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AUTOMATED IRRIGATION SYSTEM USING PLC

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Abstract: By and large, with recent technological advancement along with factors such as shortage of labor, water scarcity, higher demand for efficient farming from a limited piece of land. The need for repetitive tasks has increased in the field of agriculture. PLC demonstrates its Software and Hardware implementation in Automated Irrigation Process. Visualization or a Human Machine Interface is made to control and monitor the entire process from one location. It is designed for water level and flow control using moisture sensor, float level sensor, solenoid valve. It uses electronic controller which is programmed to receive the input signal varying moisture condition of the soil through the moisture sensor which acts as interface between the field and controller. Once controller receives the signal, it generates an output that drives a relay for operating the water pump. An LCD is also interfaced to the controller to display status of soil moisture content and water pump operating status. The result shows that sandy soils require less water than loamy soils and clay soils require most water for irrigation.

***Index Terms* – Automation, Programmable Logic Controller, WPL Delta PLC Software**

I. INTRODUCTION

Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Automation covers applications ranging from a household thermostat controlling a boiler, to a large industrial control system with tens of thousands of input measurements and output control signals. In control complexity, it can range from simple on-off control to multi-variable high-level algorithms. In the simplest type of an automatic control loop, a controller compares a measured value of a process with a desired set value, and processes the resulting error signal to change some input to the process, in such a way that the process stays at its set point despite disturbances. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques. The benefit of automation includes labor savings, savings in electricity costs, savings in material costs, and improvements to quality, accuracy, and precision.

Automation encompasses many vital elements, systems, and job functions:

Automation provides benefits to virtually all of industry. Here are some examples:

- **Manufacturing-** It includes food and pharmaceutical, chemical and petroleum, pulp and paper
- **Transportation-**It includes automotive, aerospace, and rail
- **Utilities-** It includes water and wastewater, oil and gas, electric power, and telecommunications
- **Defense**
- **Facility operations**, including security, environmental control, energy management, safety, and other building automation

Automation crosses all functions within industry from installation, integration, and maintenance to design, procurement, and management. Automation even reaches into the marketing and sales functions of these industries.

Automation involves a very broad range of technologies including robotics and expert systems, telemetry and communications, electro-optics, Cyber security, process measurement and control, sensors, wireless applications, systems integration, test measurements.

The main advantages of automation are:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.
- Increased consistency of output.
- Reduced direct human labor costs and expenses
- Installation in operations reduces cycle time.

• Can complete tasks where a high degree of accuracy is required.

• Replaces human operators in tasks that involve hard physical or monotonous work (e.g., using one forklift with a single driver instead of a team of multiple workers to lift a heavy object)

• Reduces some occupational injuries (e.g., fewer strained backs from lifting heavy objects)

• Replaces humans in tasks done in dangerous environments (i.e. fire, space, volcanoes, nuclear facilities, underwater, etc.)

• Performs tasks that are beyond human capabilities of size, weight, speed, endurance, etc.

• Reduces operation time and work handling time significantly.

• Provides higher level jobs in the development, deployment, maintenance and running of the automated processes.

II. PROGRAMMABLE LOGIC CONTROLLER

PLC stands for "Programmable Logic Controller". A PLC is a computer specially designed to operate reliably under harsh industrial environments – such as extreme temperatures, wet, dry, and/or dusty conditions. It is used to automate industrial processes such as a manufacturing plant's assembly line, an ore processing plant, or a wastewater treatment plant. PLCs share many features of the personal computer you have at home. They both have a power supply, a CPU (Central Processing Unit), inputs and outputs (I/O), memory, and operating software (although it's a different operating software). The biggest differences are that a PLC can perform discrete and continuous functions which a PC cannot do, and a PLC is much better suited to rough industrial environments. A PLC can be thought of as a 'ruggedized' digital computer which manages the electromechanical processes of an industrial environment. PLC's plays a crucial role in the field of automation, using forming part of a larger SCADA system. A PLC can be programmed according to the operational requirement of the process. In the manufacturing industry, there will be a need for reprogramming due to the change in the nature of production. To overcome this difficulty, PLC based control systems were introduced.

