A
PROJECT
REPORT
on

Automatic Hydroponic Farming System

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

Bachelor of Technology

in

Electrical

Engineering

by

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2022

DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or
diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Signature

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Date: 10/12/22

CERTIFICATE

This is to certify that Project Report entitled, **“Automatic Hydroponic Farming System”** which is being submitted by **Yogesh Pal and Vikas Kuntal** in partial fulfillment of the requirement for the award of degree B.Tech in Electrical Engineering and submitted to the department of Electrical Engineering of GLA University, is a record of the candidate own work carried out by him/her under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

Date:10/12/22

Mr Sachin Goyal
(Assistant professor)

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ABSTRACT

Soil based cultivation is now facing difficulties due to different man made reasons such as industrialization and urbanization. Also, sudden natural disasters, climate change and unrestricted utilization of chemicals for agriculture purposes cause the depletion of soil fertility and quality. That is why, scientists have developed a new alternative approach for cultivation system namely soil-less cultivation or hydroponics. Hydroponics is a method of growing plants in a water based, nutrient rich solution. Through hydroponics a large number of plants and crops or vegetables can be grown. The quality of yield, taste and nutritive value of end products produced through hydroponically is generally higher than the natural soil based cultivation. This cultivation is cost effective, disease free, ecofriendly and is gaining popularity all over the world, in both the developed and the developing countries. It has a great prospect in many countries along with high space research to fulfil the lack of arable land where proper cultivable land is not available. So, hydroponics would be a better technique to produce the different kinds of fruits, vegetables and fodder as well as meet the global nutrition demand with making advance future. In the future, hydroponics could be emerging techniques for the supplying of food to the world wide population.

Hydroponics is a technique of growing a plant in water with mineral nutrient solution mixed with it in soil less culture with continuous supply of oxygen at room temperature with indirect light. System uses less water and fertilizer as compared to soil system. Hydroponics has no part in the human work of plowing, hoeing and weeding the field activities of open field system. The growth rate and quality of plant are enhanced as roots gets nutrients and oxygen directly from water medium through process of diffusion. The measured and monitored parameters are pH, humidity, electrical conductivity of water and concentration of nutrients in water and these are useful for the design and development of controller and controlled automation hydroponic system in order to maintain the optimum plant growth. Keywords: hydroponics, nutrient solution, PLC, pH, soil-less farming

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CHAPTER 1

Introduction

“Hydroponics” a word derived from Greek to reflect the importance of ‘Hydros’ (water) and ‘Ponos’ (working). Hydroponics is a farming technique without using soil as a growing medium. This technique uses water to replace the soil in supplying nutrients and oxygen needed for plants. In order for plants to grow normally, the water conditions must be adjusted according to the needs of the plant. These conditions are in the form of nutrient levels, pH levels and oxygen levels.

Hydroponics was practiced many centuries ago in Amazon, Babylon, Egypt, china and India where ancient men used dissolved manure to grow cucumber, watermelons and other vegetables in sandy riverbeds. The “hanging harden of Babylon” and the Aztec’s floating farms were actually prototypes of hydroponic systems. Later, when plant physiologists started to grow plants with specific nutrients for experimental purposes, they gave the name “nutriculture.” Interest in practical application of “nutriculture” developed in 1925 when the green house industry expressed interest in its use. Green house soils had to be replaced frequently to overcome problems of soil structure, fertility and pests. As a result, researchers became interested in the potential use of nutriculture to replace conventional soil culture. In 1929, Dr. William F. Gericke of the University of California succeeded in growing tomato vines of 7.5 m height in nutrient solutions. He named this new production system Thus, hydroponics broke the laboratory bounds and entered the world of practical horticulture. The term hydroponics originally meant nutrient solution culture. However, crop growing in inert solid media using nutrient solution is also included in hydroponics in broad sense.

At present, there are 17 elements that are considered important to be present in nutrient solutions in hydroponic practice, these elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, copper, zinc, manganese, molybdenum, boron, chlorine and nickel. With the exception of carbon and oxygen, which are supplied from the atmosphere, important elements are obtained from the growth medium (nutrient solution).

Hydroponics has been recognized as a viable method for producing vegetables (tomatoes, lettuce, cucumber and chili) as well as ornamental plants such as herbs, roses, freesia and leafplants .

Types of hydroponic system

The growing methods for each type of crop can be different so as the hydroponic system. When you are choosing between the various hydroponic systems, knowing about the basicsof that system will help you in making the decision.

Standing Aerated Nutrient Solution:

This system is commonly known as DWC (deep water culture) system. Standing aerated nutrient solution is a hydroponic system in which the nutrient solution is static, suspending the plant roots in the nutrient solution. Replacement of nutrient solution is required every 5 to 10 days (frequency depends on the number of plants and system volume).

A crop like lettuce can be successfully grown in this system on Styrofoam sheets floating onan aerated nutrient solution.

Nutrient Film Technique (NFT):

Nutrient Film Technique, gully channels are used in this system to grow plants, the nutrient solution keeps flowing in these gully channels. A pump connected to the reservoir pumps thenutrient solution to the NFT channels.
One of the advantages of the NFT is the easy installation of the system and the relatively lowcost of the materials.

