

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION



Academic year 2022-23

**Government Polytechnic Jalgaon
(0018)**

Department of Electronics and Telecommunication

Capstone Project

Report

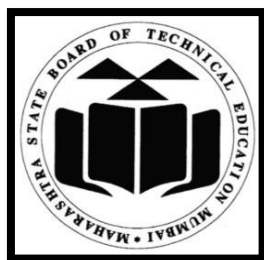
**Maintenance of Automatic hand washing Dispenser system and
improvement with Dryer using Arduino**

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Certificate

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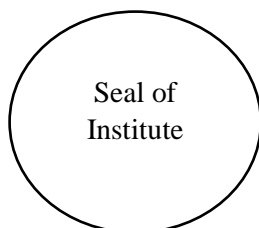
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Acknowledgement

We express our heartfelt gratitude towards **Dr. P. M. Patil** Principal, Government Polytechnic Jalgaon and Technology for granting us permission to work on this project. We express our grateful thanks to Head of department and project guide **Mr. K. P. Akole** or always supporting and helping us in our need.

We also express our gratitude and thanks to our staff tutors and all other faculty members of the department of Electronics And Telecommunications in Government polytechnic Jalgaon, for their quick help and expert opinions for completing this project. Specially thanks to our parents and friends who always supporting and encouraging us.

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Abstract

Hand hygiene is one of the most effective strategies to mitigate the transmission of pathogen. It is a challenge for society even guidelines are provided by WHO, NIH and health care centres. The hand hygiene compliance by all the organization has been difficult to achieve because of several factors such as diverse environment, work culture, process and task requirements. This project is the design and implementation of a hand wash system that matches human cognitive and physical strength and make allowance for human limitation by eliminating all the problem faced in hand hygiene compliance.

The project aims to do maintenance of hand wash system installed in EJ department and improve it. This improved project is a user friendly hand wash system which is all-in-one unit of soap solution dispenser, water dispenser and hand dryer. The system design uses Ardino UNO, Relay driver module, IR sensors, solenoid valve for soap and water, dryer and the frame of system. The sequential independent operation of the system being controlled by microcontroller ATmega328 integrated on Arduino UNO. The system utilizes the IR sensors to detect the presence of hand ranges from 2 to 30cm commence the hand washing process. When power supply ON then hand wash station detects user's hand by IR sensors it will send input signal to microcontroller and access the program. After that Arduino UNO gives pulses from output pin and relay driver is used as a switch and makes the valve run and hand wash and water dispense as well as dryer will operates. The process duration is marked in sketch of arduino. The hot dryer used to dry the hands to make sure that all bacteria will be removed. This automatic system helps us to save time, cost and man-power.

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Chapter 1. Introduction

Hand hygiene is one of the most effective strategies to mitigate the transmission of pathogen and avoid outbreaks such as bacteria, viruses, and micro-organisms. Hand washing system plays vital role to protect human health by harmful microbes. It is one of the simplest, low tech and most cost-effective public health measures to prevent transmission of viral diseases. Most of the hand wash system consists of hand washing dispenser and water dispensing. After washing hands, it is so essential to dry the hands because wet hands spread germs more easily. Frequently people washing their hands and dry them by using cotton towels at home. May be these towels used many times contains bacteria. In new hand drying methods paper towel dispenser are used. According to the research papers, it is found that there is increase of bacterial transfer and cross-contamination potential associated with paper-towel dispensing. The paper towel exists from folded paper towel dispenser located at hand wash stations. The zigzag of hands to paper-towel dispensers and back again, especially when people often have trouble taking paper from the dispenser, allows any residual germs from poor washing to transfer to the dispenser outlet and next lot of papers towels through contact.

The users may want to make sure that they are not using the same part of paper towel for each section of hand or make sure that use more towels to do the job. The latter is obviously not the most sustainable, environmentally friendly option though. Paper towels have been shown in studies to be very good at removing bacteria from the hands; however a study has shown that bacteria can transfer back to the hands from a previously dry unused paper towel. Also, this paper towel makes much garbage. Hence, cloths or paper towel is replaced by air hand dryers. These method dry hands without touching anything with the help of automatic sensors. But the hand dryer should be quick and at high speed which can dry hands quickly and completely from all sides.

The Covid-19 pandemic caused by the coronavirus in last 2 years 2019-2021 has led to a dramatic loss of human life worldwide and presented an unprecedented challenge to public health. Because of that more and more people on their daily lives gave more attention to health habits; the daily number of hand-washing increased than before. This prompted us to contribute with this project as a way to increasing the practice of hand washing in our society so as to remain healthy. This machine is specially designed for use in the offices, public restroom and as well for the general domestic washing and drying of the hands at home. It supplies both soapy and clean water in a sequential order during the washing and rinsing cycle and then supplies a warm air current to dry up the completely washed hand thereof. It is the design which is easy to use. More importantly, it can avoid the contagious diseases; for example, when it was a manual type hand washing machine, to turn on/off the tap, you must need the help of your hands. In this case, your hands or fingers would be infected with any virus left by any possible previous user if he or she is infected with a disease. With the automatic type, you will not only use the water at ease, but also avoid any possible contact with any contagious disease.

Also some cases were considered whereby people would inevitably, more or less, waste some water as we might have seen people washing their hands at any public places or at home. It is not necessarily because people tend to waste some water at their own will, for example, when it is a traditional mechanical type, people would wash their hands under the pressed water with the switch on, as the switch is positioned at this state, the water keeps being pressed down at the same amount no matter when the person really needs the water to wash or not. This causes low efficiency of water usage. Another possibility is that people who are in a hurry may often unconsciously forget about turning the tap off, if they really forget about it, the water would keep flowing or dripping until it gets turned off by the next user. As for the automatic type, it turns on and off automatically as it senses any object with energy or heat. In this case, the unnecessary waste of water can be avoided. Therefore with all these benefits, the automatic hand wash systems are becoming increasingly popular among schools, families, dining halls, companies or any other public places

Through all those reviews this project conceptualized a hand washing system that will automatically wash hands be integrated with a hand dryer. This project came up with a design that will reduce the risk of transfer of disease, solve the challenges experienced related to washing and drying of hands. This will also improve the level of hygiene of individual and also the awareness of people that there is design like this and named as “Smart Hand Washing Station”.

1.1 Maintenance

Maintenance is a routine and recurring activity of keeping a particular machine or facility at its normal operating condition so that it can deliver its expected performance or services without causing any loose of time on assonance equipment is designed, fabricated and installed, the operational availability of the same is looked.

- Once equipment is designed, fabricated and installed, the operational availability of the same is looked after by the maintenance requirement. The idea of maintenance was introduced along with inception of the machine. In the early days, a machine was used as it worked. When it stopped Working, it was either repaired or discarded.
- The high-cost sophisticated machines need to be properly maintained during their entire life cycle for maximizing their availability. The development of mechanization and automation of production systems and associated equipment, with the accompanying development of ancillary services and safety requirements, has made it mandatory for engineers to think about proper Maintenance of equipment.
- Maintenance function also involves looking after the safety aspects of certain equipment where the failure of component may cause a major accident.

1.1.1 Definition: -

“Maintenance is a routine and recurring activity of keeping a particular machine or facility at its normal operating condition so that it can deliver its expected performance or service without causing any loose of time on account of accidental damage or breakdown.”

1.1.2 Purpose of Maintenance: -

- The main purpose of maintenance in industrial Perspective is to reduce the business risks.
- Production Capacity productivity and business profit mainly depends on maintenance operations.
- Its main purpose is to support configure diagnose, repair, update and mange equipment throughout its life cycle.
- In general, maintaining all equipment its full functionality and helping productivity is the main function of maintenance

1.1.3 Function of maintenance: -

Maintenance functions can be two categories.

a) Basic Functions: -

- 1) Replace
- 2) Repair
- 3) Rebuild
- 4) Lubricate
- 5) Inspect or Check

b) Composite functions: -

- Protecting the buildings, structures and plants.
- Reducing downtimes and increasing equipment availability.
- Analyse repetitive failure and arrange their elimination.
- Controlling and directing labour forces and economy of maintenance.
- Ensuring safety of installation and reducing environmental pollution.
- Cost reduction and cost control.
- Waste reduction and waste recovery.
- Improving technical communication.

1.1.4 Maintenance fundamentals: -

1] Primary Functions: -

- Select the right bearings, fasteners, chains, sprockets, belts, cylinders, actuators and other devices.
- Equipment Inspection and lubrication.
- Monitor oils, lubricants and lubrication system. And Cooling and circulating systems.
- Electrical Control system - Interpret electrical Symbols, ladder diagrams, and electrical diagrams and how to use them as road maps to isolate electrical problems.
- Install and monitor proper ventilation and environmental control system to maximize service.
- Utility (steam, gas, air, etc.) generation and distribution.
- Alterations, up-gradation and new installations.
- Step-by-step troubleshooting procedures all the components of the establishment.

2] Secondary Functions: -

- Store keeping and Inventory management
- Plant protection.
- Waste disposal.
- Plant and equipment insurance administration.
- Other services as may come up.

1.1.5 Basics of (PORM) Productivity, Quality, Reliability and Maintainability: -

Each one has different role and affect the performance of others. Their interrelation is shown in fig. (PORM Inter-relationship).

1] Productivity: -

Productivity is measure of economic efficiency which shows how effectively economic inputs are converted into output. To Define Productivity to be measure for whole department or a fixed group who always remain together when on work or individual maintenance worker basis. Different industries attempt their own metrics to indicate change in maintenance productivity.

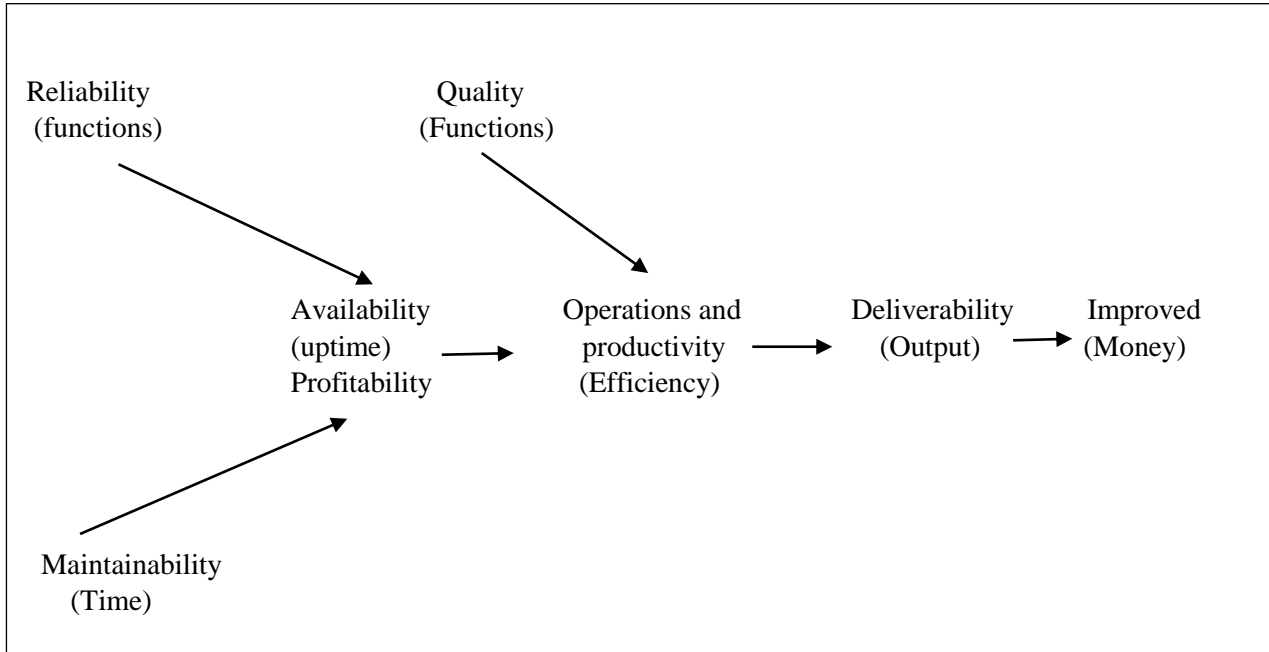


Fig 1.1 PQRM Inter-relationship

2] Quality: -

- It is the on-going process of building and sustaining relationships by accessing, anticipating and fulfilling stated and implied needs.
- In industries - it is the extent to which products, Services, processes and inter-relationships free from defects constraints and items which do not add value for customers and commodity Conforms to standard applied to say Commodity by mechanical or another standard.
- Quality can be static or dynamic. Static keeps in the industry and dynamic to excel or win it.

3] Reliability: -

- Focuses in ability of a product to perform its intended function.
- It can be defined as an item will continue the probability that to perform its intended Function without failure for a specified period of time.
- Product could be an electronic or mechanical component hardware, a software product etc.
- Reliability is important for
 - Reputation of the company
 - Customer satisfaction
 - Customer requirements

4] Maintainability: -

- Ease with which system component can or be modified to correct faults, improve performance.
- Also be defined as measures taken during design, development and installation of a manufactured product that reduce required maintenance, man-hours, tool

1.1.6 Maintenance Strategies / Types: -

The long-term plan, covering all aspects of the maintenance management which sets the direction for maintenance management and contains Firm action plans for achieving a desired Future state for maintenance Function is known as maintenance strategy. Maintenance type through meaning somewhat same as other term may be the more appropriate term which is defined as what kind of maintenance Functions are to be performed and what type of maintenance methodology is to be chosen to plan and execute those Function in most efficient way.

- **Basis of selecting maintenance strategy: -**

When determining the right maintenance strategy for given equipment or system we have two primary Factors to consider:

- 1) Cost of Equipment Failure
- 2) Ease of monitoring the equipment

1] Cost of Equipment Failure: -

One of the costs associated with equipment Failure is equipment downtime. The longer a piece of equipment is down, the more it's going to cost. Due to machine downtime certain breakdown are definitely a worth preventing, especially for equipment that central to keep processes running. Downtime isn't the only Factors to consider in overall costs. However additional Factors such as repair costs safety, and environment impacts are also concern well worth considering.

2] Ease of Monitoring: -

The second Factor to consider when determining the incurs maintenance strategy is the ease of monitoring. Watching over each piece of equipment incurs a cost. If the cost of monitoring a given asset would be more than that of Failure mode it prevents it may not be worth implementing. Where monitoring is more maintenance strategies that require less vigilance may be more appropriate.

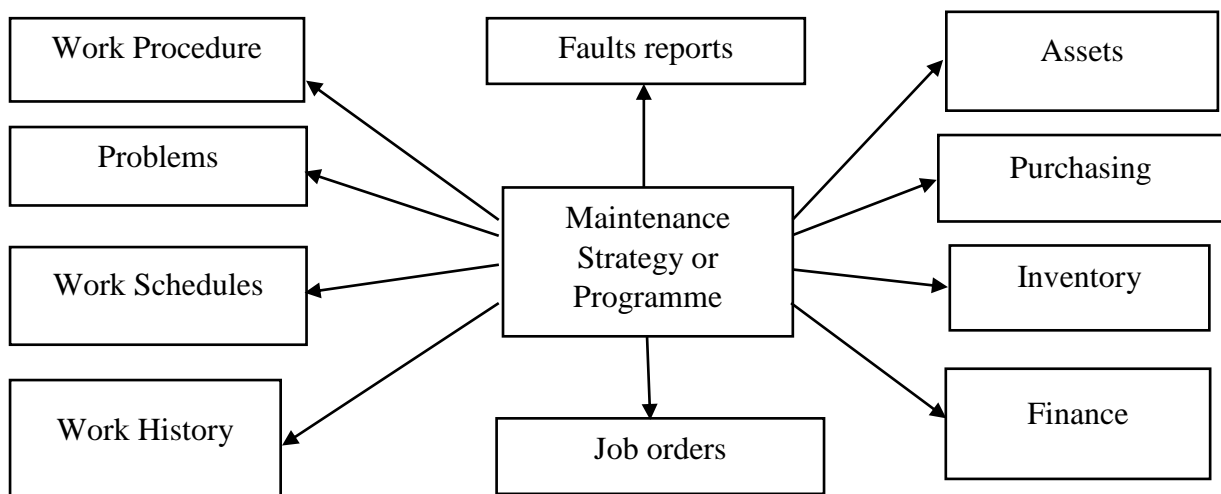


Fig. 1.2 Maintenance strategy or programme

- **Types of Maintenance: -**

1] Unplanned Maintenance: -

The maintenance task that occurs unexpectedly. It happens when there is no Formal strategy in place to address a repair, replacement or Inspection before it's needed.

A] Reactive or breakdown Maintenance: -

Only when the equipment fails to perform designed Function or comes to a grinding halt, any maintenance or repair job is taken. This type is called a reactive maintenance. Reactive maintenance is always in Fire Fighting mode it requires high cost but has lower reliability, as compare to all other maintenance types.

B] Corrective Maintenance: -

Corrective maintenance means maintenance actions for correcting or restoring a failed unit. Its scope is very vast and may include different types of actions, typical adjustment and minor repair to minor redesign from of equipment. This maintenance is done to eliminate or reduce the repetitive breakdowns. Generally, small or medium redesigns are done in this type.

C] Opportunity Maintenance: -

Opportunity maintenance gives the maintenance staff an opportunity to replace or repair those items, which are found to be defective or need replacement in the immediate Future during maintenance of machine or a component.

This maintenance strategy is considered important when dealing with complex system. Opportunity maintenance allows the lowest cost and most effective maintenance programme by determining the correct activity at the correct time. Because of this type of maintenance, the lifetime of equipment extends and reduces the Frequency of service interruption.

2] Planned Maintenance: -

Planned maintenance refers to any maintenance - activity that is planned documented scheduled. It reduced downtime by having all necessary resources on hand. Routine maintenance, preventive maintenance, predictive and proactive maintenance.

A] Routine Maintenance: -

It is simplest but very essential Form of maintenance system. Earlier the routine maintenance was considered about preventing failure. Routine maintenance intervals involve jobs such as cleaning, lubrication, inspections and minor adjustment pressure, Flow, tightness etc. and tightening of loose parts. This maintenance is generally so small duration and needs very little investment in time and money.

B] Preventive Maintenance: -

Preventive maintenance is the act of performing regularly scheduled maintenance activities to help prevent unexpected Failure in the Future simply; it is about fixing things before they record.

