A Low-Cost Smart Irrigation System using IoT

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Abstract— **Today we are living in the 21st century where automation is playing an important role in human life. Automation allows us to control appliances automatic control. It not only provides comfort but also reduces energy consumption, increase efficiency and saves time. Today industries use automation and control mechanism which is high in cost and not suitable for use in agricultural farms. Hence, this project focuses on the development of a smart irrigation technology at a low cost which is usable for Indian farmers.**

The farm parameters such as soil moisture, temperature, humidity which are essential to be maintained are considered in this work. These parameters are monitored and the measurement values are sent through the main gateway from sub-nodes using special communication protocols. The data collected in the microcontroller is then sent to the cloud platform from where the farmer is able to monitor his farm. Under extreme conditions, the farmer is alerted by notifications. This makes the farmer take necessary actions. The farmer will be able to control the motor and valves in the field based on the requirement. This setup can be made crop-specific and will improve the yield resulting in the economic growth of the country.

The moisture is measured by resistive hygrometer which is connected with a soil moisture module which converts the resistance value to voltage. This voltage is read by an ADC which gives digital value of soil moisture. The temperature and humidity are measured using the DHT11 module which contains a thermistor for temperature measurement and capacitive humidity sensor.

*Keywords— **Soil Moisture, Humidity, Arduino, Node-MCU, Cloud, Temperature***

I. INTRODUCTION

A. *The agricultural scenario of India now*

India's economic security continues to be predicated upon the agriculture sector, and the situation is not likely to change in the foreseeable future. Even now, agriculture supports 58% of the population, as against about 75% at the time of independence. In the same period, the contribution of agriculture and allied sector to the Gross Domestic Product (GDP) has fallen from 61 to 19%. As of today, India supports 16.8% of the world population on 4.2% of world water resources and 2.3% of global land. And per caput availability of resources is about 4 to 6 times less as compared to the world average. This will decrease further due to increasing demographic pressure and consequent diversion of the land for non-agricultural uses.

Around 51% of India's geographical area is already under cultivation as compared to 11% of the world average. The present cropping intensity of 136% has registered an increase of only 25% since independence. Further, rainfed drylands constitute 65% of the total net sown area. There is also an unprecedented degradation of land (107 million ha) and groundwater resources and also a fall in the rate of growth of total factor productivity. This deceleration needs to be arrested and agricultural productivity has to be doubled to meet the growing demands of the population by 2050. Efficiency-mediated improvement in productivity is the most viable option to raise production.

The country recorded impressive achievements in agriculture during the three decades since the onset of the green revolution in the late sixties. This enabled the country to overcome widespread hunger and starvation; achieve self-sufficiency in food; reduce poverty and bring economic transformation in millions of rural families. The situation, however, started turning adverse for the sector around mid-nineties, with slowdown in the growth rate of output, which then resulted in stagnation or even declines in farmer's income leading to agrarian distress, which is spreading and turning more and more serious.

The natural resource base of agriculture, which provides for sustainable production, is shrinking and degrading and is adversely affecting the production capacity of the ecosystem. However, demand for agriculture is rising rapidly with an increase in population and per caput income and growing demand from the industry sector. There is, thus, an urgent need to identify the severity of the problem confronting the agriculture sector to restore its vitality and put it back on a higher growth trajectory. The problems, however, are surmountable, particularly when new tools of science and technology have started offering tremendous opportunities for application in agriculture.

B. *Water Scarcity*

The agricultural sector is going to face grim competition for supplies of fresh water, with its share dropping to 75% from the present 83% in the near future, in the wake of growing industrial and domestic sectors. The judicious management of water resources is, therefore, going to be crucial to sustaining agricultural growth in the country. Presently, the groundwater is being overdrawn in Central Punjab, Haryana, Western Uttar Pradesh, Rajasthan, Tamil Nadu, and West Bengal, forcing a sharp fall in the water table in these areas. The excess use of canal water in south-western Punjab, Haryana and Rajasthan is leading to waterlogging and development of secondary salinity. The conjunctive use of water and diversification of rice-wheat is required for solving the emerging problem. Large volumes of wastewater (18.4 million m3/day) need to be utilized for irrigation after their proper treatment, especially in peri-urban areas. The micro-irrigation and resource conservation technologies (RCTs), economizing on water and nutrients require to be promoted in a big way.

