Remote Based Intelligent Agriculture Monitoring System

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Abstract: The most important challenges in the field of agriculture are to improve the productivity of the farm and to maintain the crop filed. The key objective of the proposed system is to control the cropland functionalities such as the cultivation period, pump functionalities, future plantation suggestions using the Internet of Things. The proposed IoT-based agriculture monitoring scheme uses the concept of sensor networks. Smart agriculture is a new strategy which is getting popular amidst the agriculturists. A farm which has deployed sensor networks can have better control over the crops, help to collect useful data, and automate various farming routines. The mode of communication involves mail alerts over the suggestion and cultivation period. The humidity, temperature, pH value of the soil is continuously acquired as data from the sensors deployed in the field. This helps to reduce the expenditure and human intervention which ensures maximum yield to the farmers.

Keywords: Internet of Things, Sensor Networks Smart Suggestion, Raspberry Pi 3, Web Application, Android Application.

1. INTRODUCTION

The population of India is nearly 135 crores. It is essential that a balanced tradeoff should be attained between the population growth and a health. Due to the drastic increase in the population, the need for agricultural production is high. The system of irrigation followed plays a major role in the increase in agricultural production. The objective of Remote based Intelligent Agriculture Monitoring system is to create an IoT based sensor data platform. A smart agriculture monitoring system or Intelligent farming system is an influencing technical concept where data from several agricultural fields from small to large scale and its surrounding details are collected using different sensors. The collected data are analyzed by the admin system, from that analysis local farmers can make a short term and long-term conclusion on weather patterns, soil fertility, quality of crops and amount of water that will be required for future sessions. Collectively the data acquired by the IoT based system based on various parameters related to the soil and plants are vital in implementing the control systems for smart farming.

IoT has revolutionized the domain of technology by its capability to get connected with any system and communication model which is equipped with sensors, microcontrollers, and transceiver to read and transmit the parameters relevant to the environment in which it is established. Besides the communication of the sensed data from the environment with another sensor system or the user, IoT has become an inevitable part of the Internet networking system. Each component which is being used in an IoT based system is provided with a unique identifier, mapped with the system and is allowed to communicate the data, which helps the work to be accomplished without any human intervention. The growth of IoT is experiencing an exponential trend since the objects connected to it is getting expanded day-to-day. The flexibility of deployment makes it applicable for many domains which include precision farming, smart grids, environmental monitoring and similar communications. The implementation of IoT in the agricultural domain has increased to a very large scale due to the properties of IoT namely scalability, reliability, interoperability and pervasiveness. This connectivity of IoT has extended to electronic devices and smart devices which is termed Internet of Everything (IOE). This has the capability of Machine-to-Machine (M2M) communication. IoT helps in connecting devices, systems and services which are diversified in terms of protocols, applications and domains.

The Indian economy has a huge inclination towards agriculture since it is one of the factors that determines the economy if the nation. It is becoming difficult to maintain the soil with its original properties due to various climatic changes. Also, climatic condition such as drought, flood, etc. badly affects the agricultural field. The manual method of monitoring the crops becomes very hard and hence the Embedded System that automates the process is made available to the farmers at an affordable price. The low rainfall and heavy rainfall affect the crop yield. So, the smart system ensures the proper water distribution of crops which can result in a good yield for farmers. The foremost goal of this smart system is to help maintain the soil with all its original properties and pH level. This smart system also ensures a healthy environment for the crops.

2. RELATED WORK SURVEY

The work IOT based smart crop field-monitoring and automation irrigation system proposed a system of smart agriculture by making some addendum in the traditional methods of agriculture thereby modernizing the same. The work focus on the high precision monitoring of data and design of a control automation with the help of IoT. The system used Raspberry pi and deploys a cloud-based IoT system to monitor the real-time data received from the field [1]. The IoT Based Intelligent Agriculture Field Monitoring System proposed a cost-effective system made from low-cost sensors and simple circuits aiming towards the automatic control over the flow of water. The system into account the humidity and temperature level which is visualised by the user through an LCD screen. This system maintains an adequate level of moisture in the soil and water the crops according to the requirement. This system was implemented with Arduino Uno [2]. The automation in agriculture and IoT proposed a technique to manage the agricultural work and helps the farmers in decision making on the harvest depending upon the demand in the market. This work not only improves the agricultural output but also serves to improve the standard of living of farmers [3]. The work “Design and Implementation of an IoT based Automated Agricultural Monitoring and Control System” proposed an automated farm control system using cloud-based IoT solution to monitor and to control multiple areas of the farm which play a critical role in the entire farming process. The user can take appropriate actions based on the inference produced by the system [4]. “Cloud-Based Data Analysis and Monitoring of Smart Multi-level Irrigation System Using IoT” is a system proposed in which the local