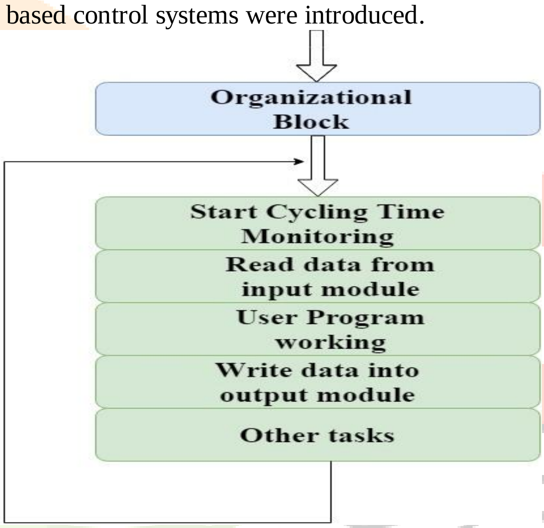

Fig.2.1. Block Diagram of How A PLC Works

A PLC Scan Process includes the following steps:

- The operating system starts cycling and monitoring of time.
- The CPU starts reading the data from the input module and checks the status of all the inputs.
- The CPU starts executing the user or application program written in relay-ladder logic or any other PLC-programming language.
- Next, the CPU performs all the internal diagnosis and communication tasks.
- According to the program results, it writes the data into the output module so that all outputs are updated.
- This process continues as long as the PLC is in run mode.

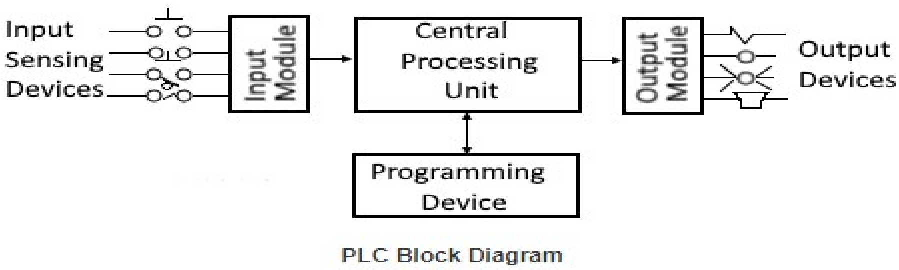

Fig.2.2.Architecture of PLC

Programmable Logic Controllers continuously monitors the input values from various input sensing devices (e.g. accelerometer, weight scale, hardwired signals, etc.) and produces corresponding output depending on the nature of production and industry.

A typical block diagram of PLC consists of five parts namely:

• Rack or chassis

• Power Supply Module

• Central Processing Unit (CPU)

