Artificial Intelligence and IoT based Smart Irrigation system for Precision Farming

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Abstract: The application of the technology needs to be employed to the all phase of agriculture. It needs to be precision agriculture rather than traditional as optimization of the resources give the benefit to the farmers and ultimately affect to the GDP of the country positively. The crop production must be increase as the demand is high and production is low. Here, in this paper, the model and framework are proposed for the irrigation system. The objective is to save the water and supply it to the crop only when it is actually required. The Internet of Things (Iot) with the artificial intelligence technologies are adopted to control the irrigation system using smart phone. The moisture level of soil is detected and stored using various sensors which are spread over the farm. The aim is to automate the irrigation system for the crop.

Keywords: Agriculture, Irrigation, Internet of Things (IoT), artificial intelligence

1. Introduction

Farming is one of the uncommon ventures where the computer technologies have not acknowledged in an enormous scope. The main reason for this is the financial state of the majority of the ranchers in India or any emerging nation. Due to an overpopulation and urbanization, the shortage of the agrarian items is increasing gradually. Essentially the rustic territory is diminishing fundamentally step by step and the measure of cultivating is additionally diminishing which may bring about reduction in farming creation. Presently to beat this circumstance, it is required to expand crop productivity by using the resources prudently. Precision agriculture plays a vital role to come out from such challenges. Here, the efforts are given to minimize the wastage of available resources. "Precision agriculture" is a methodology where the harvest cultivating procedure are carried out with the ideal measure of assets needed by the yield for definite time span. For example, in customary irrigation procedure, the irrigation process is carried out based on the experience of farmer without looking at the actual need of the crop. So as a result, there is a chance of water wastage that affects to the crop production.

On the other side, when crop required the water, it is not having at that time and again affects to the crop production. Therefore, by employing the precision agricultural methods, the problem of over irrigation and under irrigation can be solved easily.

There are different technology available to automate any kind of work but Internet of things (IoT) has been applied to the domain like agriculture, hospital, various industries, banking education, home appliances etc. to carried out the work precisely and accurately. Among this, the agriculture sector is being increasing as food is the basic necessity of human as well as animal. There are various approaches and methods are employing to increase the crop production at various stages of farming process. The irrigation process is one of the important phase of the farming. Farming can be made more efficient & accurate with the implementation of IoT device.

Here, in this paper, a model is proposed for sensor based irrigation system, which is utilized to recognize the dampness of the soil. The level of the water is detected using various sensors that are placed in the farm at certain distance. The objective of the proposed work is to collect the data from the sensors and send it to the farmer using IoT Techniques as and when required by the farmers.

1.1 IoT in Agriculture

IoT is a novel technology which is mostly used nowadays almost in all field. Many area of applications required controlling or command of an object or thing from remote location. An IoT is basically number of physical objects or things which are connected together using an internet. Each of these things can be identify uniquely and controlled by the user from its remote locations [9]. IoT is a newer domain where different types of software and hardware are integrated together. It includes software like basic programs for interconnections, mobile applications or windows applications. It also includes various hardware devices like wireless connectors, electronic sensors RFID tags for identifications and many more [1].

A new area of agriculture where a focus is made on quality of crop and attempts are made to increase the quantity is named as precision agriculture. Nowadays most of the research in agriculture domain is made in precision agriculture. Precision agriculture specifically involves various Information Technology concepts for achieving the goals. IoT in agriculture field basically involves sensor network where number of sensors such as

temperature, moisture, light and speed are involved. Recent technologies such as WiFi, Bluetooth, RFID, WLAN, LTE and PON are used with IoT network. IoT demand increases day by day due to its simplified hardware which involves low cost microcontroller, low cost computing devices and wireless sensors. Another important concept is which type of IoT cloud platform is used to create or develop the application. Various cloud platforms are provided by Microsoft, Google, IBM, Salesforce and many more.

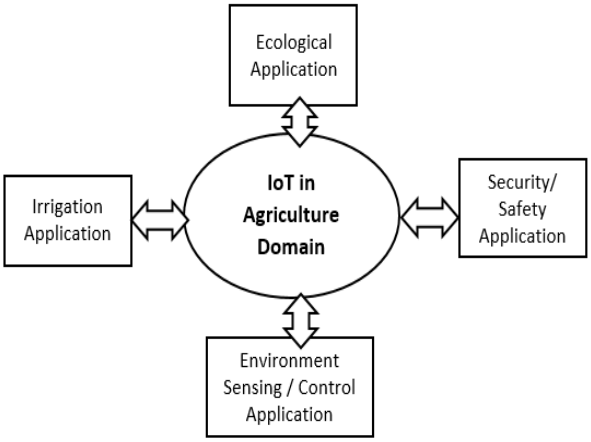

Fig 1: IoT in agriculture domain [1]

Various application areas in agriculture domain are shown in Fig 1. It is broadly classified into four major categories. Environment sensing / control application basically deals with the issues related with how to sense environmental parameters such as temperature, air moisture, soil moisture, wind speed etc. Irrigation application basically deals with issues related with irrigation of crops, its timing and frequency based on collected data from soil and water level. Security / safety address the issues related with protection of farm under critical environmental situations such as protecting crops from heavy rain, high wind situation as well as provide safety from animals and others. Ecological application deals quality parameters of agriculture products such as optimal growth, productivity and pest control.

