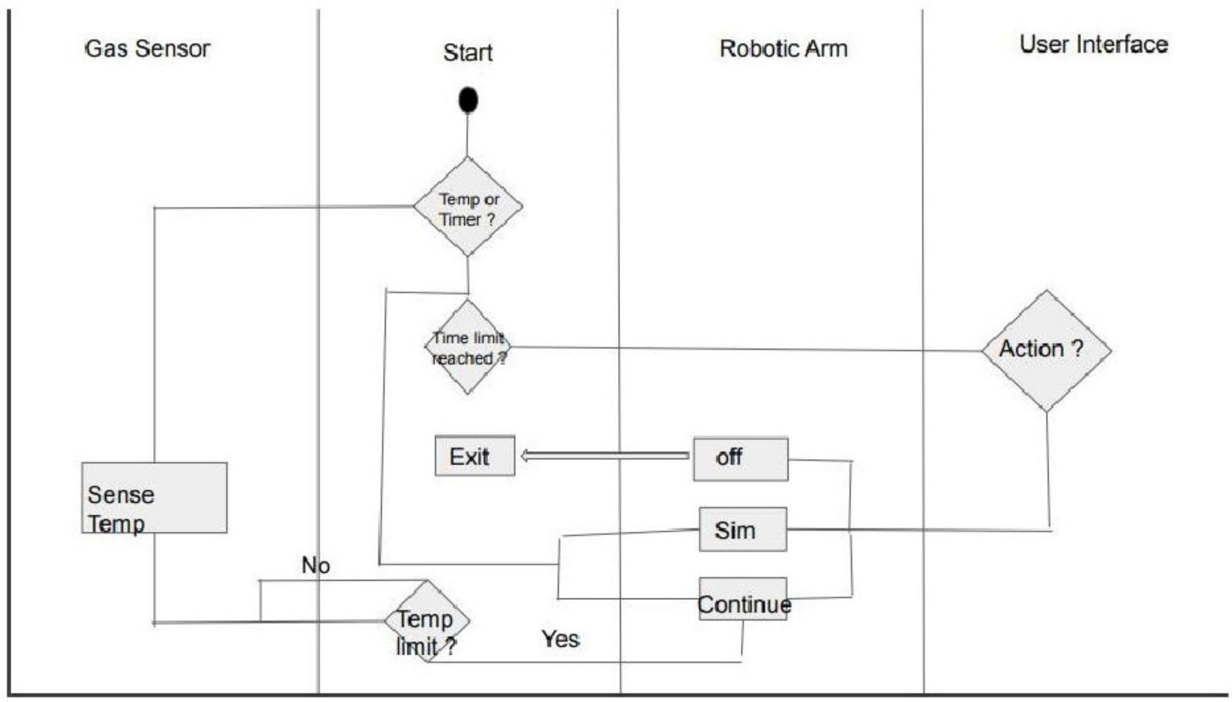



Fig. 2.3 Activity Diagram

This will be the basic activity of the KAS. The app will ask you to specify if you want to turn off the gas at a specific temperature or time. If you specified temperature then it will take into consideration a minimum threshold temperature and if it exceeds the minimum temperature then the robotic arm will turnoff the gas. The temperature will be sensed by IR sensors that can sustain in extreme temperatures. if you considered time then it will ask you the time at which it should be turned off and after that time it will turn the gas off. There are also some functions where you can manually operate it and slim the flame. These are the basic activities that can be performed using the robotic arm for cooking. Other than that the arm can be used for cleaning , lifting and other stuff like stirring , covering with a lid etc. It can also be used to turn on and off mixer grinders etc.

## 2.4 Use Case Diagram

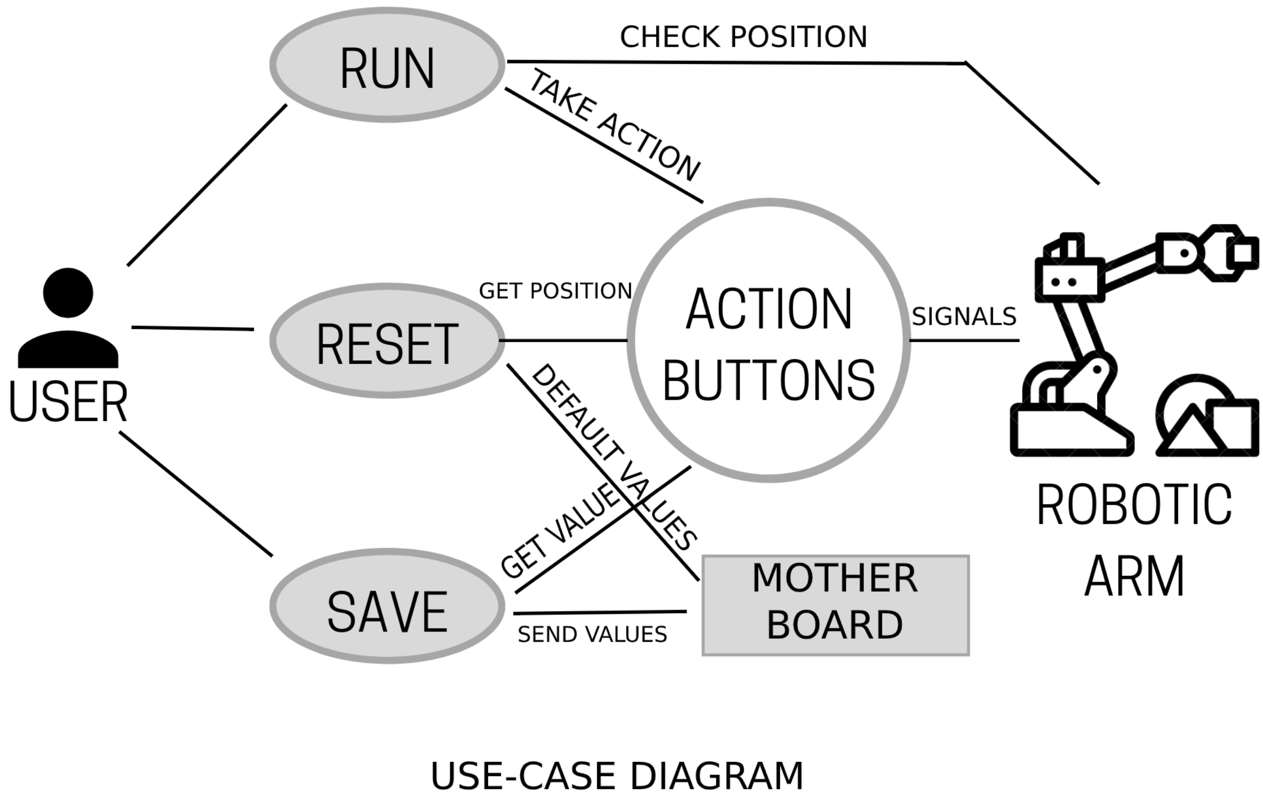



Fig.2.4 Use Case Diagram

## 2.5 Description of use case diagram

In the KAS the user will interact with the robotic arm by an smart phone application via Node MCU. The user will have 3 options Run, Reset and Save, The run command will make the robotic arm move in the direction of the co-ordinates given by the user in the app. The reset button will reset the robotic arm and it will return to it's origin. The save button will help the robotic arm to execute a previously executed task by saving the co-ordinates in it's memory. The constant exchange of values such as position, signals, actions to be performed will be done using wired and wireless communications. We can use WiFi or Bluetooth both to exchange data. The robotic arm will keep doing the actions on the environment until it's stopped. These are the basic activities that can be performed using the robotic arm for cooking. Other than that the arm can be used for cleaning , lifting and other stuff like stirring , covering with a lid etc. It can also be used to turn on and off mixer grinders etc.

## 2.6 Project Modules

### 2.6.1 Module 1 - Robotic Arm


Fig. 2.6.1 3D Model of the Robotic Arm

The robotic arm will look like this. It is made using 3D printing. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. 3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine. 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

### 2.6.2 Module 2- Servo Motors


Fig. 2.6.2 MG996R Servo Motor


Fig. 2.6.2 SG90 Micro Servo Motor

These servo motors will be attached to the robotic arm to ensure its movements and it will help to lift things and take load. Robotic arm has 5 degrees of freedom, achieved by using 6 Servo motors. 3 main motors at Elbow, waist and shoulder while other 3 on the wrist. The motors used at the Elbow , waist and shoulder are MG996R Servo motors and the ones used on wrist pitch, wrist roll gripper are S690 Micro servo motors. A servo motor consists of a DC motor, a gear system, and a position sensor. The positions sensor feeds the info about the position of the shaft to the control circuit. It requires up to 4.8V to 6V of power supply to operate hence the motors are connected to external batteries. The motors help the robotic arm to move and it can pick up to 10 kg load. The whole system is connected to the node mcu and the commands to move is provided via that. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction.

