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Automatic water and fertilizer sprinkling system based on PLC for Agriculture application

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Abstract:

In recent times automation based on PLC is increased in almost all industry environments. This paper presents an automatic irrigation system based on PLC employing moisture and PH sensors. The function of soil moisture sensor is to identify the amount of water required for irrigation; PLC then controls the water pump through a relay and a solenoid valve based on moisture content that is less or at correct level. Fertilizer spraying system is also added to the water irrigation system based on pH content in the soil. If PH level is less than 5.5 or higher than 7 that is if it is more acidic or becoming neutral then spraying motor is turned off and particular solenoid valve is closed. Agriculture using automation techniques like Automatic moisture detection and water sprinkling system and fertilizer spray system according to predefines time interval and fertilizer spray cut off due to high or lower pH value than the optimum pH value for healthy plant growth, by this system agriculture can be done efficiently and lead to increase in crop production and quality. The proposed automation scheme is implemented in real time using Siemens LOGO PLC platform and it produced an automatic irrigation system which also minimizes the cost required during irrigation.

Keywords: *Programmable logic controller, moisture sensor, pH sensor, solenoid valve, relay, automatic irrigation system.*

I. Introduction

Irrigation is the most important cultural practice and most labor task in daily agriculture sector. To do this automatically, sensors and methods are available to determine when plants may need water. Automation involves improving the speed of production, reduction of cost, effective use of resources. The main objective of this paper is to develop a PLC system to irrigate the plant automatically. This project is also to send a short message service (SMS) to farmer and motor ON and OFF condition. Many sensors are used in our project. There are ph sensor and soil moisture sensor. By using these sensors, we can find whether the soil is wet or dry. If it is dry, pumping motor will pump the water. Bio electrodes are used to measure the nutrient content of plant. In this system, the main controlling device is PLC. The pumping motor will pump the water into the field by until the field is wet which is continuously monitor by the PLC. A PLC is a control system that continuously monitors the state of

input device and makes decision based upon the program to control the state of output devices. PLCs are "Programmable Logic Controllers" that are being used in manufacturing processes. As already mentioned the project of this research is to develop an economical PLC based irrigation controller that automatically adapts the actual weather conditions, using simple sensors and carries out the irrigation accordingly**.** It is done through narrow tubes that deliver water directly to the base of the plant. A PLC is a control system that continuously monitors the state of input device & makes decision based upon the custom program to control the state of output devices. PLCs are "Programmable Logic Controllers" that are being used extensively in manufacturing processes. As already mentioned the aim of this research is to develop an economical PLC based irrigation controller that automatically adapts the application depths to actual weather conditions, using simple sensors and then carries out the irrigation accordingly. In this paper we are implementing Automatic drip irrigation by sensing the Moisture of the soil, pH sensor.

II. Related Works

Niteen Naik, Rohit Shinde, Ganesh patil, Navnath margale presented "AGRICULTURE AUTOMATION USING PLC" In India, the market is mainly based on agriculture and the climatic environment is isotropic and is not able to make full use of agricultural assets. The main cause is the lack of rains in many parts of India and scarcity of land water. Manual control irrigation techniques lead to many problems like additional water consumption, delayed water supply, additional or insufficient fertilizer consumption, bad quality of fertilizer preparation etc. Agriculture using automation techniques like Automatic water dripping system, Automatic chemical spray system and Automatic chemical preparation system can do agriculture efficiently and lead to increase in crop production and quality.

Santosh, Sanket, Shriyo, Sugandha "Plc Based Automated Drip Irrigation" Drip Irrigation is a progressing technology in the field of Agriculture and irrigation. 'Drip irrigation, is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. Use of automated drip irrigation we can save more water & increase our economy by increasing production with less man power. The major part of agriculture is the efficient use of water for irrigation, where it is not feasible to implement full scale evaporate transpiration based irrigation controller. During the growth season crop water does not remain constant and varies depending on the canopy, climate conditions such as temperature, wind, relative humidity and solar radiation. Thus, it is necessary to find an economic irrigation controller that can adapt the daily water application as per the plants requirement. Due to development of programmable logic controller (PLC) and their affordable price has made it possible to use them as stand-alone irrigation controllers.

L. SAROJINI, J. JENIFAR, M. MYTHILI, This project aims to develop the automated drip irrigation using PLC and biosensors for monitoring and managing the agriculture field. Drip Irrigation is a progressing technology in the field of Agriculture and irrigation. It is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the roots of plant, through a network of valves, pipes and emitters. Automatically water will irrigate 4hrs/day at near the root of the plant through emitters using biosensors and also fertilizers are supplied to the plant 3 days once. By using drip irrigation the water will be maintained at the constant level i.e. the water will reach the roots drop by drop.

