Implementation of Irrigation Network Using Microcontrollers

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***Abstract*— India's rapidly growing population has led to an increased demand for food, making the development of agriculture a critical need for the country. However, Indian agriculture is largely dependent on monsoons, which can be unreliable sources of water. As a result, there is a need for an irrigation system that can provide water to crops based on their specific soil types.**

To address this issue, a Microcontroller based automated irrigation system has been developed. This automated irrigation system is a game-changer for Indian agriculture. With its ability to provide water to crops based on their specific soil types, this system ensures that each crop receives the optimal amount of water, reducing water waste and increasing productivity. Furthermore, the system's ability to respond to changes in temperature and humidity in the surrounding environment minimizes the need for human intervention, making it a cost-effective solution for farmers. The inclusion of a solar panel and battery also means that the system can operate in areas where electrical power is difficult to obtain, making it accessible to even more farmers.

Overall, the Microcontroller based automated irrigation system provides an efficient and effective way to manage the water supply for crops, reducing the risk of water waste or shortages. This innovative technology can help to improve agricultural productivity in India, ensuring a stable food supply for the growing population.

I. INTRODUCTION

Micro-controllers are small and low-power computer systems. They can be used to control a huge variety of devices and systems, including irrigation systems. In this field, microcontrollers play a crucial role in managing and controlling the amount and timing of water that is delivered to the crops. By using these microcontrollers, the farmers can easily turn the water supply on and off based on factors such as weather conditions, soil moisture levels, and specific times. This level of precision and control is much better than that provided by humans, which leads to a more efficient use of water resources, which are a scarcity for India, and higher crop yields. For this reason, microcontrollers are considered to be an indispensable tool in modern irrigation systems.

Automatic irrigation systems have become increasingly popular in modern agriculture and horticulture, due to the various benefits they offer. These systems are designed to provide the right amount of water to crops while conserving water resources, making them an essential tool for farmers. One of the key benefits of automatic irrigation systems is increased efficiency. These systems can be programmed to turn on and off at specific times, reducing the amount of time and effort required to manually water crops.

Another advantage of automatic irrigation systems is improved crop yield. Proper watering is essential for optimal crop growth, and automated systems ensure that crops receive the right amount of water at the right time, leading to improved crop performance. Additionally, automated systems can save on labour costs and reduce water waste, leading to lower costs for farmers and growers. Moreover, automatic irrigation systems offer greater flexibility in managing irrigation. These systems can be programmed to respond to various conditions such as weather and soil moisture levels, allowing for greater flexibility in managing irrigation. Consistency is also a key advantage of automated systems, providing consistent and reliable irrigation, reducing the risk of under or over-watering, and helping to maintain healthy crops.

Overall, automatic irrigation systems offer many benefits for farmers, growers, and the environment. These systems have become a critical component in modern agriculture and horticulture, providing water conservation, increased efficiency, improved crop yield, cost savings, flexibility, and consistency.

II. Microcontrollers In Drip Irrigation

Drip irrigation systems have become an essential component of modern agriculture, delivering water directly to the roots of plants through a network of small tubes and emitters. This ensures optimum use of water resources, since it is well known to be a scarce resource. To ensure precise and efficient irrigation, microcontrollers are used to control the timing and amount of water delivered. These microcontrollers are programmed to turn the water supply on and off at specific times, taking into account various factors such as weather conditions, soil moisture levels, and the water requirements of crops.

With the help of these microcontrollers, the flow of water in a drip irrigation system can be monitored and adjusted to ensure optimal coverage, thus improving crop yield. Additionally, microcontrollers can be connected to sensors and other monitoring devices, allowing for real-time monitoring, and control of the system.

In summary, the use of microcontrollers has revolutionized the way water is delivered to crops, making it possible to conserve water and improve crop performance with greater efficiency and precision. As a result, microcontroller-based drip irrigation systems have become a critical tool in modern agriculture.

III. Key Elements To Be Considered

We have to consider some key elements while designing a mechanical model. Now we briefly discuss about these key elements.

a) **Flow**: You can measure the output of your water supply with a one or five gallon bucket and a stopwatch. Time how long it takes to fill the bucket and use that number to calculate how much water is available per hour. Gallons per minute x 60=number of gallons per hour.

b) **Pressure**: Most products operate best between 20 and 40 pounds of pressure. Normal household pressure is 40-50 pounds.

