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Smart Automated Farming System using IOT and Solar Panel

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Abstract—Present work focuses on need of automation in farming by using IOT technology. Automation of farming envisages monitoring and controlling of various parameters which could be helpful in increasing productivity. The proposed system provides a technological solution to the various problems like, maintenance of water requirements, humidity level, maintenance of proper temperature, and proper availability of light for sophisticated plants, fire alert and to keep a check on unwanted entry in the farming lands including timely and sufficient supply of electricity. This hardware provides an effective and efficient solution to the defined problems in Indian farming system by using node MCU Wi-Fi module. Different sensors like humidity sensor, soil moisture sensor, PIR sensor, fire sensor, light sensor and temperature sensor have been used for monitoring and controlling of various problems technologically. In proposed system a Wi-Fi module has been used which automatically informs the farmer about the water requirement, site temperature, humidity and moisture, light, fire alert and about the unwanted occupancy or encroachment by displaying real time data which can be seen and accessed over internet using IOT technology from anywhere in the world. System is equipped with solar panel which provides power backup to the system even in the absence of power supply. We have used five different sensors on three different plants with different environmental conditions and the performances of different sensors are found to be upto the desired expectations.

Keywords: *Automated Farming*, *Node MCU Wi-Fi Module*, *Humidity Sensor, Soil Moisture Sensor, PIR Sensor, Solar Panel*

INTRODUCTION

The history of Agriculture in India dates back to Indus Valley Civilization Era and even before that in some parts of Southern India[1].Today, India ranks second worldwide in farm output. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. India exported $38 billion worth of agricultural products in 2013, making it the seventh largest agricultural exporter worldwide and the sixth largest net exporter [2] .Most of its agriculture exports serve developing and least developed nations [2]. Indian agricultural/horticultural and processed foods are exported to more than 120 countries, primarily in the Middle East, Southeast Asia, SAARC countries, the EU and the United States(3; Yalla *et al.* 2013).

We live in a world where everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use. One such field is that of agriculture. Automated farming envisages monitoring and controlling of the climatic parameters which directly or indirectly govern the plant growth and hence their production.

Problems of over exploitation of ground water in India are bound to become more acute and widespread in the years to come unless corrective mechanisms are put in place before the situation becomes worse. Other problems related to farming like maintenance of humidity level, maintenance of proper temperature, proper availability of light for sophisticated plants,keeping a check on unwanted entry in the farming lands and fire alert require a need of technological solution. On the other hand, the most

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important parameter for the agriculture is regular and adequate supply of electricity. Highly unreliable power supplies with frequent power cuts have not only lowered the efficiency but also causes problem to the farmers who cannot start their work without it.Apart from the problems mentioned here there are lots of problems in the field of agriculture which need to be addressed with solution using technology.

The proposed system uses a hardware which provides an effective and efficient solution to the defined problem in Indian farming system. The solution provided is eco-friendly, economical and electronically operated, making Indian farming system more farmers friendly. The proposed system is connected with internet using node MCU Wi-Fi module capable of displaying real time data which can be seen and accessed over internet using IOT technology from anywhere in the world.

