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IoT based Smart Irrigation and Tank Monitoring System

Sukriti[1], Sanyam Gupta[2], Indumathy K[3]

B. Tech, Department of Computer Science and Technology, Vellore Institute of Technology, Vellore, India [1,2]

Assistant Professor, Department of Computer Science and Technology, Vellore Institute of Technology, Vellore, India[3]

ABSTRACT: The Indian economy is based on agriculture - about 70% of its population depends on agriculture and it contributes to 1/3rd of the national income. Yet, being a country which has the capacity to produce three crops in a year, the ceaseless cases of farmer suicides has become an ignominious fact. The development of agriculture has much to do with the economic welfare of the country.Indian monsoon being erratic in nature, there is irregularity in the distribution of rainfall throughout the year. The irrigation system helps the farmers to have less dependency on rain water. Balanced irrigation has been considered essential for optimal development of crops. Superfluous irrigation leaches nutritive elements of the soil as water seeps down due to gravitational force of the earth. It also causes water logging. Similarly, scant irrigation can be harmful as water does not reach the lithosphere. Irrigation practices in India need constant monitoring. This paper focuses on reducing the water wastage by using smart irrigation. It discusses how Internet of Things (IoT) can be used to achieve optimal irrigation by continuously monitoring the water level. It also discusses how water supply can be maintained using the proposed mobile application.

KEYWORDS: Internet of Things; Arduino; irrigation; water tank; sensors; Wi-Fi module

I. INTRODUCTION

With India's population crossing 1.3 billion in 2016, a balance between the optimum population growth and a healthy nation is far to be achieved. Despite of being self-reliant in food production, starvation death is frequent in India. Water shortage in India is also a particularly acute crisis. Between 1947 and 1967 India underwent the Green Revolution, resulting in a huge increase in agricultural production, making India one of the world's biggest exporters of grain. Unfortunately, this huge surge in agriculture required significant water resources for irrigation and accelerated the onset of present water shortages.

This paper focuses primarily on reducing the wastage of water and minimizing the manual labour on field for irrigation. It provides an alternative to a primitive method of irrigation in which an alarm intimates a farmer when water reaches a certain level of the tank. The farmer then shuts off the alarm manually and closes the water inlet to stop the supply. Leakage of water from the tank or a damaged alarm can result in wastage of a valuable resource. The proposed system will allow farmers to continuously monitor the water levels inside the water tank and the moisture level in the field, controlling the supply remotely over the internet. When moisture goes below a certain level, sprinklers would be turned on automatically, thus achieving optimal irrigation using Internet of Things.

IoT helps organizations and individuals access information, facilitating major decision making processes. It revolves around increased machine-to-machine communication and reduced human-to-human or human-to-computer interaction. It refers to a wireless network between objects. It enables new forms of communication between people and things, and between things themselves. An object can be a physical device, building, vehicle, machinery etc. - embedded with electronics, software, sensors, actuators and network connectivity to collect and exchange data. Things are able to take actions on their own initiative; thus human-centric mediation role is eliminated. The Arduino board, a microcontroller, controls the digital connection and interaction between objects in the proposed system, enabling the objects to sense and act. The Wi-Fi module ESP8266 connected to Arduino contains TCP/IP stack which enables the microcontroller to access the Wi-Fi network. Also, with its powerful on-board processing, various sensors and other application specific devices can be integrated to it. The Arduino Integrated Development Environment connects to the Arduino to upload programs and communicate. In the proposed system, sensors detect the water and moisture level and

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send readings to a fixed access point, such as a personal computer, which in turn can access irrigation modules installed in the field or the physical module in the water tank, wirelessly over the internet. [4]

II. RELATED WORK

A. *TANK OVERFLOW CONTROL MODEL*

The tank overflow control model is a primitive method in which a wire is introduced at a desired water level inside the tank. When water reaches this level, it touches the open wire and completes a circuit resulting in an alarm to notify the farmer. The farmer then shuts off the alarm manually.In case of water leakage, the buzzer will never go off and the motor may keep running for a long duration, causing wastage of water and electricity. [6]