c) **Water Supply & Quality**: City and well water are easy to filter for drip irrigation systems. Pond, ditch and some well water have special filtering needs. The quality and source of water will dictate the type of filter necessary for your system.
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d) **Soil Type and Root Structure**: The soil type will dictate how a regular drip of water on one spot will spread. Sandy soil requires closer emitter spacing as water percolates vertically at a fast rate and slower horizontally. With a clay soil water tends to spread horizontally, giving a wide distribution pattern. Emitters can be spaced further apart with clay type soil. A loamy type soil will produce a more even percolation dispersion of water. Deep-rooted plants can handle a wider spacing of emitters, while shallow rooted plants are most efficiently watered slowly (low gap emitters) with emitters spaced close together. On clay soil or on a hillside, short cycles repeated frequently work best. On sandy soil, applying water with higher gap emitters lets the water spread out horizontally better than a low gap emitter.

e) **Elevation**: Variations in elevation can cause a change in water pressure within the system. Pressure changes by one pound for every 2.3-foot change in elevation. Pressure compensating emitters are designed to work in areas with large changes in elevation.

f) **Timing**: Watering in a regular scheduled cycle is essential. On clay soil or hillsides, short cycles repeated frequently work best to prevent runoff, erosion and wasted water. In sandy soils, slow watering using low output emitters is recommended. Timers help prevent the too dry/too-wet cycles that stress plants and retard their growth. They also allow for watering at optimum times such as early morning or late evening.

g) **Watering Needs**: Plants with different water needs may require their own watering circuits. For example, orchards that get watered weekly need a different circuit than a garden that gets watered daily. Plants that are drought tolerant will need to be watered differently than plants requiring a lot of water.

IV. Proposed System

[A] DESCRIPTION OF COMPONENTS

Following are the major components used from which microcontroller based automated irrigation system has been fabricated.

1. Soil moisture sensor
2. Microcontroller
3. Relay
4. Solenoid valve
5. Liquid crystal display
6. Power supply

1.Soil moisture sensor: The moisture sensor is buried in the ground at required depth. The working of the moisture sensor is simple and straightforward. The moisture sensor just senses the moisture of the soil. The change in moisture is proportional to the amount of current flowing through the soil.

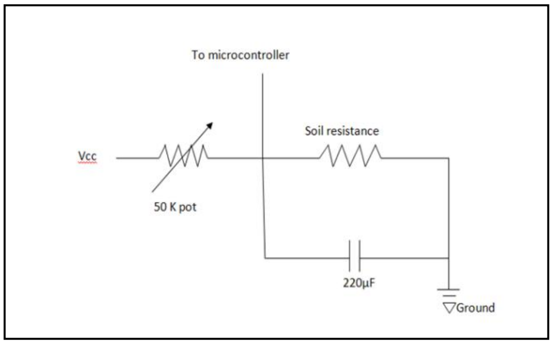


Fig 1. Circuit Diagram of Soil Moisture sensor

2.Microcontroller: The *PICI6F877A* is an 8-bit microcontroller and it is a very robust controller that suits this particular application. The PICI6F877A is a low-power CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into a 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial appliances and consumer applications. PIC16F874A/877A devices are available in 40-pin and 44-pin packages.

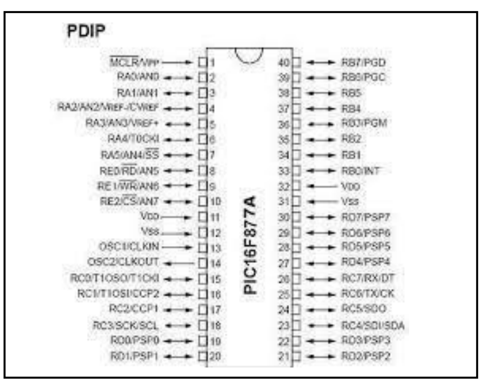


Fig 2. *PICI6F877A Microcontroller*

3.Relay: A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit.

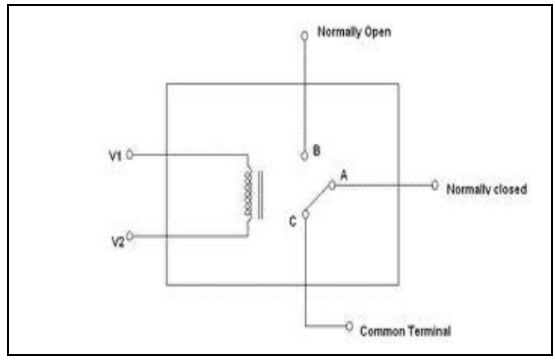


Fig 3. *Circuit diagram of a relay*

The above diagram shows the representation of a relay. By default, when there is no excitation in the coil the NC (Normally Closed) and C (Common Terminal) are connected through the contact internally. When the coil is excited by providing the required coil voltage, the contact switches from the NC to NO (Normally Open) side. In this case, the C and NC terminals are connected internally.

