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Decision Support System for Smart Agriculture using IoT

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Abstract: *Smart farming based on IoT technologies will enable growers and farmers to reduce waste and enhance productivity with the help of various sensors ranging from the quantity of fertilizer utilized to the soil quality of the farm. In this paper, the proposed projects aim for the motivation of the farmers working in the farm lands and are only dependent on the rainfall and bore wells for irrigation of their land. Currently, the farmers are dependent on the traditional methods of water management and farming. The farmers are suffering from various changes in the atmosphere due to various environmental factors. Proper data analysis and availability of timely solutions may improve the productivity of the crop by optimizing the requirement of the resources will help farmers to improve their financial condition and ultimately will improve our National Economy. In this paper, a Smart IoT based Agriculture System assisting farmers in getting real time data such as temperature, soil, humidity etc. for efficient environment monitoring which will enable them to do smart farming and increase their productivity. The proposed project is integrated with IoT Technology with various sensors and real time data can be obtained through smart phones.*

Keywords: Agriculture, Cloud Computing, IOT, Smart Farming

1. Introduction

The Internet of Things (IoT) is an environment in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring Human-to-Human or Human-to-Computer interaction. IoT has evolved from the convergence of Wireless Technologies, MicroElectroMechanical Systems (MEMS) and the Internet. IoT is more than smart homes and connected appliances. IoT is about connecting devices over the Internet, letting them talk to us, applications, and each other. Essentially, it is an overarching platform that allows a variety of devices or machines to communicate with each other by "Machine to Machine" communication (M2M).

In Internet of Things (IoT) based smart farming system, a system is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil testing, etc.) and automating the irrigation system. The field conditions can be monitored and managed with the help of expert system by the farmers from anywhere. IoT-based smart farming is highly efficient when compared with the conventional approach. The analysis can be done for the following parameters:

1. Atmosphere analysis
2. Soil testing analysis
3. Water management analysis
4. Resources and Fertilizers requirement analysis

The future of Smart Computing will be totally based on Internet of Things. Currently IoT is playing an important role in transforming the conventional methods from homes to offices to future age band. IoT is used everywhere in computing [1] gaining an important place in research across the world and especially in area of future decision support system. Internet of Things refers to uniquely identifiable objects, things and their respective virtual representations in Internet like structure which was proposed in year 1998 [2]. In 1999, the term "Internet of Things" was discovered by "Kevin Ashton" with regard to supply chain management. Presently IoT has been used by its strength and adaptability. IoT has positioned the foundation of development of different products like smart living, e-health services, automation and also smart education. IoT these days is being used in business management, manufacturing, intelligent transportation and even agriculture from commercial point of view.

The main areas where IoT based research is going on and new products are launching on everyday make the activities smarter and efficient towards better production is "Agriculture". Agriculture sector is regarded as the more important sector globally for ensuring food security. Agribusiness required the devotion of numerous regular asset including, land, water, and ecological condition and the real time data for analysis. The quality and amount of characteristic asset has debased throughout the years because of monetary issues related with expanded cost of info and diminishing ranch salary always declining land, labor, resources, and environmental issue, for example, soil and water contamination putting the suitability without bounds horticulture operation at chance. Our life is turning into more smart and simple because of the IoT technologies and applications gradually.

It is clear that in the agriculture field the IoT, cloud and decision support system concepts are used separately to predict the crop yields. As a novelty, a smart agricultural model is proposed by integrating the above concepts to deliver the prediction attributes to the farmers through the mobile computing technology called IOT. The solution for this is to embrace the savvy agribusiness framework in light of IOT with help farming administration and development of products including less utilization of water, compost and pesticide.This technology is used in the agriculture field to collect the data through the sensors and stored in the cloud database through the internet. Then using the expert system techniques to analyze and predict the crop and cost of the fertilizers.

Internet of Things (IoT) technology has brought revolution to each and every field of common man's life by making everything smart and intelligent. Internet of Things refers to a network of things which make a self-configuring network. The development of Internet of Things Smart Farming based devices is day by day turning the face of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage.

The aim is to propose a Smart IoT based Agriculture Decision Support System for farmers. The proposed system collects the data is real time using IOT based sensors related to farming getting and transfers it to the cloud for data analysis, which will be processed using expert system and will be available for the farmers as decision support system. The output of the proposed system will help farmers to optimize the resources such as seeds, pesticides, fertilizers, water etc. this will improve the crop yield at the same time reduces cost of production. Real time data acquisition through IOT and processing using expert system are the real features of the project which will provide timely expert opinions with improved accuracy to the farmers which indeed is the major need of farming.