### 2.6.3 Module 3- Node MCU

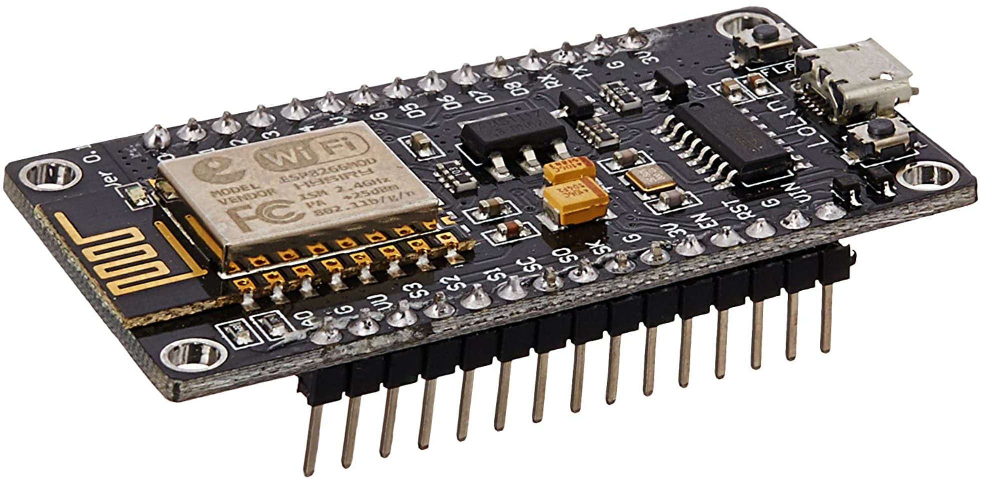


Fig. 2.6.3 Node MCU

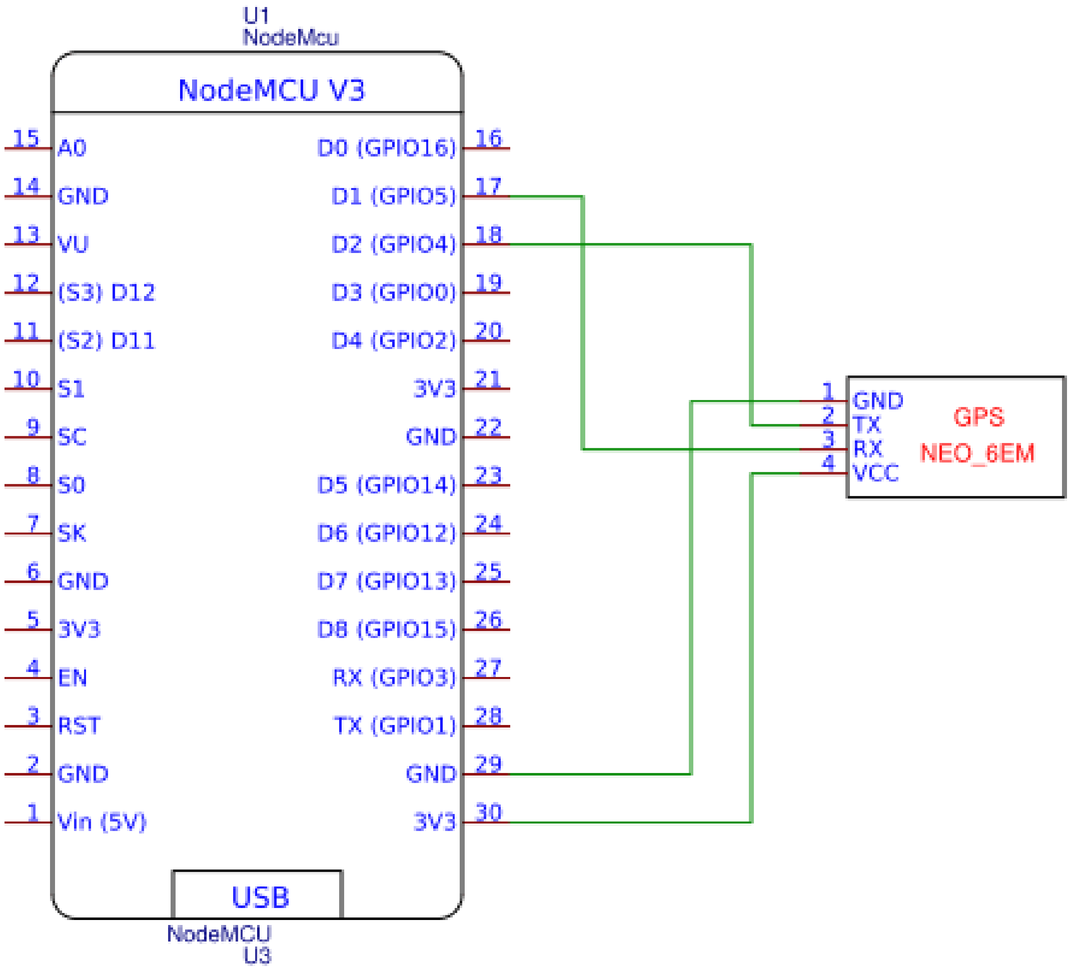



Fig. 2.6.3 Node MCU Pin Diagram

The Node mcu is the interface between UI and the Robotic arm. All exchange of data will be done via node mcu.NodeMCU (Micro Controller Unit) is an open source IoT platform.It includes firmware whichruns on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.The firmware uses the Lua scripting language. Firmware can provide a standardized operating environment for the devices, acting as the device's complete operating system, performing all control, monitoring and data manipulation functions. It has 16GPIO pins. The device features 4MB of flash memory, 80MHz of system clock, around 50kof usable RAM and an on chip WiFi Transceiver. All the connections of servo motors will be controlled by Node MCU. Node MCU will be receiving control signals from user device from an software application. This interface between an user device and Node MCU will be managed by Bluetooth or an WiFi connection.

### 2.6.4 Module 4- Smart Phone Application

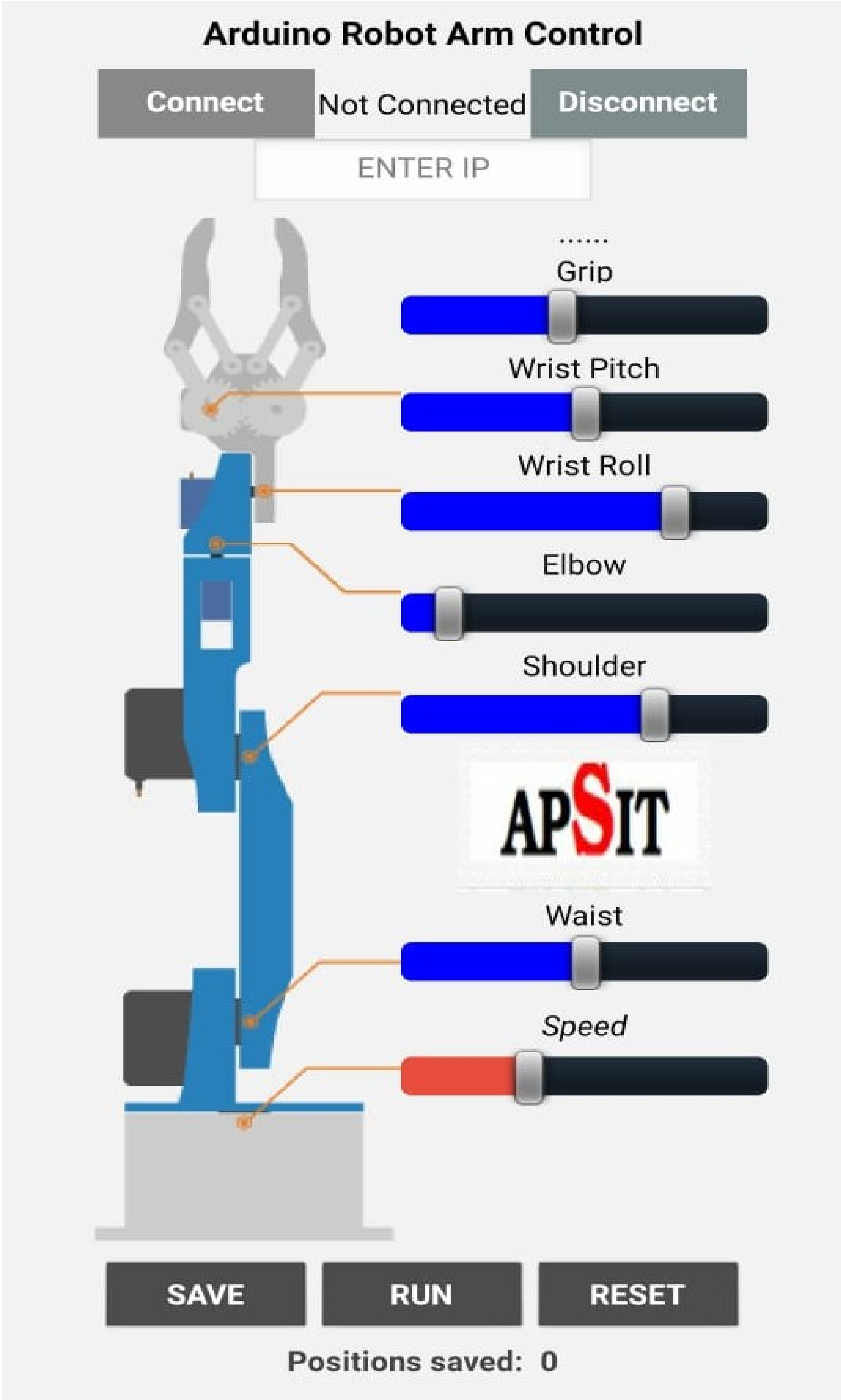



Fig. 2.6.4 Smart Phone Application UI

The application will help you to control your arm. It is very small in size and can run on both Android as well as iOS. Application development is the process of creating a computer program or a set of programs to perform the different tasks that a business requires. From calculating monthly expenses to scheduling sales reports, applications help businesses automate processes and increase efficiency. Every app-building process follows the same steps: gathering requirements, designing prototypes, testing, implementation, and integration.

# Chapter 3

# Project Implementation

## 3.1 Module 1 - Robotic Arm

Robotic Arm is the device which will be used to perform all the actions on the environment i.e (Kitchen) like Turning Gas on  off, Stirring food, etc. The robotic arm will receive all the commands from the user from the application in their phone via Node MCU. The parts of the Robotic Arm was printed by a 3D Printer as this is just a prototype, the actual robotic arm must be made of an insulating material so it can handle high temperature conditions. The Robotic arm consists of 5 degrees of freedom i.e The base, elbow , shoulder,wrist and the gripper. All these work in unison to perform the various actions in the environment. The robotic arm is used for multiple industrial applications, from welding, material handling, and thermal spraying, to painting and drilling. The robotic technology also provides human-like dexterity in a variety of environments. These may include servicing nuclear power stations, welding and repairing pipelines on the ocean floor, remote servicing of utility power lines, or cleaning up radioactive and other hazardous wastes. An example of where automated robotic arms are used is in the auto-manufacturing industry. Robots have been a boom to the auto-manufacturing industry. Most industrial robots work in auto assembly lines, putting cars together. Robots can do a lot of this work more efficiently than human beings because they are so fast and precise. They also have significantly reduced worker injuries, including repetitive stress injuries and more significant mishaps that can do major harm. Additionally, the robots turn out a more consistent product at a significantly cheaper cost than can humans. Currently, robotic-assisted auto manufacturing allows a car to be made with much more precisely as robotic arms always drill in the exactly the same place, and they always tighten bolts with the same amount of force, no matter how many hours they've been working. Finally, robots save on the cost of labor: There are no sick days, strikes, work slowdowns or other problems that can crop up with humans. Robots can, in fact, work around the clock with a minimum of human supervision. The auto-manufacturing industry is a specific example of where the design of our robot can be applied. In this industry robots may be required to collect and stack tyres just as our one does.