4.Solenoid valve: A solenoid valve is an electromechanical valve for use with liquid or gas. 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

5.Liquid crystal display: The LCD will display the alphabets, numbers, characters, and symbols. The LCD used here is eight-bit parallel type and the display size is 16*2. Liquid Crystal Display is used for displaying the moisture value. LCD consists of three control pins and eight data pins. Based on the commands given to the control pins, data can be read from or write to the LCD. The eight data pins of the LCD are connected to the PORTB pins RB0-RB7. Three control pins are connected to PORTC pins. RC0, RC1, RC2 are used for register select (RS), read/write (R/W) and enable (E) respectively.

[B] WORKING

The area to be irrigated using the system is divided into discrete zones, possibly with different soil conditions. Each zone has an overhead sprinkler or a drip, along with a solenoid and soil moisture sensor. The valve can turn on/off to start/stop the flow of water respectively. The sensor produces electrical signals proportionate to the moisture level of soil. These analog signals are carried to the *PICI6F877A* microcontroller which are converted to digital signals. Microcontroller is coupled in controlling relationship with valve and periodically interrogates signal from sensor. The microcontroller makes the decision to turn the water flow on or off based on the algorithm that is programmed into it. The soil moisture and status of motor is displayed on LCD.

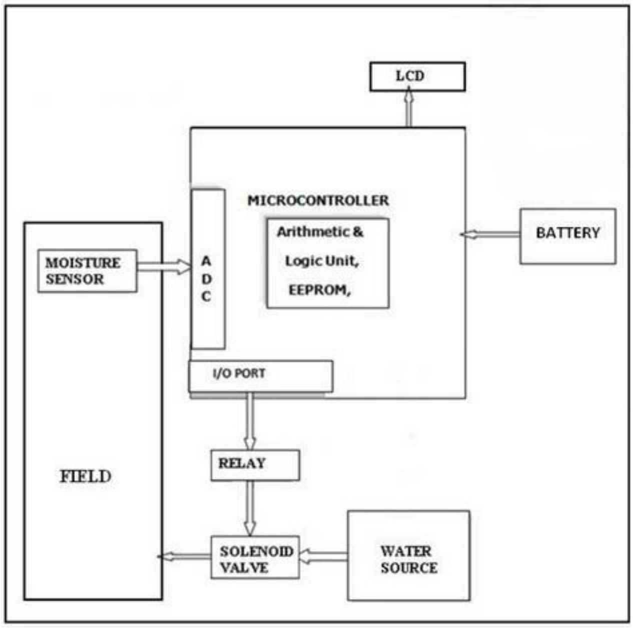
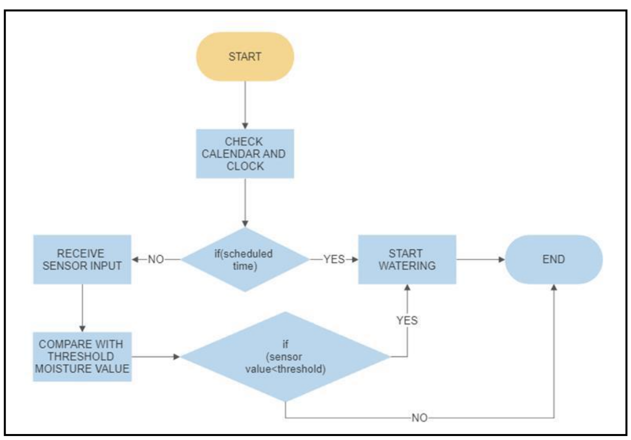


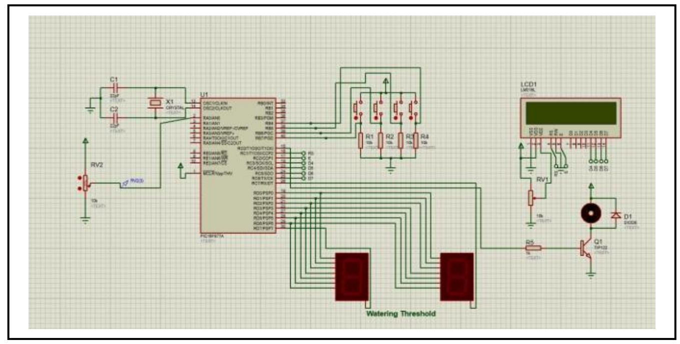
Fig 4. Simplified working of the Microcontroller-based irrigation system

[C] FLOWCHART OF ALGORITHM



The microcontroller starts up and checks the inbuilt calendar and clock to see if it is the scheduled time of irrigation. If it is the scheduled time, the valve is turned on and plants are watered for a certain amount of time and then valve is switched off. If the microcontroller does not encounter the scheduled time, then it becomes ready to receive input from sensor and compares it with the threshold moisture value. If the soil moisture is too low, the microcontroller bypasses the scheduled time requirement and turns the valve on regardless.