Commodity	Required production (million tonnes)	Required growth rates (%)
Rice	105.0	2.06
Wheat	79.0	0.95
Total cereals	232.0	2.21
Coarse cereals	48.0	5.15
Pulses	20.0	2.35
Total food grains	252.0	2.21
Milk and milk products	113.0	3.18
Egg	62.0	6.09
Meat	8.6	5.
Fish	8.6	4.39
Edible oilseeds 40% imports dependence	31.8	2.87
Vegetables	109.0	2.51
Fresh fruits	67.0	3.46
Sugar and G*ur*	35.5	3.87

Table 1.1 Required amount of food production in India due to increasing population

C. Smart irrigation

Agriculture is considered as the basis of life for us as it is the main source of food and other raw materials. It plays a vital role in the growth of country's economy. Growth in the agricultural sector is necessary for the development of the economic condition of the country. Unfortunately, many farmers still use traditional methods of farming. In India, most of the irrigation system are manually operated ones. These outdated techniques are replaced with automated techniques. This paper focuses primarily on reducing the wastage of water and minimizing manual labour on the field for irrigation [1]. Recent advances in soil water monitoring combined with the growing popularity of Wireless Sensor Networks make the commercial use of such systems applicable for agriculture and Gardening.

The system designed is programmed to irrigate at regular time intervals for predefined periods of time. In this technique, soil moisture sensors are placed root zone of the plant and near the module and gateway unit handles the sensor information and transmit data to the controller which in turns operates the of control the flow of water through the valves. To give proper attention to the land located far away from the human settlement, supervisory automatic control systems like multi-terminal control systems are used since in many processes, factors like soil, salinity, irrigation, temperature, light intensity, etc. needs repeated tasks and have to work in abnormal environmental conditions of the soil and to overcome the flaws in the existing system here we are irrigating the land based on the soil humidity(moisture) and at the same time the status of the irrigation is updated wirelessly to the dashboard developed. The proposed system will allow farmers to continuously monitor 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 the Internet of Things.

II. LITERATURE REVIEW

1. Various researches have been carried out on how soil irrigation can be made more efficient. The researchers have used different ideas depending on the condition of the soil and quantity of water Different technologies used and the design of the system was discussed by the researchers. This paper aims at reducing the wastage of water and the labour that is used to carry out irrigation manually. The proposed system aims at detecting the moisture content of the soil using sensors that are placed directly into the soil. These sensors sense the water level of the soil and if the water level is not adequate then the user will be notified through a message that will be sent to the application which would be installed on the user's mobile phone.

2. The Arduino board, a microcontroller, controls the digital connection and interaction between objects in the proposed system, enabling the objects to sense and act. Also, with its powerful on-board processing, various sensors and other application-specific devices can be integrated into it. In the system, sensors detect the water and moisture level and 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.

3. A wireless application of drip irrigation automation supported by soil moisture sensors Irrigation by the help of freshwater resources in agricultural areas has crucial importance. Traditional instrumentation based on discrete and wired solutions, presents many difficulties in measuring and control systems, especially over the large geographical areas. If different kinds of sensors (i.e. humidity, and etc.) are involved in such irrigation in future works, it can be said

that an internet-based remote control of irrigation automation will be possible.

4. In the present scenario, the availability of power and water is insufficient to satisfy the farmer's requirements. Traditionally, implemented techniques of irrigation are proving to be less futile as these are not good at multitasking different concerns which are a combination of availability of water, sources of energy and timely soil profile analysis. With the merger of automation and the methods of irrigation used earlier, the scope to mitigate issues concerning water and power issues, is huge. An IoT based solar power smart irrigation system with monitoring and control features is designed and implemented. The sensor enables the proposed model of smart irrigation system along with its Android Application and ESP8266 as its main controller.

5. An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to an android application

III. CIRCUIT

3.1 Connection diagram

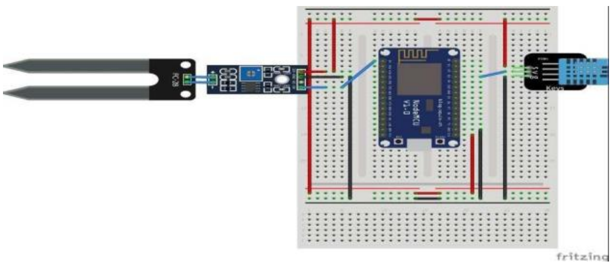

Fig 3.1 Connection diagram

3.2Hardware description

3.2.1 NodeMCU

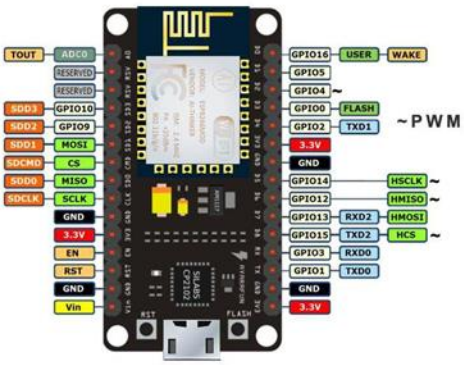

Fig 3.2 NodeMCU (ESP8266) pinout

NodeMCU is an open-source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits.