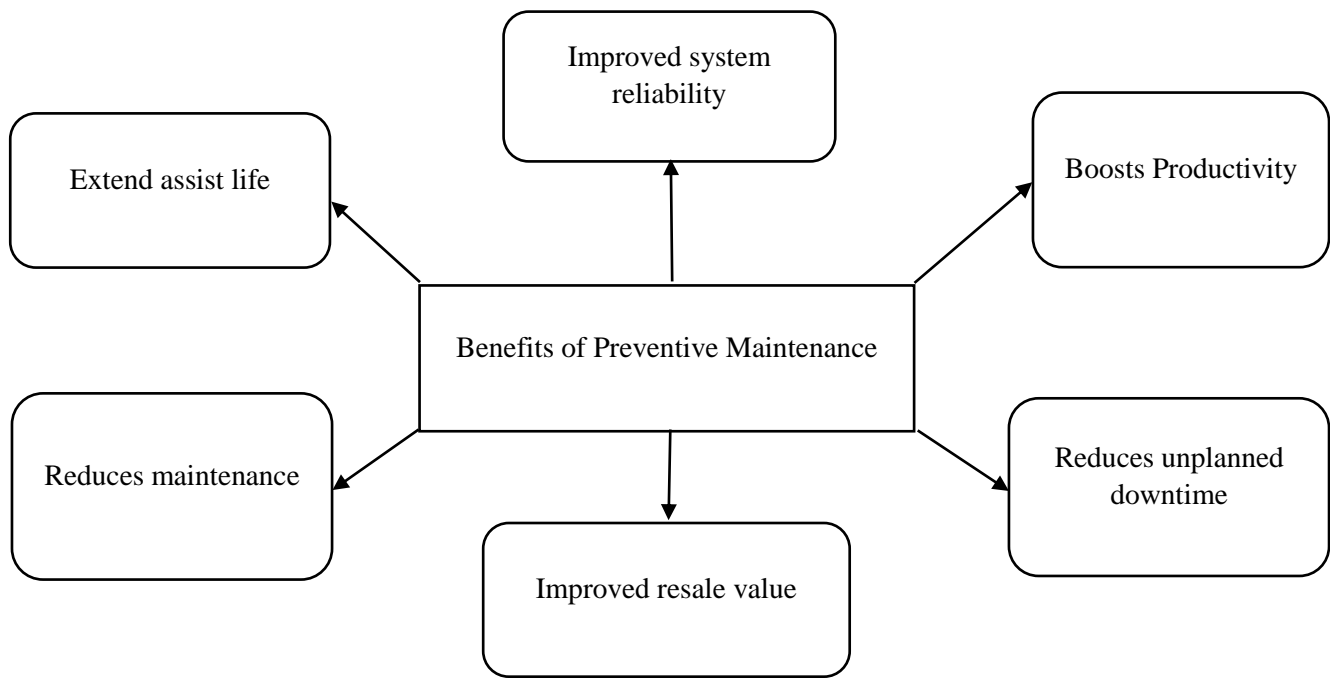


Fig. 1.3 Benefits of preventive Maintenance

- **Future of preventive maintenance with AI and IoT: -**

Increasingly, deploying AI and IoT technologies in operations has resulted in continual optimization of both the assets and activities that drive the industrial sector from the perspective of assessing the Future of preventive maintenance. It is clear the use of a remote monitoring and analytical modelling has already resulted in a net reduction in the amount of resources allocated to executing preventive maintenance tasks. From an asset perspective more extensive data collection and analysis made possible with today's AI and IoT solution has enabled manufacturer to get valuable data that has improved reliability to their operations and products.

C] Condition-based Maintenance/ Predictive Maintenance: -

Condition based maintenance is a maintenance strategy that monitors the actual condition of an asset, to decide what maintenance needs to be done. CBM dictate that maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure. Such as whenever an equipment or machine giving noise or getting hot the equipment was taken down to detect problem and machines get maintained.

The idea of CBM is real time monitoring which will give maintenance teams enough lead time before a Failure drops below occurs or performance an optimal level.

3] QAMM (Quality Assurance Maintenance Management): -

QAMM is set of terminologies which uses some of the earlier maintenance strategies with quality especially in view. Maintenance strategies used in QAMM are normally combination of preventive, predictive and proactive maintenance.

1.1.7 System Approach to Maintenance Functions: -

In an industry, various maintenance functions have to be integrated within themselves and with other activities/ operations/ strategies so that the maintenance becomes an effective one and delivers desired result. Maintenance is dependent on industry's other factors/disciplines. Maintenance has different level of controls over different Factors.

- **Maintenance and Repair Technologies: -**

Technologies required for various maintenance and repair activities functions can be classified in two categories -

Category - 1

This includes the technologies to determine if maintenance/repair action is required and to quantify actual defects residual life or operational expectancy and reliability. These technologies can be also termed as Health and Usage Monitoring System (HUMS).

Category -2

This includes the technologies required to actually repair / improve the different parts/ components / systems by more efficient techniques, shorter repair cycle time and low cost etc.

A] Inspection and Testing: -

This is normally first step and then intermediate steps. Different types of inspection and testing taken by maintenance: -

- Dimension and coordinates measuring
- Surface roughness and flatness checking Gauging and calibration
- Optical inspection and of inaccessible space through Bore scope and Endoscope etc.
- Chemical Testing
- Tensile Testing
- Pressure testing and flow testing
- Few non-destructive testing
- Hardness testing
- Grain Size Determination by Replication
- Electrical current and flux testing, etc.

B] Dismantling and Assembling: -

These are the basic function of maintenance, when a failed equipment or working equipment is opened partially or completely necessary repairs, adjustment changing of elements and components are done and component is fitted back in position using common or special tools.

C] Maintenance Cleaning: -

Cleaning of equipment components, working tools, workplace etc. before taking repairs. During and after repairs is of prime importance cleaning is purely technical requirement. Cleaning of components is normally assisted by kerosene, petrol, carbon-tetra-chloride

CCTC) and many other solvents. For cleaning of rust, sediments and deposits from water cooled components, heat exchangers and tube-nests etc. suitable chemical and solvents are used. High pressure water jets are used for descaling of big tube-nests, heat exchangers etc. Magnetizers have been developed, which can be damped on the pipelines. By placing of magnetizers on the pipe length the rust and sludge can be taken to tank and removed.

Steam cleaning, Scrubbing, Skinning, etching, vacuum cleaning, extractors and many other techniques of cleaning used as per need.

- **Types of Cleaning: -**

- 1) Aqueous Cleaning
- 2) Vapour Degreasing
- 3) Steam cleaning
- 4) Paint Stripping
- 5) One step Alkaline Cleaning (for steel and Titanium)
- 6) Power Wash
- 7) Aluminium Oxide and Plastic Grit Blast

D] Lubrication: -

Lubrication for machine plays the same role as blood for the human being. Improper or ineffective lubrication is leading cause of mechanical failure and production losses for production department, it is essential that machinery be corrected and adequately lubricated.

- Function and Failure cause of Lubrication: -

The main functions of lubrication in bearings, gears and other rotating and sliding components are as follows: -

- Friction and Wear Control
- Corrosion Control
- Temperature Control
- Contamination Control
- Power and Work Transfer

E] Maintenance Machining or Repair Machining: -

Maintenance machining is done to repair d damaged or degraded component. And it lays more emphasis on in-situ machining. It also involves in making few spares parts and components in convectional machine shop.

1. Thread Inserts: -

These are used for quicker repair and remaking of threads to original or desired size. Thread inserts are also used in little original equipment where it can be removed in case of damaged and renewed. These are precision formed screw thread coils of carbon steel or stainless steel wire having a diamond shaped cross section. Thread inserts increase the load bearing capacity of screw joints and they are very wear resistant. They are" used in soft materials, especially frequently connected and disconnected assemblies.

2. In-Situ Machining: -

In situ machining is very or On-site machining beneficial for reconditioning of damages in heavy components or components which not are dismantled easily. It reduces the exorbitant cost of shutting down, removing and transporting parts for shop repair. In this specialized portable machine tools are developed, which can be set up on the part requiring repair using the latest techniques to ensure correct alignment and accuracy. Machining takes one tenth time of grinding so when a major failure occurs and lot of material needs to come off we can reduce down time considerably.

3. Metal Stitching: -

Also known as metal locking, metal lace it is a mechanical approach to repair of vital. Machine parts and was considered as the solution to problems of welding and brazing etc. The use of metal stitching has grown in application from small water pump to huge turbine generating equipments. This cold process is extremely versatile and can be applied to the repair of wide range of industrial equipment.

F] Maintenance Welding: -

Welding way is the most economical and efficient to join metals permanently. It is only way to join one or more pieces to act as single piece. Welding ranks high among industrial processes and involves more sciences and variable than those involved in industrial process. It is vast subject and is used extensively for manufacturing various components. Repair welding and surfacing are not considered in the field of maintenance welding. Often it is extremely difficult to separate what is considered repair welding, from maintenance welding, and surfacing can be included in both situations. The same basic factors apply to both weld repair and surfacing.

G] Surfacing Hard facing and Coaling: -

Surfacing and micro-surfacing are used more for road maintenance; micro surfacing being a thin polymer modified cold-mix paving system that can remedy a broad range of problems on today's street. It is low-cost preventive maintenance treatment, which retards deterioration of the pavement, maintenance or improve the functional condition. In surfacing the surface characteristics desired for the finished job depend entirely on the serving to which the surface will be exposed. Surfacing can be done by most of the welding technologies.

H] Micro Welding and Micro Joining Technologies: -

Micro-joining is critical to the successful performance of many components for miniaturized products, with sophisticated joining processes needed to achieve low defect rates. As name indicates the welding application is of small and miniature nature, sometimes as small as human hair. This state-of-art interconnection/joining system is used manufacture of microelectronic mechanical systems (MEMS) Micro welding includes smaller / miniature resistance welding, plasma arc welding, ultrasonic welding, wire bonding, laser beam welding, microwaving/soldering etc.

I] Plating: -

It is a method to apply metallic coating to another material. It can be applied to almost coarse material. The most any common surface that plated is metal and plastic. Plating used for different reasons such as to increase sturdiness, provide high hard shell, to avoid corrosion to give attractive finish, to conduct electricity.

- There are few ways of conducting plating process: -
 - Electroplating
 - Selective immersion free plating
 - Metal spraying
 - Vacuum metalizing Tinning
 - Galvanizing etc.

It is mainly done by fusion process by which weld materials, with superior properties that the substrate, are applied to the substrate. Hard-facing processes very useful for improving and corrosion resistance to selected areas of machinery.

J] Coating and Cladding: -

Metal coating and cladding are similar technologies provides high-tech coating applications for a variety of end uses to enhance functional performance. Metallic coating provides a layer that changes the surface properties of work piece to those of the metal being applied. Metallic coatings are deposited by galvanizing, electroplating plating spraying, and hot dipping. Chemical vapour deposition and thermal spraying etc.

Cladding is often applied at mill stage by the manufacturer's sheet, plate or tubing, Cladding by pressing, rolling or extrusion can produce a coating in which the thickness and distribution can be controlled over wide ranges and the coating produced free of porosity.

1.2 Existing System

1.2.1 Methodology: -

An automatic hand washing system was designed, which will be presented in two stages describing the instrument structure and control parts. This work focused on using the elasticity of pumps and improving people's access to devices.

Topic A: Automatic hand wash dispenser

- 1) When IR sensor detects the user's hand then it will send order to the solenoid valve.
- 2) After receiving order, solenoid valve gets activated.
- 3) After getting activated the hand wash will pass through solenoid valve.
- 4) When user will remove hand, the IR sensor will send order to the solenoid valve to get deactivated.

Topic B: Automatic Water dispenser

- 1) When proximity sensor detects the user's hand then it will send order to the solenoid valve.
- 2) After receiving order, solenoid valve gets activated.
- 3) After getting activated the water will pass through solenoid valve.
- 4) When user removes hand, the proximity sensor will send order to the solenoid valve to get deactivated.

1.2.2 Block Diagram: -

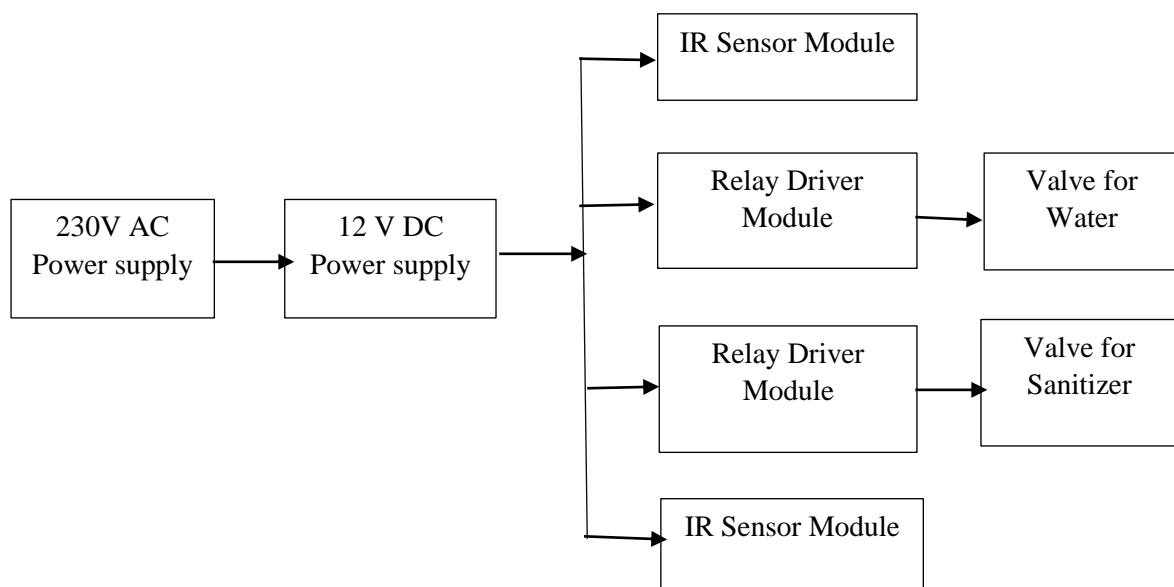


Fig. 1.4: Block Diagram of Existing system

1.2.3 Components and their Specifications: -

Table 1.1 Components and their specifications

Sr. No.	Components Name	Specifications	Quantity
1	Solenoid Valve	24V DC	2
2	IR proximity sensors	2-10 meters	2
3	Relays	5V	2
4	Voltage Regulator	12V DC	1
5	24V DC Adopter	24DC	1
6	Connecting wires	copper wire single strand	as per req.

1.2.4 Testing Procedure: -

- 1) Check overall performance of the hardware and verifying it against the design specification.
- 2) Check continuity of all wires and component connections.
- 3) Verification of basic electronic parameter such as voltage, current, resistance, conductance and capacitance. This could be applicable in the design phase and regular maintenance of the hardware.

❖ Component Testing: -

1) Solenoid Valve Testing: -

- Wear Protective equipment.
- Set the multi-meter to ohms.
- Place your probes on the solenoid terminals.
- Apply current to solenoid.
- Evaluate results.

2) IR sensors: -

Step 1: Checking the transmitting IR LED

- a) To Test IR LED emitter:
 - Switch mode on multi-meter to diode measurement.
 - Connect the red probe to the positive pin of the LED (Longer pin)
 - Connect the black probe to the negative pin of the LED (shorter pin)
- b) Check Value on screen:
 - If you see the value on the display of the multi-meter change.
 - This means the LED emitter is still working fine.

Step 2: Check receiver IR LED

- a) To Test IR LED receiver:
 - Switch the mode on the multi-meter to the resistance measurement mode (Ohm)
 - Connect the red probe to the positive pin of the LED (Longer pin)
 - Connect the black probe to the negative pin of the LED (shorter pin)
 - Check Value on screen

3) Relay: -

- Do a basic visual inspection of the relay.
- Disconnect the power source.
- Consult the relay schematic or data sheet.
- Determine the requirement of the relay coil.
- Find out if the control coil is diode protected.
- Assess the contact configuration of the relay.
- Test the de-energized condition of the relay contacts.
- Energize the relay.
- Check the energized condition of the relay contacts.

4) Voltage regulator: -

- Set the multi-meter to voltage setting.
- Attach the red wire to the input pin and the black wire to the ground pin.
- Touch the black wire to output and the red wire to the ground pin.
- Read the output on the multi-meter.

5) Proximity sensors: -

- Set your digital multi-meter to 20V DC.
- Connect the red probe to the sensor signal.
- Connect the black probe to Sensor GND.
- First check your proximity sensor signal voltage should be 12V, but it's not detected. It means you have a bad proximity sensor.
- Now, check for a good proximity sensor. If you receive a 0v, it means you have a bad proximity sensor.

❖ Probable Defaults: -

There is default in proximity sensors in hardware. In proximity sensor there is a poor connection or signal interference from contamination. There is a metal particle on the face of sensor. Hence minimum range of the proximity sensors occur which causes the fluctuation in working of hardware device. There is also the connecting wires damage. Because of the wire damaging flow of current was broken.

❖ Troubleshooting and Maintenance procedure: -

- 1) Clean, reset connectors and correct the cause of contamination.
- 2) Metal particles will not let the switch change state. Clean metal particles from the face of the sensors.
- 3) Tight the proximity sensors connectors.
- 4) Change the damaged wires and properly solder them.
- 5) Check the overall performance of the hardware product.
- 6) Add the different protective cabinet packaging to the system.

1.2.5 Maintenance Strategies/Types applicable: -

There are many types of strategies or types of maintenance are applicable in maintenance of hand wash system. This maintenance task occurs unexpectedly and happens when there is no formal strategy in place to address repairs, replacement or inspection before it's needed. Hence it is unplanned maintenance. When we received the system it fails to perform designed functions or completely breakdown, then the repair takes place known as reactive or breakdown maintenance. After testing of hand wash system we find a default in a small medium of system which affects whole system to be failed to perform. In that condition the maintenance is done known as corrective maintenance. As a capstone project when we get the hand wash system for maintenance purpose as an opportunity to repair it, so it is nothing but opportunity-based maintenance. By above description we can say that the combination of reactive, corrective and opportunity-based maintenance strategies is applicable in maintenance of hand-wash system.

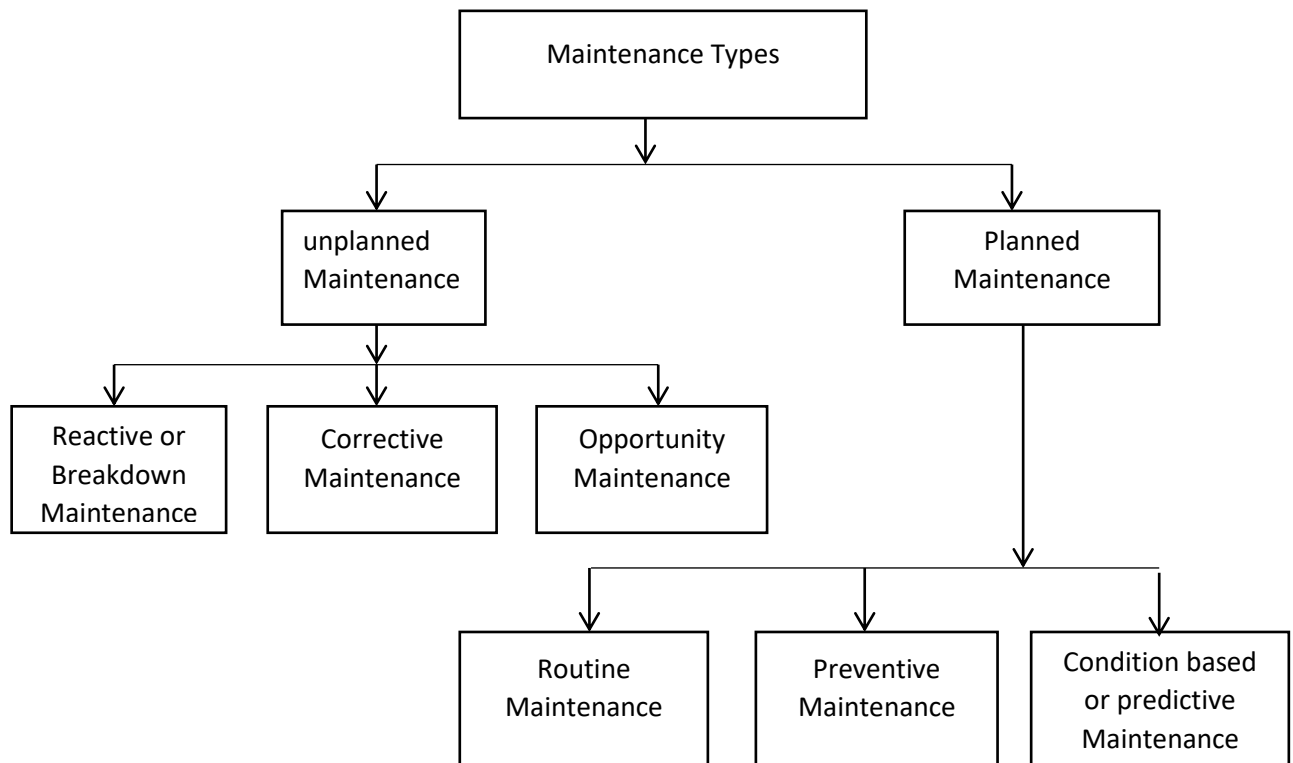


Fig. 1.5: Maintenance Types

1.2.6 Drawbacks of the hardware system: -

The hand washing dispenser system installed in the institute is relay logic control-based system which has so many drawbacks. The relay has drawbacks such as contact is damaged over time and continuous use. They generate a lot of noise with the activation and deactivation of the contacts. The relay switching time is high. So, when sensor detects the hand the hardware device takes much time to dispense the hand wash and water. It the major drawback of the hardware system.