### 3.1.1 The Robotic arm after full assembly

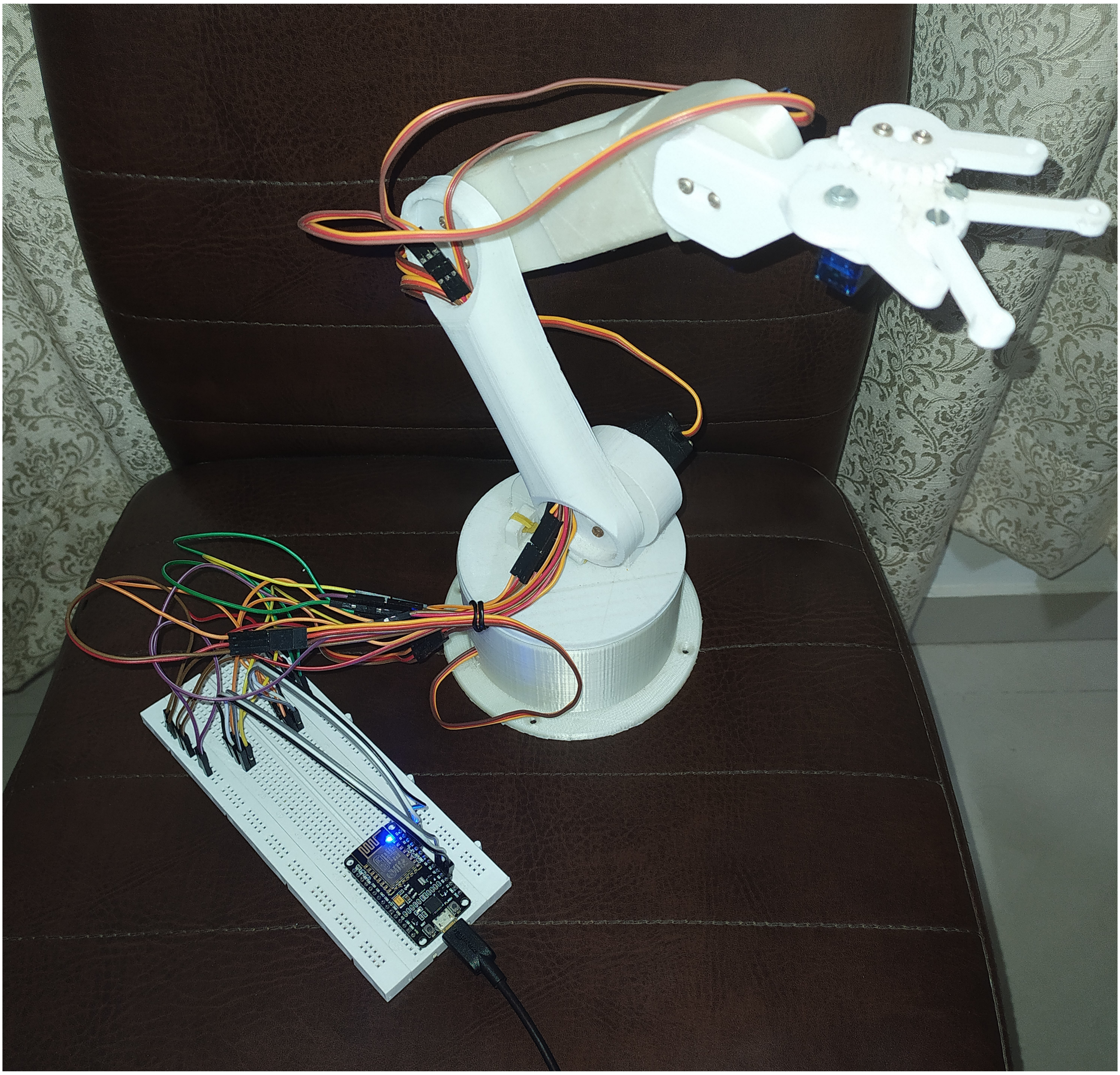


Fig. 3.1.1 Actual Hardware Setup

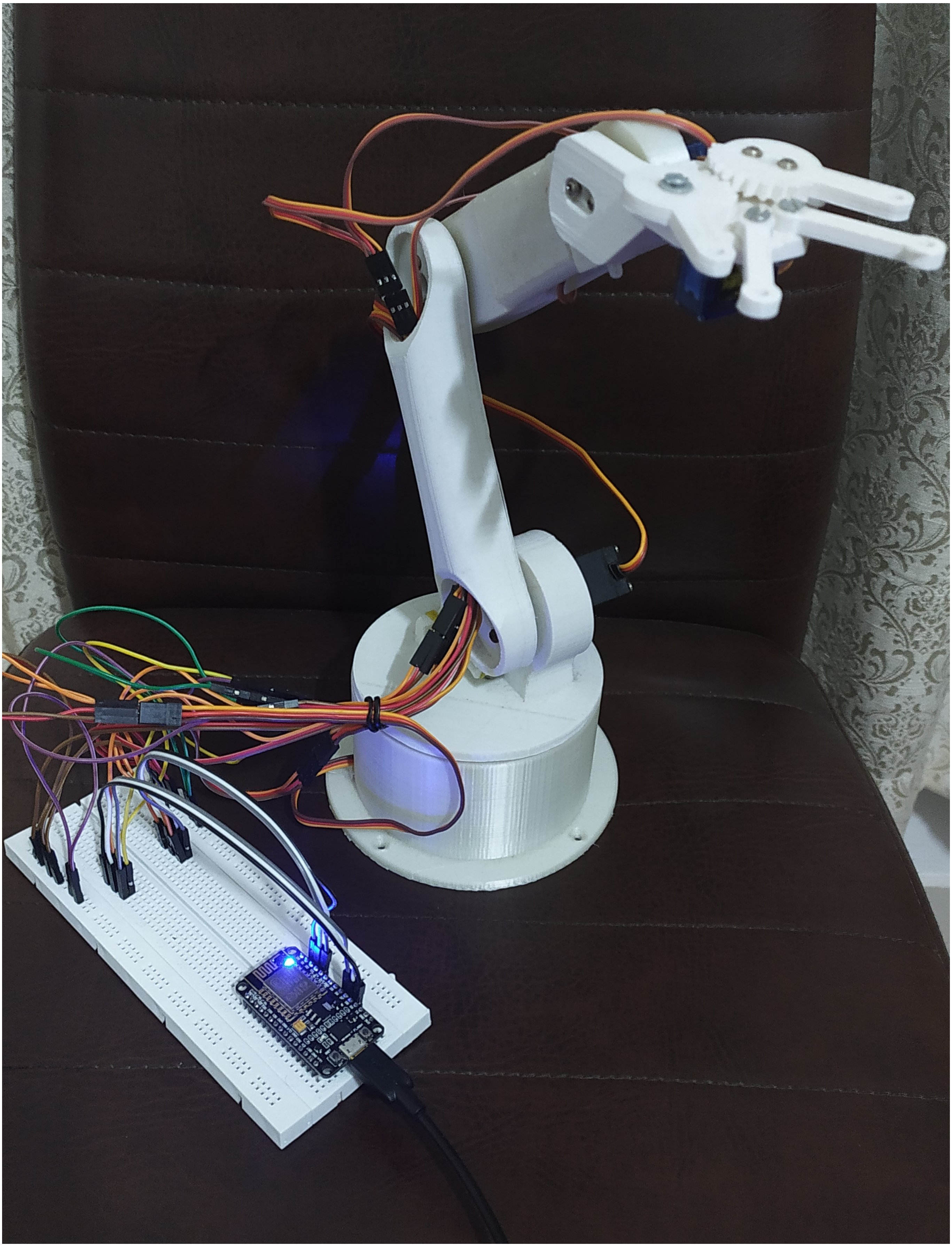


Fig. 3.1.1 Actual Hardware Setup

### 3.1.2 The 3D Models of each part of the robotic arm

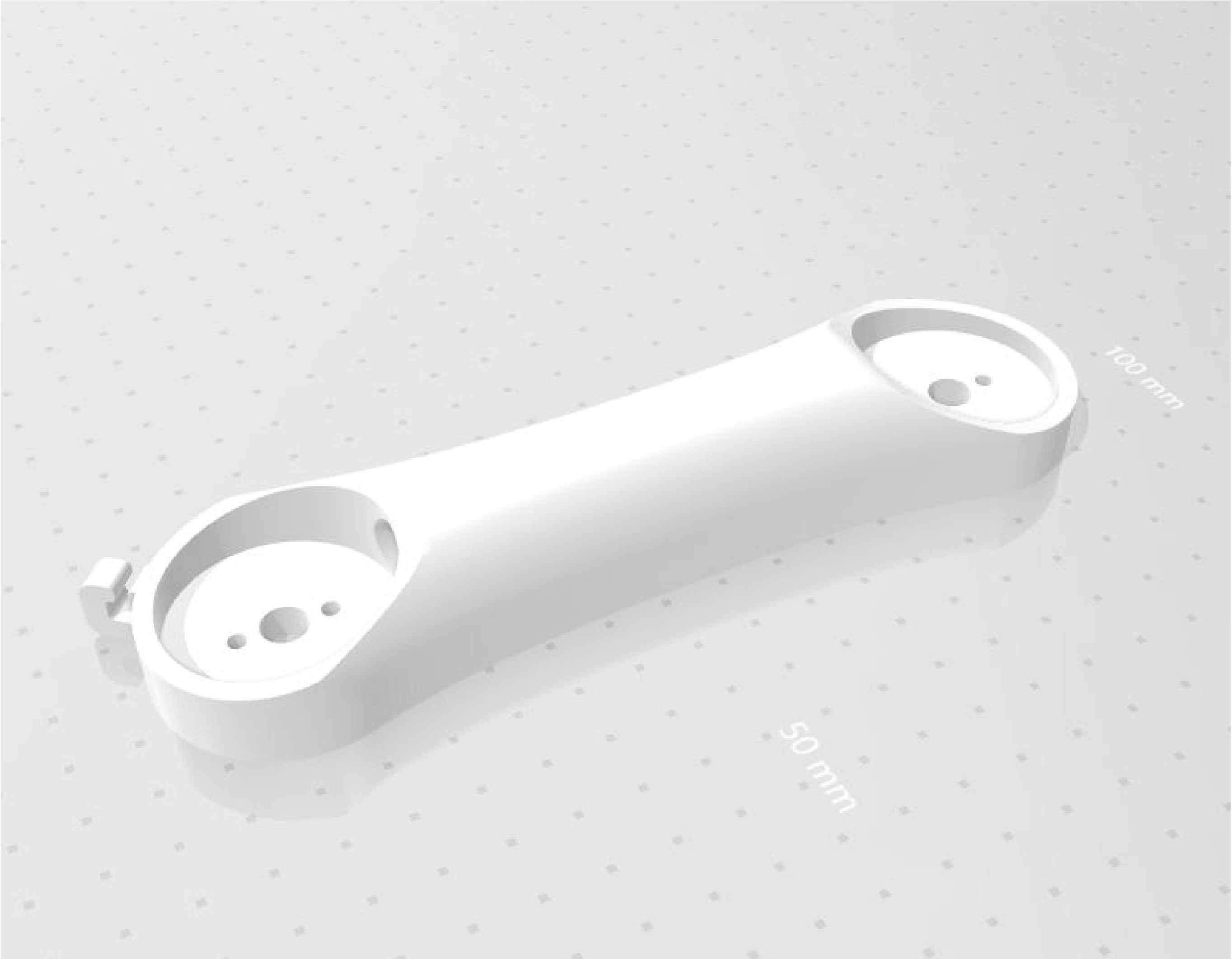


Fig. 3.1.2 3D Printed Arm 1

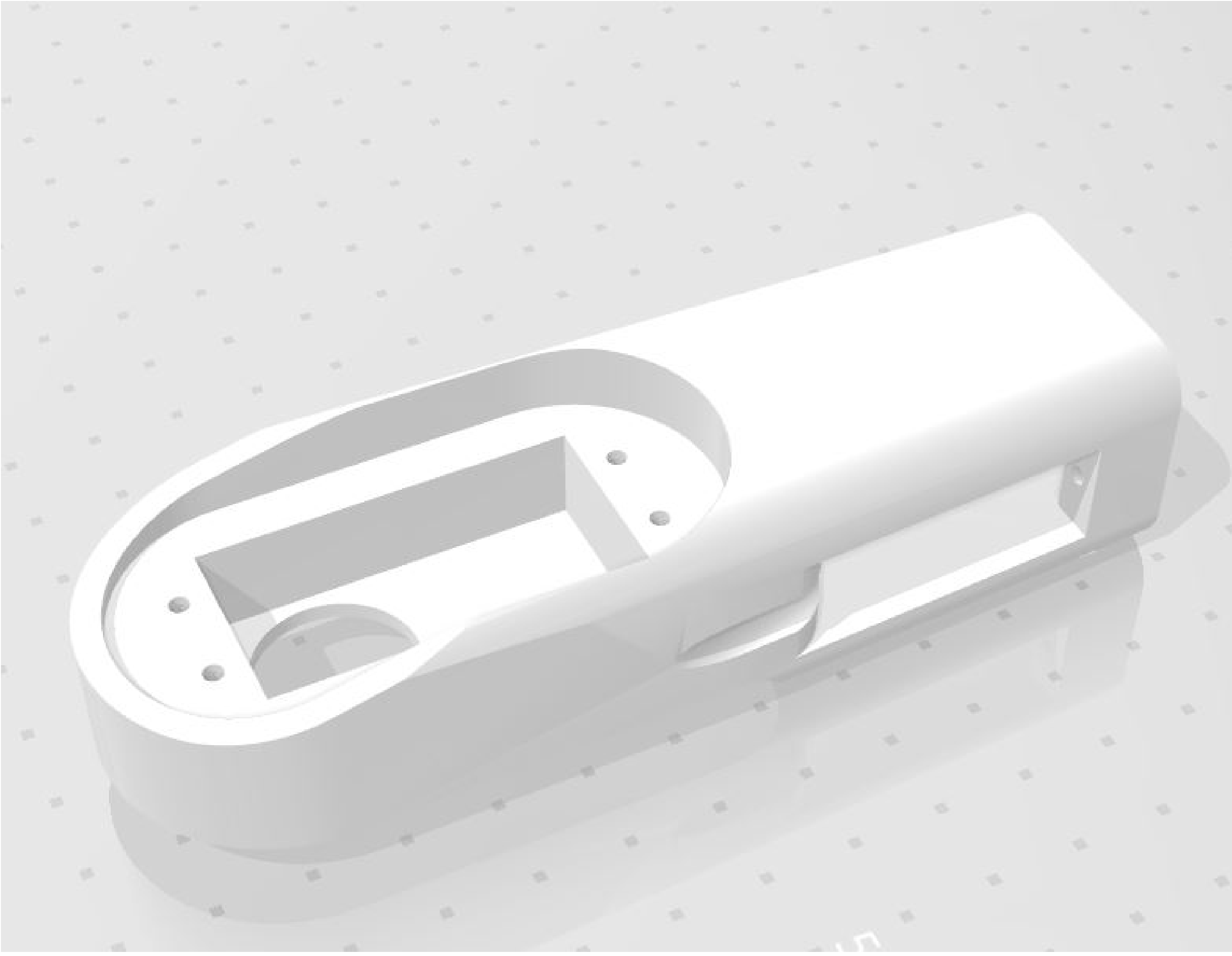


Fig. 3.1.2 3D Printed Arm 2

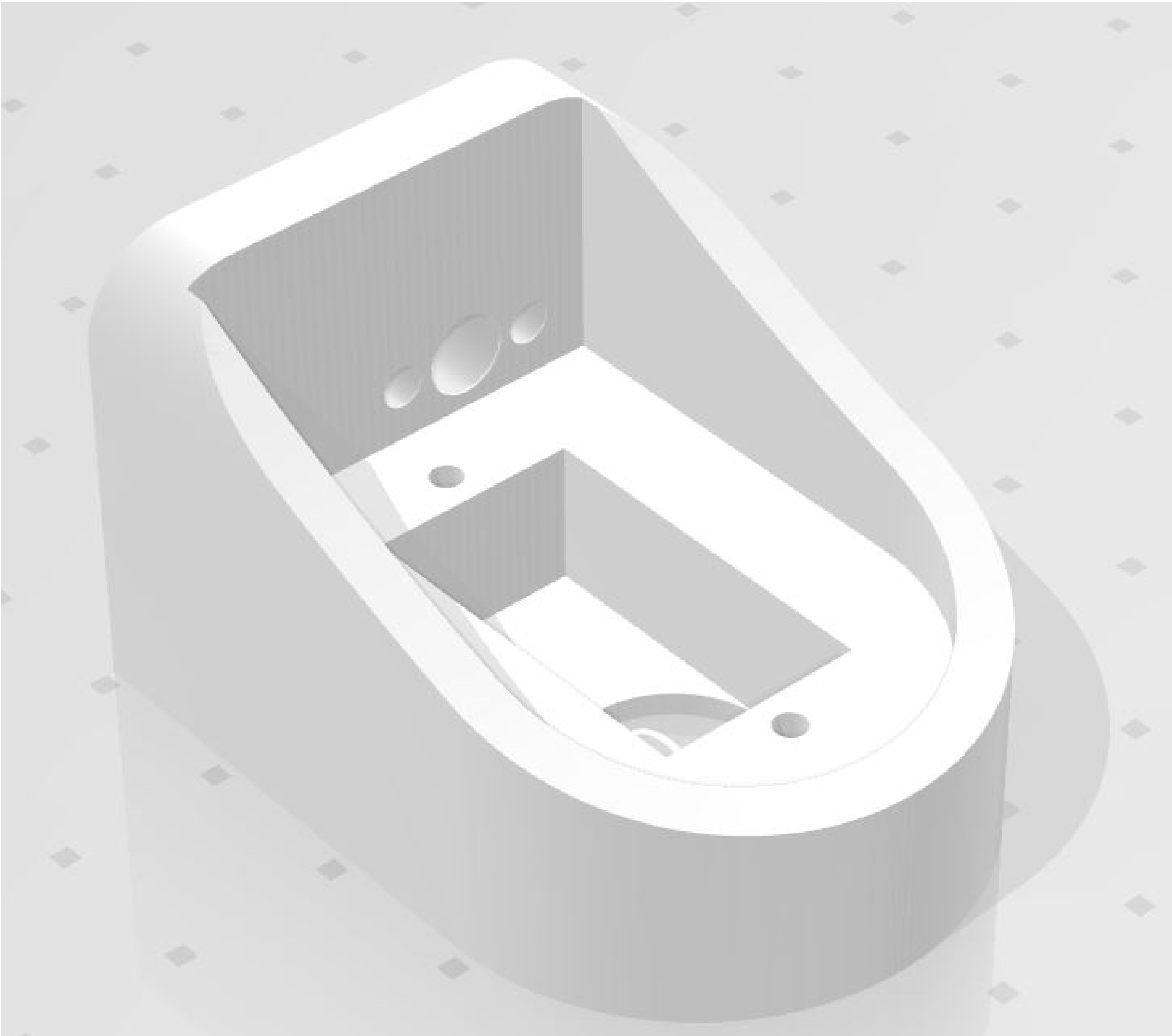


Fig. 3.1.2 3D Printed Arm 3

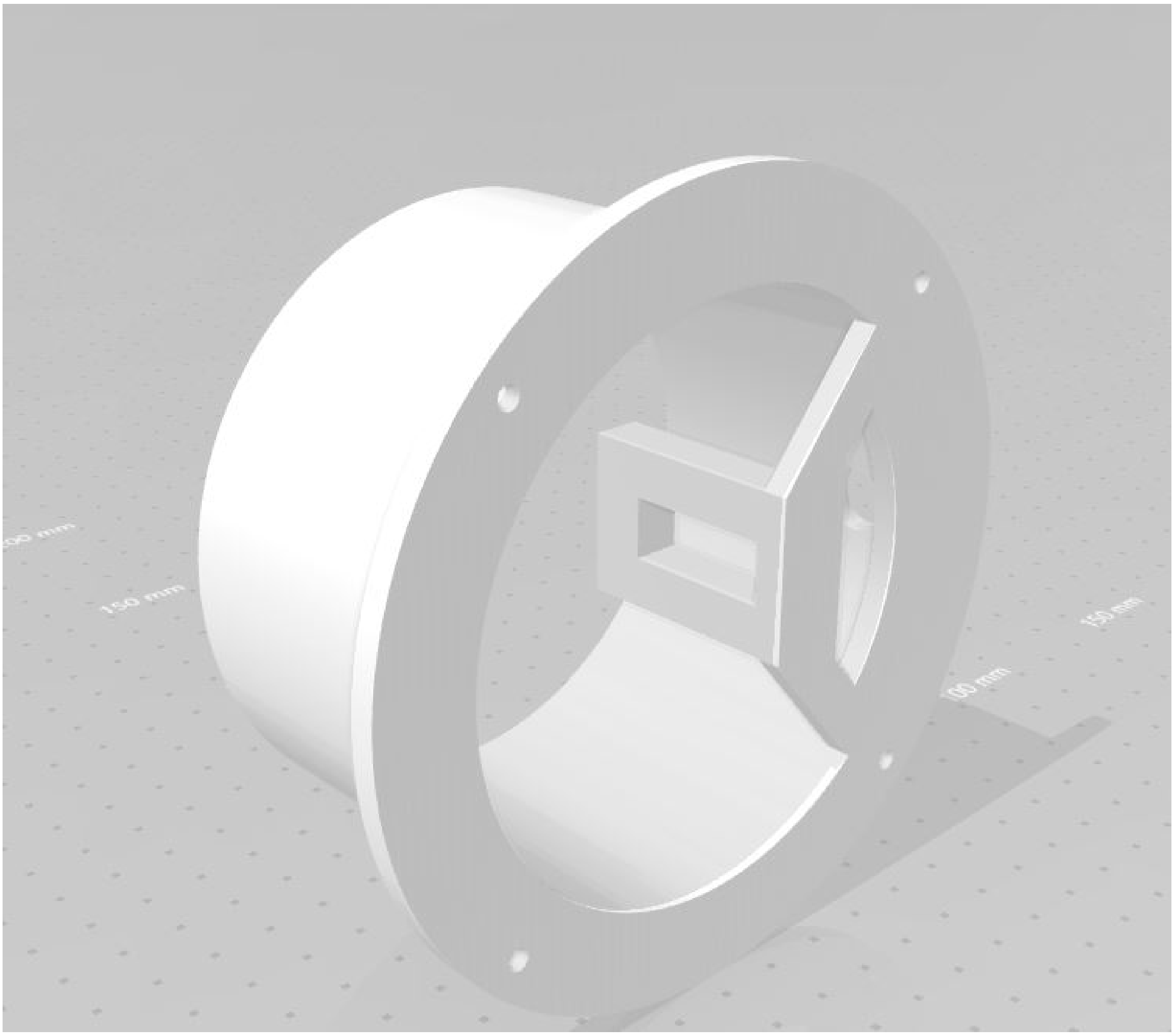



Fig. 3.1.2 3D Printed Base

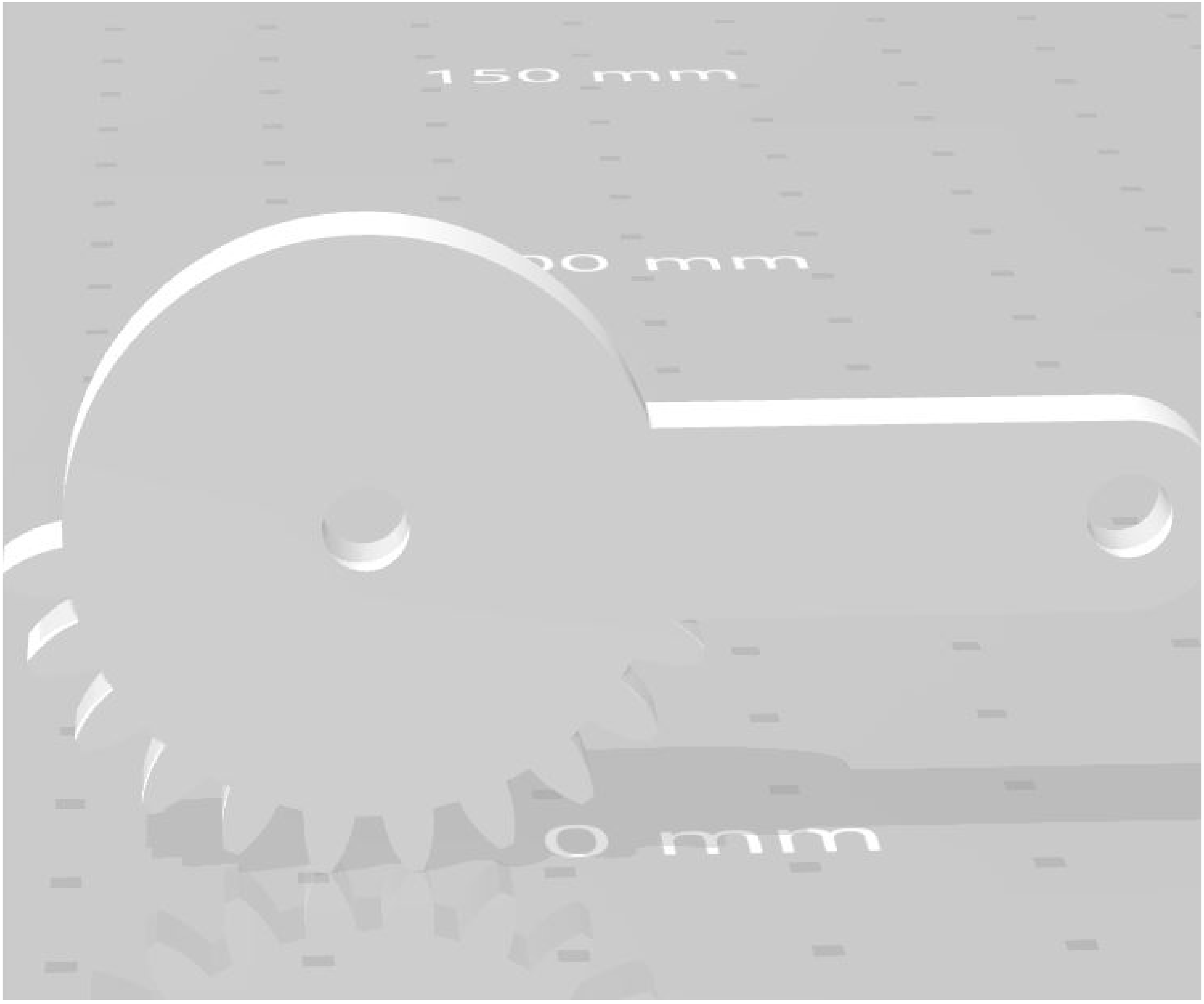


Fig. 3.1.2 3D Printed Gear

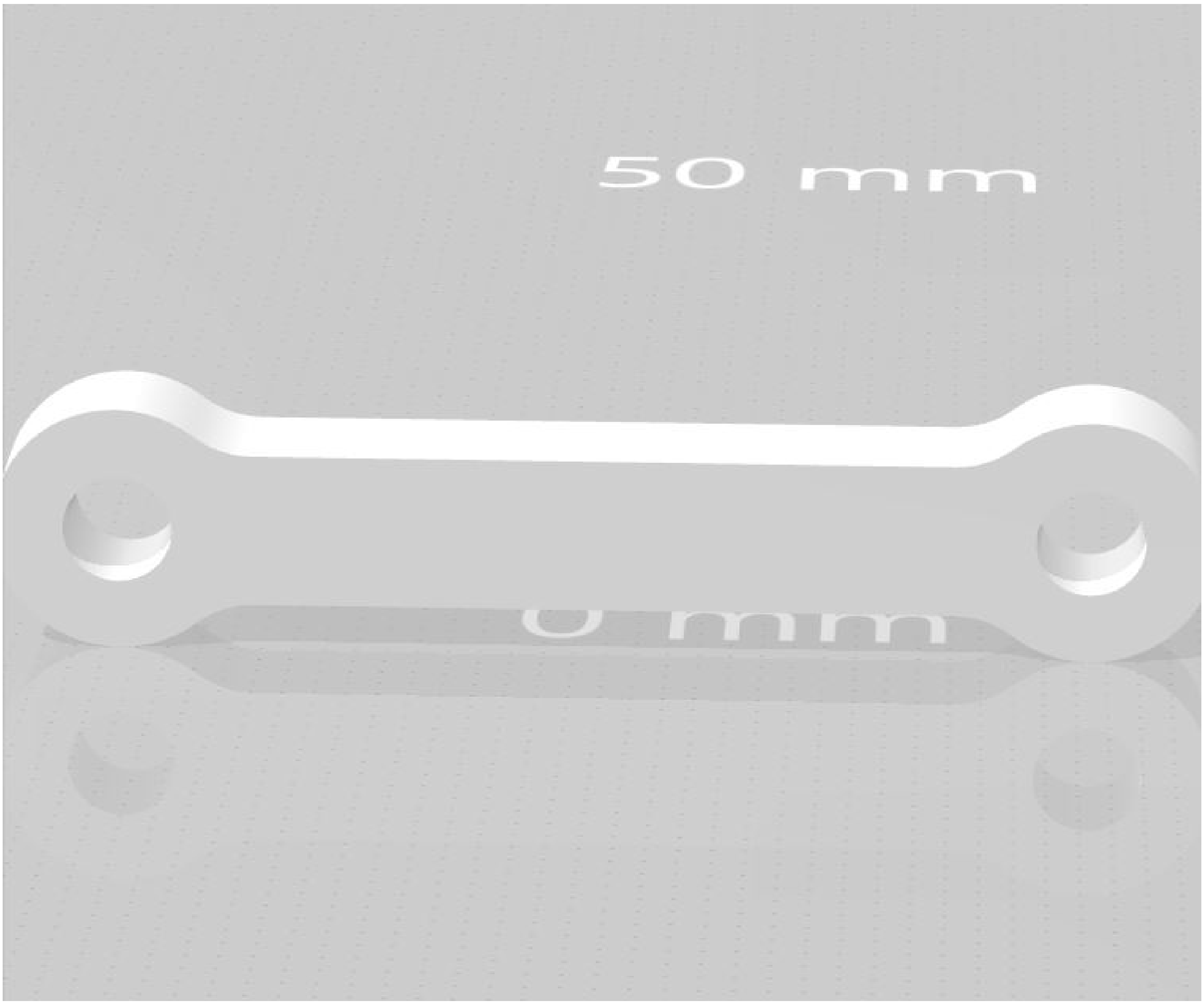


Fig. 3.1.2 3D Printed Grip Link

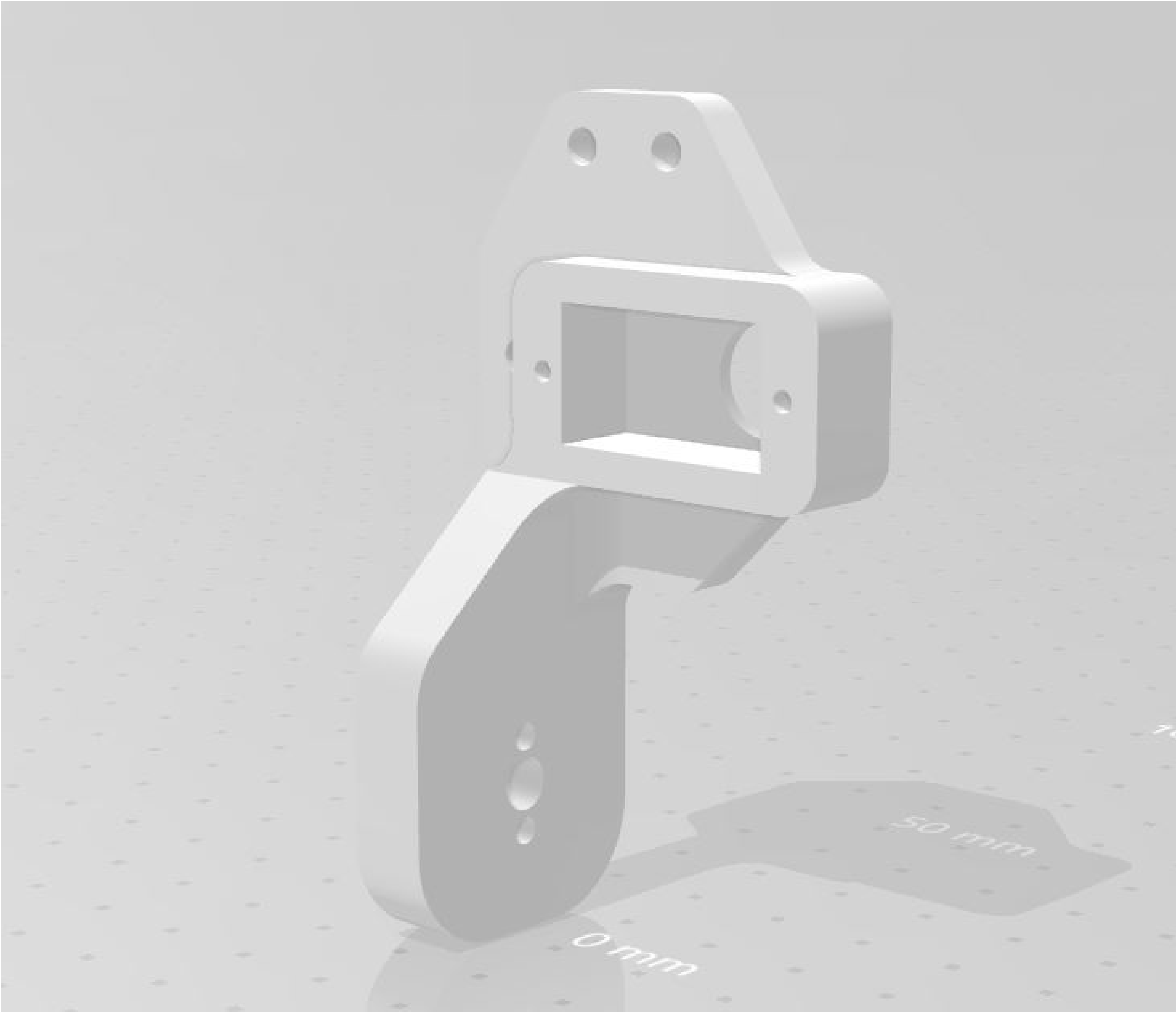



Fig. 3.1.2 3D Printed Gripper Base

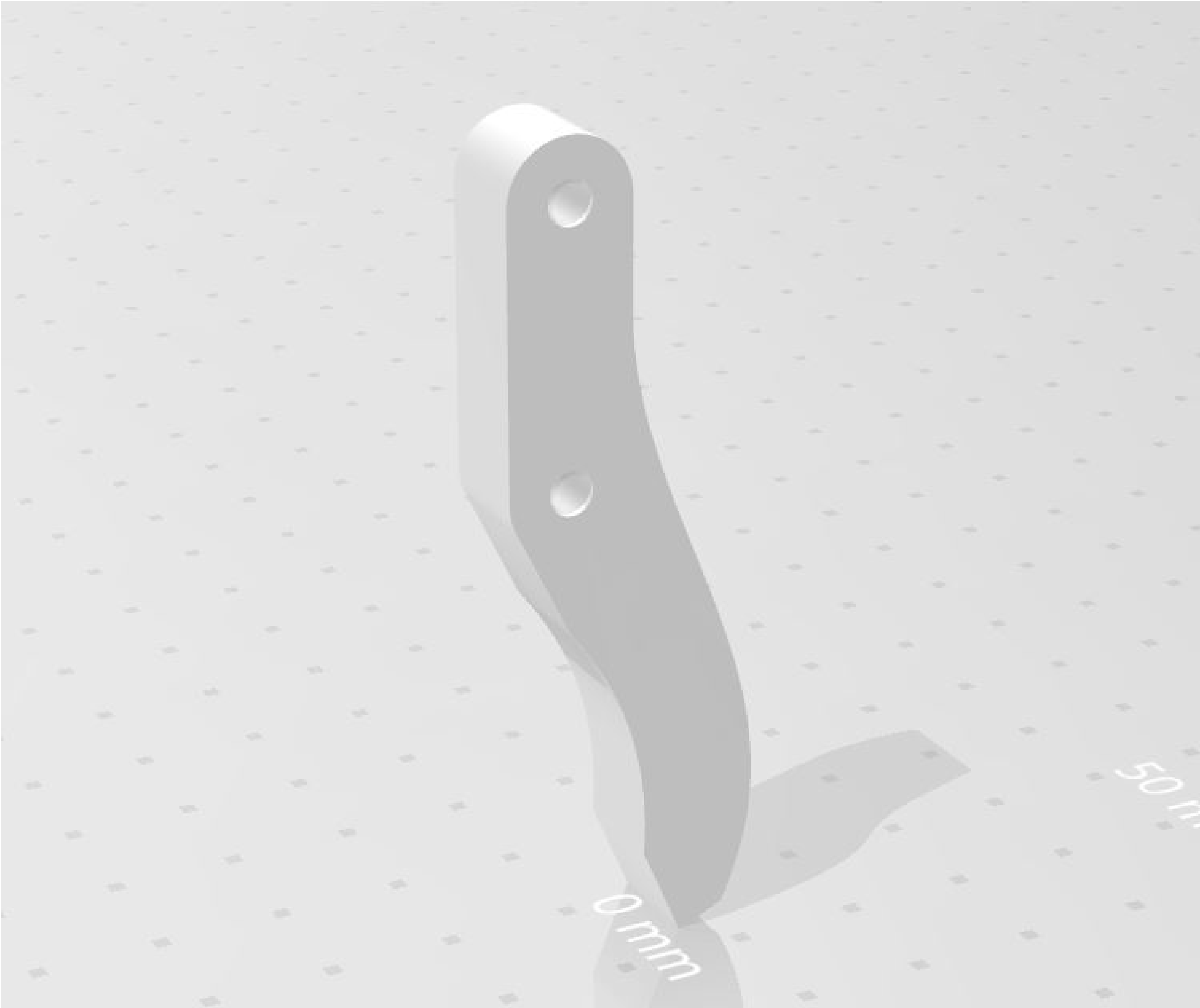


Fig. 3.1.2 3D Printed Gripper

