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Low Cost Automatic Irrigation System with Intelligent Performance Tracking

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Abstract

Water is the elixir for agricultural process as the entire procedure relies merely on that. Optimization and effective usage of water in agriculture is an essential phenomenon. Wide varieties of automatic irrigation systems exists in practice but none of them proved to be efficient in terms of cost, technology adopted and fixing the loopholes which is evident from the current literature. Efficiency should be achieved in all the aforementioned levels for enhancing the agricultural productivity. Drip emitters with sensors helps in proper water distribution of agricultural crops which in turn prevents the water wastage and soil degradation. It joins hand with the emerging technology Internet of Things to enable smart tracking and solving the irrigation related issues. Hence the major focus is to assist the farmers for irrigation by applying organized procedures for getting the details regarding amount of water to be dispersed, issues in the water dispersion and water inlet flows. Effective automatic irrigation is the needy solution in today's scenario as agriculture is the backbone in spite of the growth and advancement of any other processes. Our system attempts to fix the loopholes in the existing ones by tracking the water pressure in the dispersion pumps and checking the inlet, outlet flows. It eradicates the agricultural overhead with a complete user friendly interface. The interrelated computing devices manage the ability of data transfer over a network with minimized human intervention. Low cost is achieved in the irrigation process with the

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help of drip emitter connected to the semi-submersible water pump. Experimental test bed is done with the water pumps and sensors for validating its accuracy and effectiveness

Keywords*:* IoT, smart irrigation, soil moisture prediction, microcontroller, rain water sensor

1 Introduction

As water scarcity is the critical issue in today's scenario due to the tremendously increasing world population. The availability of fresh water is limited around 2.5 – 2.75% inclusive of 1.75 – 2% of frozen glaciers, ice and snow, 0.5 – 0.75% as fresh ground water whereas less than 0.01% is available in the surface [1][2]. No life could survive without water as global warming is another source which effects in the quick evaporation of it. Hence, Top priority should be given in preserving the water resources especially when utilized for agricultural purposes as it is the vital source. Without water it is impossible to carry out the food cultivation. Such difficulties paved way for the implementation of new methodologies by adopting smart technologies to proceed to a sustainable agriculture. Automated Irrigation System will monitor the water flow in soil without much human interaction, meanwhile maintaining moisture of the plants. This system automatically turns the controls ON or OFF by detecting the water content in the soil [5]. This automated irrigation system not only minimize the excess wastage of water but also implies reduction of labour and other agriculture related overheads. If any leak in the water pipe exists, we could easily identify the leak and fix it by adopting the appropriate moisture and rain water sensors which in turn helps in water utilization in an optimized way we can save the water and effective use of water resources.

2 Related Work

There are many irrigation systems proposed by researchers related to the smart irrigation. Arduino microcontroller [11] was used in order to have an automatic control on the level of water in the tank. Well spelt out algorithm is used to achieve the same. To display the level of water in the tank Liquid Crystal Display (LCD) function is used. It recommends the use of protection devices such as circuit breaker overload and phase failure relays in order to increase the reliability of the water pump.

Basically, all the smart irrigation systems are developed with the Arduino [6][7][8] for automatic plant watering for controlling the moisture sensors for soil and water pump. For enhancing the watering efficiency, drip irrigation is proposed [9][10] with Raspberry Pi and Arduino for watering the plants in home and controlling the same via email. The general phases of such systems involve acquisition block, microcontroller block and monitoring block. The acquisition block contains the moisture sensor for

measuring the water levels of the agricultural crops in the soil level. Appearance of wet soil levels is indicated through the low voltage levels whereas the dry soil levels are indicated via the high voltage levels. In the microcontroller block, based on the input obtained from the soil moisture sensor, the level of water which needs for the plant will be computed. The monitoring block includes the relay module and DC watering pump. Automatic electronic switch is used as a relay to control the switch movements ON and OFF. The switch is responsible for controlling electric signal which passes through the water pump. In turn if a system detects sufficient water level in the plant, the relay path will be closed thereby stopping the outlet of water pump.

Few researches have used sensor based microcontrollers [12] [13] to monitor the soil temperature and moisture. Servo motor was used for uniform transmission water in the plants. This system helps in increasing the life time of sensors by decreasing the power consumption levels. Data is collected from the sensor for every 10 seconds to monitor the soil levels. A solenoid value [14] was used for controlling switch related to water pumps.