Related Work

Satya Prasanth Yalla*et al*.(2013)discussed about automatic supply of water to fields, automation of system is provided with modules and soil moisture sensor, the source to generate electricity through renewable resources, prefer sunlight as the main source. Pradeep *et al*. (2011), havedeveloped and atomized the PV farmers pump by considering the power supply, direct current (dc),alternating current (ac), inverter frequency, GSM technology, awell, water level in the well, submersible pump. Herethe investigators have introduced an advanced technique using GSM module. JiaUddin *et al.* (2012)have proposed a model of variable rate automatic microcontroller based irrigation system. They have used solar power as the only source of power to control the overall system. Sensors are placed on the paddy field and these sensors continuously sense the water level and keep farmer informing about the water level through messages. Binoy seal *et al.* (2014)in their work, have discussed the design of solar tracking system to harness maximum solar energy that is converted into electrical energy which is used further to power the irrigation system. Ishwar Kumar *et al.* (2014)have discussed solar powered auto tracker along with an automatic water flow control using a moisture sensor. They have proposed a solution for the present energy crises for the Indian farmers. Nilesh R. Patel *et al.* (2013)have discussed different monitoring and controlled systems in order to increase the yield. Since the disease in crops is one of the key factors that causes the degradation of yield. So they have developed a monitoring system which mainly focuses on predicting the onset of the germination of the diseases. They have employed a sensor module to detect different environmental conditions across the farm and the sensed data is displayed on LCD using microcontroller. Shiraz Pasha B.R. *et al.* (2014)have made an attempt to automate farm or nursery irrigation that allows farmers to apply the right amount of water at the right time, regardless of the availability of labor to turn valves on and off. The Microcontroller based automated irrigation system consists of moisture sensors, analog to digital converter, microcontroller, relay driver, solenoid valve, solar panel and a battery. The system can be used in the areas where electrical power is difficult to obtain. This system is eco friendly and it uses a renewable source of energy. Basava Sidramappa Dhanne *et al.* (2014) in their work focuses on automatic supply of water to fields. The automation of system is done with modules,soil moisture sensor and the source to generate electricity through renewable resources. The objective of the work is to supply water to the fields through solar powered water pump and automate the system for better management of resources.M Chetan Dwarkani *et al.* (2015) have proposed a novel methodology for smart farming by linking a smart sensing system and smart irrigator system through wireless communication technology. They also demonstrated the detailed modeling and control strategies of a smart irrigator and smart farming system. Nikesh Gondchawar and R.S. Kawitkar (2016) aims at smart agriculture by using automation and IOT technologies. The highlighting features of their system includes smart GPS based remote controlled robot to perform tasks like weeding, spraying, moisture sensing, human detection and keeping vigilance. N.Suma *et al*.(2017) in their work have discussed smart agriculture techniques using IOT including various features like GPS based remote controlled monitoring, moisture & temperature sensing, intruders scaring, security, leaf wetness and proper irrigation facilities. Kayode E. Adetunji and Meera K. Joseph (2018)in their work have discussed the development of a cloud-based monitoring platform to monitor agricultural resource. Soil moisture (percentage volumetric water content), humidity, ambient temperature, dew point and soil temperature were used as variables for monitoring. They discussedhow the cloud computing could be implemented to the agricultural sector. Shivang *et al*.(2018)have discussed about IOT (Internet of Things) which is basically a network of objects enabled by internet coupled with the web services. They have designed aIOT network divided in three subsystems which could be employed to resolve three major problems like supply-demand anomaly, the irrigation problem including data acquisition using the different

sensor nodes and designing of a model that would reduce the transportation costs of the farmers considerably by enabling a pool system wherein every farmer would benefit and reduce their expenses.Sercan *et al.*(2018)have studied the regression trees to obtain the sensor data relations from 8 different data related to light, temperature, humidity, rain, soil moisture, atmospheric pressure, air quality, and dew point. A test prototype of the hardware together with the software design is created for data monitoring and sensor fusion in different combinations. In their work, different input devices are synchronized by using a microcontroller system and each data, obtained from the sensors, are sent wirelessly by an (Internet of Things) IoT device to the cloud, by recording and monitoring from the graphical user interface on the web as a real-time environment to apply data mining algorithms thereafter.

Shanmugasundaram *et al.* (2018) have developed an optimized irrigation system which collects database from the field using sensors and analytics is done for deciding the threshold values. Outcome of this system would be helpful in increasing groundwater table. System has an added feature that it does not require any human interventions.

Features of the Proposed System

Based upon the knowledge that we extracted by thorough study of literature survey we have proposed this system. From [6] we came to know that how water level sensor could be used in sensing water level and the information regarding water level could be float through message. To meet out energy crisis in farming we can use solar energy[7],[8].Reference[9] was helpful in deciding to incorporate LCD display panel while [14],[16] were useful in understanding the use of IOT in proposed system in order to make it a smart device. Idea of Automatic water supply and use of soil moisture sensor was understood well by [11].

In the proposed system, there are many features which have been incorporated to enhance its utility, and thus make it more and more farmers friendly. This system is connected with internet using node MCU Wi-Fi module which can display real time data that could be seen and accessed over internet using IOT technology from anywhere in the world. The features are enlisted as below:

- This model has a provision of water pump which starts automatically when soil needs water and the real time information could be accessed from display from anywhere in the world using IOT.
- For sophisticated crops, if light decreases below a predefined limit an automatic artificial lighting system switches 'ON' automatically. The real time information regarding intensity of light could be accessed from anywhere in the world using IOT.
- For humidity, if the humidity increases above a predefined limit the water spreading jet motor starts automatically and information regarding humidity level percentage could be accessed over internet.
- On temperature rising, the system automatically turns 'ON' the fan for sophisticated crops and updates the temperature values over internet.
- If any alarming situation like unwanted occupancy or fire happens then buzzer starts to beep and we get the update over internet.
- The system is also equipped with solar panel which provides power backup to the system in the absence of power supply.
- There is a real time display system which displays information collected by all sensors along with decision/action taken by microcontroller over internet.
- It has a provision of automatic and manual operation of relay using switches, provided on control panel over internet which can be accessed from anywhere in the world.

