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IOT-Based Smart Irrigation System using DTMF and 8051 MCU

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Abstract: In almost every facet of agriculture and gardening, irrigation is the cornerstone activity, with the regular watering of plants and crops paramount to their growth and well-being. However, this essential task often proves burdensome for individuals preoccupied with daily commitments. For farmers, the significance of water supply is further emphasized, as rainwater assumes a critical role in sustaining their crops. While relying on the unpredictability of monsoon rains, canals, and groundwater resources, farmers face the challenges of ensuring a consistent and appropriate water supply, as each crop type necessitates distinct watering regimens. Any insufficiency in providing water to crops can lead to devastating consequences, resulting in the potential destruction of crops and plants. Addressing these challenges and aiming to revolutionize irrigation practices, this paper proposes an IOT-based Smart Irrigation System using DTMF (Dual Tone Multi-Frequency) and 8051 MCU (Microcontroller Unit) as an innovative and transformative solution. This cutting-edge system combines the power of DTMF technology with the versatility of the 8051 microcontrollers, enabling remote control and monitoring of the irrigation process. By leveraging the interactive capabilities of mobile or landline phones, the system allows users, including farmers and gardeners, to conveniently manage irrigation operations from a distance, reducing the need for constant physical presence. This intelligent irrigation system exhibits applicability in automating the irrigation processes of various settings, including gardens, nurseries, and greenhouses. By carefully regulating the water supply to plants based on specific predefined conditions, the system ensures the provision of an optimal and essential amount of water. As a result, the system achieves energy conservation while effectively mitigating any potential water scarcity issues.

Keywords: Smart irrigation system framework, Agriculture, Internet of things, DTMF.

I. INTRODUCTION

The Food and Agriculture Organization (FAO) asserts that small-scale farming plays a substantial role in bolstering rural economies and ensuring food security. However, smallholders often contend with a myriad of constraints that curtail their capacity to achieve profitability and foster economic progress[1].

In India, agriculture plays a pivotal role in the nation's economic growth, contributing approximately 17.8% as of 2022. The escalating demands of a growing population necessitate an increase in both the quantity and quality of food production. This surge in demand, coupled with the country's economic growth, drives intensive agricultural production. The adoption of Internet of Things (IoT) technology is catalyzing economic mass production in the agricultural sector [2]. By providing a versatile platform, IoT is revolutionizing the agricultural industry, enabling the seamless integration of various tools to address diverse challenges faced by farmers in the field. IOT connectivity facilitates real-time monitoring and management of farms, empowering farmers to remotely access and control their agricultural operations from anywhere and at any time. Extensive research is being conducted in various agricultural sectors, leveraging IoT technology to improve irrigation management, soil health management, precision farming techniques, livestock monitoring, and Blockchain integration in agriculture.

II. LITERATURE SURVEY

In recent years, there has been growing interest and research attention directed towards harnessing the potential of the Internet of Things (IoT) to enhance various aspects of agriculture. Among these, one significant focus area has been the application of IOT in achieving precise irrigation and effective water management in agricultural practices. In the study presented by the authors in reference [3], a novel approach to precision farming was introduced. This approach involved the integration of IoT technologies to monitor and control critical environmental factors, such as temperature, humidity, sprinkler water flow, and soil moisture levels. By deploying IoT enabled sensors and devices, the system aimed to provide real time data and insights, enabling farmers to make informed decisions regarding irrigation schedules and water application strategies.