There are two different types of NFT system:

1. Horizontal NFT System
2. Vertical NFT System

Aeroponic System:

Aeroponic System drastically reduces the amount of water used in growing crops. In this system, plant roots get their nutrients and water through the aerosol mist sprayed on them. Plant roots get the oxygen from the air while suspending.

Aeroponic System is comparatively challenging to manage but much more economical in theuse of nutrients and water.

Dutch Bucket Grow System

As the name is depicting, this system uses buckets to grow plants. These buckets can vary in size, depending on the requirement of the grower. The bucket has a growing media like vermiculite to support the growing plant.

Plants having much larger roots are grown with the help of the Dutch Bucket system like tomato and cucumber.

Hydroponics farming has been around for decades, but now it’s gaining traction as a means to grow to produce locally. The practice is seen by some as an environmentally friendly way to provide the population with resources.

With the advancements in technology, it is now possible to have a vertical farm in urban spaces that is cleaner and more efficient than ever before. Vertical farms use around 95% lesswater as well as having many other benefits.

The hydroponic method effectively feeds the world due to its minimal water and soil usage. This technique is more cost-effective than traditional farming, relying on heavy machinery and pesticides to produce food.

BASIC REQUIREMENTS OF HYDROPONICS

Soils naturally maintain the temperature and aeration needed for root growth. When the soil is poor, plant growth and yield decline also due to unsuitable aeration and temperature. Plant cultivation is impossible under ill drained condition due to these conditions. Soil adjusts itself to provide suitable conditions for plant growth. It is called the buffer action of the soils. Plants also absorb nutrients released through natural mineralization. In a solution or inert medium, maintenance of acidity or alkalinity (pH) and electrical conductivity (EC) in suitable ranges for plant root system is called buffer action. This requirement must be artificially maintained in hydroponics. In any hydroponics system the following basic requirements must be maintainedat optimum levels.

- The nutrient solution or the fertilizer mixture used must contain all micro and macro elementsnecessary for plant growth and development.

- Buffer action of the nutrient solution must be in the suitable range so that plant root system or the inert medium is not affected.

- The temperature and aeration of the inert medium or the nutrient solution is suitable for plantroot system.

