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Simulation of Smart Agricultural Electric Fence with Automated Irrigation Control System using Proteus Design Suit

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***Abstract*—Agricultural sector is considered as the backbone of the Indian economy which is the most essential aspect of human life. Suitable atmospheric conditions are needed for desired plant growth, enhanced agricultural fields, and effective use of water and other resources. Conventional irrigation systems, such as surface, sub-surface, drip and overhead sprinklers irrigation methods are being unproductive which gave way for the emergence of an optimized method to irrigate the agricultural fields. Many innovative ideas are being explored to assist agricultural automation prosper and reach its full potential. Extended periods of dry weather conditions caused by fluctuations in average annual precipitation may dramatically change agricultural productivity. The expenditures of cultivating many of these crops, along with their relative drought tolerance, necessitate the use of an adequate irrigation infrastructure for efficient and effective performance. This paper will go through the details of creating a smart agricultural electric fence security with soil humidity based automatic irrigation systems using arduino which is distinctive enough that it generates shocks along with sending alert messages to the user through Iot technology. The data collected by the fence and irrigation systems is visualised and processed using IoT cloud computing. The proprietary software Proteus Design Suite programme is used to model and simulate the work.**

Keywords—Electric fence security, Automatic irrigation, arduino, Soil moisture sensor, motor pump.

I. INTRODUCTION

With the latest innovations in IoT, Data Management, Cloud, and Computational Science, the world is changing toward effective alternatives to actual concerns [1]. In the Indian perspective, agriculture is the backbone of this emerging nation's economy, therefore switching from traditional agricultural practises to a far superior and intelligent approach to agriculture would eventually affect the current situation [2].

The adoption of information technology in the agricultural sector, which has now been broadly employed in industry, environmental monitoring, and other parts of life, could play a significant role in the growth of the regional economy [3]. IoT is a growing paradigm that has infiltrated other sectors and rendered them increasingly efficient. It is advancing nowadays with the introduction of innovative sensors, sensor systems, and RF-based telecommunications. [8, 9]. Even though most farmers lack information on how much water plants require, they utilise inappropriate quantities of water, diminishing soil fertility [4]. Hence crop failure occurs as a result of inefficient crop management, leading to a massive loss for the farmers [5].

The smart technology must assist farmers in providing water to crops at specific intervals and quantities as per requirement by the crops. The automated smart agriculture system monitors the moisture and temperature swings in the cultivated area, which provides a precise timing for the water pumping motor to switch on and off. As a result, automatic operation prevents human mistakes and monitors soil moisture levels [6, 7].

The preponderance of electric fences are utilised in agriculture. Unlike ordinary fences, which are just built to make a physical barrier, electric fences are built to establish both psychological and mental barriers. The mental barrier is created by passing an electric shock through the fence wire, which both resists the animals and renders them less inclined to come into touch with the fence anymore. However, with this commercial fencing system, the electric shock is intended to keep intruders or animals out and is often accompanied by sensing the animals or intruders first and then notifying the user, while high voltage pulses are also triggered to fence wires.

This article proposes a basic framework that uses a microcontroller to manage the irrigation and watering of plants or crops with minimum human involvement, as well as to safeguard them from animals or intruders through a smart fence system and data monitoring over IoT.

II. PROPOSED METHODOLOGY

The proposed approach regulates the use of water for agricultural fields and defends crop fields against animals and intruders, leading to higher agricultural yields.

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Furthermore, the system is controlled and monitored by the farmer through web services. The proposed system is depicted in Fig. 1, which consists of a soil moisture sensor to measure the moisture level in the soil, a humidity and temperature sensor to detect the ambient humidity and temperature, and a water level sensor to monitor the quantity of water in the source (Tank). It also features a voltage sensor to detect intruders. And to monitor and manage the entire system, the acquired values from the sensors are transferred to the ThingSpeak cloud through the Wi-Fi module ESP8266.