1.2.7 Improved System: -

To remove the drawback of the hand wash dispenser system microcontroller is used to control the action of relay logic and their switching time. The microcontrollers are typically programmed to execute a task within an application. We can set the time as per requirement. Also, we can add the hand dryer system as an improvement purpose.

Chapter 2. Literature Survey

2.1 Maintenance Engineering

AUTHOR: Er. Sushil kumar srivastava

Publication: S. Chand & Company Pvt. Ltd. (AN ISO 9001:2008 COMPANY), Ram Nagar, New Delhi-110055

Period: 1995-2004

First Edition: 1998

Revised edition: 2010

ISBN: 81-219-2644-0

INFERENCE:

The book “Maintenance Engineering” includes all the aspects of maintenance principles, practices, techniques, technologies, methodologies and management. This book is designed to be used as a textbook and reference book for many disciplines. The book is immensely useful to a person working in an associated with maintenance and upkeep machines, equipments and system in shop, plant or industry.

2.2 Electronic Devices and Circuit

AUTHOR: David A. Bell

Publication: Oxford University Press, Ground floor, 2/11, Ansari road, Daryaganj, New Delhi, 110 002, India.

First Edition: 2008

Revision Edition: 2017

ISBN: 0-19-569340-9

INFERENCE:

The chapter 2 of the book “Electronic devices and Circuit” proposed operation, characteristics, parameters, circuit design and testing procedure of bridge rectifier and power supply. The chapter also covers the filter circuit design and selection of the component for designing of power supply circuit in this book Circuit design and analysis methods are extensively treated using currently available device, standard value components, and parameters from device manufacturer’s data sheets. All circuit present can be laboratory tested to check the authenticity of the design process. To reinforce the application based learning it is helpful for undergraduate engineering courses in electrical and electronic engineering.

2.3 Automated Hand Washing System with hand dryer

Author: Johan B. Sy, Wubishet Degife, Wondetir Tekla, Edward B. Panganiban

Publication: International Journal of Emerging Trends in Engineering Research, Volume 8, no. 9

Year: 2020

ISSN: 2347-3983

INFERENCE:

The research paper proposed in an urgent need to combat COVID-19 to find strategies to minimize the divesting effect that causes in the community. This research paper focuses on hand washing system with a dryer that could be deployed in public or private area. The system initial design concept, prototype, screen capture of control system model, software routine, dimension of hand washing matching machine frame and arguing script all are presented in research paper. An important feature designed into the system is the essentially independent operation of two systems. The system encourages the user to observe the proper WHO protocol in hand washing through a sequence of soap and water delivery.

Chapter 3. Scope of the Project

3.1 Market Overview

The global hand wash station market was valued at USD 1012.38 million in 2022. It is expected to reach USD 1440.93 million by 2031, growing at a CAGR of 4% during the forecast period (2023–2031).

Hand hygiene, commonly referred to as hand washing, is the practice of washing one's hands with soap or hand wash and water to eliminate viruses, bacteria, and other harmful and undesired items that have adhered to the hands. A hand basin with hot and cold flowing potable water, a dispenser for liquid or powder soap, and a hand drying technique that employs paper towels in a dispenser or uses forced air are all considered hand washing stations. Hand wash stations are in demand in public spaces due to rising consumer awareness of airborne illnesses like COVID-19, influenza, chickenpox, mumps, measles, tuberculosis (TB), and diphtheria. The market for hand wash stations has also grown due to increased government initiatives, communities, and NGOs working together to educate people about airborne diseases through online and offline advertisements.

3.2 Recent Developments

December 2022- At the PACK EXPO International Trade Show, Meritech introduced EVO, the most recent iteration of CleanTech Automated Hand washing Technology.

December 2022- Dr. Teal's, a leading personal care and wellness brand, announced the brand's newly released Moisturizing Hand Soap made with pure Epsom salt and finely granulated pumice stone to exfoliate hands gently and thoroughly cleanse.

3.3 Global Hand Wash Station Market Opportunities

- Rising Investments from the Government

Millions of individuals are presently afflicted by the pandemic, and numerous fatalities have already occurred. Moreover, the only way to prevent people from contracting contagious diseases like COVID-19 is through social distancing and routine hand washing. Additionally, the government has invested in installing hand-washing facilities in various locations, including airports, hospitals, hotels, bus terminals, train stations, restaurants, independent shops, business centres, industrial facilities, and temples.

In addition, the United Nations Children's Fund (UNICEF) provided three sets of criteria for properly using hand washing stations. The station should first make recommended hand washing possible. Second, the design should be flexible enough to accommodate local conditions, allowing for adequate water and soap use and local manufacturing, management, and repair. Third, the design should offer all users a pleasurable, practical experience.

3.4 Key Players of Hand Wash Station Market

- **The global hand wash station market's major key players are: -**
 - 1) Acorn Engineering Company Inc.
 - 2) Monsam Enterprises Inc
 - 3) Polyjohn Enterprises Corp
 - 4) Satellite Industries
 - 5) JW Craft Portable Restrooms Inc
 - 6) Meritech System LLC
 - 7) Texas Waste Co.
 - 8) Crown Verity Inc
 - 9) Teal Patents Ltd
 - 10) Belson Outdoors LLC.

3.5 Global Hand Wash Station Market Scope and Market Size

The hand wash station market is segmented on the basis of type and application. The growth amongst these segments will help you analyse meagre growth segments in the industries and provide the users with a valuable market overview and market insights to help them make strategic decisions for identifying core market applications.

1. Type

- Single Sink
- Multiple Sinks

2. Portability

- Permanent
- Portable

3. Material

- Ceramics
- Alloy
- Others

4. End User

- Community
- Commercial

Chapter 4. Methodology

The development of this project used different methodologies, design, modelling and simulation, hardware manufacturing.

4.1 Design

4.1.1 Block Diagram: -

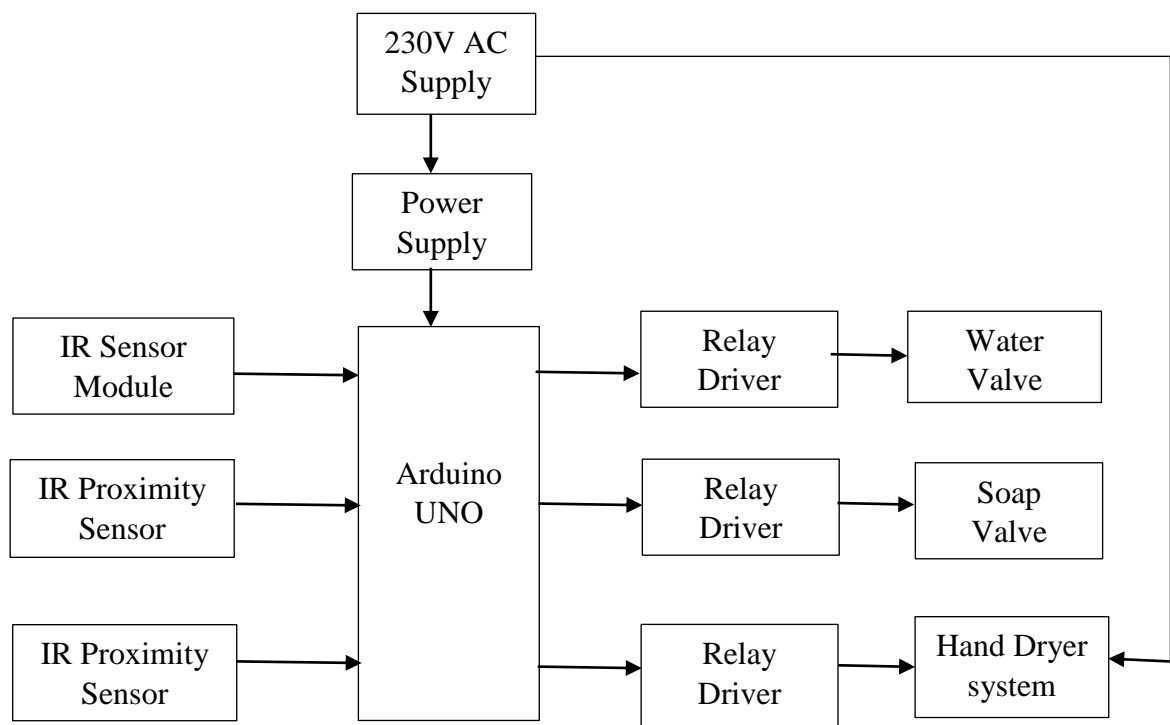


Fig.4.1 Block diagram

4.1.2 Control System: -

Topic A: Automatic hand wash dispenser

- 1) When IR sensor detects the user's hand then it will send input signal to microcontroller.
- 2) After receiving the signal microcontroller access the program.
- 3) The Arduino UNO gives pulses from output pin.
- 4) The solenoid valve cannot use directly hence relay driver is used as a switch and makes the valve run and some drops of hand wash dispense.
- 5) According to the instruction in microcontroller valve automatically stops after few sec.

Topic B: Automatic Water dispenser

- 1) When IR sensor detects the user's hand then it will send signal to Arduino UNO.
- 2) After receiving the signal microcontroller access the program.
- 3) The Arduino UNO gives pulses from output pin.
- 4) The solenoid valve cannot use directly hence relay driver is used as a switch and makes the valve run and some water dispense.
- 5) According to the instruction in microcontroller valve automatically stops after few sec.

Topic C: Automatic Hand dryer

- 1) The IR sensor detects the user's hand and sends the signal to Arduino UNO.
- 2) Emitting an invisible ray of infrared light, the sensor on a hand dryer is triggered when an object (in this case, your hands) moves into its path, bouncing the light back into the sensor.
- 3) The Arduino UNO switch the relay driver and start the hand dryer system to remove excess moisture will depend on the model of dryer you use, but all dryers have two things in common the hand dryer motor and the fan.

4.1.3 Components and their Specifications: -

Table 4.1: Components and their specifications

Sr. No.	Component	Specifications	Quantity
1	Diode	1N4007	9
2	Capacitors	1000 μ F 16V, 100 μ F 16V, 100 μ F 16V	5
3	Voltage Regulator	7812, 7805	2
4	LED	5mm, RED	3
5	Resistors	470 Ω $\frac{1}{4}$	3
		200K Ω $\frac{1}{4}$	1
6	PCB	Copper clad laminate (phenolic) with dimensions – 20*20cm	1
7	Transformers	0-12V 1A, 230-230V 1A, 230-230V 500mA	3
8	D.C.Adopter	24V A.C. to D.C	1
9	Power cable	1M	1
10	Rainbow wire	1M	1
11	Relay module	12V DC, sugar cube relays	1
12	Microcontroller board	Arduino UNO R3	1
13	IR proximity sensor	Long range, E18-D80NK	3
14	Solenoid valve	24V	2
15	Power supply	5V DC	1

4.1.4 Components Descriptions: -

1) Arduino UNO: -

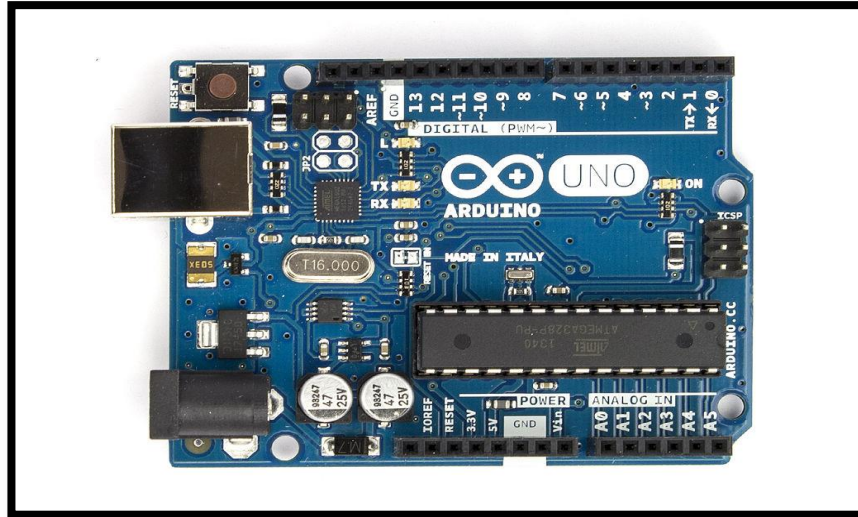


Fig.4.2. Arduino UNO board

Arduino is a computing system so it is open-source hardware and software platform. UNO R3 Arduino is a latest version. Arduino is available in: - nano, Pico, R1, R2, R3. Arduino board design use a variety of microprocessor and microcontrollers.

❖ Arduino UNO R3 board specifications: -

- 1) 14 digital I/O pins (0-13).
- 2) 6 Analogue Input pins (0-5).
- 3) 6 Analogue output pins (3,5,6,9,10 and 11).
- 4) Serial communication with universal serial bus (USB).
- 5) Powered up from computer's USB port.
- 6) Based on ATmega328 AVR microcontroller.

❖ Components on Arduino UNO R3 board: -

- 1) USB connector
- 2) Power port
- 3) Microcontroller
- 4) Analog input pins
- 5) Digital pins
- 6) Reset switch
- 7) Crystal oscillator
- 8) USB interface chip
- 9) TX RX LEDs
- 10) JTAG Cable

1) USB connector :

This is a printer USB port used to load a program from the Arduino IDE onto the Arduino board. The board can also be powered through this port.

2) Power port :

The Arduino board can be powered through an AC-to-DC adapter or a battery. The power source can be connected by plugging in a 2.1mm center-positive plug into the power jack of the board.

The Arduino board can be powered through an AC-to-DC adapter or a battery. The power source can be connected by plugging in a 2.1mm center-positive plug into the power jack of the board. The Arduino UNO board operates at a voltage of 5 volts, but it can withstand a maximum voltage of 20 volts. If the board is supplied with a higher voltage, there is a voltage regulator that protects the board from burning out.

3) ATmega328 Microcontroller :

It is the most prominent black rectangular chip with 28 pins. Think of it as the brains of your Arduino. The microcontroller used on the UNO board is ATmega328P by Atmel (a major microcontroller manufacturer). ATmega328P has the following components in it

- Flash memory of 32KB. The program loaded from Arduino IDE is stored here.
- RAM of 2KB. This is a runtime memory.
- CPU: It controls everything that goes on within the device. It fetches the program instructions from flash memory and runs them with the help of RAM.
- Electrically Erasable Programmable Read Only Memory (EEPROM) of 1KB. This is a type of nonvolatile memory, and it keeps the data even after device restart and reset.

ATmega328P is pre-programmed with bootloader. This allows you to directly upload a new Arduino program into the device, without using any external hardware programmer, making the Arduino UNO board easy to use.

Analog input pins.

4) Analog input pins

The Arduino UNO board has 6 analog input pins, labeled “Analog 0 to 5.” These pins can read the signal from an analog sensor like a temperature sensor and convert it into a digital value so that the system understands. These pins just measure voltage and not the current because they have very high internal resistance. Hence, only a small amount of current flows through these pins.

Although these pins are labeled analog and are analog input by default, these pins can also be used for digital input or output.

5) Digital pins

These pins labeled “Digital 0 to 13.” These pins can be used as either input or output pins. When used as output, these pins act as a power supply source for the components connected to them. When used as input pins, they read the signals from the component connected to them. When digital pins are used as output pins, they supply 40 milliamps of current at 5 volts, which is more than enough to light an LED.

Some of the digital pins are labeled with tilde (~) symbol next to the pin numbers (pin numbers 3, 5, 6, 9, 10, and 11). These pins act as normal digital pins but can also be used for Pulse-Width Modulation (PWM), which simulates analog output like fading an LED in and out.

6) Reset switch

When this switch is clicked, it sends a logical pulse to the reset pin of the Microcontroller, and now runs the program again from the start. This can be very useful if your code doesn't repeat, but you want to test it multiple times.

7) Crystal oscillator

This is a quartz crystal oscillator which ticks 16 million times a second. On each tick, the microcontroller performs one operation, for example, addition, subtraction, etc.

8) USB interface chip

Think of this as a signal translator. It converts signals in the USB level to a level that an Arduino UNO board understands.

9) TX – RX indicator

TX stands for transmit, and RX for receive. These are indicator LEDs which blink whenever the UNO board is transmitting or receiving data.

Now that you have explored the Arduino UNO board, you have started your journey toward building your first IoT prototype. In the next article, we will discuss Arduino programming and do a few experiments with Arduino and LEDs.

❖ Arduino software features: -

a) In-system Programming (ISP)

- ✓ Once the product is designed, we need to change the board again and we need to change program is In-system Programming.

b) Bootloader

- ✓ Bootloader is the firm where it is available in the memory programming also available in memory.
- ✓ Bootloader is one thing this program is executed once switch ON the Arduino board or once you reset the Arduino board it executes the booting program and configure the I/O devices as well as the memory.

c) Opti boot loader

d) On-chip debugging

❖ Arduino Program structure: -

- **Sketch:** The first new terminology is the Arduino program called sketch.
 - The basic code structure of Arduino programming is simple and is composed of two parts.
 - 1) Setup
 - 2) Loop
 - Every sketch needs void type functions, setup() and loop(). A void type functions doesn't return any value.
 - The setup() method is run, once just after the Arduino is powered up.
 - The loop() method is run continuously afterwards.
 - The sketch will not compile without either one.

- Basic structure :

```
Void setup()
```

```
{  
}
```

```
Void loop()
```

```
{  
}
```

❖ **Input Output Pin mode setup: -**

1) **Pinmode: -**

- This command is used to set pins as input or output in the setup loop.
- Arduino digital pins are set to input by default hence there is no need to specifically declare them as inputs using pinmode().
- The syntax for declaring pins using pinmode()

```
Void setup()
```

```
{
```

```
pinMode(11, INPUT);
```

```
pinMode(12, OUTPUT);
```

```
}
```

```
Void loop()
```

```
{
```

```
}
```

- **Digital input**

2) **digitalRead**

This function is used to read the digital value of a pin. The result is either high or low.

```
#define s1 11
Void setup()
{
  pinMode(11, INPUT);
}
Void loop()
{
  int value=digitalRead(11);
}
```

- **Digital output**

3) **digitalWrite**

- Sets the pins on or off, by giving them either high or low output.
- The function takes two parameters the pin no and either high or low.

```
Void setup()
{
  pinMode (12, OUTPUT);  // set pin 12 as output
}
Void loop()
{
  digitalWrite(12, HIGH);  // sets the value of pin 12 as high
}
```

- **Analog input**

4) **analogRead**

- This function reads the value from a specified analogue pin and returns a value between 0-1023.
- It only works on the six analogue pins from 0-5.

```
#define s1 0
Void setup()
{
  pinMode(0,INPUT);
}
Void loop()
{
  Int value=analogread(0);  /* Reads the analogue value of the analog pin 0
}
```

- **Analog output**

5) **analogWrite**

- This function is used to give an analog output. Analog output can only be given to pins 3,5,6,9,10,11 on the UNO.
- Values between 0-255 can be given to the analog pins.

```
#define s1 3
```

```
Void setup()
```

```
{
```

```
pinMode(3, OUTPUT);
```

```
}
```

```
Void loop()
```

```
{
```

```
analogWrite( 3, value);    // sets the value of analog pin 0 equal to value (must be  
from 0-255)
```

❖ **Arduino Programming Interface: -**

Arduino IDE: -

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment. The program or code written in the Arduino IDE is often called as sketch. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension ‘.ino’.