• Input & Output Module

• Communication Interface Module

III. BLOCK DIAGRAM

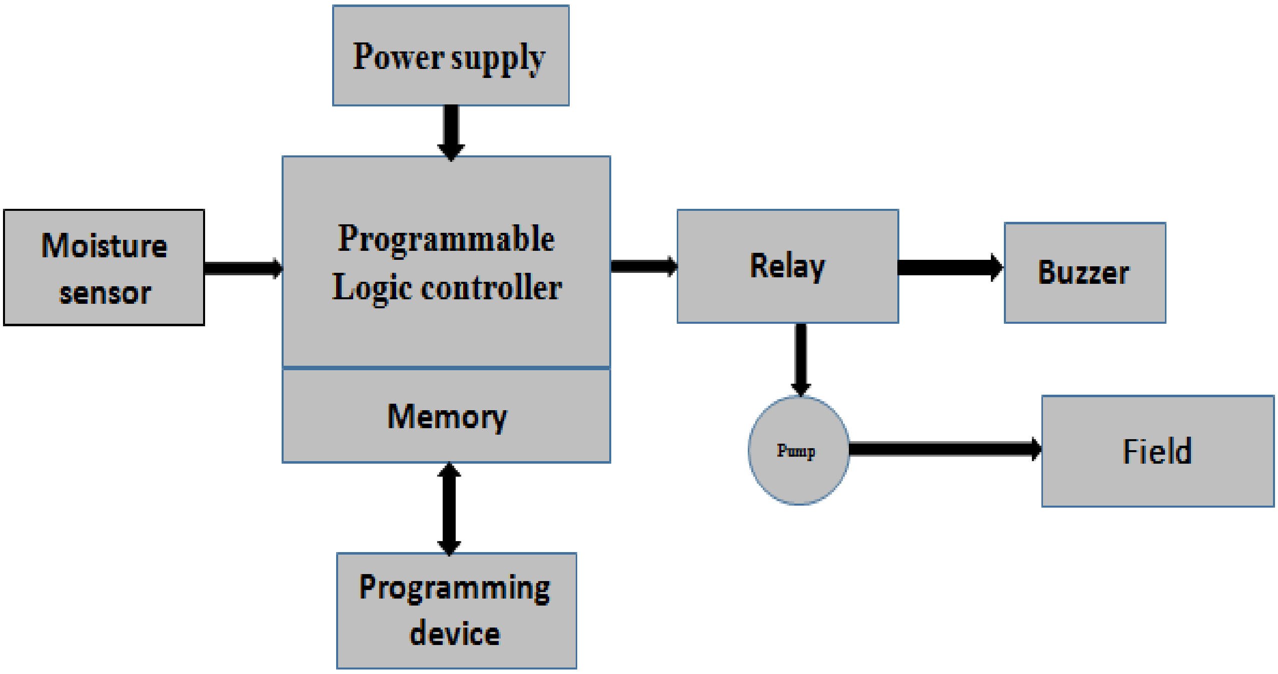

Fig.3.1. Block Diagram of system

In the conventional system the components like motor needed to be controlled manually. As, we want to implement atomization these components need to be controlled automatically with the help of PLC depending upon the program fed in it. Also, for this a climatic criterion is required to control the dripping action of water .In this system we are using the moisture content present in the soil. To determine the moisture content present in the soil we are using the soil moisture sensor. The PLC continuously monitors the inputs and the controls the outputs depending upon the changes in the inputs and the program fed in it. The output of the soil moisture sensor is used as an input to the PLC.

The soil moisture sensor detects the amount of water present in the soil and converts it into a value and provides it to the PLC. A threshold value is provided into the PLC program .Now if the value of the water content present in the soil is less than this threshold value, it means that the soil is dry then, the PLC send a control signal to turn on the motor, and open the main valve and the respective control valve .so that the dripping of water starts. Whereas, if the value of the water content present in the soil is greater than this threshold value , it means that the soil is wet then, the PLC send a control signal to turn off the motor, and close the main valve A and the respective control valve .so that the dripping of water stops .

The soil moisture sensors which are nothing but copper strands are inserted in the soil. The soil sensing arrangement measures the conductivity of the soil. Wet soil will be more conductive than dry soil. The soil sensing arrangement module has a comparator in it. The voltage from the prongs and the predefined voltage are compared and the output of the comparator is high only when the soil condition is dry. This output from the soil sensing arrangement is given to the analogue input pin of the microcontroller. The microcontroller continuously monitors the analogue input pin.

When the moisture in the soil is above the threshold, the microcontroller displays a message mentioning the same and the motor is off. When the output from the soil sensing arrangement is high i.e. the moisture of the soil is less. This will trigger the microcontroller and displays an appropriate message on the LCD and the output of the microcontroller, which is connected to the base of the transistor, is high. When the transistor is turned on, the relay coil gets energized and turns on the motor. The LED is also turned on and acts as an indicator. When the moisture of the soil reaches the threshold value, the output of the soil sensing arrangement is low and the motor is turned off.