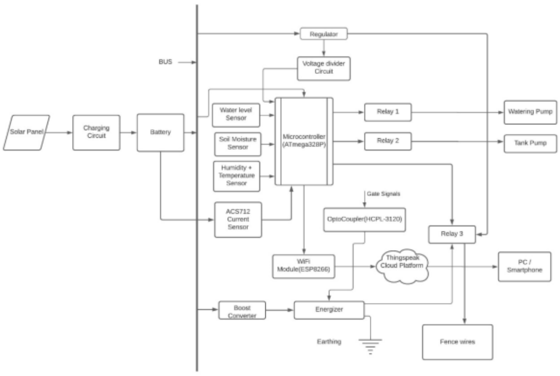

Fig. 1. Block diagram of the proposed smart irrigation and fencing system.

An algorithm has been devised in such a way that the moisture level in the soil is communicated to Arduino at periodic intervals, which decides whether or not to water the plants by turning on or off the relay that controls the watering pump. Similarly, the water level sensor is implemented to make sure that the tank is not empty by regulating the corresponding relay thus turning on or off the tank pump. Using a DHT11 humidity and temperature sensor, the system can however measure ambient temperature and humidity.

When an intruder or animal comes in contact with the fence wires, a circuit is built in which a low voltage is initially injected to the fence, then a high voltage pulse from the energiser is transmitted by the operation of the relay when the intruder is detected.

The overall system operates on a battery that is charged by photovoltaic panels. The current and voltage in the battery are monitored on a routine basis by the current and voltage sensor, and these values are recorded using ThingSpeak with the aid of an Arduino UNO and an ESP8266 Wi-Fi Module.

III. IMPLEMENTATION OF SMART AGRICULTURAL ELECTRIC FENCE WITH AUTOMATED IRRIGATION CONTROL SYSTEM

The work is segregated into four main sections in order to achieve the proposed methodology. They are as follows;

A. Battery charging model

As illustrated in Fig. 2, the Solar Battery Charger will accept the dc input from the 30W solar panel and regulate the voltage in order to charge the 12V battery from it. The constant voltage will be provided through the charging control circuit. The charging current is routed by diode D3 to the LM317 voltage regulator. The output voltage and current are controlled by altering the LM317 voltage regulator's adjustment. The same current is used to charge the battery which is connected to power up the irrigation model.

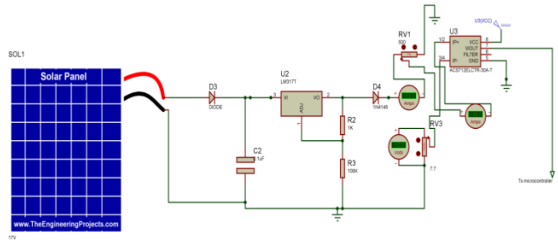

Fig 2: Solar Battery Charger model.

B. Irrigation model

The Automated Irrigation System is composed of three major elements: the Arduino Uno Microcontroller, sensors, and a motor driving circuit. The Microcontroller is powered from the battery charging model and will be able to get information such as soil moisture content, water level, temperature, and humidity. The microcontroller's function is to evaluate the input data and compare it to the threshold value defined in the Arduino code. The result will be determined by comparison of threshold value and input data. In this case two pumps were used: a tank pump and a water pump. The tank pump is used to send water from the borewell to the tank, while the water pump is used to transport water from the tank to the agricultural field. Fig 3 shows the simulated structure of the irrigation model using Proteus.

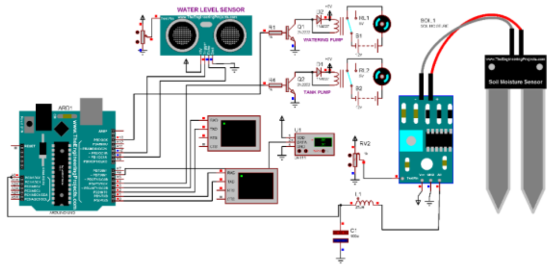

Fig 3: Simulated structure of irrigation model

C. Fencing model

The smart fencing model is made up of an energizer circuit that creates high voltage impulses that are subsequently transmitted to the fence wires. By delivering a low voltage to the same fence wires, a breach is detected. The energizer and a low voltage detecting component should not function at the same time.