The use of IoT in precision irrigation has the potential to optimize water usage, reduce wastage, and improve overall crop productivity by tailoring irrigation practices to the specific needs of each crop and its growth stage. This advancement in agricultural technology holds promise for enhancing water efficiency and sustainability, while simultaneously contributing to improved crop yields and resource conservation in the context of modern agriculture. The researchers in [4] proposed a design methodology that allows for the remote control of multiple water pumps distributed across a specific agricultural site. In their work, they specifically considered a scenario involving four pumps. The paper provides a comprehensive electronic design and simulation results at different stages of the system's development. The electronic design is based on discrete passive and active electronic components, ensuring practical implementation. The researchers utilized the Multism program for system testing and simulation, which allowed for a thorough evaluation of the proposed design's performance. The simulation results demonstrated the system's capability to effectively control the switching state of the motors. The DTMF commands employed in the study enabled the precise switching ON/OFF of specific motor pumps or all of the four motors, providing a flexible and efficient means of remote pump control. Overall, the presented research highlights the successful application of the DTMF technique in the context of agricultural pump control, offering a viable and practical solution for remotely managing multiple water pumps. The integration of artificial intelligence (AI) techniques for monitoring and decision support, in conjunction with the Internet of Things (IoT) and communication systems, has paved the way for the development of sophisticated smart agriculture assistance systems [5-6]. Researchers have proactively developed mobile applications to establish seamless communication channels for transmitting sensor data collected from the agricultural field [7]. In the domain of plant disease prediction, a multitude of machine learning algorithms have been employed, exhibiting promising results in accurately forecasting and diagnosing various plant diseases. Additionally, the synergy between IoT and AI has led to the creation of robust surveillance systems that leverage AI-driven techniques for real-time monitoring and early detection of potential issues in agricultural settings [8].

The implementation of AI, IoT, and communication technologies has unlocked new possibilities for revolutionizing agriculture, enhancing productivity, and ensuring sustainable resource management. Smart agriculture assistance systems harness the power of AI to analyze large volumes of data from IoT-enabled sensors, providing actionable insights to farmers and decision-makers. The real-time data captured through mobile apps facilitates swift communication between farmers and the smart system, enabling timely responses to changing environmental conditions and crop health. Machine learning algorithms applied to historical and real-time data enable the accurate prediction of crop diseases, allowing for proactive disease management strategies and optimized use of agricultural inputs.

Moreover, IoT-based surveillance systems, underpinned by AI techniques, offer continuous monitoring of crucial parameters such as soil moisture, temperature, and humidity, thereby enabling the detection of anomalies and potential crop stress. The real-time alerts and decision support provided by these systems aid farmers in optimizing irrigation, nutrient application, and pest control measures, leading to improved crop yields and resource efficiency.

III. PROBLEM STATEMENT

In the context of modern agriculture, farmers face challenges in efficiently managing irrigation activities while minimizing physical involvement, especially in situations where there is a risk of contagion spread or other health hazards. The need for constant physical monitoring and intervention in irrigation practices poses significant risks to farmers' health and agricultural productivity. To address these challenges, we propose the development of an IoT-based Smart Irrigation System using DTMF and 8051 MCU. The primary goal of this system is to enable automated and safe irrigation processes, reducing the need for direct physical contact with crops while ensuring optimal water supply for their growth. Additionally, the system aims to monitor crop development, providing farmers with valuable insights and control over irrigation practices remotely. By achieving this, the proposed system seeks to enhance agricultural productivity, minimize health risks for farmers, and foster sustainable irrigation practices in modern agriculture.

IV. PROPOSED METHODOLOGY

The methodology of this project revolves around the utilization of the Dual Tone Multi-Frequency (DTMF) tone command, which enables the remote control of various electrical loads, including agricultural pumps, domestic appliances, and industrial equipment. This approach offers a practical and efficient solution to address the challenges of manual load operation, particularly in scenarios where the loads are spread over large areas, such as industrial setups and agricultural fields. In industries, operating loads that are dispersed across extensive factory floors or production facilities can be a laborious and time-consuming task for workers. The need to physically access different locations to switch ON/OFF various loads can lead to inefficiencies, increased effort, and potential delays in operations.

Similarly, in agricultural fields, farmers often face difficulties in managing irrigation pumps and other electrical loads that are spread across vast areas. Manually controlling these loads can be tiring and impractical, especially when real-time adjustments are required.