2] Relay: -



Fig.4.3.Relay Driver Module

- **Pin details: -**

Relay module consists of six pins such as normally open pin, normally closed, common, signal, VCC and ground pins.

1) Signal Pin:-

It is used to control the relay. This pin can be active low or active high. In case of active low, the relay will activate when we apply an active low signal to the signal pin. On the contrary, in the case of an active high, the relay will activate when we apply an active high signal to the signal pin. But usually, these modules work on an active high signal. This signal will energize the relay coil to make contact with the common terminal with the normally open terminal.

2) VCC Pin: -

As its name suggests, it is a 5V relay. That means it requires 5V DC to operate. Hence, connect the 5v DC power supply to this pin.

3) Ground Pin: -

Connect it with the ground terminal of 5V power supply. Furthermore, if you are driving a relay module with a microcontroller, also connect this pin with the ground terminal of the microcontroller.

4) Common Pin: -

This terminal is connected with the load that we want to switch with the relay module.

5) NC Pin: -

As the name of the normally close terminal suggests, it is normally connected with the COM pin and forms a closed circuit. But this normally closed connection breaks when the relay is activated by applying an active high or active low signal to the signal pin of the relay module from a microcontroller.

6) NO Pin: -

This pin is normally open unless we apply an activation signal to the signal pin of the 5V single channel relay module. In this case, the COM pin breaks its connection with the NC pin and makes a connection with the NO pin.

7) Input Connector: -

On the right-hand side of the relay module is an input connector. It is used to provide input signal and 5V power supply. Furthermore, it also provides power to the status LED, power LED and relay coil.

8) Output Terminal: -

On the left hand of this figure is an output terminal which is used to connect a DC/AC load and DC/AC input power source. We will discuss the wiring diagram to connect a LOAD and power source with this terminal in later sections of this tutorial. Each terminal of the output connector is connected with NO, NC and COM pins of 5V relay. Each point of the module has screws which make it easy to connect cables and wires with the relay module. This 5V relay module supports 10A maximum output current and maximum contact voltage of 250V AC and 30V DC. If you are using a high AC voltage and high current load with this module, you should use thick main cables.

9) Status LED: -

Status LED is SMD LED which is connected through current limiting resistor and it is available on top right corner of the module. It shows the status of the relay. In other words, the status LED turns on when the relay is active and the coil is energized through a signal input pin. The DC current passes through a relay coil.

10) Power LED: -

Power LED is also a SMD type and it shows the status of power source connected with the 5V single channel relay module. Do not connect more than 5V source to VCC and GND

11) Freewheeling Diode: -

A freewheeling diode is connected across the coil to avoid the effect of back EMF. It is also known as a fly back diode. The coil used in the relay is an inductive type. When the current passes through an inductive load, it produces a back EMF voltage. This back EMF may damage the circuit. Therefore, a freewheeling diode is used to avoid this effect.

• Circuit Diagram: -

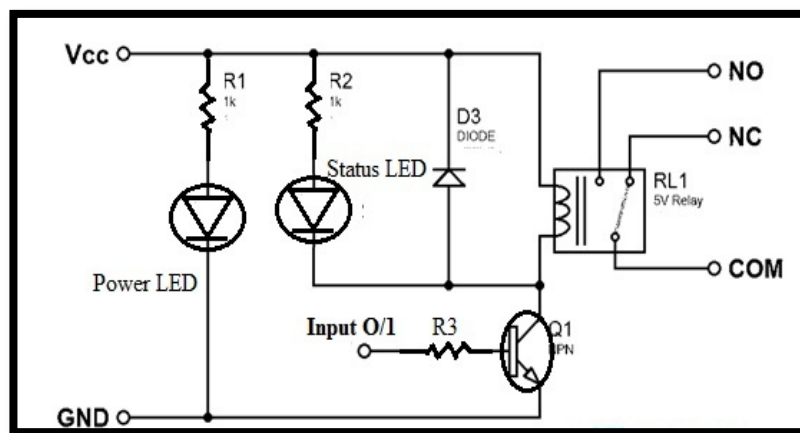


Fig.4.4: Circuit Diagram of Relay driver module

- **Specifications of Relay driver: -**

1. Low Level channel relay module
2. Output channel: 1
3. Trigger mode: Low Level
4. Working voltage: 5V
5. Relay Load voltage: - AC 125V / 250V, 10A, DC 28 V/30V, 10A
6. Total size: - 43 x 17 x 19 mm / 17x 0.67x 0.75 (L-W-T)
7. Package content: 1 x Relay module
8. Indicator Light – 1] green switch
2] Red power
9. Built in potentiometer: - Sensitive control It is used as a single chip minicomputer board module
10. Pin - 3 pins (VCC, GND, IN)
11. Relay contact: - NO, COM, NC
12. Freewheeling diode (D3) The diode connected across the relay coil is called a flyback diode or freewheeling diode. When the coil is energized, the flyback diode is reverse biased and has no role in the relay operation. The flyback diode is forward biased by the counter EMF generated during coil de-energization.
13. Relay available in market: - Teledyne relay

3] Solenoid Valve: -

A solenoid valve is an on/off electromechanically operated valve which consists of an electromagnetic actuator (solenoid) and a valve body. The solenoid-plunger assembly is the valve actuator responsible for opening and closing the valve. This actuator can be arranged in such a way that the plunger action can either open or close only. There is no intermediate or in-between position, so there is no way for a solenoid to throttle flow. The valve body consists of the pressure containing parts in-contact with the process fluid.

The solenoid converts electrical energy into a mechanical pull/push action. This consists of a coil of wire tightly wrapped around an iron core, and a ferromagnetic plug or plunger. Components vary depending on the design. As an electrical current passes through the coil, a magnetic field is generated. The magnetic field lines can be imagined as a series of circles with the direction of its current axis. In the case of a flowing current along a looped coil, the circles combine forming the magnetic field.

Adding more loops will increase the amount of magnetic field lines or flux. This increases the electromagnetic force of the solenoid. which also means more force for actuating the valve. Another way to increase the force of attraction is to increase the amount of current drawing through the coil. This is done by increasing the supply voltage into the solenoid. Solenoids valves can operate with either DC or AC. Common DC voltages are 6, 12, 24, and 240 volts while AC at 60Hz are 24, 120, 240, and 480 volts.

The working of solenoid valve is similar to that of the normal valve. The only difference here is that the solenoid valve only operates when it is supplied with DC voltage. It is two-way solenoid valve. So, it has 2 connections, one of them is liquid inlet and other is outlet. When there is input voltage on the terminal.

- **Components of Solenoid valve: -**

1. Coil
2. Core
3. Core spring
4. Core tube
5. Fixed Core
6. Diaphragm
7. Stem
8. Disc
9. Seal
10. Bonnet
11. Body
12. Bleed orifice



Fig.4.5 solenoid Valve

4] IR Proximity Sensor: -

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named William Herchel in 1800. While measuring the temperature of each colour of light (separated by a prism), he noticed that the temperature just beyond the red light was highest. IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation.

There are two types of infrared sensors: active and passive. Active infrared sensors both emit and detect infrared radiation. Active IR sensors have two parts: a light emitting diode (LED) and a receiver. When an object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver. Active IR sensors act as proximity sensors, and they are commonly used in obstacle detection systems (such as in robots).

The main benefits of IR sensors are low power usage, their simple design & their convenient features. IR signals are not noticeable by the human eye. The IR radiation in the electromagnetic spectrum can be found in the regions of the visible & microwave. Usually, the wavelengths of these waves range from 0.7 μm to 1000 μm . The IR spectrum can be divided into three regions like near-infrared, mid, and far-infrared. The near IR region's wavelength ranges from 0.75 – 3 μm , the mid-infrared region's wavelength ranges from 3 to 6 μm & the far IR region's infrared radiation's wavelength is higher than 6 μm . IR sensor consist of indicator light to detect an obstacle and pre-set knob to fined tuned distance range.

- **E18-D80NK IR Obstacle Avoidance Proximity Sensor:**

E18-D80NK Infrared Obstacle Avoidance Sensor is a low-cost IR Proximity Sensor with an adjustable range of 3 cm to 80 cm. The E18-D80 sensor comes with IR Transmitter and IR receiver in one module. The IR transmitter transmits modulated IR signal, which is then reflected by the object in its path and then detected by the receiver. This sensor has less interference by sunlight because of the modulated IR light.

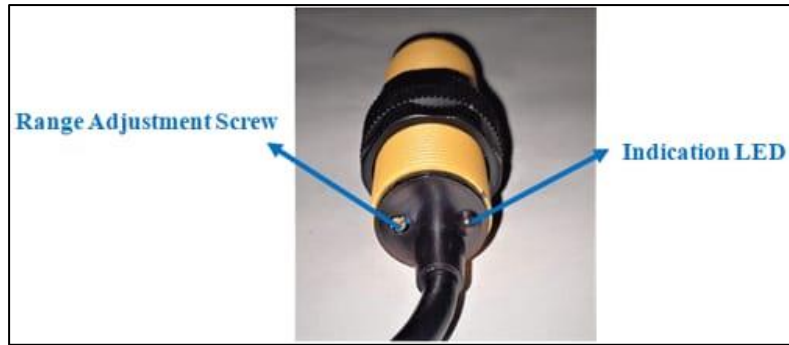


Fig. 4.6 E18-D80NK IR proximity sensor

E18-D80 IR Sensor is widely used in robots to avoid obstacles, industrial assembly lines, Reverse Car Parking, and many other automation applications. The detection range can be adjusted according to the application using the multi-turn screw that is located at the back of the sensor. The switching signal output changes according to the obstacle detection. It remains high when no obstacles and changes to low when there are obstacles. A red LED is placed behind the probe that turns high whenever an obstacle is detected. The E18 sensor operates on 5V and consumes around 5mA to 30mA current without any load.



Fig. 4.7 E18-D80NK IR proximity sensor connecting wires

- **Specifications: -**

Table 4.2 specification of IR proximity sensor

Sr. No.	Parameters	Specifications
1	Current consumption	>25mA (min) ~100mA (max)
2	Operating Voltage	5V DC
3	Cable Length	45cm
4	Distance measuring range	3cm to 80cm
5	Dimensions	8.9×8.8×2.7cm
6	Diameter	17mm
7	Environment Temperature	-25°C ~55°C

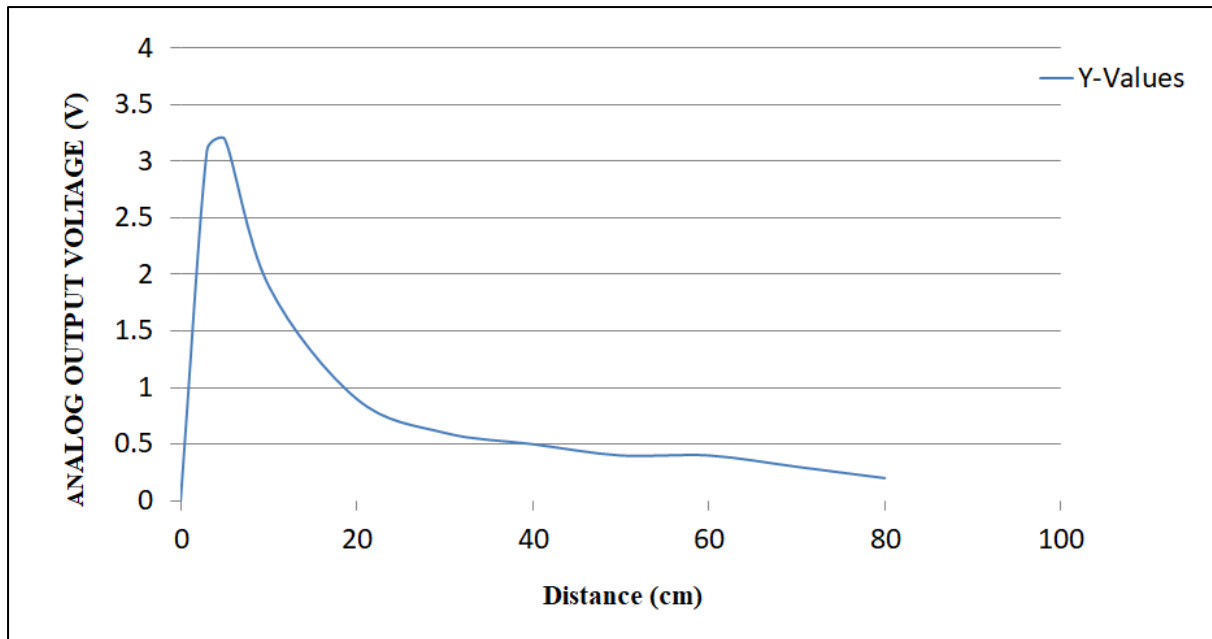


Fig. 4.8: Graph of Analog output voltages (V) and distance (cm) of E18-D80NK IR sensor

5] IC Voltage regulator:-

IC Voltage Regulator uses integrated circuits for voltage regulation. One advantage of IC voltage regulator is that properties like thermal compensation, short circuit protection and surge protection can be built into the device. Most of the commonly used IC voltage regulators are three-terminal devices.

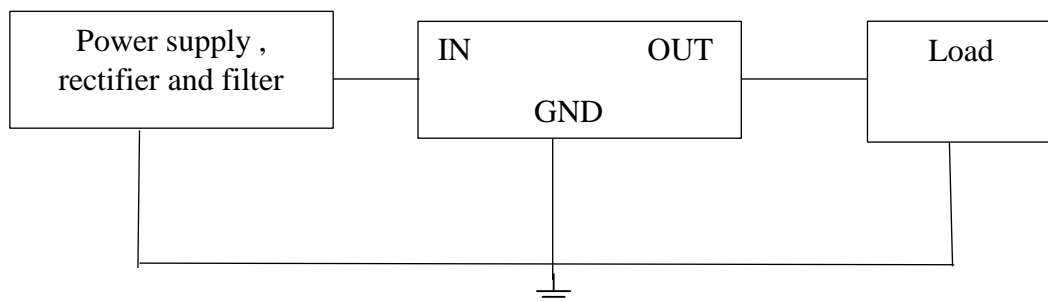


Fig 4.9 Schematic Symbol for 3 terminal IC voltage regulators

- **Types of IC Voltage Regulators**

There are basically four types of IC voltage regulators:

1. Fixed positive voltage regulator
2. Fixed negative voltage regulator
3. Adjustable voltage regulator
4. Dual-tracking voltage regulator

1. Fixed Positive Voltage Regulator

This IC regulator provides a fixed positive output voltage. Although many types of IC regulators are available, the 7800 series of IC regulators is the most popular. The last two digits in the part number indicate the D.C. output voltage. For example in table 4.3 the 7812 is a + 12V regulator whereas the 7805 is a + 5V regulator. The series (7800 series) provides fixed regulated voltages from + 5 V to + 24V.

Table 4.3: The 7800 series

Sr. No.	Type Numbers	Output Voltages
1	7805	+5V
2	7806	+6V
3	7808	+8V
4	7809	+9V
5	7812	+12V
6	7815	+15V
7	7818	+18V
8	7824	+24V

2. Fixed Negative Voltage Regulator

This IC regulator provides a fixed negative output voltage. The 7900 series of IC regulators is commonly used for this purpose. This series (7900 series) is the negative-voltage counterpart of the 7800 series in table 4.4. The 7900 series provides fixed regulated voltages from – 5V to – 24 V.

Table 4.4: The 7900 series

Sr. No.	Type Numbers	Output Voltages
1	7905	–5V
2	7905.2	–5.2V
3	7906	–6V
4	7908	–8V
5	7912	–12V
6	7915	–15V
7	7918	–18V
8	7924	–24V

3. Adjustable Voltage Regulator

The adjustable voltage regulator can be adjusted to provide any D.C. output voltage that is within its two specified limits. The most popular three-terminal IC adjustable voltage regulator is the LM 317. A LM317 voltage regulator, for example, can be made to output any voltages from +1.2V to 37V.

4. Dual Tracking Voltage Regulator

The dual-tracking regulator provides equal positive and negative output voltages. This regulator is used when split-supply voltages are needed. The RC4195 IC is the example of dual tracking voltage regulator. The RC 4195 IC provides D.C. outputs of + 15V and – 15V. The device needs two unregulated input voltages. The positive input may be from + 18V to + 30V and the negative input from – 18V to –30V.

A. 7812 Voltage regulator:-

The 7812 IC is a fixed voltage DC linear regulator that eliminates power distribution problems caused by single-point regulation. It belongs to the 78XX series of regulators and can output 12V at up to 1A. With a good heat sink, the 7812 IC can supply 1A for input voltages from 14 to 35V.

- **Features of 7812**

- 1) IC 7812 +12V 1A regulator
- 2) The operating voltage is dc 5v to 18v
- 3) Output current maintains 1 Ampere
- 4) Internal Short Circuit Current Limiting
- 5) Internal Thermal Overload Protection
- 6) Internal Safe–Area Compensation
- 7) Output Voltage Tolerance is 2% to 4%
- 8) Temperature Range of –40°C to +125°C

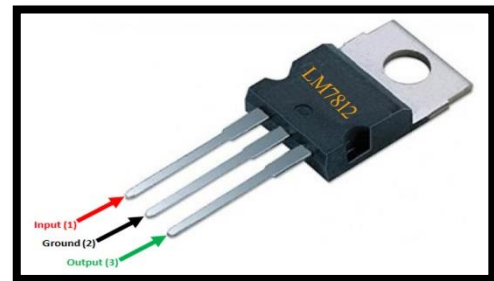


Fig 4.10 voltage regulator 7812

- **Pinout of 7812**

The 7812 pinout is relatively straightforward and enables it to generate positive voltages concerning the Ground. The 7812 pinout is as follows:

Table 4.5 Pin description of 7812

Pin Number	Pin Name	Description
1	Input (Vin)	Unregulated input voltage
2	Ground	Connected to ground
3	Output (Vout)	Regulated output voltage (+12V)

B. 7805 Voltage Regulator:-

IC 7805 is a linear voltage regulator and it includes three terminals including 5V of the fixed output voltage. This voltage is used in a variety of applications. At present, the manufacturing of this voltage regulator can be done by different manufacturing companies like STMicroelectronics, ON Semiconductor, Texas Instruments, Infineon Technologies, Diodes incorporated, etc

- **Features of 7805**

- 1) It uses fewer components to work properly.
- 2) It delivers the current up to 1.5 A.
- 3) Thermal shut down & internal current limiting.
- 4) Minimum & maximum input voltages are 7V and 25V.
- 5) The operating current is 5mA.
- 6) Protection of short circuit and thermal overload.
- 7) The highest junction temperature is 125°C.

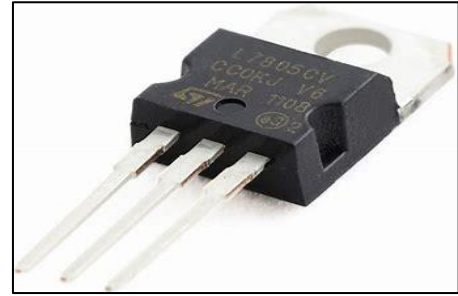


Fig. 4.11: Voltage Regulator 7805

- **Pinout of 7805**

The pin diagram of the 7805 voltage regulator is discussed below. This voltage regulator includes three pins namely input pin, ground pin, and output pin.