## 3.2 Module 2 - Servo Motors

Robotic arm has 5 degrees of freedom, achieved by using 6 Servo motors. 3 main motors at Elbow, waist and shoulder while other 3 on the wrist. The motors used at the Elbow , waist and shoulder are MG996R Servo motors and the ones used on wrist pitch, wrist roll gripper are S690 Micro servo motors. A servo motor consists of a DC motor, a gear system, and a position sensor. The positions sensor feeds the info about the position of the shaft to the control circuit. It requires up to 4.8V to 6V of power supply to operate hence the motors are connected to external batteries. The motors help the robotic arm to move and it can pick up to 10 kg load. The whole system is connected to the node mcu and the commands to move is provided via that. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn the servo in a clockwise direction toward the 180° position. When these servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.There are two types of servo motors - AC and DC. AC servo can handle higher current surges and tend to be used in industrial machinery. DC servos are not designed for high current surges and are usually better suited for smaller applications. Generally speaking, DC motors are less expensive than their AC counterparts. These are also servo motors that have been built specifically for continuous rotation, making it an easy way to get your robot moving. They feature two ball bearings on the output shaft for reduced friction and easy access to the rest-point adjustment Potentiometer. Servos are used in radio-controlled airplanes to position control surfaces like elevators, rudders, walking a robot, or operating grippers. Servo motors are small, have built-in control circuitry and have good power for their size.