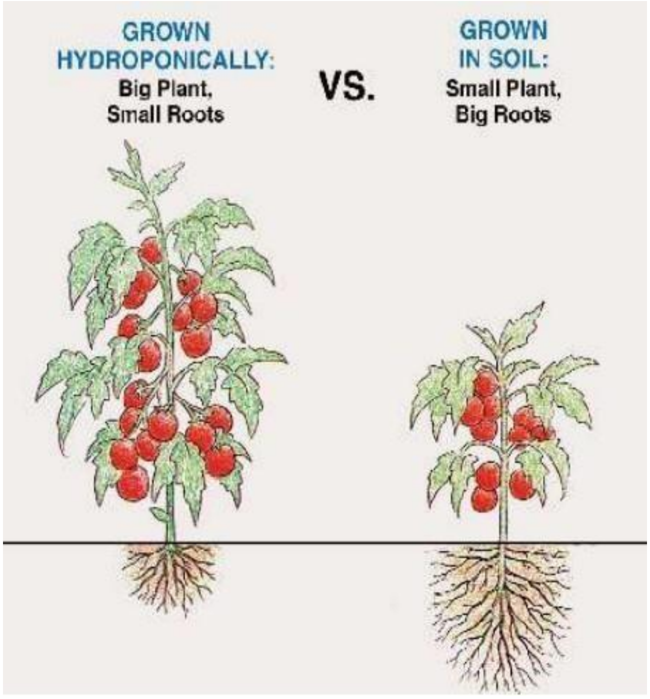

Fig.1.1 Plants to grow with hydroponic system

Circuit diagram of Automatic Hydroponic Farming System

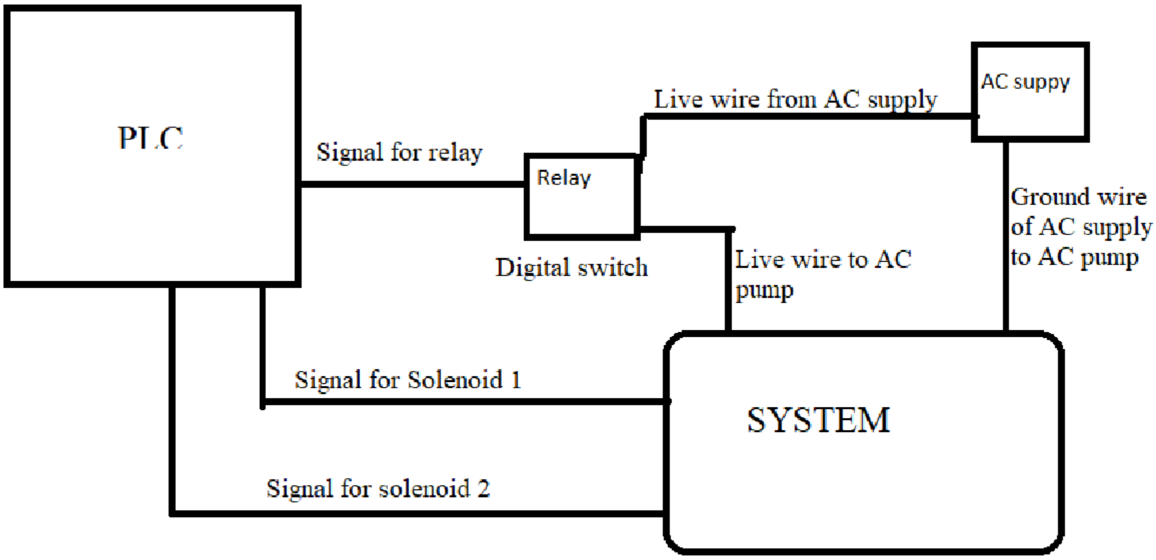

Fig.1.2 Circuit diagram

PLC-Programmable Logic Controller

SYSTEM – consist of water container, structure where plants are placed , solution A,solution B and AC pump

Relay- It is a digital switch used to connect AC supply to pump when needed.

Solenoid 1 and solenoid 2 signals lines are used open or close solenoid valve.

CHAPTER 2

Methodology

1. Water Pump:-

The water pump can be defined as a pump which uses the principles like mechanical as well as hydraulic throughout a piping system and to make sufficient force for its future use. They have been approximately in one structure otherwise another because of early civilization. At present these pumps are utilized within a wide range of housing, farming, municipal, and manufacturing applications. These pumps are of different ratings used for different purposes.

The pump used in this project is AC water pump having rating 220 volt, 50Hz, 18 watt.

The working principle of a water pump mainly depends upon the positive displacement principle as well as kinetic energy to push the water. These pumps use AC power otherwise DC power for energizing the motor of the water pump whereas others can be energized other kinds of drivers like gasoline engines otherwise diesel.

Water pumps are classified into two types namely positive displacement and centrifugal. These pumps are mainly designed for supplying water from one location to another constantly.

Centrifugal Water Pump

Centrifugal pumps are designed with a rotating impeller which can be used for supplying the water into the pump and force the discharge flow. These pumps come in several types which includes trash, submersible, and standard models. By using these pumps, all types of liquids can be pumped with low-viscosity. And also these pumps work fine with thin fluids & gives high flow rates.

Positive Displacement Water Pump

Positive displacement pumps supply a set amount of flow throughout the mechanical contraction and development of a stretchy diaphragm. These pumps are applicable in several industries that control high-viscosity fluids wherever responsive solids may be there. These are suggested for the applications wherever a combination of high pressure and low flow is required.

Water pumps are used for dewatering reasons decreasing the downtime from huge rain events. The common applications of these pumps include buildings, wells, boost application, circulation of hot water, sump pits, protection of fire systems, etc

The flow of water can increase & water pumps let you supply the water rapidly to reduce downtime. These pumps are appropriate for applications like electric, hydraulic, gas-powered,and otherwise manual.

Note:- Pump that we have used is interfaced with relay then relay is interfaced with PLC.

Ac pump negative wire given to ac supply negative directly, whereas live given to relay and the to ac supply where relay act as digital switch and decide when to open or closethe switch according to the PLC signal received by relay.

Fig.2.1 AC pump

2. 24 volt relay board:-

Relay is electromechanical switch. We have used compact relay module with slim electromechanical 4 channel relay-pluggable. Input voltage is 24 volt DC and maximum load current is 6 Ampere. Jumpers are provided for selection between positive looping/negative looping. Rated voltage is 250 volt AC. Maximum switching voltage is 400 volt AC.

Industrial Relays have been used in Automation for decades**.** These fundamental building blocks of electrical circuits allowed the first automated systems to function without the need of modern PLCs and computers. Although you won't find any relay based logic circuitry today, they still play an important role in modern control systems.

A mechanical relay has a major advantage over a solid-state contact: it's able to conduct large currents & supply loads which would require a much larger and expensive semiconductor.
They do have some drawbacks; one of which is the fact that they break down much faster due to repetitive motion. Although a relay isn't recommended for many cases, it should still be used for loads which require a high amperage: motors, heaters, actuators, etc.

A mechanical relay will contain two main components: **a coil & one or multiple sets of contacts**. As the coil is energized, the normally open set of contacts are closed and the normally closed are opened. It's important to know the terminology as well as the difference between the two. Furthermore, it's important to quickly determine the configuration of a specific relay and circuit based on the diagram on the front of a specific relay.

We have used relay with PLC. An output from a PLC or an auxiliary device such as Point IO or Flex IO may be used to power the coil of a relay. By programming the coil to turn ON and OFF, the contacts of the relay will transition from de-energized to energized and back.

Do use a relay on loads which exceed the current requirements of a standard input/output. This includes heaters, valves, motors, etc. In certain circumstances, these components will include an on-board relay and thus will not require a separate component. An example of this would be an SMC valve which has an internal relay and can be driven by a standard output. No relay is required in this case.

Avoid using relays in circuits which can be driven through a solid state output. In other words, use a standard output tied directly to a load instead of a relay if you can. The issue with using a mechanical relay is that it will breakdown after a certain number of uses. A solid-statecomponent will last much longer.