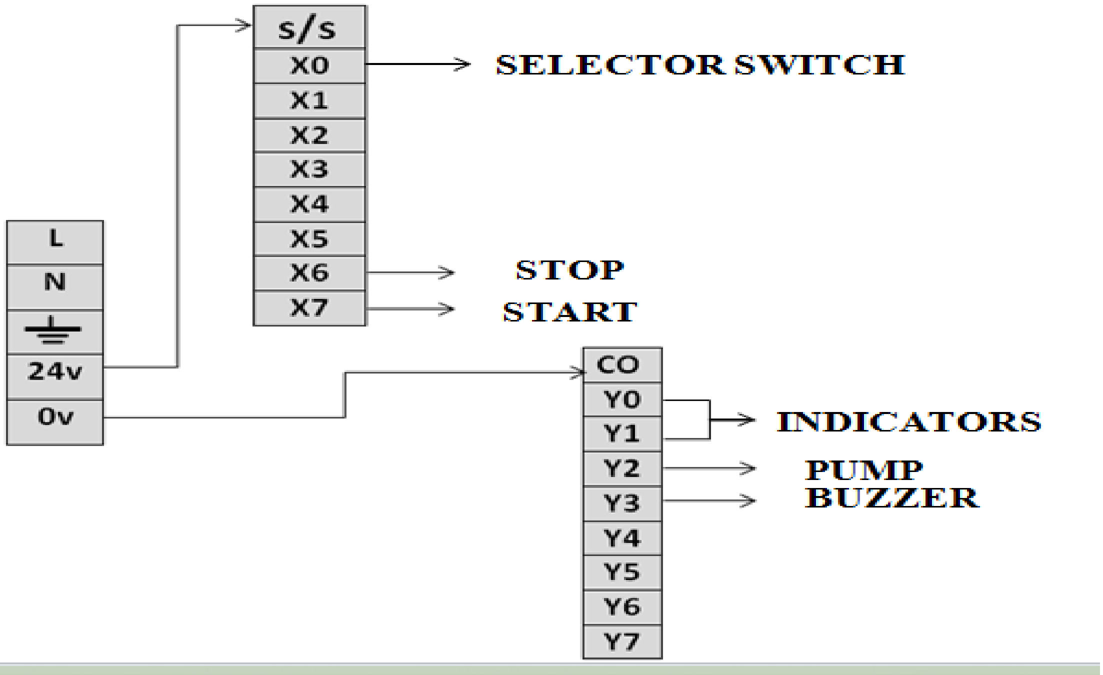

Fig.3.2. Connections diagram of automated irrigation system using PLC

IV.SOFTWARE WORKING

4.1. AUTOMATIC MODE

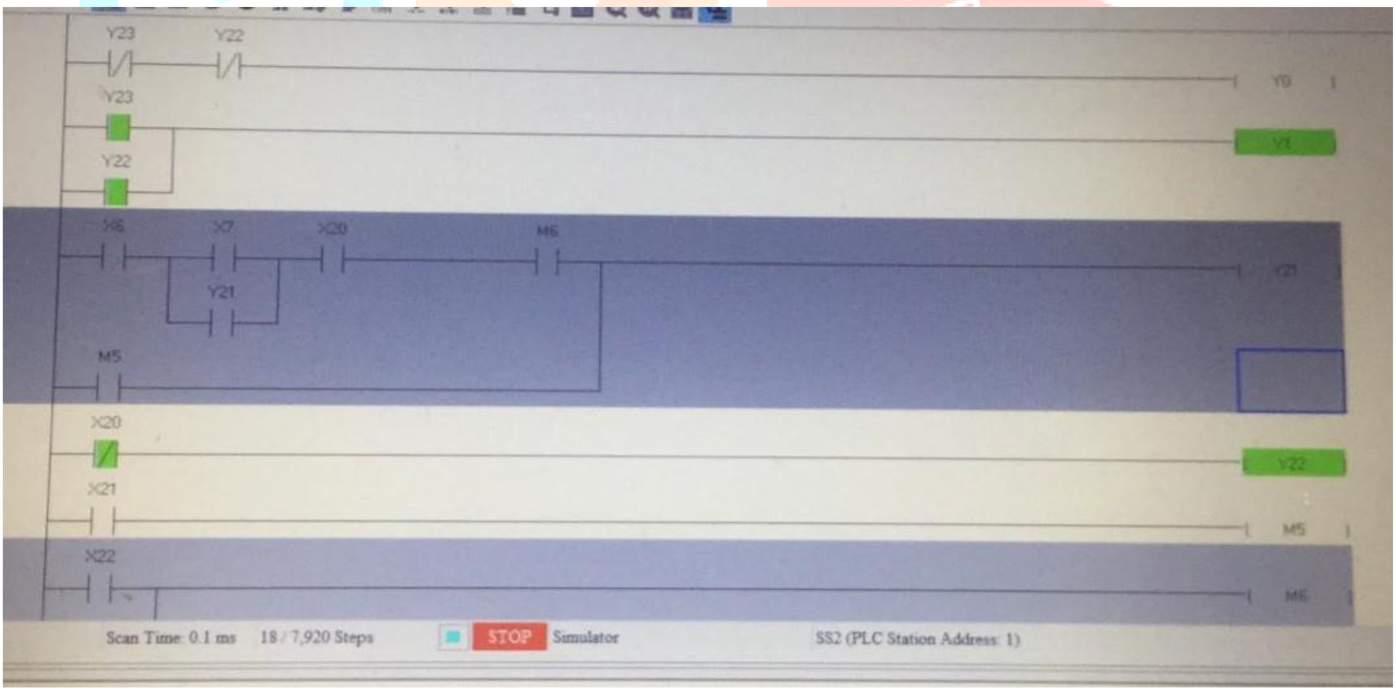

Fig.4.1. Ladder Diagram for automatic mode using PLC

- Using delta PLC software, automatic mode Y0, Y1 are red and green lights of the system which explain ON and OFF condition of the system..Y22, Y23 are pump and buzzer they are ON condition and it blows green light.
- X20 is level sensor which gives information about water level in the tank through Y22 pump so it can decides that the pump should turn ON/OFF.
- X21 is the automatic level sensor gives information to M5 so that M5 can pass the information whether the system operating in manual or automatic mode.
- X22 is the water level it gives information to M6. So that can display on LCD by using delta PLC.

