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HORTICULTURE AND PLANTATION CROP USING REMOTE SENSING DRIP IRRIGATION SYSTEM

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Abstract
Drip irrigation is a type of irrigation system in agriculture. India has produced 1.6 million tonnes of horticulture produces through precision agriculture. Many irrigation techniques are available in agriculture, drip irrigation one of the efficient irrigation technique for horticulture. Applying water directly to the root zone has the main advantage for drip irrigation. The commercial drip irrigation system available on the market are made to control based on the manual type with time duration. The current system requires human resources to control and monitor the irrigation process. The lake of monitoring may result in the root zone to be wetting more than the required. Lake of data collection from the root zone and monitoring the irrigation with these electro-mechanical devices is a big challenge. To improve the irrigation efficiency the proposed approach design with an embedded system for drip irrigation to monitor the irrigation process in horticulture. The microcontroller and sensor-based remote sensing drip irrigation system have tested for the durability of the components in the horticulture field. The data collection and overall functionally of the device to achieve successful results in the prototype model of remote sensing drip irrigation system.

Keywords: Precision agriculture, Automatic Drip irrigation system, Embedded system, Microcontroller, Remote Sensing.

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INTRODUCTION

In India agriculture plays a significant part in the development of economics [3]. In 2020 due to the pandemic situation of COVID-19 shows the essence of innovative techniques and human less food production in the agriculture field. Thus, the research community is focusing on using automatic techniques in agriculture. Irrigation, which is an important aspect of agriculture, is also undergoing these technological advancements. Today, various new irrigation techniques are found to be more effective than old techniques. The irregular water spreading can cause damage to crop efficiency. Horticultural crops are an important gathering of the diverse agro-ecological conditions in the Indian agricultural economy. Indian food capacity needs more in the upcoming years [1]. The insufficient human workforce is the major problem in agriculture, researchers and scientists are leaning towards using innovative techniques with automation in agriculture to increase agricultural production. A horticultural crop is an essential source of revenue in the food industry [2]. Irrigation, which is an important aspect of a horticultural crop, is also undergoing these technological advancements. Today, various new irrigation techniques are found to be more effective than old techniques.

Drip Irrigation is one of the capable irrigation techniques for horticulture [4]. It is one of the inexpensive techniques and requires human resource for monitoring. In drip irrigation, uniform distribution of water applied to a field to achieve efficient irrigation. In the horticulture crop, enough water near the root zone is an important process [5].

This research paper discusses drip irrigation and how technology has implemented to automate the process of drip irrigation. Section 2 describes the manual drip irrigation working principle with limitations. The proposed drip model for automatic irrigation is explained in section 3. The prototype field experimental results are discussed in section 4. Finally, a conclusion with feature scope is provided in section 5.

DRIP IRRIGATION SYSTEM

Drip irrigation is a type of microsystem to save water in agriculture. The commercial drip irrigation system was established in 1959 by Blass [3]. Drip irrigation allowing water to the roots of plants from buried below the surface or above the soil surface. Drip irrigation is most suitable for row crops, normally the crop would be planted along contour lines and the water supply water pipes. Drip irrigation systems distribute water through a network of valves, pipes, tubing, and emitters [3]. In drip irrigation, water is applied intermittently to the roots of the planets through manual series of ON and OFF cycles. In drip irrigation, the field is divided into many halves, so while the one halve is undergoing the ON cycle, the remaining will undergo the OFF cycle.

Most of the Indian farmers implementing the water irrigation using a manual controller placed at the corner of a field or halve that is gated pipes are placed across the field which carries water to the root zone [6]. Figure 1 shows the pictorial view of the drip irrigation technique. The pipe system receives water from a source unit based on the pressure. The water discharge control and pressure are controlled the control head [7]. The major benefit of this system is joining the fertilizer through the water so this control head units contain a filter to clear the water [7]. The water flow network through the PVC or polyethylene hose usually 13-32 mm diameter in the field. In the control head divided based on the field halve like mainlines, sub mains and laterals. In the lateral are connected with the dripper or emitters devices for the discharge of water to the plants.

