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Automated Irrigation with Deterrent System

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***Abstract*— The automatic plant irrigation system presented in this project addresses critical challenges in agriculture by leveraging sensor technology and automation to enhance efficiency and reduce manual labor. By integrating soil moisture sensors, the system autonomously monitors and manages irrigation, ensuring plants receive water precisely when needed, thereby optimizing water usage and promoting plant health. This technological advancement not only relieves farmers from the laborious task of manually controlling irrigation but also contributes to sustainable farming practices by reducing water wastage. Furthermore, the system incorporates an innovative automatic deterrent mechanism aimed at minimizing pesticide use. By deploying this system, harmful pesticides are substituted with environmentally friendly deterrents, thereby promoting ecological balance and reducing the health risks associated with pesticide exposure.**

***Keywords*—** *Arduino Nano, Soil moisture, Pump, Ultrasonic sensor, LCD display, Stepper motor.*

I. INTRODUCTION

Agriculture stands as the backbone of India's economy, providing livelihoods to a vast majority of its population. Over the past decade, there has been notable progress in crop cultivation; however, this growth has been tempered by challenges affecting crop quality and yield. Issues such as water scarcity, soil degradation, improper fertilizer usage, changing climatic patterns, and crop diseases are significant contributors to declining crop standards and consistent food pricing pressures. Effective agricultural interventions are crucial to address these challenges and enhance productivity sustainably. One promising solution lies in leveraging IOT (Internet of Things) technology integrated with wireless sensor networks. IOT facilitates the interconnection of diverse devices and systems, enabling real-time data collection and analysis across agricultural operations. This integration aims to ensure timely and accurate information dissemination, empowering farmers with actionable insights for decision-making.

In the context of agriculture, one critical area IOT can revolutionize is irrigation management. Given the unpredictable nature of rainfall, IOT-enabled systems offer precise monitoring and control of water distribution. This capability not only optimizes water usage but also mitigates the risks associated with irregular rainfall patterns, thereby promoting crop health and yield stability.

By harnessing IOT technologies in agriculture, India can foster sustainable farming practices, improve crop quality,

and bolster food security amidst evolving environmental and economic challenges. This approach not only supports the Livelihoods of millions but also strengthens the resilience of the agricultural sector in the face of future uncertainties.

II. LITERATURE SURVEY

Labor Cost Reduction in Agriculture through Smart Irrigation Systems: A Study. Journal of Agricultural Engineering A study conducted by Liu et al. (2018) found that smart irrigation systems reduced labor costs by up to 70% compared to traditional irrigation methods.

The study showed that the use of automation and remote monitoring in smart irrigation systems reduced the need for manual labor and improved the efficiency of irrigation operations. Included in our project for Enhancing Agriculture using Microcontrollers, automatic deterrent systems are designed to protect fields, gardens, and other outdoor areas from animals and humans [1].

Development of an Automatic Irrigation and Deterrent System Using Arduino Microcontrollers. Journal of Agricultural Engineering and Automation, This system uses the Arduino UNO processor for control. A soil moisture sensor measures soil moisture, displaying the percentage on an LCD screen. If moisture falls below a threshold, the controller activates a 5V DC water pump via a ULN2003 motor driver circuit to irrigate the field [2].

III. REQUIRED COMPONENTS

The Arduino Nano is a compact and versatile microcontroller board built around the ATmega328 (Arduino Nano 3.x), designed specifically to be user-friendly on breadboards. It offers a comprehensive range of functionalities akin to traditional Arduino models, albeit packaged in a smaller format. Notably, it does not include a DC power jack, opting instead to utilize a Mini-B USB cable for both power supply and data communication, which enhances its flexibility and ease of integration into various projects. Due to its diminutive size, the Arduino Nano is particularly suited for applications where space is limited but robust microcontroller capabilities are essential. Despite its compact design, it retains the core features that make Arduino boards popular among hobbyists and professionals alike, such as digital and analog I/O pins, PWM outputs, UART communication, and SPI capabilities. These attributes make it well-suited for a wide array of projects ranging from simple DIY electronics to more complex embedded systems.