Relays play an important role in modern control systems despite being a foundational block a few decades ago. Although they aren't used as excessively as they were in the past, relays arecapable of running large loads and to separate logical areas of circuits.

Note:-

We have connected wire at Normally closed point on the relay so to make it in off mode we have to provide a high signal continuously when we do not want AC pump to be in start.

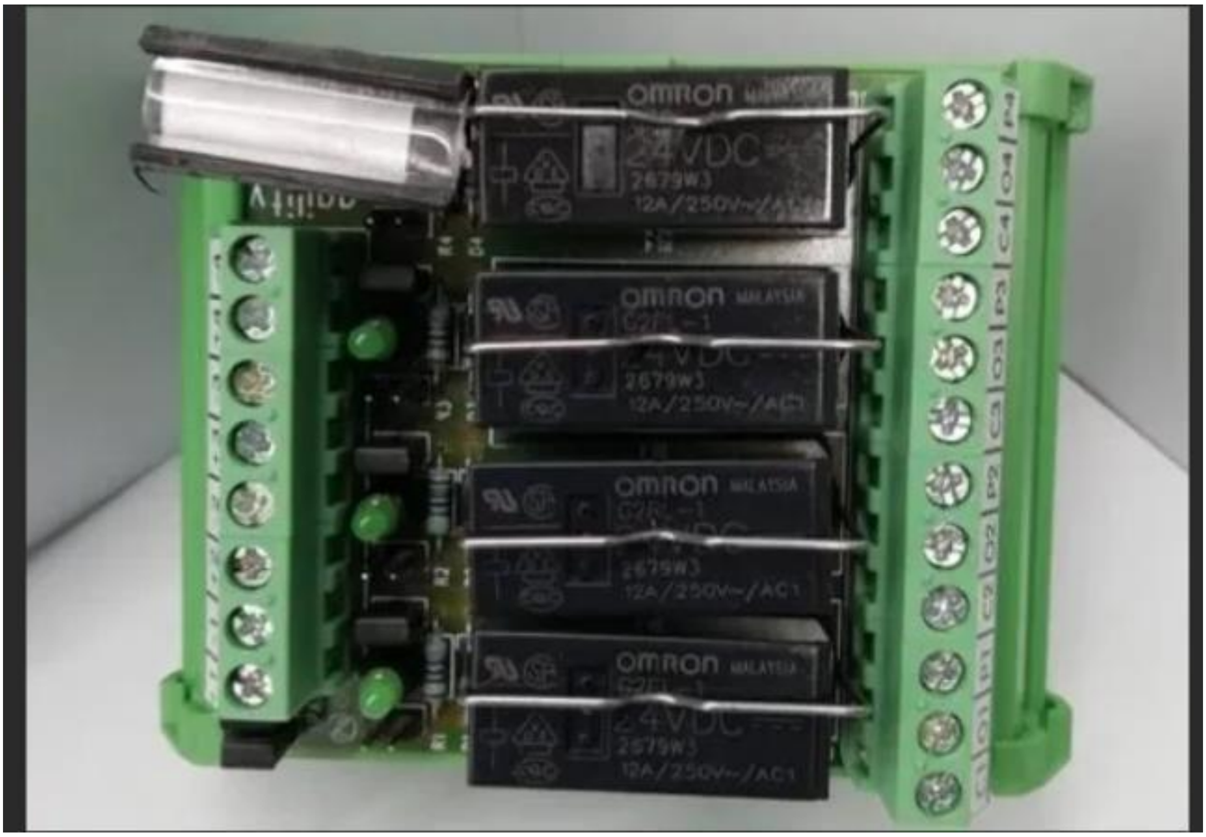

Fig.2.2 Relay

3. PLC (Programmable Logic Controller):-

PLC is a digital computer control system adapted to control the robotic devices and other manufacturing processes. It involves a basic study of Microcontrollers, digital circuits, and designing skills.

It provides easy, flexible, high-reliability programmable controllers suitable for simple and harsh environments. It monitors the state of input devices, takes decisions, and controls the output devices**.** The applications include Robotics, water filling tanks, etc.

PLC ranges from small devices with few Input/Outputs to large devices with thousand of Input/Outputs.

There are three types of PLC,

Modular PLC

In modular PLC, modular means adding modules. It allows us to expand the structure of PLC. It is useful when there are a large number of inputs and outputs. We can add more input and outputs by adding the modules in the PLC.

It also has more memory and capability to store information.

Rack PLC

The modules in the rack type PLC are arranged in the rows. The racks are placed inside the cabinets. The slots in the rack PLC communicate with each other connected by the standard network or bus.

Compact PLC

The Input / Output (I/O) modules in the compact PLC are determined by the manufacturer of that PLC. It means that the I/O is fixed. But, the compact PLCs are used for small scale applications

The PLC stands for Programmable Logic Controller. It is a ruggedized and adapted industrial computer for controlling manufacturing processes such as assembly lines, machineries, robotic devices, or any activity requiring high dependability, ease of programming, and process fault identification. PLCs have a large number of input and output pins, as well as memory and are easier to programme. Ladder diagram, functional block diagram, instruction list, structural text language, and sequential function chart are the programming languages. The ladder diagram is an example of easy-to-understand and user-friendly terminology. The SIMATIC S7-1200 PLC is used in our project. Compact, versatile, and scalable automation solutions are required. Standard and failsafe versions of Siemens SIMATIC S7-1200 PLCs are available. With pluggable signal, communication, and module boards, it may be customised to meet specific needs. PLCs automate processes by monitoring inputs and other variable values, making choices based on a stored programme, and controlling outputs.