The hardware developed for the present system consists of the following sensors/modules and circuitry:

- ESP 8266 node MCU Wi-Fi module.
- LDR (Light Dependent Register) sensor.
- Flame sensor.
- Soil moisture sensor.
- PIR sensor.
- HT11 Temperature and Humidity sensor.
- Multiplexer module.
- Buzzer.
- Relay section.
- Solar panel with power backup battery.

As we have already explained in features of the project that the heart of the system is Node MCU Wi-Fi module:

- We need soil moisture sensors to detect the humidity of the soil, LDR sensor for monitoring the intensity of the light. DHT 11 sensor for monitoring the temperature and humidity, Fire sensor and PIR sensor for detecting any alarming situation like fire happens or unwanted occupancy.
- This system has power backup system with solar panel which provides power to the system in the

absence of power supply. We can monitor the real time data of all the sensors in graphical form over web page from anywhere in the world and take necessary action whatever needed according the sensor value. It has a provision of automatic and manual operation of relay using switches, provided on control panel over internet which can be accessed from anywhere in the world.

Block diagram of the system is shown in Fig. 1

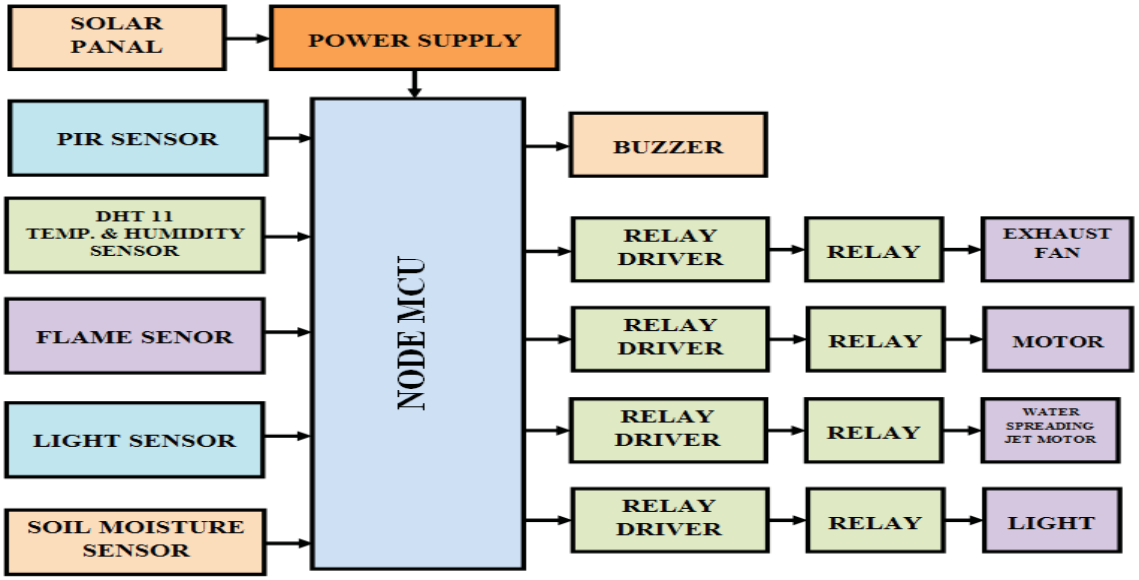

Fig. 1: Block Diagram of the Proposed Model

Circuit diagram of the system is shown in Fig. 2

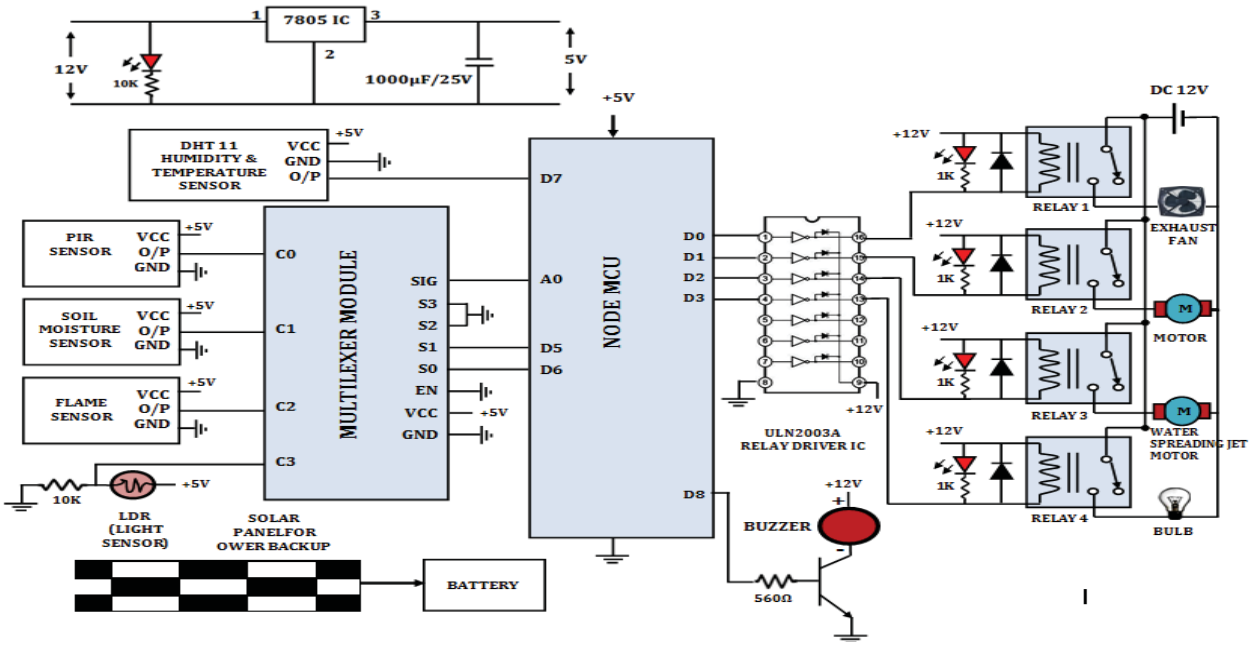

Fig. 2: Circuit Diagram of the Proposed Model

ALGORITHM AND IMPLEMENTATION

We propose to design a model by using control engineering to overcome the problem defined and also to add other useful features. The step by step methodology is adopted to develop hardware of the overall proposed system. The main objective is to build a general system to obtain data from external devices (sensors) and to manipulate it to achieve a specific output.

DEVELOPMENT OF ALGORITHIM AND DISPLAY PANEL OVER IOT

A program is developed in Arduino IDE to run the hardware system which is based on IOT and node MCU Module. The flow chart of the system and the associated sensor systems on the basis of which the program has been developed is shown in Fig. 3 (a), (b), (c), (d), (e) and (f).