Table 4.6 Pin description of 7805

Pin Number	Pin Name	Description
1	Input (Vin)	Unregulated input voltage
2	Ground	Connected to ground
3	Output (Vout)	Regulated output voltage (+5V)

6] PCB (Copper Clad laminate):-

The base material plays a vital role in determining the characteristics and capabilities of printed circuit boards. Depending on the desired use of the product, the PCB base material must meet varying requirements.

- **Introduction:**

Copper Clad Laminate (CCL) is the base material of PCB. Bonding a layer of copper foil to a non-conductive substrate, such as fiberglass, plastic, or paper-phenolic made this laminate. The copper layer serves as the conductor for the electrical signals in the PCB, while the substrate provides mechanical support.

Copper-clad combines copper plating with a second metal (core material). Furthermore, they have almost the same properties as copper but aren't 100% copper. Thus, the fusion consists of copper and steel and copper and aluminium. CCL has many applications, from simple circuits to large, complex multi-layer boards.

- **Benefits of Copper Clad Laminate:**

- 1) Copper is an excellent conductor of electricity.
- 2) The fiberglass base material provides mechanical stability and durability.
- 3) It provides a cost-effective solution for PCB fabrication.



Fig 4.12 : Copper clad

- 4) CCL has various PCB applications, from single-layer to multi-layer boards.
- 5) CCL is easy to work with during the PCB fabrication process. It reduces the cost and time required for production.
- 6) With the CCL, the final product has a smooth and uniform surface. Thus, it helps in providing a high-quality finish for the PCB.

- **Properties of Copper Clad Laminate:**

- 1) **Electrical Conductivity:** The copper layer on the CCL provides excellent electrical conductivity for efficient signal transmission.
- 2) **Thermal Conductivity:** Copper is a good conductor of heat, dissipating heat that generates during the operation of the PCB.
- 3) **Mechanical Strength:** The fiberglass base material provides mechanical stability, helping to protect the PCB from damage and ensuring its longevity.
- 4) **Chemical Resistance:** CCL has good resistance to chemicals, making it suitable for use in harsh environmental conditions.
- 5) **Thermal Stability:** CCL has high thermal stability, allowing it to maintain its structural integrity under extreme temperatures.
- 6) **Flexibility:** CCL is flexible, making it suitable for applications where the PCB may be subject to stress or strain.
- 7) **Surface Finish:** The surface of the CCL is smooth and uniform, providing a high-quality finish for the PCB.

- **Material used in copper clad laminate:**

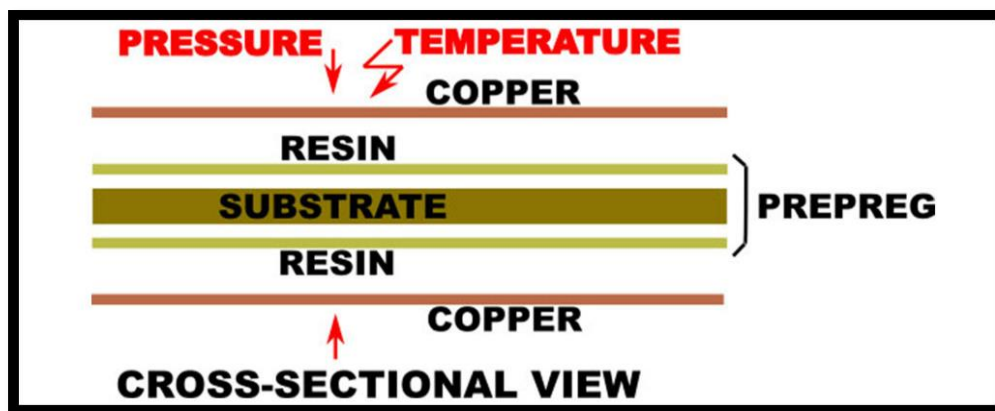


Fig 4.13: Cross section of Copper Clad

- Copper Clad Laminates (CCLs) are composite materials of several layers:

- 1) **Copper foil:** This layer provides electrical conductivity and is the primary material used to create the circuit patterns on the PCB.
- 2) **Dielectric (insulating) material:** This layer provides electrical insulation between the copper and base material. Fiberglass or phenolic resin is the base materials for it.
- 3) **Base material:** This layer provides mechanical support and stability to the CCL. It includes fiberglass, paper, or synthetic materials, such as polyimide or polyester.

7] Hand Dryer:-



Fig. 4.14: Hand dryer

- **Specifications:**

- 1) Operating Voltage: 230V A.C.
- 2) Power Requirement: 1000 Watt
- 3) Number of heat setting: 10
- 4) Number of heat setting: 2

8] 24V A.C/ D.C. Adopter:-

An AC adapter, AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Other common names include wall wart, power brick, wall charger, and power adapter. Adapters for battery-powered equipment may be described as chargers or rechargers (see also battery charger). AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply. External power supplies are used both with equipment with no other source of power and with battery- powered equipment, where the supply, when plugged in, can sometimes charge the battery in addition to powering the equipment.



Fig. 4.15: 24V D.C. Adopter

4.2 Modeling and Simulation

4.2.1 Software

❖ Introduction to Proteus: -

- Proteus is used to simulate, design and drawing of electronic circuits. It was invented by the Labcenter electronic.
- By using proteus you can make two-dimensional circuits designs as well.
- With the use of this engineering software, you can construct and simulate different electrical and electronic circuits on your personal computers or laptops.
- There are numerous benefits to simulate circuits on proteus before make them practically.
- Designing of circuits on the proteus takes less time than practical construction of the circuit.
- The possibility of error is less in software simulation such as loose connection that takes a lot of time to find out connections problems in a practical circuit.
- Circuit simulations provide the main feature that some components of circuits are not practical then you can construct your circuit on proteus.
- There is zero possibility of burning and damaging of any electronic component in proteus.
- The electronic tools that are very expensive can easily get in proteus such as an oscilloscope.
- Using proteus you can find different parents of circuits such as current, a voltage value of any component and resistance at any instant which is very difficult in a practical circuit.

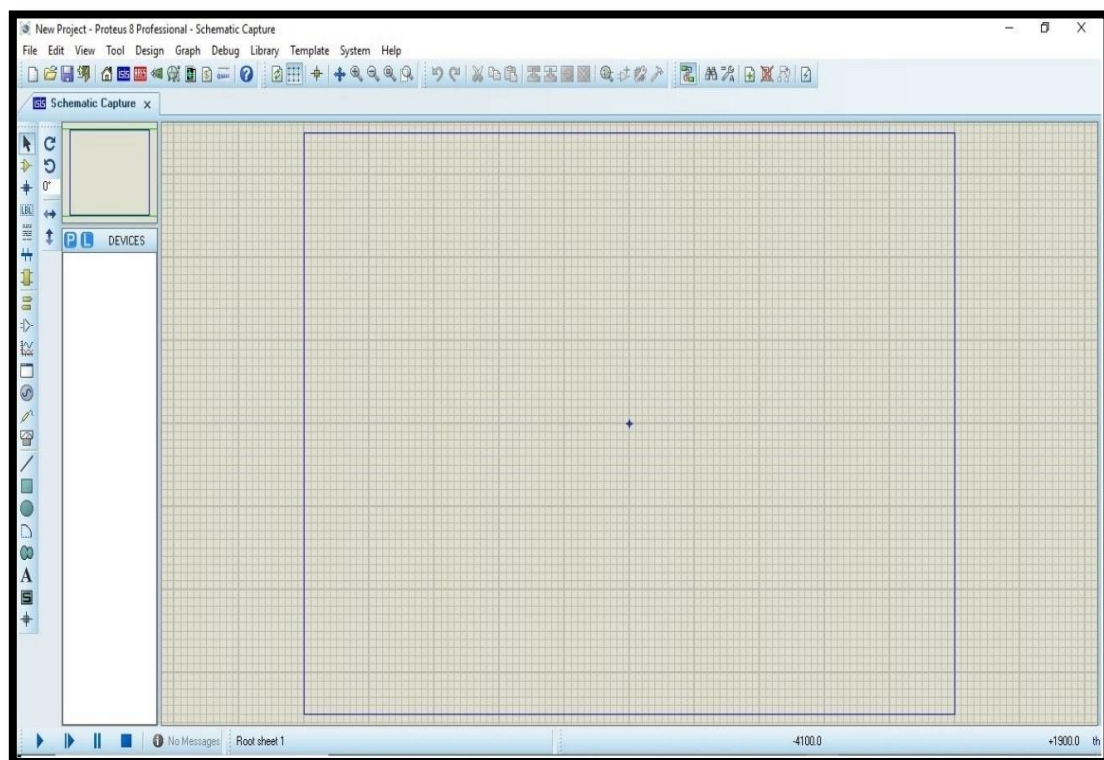


Fig.4.16 Proteus software

❖ Features of Proteus: -

- There are 2 main parts of proteus first is used to design and draw different circuits and the second are for designing of PCB layout.
- First is ISIS that used to design and simulate circuits. And second is ARES that used for designing of a printed circuit board.
- It also provides features related to the three-dimensional view of design in PCB.

❖ Proteus Layout: -

- 1) Click on proteus icon and see this window from a new file option.

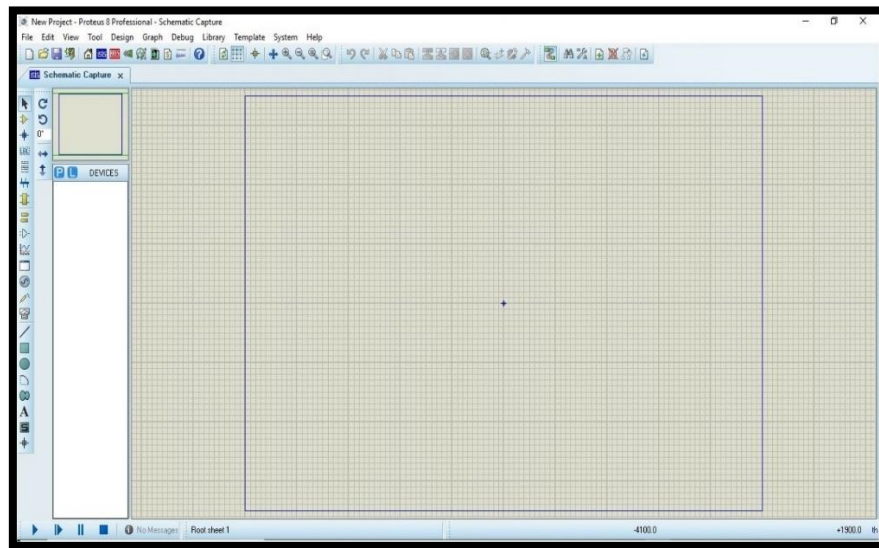


Fig.4.17 Proteus Layout

- 2) In the above figure, see the proteus window and this window has many sections that are explained in the below figure.

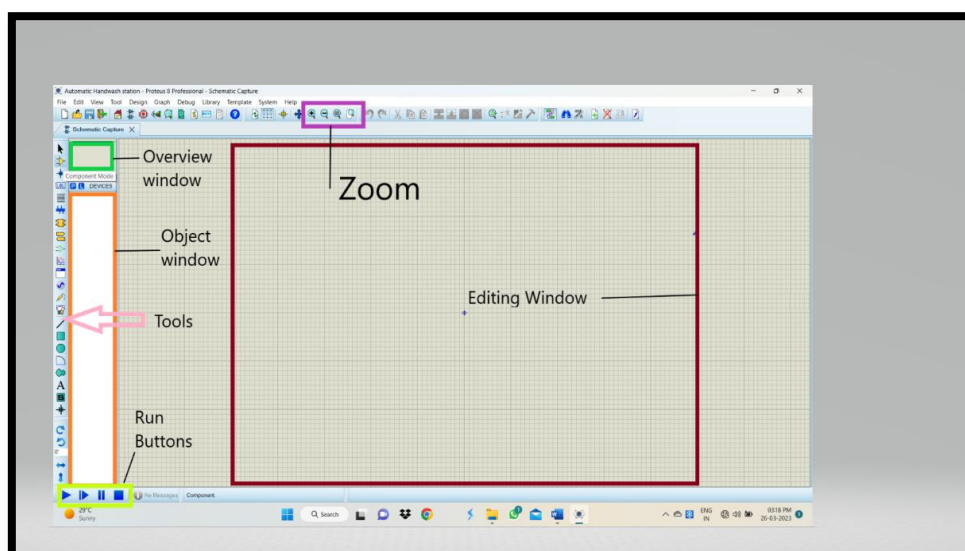


Fig. 4.18 Section of proteus

1) Editing Window: -

In the above figure, you can see that the dotted portion is called an editing window. This is a drawing portion of proteus where you simulate your engineering circuits and projects.

2) Overview Window: -

In the overview window, you see the complete view of your complete design.

3) Object Selector: -

This section has 2 buttons P and E. P is used to select different components and shown in this box. The E button is for edit something for example you want to vary any value of components than you can use this edit button.

4) Zoom Option: -

By using this option you can easily zoom in and zoom out your layout and can observe complete simulation very clearly.

5) Tool Option: -

By using this option you can select different devices like voltmeter, ammeter, oscilloscope, etc.

6) Run Buttons: -

At the left bottom there are 4 buttons Run, stop, pause and stop. These buttons are like the remote control and on and off your circuit.

❖ How to Make Circuit in Proteus: -

Step 1: - First of all click on proteus Icone in computer and click on a new file option

Step 2: - After that, Editing window open. Save it as the name handwash dispenser system.

Step 3: - After a move to the component option as shown in the below figure and select the elements for project.

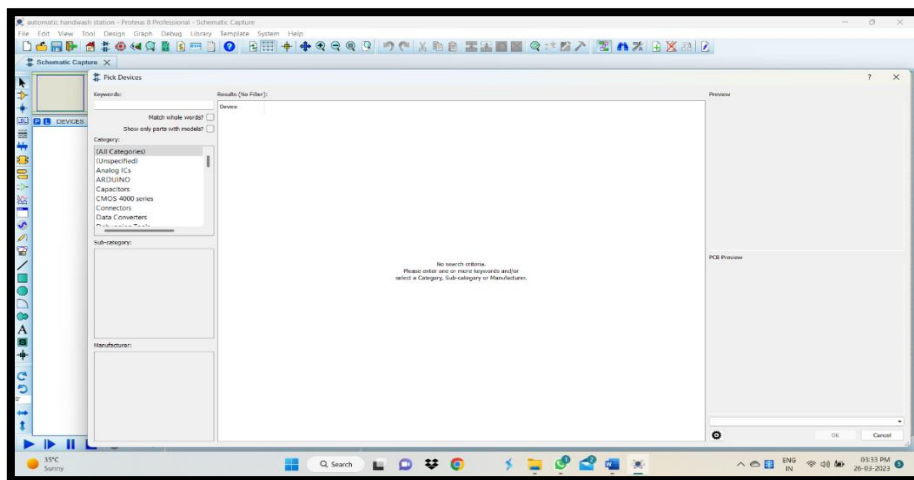


Fig.4.19: Selection of Components

Step 4: - After clicking on components mode you will see two buttons P and L. If you move to P button you will see Pic from Libraries. It is used to select different components for circuit construction.

Step 5: -click on the P button you will see box. Type your component for a circuit.

Step 6:

- When select components for project see them in a box shown in the below figure.
- After the selection of components make the circuit layout of your project and connect all these components with the wires.
- For connection of one component to other clicks left of first one terminal of component and drag it to other components.
- If you want to remove any component or remove its connection just double click on respective of a component of wire.
- If you want to change the values of any component such as resistance, capacitor, then click right on that component and select the desired value and click OK button.

Step 7: - When you connect all components in the circuit like run button in left bottom see the practical working of your circuit.

Step 8: Observe the simulation circuit then click on stop button on the left bottom to stop the working of the circuit.