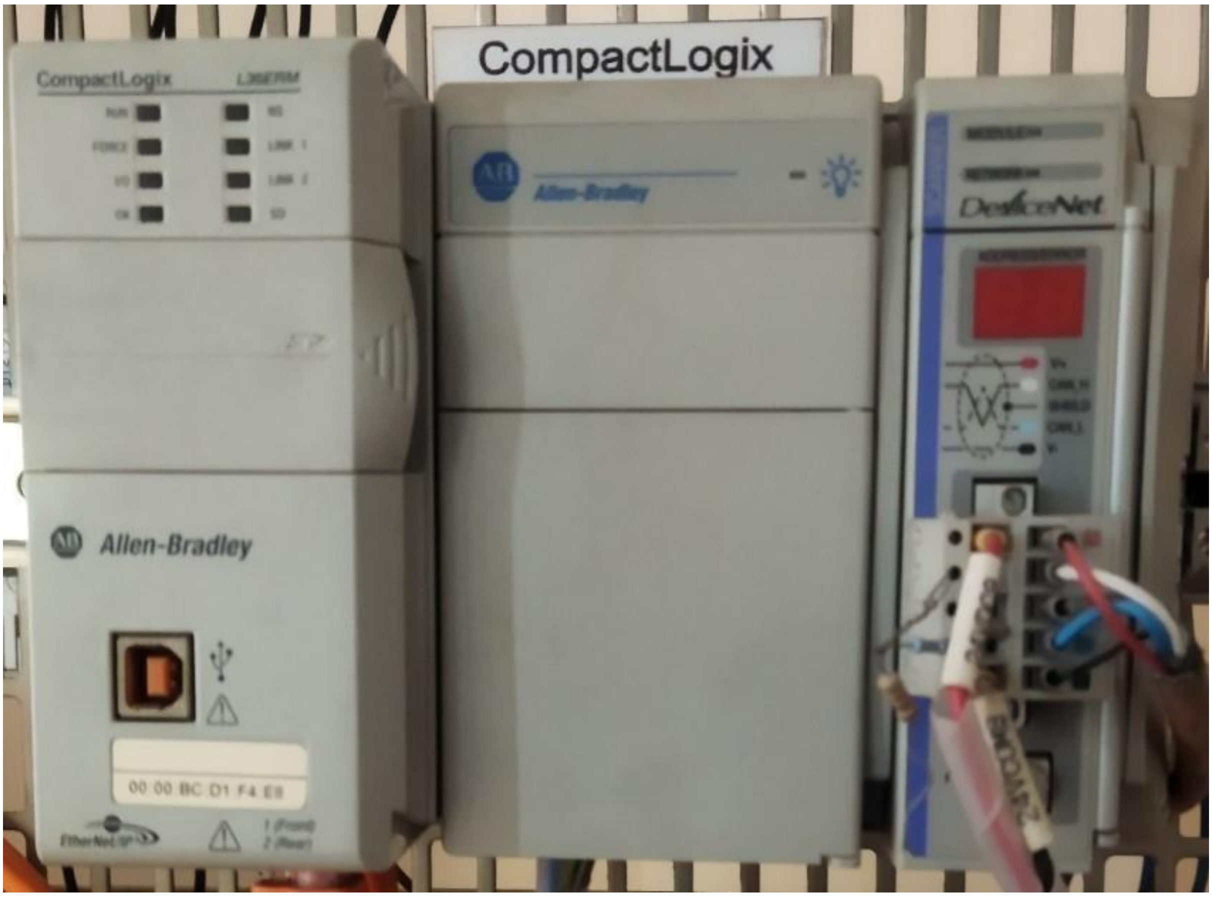

Fig.2.3 PLC

CHAPTER 3

Ladder Logic-

Ladder logic (also known as ladder diagram or LD) is a programming language used to program a PLC (Programmable Logic Controller). It is a graphical PLC programming language which expresses logic operations with symbolic notation. Ladder logic is made outof rungs of logic, forming what looks like a ladder – hence the name ‘Ladder Logic’.

Ladder logic is mainly for bit logic operations, although it is possible to scale a PLC analog input. Even simple bit logic operations can be beneficial in more advanced PLC programs and SCADA system programming.

The people or the organization that sets the standards for ladder logic is PLCOpen. Ladder logic is not only a programming language for PLC’s. It is one of the standardized PLC programming languages. This simply means that ladder logic is described in a standard. That standard is called IEC 61131-3. But for now, the only thing you need to know is that there isa standard describing this programming language.

Ladder logic is a graphical programming language which means that instead of text, the programming is done by combining different graphic elements. These graphic elements are called symbols.

One of the smart things about the ladder logic symbols is that they are made to look like electrical symbols. Ladder logic was originally created for technicians, electricians, and people with an electrical background. People who are used to look at electrical diagrams andschematics.