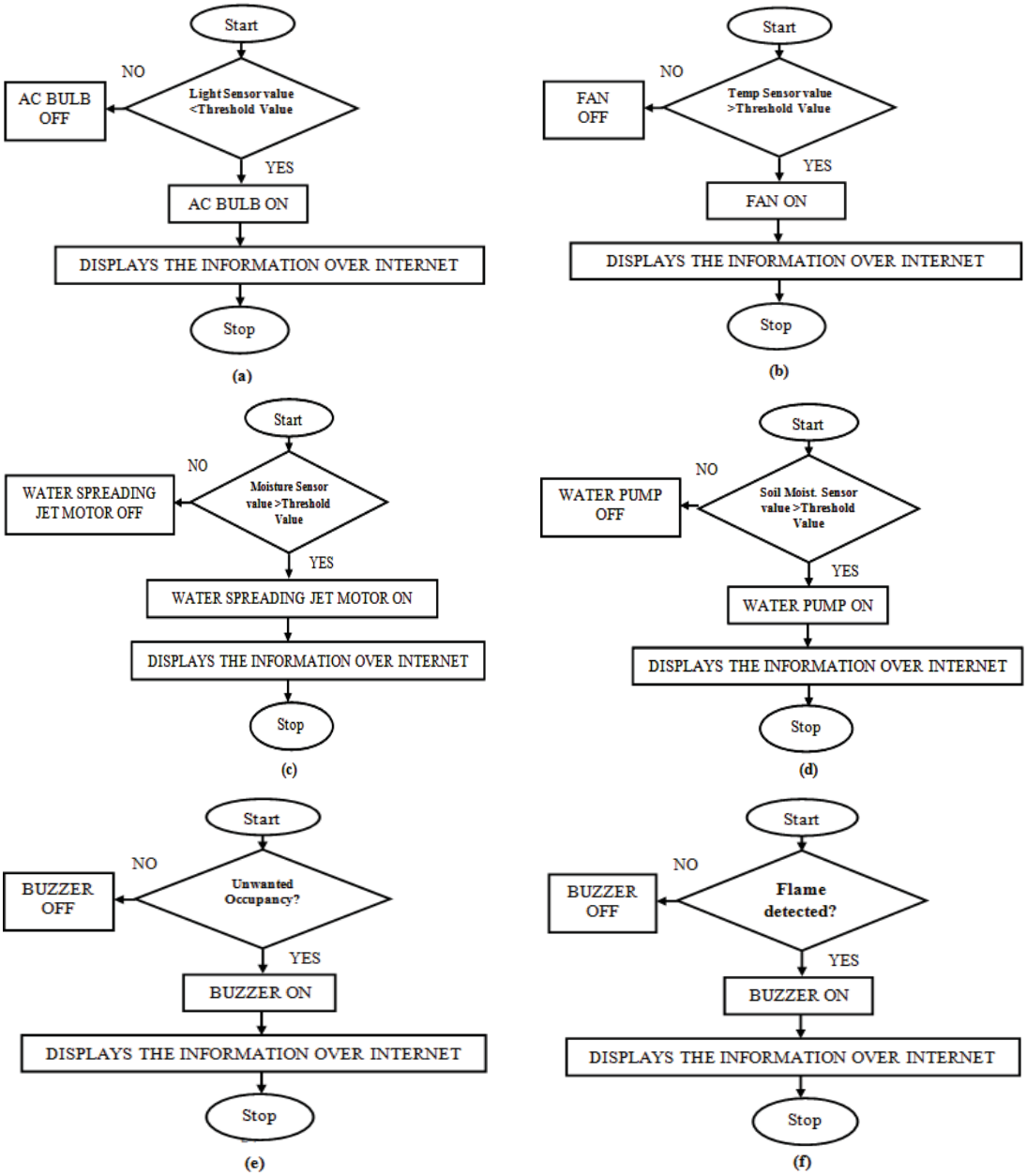

Fig. 3: Flow Charts for the System

a. Light Sensor System (b) Temperature Sensor System (c) Humidity Sensor System.

b. Soil Moisture Sensor System (e) Occupancy Sensor System (f) Fire Sensor System.

The display panel which we have prepared under the io.adafruit.com is shown in Fig. 4. This can be accessed over internet from anywhere in the world using IOT technology. We can also get the real time monitoring system in gauge form. We are monitoring six sensors here i.e. temperature sensor, humidity sensor, fire sensor, light sensor, soil moister sensor, motion (PIR) sensor. This display system has automatic and manual operation of relays. If any sensor reading goes beyond the threshold level value then relay triggers automatically. We can also operate the relay manually, if we wish.