4.2. MANUAL MODE

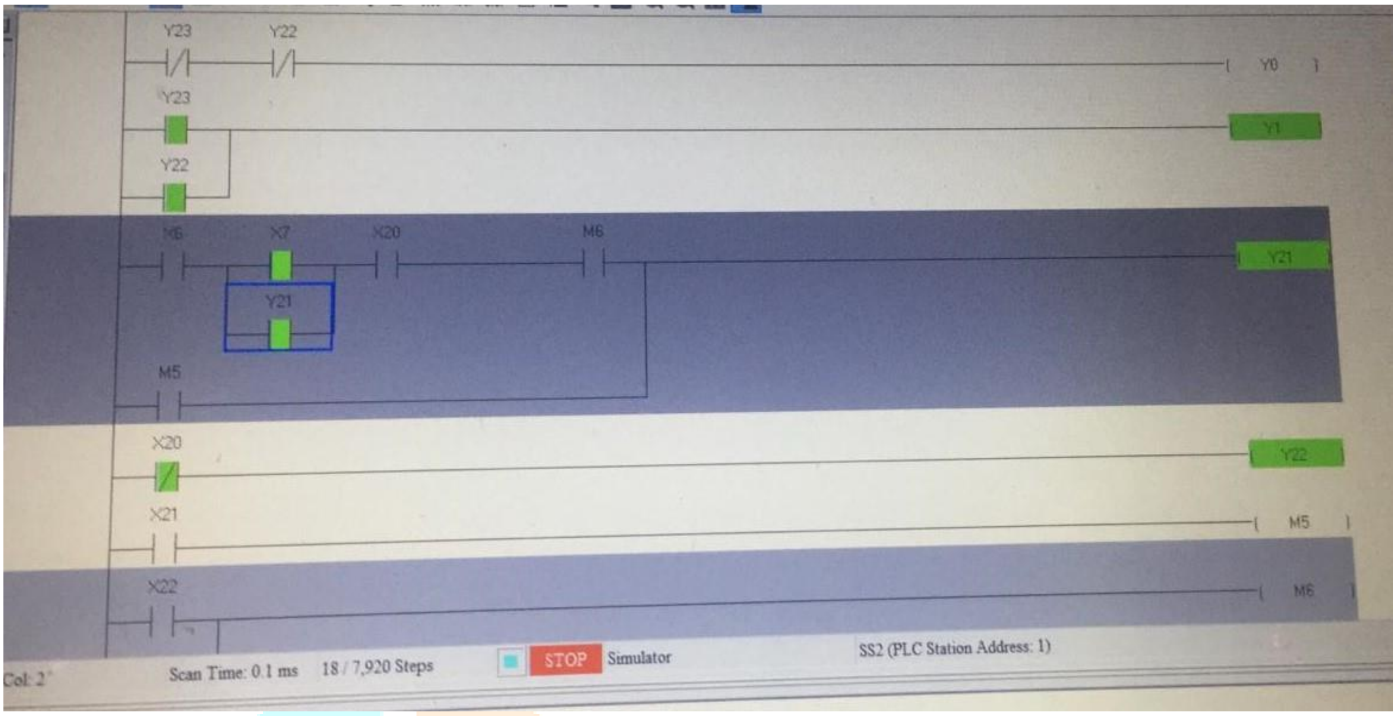

Fig.4.2. Ladder Diagram for Manual mode using delta PLC

Using delta PLC software manual mode condition X6, X7 are STOP and START which switches ON/OFF manually. When the manual start button is ON it takes information from level sensor (X20) and gives it to memory switch which stores information and pass it toY21 (LCD) to display the status to operate. If any fault occurs information is given back to manual start operation through M5 and after clearing the fault the operation starts again.