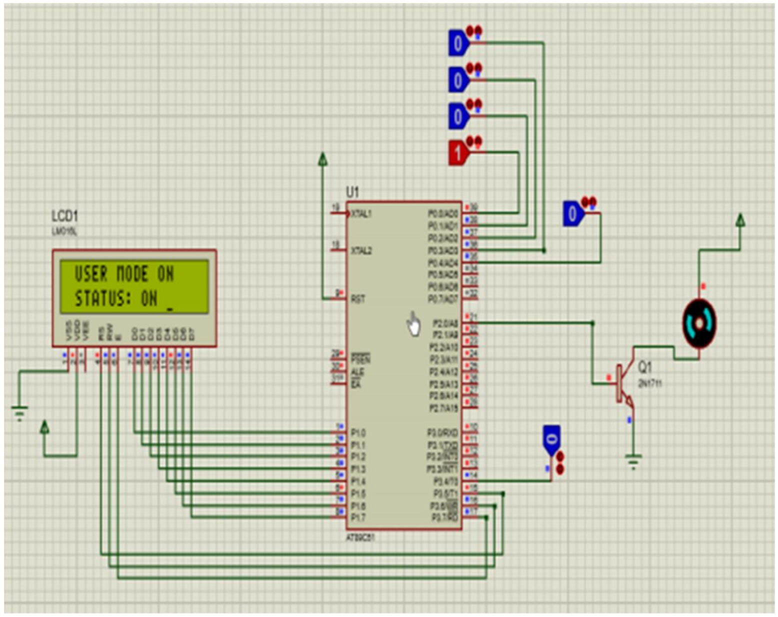

Figure1. Proposed IOT architecture in proteus.

To address these issues, the proposed system as show in in figure 1. incorporates DTMF technology, commonly used in telecommunication systems, to provide remote control functionality. The system involves interfacing a cell phone to a DTMF decoder, which can decode DTMF tone commands received from the phone's audio output socket. These tone commands are typically generated by pressing keys on the phone's keypad while making a call or sending a message. The DTMF decoder analyzes the frequencies of the received tone commands and converts them into equivalent digital codes. These digital codes are then fed to a microcontroller from the 8051 family, which acts as the central processing unit of the system. The microcontroller serves as the core intelligence of the setup, responsible for interpreting the received digital codes and generating appropriate signals to control the electrical loads.

Based on the commands sent from the sender's mobile phone, the microcontroller initiates the actuation of specific loads by activating the corresponding relays.

A relay driver IC interfaces with the microcontroller and the relays to ensure seamless control. The relays, which are electromechanical switches, serve as intermediaries between the microcontroller and the electrical loads. When the microcontroller activates a relay, it either connects or disconnects the electrical load, effectively switching it ON or OFF.

Through this mechanism, users can conveniently control various electrical loads from their mobile phones. By simply dialing or sending specific codes through DTMF tones, they can remotely operate pumps, appliances, or machinery, eliminating the need for physical presence near the loads.

This remote control capability offers numerous advantages, including improved efficiency, reduced manual effort, enhanced safety, and real-time load management. In industrial settings, the proposed system streamlines load operation, enabling workers to remotely manage equipment and machinery from centralized control stations or even from their personal mobile devices. This minimizes the need for extensive physical movement and facilitates rapid responses to operational requirements. Similarly, in agriculture, the system empowers farmers to remotely control irrigation pumps and other electrical loads across vast agricultural fields. By accessing their mobile phones, they can turn pumps ON/OFF based on crop water requirements or environmental conditions, optimizing water usage and ensuring efficient irrigation.

The proposed Smart Irrigation System using DTMF and 8051 MCU presents an intelligent and practical approach to address the challenges associated with manual load operation in industrial and agricultural contexts. The integration of DTMF technology with the 8051 microcontroller enables seamless remote control of electrical loads, paving the way for enhanced productivity, convenience, and energy efficiency in these domains.