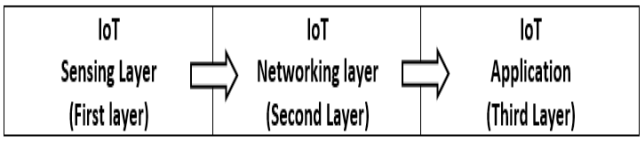

Fig 2: IoT three layers architecture [1]

There are multiple ways to define IoT layers. In some literature [2] layers are mentioned while in other literature[3] layers are mentioned. Fig 2 shows three-layer architecture of an IoT system where the lowest layer is IoT sensing layer. It basically deals with senor device which are used to collect the row data from selected farming application. The middle layer is networking and data communication layer which basically deals with sending collected data over network from one node to another. It also shows the interconnection between smart devices using cloud technology. The uppermost layer is an application layer which basically provides direct services to users of the application. It also involves various protocols for passing information to users of application. In recent IoT technology a top most layer is added which deals with Data Analytics. When user wants to involve the concept of artificial intelligence, machine learning or deep learning then this layer is useful because it collected and analyzed data based on user requirement in meaningful ways.

1.2 Hardware Devices required in IoT based Agriculture Applications

Various devices used in precision agriculture applications are Microcontrollers, Sensors, cameras, drones, LCD screen, LED indicators, Power supply module, Relays, PC / Laptop /Mobile, Mechanical devices such as water pump etc. All physical devices together with Software supports create an IoT Network. Below is the description of various system components used in the system.

Microcontroller / Microprocessor:

It is the heart of any embedded system. For reliable system functioning now a days raspberry Pi is used in many embedded systems.

Fig 3: Raspberry pi

Soil Moisture sensor:

It is a kind of probe which task is to detect the moisture level of soil. Using this you can find how much moist is there in your plants or soil. It is having four terminals Vcc, ground, Digital output interface and analog output interface.

Fig 4: Soil Moisture Sensor

LCD Display:

LCD display is used to display the details of sensor data on screen. It is generally available with (16 x 2) size where there are 2 rows and 16 columns. Once the data transfer is completed then user can display the message on screen.

Fig 5: 16x2 LCD display

Relay:

Relay is basically used for current conversion in embedded system. Whenever a signal from high power circuit is given to computer or vice versa then current conversion must be required. It is implemented by a circuit known as relay.

Fig 6: channel relay

2. Literature survey

J. Shenoy and Y. Pingle, the writers, mentioned potential solutions for lowering transportation costs for agricultural goods, as well as providing a solution for eliminating middlemen, who typically receive a larger market share than farmers and customers. This approach aids in the cooperation of farmers and agricultural commodity buyers [4].The author Ji-chun Zhao et al. applied the IoT with greenhouse monitor system based for monitoring and controlling the agriculture production [5].

The IoT and automation was applied to manage agricultural work. Based on this, farmers will plan which crops to grow based on consumer demand rather than investing the majority of their time on crop maintenance [2].

The author had demonstrated on how technologies like IoT, cloud operation and big data can help in smart farming as well as to the farmers in the aspect of production [6]. The control of water and electricity wastage in poly house is carried out using IoT with network sensors to enhance quality and quantity of production, save resources like water and electricity, and make more production of the crop. The aim is to optimize the usage of resources and maximize the production using smart farming [7].

The sensor based Internet of Things (IoT) and Machine Learning techniques are employed together in "smart agriculture management system" (SAMS) to support the agrarians for maximizing the crop production and reduction in resource wastage[8].

The authors propose a project to make agriculture smarter with the use of robotics and IoT technology, which involves a smart GPS-based remote controlled robot that can perform tasks such as weeding, spraying, moisture sensing, bird and animal scaring, vigilance, and so on. Second, it provides smart irrigation with intelligent control and decision making based on precise real-time field data. Third, smart warehouse management provides temperature and humidity control, as well as theft monitoring in the warehouse [9].

The various areas where IoT has been employed in agriculture related work are discussed in depth [10]. There are various model proposed by the authors. One of them is Smart Drone, a crop land eye-in-the-sky that is more powerful than satellite technology in building a Smart Agriculture. [11].