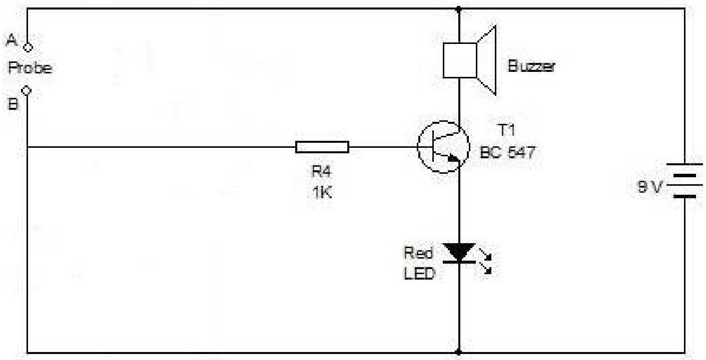

Fig. 1. Circuit of existing Tank Overflow Control Model

B. *IOT BASED AUTOMATED IRRIGATION SYSTEM*

This system uses a technique for irrigation in which the farm is periodically irrigated using a sprinkler, with a certain volume of water. The irrigation stops automatically once the given volume of water has been sprinkled. This system does not take the moisture content of the soil into consideration before irrigating it. This may result in the farm getting over irrigated if the moisture content of the soil is already high. [1]

C. *THE SOIL MOISTURE CONTENT MONITORING AND IRRIGATION SYSTEM CONTROL, WHICH IS BASED ON INTERNET OF THINGS*

This model calculates the soil moisture and irrigates the farm accordingly. The soil moisture content is not monitored continuously. Once water has been sprinkled, it doesn't check if the moisture content of the soil is sufficient.

III. PROPOSED SYSTEM

The proposed system allows users to continuously monitor the water level in the tank, remotely on a mobile application through internet. The mobile application can be used to shut the water supply automatically, irrespective of the physical location of the user, provided the user has internet connectivity. Thus the task of switching off the motor manually has been automated. The smart irrigation system can be installed in farms to monitor the moisture content of the soil continuously. It would turn on the sprinklers automatically when water content of the soil goes below a certain level. The user can check if the farm is well irrigated remotely on the mobile application, without visiting the farm. These systems would improve the livelihood of farmers extensively.

Extraction of high level information from raw sensory data is one of the most important aspect of IoT. The machine interpretable data is processed to obtain useful information, which is the basis of implementation of the proposed model. The Arduino board, a microcontroller, is the main component of the system. It controls the digital connections and acts as a bridge between the sensors and the mobile phone application. The Wi-Fi module connects the Arduino board to the hotspot providing access to the Internet. The Arduino board then transmits the readings to the mobile application over the Internet. The Wi-Fi module used is ESP8266. The ESP8266 provides internet to Arduino to facilitate communication between Arduino and Android device. The module consists of 8 I/O pins which are (TXD,

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RXD, CH_PD, GPIO0, GPIO2, GND, RST, and VCC). It should be provided with an external voltage of not more than 3.3V, to avoid heating. Before coding, the module should be flashed, to update the firmware with proper baud rate. It can be connected to Arduino's 3.3V pin or a separate 3.3V and 500mA supply. However, the Arduino works at 5V. If the TX and RX pin of Arduino and Wi-Fi are connected, the circuit may become unstable and get damaged. Hence, a battery eliminator is used to provide 3.3V to the Wi-Fi module and 5V to the Arduino.

Sensors measure the water level inside the tank and the moisture content of the soil. The HC-SR04 ultrasonic sensor is used for non-contact range detection. It can be used to determine the distance to an object. Its minimum range is 2cm and maximum range is 4m. It can be powered using a 5V DC power supply. Soil moisture sensor measures the moisture in the soil. It has 2 probes which act as a variable resistor. Higher water content in the soil results in better conductivity between the probes and a lower resistance.

