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Research Article

Design of Infrastructure for Precision Agriculture to Empower Farmers

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Abstract

Agriculture is primarily business in India, where 58% of the population depends upon agriculture. Precision farming is regarding doing the Right things in proper place, in the right manner, at the proper time. Managing crop production inputs like water, seed, chemical etc to increase yield, quality and profit, also focusing on reduction in waste of water and becomes eco-friendly. The intent of precision agriculture is to match agricultural inputs and practices as per crop and agro-climatic conditions to boost the yield of crop. Wireless sensor network (WSN) is a crucial and exciting technology with nice potential for application in varied fields together with drugs, transportation, agriculture, process management, global scale environmental watching and Precision agriculture. This work includes algorithm to compute the period of irrigation and take decisions according to the measured parameters. Hardware and software design are proposed this paper.

Keywords: Precision Agriculture; Crop Yield; Water Wastage; WSN; Nodes

Abbreviations

WSN: Wireless Sensor Network; DSS: Decision support System; DHT: Digital Humidity Temperature

Introduction

India is especially an agricultural country. Agriculture is the earning source for many of the Indian families. Over hour of India's expanse is cultivatable creating it the second largest country in terms of total cultivatable land. Most of the farming in Republic of India is monsoon dependent. Green revolution began in Republic of India with an objective to offer bigger emphasis on Agriculture. Vital increase in the production of food crops, the productivity of land accumulated tremendously giving immense economic boost to Irrigation that consumes 81% of the overall water use within the country wants a correct overhaul if the country has to improve agricultural output and boost the general economy. Irrigation water is changing into a scarce artifact. so correct harvesting and economical utilization of water is of nice importance. Intensive cultivation as a result of introduction of high yielding varieties within the middle 1960's needed higher energy inputs and higher management practices. Land preparation, harvesting, separation and irrigation area unit operations, which utilize most of the energy employed in agriculture. Small and marginal farmers have restricted resources particularly in rain-fed regions wherever solely animate power is employed leading to low productivity.

Agriculture mechanization is viewed as package of technology to guarantee in timely field operations to extend productivity, scale back crop losses and improve quality of crops and increase land utilization. Usage of excess chemical is big issue in India, Excess chemical usage not solely makes the plants addicted to the synthetic fertilizers however additionally erodes the land quality, impure well water and just in case of surface runoff, pollutes the close water bodies. The excessive evaporation cause salts to accumulate on the fields creating them lose their fertility quickly. Lack of correct understanding of the necessity to grow crops sustainably can push farmers into vicious circle of debts, significant use of fertilizers, water management and low productivity. Agriculture currently ought to shift to knowledge-based from resource-based technology. This state of affairs at the side of increasing industrialization and urbanization are swing tremendous strain on the restricted and dwindling land and water resources. Unless corrective measures are taken, there is also irreversible harm to the setting and also the resource base. The challenge is to provide enough food on property basis to fulfil the essential necessities of the ever-increasing population whereas maintaining the natural resources and protective diversity. It, therefore, needs information and resource conservation based mostly technology and machines for property agricultural production and productivity. Once taking review on all the condition we've set to style a system that overcomes all the issues facing cultivators. The most aim of the system is to extend crop productivity with less time consumption.