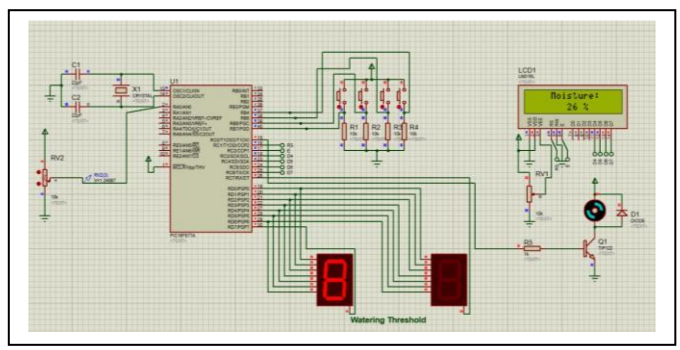
V. Circuit Design and Simulation



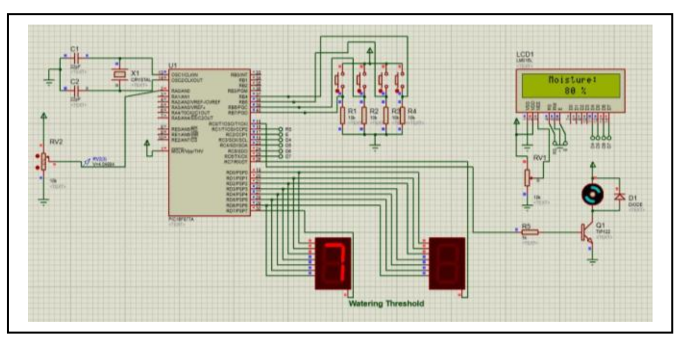
Using PROTEUS software, we implemented a smart irrigation system with a PIC microcontroller system. The LCD display on the right shows us the moisture content in soil . The threshold value is visible at the bottom. If moisture level is less than threshold value then the motor and hence, the water flow is turned on. The motor remains in off state if moisture level is above the threshold value.

[A] Simulation

(i) At moisture=26% but threshold=85%, motor turned on:



(ii) At moisture=80% but threshold=75%, motor turned off:



VI. Disadvantages And Challenges Faced

(i) The key disadvantage is that the equipment is expensive since continuous data transmission increases the cost, complexity, and power requirements of the system. As a result, users need to assess whether these costs are outweighed by the advantages.

(ii) It is only possible to use them on farms of a significant size.

(iii) Part of the farm will need to be excavated in order to install pipework and connect it to the plumbing system of the house, which is a laborious and time-consuming process that will prevent any work from being done in the garden during that period.

(iv) They also have a limited life span after installation as a result of the deterioration of the plastic components in a hot, arid climate when exposed to ultraviolet light.

(v) For it to operate efficiently, it requires regular maintenance as it is automatic.

(vi) Pests that dwell underground can cause damage to water delivery systems, which can lead to broken parts or standing water.

VII. CONCLUSION AND FUTURE SCOPE

The microcontroller-based drip irrigation system is shown to be a real-time feedback control system, which monitors and controls all of the activities of the drip irrigation system effectively. Since the system is automatically monitored and controls the on and off of the pump, this feedback control system monitors and controls all of the activities of the drip irrigation system. The system built is cost effective when compared to other techniques to build such systems. Therefore, the purpose of developing an Automated Plant Irrigation System was effectively achieved, and the system satisfies the desired objectives.

There is always opportunity for improvement, and as there is always room for improvement, it is possible to modify the product so that it can be used in a larger variety of settings and on a smaller scale budget. The drip irrigation system that is currently available for purchase only takes into account the soil moisture content that is already existing in the soil; it does not take into account any other environmental circumstances or characteristics. The prototype is being created to address the deficiencies that are present in the commercial drip irrigation control system while considering the circumstances of the surrounding air, such as its temperature and humidity levels. The future of the product may be improved if it were to be implanted with a wireless unit, and all the data that was obtained was handled wirelessly. This would reduce the maintenance costs as well. It is also possible to construct humidity, temperature, light and soil moisture sensors in order to attain results that are more precise. This soil moisture sensor-based irrigation system provides water according to the plant's demand, making it helpful not just for research on plant physiology and irrigation but also for uses in the commercial sector. A timer that is incorporated into the microcontroller unit and works in parallel with the sensor system is another feature that can be included in this component. In the event that the sensors fail to work, the timer will shut off the valves after a predetermined amount of time, which may prevent further damage.

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