Tiny OS based IRIR mote [15] was used for the measurement of moistures in the paddy plant soil levels. The motor was used to run the sensor nodes which in turn forms the mesh network. Server is generally used for handling the related translations and buffering. IoT based agricultural system [16] uses a remote controlled robot and the same has been tracked using GPS. The major functions like spraying, sensor monitoring for moisture level of plants, scaring bird and animals. This also includes a smart system for monitoring moisture and humidity. For monitoring soil related parameters pH sensors are also utilized. A mobile integrated system is added to enable monitoring via the Bluetooth device [17] [18].

The capillary irrigation [19] is used in order to reduce the water consumption during cultivation. In this process, water is transferred directly to the root part of the plant. The new techniques like Precision Agriculture (PA) [20], fuzzy controller [21] were utilized to automate the water levels of the selected plants. Due to the prevalent use of emerging technologies related to Artificial Intelligence (AI), the related techniques feedforward MLP neural networks [22] [23] [24] is used as a smart controller.

The existing systems delivers the required amount of water for the selected plants through the soil moisture sensor, humidity levels with the pump controlled by the micro controller. The AI techniques are applied for ensuring the correctness in the water levels. But they failed to address the performance issues in the water pump or physical damages. If the water level is not properly delivered to the plants, then there is a need to check the water pressure linked to the micro controllers and inlet flow, outlet flow verification in the water pump valves. Hence our proposed system works by considering these aspects and tries to predict the values for the selected plant category by applying machine learning algorithms as a future enhancement.

3 Methodology

In the proposed model low energy consuming systems are considered with low costs. With the help of Arduino, the complete system program could be carried out. The 12v dc motor pump is connected with relay channel. The relay channel is capable of converting the 5v power supply from the Arduino and converts it to 12v. The drip emitter is set in the pipe and installation of the rain sensor in done between the drip emitter which enables to monitor the leakage in the pipe. Soil moisture sensor is connected to the plant soil so that it can sense the soil moisture level. Setting the value of soil moisture sensor is depicted in Fig1. Complete system architecture is depicted in Fig 2. The soil moisture sensor is used to find the soil moisture content we must set some threshold value if the soil moisture less than the threshold value it will automatically flow the water to the plant otherwise the water flow must be off. If the soil level goes below 50 the sensor will alert the Arduino which in turn triggers the motor for automatic water flow to the plants. If soil value goes above 100 it will automatically stop the water flow. The soil moisture is monitored periodically. We will use drip emitter to save water and use it effectively. By using rain sensor we can find the leaks in the pipe.

3.1 Measuring Soil Values

Analysing the values of soil content is essential as it paves way for the proper supply of water to the specific plants [3][4].

Table 1 Soil Moisture Value to Supply Water to the Plants

Soil Type	Irrigation (No)	Irrigation (Yes)	Low soil moisture
Fine (Clay)	80 – 100	60 – 80	< 60
Medium (Loamy)	88 – 100	70 – 88	< 70
Coarse (Sandy)	90 – 100	80 – 90	< 80

Based on the reference values from the above table 1, the plants moisture content is verified and this is concluded by considering the type of soil nature too in account. Based on the inputs soil type, the irrigation level of soil moisture will be identified.

Algorithm

```
Begin
   Set threshold T for leveraging level of water from the tank
            Refer soil measurement values
             Initialize setup()
              set input pin and output pin of sensors
                    Read sensor value S from pin
                    If s S >= MAX_DRY then
                              Display "Soil moisture is too low”
                              Set output pin “HIGH”
                    Else
                              Display "Soil moisture is wet"
                               Set output pin “LOW”
                    End if
                    Set output value O for water level reading
                    If O <= T then
                              Display "No sufficient water levels"
                              Set output pin “HIGH” alarm
                    End if
                    End
```

4 Irrigation System Architecture

The architecture design and components of low cost irrigation system is depicted in Fig 1 and Fig 2.