V. RESULTS AND DISCUSSION

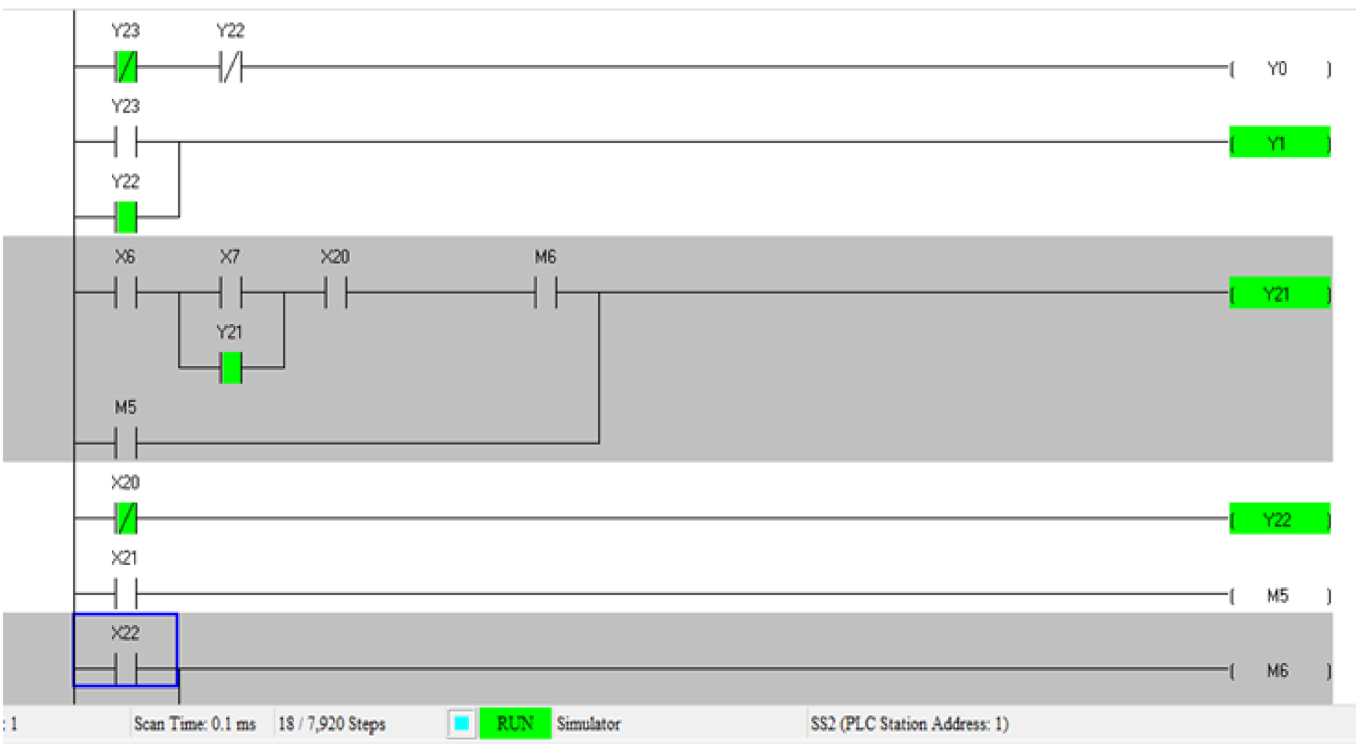

Fig.5.1. Output displayed on LCD

When you run this program, water level sensor will take as an input.LCD displays whether the pump is ON/OFF and whether the soil is dry (or) wet.