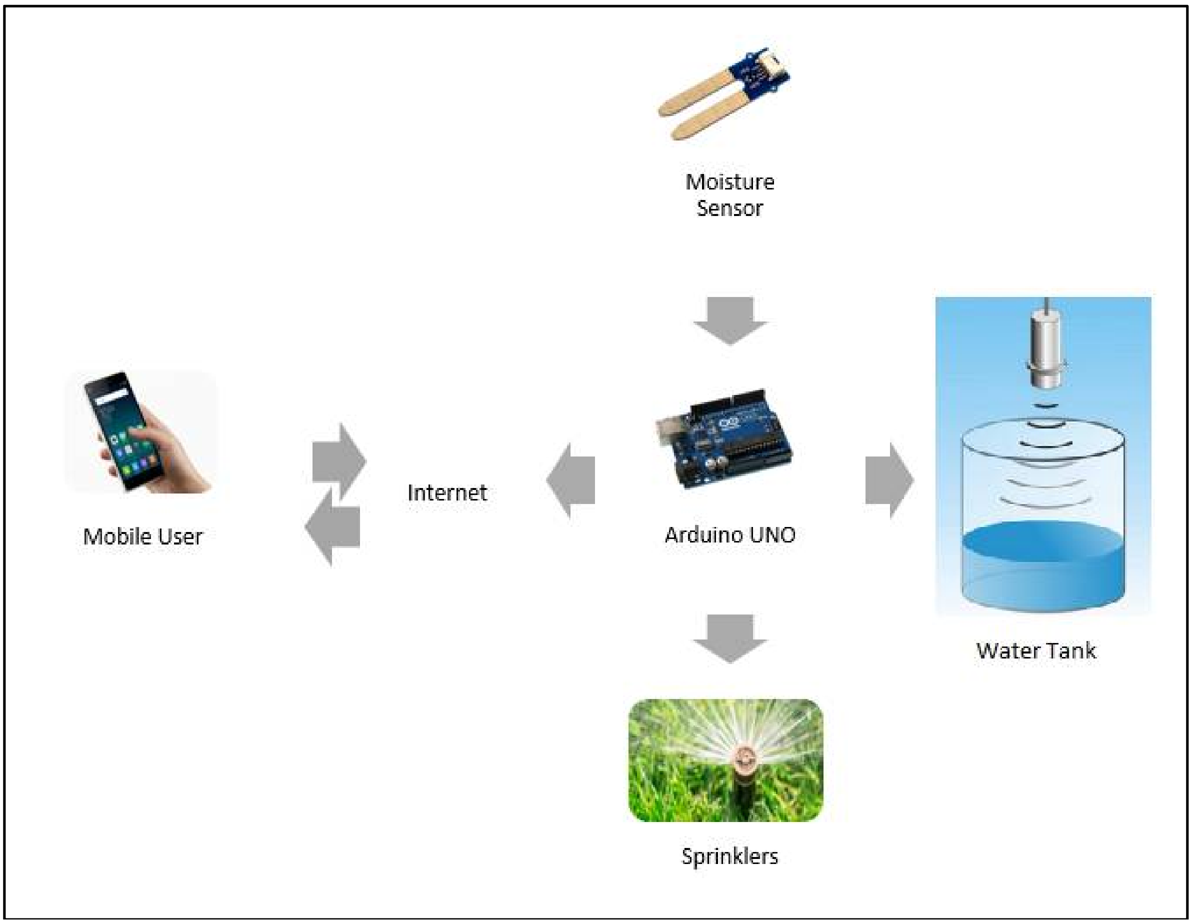

Fig. 2. Concept Sketch

IV. SIMULATION AND RESULTS

The circuit for soil moisture monitoring module consists of soil moisture sensor to measure moisture content of soil.Arduino board stores the code and provides input pins for the sensor. LEDs glow if soil moisture is below threshold value, indicating that sprinkler needs to be turned on. LCD is used to display the soil moisture content. Fig. 3. displays the various component of soil moisture monitoring module.

The circuit for tank monitoring module consists ultrasonic sensor to measure water level. LEDs glow till water level is below threshold value, showing a running motor for water inflow. Arduino board stores the code and obtains reading from ultrasonic sensors. LCD is used to display the water level. Fig. 4. shows the various components of tank monitoring module.The ultrasonic sensor is planted on top of the water tank and a floating pad is placed inside the tank.

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When the floating pad is at the bottom of the tank, the ultrasonic sensor calculates the depth of the tank. As the motor is switched on, the water level in the tank starts rising. The floating pad floats on top of water in the tank, indicating the water level. The ultrasonic sensor detects the distance of the floating pad periodically (every 1000ms) and changes are reflected in the mobile application. When the tank is full, the sensor notifies the system, which shuts down the supply of water automatically.