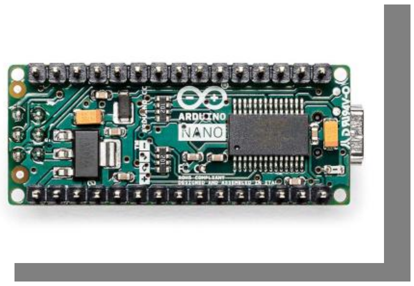


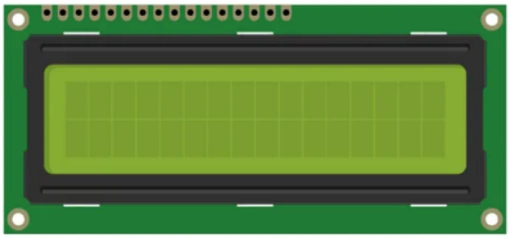
Figure 1: Arduino Nano

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. Ultrasonic sensors can measure the distance to a wide range of objects regardless of shape, colour or surface texture. They are also able to measure an approaching or receding object. Ultrasonic sensors can measure the distance to a wide range of objects regardless of shape, colour or surface texture. They are also able to measure an approaching or receding object.

Figure 2: Ultrasonic Sensor

The term LCD stands for Liquid Crystal Display that uses a plane panel display technology, used in screens of computer monitors & TVs, smartphones, tablets, mobile devices, etc. Both the displays like LCD & CRTs look the same but their

operation is different. Instead of electrons diffraction at a glass display, a liquid crystal display has a backlight that provides light to each pixel that is arranged in a



rectangular network. In simpler words it is an electronic device that is used to display data and the message. In this project, we have used LCD 16x2, with a 12c module, as the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots. So, the total pixels.

within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

Figure 3: 16*2 LCD Display

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Using I2C (Inter-Integrated Circuit) with an LCD (Liquid Crystal Display) offers a streamlined method of communication between a microcontroller and the display module. Unlike traditional parallel interfaces that require multiple data and control lines, I2C simplifies wiring by utilizing just two lines: SDA (Serial Data Line) for bidirectional data transfer and SCL (Serial Clock Line) for synchronization. This reduction in pin count is particularly advantageous in projects where minimizing hardware complexity and conserving microcontroller I/O pins are priorities. To connect an LCD via I2C, a specialized I2C backpack or module is typically employed, which acts as an intermediary, converting between the I2C signals from the microcontroller and the parallel interface expected by the LCD. Each LCD connected to the I2C bus is assigned a unique 7-bit address, allowing the microcontroller to selectively communicate with specific devices on the network. While I2C facilitates efficient communication and resource optimization, considerations such as bus capacitance, addressing conflicts, and potential speed limitations need to be managed to ensure reliable operation in diverse electronic projects.

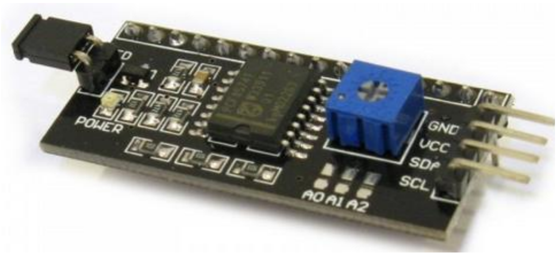

Figure 4: I2C Converter

A soil moisture sensor is an electronic device that measures the amount of moisture present in soil. These sensors are used in a wide range of applications, including agriculture, environmental monitoring, and research. The most common type of soil moisture sensor is the resistive sensor. Resistive sensors work by measuring the resistance of a circuit that is affected by the moisture in the soil. When the soil is wet, it conducts electricity better than when it is dry. This change in conductivity can be used to measure the moisture content of the soil. Resistive sensors consist of two metal probes that are inserted into the soil. The resistance between the probes is measured using a microcontroller or other electronic device. The resistance can be converted into a measurement of soil moisture using an algorithm that takes into account the properties of the sensor and the soil being measured.

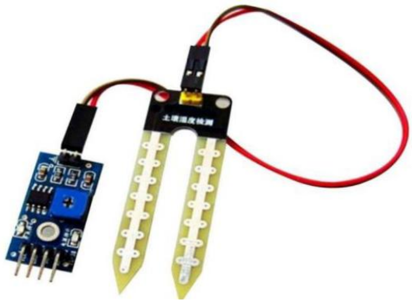

Figure 5: Soil Moisture Sensor

In simplest terms, a piezo buzzer is a type of electronic device that's used to produce a tone, alarm or sound. It's lightweight with a simple construction, and it's typically a low-cost product. A piezo buzzer works by applying an alternating voltage to the piezoelectric ceramic material. The introduction of such an input signal causes the piezo ceramic to vibrate rapidly, resulting in the generation of sound waves.