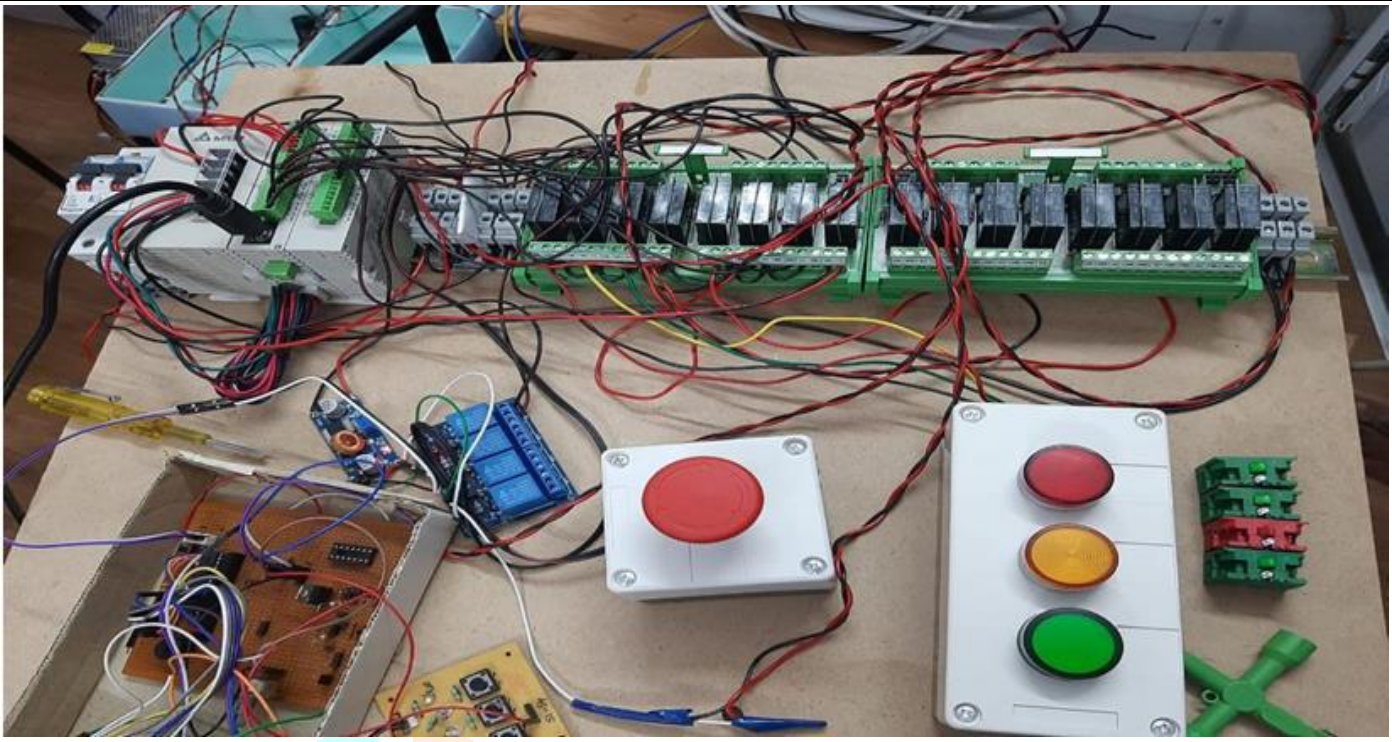

Fig.5.2.Hardware kit of Automated Irrigation System Using PLC

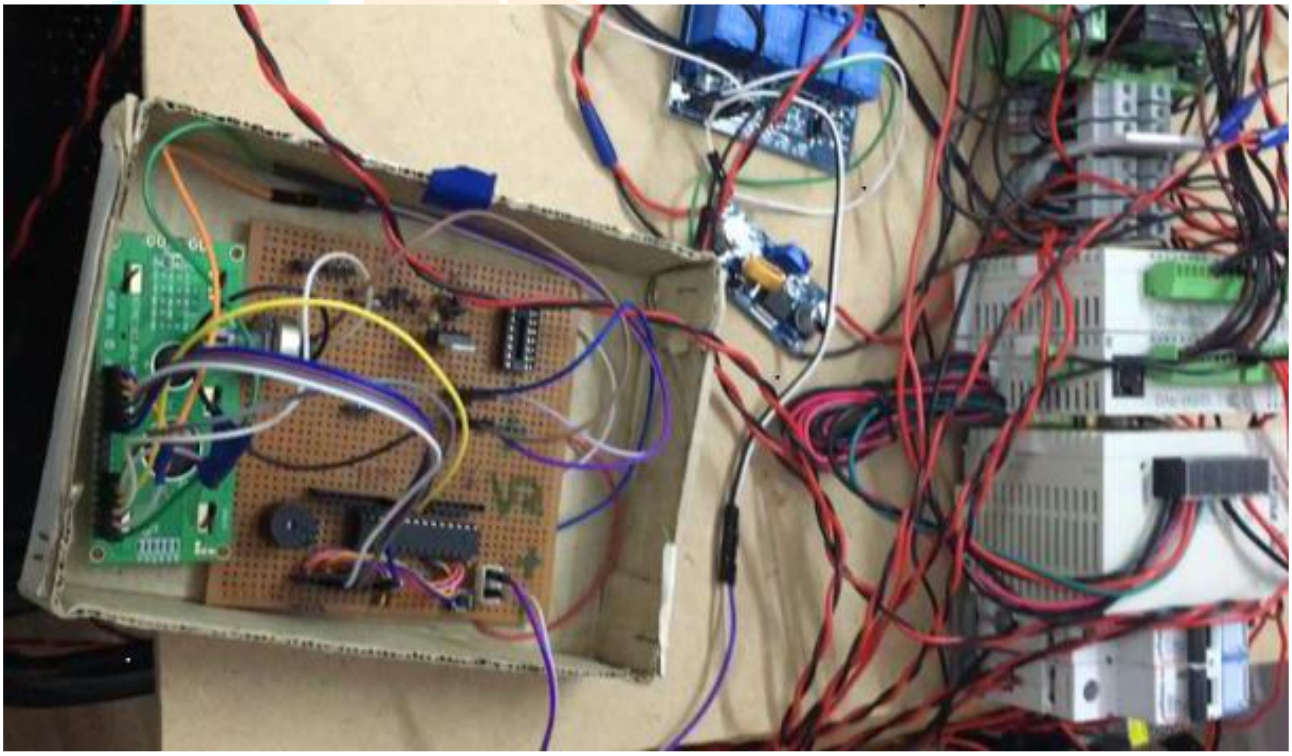

Fig.5.3. Internal wiring Connections

Here, we are giving 230vac power supply to PLC and it step down and convert power supply into 24vdc. The connections are given from PLC power supply to moisture sensor, LCD display, and relay. We are using the soil moisture sensor to determine the moisture content present in the soil. Here we are giving output connection from soil moisture sensor is used as an input to PLC and output connections are given from PLC to relay and relay is connected to buzzer and pump. The soil moisture sensor detects the amount of water present in soil and provides it to PLC. If the water level in the soil is less, then it indicates soil is dry and buzzer starts ringing and PLC sends signal to turn ON the pump and dripping of water starts. If the water level in the soil is more, then it indicates soil is soggy and PLC sends control signal to turn OFF the pump and dripping of water is stopped.

Fig.5.4. LCD indicating soil is in moist condition

The soil moisture sensor detects whether, soil is dry (or) soggy and provides to PLC. Here the water content is high, so it displays soggy on LCD, PLC sends control signal turn OFF the pump. Similarly, if the water content is low, it displays dry on LCD and PLC sends control signal to turn ON pump.