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nodes communicate to a centralized node by means of wireless communication. The centralized node which collects the data from the local nodes is connected to a cloud server. The cloud server stores and processes the data [5]. Ashifudhin and Rehana [6] proposed a system which contains an in-situ WSN which collects data from all its constituent sensors. The purpose of using the sensor node is the perform continuous assessment of the LAI that is relevant to the precise monitoring of crop growth. Jan and Nils [7] proposed a system where Zigbee was used for communication between the nodes. The data collected in real-time are fed to a server which processes the data and visualize the same to the user using a web-based java graphical user interface. Most real-time systems that are currently used uses an Android-based smartphone to monitor and to control the agricultural activities.

3. HARDWARE DESCRIPTION

Raspberry Pi

The developer board used in the proposed work is Raspberry Pi 3 Model B. This release has a 1.2 GHz 64bit quad-core processor. The board has a Broadcom BCM2837 SoC with a 1.2 GHz 64 bit quad-core ARM processor which is capable of handling most operations relevant to reception, processing and sending of data. Efficient utilization of the processor can speed-up the process by 4 - 7 folds. This processor is capable of supporting a sophisticated user-interface since it is designed to support graphic applications. This model contains an on-board Wi-Fi and Bluetooth module. It is also facilitated with USB or Ethernet ports. The most prominent programming language Python is used to design the applications deployed in this board. Though the programming language is not a major consideration in this system, the information is provided in a knowledge perspective. The advantage the programmer enjoys while using python is that most operations can be accomplished with a fewer line of codes. It can be used for development of web-based application interfaces also.

Figure 1 Raspberry pi 3

Relay Switches

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Relay switches are used to open or close a circuit. Relays are capable of accomplishing this process electromechanically or electronically. It serves as a gateway for the closing and opening of other circuits also. By default, a relay is in open condition. Figure 2 illustrates the physical appearance of a relay switch.

Figure 2 Relay Switch

Humidity Sensor

Humidity sensors serve to sense the relative humidity of the field or environment in which the sensor is deployed. Relative humidity is a measure based on the actual humidity and air temperature. It is a sensor based on the capacitive measurement. The humidity sensor used in the proposed system has two electrical conductors with a non-conductive polymer film placed between the conductors to create an electric field between them. The role of the film is to collect the moisture from air and this causes the change of voltage levels between the two conductive plates. The voltage value is obtained from the sensor and the values is converted into relative humidity using the python program.

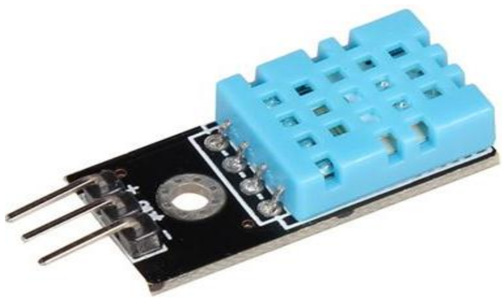

Figure 3 Humidity Sensor

DC Motor

In agriculture, water pumps have motors which help to pump the water from various water reserves to the field. It is usually connected to a relay switch. The relay helps in switching on and off the pump, which is controlled by the developer board. Since the proposed project work is a model of the smart agriculture system, the water pump is replaced by a DC Motor with a consideration that a motor is used in a water pump. Figure 4 illustrates a typical DC Motor. DC Motors are usually used in toys and small electronic appliances.

Figure 4 DC Motor

pH Sensor

pH of the soil is one of the important criteria that determines the growth of soil. If the soil is more acidic or basic, the crops cannot grow. pH is measured in a scale of 1 to 14, 1 highly acidic, 7 neutral and 8-14 is basic. The probes of the sensor are dipped into the soil which sends the value to the terminal. The acidity and basicity of the soil gets modified because of the usage of fertilizers like urea, potash etc. On alerting the user, the user can take necessary steps for the soil.

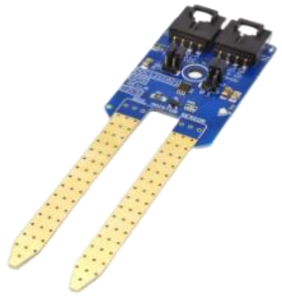

Figure 5 pH Sensor

4. PROPOSED SYSTEM DESIGN

The Figure 6 typically illustrates the block diagram of the overall proposed system. Each component in the system is connected to the developer board which forms the central node of the system. At initialization, the system verifies the hardware connections interfaced with it to ensure the connectivity and informs in case of any failure. It could be found that the pH sensor and Humidity sensor are connected to the central node. For appropriate planning in future, the history of all data that is being collected over a period of time shall be stored in the central node. The data may include the water used for previous irrigation which would help to plan the optimal usage of water in future.