III. Proposed Automation system for Agriculture Applications

Overall structure of proposed irrigation system based on PLC is shown in the figure1. Siemens LOGO PLC acts as main controller of the system. The main objective of the PLC is to read sensors and generate output based on logic created in program. PLC have faster response when compared to microcontrollers and it has long operating life programming too easy compared to Any PLC can be programmed in two ways either by ladder logic programming or by using structured text method. Ladder logic is quite simple to develop and understand program but it goes lengthy when the system involved is larger. In this system two main motors are used one for water pumping and other for spraying fertilizers. Both the motors operate on single phase nominal ac voltage and controlled by PLC using relays. The contactor type relays are used which based on energizing signal from PLC either turns on or off motor. A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; it cuts or open flow of water or fertilizer in our system.

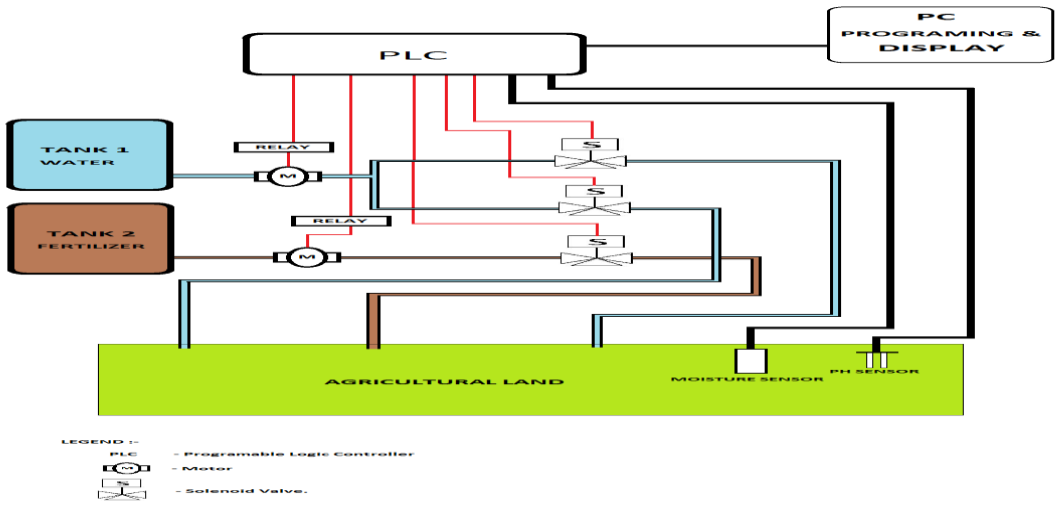

Figure1. Block Diagram of automated irrigation system using PLC

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. A pH Meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH. Here pH measurement is made for finding if it is not in the optimum range.