Figure 6: Buzzer

Using a 5V stepper motor in conjunction with a microcontroller involves understanding the principles of stepper motor control and the specifics of interfacing it with the microcontroller's output capabilities. Stepper motors are electromechanical devices that rotate in discrete steps, making them ideal for applications requiring precise positioning or continuous rotation controlled by a sequence of pulses. Firstly, stepper motors typically require a driver circuit to interface with a microcontroller.

Figure 7: Stepper Moter

IV. SIMULATION FOR THE SYSTEM

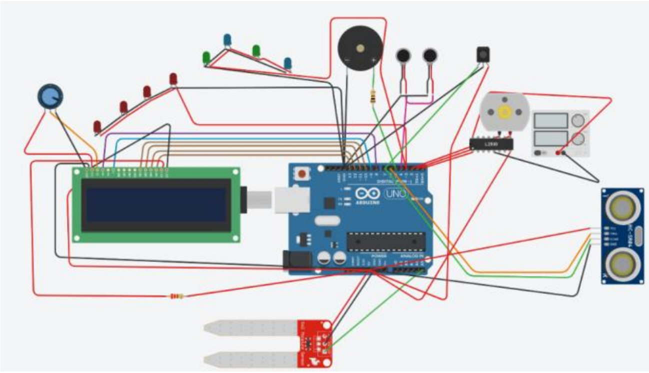

Figure 8: General simulation for irrigation system and deterrent system

The figure above depicts the functioning of the automatic irrigation system and the automatic deterrent system. As the given actions are in a while loop, the following actions keep functioning all the time. For the automatic irrigation system, we first start of by mapping the moisture value obtained by the soil moisture sensor to the appropriate percentage value. If the moisture is within the threshold value, the command given is to print the moisture percentage value on the LCD display. However, if the moisture is not within the threshold value, the command given is to activate the pump, to pump the water.

For the automatic deterrent system, we first send a trigger pulse on the ultrasonic sensor. We then wait to check if an echo pulse has been received. If no echo pulse is received, a trigger pulse is sent again. If an echo pulse is received, the distance of the object is calculated. If the distance of the object is less than 12cm, we call for a specific action to take place. If the distance of the object is more than 12cm, a separate action takes place. After the implementation of both the actions, we go back to sending a trigger pulse on the Ultrasonic Sensor [3].

V. HARDWARE INTERFACE

Figure 9: Miniature Agricultural Field

Figure 10: 16*2 LCD Display to learn about the moisture and pump status.

Figure 11: Ultrasonic sensor and water level sensor for deterrent system and sensing the moisture of soil to be displaye

VI. CONCLUSION

One of the paramount advantages inherent in a smart irrigation system lies in its capacity to conserve water resource. By customizing irrigation schedules to align precisely with the distinct requirements of crops, the system mitigates water wastage and mitigates the peril of both over- and under-irrigation. This not only results in water conservation but also diminishes energy consumption and associated expenditures. Furthermore, the smart irrigation system yields substantial benefits in terms of crop yield and quality. By administering precise quantities of water at optimal intervals, crops can absorb nutrients efficiently, promoting robust growth and health. Consequently, this can culminate in elevated yields and superior-grade produce, thereby potentially augmenting profits for farmers. Another significant advantage of the smart irrigation system is its capability to continually monitor real-time soil moisture levels and weather conditions. This empowers farmers to make informed decisions regarding irrigation scheduling, irrespective of their physical presence on the farm.

Following comprehensive research and rigorous testing, it is unequivocally concluded that an automated deterrent system employing ultrasonic sensors, LED bulbs, and buzzers constitutes an efficacious solution for detecting and deterring snakes and rats in agricultural fields. Ultrasonic sensors adeptly identify the presence of snakes and rats by emitting high-frequency sound waves that rebound off nearby objects and subsequently return to the sensor. This facilitates the detection of diminutive creatures concealed within grass or undergrowth. Upon detection of a snake or rat, the system promptly activates LED bulbs and buzzers, emitting intense flashes of light and loud noises known to deter these animals effectively. This dual approach, utilizing both visual and auditory stimuli, ensures that the animals are deterred comprehensively and deterred from revisiting the area. The system is meticulously engineered to operate at peak efficiency.

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