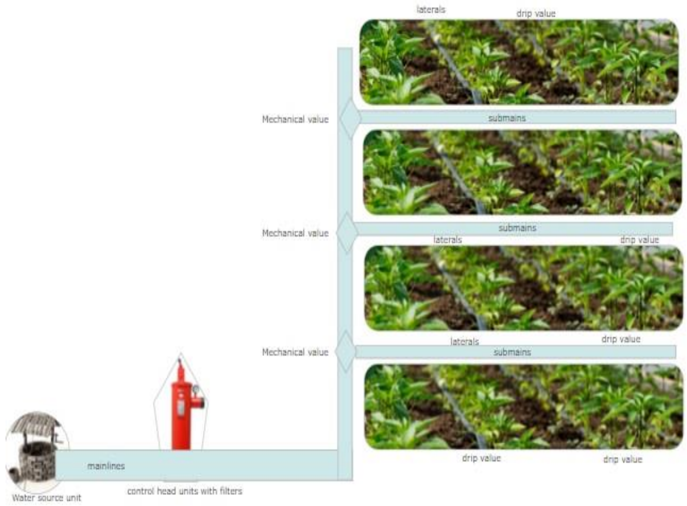

Figure 1. Manual Drip Irrigation Technique.

Many different types of drippers are available depending on the soil and plant. The fixed technology has applied in drippers to control the pressure and does not block easily. In the following section describe the limitation in the technology.

Limitation in Drip Irrigation

The drip system has not installed and managed properly then waste of water and time. Human resources are needed more for control and monitor the irrigation. Drip irrigation only wets part of the root zone in the fixed method, this may be as, low as 30% of the volume of soil wetted by the other methods [15]. Low wetted zone and high wetted zone cannot see properly, this may lead to the farmer either apply too much water or an insufficient amount of water.

Clogging is the major problem if the water is not properly filtered and the equipment like dripper not properly maintained. Depending on how well designed, installed, maintained, and operated it is, a drip irrigation system can be more efficient generally only high-value crops are considered because of the high capital costs of installing a drip system[17].

PROPOSED DRIP CONTROLLER

HL drip value

The mechanical value of the drip controller uses a high and low flow. This valve is designed to flow the water either to the high or low side of the value. This value is powered by solar power along with soil sensors. Figure 2 shows the basic mechanical model for the High- Low (HL) drip value.

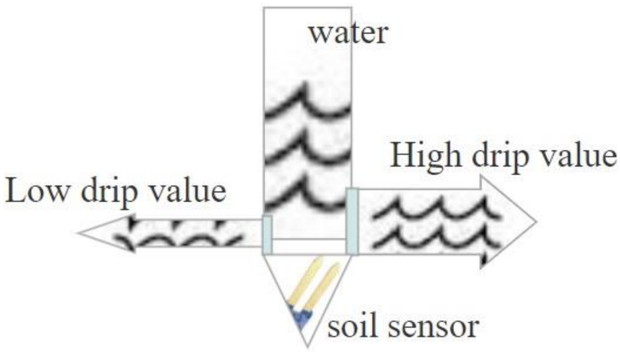

Figure 2. High- Low (HL) drip value.

Automatic Drip controller

Properly managed drip irrigation can increase horticulture and plantation crop productivity [18]. Improper water runoff at the root zone can result in deep percolation losses. The Automatic drip controller is a microcontroller-based embedded system, designed to automate the process of drip irrigation in the root zone using the sensor. The hardware implementation is the primary design and command programming languages based instructions are implemented for the hardware part of the dripper. The primary design of the embedded drip controller consists of the Arduino which is an open-source microcontroller platform and provides easy-to-use fast prototyping hardware [8].

The Arduino peripherals are connected to the central processing unit. The display unit provides the communication from the microcontroller over the universal asynchronous receiver transmitter (UART). The motor driver is connected to pins 4 and 5 of the microcontroller. Pin 3 for the flowmeter flow meter. Timer3, vout pin, and DND pin of the microcontroller is used to provide the data to the display unit. The battery form 12 volts to 5 volts of power supply board is designed from the combination of battery and the solar panel unit. The hardware of the embedded drip controller has the following components microcontroller, dripper based on the Arduino Uno board with ATmega328P processor for prototype experiment. It has 20 digital input/output pins, a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. The prototype tool connected to a laptop with a USB cable [12].

The microcontroller is the heart of the system. It receives the inputs from the display module and calculates the irrigation parameters and accordingly instructs other peripherals to achieve successful irrigation. Figure 3 shows the Arduino Uno Board with ATmega328P microcontroller.

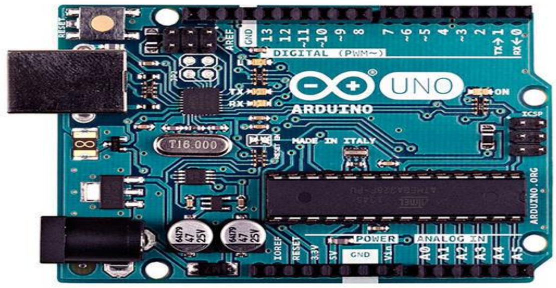

Figure 3. Arduino Uno Board with ATmega328P microcontroller.