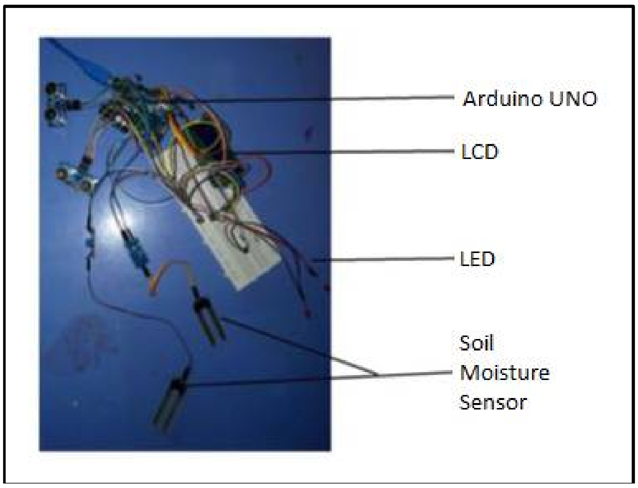

Fig. 3. Circuit for Soil Moisture Monitoring Module

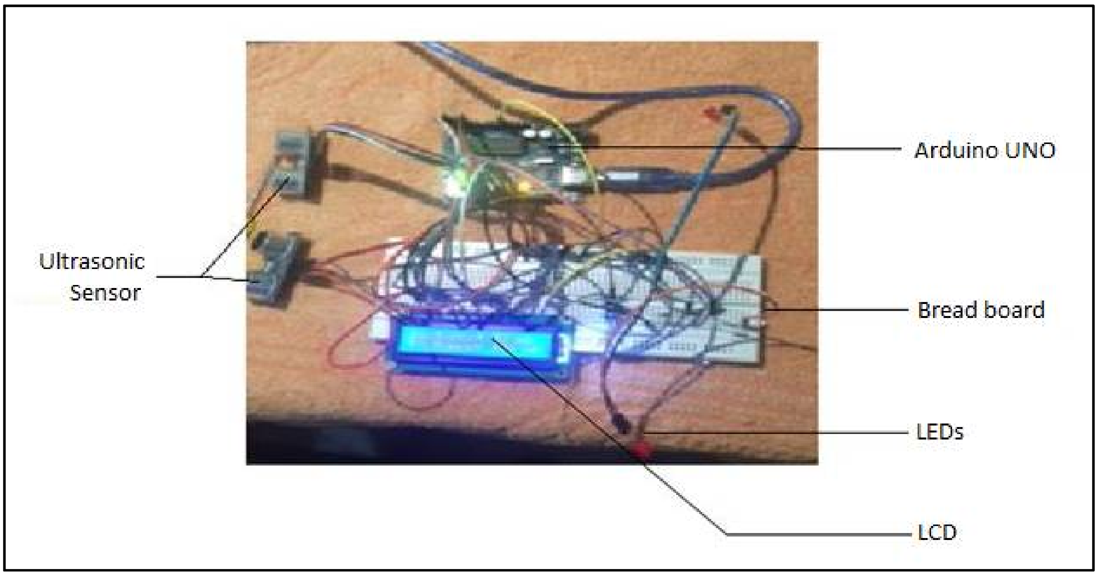

Fig. 4. Circuit for Tank Monitoring Module

Universal Asynchronous Receiver Transmitter (UART) is used for translation between serial and parallel data.The ultrasonic sensor and the soil moisture sensor provide data to the Arduino. This data is uploaded on the Blynk server. It can be seen on an Android device through the application. We used Arduino IDE for writing Arduino programs. For developing the mobile application, we used Android Studio.The application sends a request to the server. The server responds by giving the requested value, which can be seen on the application.The application displays the ultrasonic sensor reading and soil moisture reading as shown in Fig. 5.

LED starts glowing when the reading from the sensors falls below the threshold values.The threshold values for the soil moisture sensor is decided by the user. The soil moisture sensor monitors the water content in the soil continuously and warns the user if the value falls below the threshold. Also, the sprinklers are turned on automatically.

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The user can turn on the sprinklers manually as well.Ultrasonic sensor takes the reading of the water level inside the tank periodically. The user can check if the water motor is running. A warning notification is sent to the user and the LED glows when the difference between the height of the tank and the current water level is less than 10% of the total height of the tank.The prototype is lightweight and can be easily installed without hindering with its environment. The accuracy of the readings obtained is high. It reduces manual work of the user significantly.

