Report for Capstone Project:
Soil State Indicator & Automated Irrigation System
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Abstract— *Being an agriculture-prior country irrigation is the most important part of our farmer's life. But they face a lot of confusions and difficulties regarding it, most of them do not know how much water the soil needs based on it's moisture and they sometime overdo the irrigation process which not only hampers the moisture level of soil but also wastes electricity. To ease the irrigation process and save electricity the soil state indicator and automated irrigation system is created. There are many automated irrigation system but this system does not contain any complex system and make the process operate easy for the betterment of the farmers. This system uses Arduino board, which consists of ATMega328 Microcontroller. It is programmed in such a way that it will sense the moisture level of the soil and supply the water as per required. The system automation is designed to be assistive to the user.*

Keywords- Arduino, Moisture Sensor, Automated Irrigation.

I. INTRODUCTION

The most important sector of Bangladeshi economy is agriculture, contributing 19.6 percent to the national GDP and providing employment for 63 percent of the population. But the farming method remains the same as the ancient ones. Most of the farmers are not comfortable with the emerging technologies. It is mostly because the usage of those technologies require some pre-hand knowledge of technology which most of the farmers lack. On the other hand, soil degradation is a major threat in food production. To get rid of this problem, soil needs to be hydrated properly, thus comes irrigation process. The quality of soil and harvesting mostly depend on the right moisture of the soil. Right amount of irrigation provides the right moisture of the soil making the soil fertile and thus harvesting good crops. But the process of irrigation is manual still, farmers wake up all night, watch the water pump and switch off the pump whenever they think the amount of water level is right. They do the process based on assumptions, the proposed system on the other hand gives a certain estimation of how much water the soil needs and automating the whole process to save energy and ease the farmer's work. The system uses Arduino Microcontroller and with the help of moisture sensor farmers can get the current moisture level of soil. The system then provides necessary amount of water to get the required moisture level and shuts itself down automatically making the process a lot easier and efficient for the farmers.

II. OBJECTIVE

The main objective of this project is to check soil moisture and supply the required amount of water to get the optimum moisture level. The whole process is an automated one, meaning the users do not have to worry about turning the motor off, the system will automatically turn off the motor of irrigation pump once the required volume of water is fulfilled.

III. PROPOSED SYSTEM

A soil state indicator and automated irrigation system using microcontroller ATMega328P-PU is programmed in such a way that it gives the interrupt signals to the motor via the relay. Soil moisture sensor is connected to the Arduino board which senses the moisture content present in the soil. Whenever the sensor is placed in the soil it measures the moisture content of the soil, the sensor senses the change, giving signal to the microcontroller so that the pump (motor) can be activated. Finally when the required water level

is reached the sensor sends signal to the microcontroller making the motor turning off, this is the proposed automated irrigation system.

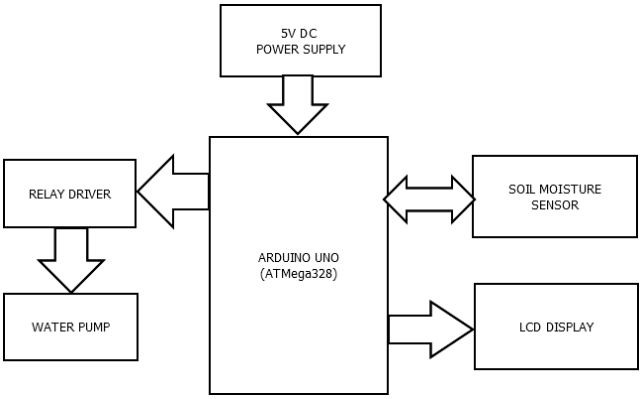

Fig.1: Proposed System Block Diagram

IV. MODULE / COMPONENT DESCRIPTION

ARDUINO

In fig.1 it is showing an Arduino board (ATMega328). Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on a computer, used to write and upload computer code to the physical board. Arduino language is merely a set of C/C++ functions.

Fig.2: Arduino UNO

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 tension-meters and gypsum blocks.