Related work

There are numerous publications on precision agriculture. The simulation of WSN for agriculture victimization OPNET simulation tools through-out that random and grid topologies were mentioned and compared [6], the study evaluated the performance of the networks by observance delay, output and wares. This approach, however, lacks smart aspects where flaws become totally inevitable. Another WSN preparation of irrigation system victimization ZigBee protocol are bestowed [2,7], this study did not take into consideration observance the performance of communication links between detector nodes that's sensible deployments as a result of it impacts battery life. Despite having an in-depth vogue for the powering aspect, it is not clear whether or not or not they monitored battery levels for the detector nodes or not [5]. An automatic Irrigation Management and programing System supported Wireless detector Network (WSN) can accept any desired irrigation programing strategy to satisfy specific environmental wants. Unlike laboratory Primarily based simulations and experimental installations, sensible readying must handle such challenges to be fully helpful. Wireless detector Networks have Associate in Nursing giant potential to irrigation management and programming management; such, if elegant, will be a solution to a affordable automatic irrigation management system acceptable for developing countries to unravel precision agriculture is mostly considered within greenhouses [3,9]. The A2S approach is designed to monitor and control the environmental parameters and the growing of cabbages and melons. However, the irrigation system in [4] considers only specific plants. In [3], a real time monitoring and control system is proposed for greenhouse to control environmental parameters like temperature and relative humidity using wireless sensor network. precision agriculture in greenhouse is developed in [1] through measuring of temperature, humidity and moisture. When the threshold values are excited, pumps and valves get activated for irrigation. Intelligent Greenhouse Monitoring System [4] and Greenhouse Monitoring System [5] are developed for monitoring of Agriculture parameters. The result shows that automatic irrigation is more efficient than the traditional scheduled irrigation. However, the systems proposed in [1,4,5] consider only one plant rather than the whole area of plants. All the above researches do not consider the period of agricultural activities such as irrigation and in turn the agricultural resources may waste.

Proposed methodology

As shown in figure 1, sensor network is deployed in planned manner inside the farm. Sensor nodes measure the temperature, ambient relative humidity, soil temperature and Soil Moisture. The communication of sensor node to the coordinator node is star topology, where the messages are received from sensor nodes to coordinator node until the coordinator node sends an acknowledgement signal to every sensor node. The coordinator node forwards the messages to the main server via zigbee connectivity. According to the sensed parameters, the system aims to determine the right time for irrigation to open up the irrigation plumb. Figure 2 shows the Precision agriculture sensor node arrangement. Heart of Every sensor node is the microcontroller. Arduino Microcontroller is used in this paper. The DHT11 is connected to the Arduino for the temperature and humidity, also thermal sensor and soil moisture sensors are used as input devices, On the other hand, the Water pump connected to the Arduino as output device. The farmer controls and monitors the parameters using Android Application. All the nodes are solar powered and coordinator node/ gateway is made up of Raspberry Pi-3, which will communicate with all the nodes at the specific time interval and accept the data from every node, all received data is then send over the internet and received by the Android Mobile as well as Server computer for further actions.

Software algorithms

The Individual description and algorithms for each library function Library: SENSOR.

The library is responsible for acquiring data from the sensors deployed on the field. It consists of following functions:

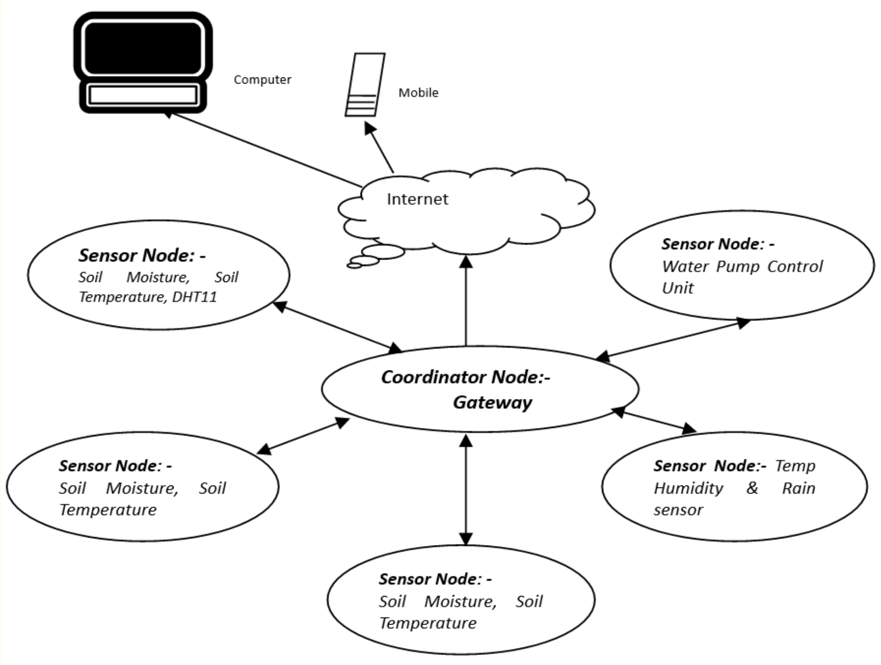

Figure 1: Wireless Sensor framework.