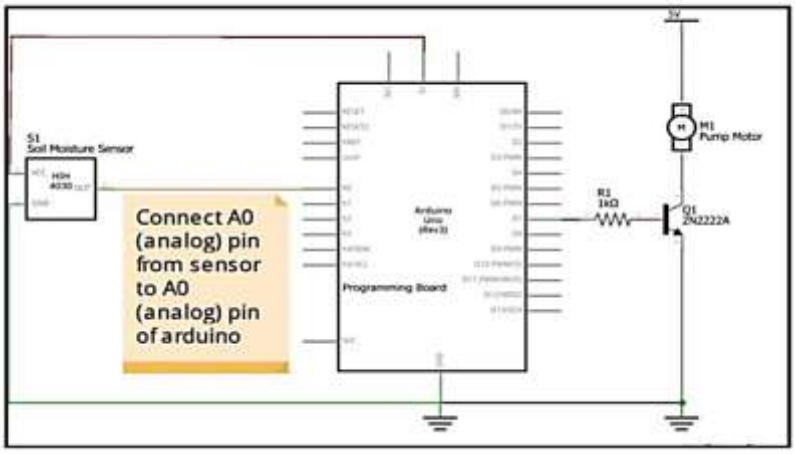

Figure 1 Irrigation System Architecture

Thus the “Low Cost Automatic Irrigation System with Intelligent Performance Tracking” has been designed and tested successfully. It was

developed through the integrated functions of all hardware components used. This fig 1 shows the pin diagram of the project. The presence of each module has been justified and carefully placed, which contributes to the best performance of the device.

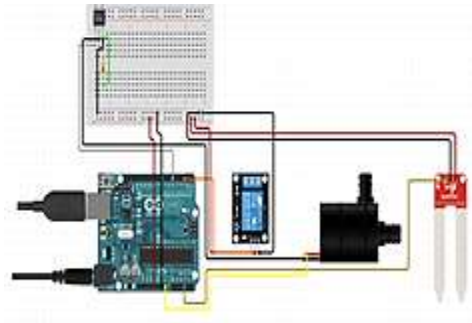

Figure 2 Irrigation System Components

4.1 Arduino uno

The Arduino Uno is a category of microcontroller of open-source type. Its board is merely based on the Microchip ATmega328P microcontroller which is developed by Arduino.cc. The microcontroller board is fully enhanced with a combination of pins of both analog and digital category which could be interfaced with any expansion boards and even with different circuits.

4.2 YL-69 Soil Moisture Sensor

The purpose of soil moisture sensor is mainly for detecting the level of humidity associated with the soil. With the sensors, automatic water dispenser system is developed in order to monitor the moisture level of soil for the selected plants. There are two parts of the monitoring sensor one with electronic board and another one with the pads associated probes responsible for detecting the water content.

4.3 5 V Two Channel Relay

The two channel relay needs to be separated electrically from the input which is a controlling one. The purpose of relays are mainly for switching the current loads in the case of high voltage flows which is more intelligent than the traditional systems in practice.

4.4 Motor Driver L293D

The L293D is a typical motor drive or motor drive IC that allows the DC motor to move in any direction. The L293D is a 16-pin integrated circuit that can control a set of two DC motors in both directions at the same time.

This means that we can control more than two DC motors at the same time with one L293D IC.

4.5 Motor 5V

The AC motor usually consists of two basic components, an external stationary stator coil whose coils are supplied with AC power to provide rotating flux, and an internal rotor connected to the output shaft which creates a second rotating flux. . The rotor flux can also be made by permanent magnets, striking of reluctance or AC or DC electrical windings.

5 Conclusion

The proposed automatic drip irrigation systems promotes direct watering of plants at its root rather than wasting water in terms of sprinkling it in the whole area. If the seeds are poured with more water, the germination will be affected hence our measure fixes it by providing the needy water. Watering the plants at the level of root also helps in turn for preventing the leaf related diseases caused by the standing water droplets in its surface. The leaks in the process of watering the plants are controlled through the microcontroller by maintaining proper pressure levels and through the rain sensor for tracking the measurement of inlet, outlet water flows. Accompanying these identified measures with the existing automatic irrigation based systems yields better results as the performance is optimized. In future, it is planned to apply machine learning, deep learning algorithms to predict the watering levels of various crops based on the existing values. Since this system functions with less energy consumption and low cost, the scope of it is wide.

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