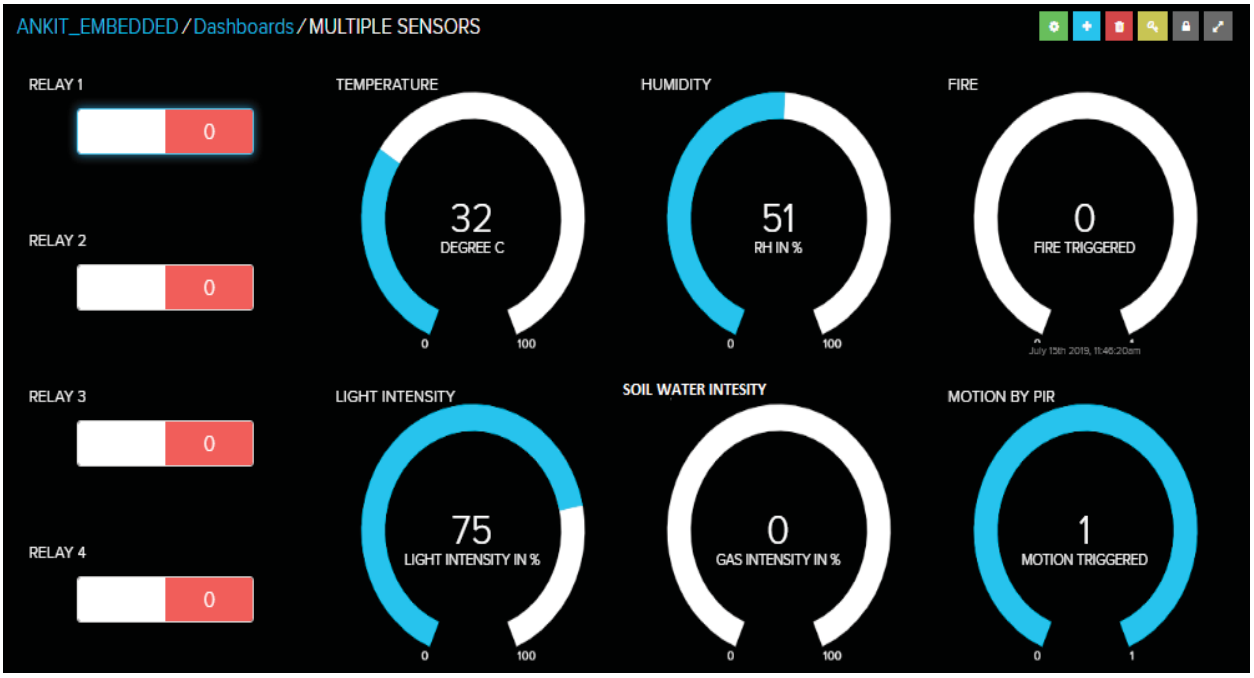

Fig. 4: IOT Based Control

IMPLEMENTATION OF PCB AND CIRCUIT

Fig. 5: (a) and (b) shows Top and Bottom View of PCB Used in this System. This PCB was Prepared using Dip Trace.

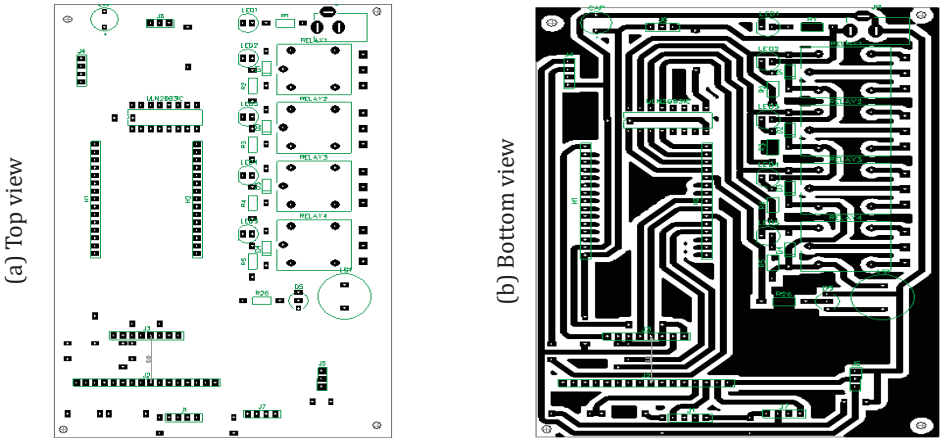

Fig. 5: PCB Prepared using Dip Trace

The original PCB is shownin Fig. 6.