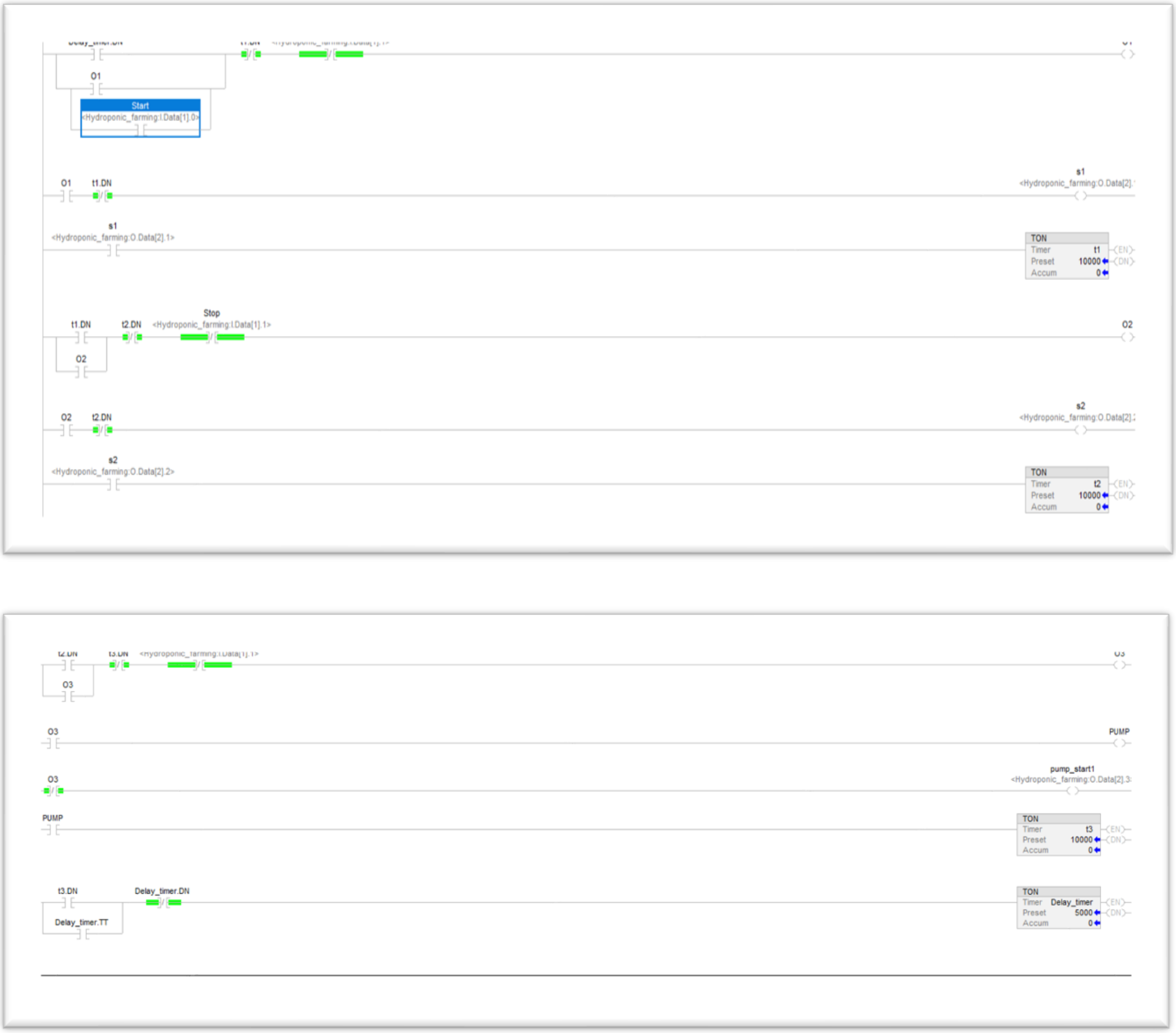

Fig.3.1 Ladder Logic

Name	Usage	Alias For	Base Tag	Data Type
Delay_timer	Local			TIMER
O1	Local			BOOL
O2	Local			BOOL
O3	Local			BOOL
PUMP	Local			BOOL
s1	Local			BOOL
s2	Local			BOOL
Start	Local			BOOL
Stop	Local			BOOL
t1	Local			TIMER
t2	Local			TIMER
t3	Local			TIMER

Fig.3.2 I/O table

The most modern Allen-Bradley PLCs have all but done away with fixed-location I/O addressing, opting instead for tag name based I/O addressing. However, enough legacy Allen- Bradley PLC systems still exist in industry to warrant coverage of these addressing conventions.

Logic for this program:

-We have three hardware that need to be controlled by PLC Ac pump and 2 solenoid valves.

-Each of the hardware is used for certain period of time.

-Therefor Timer will be used in ladder logic program.

-All of hardware that is to be connected with PLC will be acting as an output.

-All hardware will be operate on digital signal.

-Although AC pump will be operated by AC source but the relay we are using will decide the circuit will be open or close. Hence relay is connected to PLC rather then connecting pump.

-Even none of the hardware will remain “ON” together all will perform one by one.

-Assuming container of water is filled.

-So we will need first to mix minerals solution one by one.