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V. RESULTS

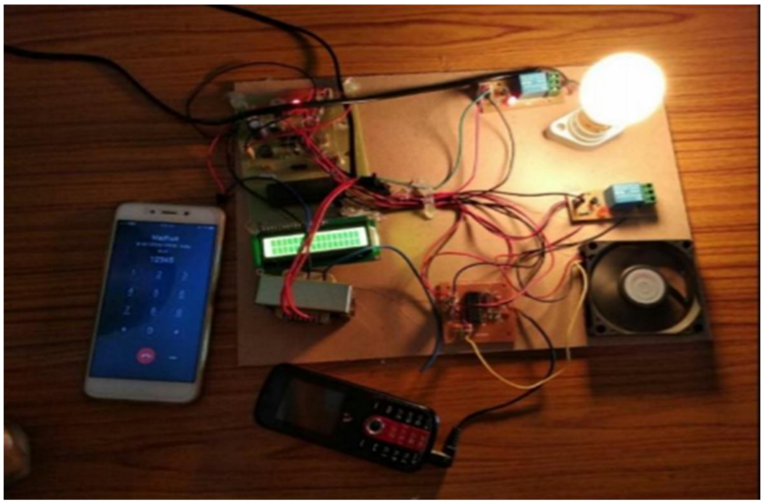

Fig 2.Constructed hardware for the proposed IOT system.

Figure 2 shows the hardware components working to enable remote control of agricultural motor water pumps. When the user inputs DTMF tones through the mobile phone, the DTMF decoder converts them into digital codes, which are then processed by the microcontroller. Based on the decoded commands, the microcontroller controls the relays to switch the pumps ON or OFF. The status updates are displayed on the LCD, providing feedback to the user about the pump's current operating mode and status. The system offers flexibility and convenience, allowing farmers to remotely manage the irrigation process, leading to efficient water usage and reduced manual effort.

The Algorithm for the core control logic of the above hardware system and the relevant portions are outlined below:

1) *Initialization of I/O Ports*
- P3.5 (RS) is used for selecting the register in the LCD display.
- P3.6 (RW) is employed for setting the direction of data transfer with the LCD.
- P3.7 (E) acts as the enable signal to trigger data transfers to the LCD.

2) *Timer Configuration*
- The program sets Timer 0 in mode 1 (16-bit timer) for specific timing requirements.

3) *Control Flow*
- The program starts from the MAIN label.
- It calls the DINIT subroutine to initialize the LCD.
- It then clears P2.0 (connected to a relay), signaling OFF status for the pump.
- The program enters an infinite loop where it waits for DTMF tone inputs from a mobile phone.
- If the input is '0,' the pump is turned OFF, and the display shows the status accordingly
- If the input is '1,' the pump is turned ON, and the display shows the status.
- If the input is '2,' the program checks if it is in Automatic mode (indicated by P3.4). If it is, it turns the pump OFF and updates the display accordingly
- If it is not in Automatic mode, it switches to Automatic mode (AMODE) and updates the display.

4) *Display Subroutines*
- The program includes subroutines for displaying specific texts on an LCD connected to the microcontroller.
- The TEXT1 subroutine displays specific text (e.g., "USER MODE ON," "AUTO MODE ON," "STATUS: ON," "STATUS: OFF") at predetermined locations on the LCD.

5) Delay Subroutine

- The DELAY subroutine introduces a delay in the program to ensure proper timing for LCD operations.

6) AMODE Subroutine

- The AMODE subroutine is called when the microcontroller is in Automatic mode.
- It reads data from the AUTO array and displays it on the LCD.

7) UMODE, AUTO, ON, and OFF Data Arrays

The program uses data arrays (UMODE, AUTO, ON, OFF) to store specific text for display purposes.

Overall, the proposed system, allows remote control of agricultural motor water pumps using DTMF tones. It interfaces with the LCD display to provide real-time status updates, enabling users to conveniently monitor and manage the pump's operation from a distance. The program also incorporates an Automatic mode, which enables autonomous pump control based on predefined conditions or sensor inputs.

VI. CONCLUSION

This study presents an investigation into the remote control of agriculturally positioned motor water pumps utilizing the Dual Tone Multi-Frequency (DTMF) technique. The proposed system is meticulously designed employing discrete components, gates, and operational amplifiers (op-amps). Through comprehensive testing and simulation using software such as MULTISIM, the functionality and operational aspects of the entire project circuit are rigorously assessed. Remarkably, the proposed circuit achieves successful and reliable motor switching, thereby enabling remote control of irrigation water pumps at distant agricultural sites without the need for frequent physical visits. The implementation of the proposed system yields several significant benefits, including improved water management leading to minimal water wastage, reduced manpower requirements, time savings, and heightened operational efficiency. Furthermore, future developments aim to enhance the practical execution of the proposed irrigation system by incorporating feedback closed-loop control mechanisms. This advancement entails the integration of sensors to automatically acquire feedback signals from agricultural sites. By incorporating such a feedback system, the overall performance of the irrigation system can be further optimized, ensuring even more efficient and sustainable water utilization for agricultural purposes.