IOT for automatic irrigation of an agriculture field offers a potential solution to support site specific irrigation management that allows producers to maximize their productivity while saving the water. The proposed research project has many advantages like:

1. The proposed project enables easy collection and management of large amount of real time through IOT which otherwise is very difficult to collect.
2. Data can be accessed from anywhere and everywhere in real time enabling live monitoring and end to end connectivity.
3. The proposed project is regarded as main component for Smart Farming with accurate sensors, smart equipments and timely analysis, which may help farmers to improve the production and to reduce the cost.
4. Cost of production can be reduced to a great level which will in turn increase profitability and sustainability.
5. Efficiency level of farming can be increased in terms of usage of Soil, Water, Fertilizers, and Pesticides etc.
6. By maintaining the database of agriculture information, the past data can also be used to design agricultural model for the region.
7. The main features of the project include efficient and low cost design, fast response and user friendly.

2. Literature Review

Traditional method of farming is no longer cost effective due to the various factors such as division of agriculture fields into small pieces, scarcity of water, cost of fertilizers and seeds etc. There is great need to introduce state of art technology which will help in the proper management of agriculture fields by optimizing resources to take timely decision, reduce the cost of production, improve the yield etc. Use of IOT technology with real time sensors will greatly help to collect the real time data at minimum of the cost. Also the data analysis and expert system interface will help the farmers to take timely and proper decision in the management of the agriculture field. Collection of data of the region will also help the decision makers to frame proper policies for the region.

The newer scenario of decreasing water tables, drying up of rivers and tanks, unpredictable environment present an urgent need of proper utilization of water. To cope up with this use of temperature and moisture sensor at suitable locations for monitoring of crops is implemented in. [3]

Since independence one of the most neglected field is agriculture, although 70 % of the population of our country is dependent of agriculture and major part of our economy depends on agriculture. We failed to update our policies related to improvement in agriculture. This results in losses in production, wastage of resources, failures of crop and unfortunately suicides by the farmers. This is in the interest on the nation to implement timely policies to help farmers manage all the activities from sowing upto selling their agriculture products. For framing such policies we need region wise real time data and needs expert analysis to find gaps and solutions to remove the gaps [5].

India being a huge country mass landscape under agriculture, it is very difficult to collect all the parameters regularly, as well as to process this collected data in the required time frame. The proposed model provides the solution of collection of real time data, its storage in the cloud base database so that it will easily available for various agencies to study and use this data for designing their policies. Also the processed data from this system will not help the farmers but the results can be used by farmers of the other region as well as agencies to design their policies. This may result into improvement in agriculture field.

An algorithm developed with threshold values of temperature and soil moisture can be programmed into a microcontroller-based gateway to control water quantity. The system can be powered by photovoltaic panels and can have a duplex communication link based on a cellular Internet interface that allows data inspection and irrigation scheduling to be programmed through a web page [4]. The technological development in Wireless Sensor Networks made it possible to use in monitoring and control of greenhouse parameter in precision agriculture [9].

After the research in the agricultural field, researchers found that the yield of agriculture is decreasing day by day. However, use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the extra man power efforts. Some of the research attempts are done for betterment of farmers which provides the systems that use technologies helpful for increasing the agricultural yield. A remote sensing and control irrigation system using distributed wireless sensor network aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to maximize the productivity with minimal use of water was developed by Y. Kim [8]. The system described details about the design and instrumentation of variable rate irrigation, wireless sensor network and real time in field sensing and control by using appropriate software. The whole system
was developed using five in field sensor stations which collects the data and send it to the base station using global positioning system (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. The system provides a promising low cost wireless solution as well as remote controlling for precision irrigation [6].

In the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity. Sensors were placed below the soil which communicates with relay nodes by the use

of effective communication protocol providing very low duty cycle and hence increasing the life time of soil monitoring system. The system was developed using microcontroller, universal asynchronous receiver transmitter (UART) interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency (RF) signals [7].

2.1 Benefits of IoT in Agriculture

The following are the benefits of IoT in Agriculture:

1. IoT enables real time data collection and analysis through different sensors and with integration of cloud computing services like fields maps, cloud storage etc., data can be accessed real time from anywhere and everywhere enabling live monitoring and end to end connectivity among all the users.
2. With IoT, efficiency level would be increased in terms of usage of Soil, Water, Fertilizers, Pesticides etc.
3. IoT is considered as the key component for Smart Farming as with precise sensors and elegant equipment's, farmers can increase the food production by 70 %.
4. With IoT productions costs can be reduced to a extraordinary level which will in turn increase profitability and sustainability.
5. With IoT, various factors would also lead to the protection of environment.