-For this purpose we will make the solenoid “ON” for certain time as per requirement.

-One thing to note is, as second solenoid gets “ON” first should get “OFF”.

-Afterwards AC pump should get start.

-Then we will provided a delay (say 30 minutes) before the processes get in loop every time.

Explanation of Rungs in ladder logic

program:-RUNG 1:

In this rung we have used 3 variable

1- Start variable, this is used to start the Automatic hydroponic farming system. This is taken as input from user through PLC panel from push button 0 on the panel.
2- Stop variable, this is used to stop the Automatic hydroponic farming system if required. This is taken as input from user through PLC panel from push button 1 on the panel.
3- O1 variable is a virtual variable used within a ladder logic program to enable the solenoid1 and timer1 to count the time(10 seconds) for solenoid 1 to remain in “ON” state.

RUNG 2:

In this rung we have used -

-O1 bit as normally open which will get high as “Start” button is pushed and this will make solenoid1 valve high.

-Also we have connected normally closed switch in series of O1 which is given “Done bit” of timer 1 which is count the time for which it should remain high/ON. As soon “Done bit” becomes high solenoid 1 get turn “OFF”.

RUNG 3:

-Normally open switch is used and it given the name of solenoid 1 .So that as soon solenoid 1 get start it also enables the timer 1to count its time period so that it can turn off the solenoid 1
. And can initiate solenoid 2 to start.

RUNG 4:

It is acting as a DOL(Direct online starter) virtual variable O2 is used for this

purpose.Also normally open switched is used and it given “Done bit ” of timer 2.

Timer 2 counts the time period for which solenoid has to be in “ON” state.

As soon as the “Done bit” gets high it close the connection and turn “OFF” the solenoid 2.

RUNG 5:

O2 virtual variable is to start the solenoid 2 valve to operate, which will get high as it gets highin rung 4.

Also normally closed switch is used in series with O2 and it is given with “Done bit ” oftimer 2.

RUNG 6:

Normally open switch is used and it is given name of solenoid 2 bit and it get high whensolenoid 2 gets high and enables the timer 2.

RUNG 7:

It is acting as a DOL(Direct online starter) virtual variable O3 is used for this

purpose.Also normally open switched is used and it given “Done bit ” of timer 3.

Timer 3 counts the time period for which AC pump has to be in “ON” state.

As soon as the “Done bit” gets high it close the connection and turn “OFF” the AC pump.

RUNG 8:

O3 variable will start the pump variable

RUNG 9:

We have used “logical not” of O3 to start the AC pump in real world as per relay configuration.

RUNG 10:

Pump variable will enable the timer 3.

RUNG 11:

Done bit of timer 3 will start the delay timer used in program to repeat itself in loop after acertain interval of time.

-Loop will continue and if we want to stop the system in any condition we can stop this using“Stop” button on PLC panel.

CHAPTER 4

Working of The Project

Construction :-

Step-1: Setting up plants to the structure (pipes), where they will get nourished through the water and required minerals.

After placing plants to the structure then we will connect the water pipes at the end and startingpoint of of taken structure for water to flow through the structure.

Then putting the pipes to the water container from where it get all required minerals and nutrition in dissolve form within water.

Fig.4.1 Structure for plants

Step-2: Now we have placed the panel holding the required mineral in dissolve form connected with solenoid valve, and minerals will get added to the container as per plc is programmed(solution A for 10 seconds and solution B for 5 seconds).

Step-3: Also relay is used to connect and control the signal for flow of minerals from solutionusing solenoid valve.