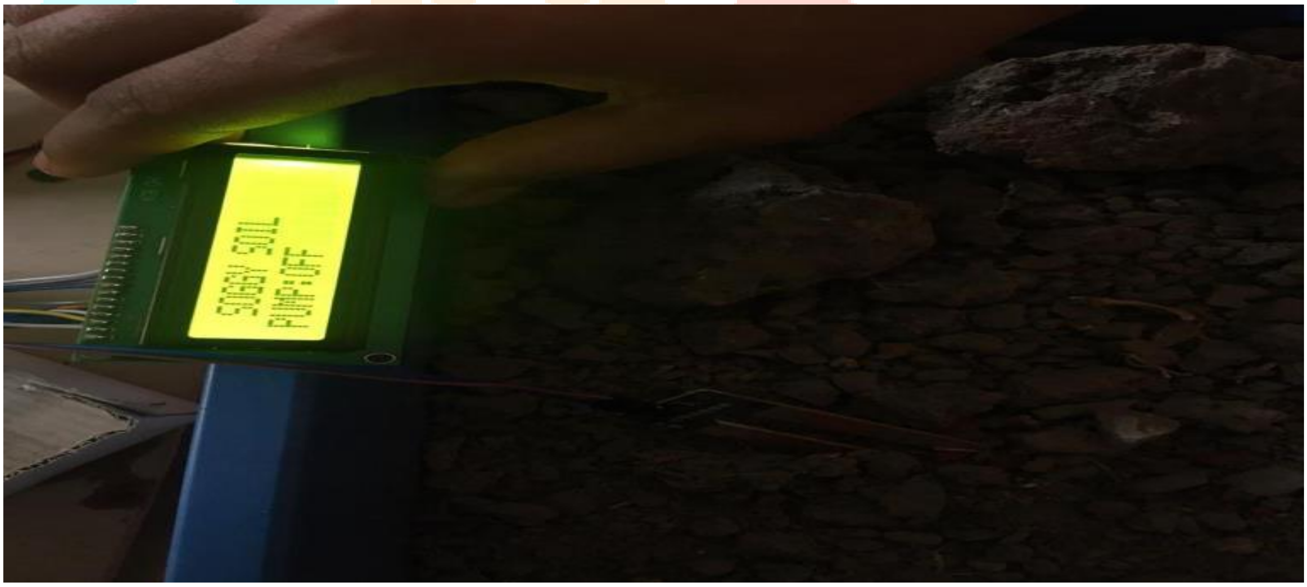

Fig.5.5. LCD indicating when soil is in Soggy condition

VI. CONCLUSION

The main purpose of this chapter is to propose automated irrigation systems that water the plant without any human control. The automated irrigation system implemented is found to be feasible and cost effective for optimizing water resources for agricultural production. Besides the automated irrigation system, the proposed system also provides the monitoring function where users are able to check the soil moisture based on the reading on the LCD display. The proposed system has been designed and tested to function automatically. For future works, the automated irrigation system can be congaed to measure the moisture level (water content) according to the moisture requirement of the different plants. We conclude that the system reduces water consumption and hence minimizes the wastage of water. In this system as we provide controlled supply of water to the crop it improves the productivity. Also due to an automated system the manpower is reduced. By implementing such a system using PLC and sensors we can increase agricultural yield and upgrade Indian economy.

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