The drip controller uses the Pololu DRV8835 Dual Motor Driver Shield for Arduino [9]. Its integrated DRV8835 dual motor driver allows it to operate from 1.5 V to 11 V, making it a great control option for low-voltage motors. The motor driver along with the corresponding microcontroller controls the two DC motors attached to the mechanical value of the drip controller for the high and low flow of water in the dripper automatically [13]. Figure 4 shows the Pololu DRV8835 Dual Motor Driver Shield for Arduino.

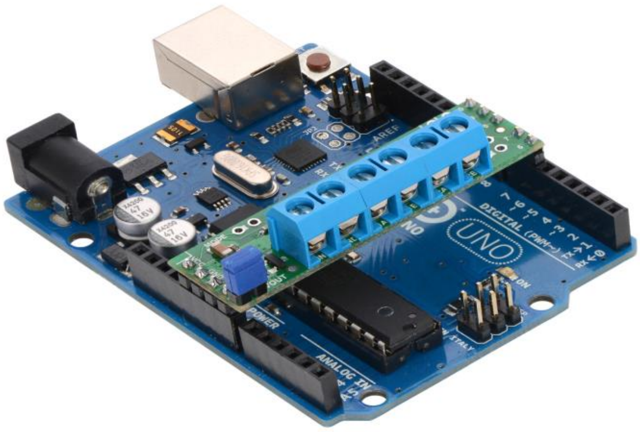

Figure 4. Pololu DRV8835 Dual Motor Driver Shield for Arduino.

The Drip controller uses a 12 Volt 7.5 Amp hour lithium iron phosphate (LiFeP) battery. The solar panel provides 14V 180 milliamps output in full sun which provides current to the system as well as charges the battery [10]. During night time or when the solar panel does not provide the required current, the system receives the current from the battery. The sensor is used to measure all parameters of the soil with the following specification Soil temperature, humidity, and electric conductivity. The Arduino IDE is used to write the commands for the drip controller. Universal Serial Bus (USB) is connected to compile the Arduino Uno board [11].
The embedded drip performs many operations while running irrigation, such as soil, battery voltage, calculates the irrigation parameters, the valve for high and low water flow, displays the operation of the microcontroller to the user, and stops the irrigation once it is completed [12]. The proposed automatic drip irrigation system performs all these tasks using a single core Arduino based microcontroller with real-time operating system Free RTOS [14].

Working of Automatic Drip Irrigator System

The automatic drip irrigator controller switching on the powers through the remote controller. The software running on the Arduino microcontroller to start the dummy task. The dummy task check where the system battery voltage and if the voltage is adequate for control the drip process then starts the system and checks the event was interrupted previously. If the voltage is inadequate, the system shuts down automatically.

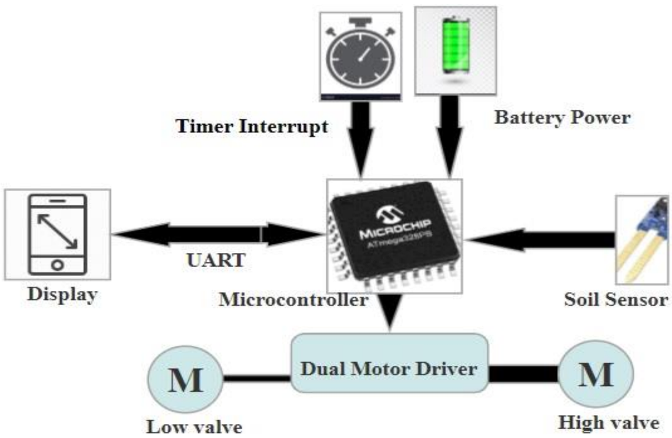

Figure 5. Architecture of Embedded Drip Irrigator.

The primary value task starts with the display module. The parameters include the time for a plant, the drip cycles, the ratio of the high flow and low flow water are calculated based on the Arduino IDE commands.

Table 1. Network Interface Specification.

Measurements	Range in ZIGBEE Network
Radio Interface	Prototype : up to 25m Field(outdoor) : up to 100m Signal transfer : 250kbps at 2,4GHz
Electrical characteristics	Supply power: 2,8 to3,3V Transmit current: 50mA (3,3V)

Table 1 shows the specification range of the ZigBee network interface this network interface was able to transmit data without packet loss up to the distance 100m in the speed of 250kbps at 2,4Ghz [16]. In the end, the system confirms with the sensor for the entered parameters. The prototype model results are discussed in the next section.