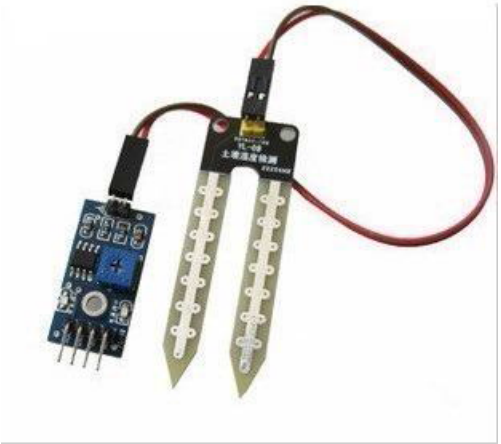

Fig.3: Soil Moisture Sensor

WATER PUMP

Water pumps are machines for moving water, they play a fundamental part in agriculture as they move water from its source to the fields and crops. Water pumps can be used with many forms of *irrigation*, such as drip, sprinklers or with a hose. But in this system the required pump is *Submersible water pump.* These pumps are lowered into the water. They have power cables and the outlet hose attached to the pump under the water, so these pump systems need to be water tight to work. These pumps push the water up from the pump's depth to the farm.

Fig.4: Water Pump

RELAY

Relay is an electrically operated switch. Several rel switch, however alternative in operation principles are used, like solid state relays. Relays are used wherever it's necessary to regulate a circuit by a separate low-power signal, or wherever many circuits should be controlled by one signal. The essential relays were handling in long distance communicate circuits as amplifiers, they unbroken the signal coming back in from one circuit and re-transmitted it on another circuit.

Fig.5: Relay Driver

LCD DISPLAY

Liquid Crystal Display (LCD) screen is an electronic display module. An LCD has a wide range of applications in electronics. The most basic and commonly used LCD in circuits is the 16x2 display. LCDs are commonly preferred in display because they are cheap, easy to programme and can display a wide range of characters and animations. A 16x2 LCD have two display lines each capable of displaying 16 characters. This LCD has Command and Data registers. The command register stores command instructions given to the LCD while the Data register stores the data to be displayed by the LCD.

Fig.6: 16x2 LCD Display

TEST SETUP

Below all assembled components are shown for the simulation purpose-

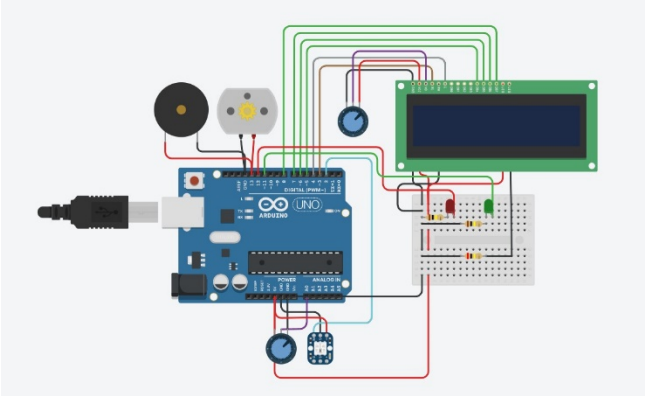

Fig.7: Setup for Simulation

For test setup simulated approach is followed. For this reason some components are replaced to that of simulated version. The components used for simulation are below-

1. Arduino UNO
2. LCD 16x2
3. Resistors – 3pcs
4. LEDs – 2pcs
5. Potentiometer – 2pcs
6. DC Motor
7. Piezo
8. NeoPixel

Here, Piezo is an electronic device that generates a voltage when it's physically deformed by a vibration,

sound wave, or mechanical strain. Similarly, when you put a voltage across a piezo, it vibrates and creates a tone. Piezos can be used both to play tones and to detect tones. In the simulation, we are replacing the relay driver with potentiometer and resistor and for moisture sensor we are building a circuit to simulate the work of an actual moisture sensor. The rest of the components are same for both experimental and simulated approach.