3. proposed model

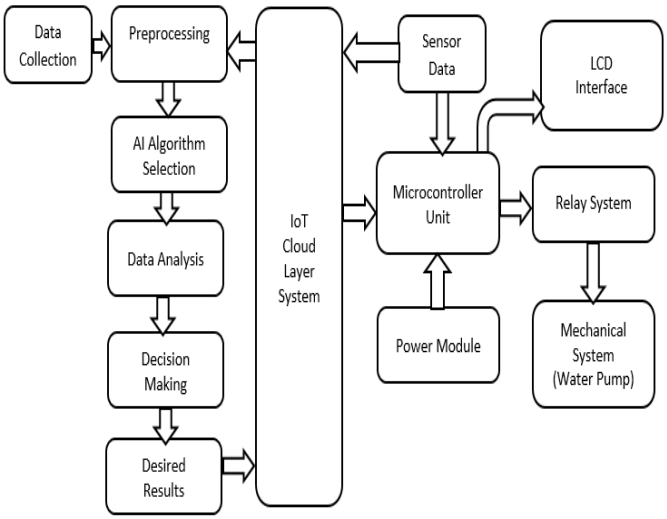

Fig 7: Proposed System Block Diagram

Proposed system block diagram is shown in Fig 7. All necessary blocks are shown in this diagram. System starts with available raw data. This raw data can be generated based on system requirements or this data can be directly generated from available sensors directly.

As a sensor soil moisture sensor can be used which can detect the level of moisture of the soil. Data collection can also be done by some predefined datasets. This data is pre-processed or cleaned so that desired data only can be generated as system input [12]. Any AI based algorithm is used which trains the data collected and after that machines are trained based on weather pattern, soil quality etc.

Data analysis will be done for processed data and based on that decision will be taken for required data. Required data will be the desired results and though IOT layers it will be passed to microcontroller or microprocessor unit. Well known microcontrollers are Arduino Uno or raspberry PI. Power module is there to supply power for all hardware. Microcontroller will process the data and send it to mechanical system through relay. Relay is current conversion device which converts incoming signal into desired current signal. For irrigation system water pump can be used as output device.

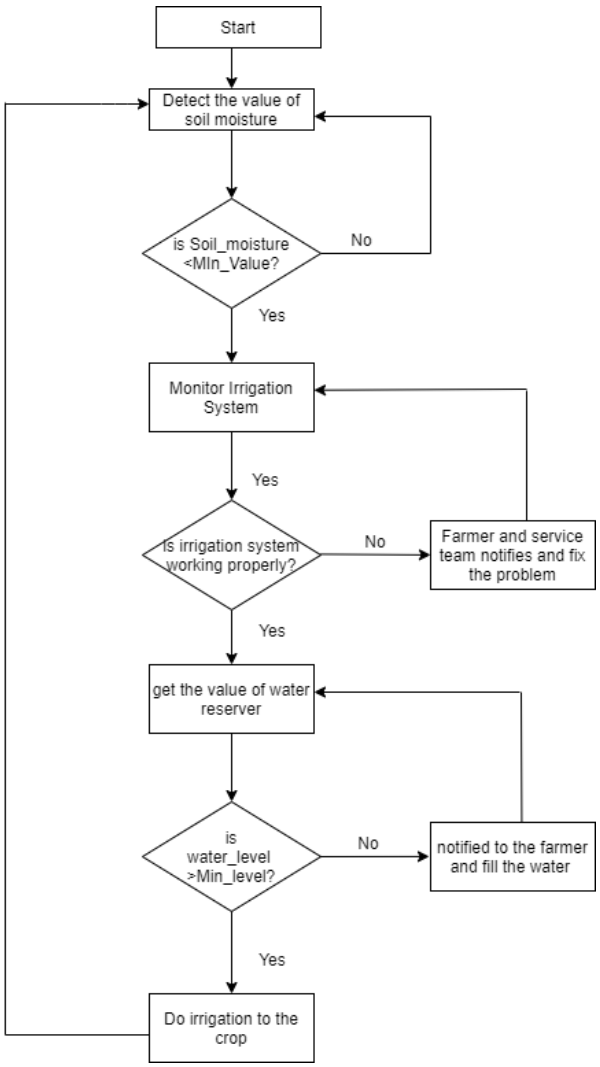

Fig 8: Proposed Irrigation Model

The proposed irrigation model is shown in the figure 8. First of all, the value of the soil from various sensors are detected and recorded in the embedded devices. Then after, it will be checked with the required level of the moisture. If it is found that the recorded values are lower than the required level, then the irrigation system will start. But before the irrigation, the level of the water in the reserve is check. Again, if it is below to the set value then the notification will send to the farmer mobile app and ask for the filling. After that, the irrigation system will start and crop will irrigate [2].

4. Conclusion

The aim of precision agriculture through the use of IoT is to advance agriculture in order to increase crop productivity and optimize resources. In addition, the farmer has been prepared to take advantage of such resources. With the advent of IoT, the aim of smart agriculture is to include the latest technology in agriculture and farming for greater crop production by assembling the current real-time status of crop and making the farmers understand the innovation in agriculture, with both a number of added features and functionality in order to enhance agricultural practices.

5. future work

Temperature, relative humidity, and light illumination across the plant, in addition to soil moisture, are important parameters to monitor and track. This could be tracked and regulated by a smart agriculture device based on IoT.

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