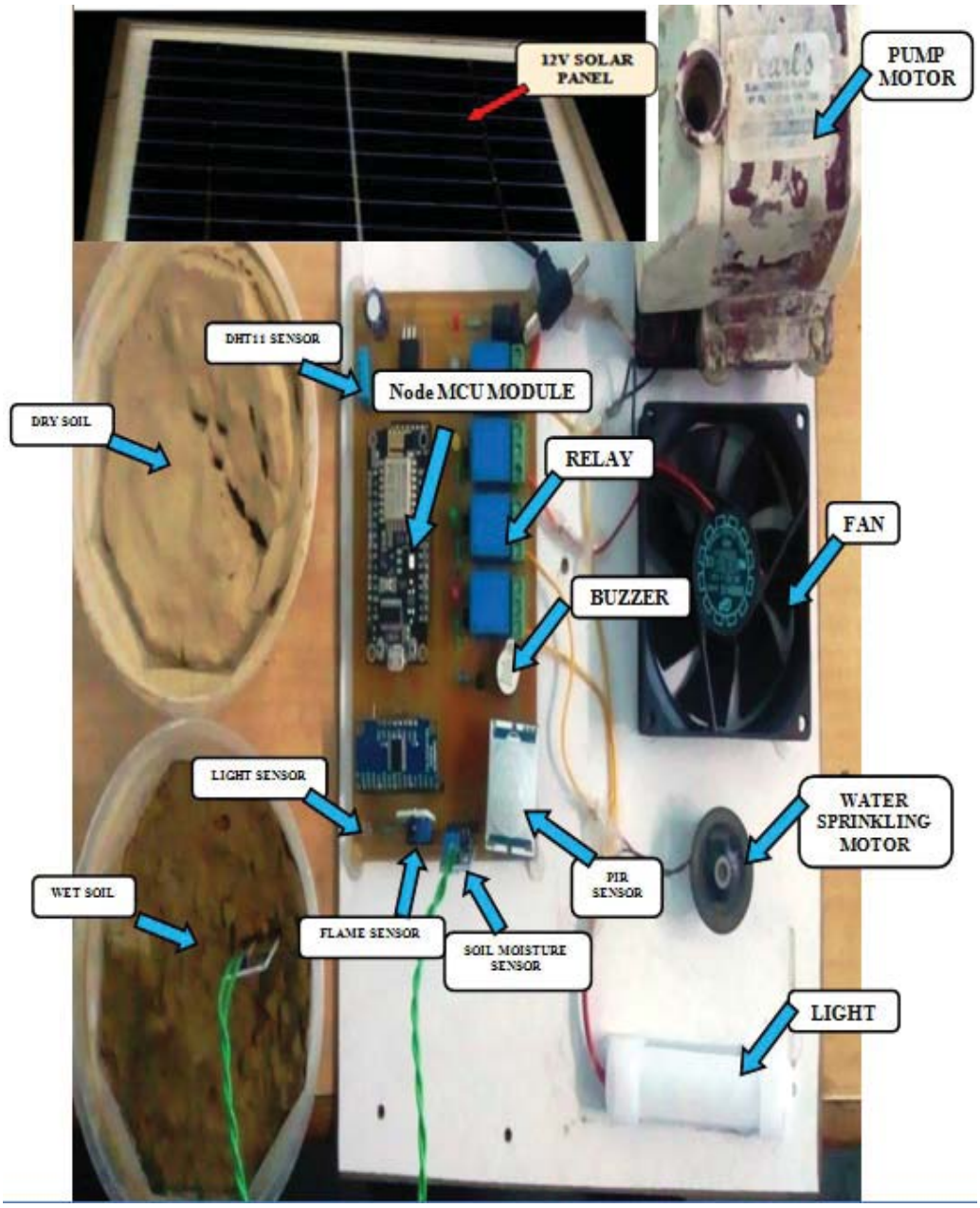

Fig. 6: Original Picture of Implemented Hardware

IMPLEMENTATION OF SOIL MOISTURE SENSOR

Out of all necessities for farming, irrigation has the most important role to play that is why it becomes important to concentrate over water retention by soil. For this soil moisture sensor has been used. For the successful implementation and to get fruitful results series of experiments using soil moisture sensor have been performed.

In this experiment a set of three different soils and plant combinations are taken say A, B and C as shown in Fig. 7.

Fig. 7: Three Different Soil and Plant Combinations A,B and C

With plant A, first type of soil is used and it isfilled to three different water levels i.e., low water content, normal water content and excess water content. It is observed during experiment that sensor is smart enough to detect the water level and information is sent through controller which is received on display panel over IOT and the necessary action is also performed like;

1. If the water level is below the predefined limit (without water) then water pump is automatically switched "ON" until it reaches to the required level (Fig. 7.1).

Fig. 7.1: Soil and Plant Combination A (Without Water)

2. If the water level is upto the predefined limit (average water) then it remains in passive mode (Fig. 7.2).

Fig. 7.2: Soil and Plant Combination B (Average Water)