A 12V battery supplies the input power, and a boost converter is designed to boost that 12V from the battery to about 400V whis is as shown in Fig 4. The output of the boost converter is then supplied to the three stage solid-state Marx generator circuit to build the energizer as shown in Fig 5.

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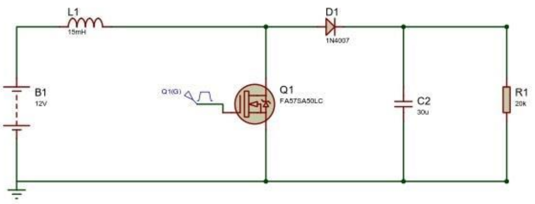

Fig 4: Simulated circuit of boost converter.

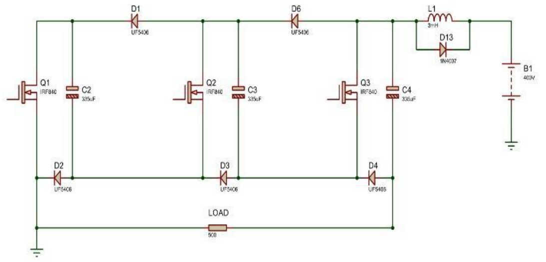

Fig 5: Simulated circuit of three stage solid-state Marx generator

D. IoT interfacing model

The IoT interfacing module is used for enhancing the control and monitoring of the entire model using Thingspeak third party cloud service provider. To meet the criteria, the entire simulated system is tested multiple times.

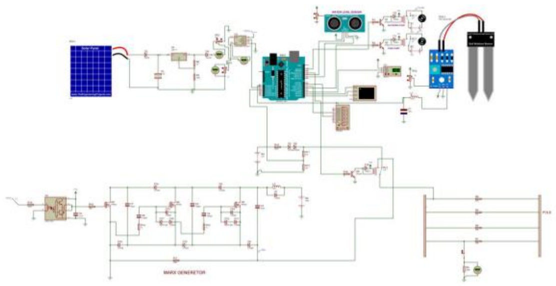

Fig 6: Simulated model of proposed smart irrigation and fencing system.

IV. RESULTS AND DISCUSSIONS

The proposed model is simulated in Proteus Design Suite which is a proprietary software tool suite used primarily for electronic design automation. The results were visualized digitally through the virtual terminal of Proteus and then that data is serially sent to Thingspeak cloud service platform through virtual compim.

Fig 7 shows the output waveform of boosted voltage from 12V to 400V from the boost converter circuit which is supplied to the electric fencing model to energize when animals or intruders are detected. If not the output from the energizer will be zero as there is no detection of animals or intruders.

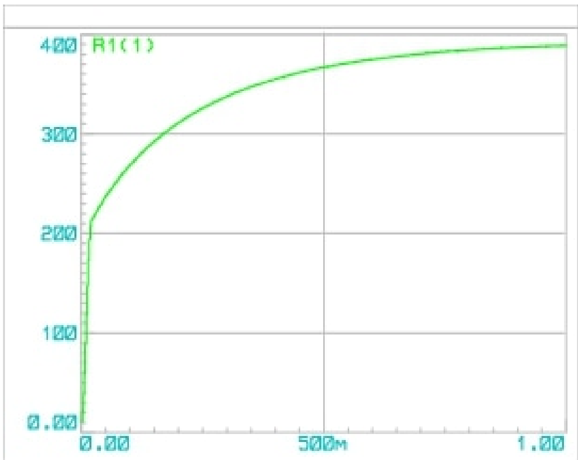

Fig 7: Waveform of boosted voltage from boost converter.