4.2.2 Simulation Circuit

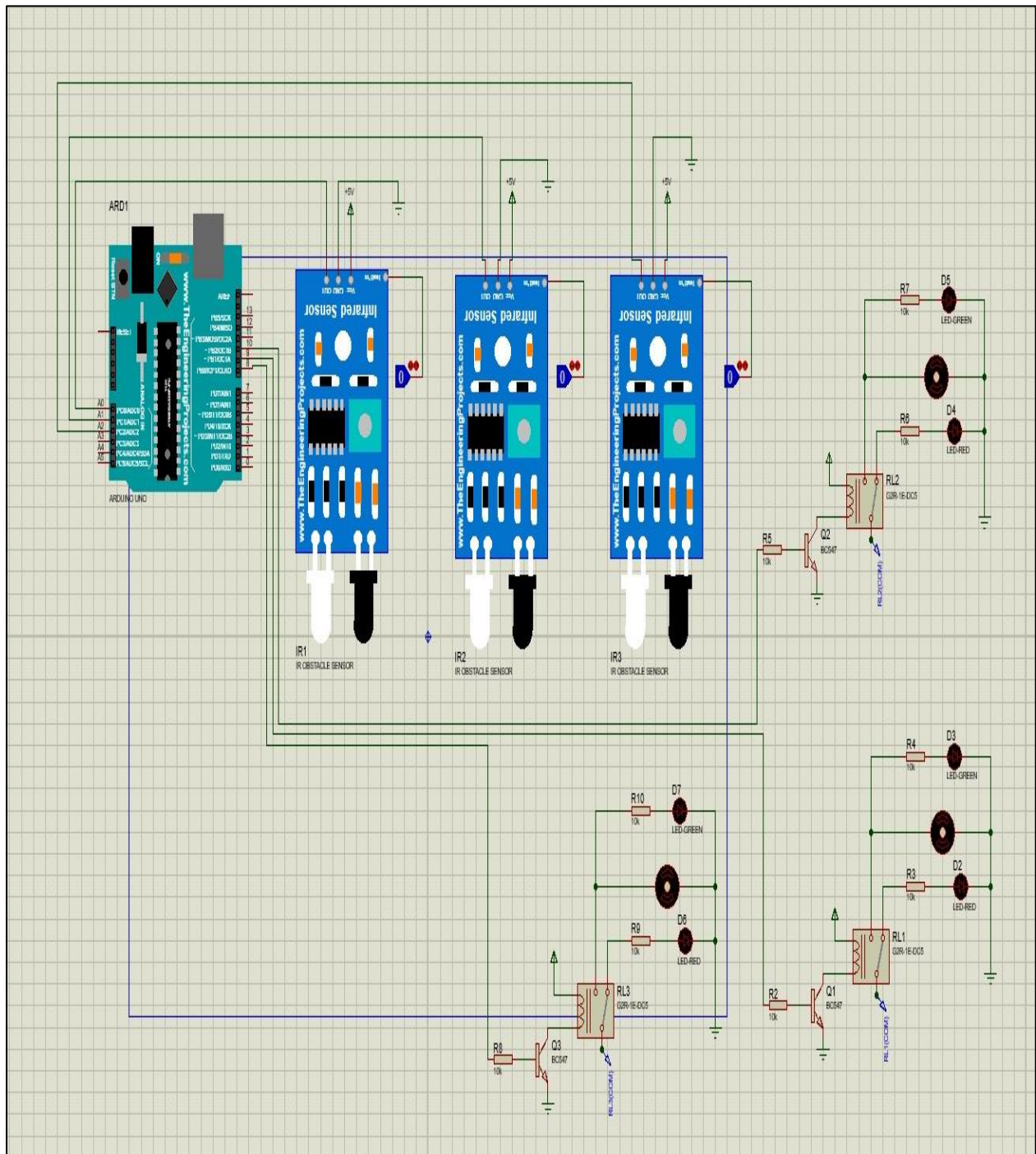
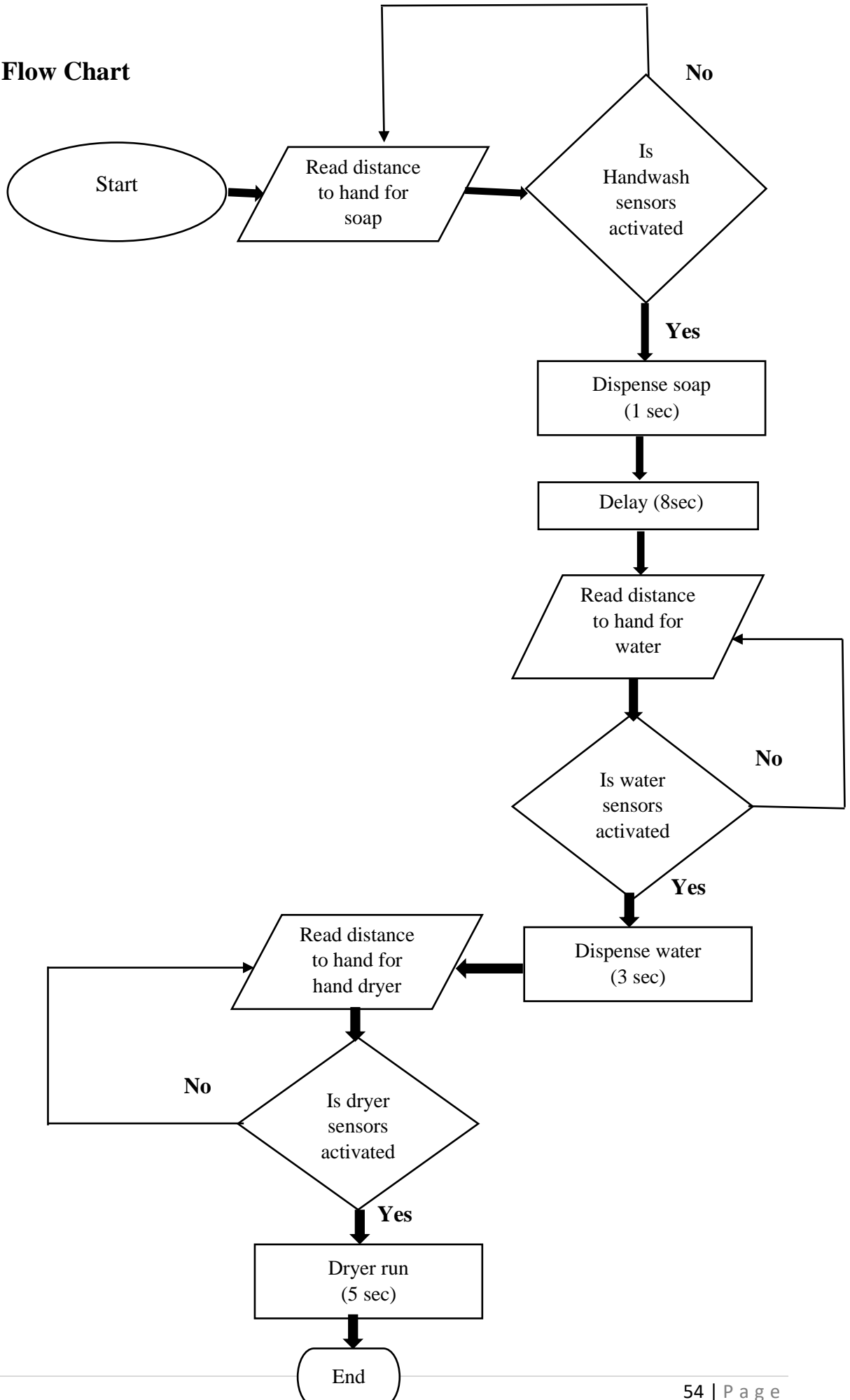


Fig.4.20: Simulation circuit of Hand wash system

4.2.3 Flow Chart



4.2.4 Arduino Sketch

```
const int valve1 = 10;           // valve is connected to pin 10
const int valve2 = 9;           // valve is connected to pin 9
const int dryer = 8;            // dryer is connected to pin 8

const int relay1 = 7;           // relay1 is connected to pin 7
const int relay2 = 6;           // relay2 is connected to pin 6
const int relay3 = 5;           // relay3 is connected to pin 5

int hasObstacle1;               //define variable for sensor1
int hasObstacle2;               //define variable for sensor2
int hasObstacle3;               //define variable for sensor3

void setup()
{
    pinMode(valve1, INPUT);      // setup the valve1 as an input
    pinMode(valve2, INPUT);      // setup the valve2 as an input
    pinMode(dryer, INPUT);       // setup the dryer as an input

    pinMode(relay1, OUTPUT);     // setup the relay1 as an output
    pinMode(relay2, OUTPUT);     // setup the relay2 as an output
    pinMode(relay3, OUTPUT);     // setup the relay3 as an output
    digitalWrite(relay1, HIGH);  //turn on relay1
    digitalWrite(relay2, HIGH);  //turn on relay2
    digitalWrite(relay3, HIGH);  // turn on relay3

    Serial.begin(9600);          // initialize serial communication at 9600 bits per second
}

void loop()
```

```

{
  hasObstacle1 = digitalRead(valve1);
  hasObstacle2 = digitalRead(valve2);
  hasObstacle3 = digitalRead(dryer);

  if (hasObstacle1 == LOW)                                // soap pump
  {
    digitalWrite(relay1, LOW);
    Serial.println("Sanitize your hand");
    delay(1000);

  }

  if (hasObstacle2 == LOW)                                // water pump
  {
    digitalWrite(relay2, LOW);
    Serial.println("Wash your hand");
    delay(3000);
  }

  if (hasObstacle3 == LOW)                                // dryer pump
  {
    digitalWrite(relay3, LOW);
    Serial.println("Dry your hand");                      // printout the state of dryer2
    delay(5000);
  }

  digitalWrite(relay1, HIGH);
  digitalWrite(relay2, HIGH);
  digitalWrite(relay3, HIGH);
  delay(200);
}

```


Chapter 5. System Design

5.1 Regulated Power Supply

An electronic circuit that produces a stable DC voltage of fixed value across the load terminals irrespective of changes in the load is known as regulated power supply. Thus, the primary function of a regulated power supply is to convert an AC power into a steady DC power. The regulated power supply is sometimes also called as a linear power supply. The regulated power supply ensures that the output power at the load terminals should remain constant even if the input power varies. The regulated power supply receives an AC power as input and generates a constant DC power as output. A regulated power supply is basically an embedded circuit consisting of various blocks.

5.1.1 Schematic of regulated power supply:-

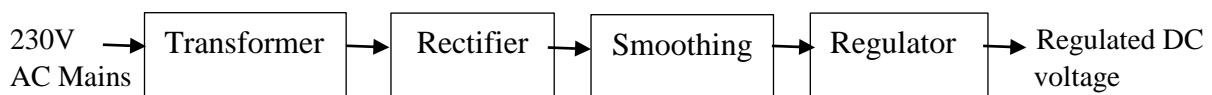


Fig 5.1: Block diagram of regulated power supply

1) Function of Step-Down Transformer

The step-down transformer used in the circuit of the regulated power supply changes the input AC voltage to the desired lower voltage value. Also, this transformer provides an electrical isolation between two circuits. The reduced output AC voltage of the step-down transformer is used as the input to the rectifier circuit.

2) Function of Rectifier Circuit:

The rectifier circuit is used to convert the input AC voltage into a DC voltage. It consists of diodes that perform the rectification process, i.e. conversion of the AC voltage into the DC voltage. However, the output of the rectifier is a pulsating direct voltage. In practice, a full wave rectifier is used for the rectification due to its technical advantages. This full wave rectifier can be a centre-tapped full-wave rectifier or a bridge rectifier. The full wave rectifier converts both positive and negative cycles of AC voltage into DC voltage.

3) Function of Filter Circuit:

Since the output of the rectifier is a pulsating direct voltage which has very high ripple content. Hence, the raw output of the rectifier is undesirable. In order to get a pure ripple free direct voltage, a DC filter circuit is used. We have different types of filter circuits such as capacitor filter choke input filter, π -filter, and LC filter. Therefore, the filter circuit converts the pulsating direct voltage into the constant direct voltage having almost zero ripple content.

4) Voltage Regulator:

The voltage regulator constitutes the last block of the regulated power supply. It monitors and corrects the fluctuations in the output voltage of the power supply. The output voltage may change or fluctuate due to any change in the input AC voltage or the change in the load or change in any physical parameters such as temperature of the circuit. Thus, the voltage regulator takes care of this problem. The voltage regulator maintains the DC voltage constant at the output terminals.

- **Features of the regulated power supply:-**

Following are the main features of the regulated power supply

- 1) The regulated power supplies have the efficiency ranging from 20% to 25%.
- 2) Regulated power supplies are relatively more reliable.
- 3) Regulated power supplies have less complex circuit and less weight.
- 4) Regulated power supplies give faster response.
- 5) The cost and noise level of the regulated power supplies is low.

- **A. 12V DC Regulated power supply:-**

The 230V A.C. mains to 12V D.C. regulated power supply is the circuit that can store the power for a long time. The circuit used is in efficient one and brought much improvement into current D.C. power supplies such as voltage regulation and removal of ripple in output.

- **Circuit Diagram**

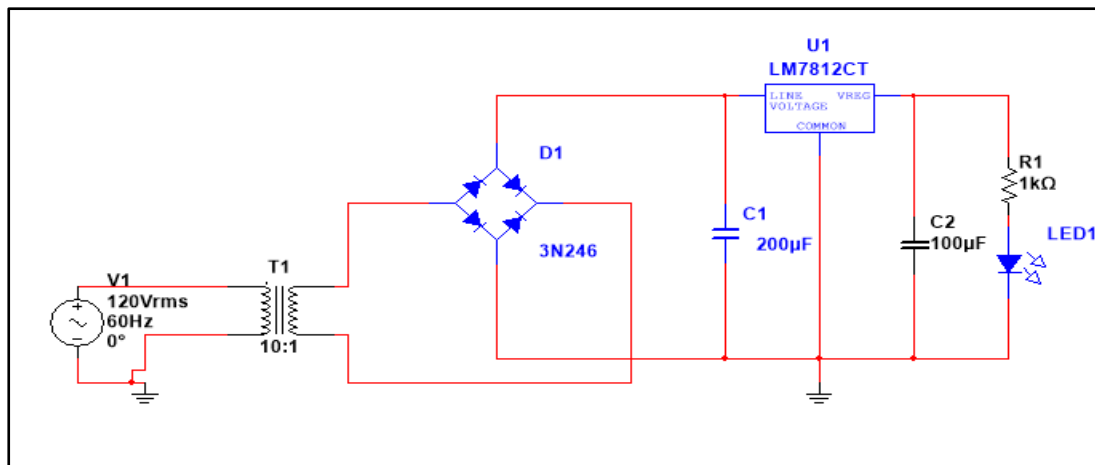


Fig 5.2: Circuit Diagram of 12V DC Regulated power supply

- **Layout of 12v Power supply: -**



Fig 5.3: layout of 12V power supply

- **Simulation: -**

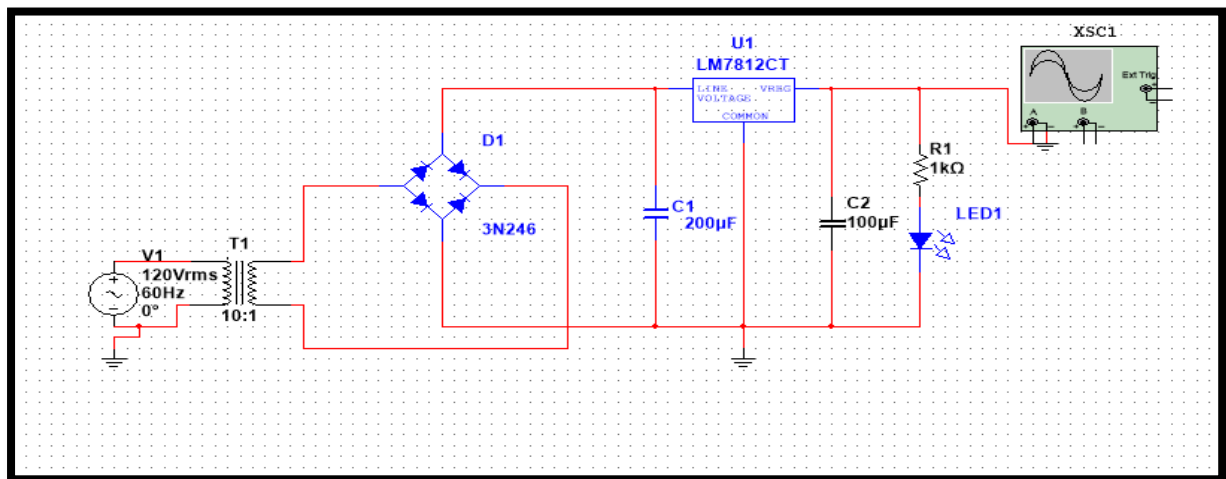


Fig 5.4: Simulation of 12V power supply

- **Waveform: -**

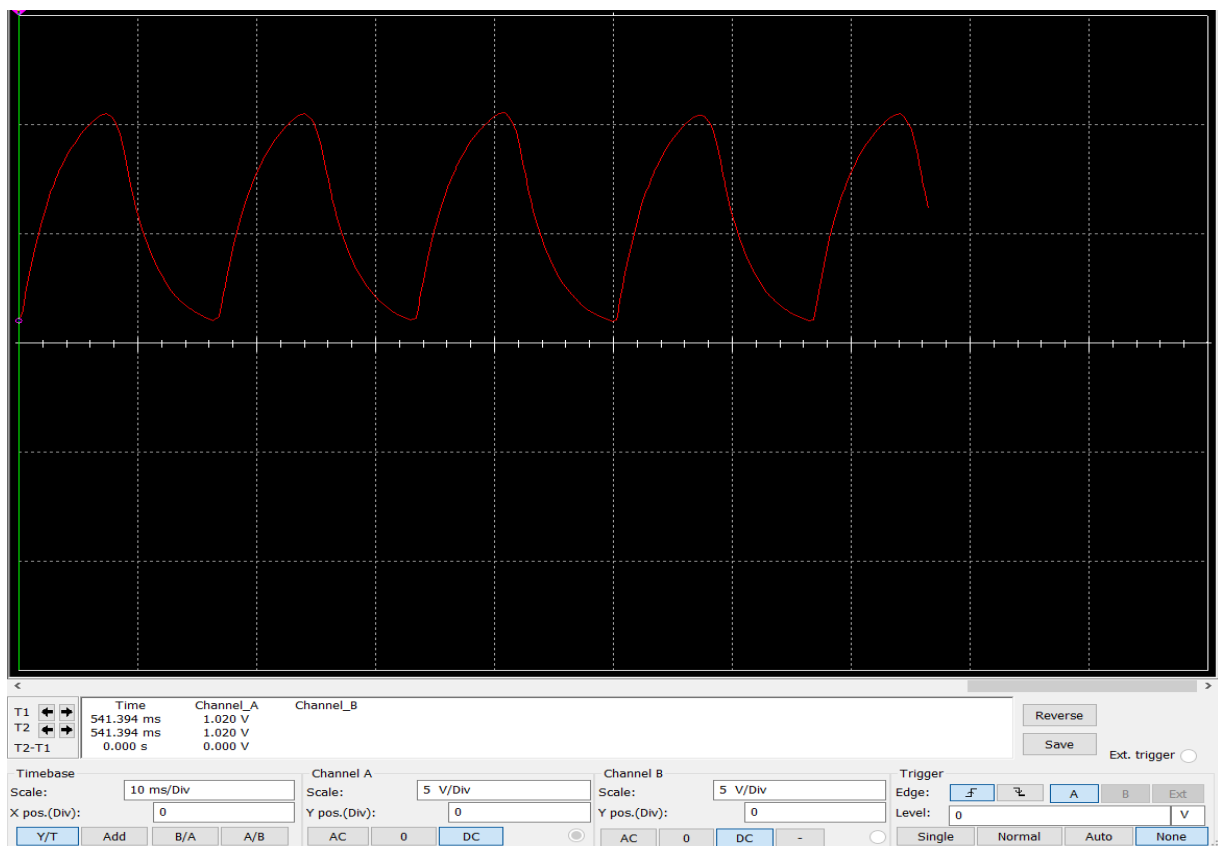


Fig. 5.5: Waveform of 12V power supply



Fig.5.6: Actual Circuit of 12V power supply

B. 5 V DC Regulated power supply:-

The 230V A.C. mains to 5V D.C. regulated power supply is the circuit that can store the power for a long time. The circuit used is in efficient one and brought much improvement into current D.C. power supplies such as voltage regulation and removal of ripple in output.