## 3.3 Module 3 - Node MCU

Install the Arduino Software (IDE) on Windows PCs This document explains how to install the Arduino Software (IDE) on Windows machines

Download the Arduino Software (IDE) Proceed with board specific instructions Download the Arduino Software (IDE) Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a portable installation. When the download finishes, proceed with the installation and please allow the driver installation process when you get a warning from the operating system. Choose the components to install. Choose the installation directory (we suggest to keep the default one) The process will extract and install all the required files to execute properly the Arduino Software (IDE)Proceed with board specific instructions When the Arduino Software (IDE) is properly installed you can go back to the Getting Started Home and choose your board from the list on the right of the page.

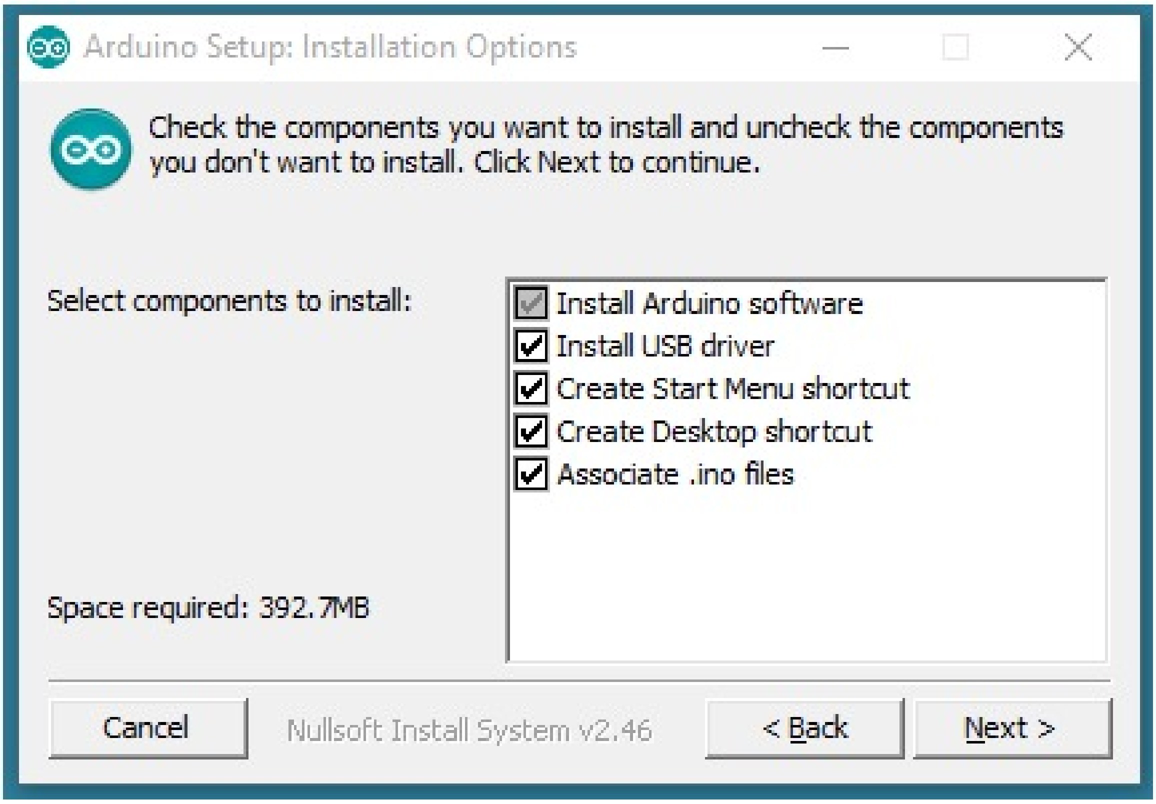
om!om!