Initially threshold values are fixed with the control system for the moisture content as 85% and for tank level as 75% which means that if the moisture content in the soil is recorded as less than 85% , then the water pump has to be activated to irrigate the land or else water pump should be in off state. In this manner, if the stored water tank level is less than 75%, then the tank pump must be activated to fill the water in the tank from the borewell or else the tank pump should be in off state. The status of water pump and tank pump has been denoted as W-PUMP and T-PUMP respectively in the virtual terminal of Proteus. Also if any animals or intruders are sensed which is indicated with the voltage of fencing as 7V, the energizer will be activated to supply a high voltage pulse to give a shock to the intruder, if not detected the intruder will not be sensed indicated by the voltage of fencing as 10V. Hence the possible cases had been tested and the digital display through virtual terminal are as follows;

E. Case 1: For given 82% moisture content and tank level of 86%.

Fig 8 shows the results displayed in the virtual terminal of Proteus, indicating W-PUMP to be in ON state to irrigate the land as the moisture content in the agricultural field is less than the threshold value 85% and T-PUMP to be in OFF state as it is above the threshold value 75% with a voltage of fencing of 10V, and hence intruder is not sensed.

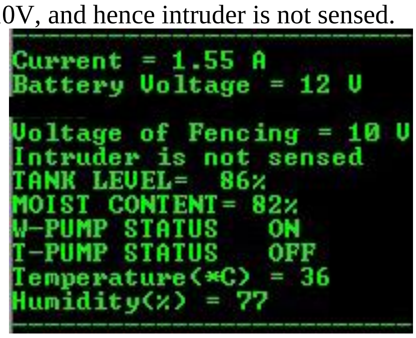

Fig 8: Output for case 1.

F. Case 2: For given 95% moisture content and tank level of 64%.

Fig 9 shows the results displayed in the virtual terminal of Proteus, indicating W-PUMP to be in OFF state to not to irrigate the land as the moisture content in the agricultural field is greater than the threshold value 85% and T-PUMP to be in ON state as it is less than the threshold value 75% with a voltage of fencing of 7V, and hence intruder is sensed and activated the energizer to give a shock to intruder.

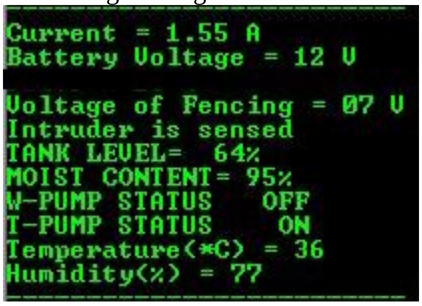

Fig 9: Output for case 1.

G. Case 3: For given 95% moisture content and tank level of 64%.

Fig 10 shows the results displayed in the virtual terminal of Proteus, indicating W-PUMP to be in OFF state to not to irrigate the land as the moisture content in the agricultural field is greater than the threshold value 85% and T-PUMP to be in ON state as it is less than the threshold value 75% with a voltage of fencing of 10V, and hence intruder is not sensed.

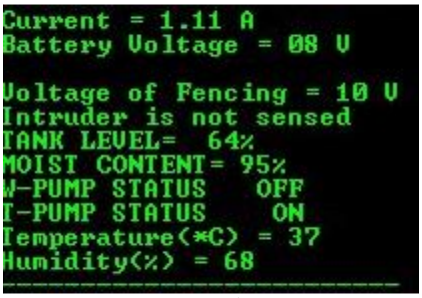

Fig 10: Output for case 1.

H. Case 4: For given 75% moisture content and tank level of 64%.

Fig 11 shows the results displayed in the virtual terminal of Proteus, indicating W-PUMP to be in ON state to irrigate the land as the moisture content in the agricultural field is less than the threshold value 85% and T-PUMP to be in ON state as it is less than the threshold value 75% with a voltage of fencing of 7V, and hence intruder is sensed and activated the energizer to give a shock to intruder.