3. If the water level is above the predefined limit (excess water) then water pump is automatically switched "OFF" (Fig. 7.3).

Fig. 7.3: Soil and Plant Combination C (Excess Water)

In order to test the compatibility of sensor with different soil and plant combinations, we have used it with combination B also, which is the second combination of plant and soil as shown in Fig. 7.4.

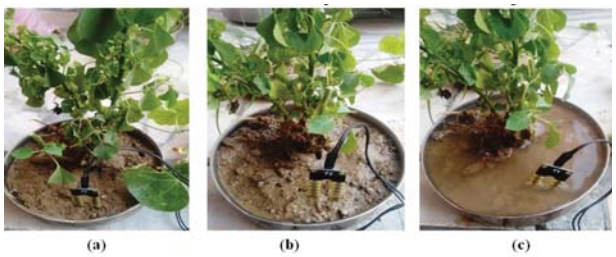

Fig. 7.4: Soil and Plant Combination B (a) Without Water (b) Average Water (c) Excess Water

The results obtained with plant A were found to be true with plant B also. For the confirmation of the results obtained with plants A and B, third and last combination of soil and plant i.e., plant C, is used as shown in Fig. 7.5.

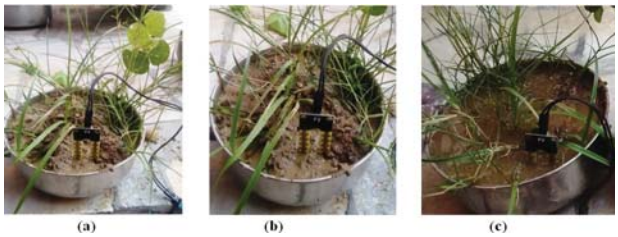

Fig. 7.5: Soil and Plant Combination C (a) Without Water (b) Average Water (c) Excess Water

The results found with combinations A and B are repeated hence it was confirmed that sensor is sensitive enough to produce the same results with different soils and different plant combinations using different water level conditions. Similarly, the other sensors were tested and it was found that their working

was upto the expectations.It may please be noted that all the activities as referred to in the manuscript have actually been carried out and keenly observed by the author himself.