EXPERIMENTAL RESULTS

The presented preliminary prototype field experiment of soil sensor-based automated drip irrigation system was conducted in Vellore, Tamil Nadu, India, the experiments were conducted with the fully charged battery. The sensor was primarily installed in 60cm depth in the dry soil field. The soil model was stored in a covered area for two weeks without any addition of water. The measurements were obtained for 24 hours in the field. The drip with sensor-based automatic embedded based system intents to use of efficient water resources in the horticulture and plantation crop results are shown in the following section.

Figure 6. Drip Irrigation System with HL Value.

The data was transmitted to the microcontroller through sensors and provide water irrigation process as per the irrigation task based on the environment and the soil. The prototyping hardware and software developed with open source experiments are evaluated with several kinds of soil samples. The results have been compared to other measurements procedures and techniques.

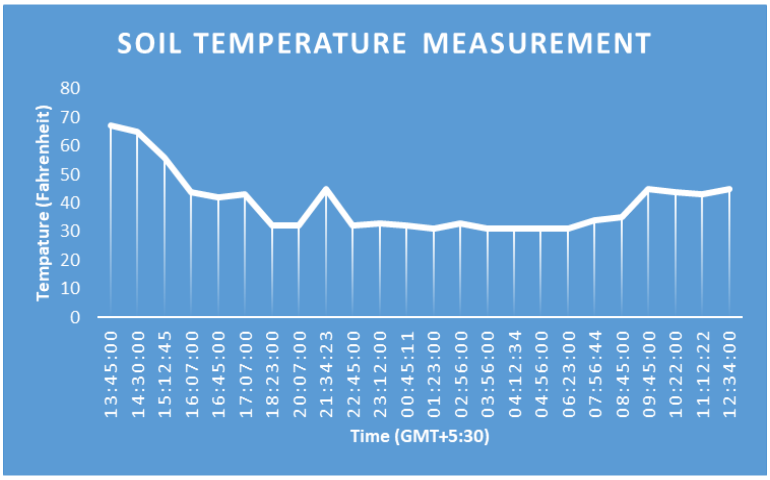

Figure 7. Soil Temperature through Sensor.

In the sample field, a soil sensor was initially installed in 60cm depth and fixed the drip irrigation system. At 13:45:00 the irrigation process stated with a charged battery. The display module provides the process of a microcontroller. The proposed HL drip value with a sensor provides the temperature in a day. The detailed graph of soil during the testing shows in figure 6. The drip value has automatically switched on based on the temperature. The HL drip value swap between high and low with the water level is monitored using the network interface shows in figure 7.

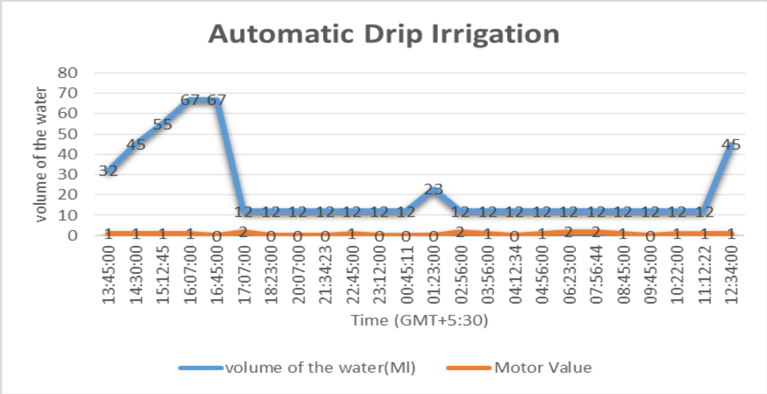

Figure 8. High- Low (HL) drip value running process.

In feature the functionality needs to be added in the system so, the microcontroller to be bidirectional data transfer with database storage for better performance. The new HL value with a sensor drip controller works with excellent output. The current hardware and software setup is well suitable for the less human resources in the horticulture and plantain crop.

CONCLUSIONS

In this research paper, the remote sensing drip controller that automates the process of water irrigation was designed, developed, and tested. The designed new drip controller with two values with an embedded control system that uses the Arduino Uno board. The software programming of the system was developed using the Arduino programming language that uses the real-time operating system to achieve multitasking. The HL dripper triggered the task from high to low as per the soil sensor data collection in the field using a network interface. The components providing expected results in a remote location using limited resources. These features may be useful in automating and monitoring water irrigation in horticulture and plantation crops during the COVID-19 pandemic period.

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