COST ANALYSIS

Estimated cost of the components are stated below for the experimental setup-

1. Arduino UNO - 400 Taka
2. Moisture Sensor - 150 Taka
3. 16x2 LCD Display - 160 Taka
4. DC Source - 40 Taka
5. Relay Driver - 180 Taka
6. Motor Pump - 450 Taka

Here, motor pump's price can vary according to its use. So, total estimated cost is around 1380 Taka.

V. RESULTS & DISCUSSION

Dedicated Arduino code is written for measuring the soil moisture. The flowchart for the program is shown Fig-8. Calibration of the sensors were made with reference to the data sheet and verified with the standard measurements. Fig.7 shows the simulated prototype of the system. In order to measure accurate parameters Arduino is powered by 5V from computer or a battery. If the magnitude of the voltage is reduced, the accuracy of the results will be affected. Arduino code measures multiple samples in the required time and displays the average values in LCD display.

Table.1: Recorded Data

Sample	Soil Moisture (%)
Sample 1	40
Sample 2	65
Sample 3	55

For moisture above 70%, water is not needed but if the moisture level is below 70% water is needed for balancing the moisture of soil.

Flowchart

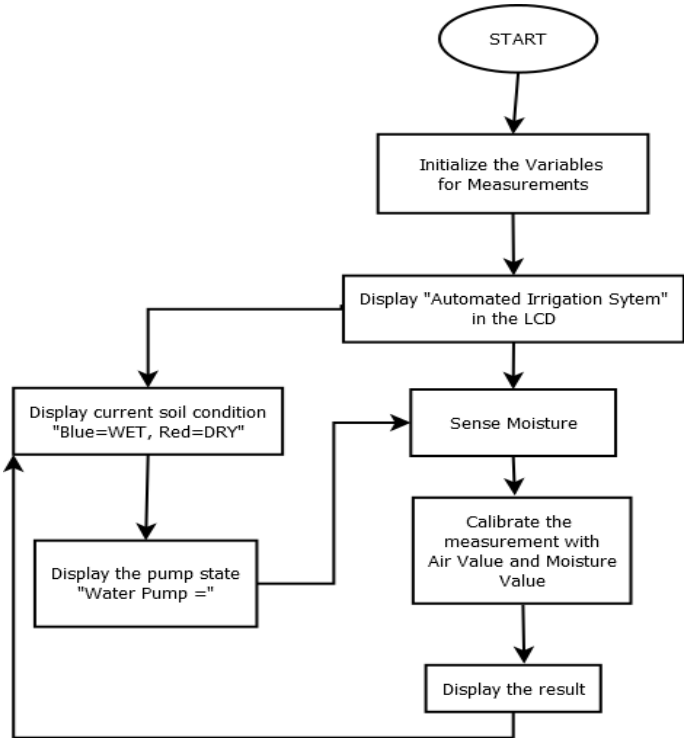

Fig.8: Flowchart for the System

VI. IMPACT ON SOCIETY & ENVIRONMENT

This project is a novel prototype module which can monitor soil moisture level and provide an automated irrigation system. Best part of this is it can be used by the farmers whenever and wherever they want. Simply we can say that this is an approachable real time field monitoring system. The microcontroller circuit has been developed with less number of components and is highly reliable and affordable. After verifying the data that was shown in display, assured about the success of the project. As ours is an agriculture based country the farmers need to be introduced to more latest technologies to make their effort efficient and easier, perhaps most importantly to ensure the quality of the crops because crops depend mostly on the soil quality. This is an eco-friendly project, with that being said it causes no harm to the environment keeping the ecosystem balanced.

VII. CONCLUSION / FUTURE SCOPE

Scope for further work on the system will include different activities. The main point of interest will be, to evaluate the recorded data and compare it with high accuracy systems. Since it an automated system, it can be made more flexible by using solar energy. This greatly improves flexibility and manageability of the system. Furthermore, it allows to control the system from a central point wirelessly, without the need of field work which can be dealt as a future work. Another important issue is to implement a temperature sensor to increase precision and calibration of the moisture sensor. Overall, this prototype project gives an overview of how it can be integrate into much larger system and can be in beneficial for society and our economy.

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