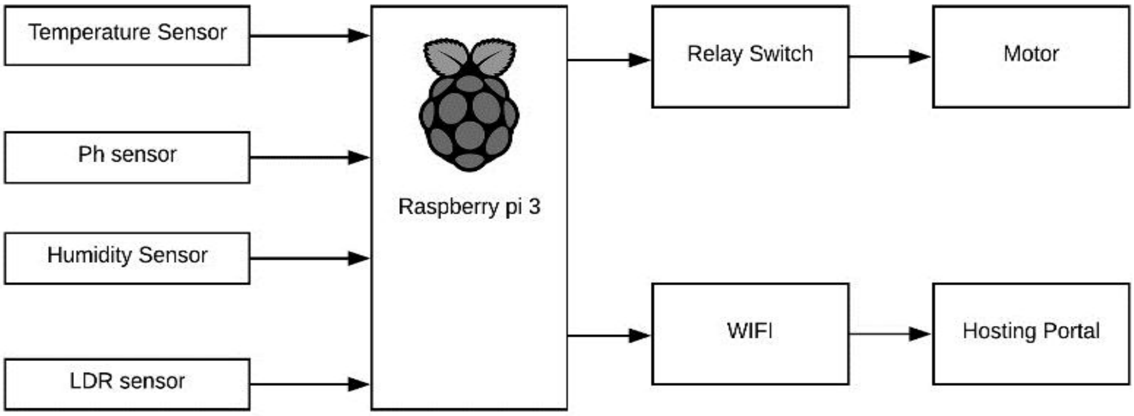

Figure 6 Block Diagram of the System

The humidity sensor and pH sensor are placed in the field to acquire real-time data. The data acquired by the sensors are transmitted to the central node. The data from the central node reaches the central database by means of Wi-Fi. The central database is available in a server which is installed with a Linux server distribution. Any Linux distro can be used. The application is programmed using python and is interfaced with PHP. The PHP is run using Apache server where SMTP is configured appropriately. Alert messages can be received either as e-mail or as SMS depending upon the need of the end-user. The system is also fed with details such as the water used for irrigation, the crop being cultivated, the maturity period of the crop etc. These details help to alert the end-user whenever required. An android mobile application is also designed to receive information and is provided to the user.