3.2.2 Soil moisture sensor

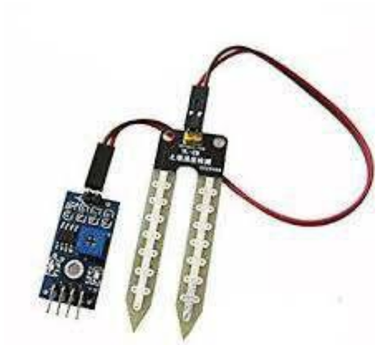

Fig 3.3 Soil Moisture sensor module

Resistive type moisture sensor: To measure the moisture content of the soil. Copper electrodes are used to sense the moisture content of soil.

3.2.3 DHT 11 (Temperature and Humidity sensor)

Fig 3.4 DHT11 sensor module

It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and sends a digital signal through the data pin.

IV. EXPERIMENTAL PROCEDURES

4.1 Materials and Softwares required

4.1.1.Sensors

- Resistive type soil moisture sensor
- DHT 11 – Humidity and Temperature sensor 4.1.2. Microcontroller
- NodeMCU (WiFi chip)

4.1.3. Software platform used

- Arduino opensource development platform(Embedded Hardware programming language) 4.1.4. Applications used
- Adafruit IO cloud platform to store and display data

- IFTTT mobile applet for providing notification alerts.

4.2 Workflow

4.2.1 Data Acquisition

- The sensor data are read by the microcontroller using the analog and digital pins
- The data from the moisture sensors are multiplexed using diode supply logic. This moisture data is read by the analog pin which is converted to digital using builtin ADC of the microcontroller.
- The data from the DHT11 sensor is read using one of the digital GPIO pins. This data is parsed into temperature and humidity values using the respective library functions.

4.2.2 Data processing

- The moisture data is mapped to percentage by using the map function for making it easily understandable.

4.2.3 Data transmission

- The sensor data if there is any change is uploaded to the cloud platform for further display and control
- The actuators connected to the microcontroller can also be controlled from the cloud application manually.

4.2.4 Notification

- The cloud application is connected with an applet IFTTT(IF This Then That) which monitors the sensor data and notifies if the data crosses the threshold.
- It also notifies the switching of actuators.

4.2.5 Flowchart

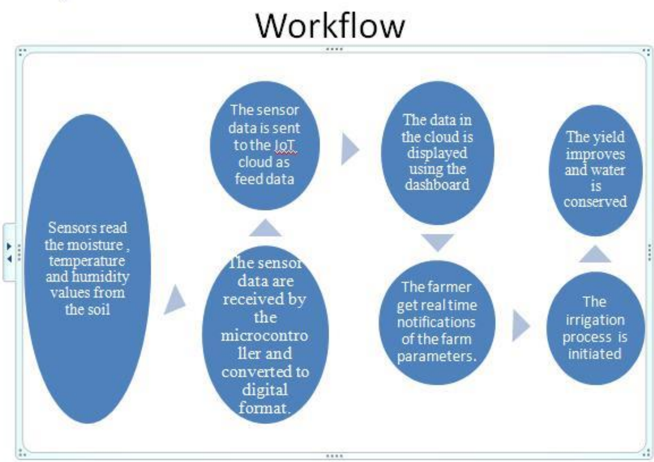

Fig 4.1 Flowchart

V. RESULTS AND DISCUSSIONS

- The sensors measured the environmental parameters of the agricultural area such as soil moisture, humidity and temperature of that area.
- The measured values a reused to decide whether to irrigate or not.

5.1 Output

Fig 5 .1 Adafruit IO Smart Irrigation dashboard

5.2 Advantages

- Water Conservation
- Real-Time Data
- Lowered Operation Costs
- Efficient and Saves Time
- Increase in productivity
- Reduce soil erosion and nutrient leaching

5.3 Challenges

- Complexity: The IoT is a diverse and complex network.
- Privacy/Security
- Lesser Employment of Manual Staff or unskilled workers
- Equipment is costlier
- Awareness of Indian farmer for this technology

VI. CONCLUSION

- We conclude that this system is easy to implement and time, money and manpower saving solution for irrigating fields.
- A farmer should visualize his agricultural land’s moisture content from time to time and water level of source is sufficient or not.
- IoT based smart irrigation system displays the values of the sensors continuously in the smartphone or on the computer’s web page and farmers can operate them anytime from and anywhere.

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