- Circuit diagram: -**

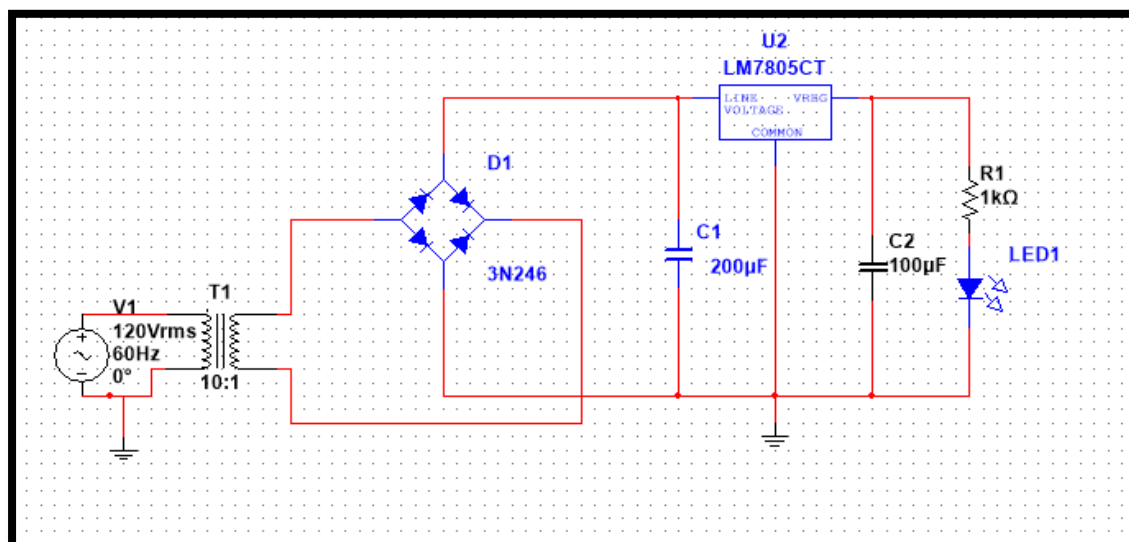


Fig. 5.7: Circuit diagram of 5V power supply

- **Layout: -**



Fig. 5.8: Layout

- **Simulation: -**

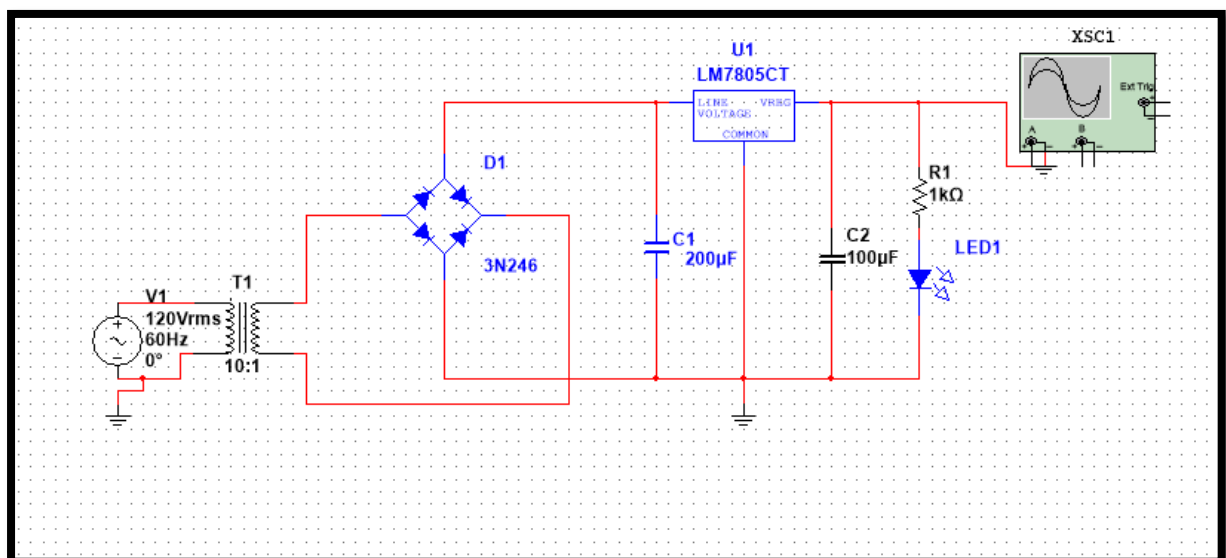


Fig. 5.9 Simulation of 5V power supply

- **Waveform: -**

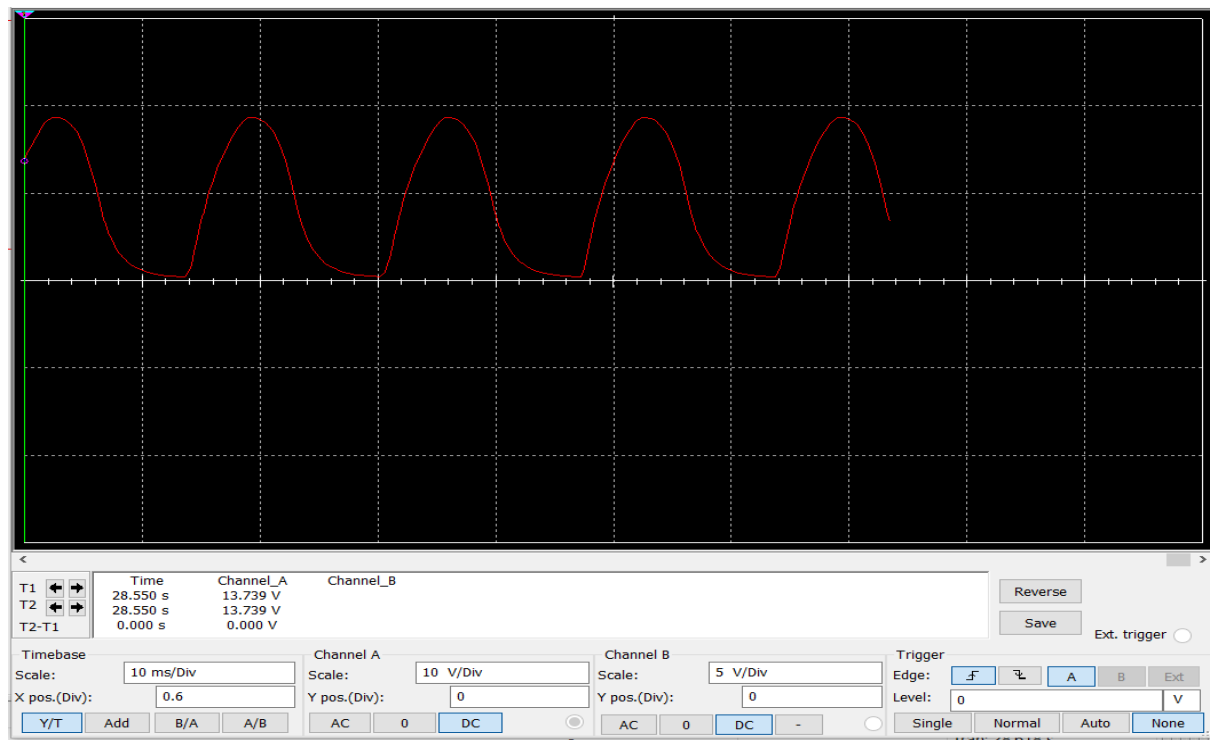


Fig. 5.10: Waveform of 24v power supply



Fig. 5.11: Actual Circuit of 5V power supply

- **Power supply performance and testing –**

1. **Source effect:** The AC supply to the input of a transformer in a DC power supply does not always remain constant. A $\pm 10\%$ variation in the AC source voltage is not unusual. When the source voltage varies, there is some variation in the DC output voltage from a power supply. This output voltage change due to change in the input is termed the source effect.

$$\text{Source Effect} = \Delta E_o \text{ for a } 10\% \text{ change in } V_s \text{ -----(1)}$$

2. **Line regulation:** If the output varies by 100 mV when the source voltage changes by $\pm 10\%$, the source effect is 100 mV. Another way of stating this output change is to ΔE_o express as a percentage of the dc output voltage (E_o).

$$\text{Line regulation} = \frac{(\Delta E_o \text{ for a } 10\% \text{ change in } V_s) \times 100\%}{E_o} \text{ ----- (2)}$$

3. **Load Effect:** The load effect defines how the output voltage changes when the load current is increased from 0 to its specified maximum level $I_{L \text{ max}}$.

$$\text{Load Effect} = \Delta E_o \text{ for } \Delta I_{L(\text{max})} \text{ ----- (3)}$$

4. **Load Regulation:** If the load current changes (ΔI_L) produces a voltage change ΔE_o of 100mV. The load effect is 100mV. As for the source effect, the load effect also be expressed as percentage of the output voltage. This is termed as load regulation.

$$\text{Load Regulation} = \frac{(\Delta E_o \text{ for } \Delta I_{L(\text{max})}) \times 100\%}{E_o} \text{ ----- (4)}$$

5.2 Interfacing of Arduino and Relay Module

Relay module for arduino is one of the most powerful application as it can be used to both A.C and D.C devices by simply controlling the relay by giving 5V. An output from a microcontroller ATmega328 on arduino is very low. It is sufficient for LED to glow but to operate or control high voltage relay module is used. In Automatic hand wash system 24V solenoid valve for soap and water dispensing is used. Hence to operate it relay modules are interfaced with Arduino UNO R3.

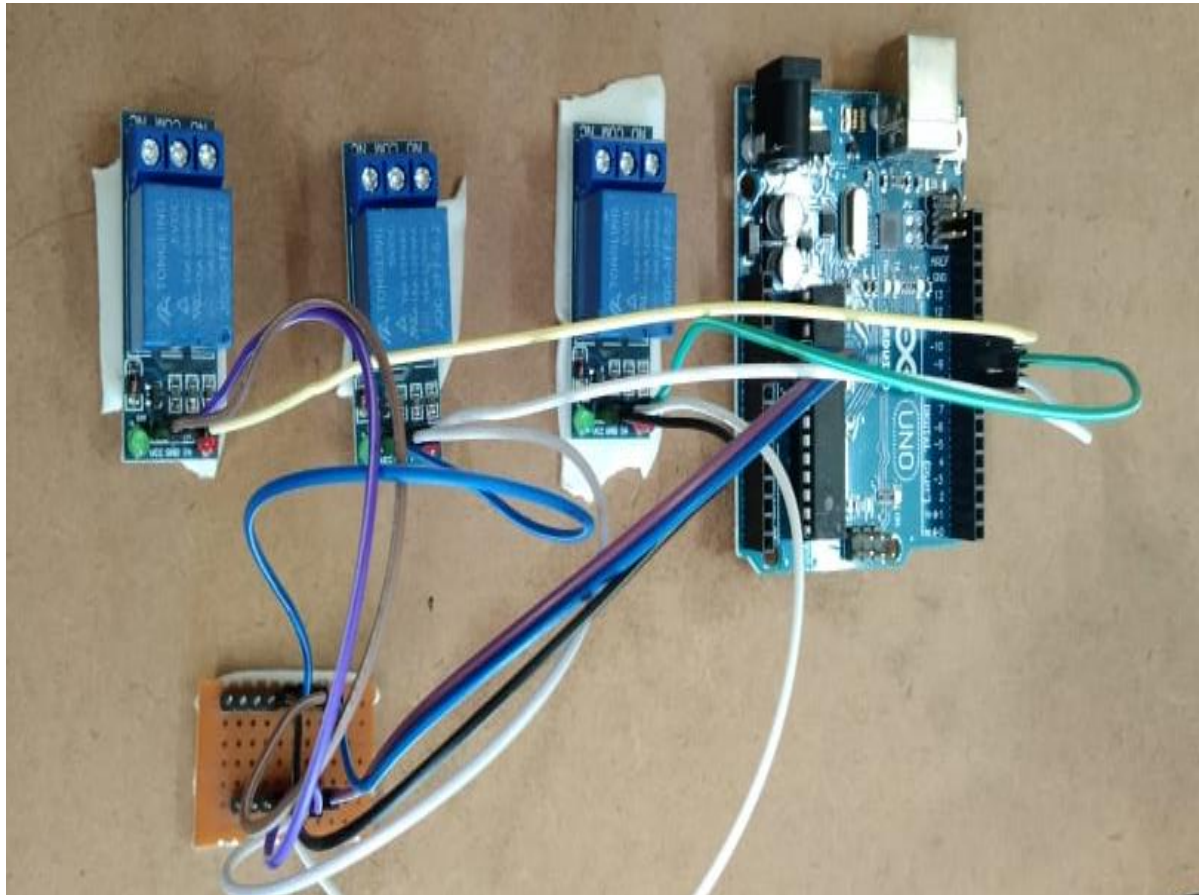


Fig. 5.12 Interfacing of Arduino UNO R3 with relay module

5.1.1 5.2.1 Interfacing Description

- GND pins of 5V relays to GND pin of arduino.
- VCC pins of 5V relay to VCC pin of arduino.
- Signal (input) pin of relays are connected to 5, 6 and 7.
- 12V power supply is given to Arduino by power port.
- Sketch is inserted by USB connector of an Arduino.

5.3 Hardware

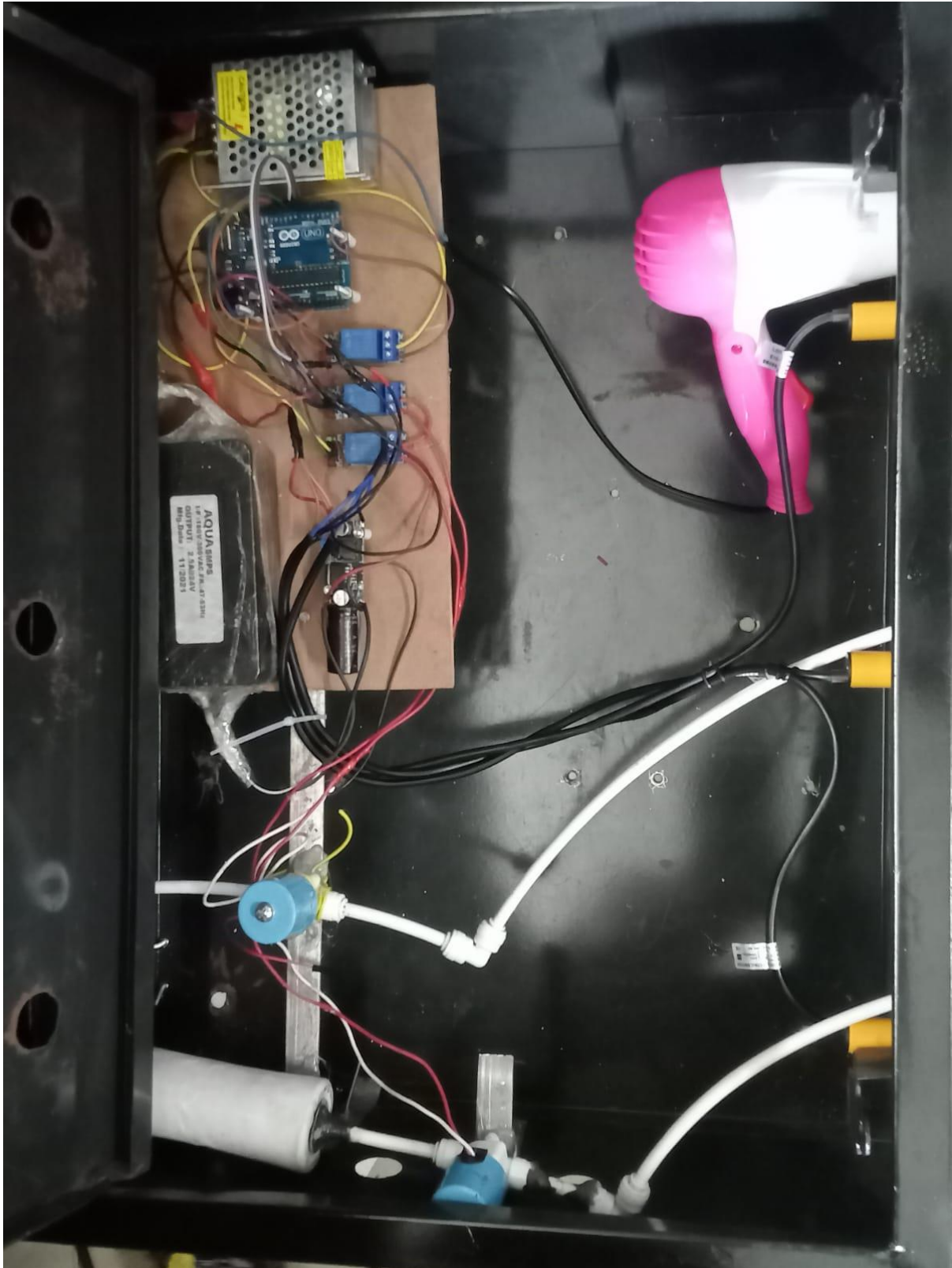


Fig. 5.13 Hardware of hand washes system

5.4 Working

An automation system is an integration of sensors, controls and actuators designed to perform a function with minimal or no human intervention. In automatic hand wash system E18-D80NK IR proximity sensors, ATmega328 micro-controller on arduino board and as actuator solenoid valve and hand dryer are used. IR proximity sensors and relay modules are operated at 5V power supply. Arduino UNO R3 uses 12V power supply and solenoid valve has of 24 V power supply.

230V A.C. Start the hand wash system. The 230V A.C. is given to hand dryer, 12V and 5V voltage regulators. 12V and 5V voltage regulators transformer steps down the A.C input signal that changes amplitude of input signal. Then bridge rectifier converts A.C. into pulsating D.C. and capacitors filters the A.C. signal. After that voltage regulator regulates voltage to 5V or 12V. The output signal is met indicated by the LED. The component which requires power supply such as arduino and relay module get start. The E18-D80NK IR proximity sensors as an input device are connected to the 10, 9, and 8 digital pins of an arduino.

The first stage of syatem is hand wash dispenser. When the soap sensor E18-D80NK detects an obstacle its indication red light will on and then input signal sends to an arduino digital pin 10. The micro-controller on arduino process the input signal by sketch and output signals are send to the relay modules which are connected to the digital pin 7. The relay modules get the signal, status LED will glow on and operate the solenoid valve 1 for soap and it dispense soap solution for 1second.

The second stage of system is water dispenser. When the water sensor E18-D80NK detects an obstacle its indication red light will on and then input signal sends to an arduino digital pins 9. The micro-controller on arduino process the input signal by sketch and output signals are send to the relay modules which are connected to the digital pin 6. The relay modules get the signal, status LED will glow and operate the solenoid valve 2 for water and it dispense water for 3seconds.

The third stage of system is hand dryer. When the water sensor E18-D80NK detects an obstacle its indication red light will on and then input signal sends to an arduino digital pins 8. The micro-controller on arduino process the input signal by sketch and output signals are send to the relay modules which are connected to the digital pin 5. The relay modules get the signal, status LED will glow and operate hand dryer for 5seconds.

In this way automatic hand washing system operates.

Chapter 6. Standard Operating Procedure

6.1 Hand Washing Instructions:

Washing your hands is simple, and it is among the most successful approaches to decrease the transmission of contagious disease. Clean hands will avoid germs from spreading from one person to another and through the community, from home and work to health care facilities and hospitals. Follow these five steps every time while using the automatic hand washing system

1. Wet your hands with clean water and apply soap.
2. Lather your hands by rubbing them together with the soap. Lather the backs of your hands, between your fingers, and under your nails.
3. Scrub your hands for at least 20 seconds.
4. Rinse your hands well under clean, running water.
5. Dry your hands using air hand dry.

Hand Washing Instructions



1)Wet your hands



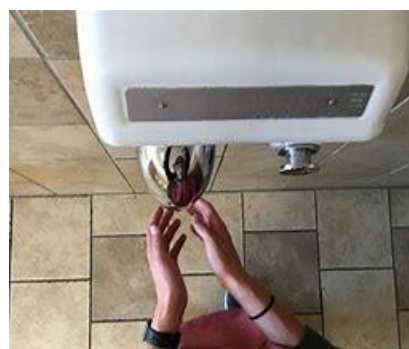
2)Lather your hands



3) Scrub your hand for 20sec



4)Rinse your hand



5)Dry your hand properly

6.2 Troubleshooting Procedure:

- For testing in handwash system there are two parts Hardware and Arduino.
- One system host and other follows the target.
- Target is actual hardware to be used.

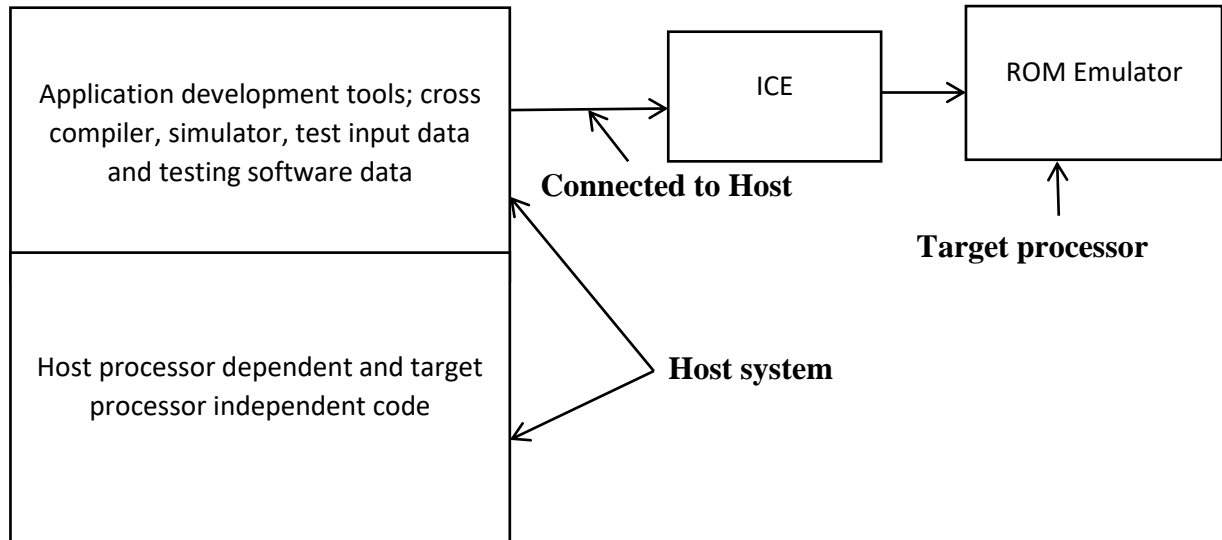


Fig 6.1 : Troubleshooting procedure

- Host machine is also used to run simulator.
- Fig.6.1. shows the test system in the development process.