Fig. 3.3 Arduino Setup Installation Process

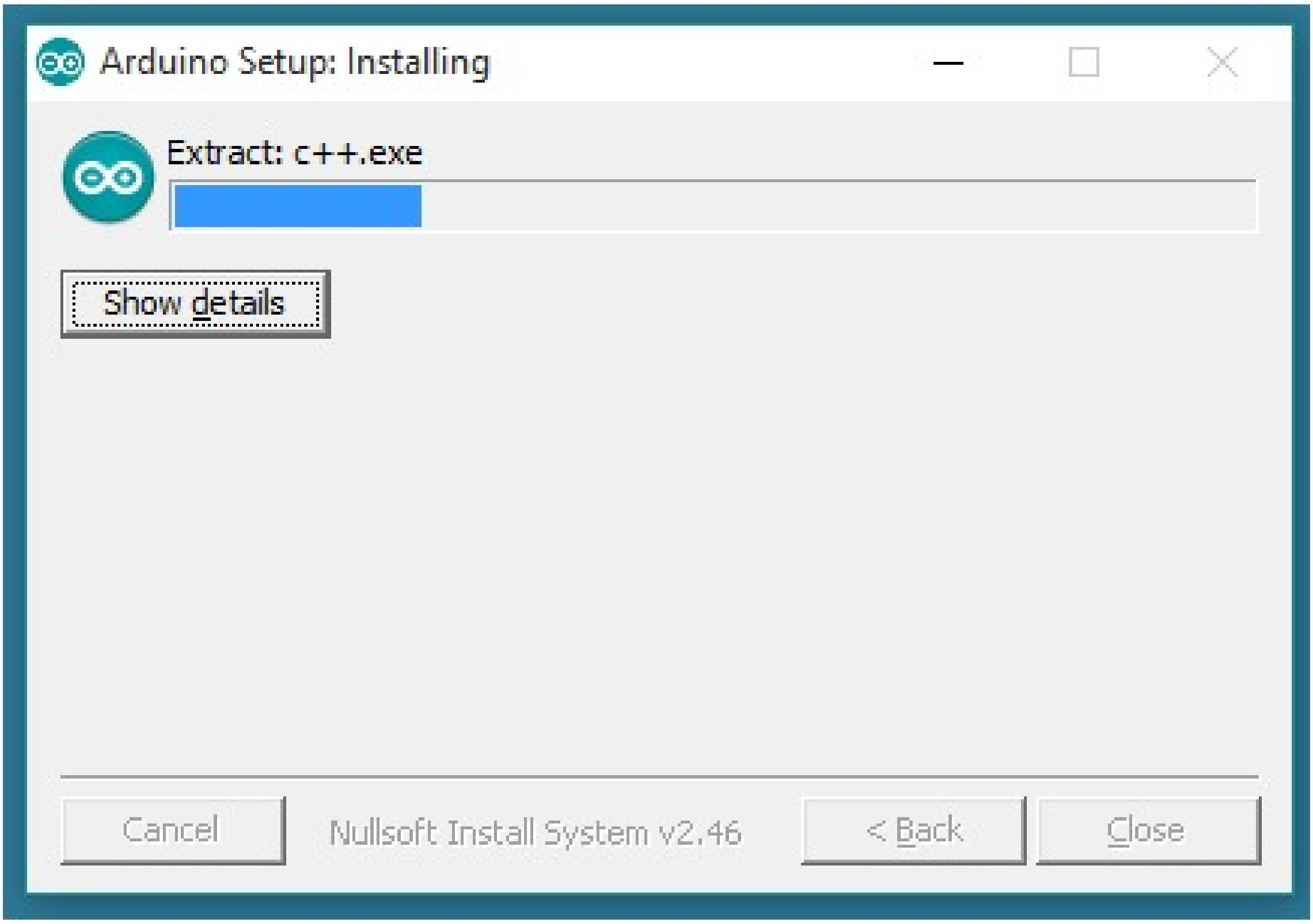



Fig. 3.3 Arduino Setup Installation Process

- Open-source
- Interactive
- Programmable
- Low cost
- simple
- smart
- WI-FI enabled
- USB-TTL included
- Plug  Play

NodeMCU DEVKIT 1.0 Specification: Developer : ESP8266 Opensource Community Type : Single-board microcontroller Operating system : XTOS CPU : ESP8266 Memory : 128kBytes Storage : 4MBytes Power By : USB Power Voltage : 3v ,5v (used with 3.3v Regulator which inbuilt on Board using Pin VIN) Code : Arduino Cpp IDE Used : Arduino IDE GPIO : 10

Advantages Low energy consumption Integrated support for WIFI network Reduced size of the board Low Cost Disadvantages Need to learn a new language and IDE Less pinout

## 3.4 Module 4 - Smart Phone Application

The whole system is supposed to be handled by the user and it can be done via an smart phone application which will allow the user to give the moving commands to the robotic arm also once if the path is given it can be stored and used again to make it function the same thing. This application is really small and it will hardly take any space in the user's device memory. The application can be built using various app development software such as Firebase, Android studio, Appy Pie etc. The app will be compatible for android as well as iOS. A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps are generally small, individual software units with limited function. This use of app software was originally popularized by Apple Inc. and its App Store, which offers thousands of applications for the iPhone, iPad and iPod Touch. A mobile application also may be known as an app, web app, online app, iPhone app or smartphone app. Mobile applications are a move away from the integrated software systems generally found on PCs. Instead, each app provides limited and isolated functionality such as a game, calculator or mobile web browsing. Although applications may have avoided multitasking because of the limited hardware resources of the early mobile devices, their specificity is now part of their desirability because they allow consumers to hand-pick what their devices are able to do. The simplest mobile apps take PC-based applications and port them to a mobile device. As mobile apps become more robust, this technique is somewhat lacking. A more sophisticated approach involves developing specifically for the mobile environment, taking advantage of both its limitations and advantages. For example, apps that use location-based features are inherently built from the ground up with an eye to mobile given that the user does not have the same concept of location on a PC.

# Chapter 4

# Testing

## 4.1 Design of Test Cases

### 4.1.1 Flow of data from application to Node MCU

In this phase we need to ensure that the data which is given by the user to execute is reaching to the Node MCU. The data transfer will be done via WiFi module. As Node MCU supports the Wifi Module we need to check whether the data that is passed to the Node MCU through the smart phone application reaches there or not.

### 4.1.2 Flow of data from Node MCU to the Servo Motors and actions on the environment

This phase will only be executed when the first phase (i.e 4.1.1 ) is executed successfully. If the Node MCU is receiving the data from the user through the application then the data must now be sent to the servo motors and it must perform the given changes in the environment. The co-ordinates of the current position of the arm must be given back to the Node MCU as well. This communication will be wired.

## 4.2 Testing

The phase 1 of the project was executed successfully. The Mobile application was used to establish communication between the application and the Node MCU. The interface which was used to establish the communication was WiFi. Power supply to the Node MCU can be given by a 5V charger. The medium to check the working was done by an LED attached to the output pin on the Node MCU. When the user gives an input to the application the signals are transmitted via WiFi and it is caught by Node MCU and the bulb glows. This gives an acknowledgement that the communication between the 2 is established.

Phase 2 is executed in terms of coding and assembly of the robotic arm. The motors are working when attached to the external batteries the combining of the 2 modules is still in the progress.

# Chapter 5

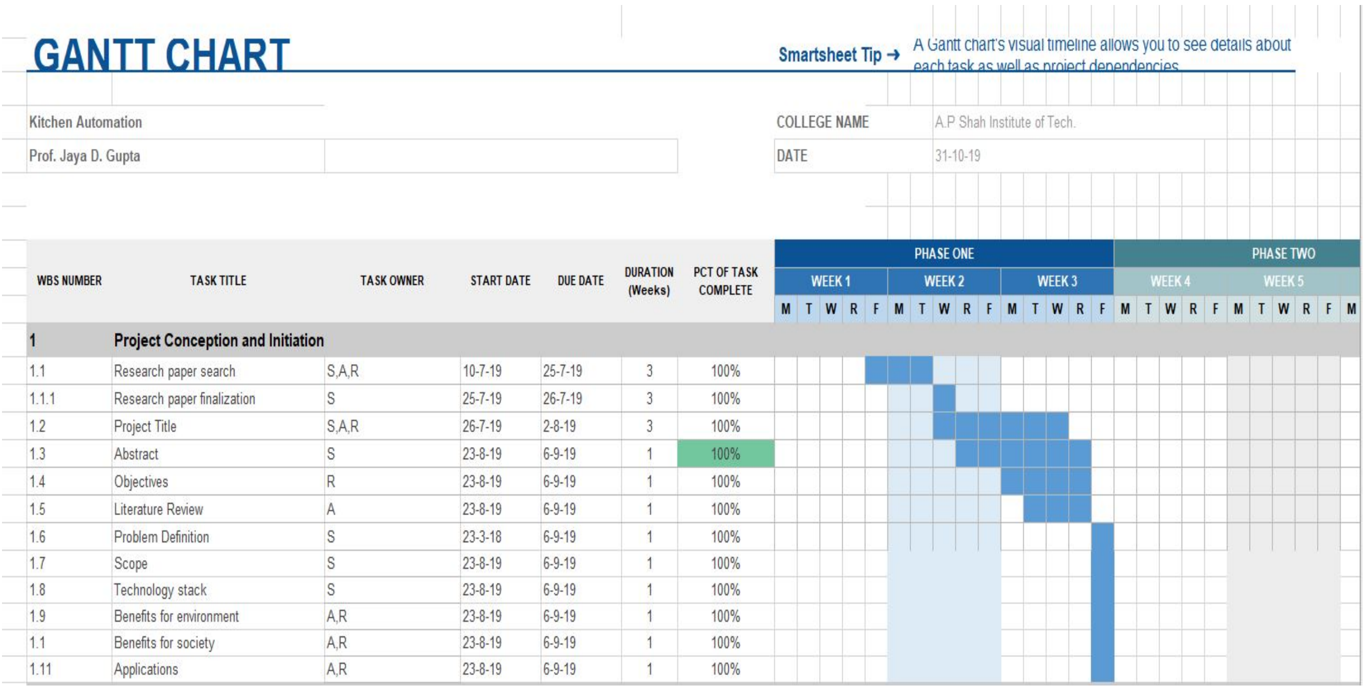
# Results and Analysis

## 5.1 Analysis of results

- This project will be useful for household kitchen activities to be carried out without investing a separate amount of time of the day.
- Safety measures are ensured due to computerized monitoring, which may not be avoided by humans in manual handling.
- It will ensure precision of activities in the Kitchen.
- All the processes that are standard can be recorded and implemented again on repetition without human intervention for the next time.
- Human assistance will be made available which would enable users to safely perform activities and also reduce human labor for household tasks thus saving money and time.