3. Proposed System

The proposed system consists of four modules with smart phone or computing system to control and monitor the system. Every module is integration with different sensors in the current system and devices and they are interconnected to one central server via wireless communication component. The server sends and receives information from user end using internet connectivity. There are two modes of operation of the system; auto mode and manual mode. In auto mode system takes its own decisions and controls the installed devices whereas in manual mode user can control the operations of system using android app or PC commands.

Combination of IOT technology, real time sensors, cloud based data collection, analysis, expert system interface and faster communication technology will result in one of the best and efficient solution for the long pending agriculture problems.

The first module consists of GPS based mobile robot which can be controlled remotely using computer as well as it can be programmed so as to navigate autonomously within the boundary of field using the co-ordinates given by GPS module. The controlled robot through remote equipped with different sensors and real time devices like camera, obstacle sensor, siren, cutter, sprayer and using them it will perform tasks like; Keeping vigilance, Bird and animal scaring, Weeding, and Spraying

The second module consists will be the storehouse. It is equipped with motion detector, light sensor, humidity sensor, temperature sensor, room heater, cooling fan altogether interfaced with AVR

microcontroller. Motion detector will detect the motion in the room when security mode will be ON and on detection of motion, it will send the alert signal to user via IoT kit and therefore providing theft detection.

Humidity sensor and Temperature sensor senses the temperature and humidity and if the value crosses the threshold then room heater or cooling fan will be switched ON/OFF automatically providing temperature and humidity maintenance. Module 2 will also controls water pump depending upon the soil moisture data sent by

The third module is a smart irrigation module with characteristics like smart control of water pump based on real time field data i.e. automatically turning on/off the pump after attaining the required soil moisture level in auto mode, switching water pump on/off remotely via mobile or computer in manual mode, and continuous monitoring of soil moisture. In this module, moisture sensor transmits the data using HT12E Encoder IC and a RF transmitter. The transmitted data is received by module 2 and there it is processed by microcontroller in order to control the operation of water pump.

There are different hardware devices are used is the proposed system some of them are AVR Microcontroller Atmega 16/32-bit, ZigBee Module, Temperature Sensor LM35, Moisture sensors, Humidity sensor, Obstacle sensor, Raspberry Pi along with some software such as AVR Studio, Proteus 8 Simulator, Matlab, Dip Trace, SinaProg, Raspbian Operating System.

4. Real Time Experimentation And Results

Experimental setup for all modules consists of mobile robot with central server, GPS module, camera and other sensors. All sensors are successfully interfaced with microcontroller and the microcontroller is interfaced with the raspberry pi.GPS and camera are also connected to raspberry pi. Test results shows that the robot can be controlled remotely using wireless transmission of PC commands to Raspberry -Pi. Raspberry -Pi forwards the commands to microcontroller and microcontroller gives signals to motor driver in order to drive the Robot. GPS module provides the co-ordinates for the location of the robot

The proposed system consists of motion detector, temperature sensor, humidity senor, cooling fan, water pump, etc. connected to the microcontroller board. The sensors gives input to the controller and according to that microcontroller controls the devices in auto mode and also sends the value of sensors to R-Pi and R-Pi forwards it to user's smart device using internet. Test results shows that when temperature level increases above preset threshold level then cooling fan is started automatically in auto mode. The water pump also gets turned ON if moisture level goes below fixed threshold value. In manual mode, microcontroller receives the controlling signals from R-Pi through ZigBee and accordingly takes the control action. The proposed system consists of a moisture sensor connected to HT12E. Moisture sensor transmits the data using HT12E Encoder IC and a RF transmitter to the Node2 where it is processed by microcontroller and accordingly water pump is switched ON/OFF.

5. Conclusion

In most of the part of our country, farmers are relying on the traditional methods of farming. Environmental factors like global warming, ozone layer, scarcity of water etc. are impacting the economy of farming adversely. To fight these factors use of real time technologies combined with the advancement in the farming inputs is the need of the time. IOT, computer analysis, Internet and improved communication, expert systems and sensors can provide great help to the farmers in monitoring and management of farm and its resources. The sensors and microcontrollers of the proposed system are successfully interfaced and wireless communication is achieved. All observations and experimental tests proves that project is a complete solution to field activities, irrigation problems, and storage problems using remote controlled robot, smart irrigation system and a smart warehouse management system. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

In the backward region like Vidharba, 80 % of the local population depends on agriculture. Since past few years irregular rainfall, climate changes and lack of knowledge of the latest development in agriculture has increased their losses. Use of IT technology combined with the current state of art in agriculture may help farmers in optimizing the resources while increasing the yield of agriculture products. This ultimately will improve their economy.

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