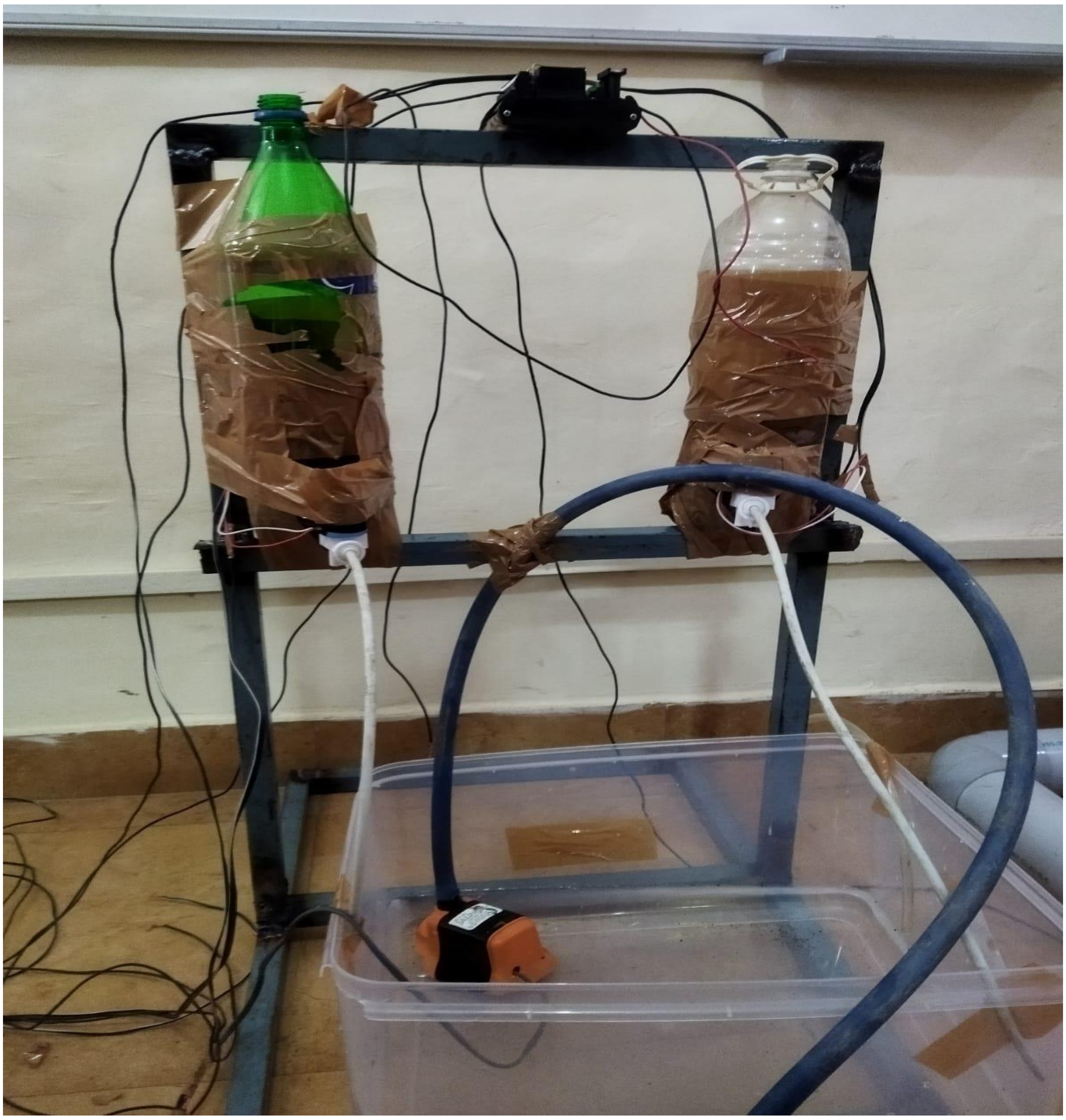

Fig.4.2 Panel

Step-4: Now we will interface our hardware to PLC.The hardware that we need to interfaceare AC pump using relay , two solenoids.

Fig.4.3 Modular PLC

Working:

Step-1: Press 0 button given on the panel of the PLC to start the complete system.

After pressing the button our system get start and mineral solution get added to container.

Fig.4.4 Pressing Push Button

Fig.4.5 System

-Now further system will work as

1- solenoid 1(Solution A) will get “ON” for 10 seconds.

2- Then solenoid 2(Solution B) will get “ON” for 5 seconds.

3- Afterwards AC pump will get “ON” for next 10 seconds .4-This will get in a loop after a delay of 30 minutes.

Fig.4.6 complete system

<u>Some Glimpses Of the Presentation Of Our Project:-</u>

Fig.4.7 Working with Hardware

Fig.4.8 Planting Plants

Fig.4.9 Testing of Hardware

Fig.4.10 Explain Our Project to Dr. Vivek Kumar Srivastava

CHAPTER 5

Conclusion

This paper shows how automatic hydroponic system can be implemented using electronic circuit. It describes how the mixture of water and nutrient solution is automatically delivered to the roots of plants. System automatically supplies nutrient into Water every day and regularly re-circulate mixture of water and solution form reservoir. System uses less water and fertilizer as compared to soil system. In controlling water flow distribution, system can change and maintain it to the desired range. Then, to do the monitoring of water flow, system can display the data reading of the sensor through Antares User Interface. Meanwhile, system can affect the plant height and leaf width to grow equally in all parts of pipe, compared to manual withoutsystem

FUTURE WORK

Although system can control the water flow to reach the desired range and distribute it equally, next research can design a system that can distribute water faster and with more accurate result using different method. So that, all actuators can be connected one another to sensors, to get better performance on distributing water equally. In controlling and monitoring the water flow,system should use a more interesting and easier user interface.

- In the contemporary times, the Hydroponics market is flourishing and contributing in shaping the future of the agriculture industry.

- Cloud Based Artificial Intelligence:Cloud based data analytics and farm output AI software. Farmers can get their farm and production details sitting in the comfort of their home or office. It measures important indicators that helps in crop planning and help connect in food security ecosystem.

There’s a huge opportunity to be able to be part of what could easily be a revolution in agriculture.

- Future of urban kids & family:The millennials and generations after that have purchasing power and are starting to control the market wallet. They are not tech resistant, but they love technology. They want pure and healthy leafy greens in their houses every week. Hence, we need to take it further, which means doing it better and always driving down costs. It’s quality food for everyone and not only for a few.Currently millennials are 50% of the labour force. By 2025, they will be 75% of the labour force, so they are defining the market preference. Millennials are the generation that is reading product labels, more than any other generation in the past has done. In the past, people were loyal to brands, volume vs. price, but that has completely changed. That is why this generation is perfect for new-age farming because they will value all these attributes that smart farming brings. They will get informed; it’s just about finding the right communication strategy.

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