# Chapter 6

# Gantt Chart


GANTT CHART

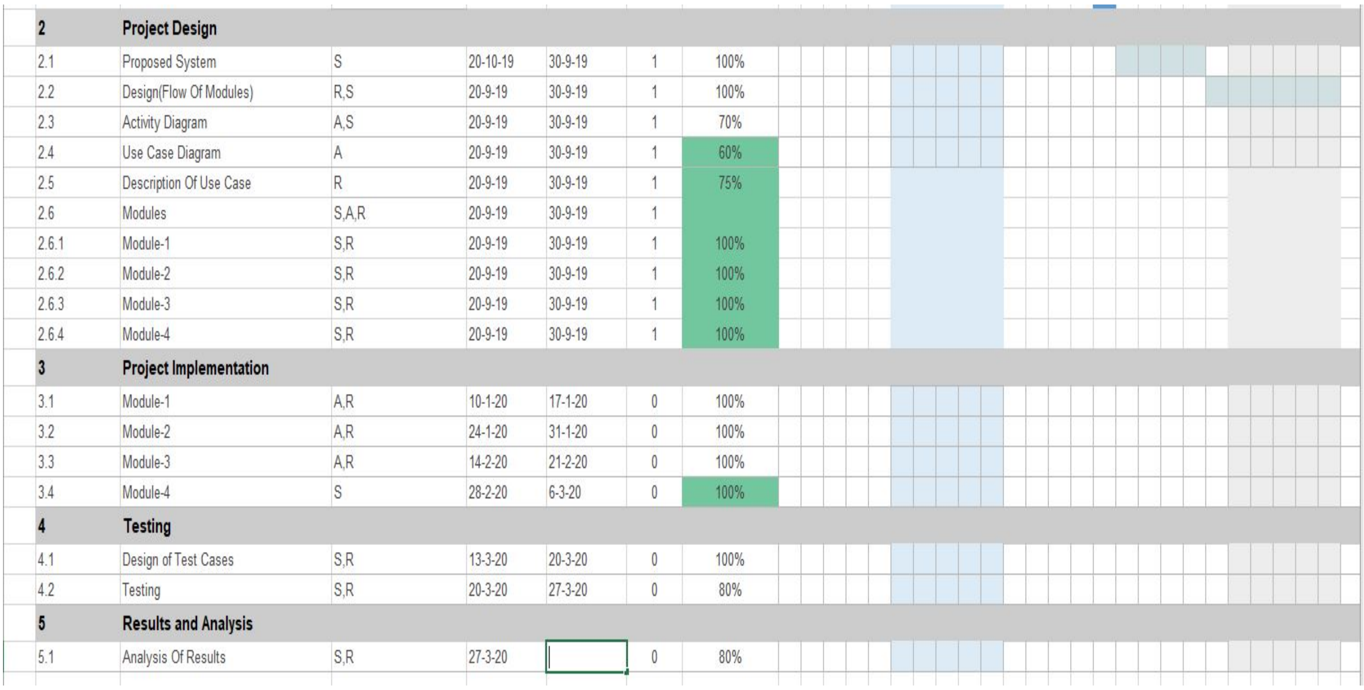
Smartsheet Tip → A Gantt chart's visual timeline allows you to see details about each task as well as project dependencies

| | | | |
|---|---|---|---|
| Kitchen Automation | | COLLEGE NAME | A.P Shah Institute of Tech. |
| Prof. Jaya D. Gupta | | DATE | 31-10-19 |

| WBS NUMBER | TASK TITLE | TASK OWNER | START DATE | DUE DATE | DURATION (Weeks) | PCT OF TASK COMPLETE |
|---|---|---|---|---|---|---|
| 1 | **Project Conception and Initiation** | | | | | |
| 1.1 | Research paper search | S,A,R | 10-7-19 | 25-7-19 | 3 | 100% |
| 1.1.1 | Research paper finalization | S | 25-7-19 | 26-7-19 | 3 | 100% |
| 1.2 | Project Title | S,A,R | 26-7-19 | 2-8-19 | 3 | 100% |
| 1.3 | Abstract | S | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.4 | Objectives | R | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.5 | Literature Review | A | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.6 | Problem Definition | S | 23-3-18 | 6-9-19 | 1 | 100% |
| 1.7 | Scope | S | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.8 | Technology stack | S | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.9 | Benefits for environment | A,R | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.1 | Benefits for society | A,R | 23-8-19 | 6-9-19 | 1 | 100% |
| 1.11 | Applications | A,R | 23-8-19 | 6-9-19 | 1 | 100% |



Fig. 6.1 Gantt chart



| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | **Project Design** | | | | | |
| 2.1 | Proposed System | S | 20-10-19 | 30-9-19 | 1 | 100% |
| 2.2 | Design(Flow Of Modules) | R,S | 20-9-19 | 30-9-19 | 1 | 100% |
| 2.3 | Activity Diagram | A,S | 20-9-19 | 30-9-19 | 1 | 70% |
| 2.4 | Use Case Diagram | A | 20-9-19 | 30-9-19 | 1 | 60% |
| 2.5 | Description Of Use Case | R | 20-9-19 | 30-9-19 | 1 | 75% |
| 2.6 | Modules | S,A,R | 20-9-19 | 30-9-19 | 1 | |
| 2.6.1 | Module-1 | S,R | 20-9-19 | 30-9-19 | 1 | 100% |
| 2.6.2 | Module-2 | S,R | 20-9-19 | 30-9-19 | 1 | 100% |
| 2.6.3 | Module-3 | S,R | 20-9-19 | 30-9-19 | 1 | 100% |
| 2.6.4 | Module-4 | S,R | 20-9-19 | 30-9-19 | 1 | 100% |
| **3** | **Project Implementation** | | | | | |
| 3.1 | Module-1 | A,R | 10-1-20 | 17-1-20 | 0 | 100% |
| 3.2 | Module-2 | A,R | 24-1-20 | 31-1-20 | 0 | 100% |
| 3.3 | Module-3 | A,R | 14-2-20 | 21-2-20 | 0 | 100% |
| 3.4 | Module-4 | S | 28-2-20 | 6-3-20 | 0 | 100% |
| **4** | **Testing** | | | | | |
| 4.1 | Design of Test Cases | S,R | 13-3-20 | 20-3-20 | 0 | 100% |
| 4.2 | Testing | S,R | 20-3-20 | 27-3-20 | 0 | 80% |
| **5** | **Results and Analysis** | | | | | |
| 5.1 | Analysis Of Results | S,R | 27-3-20 | | 0 | 80% |

Fig. 6.1 Gantt chart

# Bibliography


[1] https://iotdesignpro.com/projects/iot-based-robotic-arm-using-esp8266 Real Time Project of Robotic Arm Controlled by Android Mobile Application via Node MCU

[2] https://youtu.be/FO0Jctgfr4NodeMCU basicsforintegration

[3] https://ieeexplore.ieee.org/Xplore/home.jsp IEEE papers referenced and referred for best implementation method.

[4] https://en.wikipedia.org/wiki/NodeMCU Node MCU functioning and pins and configurations

[5] https://youtu.be/p06NNRq5NTU Real Time Project of Robotic Arm Controlled by Android Mobile Application via Node MCU

[6] https://ieeexplore.ieee.org/document/8384639/authorsauthors D. Corinaldi, L. Carbonari, M. Callegari, "Optimal motion planning for fast pointing tasks with spherical parallel manipulators", IEEE Robotics and Automation Letters, vol. 3, no. 2, pp. 735-741, 2018.

[7] https://ieeexplore.ieee.org/document/8230356/figuresfigures Authors:Souveer Gunputh, Anshu Prakash Murdan, Vishwamitra Oree. Published in: 2017 IEEE 9th International Conference on Communication Software and Networks (ICCSN) Date of Conference: 6-8 May 2017 Publisher: IEEE Conference Location: Guangzhou, China

# Appendices

## Appendix-A: Install the Arduino Software (IDE) on Windows PCs

1. Download the Arduino Software (IDE) proceed with board specific instructions

2. Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a portable installation.

3. When the download finishes, proceed with the installation and please allow the driver installation process when you get a warning from the operating system.

4. Choose the installation directory (we suggest to keep the default one)

5. The process will extract and install all the required files to execute properly the Arduino Software (IDE)

6. Proceed with board specific instructions When the Arduino Software (IDE) is properly installed you can go back to the Getting Started Home and choose your board from the list on the right of the page.

## Appendix-B: Installation of Solid Works

1. go to google.com and write SOLIDWORKS

2. Click on the 1st link i.e www.solidworks.com l

3. click on try now

4. Sign up for thefree trial version and verify your email

5. install the application and upload all your STEP, STL files on solid works to mod-

ify

# Appendix-C: Using MIT app inventor

1. go to https://appinventor.mit.edu/

2. Click on create apps

3. Link with your gmail id

4. Sign up for thefree trial version and verify your email

5. Agree to the terms and conditions

6. There will be various functions like Drag  Drop functionalities for GUI, Design block will deal with the design of the application i.e the frontend and the code block will have all the backend functionalities. Use all these functions to create your own application

## Acknowledgement

We have great pleasure in presenting the report on **Kitchen Automation.** We take this opportunity to express our sincere thanks towards our guide **Prof. Jaya D. Gupta** & Co-Guide **Prof. Amol R. Kalugade** Department of Computer Engineering, APSIT thane for providing the technical guidelines and suggestions regarding line of work. We would like to express our gratitude towards his constant encouragement, support and guidance through the development of project.

We thank **Prof. Sachin Malve** Head of Department,Computer Engineering, APSIT for his encouragement during progress meeting and providing guidelines to write this report.

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We also thank the entire staff of APSIT for their invaluable help rendered during the course of this work. We wish to express our deep gratitude towards all our colleagues of APSIT for their encouragement.

**Sailee Angane:**
**16102024:**

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**16102021:**

**Arafaat Chaudhary:**
**16102009:**

# Publication

Paper entitled **"Kitchen Automation"** is presented at **"A.P Shah Institute Of Technology"** by **"Sailee Angane , Rajat Bopalkar, Arafaat Chaudhary".**