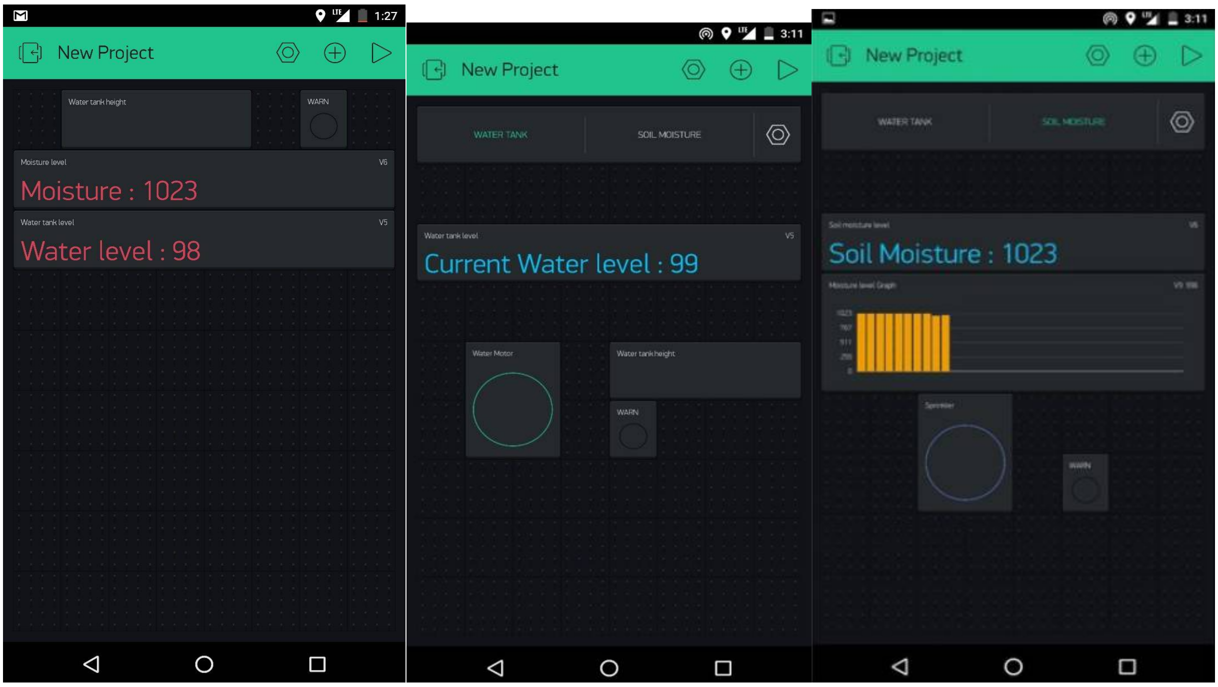

Fig. 5. Application User Interface

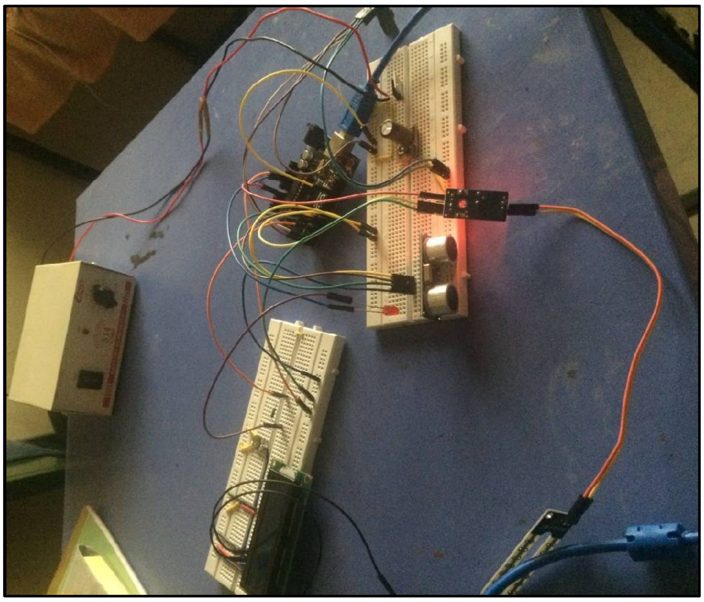

Fig. 6. Circuit for Smart Irrigation and Tank Monitoring System

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V. CONCLUSION

The proposed smart irrigation system will act as a boon by optimizing irrigation while addressing the issue of water shortage by inducing judicial use of water through innovative IoT based technique. The smart irrigation module can be modified according to the specific need of different crops. This data can be stored on the server. Based on the crop selected by the farmer on the mobile application, data would be retrieved from the server and the system would adjust itself accordingly, resulting in efficient irrigation and increased harvest.

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BIOGRAPHY

Indumathy K is an Assistant Professor in School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, India. She received B. Tech degree in Information Technology from Anna University in 2009 and M. Tech degree in Embedded Systems from Sastra University in 2011. Her research interests are Embedded Systems, Cryptography, IoT and Wireless Sensor Networks.

Sukriti is a Computer Science student pursuing B. Tech at Vellore Institute of Technology, Vellore, India. Her research interests are IoT, Algorithms and Machine Learning.

Sanyam Gupta received B. Tech degree in Computer Science and Engineering from Vellore Institute of Technology, Vellore, India in 2016. His research interests are IoT, Networking, Healthcare, Agriculture and Data Storage Management.