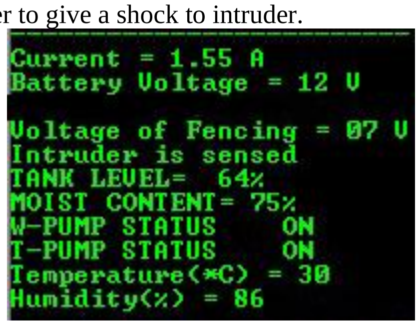

Fig 11: Output for case 1.

The Fig 12 shows the graphical output at the Thingspeak cloud service and are able to observe the monitored data only after logging in to the Thingspeak portal using the dedicated secured username and password and hence the cloud provided the expected reliable output of visualization of variation in temperature, humidity and moisture content, water level in tank, and fence voltage for detection of intruder.

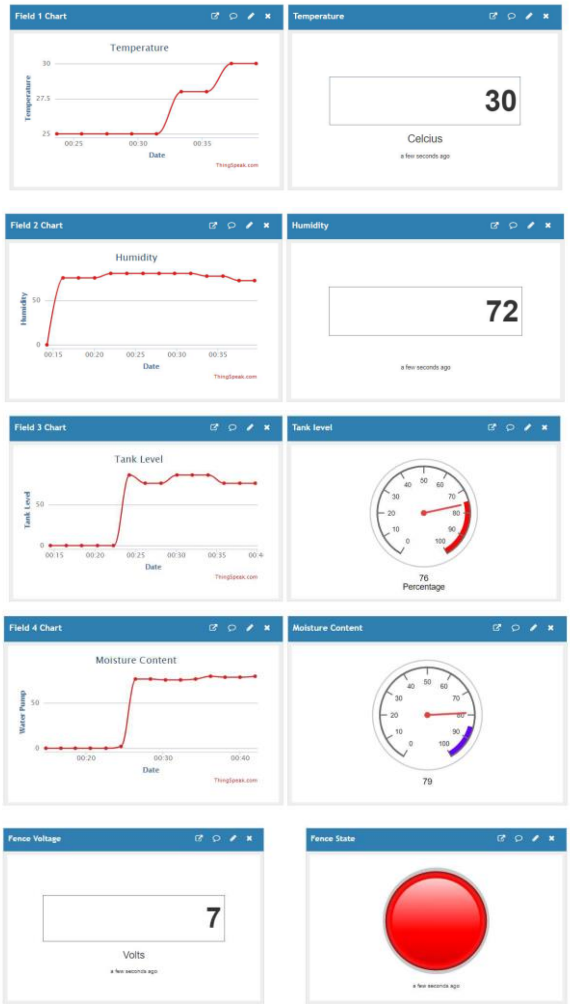

Fig 12: Thingspeak IoT Cloud Output results

V. CONCLUSION

With the advent of IoT, the goal of smart agriculture is to provide the modern techniques in farming for efficient agricultural production by obtaining the established real-time status of crops and allowing the farmers to fully comprehend the improvement in agricultural methods, with a lot of additional attributes and functionality. This paper discussed a proposed simulation model of smart agricultural electric fence with automated irrigation control system using Proteus Design Suit in building a Smart Agriculture. The designed smart system assists the farmer in observing and analysing the factors that must be considered while cultivating the crop, such as temperature, humidity, and moisture. The farmer would be able to observe and comprehend the changing pattern of weather variations. As a result, artificial intelligent techniques are used to irrigate the agricultural land as per crop requirement and hence the system will be efficient, adaptable and user-friendly as evident from the current simulated work on smart irrigation and electric fencing for detection of intruders.

Although the existing system is adequate, several prospective improvements can be achieved, such as monitoring of crop health based on leaf characteristics, identifying pest attacks using image processing where the farmers can send the visuals of diseased crops and receive pesticide guidelines through online mode, implementing a smart irrigation system to monitor weather, and recommending suitable fertiliser.

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