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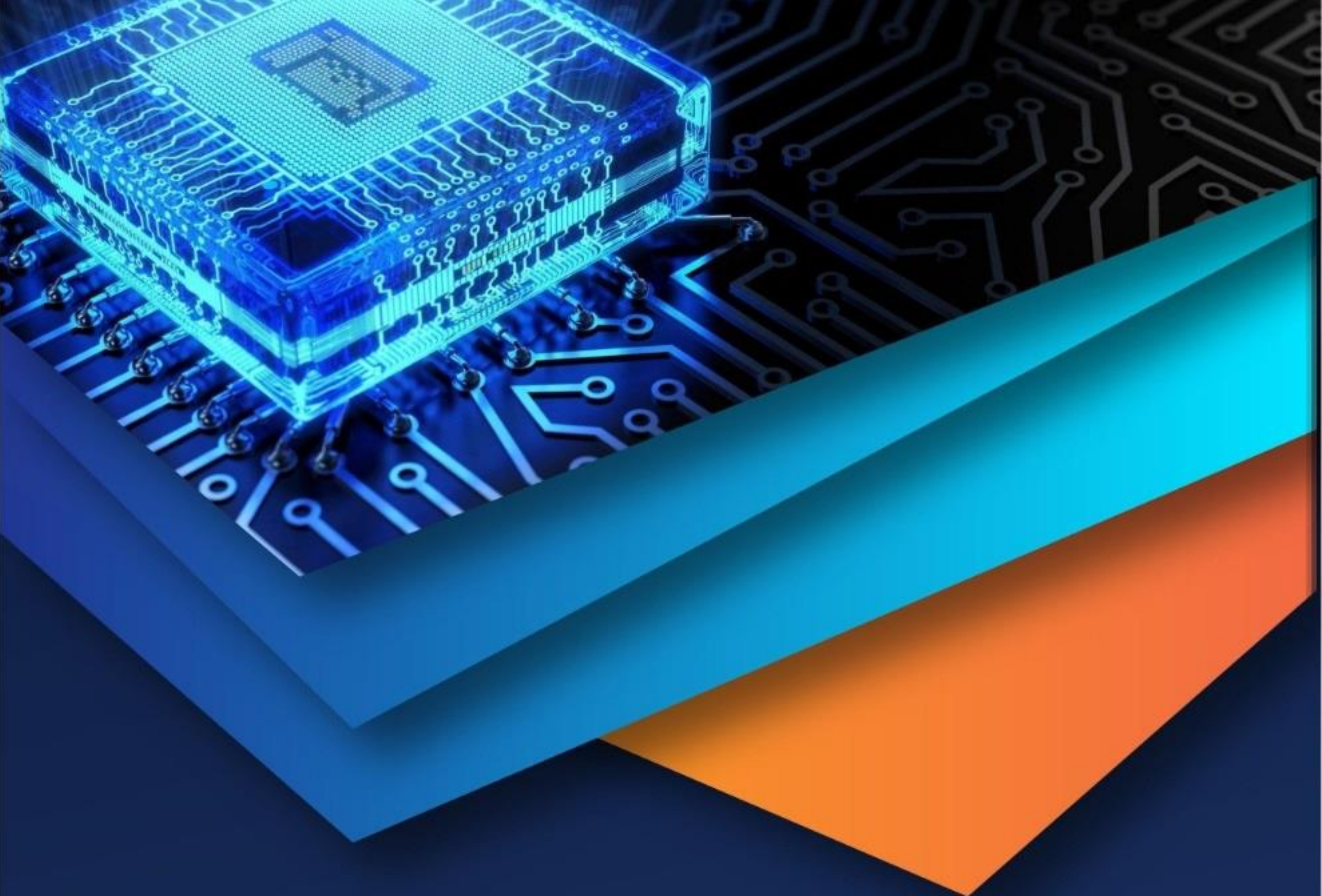

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