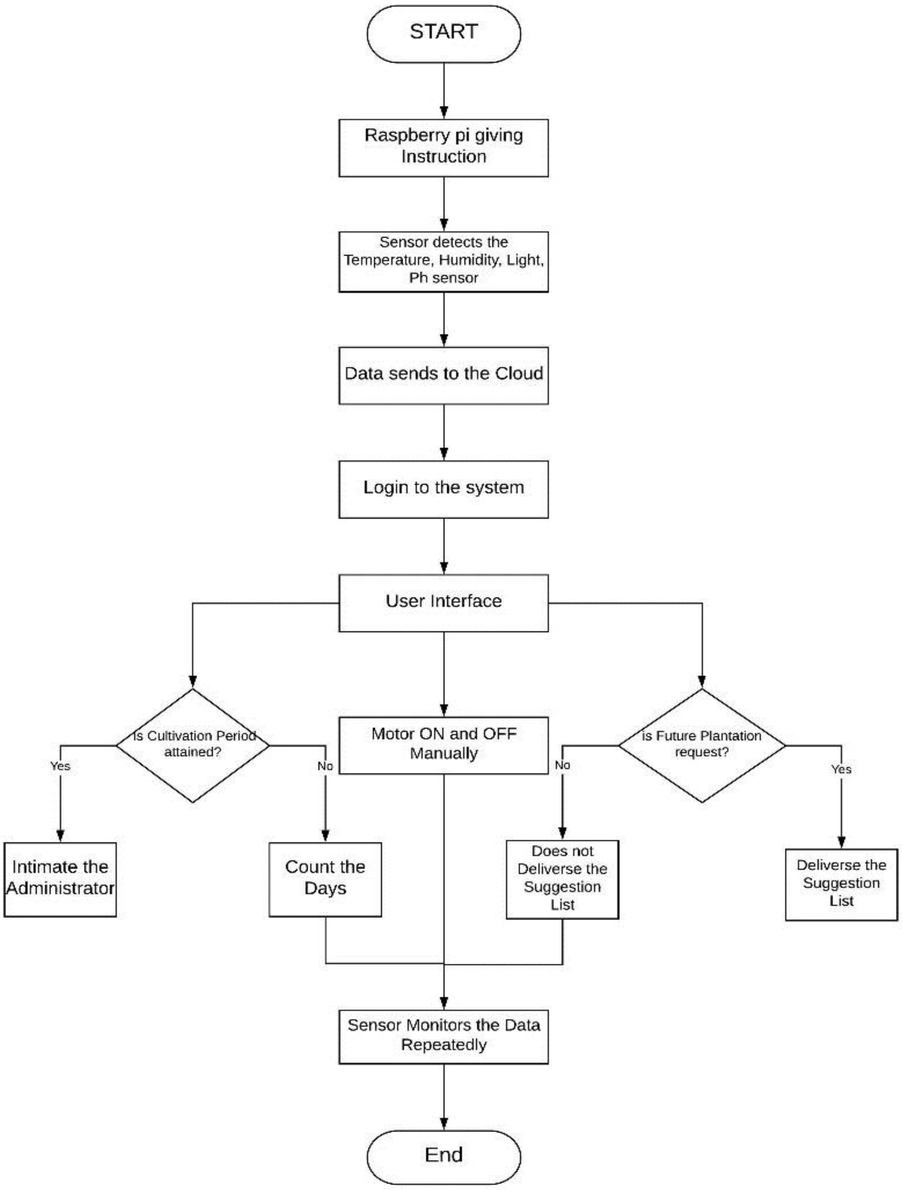

Figure 7 System Flow Diagram

5. EXPERIMENT AND RESULT

The physical design of the hardware is as shown in the Figure 11. The results which were obtained in real-time are shown in Figure 8. Figure 9 shows a screenshot of the interface in the developed mobile application. Figure 10 shows the recommendation for the future irrigation plan. The data received from the sensors are stored in a cloud-based server through the central node and is being processed. The outcomes of the processed information can be viewed by the farmer through his mobile phone or using a PC. The data accumulated in the system can be stored in a common portal which can be used by other agricultural practitioners. The data can be cross-verified with the manual records which are filed in research organizations so far. The sensor values are verified against standard threshold by the central node each time it processes the data to the cloud-based server. Since the data is stored only after certain validation, the data is much reliable and can be used for various purposes.

Proposed System Implementation Images:

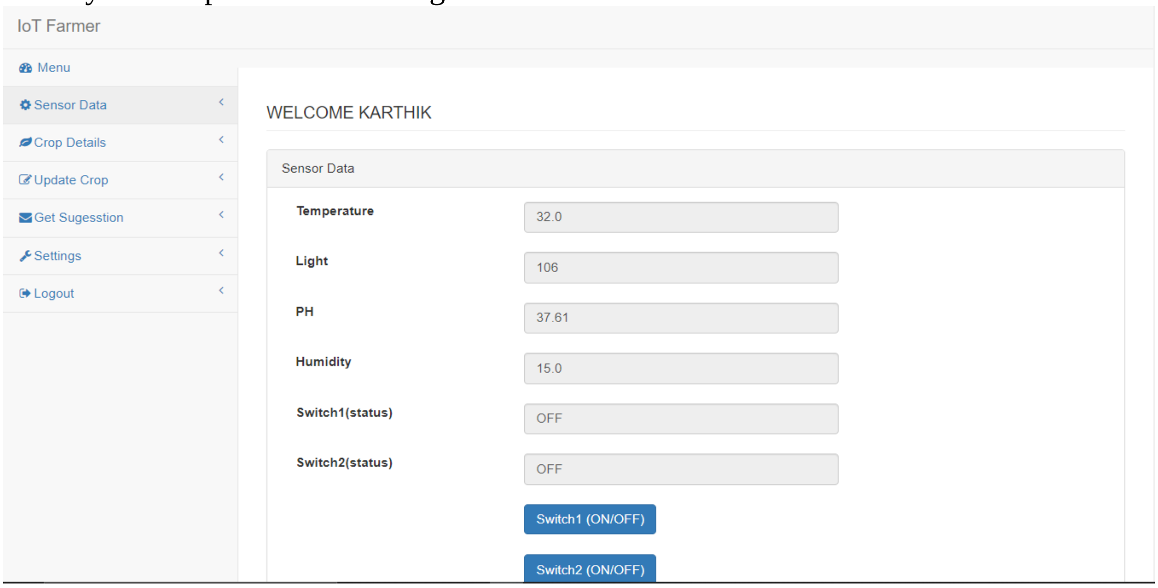

Figure 8 Web Application User Interface

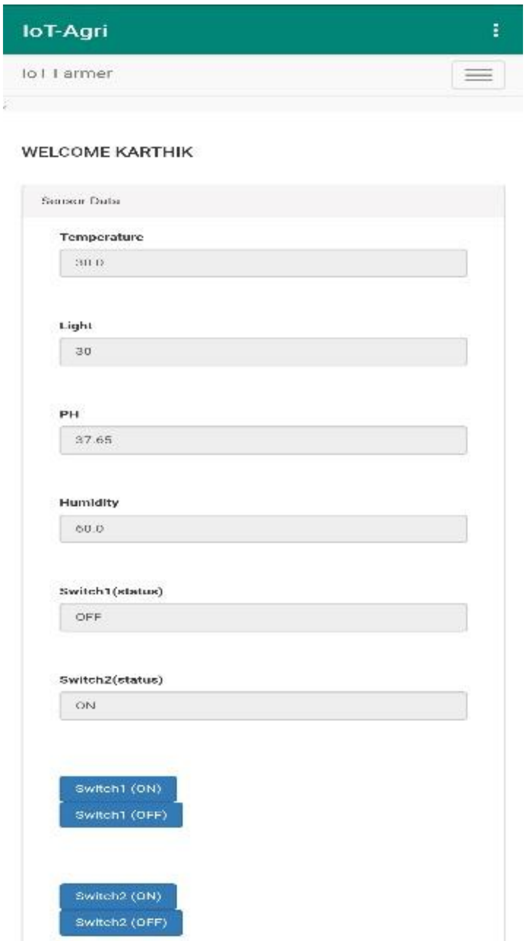

Figure 9 Android Application User Interface

Figure 10 Crop Suggestion Mail Screenshot

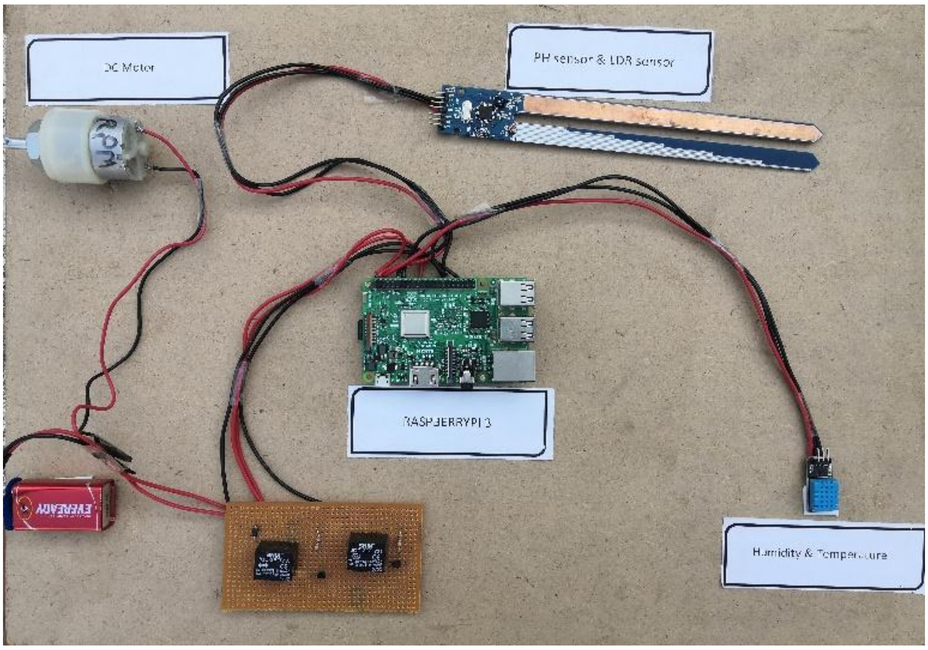

Figure 11: Hardware Kit

6. CONCLUSION

In this work, a Smart agriculture monitoring system is designed and developed which is cost-effective, less complex and more accurate. The system uses only two sensors namely the humidity sensor and the pH sensor. The data acquired from these sensors are used to calibrate the system. The results obtained proves the system to be satisfactory compared to that of most systems that are created with expensive hardware. The hardware and software are both open-sourced and hence any one can avail and use it with much ease. Introduction of such a system amidst farmers will definitely improve the yield and would reduce the cost. It also acts as a recommender system for future irrigations and helps the farmer in the decision-making process with optimal resource utilization. In future, the data could be fed to machine-learning algorithms to automate the optimality of the results.

7. REFERENCES

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