RESULTS, DISCUSSION AND ANALYSIS

We have designed and developed a system which provides electronic and eco-friendly solution to the problems related to Indian farming system. The cost analysis (table 1) of this system shows that implementation of this system is very cheap. This will result in reducing problems faced by farmers especially in the field of irrigation system.

Table 1: Cost Analysis of the Hardware Model

Sr. No.	Component(S)	Quantity	Rate	Amount In Rs.
1	NODE MCU	1	450	450
2	Soil Moisture Sensor	1	250	250
3	DHT11 Sensor	1	150	150
4	Flame Sensor	1	120	120
5	PIR Sensor	1	150	150
6	LDR	1	10	10
7	WATER PUMP (230V, 50Hz AC)	1	250	250
8	DC Motor (12V, 100RPM)	1	225	225
9	MUX IC	1	230	230
10	Fan (12V, DC)	1	300	300
11	IC ULN2003A	1	20	20
12	Trim POT 10kΩ	1	10	10
13	Relay 12V	4	20	80
14	AC Bulb with Holder (White) (0W)	1	130	130
15	Buzzer	1	20	20
16	Transistor BC547	1	8	8
17	DC Socket (Male & Female Type)	1 Each	15	30
18	12V/1A DC Adapter	1	250	250
19	LED (2 Red, 1 Green, 1 Yellow and 1 Blue)	5	1	5
20	Diode (IN4007)	2	2	4
21	Resistances (560Ω, 1KΩ, (1/4W))	6	----	6
22	Burg (Male and Female Type)	4 Each	15	60
23	Connectors (6 pin, 4 pin, 3 pin and 2 pin)	4	10	40
24	PCB (Glass Epoxy)	1	350	350
25	DC (12V/2.5mA) Battery	1	600	600
26	Solar PV Panel	1	800	800
27	Connecting Wires and Jumper Wires	----	----	40
28	IC Base (16 Pin)	1	2	2
		TOTAL		4590

This system leads to various pleasant results. These are;

Solution to Water Problem

Proposed model is equipped with a water pump which automatically starts to function when soil needs water. Hence it is helpful to meet out the water requirements.

Solution to Unwanted Occupancy

Problem of unwanted occupancy and vandalization of crops is resolved by using an automatic buzzer system which provides information about any unwanted entry/occupancy if detected in farmer's land.

Solution to Humidity Level Maintenance

Problem of maintenance of humidity level is resolved by using water spreading jet motor which starts automatically when humidity increases by a predefined limit.

Solution to Temperature Maintenance

Problem of maintenance of temperature for sophisticated crops is resolved by using fan which operates automatically when the temperature. This feature is useful for sophisticated crops.

Solution to Electricity Supply

For uninterrupted power back up and supply the system is equipped with solar panel and battery which provides power backup to the system even in the absence of power supply.

Solution to Light Arrangement for Sophisticated Plants

The requirement of proper light for sophisticated crops is resolved using the automatic artificial lighting system which switches 'ON' if light decreases below a predefined limit for crops.

Solution to Communication Problem

IOT based module is used in system which keeps updating the farmer regarding various field conditions like temperature, humidity, moisture, light, fire and unwanted occupancy by real time monitoring over internet which can be accessed from anywhere in the world.

CONCLUSIONS

The proposed system is equipped with useful features and leads to various pleasant results. The system provides technical solution to various problems in the field of agriculture like water problem, unwanted occupancy, humidity level maintenance, temperature maintenance, electricity supply, and light arrangement for sophisticated plants, fire alert and updating farmers regarding various field conditions. AnIOT basedWi-Fi module is used in this system which automatically informs the farmer about the temperature, humidity, moisture, light, unwanted occupancy and fire alert by displaying real time data over internet from all over the world. We can operate the relay manually as well as automatically from internet. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

FUTURE SCOPE

The utility of the proposed hardware could be enhanced by adding other features. Hence, with some modificationsthe system can be used for the purposes such as;

Implementation of Inverter

As the system has a solar panel which charges battery and provides DC supply which is used to provide back up to microcontroller in absence of power supply. By incorporating inverter in the system one can convert DC into AC so that ac appliances like water pump, automatic lighting system etc. could be run easily.

Implementation of Gas Sensor

Though the system is equipped with number of sensors but still there is a scope to add other sensors. By adding one important sensor like gas sensor the utility of the system could be enhanced. That will be helpful in saving crops from damage caused by fire.

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