• Troubleshooting of arduino: -

- Check Power Led
- Check Microcontroller
- Check FTDI Chip
- Check Pin 13 Led Blinking
- Check Voltage Regulator
- Check 5V Output Pin Voltages

1) Check Power LED: -

Majority of Arduino boards have power led on board that helps to identify whether Arduino is turned on or not. So, the first thing to do with the Arduino is to check the led, connect Arduino with PC or power it is using any external supply. If the LED turns on, then it means the Arduino is working or at least it is getting the 5V to run that led. If the LED doesn't turn on then the voltage regulator probably needs to be replaced.

2)Check Microcontroller: -

Microcontroller is the brain behind Arduino, if it goes out of working then Arduino is of no use. Usually, Arduino boards such as Uno come in two variants SMD (Surface Mounted Device) or in DIP (Dual In-line Packaged). If the Arduino microcontroller burn out than it can easily be replaced in case of DIP Arduino while SMD based Arduino board is needs to be completely replaces with a new one as it's hard to solder the SMD microcontroller on Arduino. To test if a microcontroller is out of order use logic analyzer, multiple USB based analog logic analyzer are available that connect with digital pins to test microcontroller working.

3)Check ATmega16u2: -

Arduino latest models have ATmega16u2 microcontroller that helps Arduino to get recognized by PC and build serial communication between Arduino and PC. It might be possible that an electric or voltage surge can burn out this chip, so the Arduino board will not be recognized by your PC. If the chip is in working condition but not recognized by PC then try to update the bootloader program along with correct fuses. If the issue persists then replace the serial chip or buy a new Arduino board.

4)Check Pin 13 LED Blinking: -

Arduino IDE has a test program known as Led Blink sketch which comes by default in the new Arduino board. Arduino is equipped with a built-in LED on pin 13. Upload the blink sketch by connecting the Arduino board with the PC. If the Led starts blinking with a delay of 1 sec, then it shows the Arduino is fine and working accordingly.

5)Check Voltage Regulator: -

Arduino has on-board two voltage regulators once the Arduino is powered up voltage goes through these two regulators and then given to Arduino and microcontroller. One voltage regulator is of 5V and other one is of 3.3V. Voltage given through Vin and DC barrel jack is passed through these regulators. Once the regulators start heating due to excess voltage it can damage the Arduino board and may shut it down permanently.

6)Check 5V Output Pin Voltages: -

Once the voltage is regulated, we can get the regulated 5V output from Arduino using a 5V output pin. If the 5V pin is giving output less or more than 5V then there is a high probability that the Arduino board might be damaged somewhere or going to shut down soon. Atmel microcontrollers are designed to work on maximum voltage of 5.5V anything above that can fry your Arduino board permanently.

Chapter 7. Conclusion and Future Scope

7.1 Conclusion

Our project is completed with expected outcomes and implemented at our college department. Its design provides health hygiene facilities to all users as per WHO rules. The design should allow easy regular cleaning or disinfection of taps, soap dispenser. Refilling of consumable soap storage should be easy. In schools and colleges this design project is too helpful to keep away bacteria's from students and their study doesn't interrupt because of spreading diseases. The system is easy to operate by anyone. The protocols given by different health care departments are perfectly and 100% followed by hand wash dispenser system with hand dryer.

7.2 Future Scope

7.2.1 AI- Recognition Technology in Hand washing System

- **Artificial Intelligence:**

AI is defined as the study of making computers do things intelligence. AI is combination of computer science, physiology and philosophy. Basically, AI is combination of science of human intelligence and an engineering disciplines (SMART physical system).

- **Introduction:**

Fujitsu Laboratories Ltd. and Fujitsu Research and Development Center Co., Ltd. (FRDC) announced the development of "Actlyzer" hand wash movement recognition technology, which leverages AI and machine learning techniques to identify complex hand washing movements from video data captured by camera.

Amidst the ongoing global COVID-19 pandemic, the importance of hand washing as a measure to protect people's health from bacteria, influenza, and other infectious diseases is gaining renewed attention worldwide. Under new regulations planned to come into effect in June 2020 in Japan, food business operators will also be required to implement stronger measures to ensure hygiene in accordance with international HACCP food safety standards, creating an urgent need for a non-invasive approach to quickly and accurately confirm that handwashing is carried out in a proper manner. Anticipating this, Fujitsu has expanded the recognition function of its existing "Actlyzer behavioral analysis technology", which can recognize a variety of subtle and complex human movements without relying on large amounts of training data. Specifically, Fujitsu has refined recognition capabilities for hand movements to create technology to automatically recognize complicated hand movements performed during hand washing.

This technology makes it possible to easily determine whether someone is following each of the 6 steps for hand washing recommended by the Japanese Ministry of Health, Labour and Welfare, reducing the number of man-hours required for intrusive visual checks by inspectors for on-site sanitation management.

Moving forward, Fujitsu envisions this technology being used in a variety of other contexts, including in medical facilities, schools, hotels, and venues for large events, and

plans to conduct field trials and additional research and development into it as a potential solution for its AI portfolio in the future.

7.2.2 Challenges

Gesture recognition using deep learning is a common technique for identifying hand and finger movements. This conventional technique can detect multiple feature points, such as joints and fingertips, from an image of the hand, and determine the hand gesture based on the positional relationship of the feature points (Figure 2 Left). However, one issue with the existing technology was that when people wash their hands correctly, both hands overlap and are lathered with soap, which obscures the detection points on the fingers and prevents accurate gesture recognition.



Figure 7.1: Conventional hand tracking tech (Left: Gesture recognition results; Right: Hand wash behavior)

7.2.3 Newly Developed Technology

To resolve this challenge, Fujitsu Laboratories Ltd. and FRDC have developed a new AI technology that automatically and accurately recognizes hand movements under the conditions described above, expanding the recognition function of the original Actlyzer behavioral analysis technology.

With the new technology, the complex hand movements of handwashing are captured as a combination of hand shape and repetitive rubbing motions, detected by two deep learning engines: Hand Shape Recognition and Motion Recognition. The two-hand shape recognition engine uses a learned model of a basic shape of two hands, which is a typical form of hand movement in which hands are placed on top of each other, to determine the hand shape for each frame of the image. Focusing on the overall shape solves the problem of when fingertips and joint feature points cannot be correctly detected due to hand overlap or foam. In addition, Fujitsu's unique AI technology "High Durability Learning (High Durability Learning)", which can track data changes, is applied to ensure that the basic shape of both hands is recognized with high accuracy even when the camera position or lighting changes during operation. The motion recognition engine uses a learned model that detects periodically changing motion from successive frames and counts the number of iterations as the number of rubs from the iteration pattern and its period.

In addition, the results of these two recognition engines are fed back to each other to improve recognition accuracy. The motion recognition engine sets a threshold value for the magnitude of the motion to be judged in accordance with the steps recognized by the two-

hand shape recognition engine to prevent detection of erroneous periods, such as hand tremors not related to foam motion or rubbing. The two-hand shape recognition engine improves detection accuracy by filtering the judgment result using the repetition pattern period detected by the motion recognition engine.

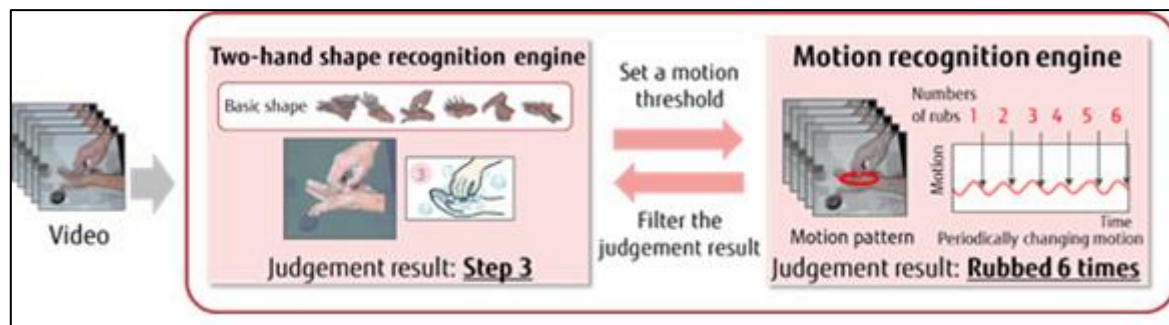


Figure 7.2: Recognition of complex two-hand finger movements as a combination of the overall shape and movement patterns of both hands

7.2.4 Effects

A hand-wash video data set with approximately 2000 variations; including people, camera positions, and soap types, was independently filmed and collected for learning and evaluation. It was confirmed that the accuracy of 6 steps of correct hand washing is average of 95% or more, and that the accuracy of the number of hands rubbing movements is 90% or more. When operating the system on site, omission of action could be prevented because the person washing their hands always knows how long to scrub their hands and which of the six stages they've completed because the system determines it's displayed on the screen until it's completed. In addition to this, the system automatically records data with the starting time stamp and length of action of completing each six steps, and the number of times of rubbing.

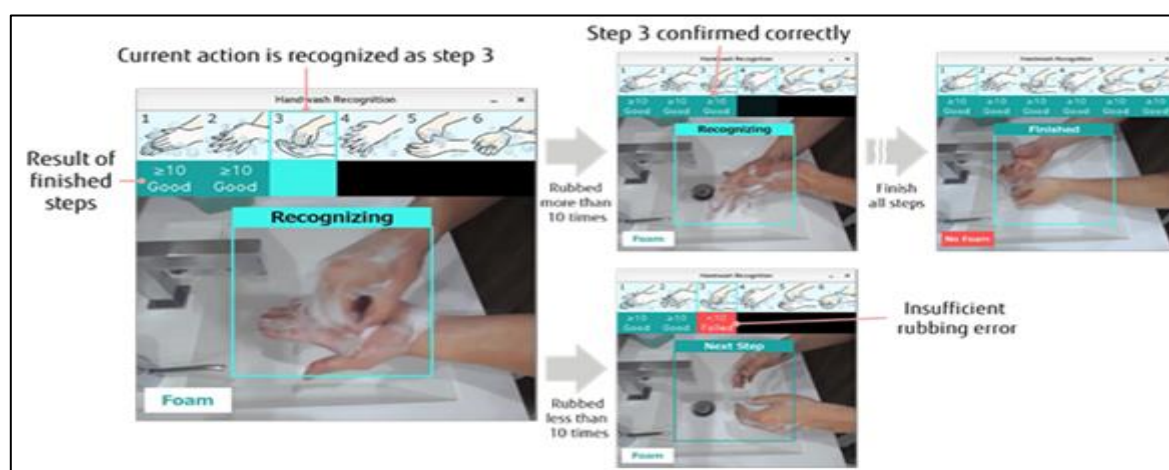


Figure 7.3: Example of recognition display

This technology automates on-site hand washing checks for workplaces that require strict hygiene control, eliminating the number of man-hours needed for visual confirmation and manual recording. Additionally, because the system doesn't recognize incorrect or incomplete hand washing, Fujitsu expects the solution will help educate users and ensure standardization for the right way of hand washing.

• **Appendix 1: Abbreviations**

AC – Alternating Current

AI – Artificial Intelligence

ARES - Advanced Reciprocating Engine System

AVR – Advanced Virtual RISC

CBM – Condition Based Maintenance Schedules

CCL – Copper Clad Laminate

CCTC – Carbon -Tetra -Chloride

DC – Direct Current

EDM – Electro – Disintegration Machine

EMF – Electromotive Force

FTM – Fixed Time Maintenance Schedules

GND -Ground

HUMS – Health and Usage Monitoring System

IC – Integrated Circuit

ICSP – In- Circuit Serial Programming

IDE – Integrated Development Environment

IOT – Internet of Things

ISIS – Integrated Standby Instrument System

ISP – In System Programming

IR – Infrared

LED – Light Emitting Diode

MEMS – Microelectronic Mechanical System

NC – Normally Closed

NO – Normally Open

OS – Operating System

PCB – Printed Circuit Board

PQRM – Productivity, Quality, Reliability and Maintainability

SMD – Surface Mount Device

TTL – Transistor - Transistor Logic

USB – Universal Serial Bus

VCC – Voltage Common Collector

• Appendix 2: Project Management Cycle:-

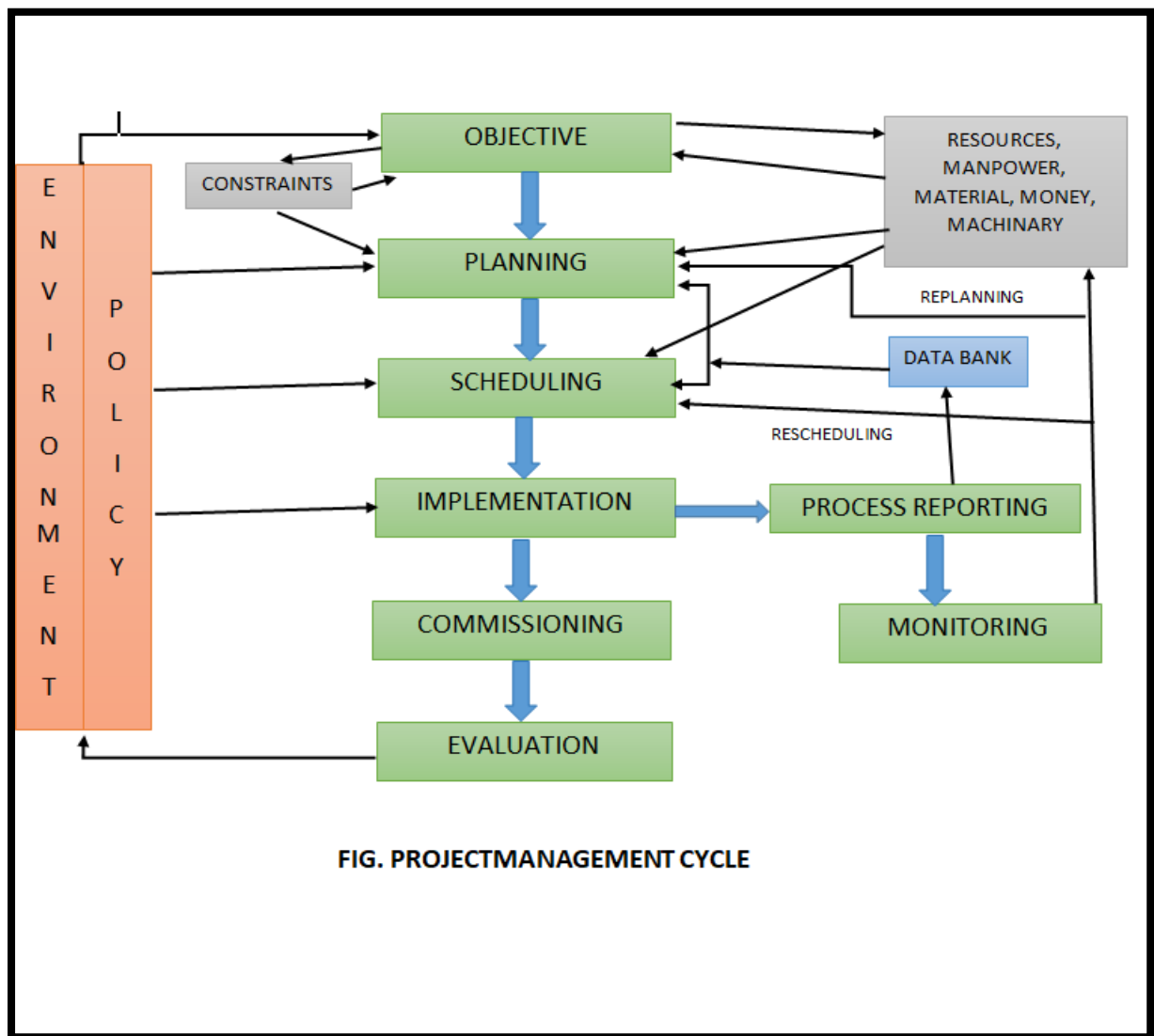


Fig.: Project Management Cycle

▪ Project Management Overview

Project management is a systematic approach to achieve specific objectives within a defined timeframe. It involves several key stages, including objective setting, planning, scheduling, implementation, commissioning, and evaluation. Here's a simplified description of each of these points:








- a) **Objective:** In project management, the objective refers to the desired outcome or goal that the project aims to achieve. It is important to clearly define the objective at the beginning of the project to provide a sense of direction and purpose.
 - b) **Planning:** Planning involves outlining the necessary steps, resources, and strategies required to reach the project objective. It includes creating a detailed roadmap that identifies the tasks, milestones, and deliverables, as well as determining the project scope, budget, and potential risks.
 - c) **Scheduling:** Scheduling is the process of creating a timeline or schedule for the project. It involves setting deadlines for tasks and allocating resources based on their priority and dependencies. A well-designed schedule ensures that activities are completed in a logical sequence, optimizing efficiency and minimizing delays.
 - d) **Implementation:** Implementation is the stage where the actual work takes place. It involves executing the tasks and activities outlined in the project plan. The project manager coordinates and oversees the team members, assigns responsibilities, and monitors progress to ensure that the project stays on track.
 - e) **Commissioning:** Commissioning refers to the final stage of a project, where the completed deliverables are reviewed, tested, and handed over to the stakeholders. This involves verifying that the objectives have been met, conducting quality checks, and ensuring that the project aligns with the desired standards and requirements.
 - f) **Evaluation:** Evaluation involves assessing the project's overall performance and outcomes. It aims to determine if the project objectives were successfully achieved and if the project was completed within the defined constraints of time, cost, and quality. Evaluation helps identify lessons learned, best practices, and areas for improvement in future projects.
- These are simplified descriptions of the key aspects of project management. In practice, project management involves many other activities and techniques to ensure successful project execution and delivery




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Sr. No.	QR codes	Links or descriptions
1		Maintenance engineering book by Er. Sudhil Kumar Shrivastava
2		Electronics devices and circuits book by David A. Bell
3		Learning Materials of Emerging and Trends in Electronics
4		Research Paper on Automatic Hand Washing System with hand dryer by International Journal of Emerging Trend in Engineering
5		Scope of Project - Hand Wash Station Market Outlook, Size Forecast to 2031 (straitsresearch.com)
6		Research paper on Design and implementation of Automatic hand washing machine using Arduino - (PDF) DESIGN AND IMPLEMENTATION OF A SMART HAND WASHING MACHINE USING ARDUINO (researchgate.net)
7		Arduino Information - https://docs.arduino.cc/hardware/uno-rev3

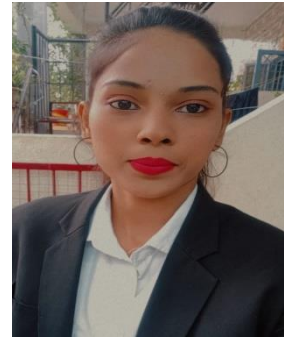
8		<p>Proteus software</p> <ul style="list-style-type: none"> - https://www.theengineeringknowledge.com/introduction-to-proteus/
9		<p>IC Voltage regulator</p> <ul style="list-style-type: none"> - https://components101.com/regulators/7824-voltage-regulator
10		<p>Embedded Systems Architecture, Programming and design by Raj Kamal book Chapter 14 - Testing Simulation and Debugging Techniques</p>

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