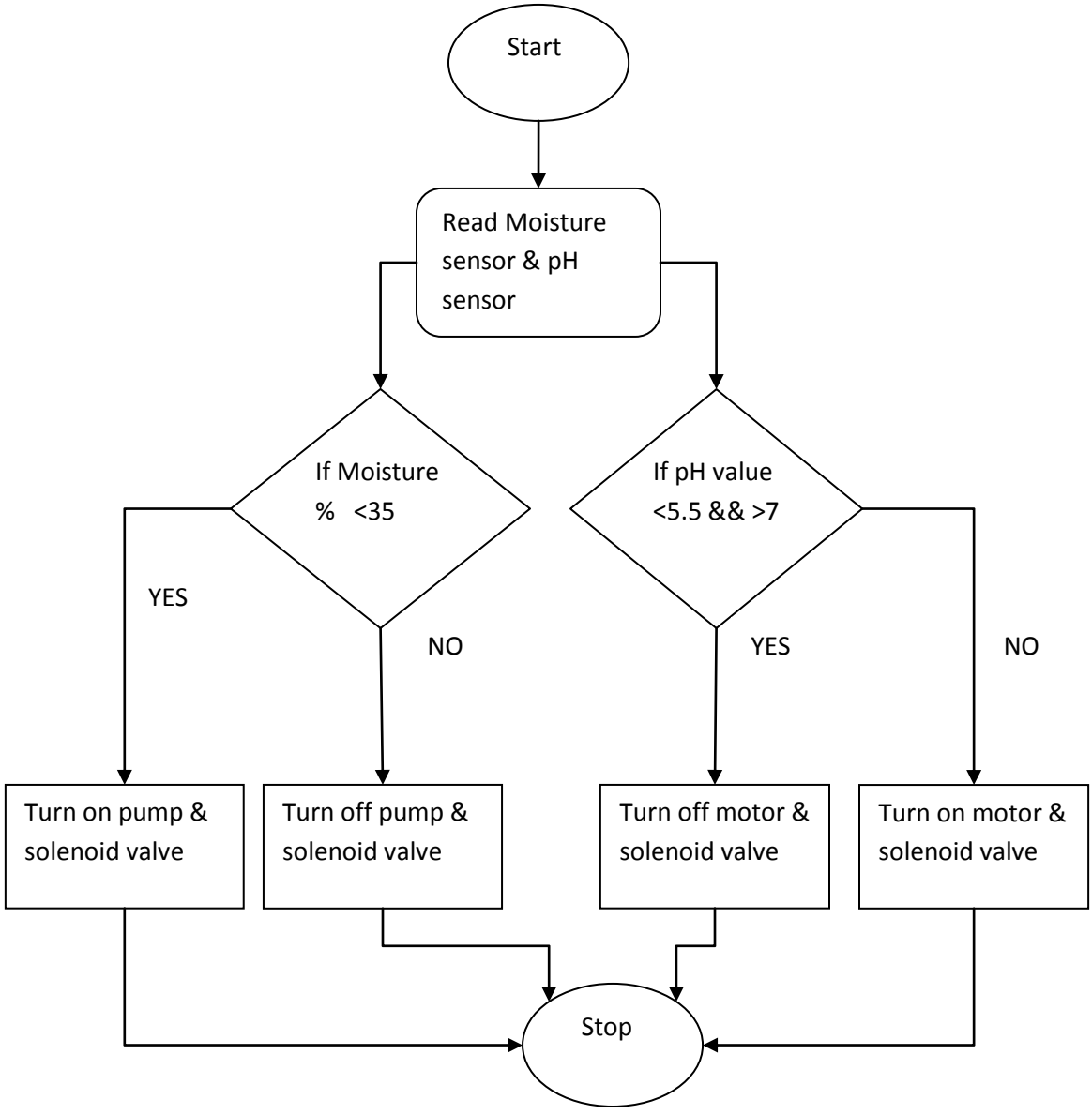

Figure2. Flow chart depicting logic involved in program

A. Water Pumping motor

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: *direct lift*, *displacement*, and *gravity* pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. Single stage pump – When in a casing only one impeller is revolving then it is called single stage pump. Double/multi-stage pump. When in a casing two or more than two impellers are revolving then it is called double/multi-stage pump.

B. Relay

A contactor is an electrically controlled switch used for switching an electrical power circuit, similar to a relay except with higher current ratings and a few other differences. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

Figure3. 12v contactor Relay

C. Solenoid valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Besides the plunger-type actuator which is used most frequently, pivoted-armature actuators and rocker actuators are also used. There are many valve design variations. Ordinary valves can have many ports and fluid paths. A 2-way valve, for example, has 2 ports; if the valve is open, then the two ports are connected and fluid may flow between the ports; if the valve is closed, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed normally open (N.O.). Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed normally closed. There are also 3-way and more complicated designs. A 3-way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port).

Figure4. Two port Solenoid valve

D. Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property

of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners. Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include densitometers and gypsum blocks.

Figure5. Soil moisture sensor

E. PH Sensor

A pH Meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH. The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a potentiometric pH meter. The difference in electrical potential relates to the acidity or pH of the solution. The pH meter is used in many applications ranging from laboratory experimentation to quality control. Potentiometric pH meters measure the voltage between two electrodes and display the result converted into the corresponding pH value. They comprise a simple electronic amplifier and a pair of electrodes, or alternatively a combination electrode, and some form of display calibrated in pH units. It usually has a glass electrode and a reference electrode, or a combination electrode. The electrodes, or probes, are inserted into the solution to be tested.

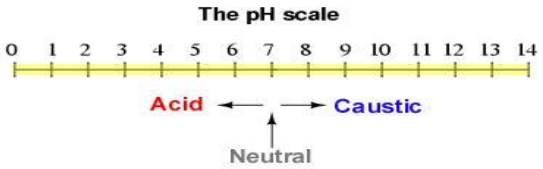

Figure6. PH chart showing acidic and base pH levels

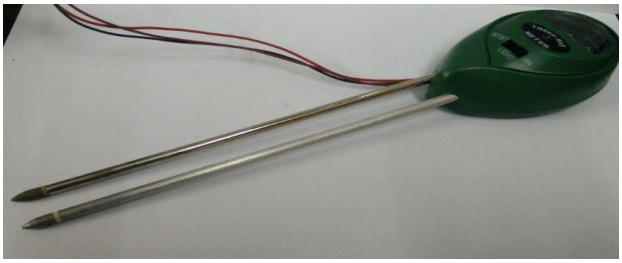

Figure7. PH Sensor

Conclusion

This paper presented an automatic irrigation system based on PLC employing moisture and PH sensors. The function of soil moisture sensor is to identify the amount of water required for irrigation; PLC then controls the water pump through a relay and a solenoid valve based on moisture content that is less or at correct level. Fertilizer spraying system is also added to the water irrigation system based on pH content in the soil. If PH level is less than 5.5 or higher than 7 that is if it is more acidic or becoming neutral then spraying motor is turned off and particular solenoid valve is closed. The PLC has been used to control Water supply motor and Solenoid valve according to the moisture content in the soil, to apply fertilizer timely by switching on the fertilizer motor and solenoid valve and continuous monitoring of pH level and stop supply of fertilizer if the pH is Lower or greater than the optimum pH valve for plant growth. By this water management is archived by reducing the over watering of plants and over sprinkling of fertilizer. This improves the crop quality and quantity in lower cost than conventional method. The purpose of this project is to perform a proof of concept study on Agriculture automation using PLC.

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