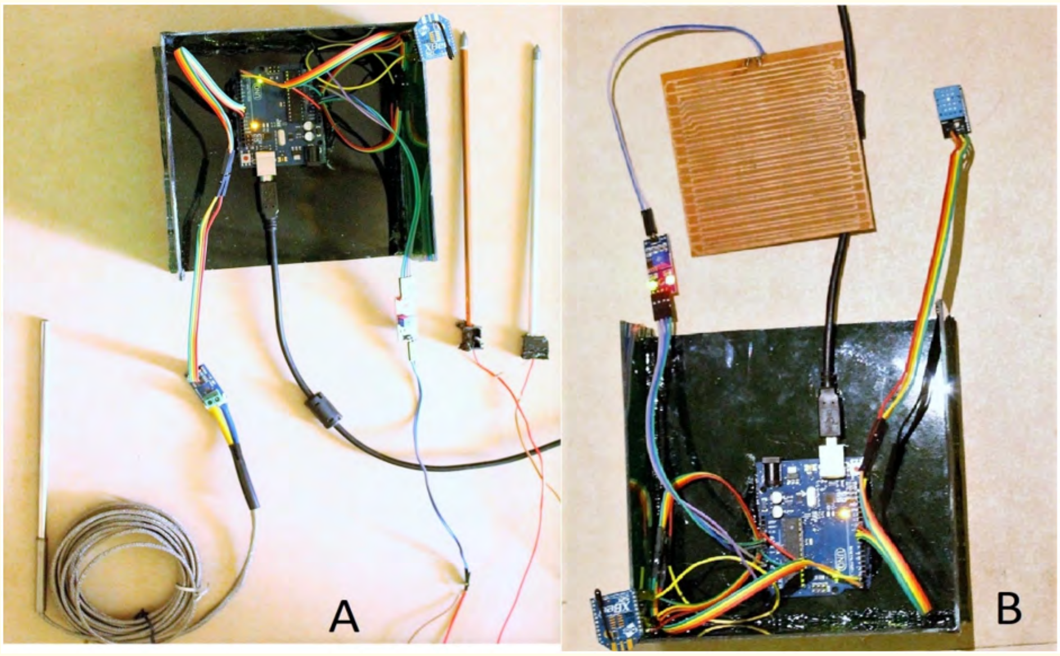

Figure 2: Sensor Node Arrangement.
A) Node for Soil Temp. and Moisture. B) Temp. Humidity (DHT11) and Rain Drop Sensor Node.

Request data (): Sends a request to the nodes sequentially.

Algorithm:

1. Initialization
2. Set up serial interface of raspberry pi
3. Time delay
4. End initialization
5. Set flag0
6. While flag0 = true
7. Send request frame to the selected node
8. Wait for acknowledgement
9. If transmission successful
10. Set flag1
11. Return flag1
12. Reset flag0
13. Else if transmission unsuccessful
14. Reset flag1
15. Return flag1
16. Else
17. Go to 6

Listen response (): Receives the sensor data acknowledgement.

Algorithm:

1. Initialization
2. Set up serial interface of raspberry pi
3. end Initialization
4. Select the receiver buffer size
5. Read flag1 from request data ()
6. While flag1 = True
7. Listen for acknowledgement from selected node
8. Check for valid frame format of the received packet
9. If packet valid
10. Return the received packet frame
11. Else
12. Go to 6

Validate (): Performs validation of the data packets and nullifies the rotation of received data packet during transmission.

Algorithm:

1. Select node
2. If atmosphere node is selected
3. Check for presence of sensor data markers in packet
4. If all markers present
5. Accept data
6. Null the rotation
7. Obtain original packet
8. Return original packet
9. Else
10. Exit
11. Else if soil node is selected
12. Check for presence of sensor data markers in packet
13. If all markers present
14. Accept data
15. Null the rotation
16. Obtain original packet
17. Return original packet
18. Else
19. Exit
20. Else
21. Exit

Atmosphere node de (): Extracts the sensor data for atmosphere temperature, humidity, rain indication from the validated data packet.

Algorithm:

1. Take original atmosphere node packet from validate ()
2. Extract atmosphere temperature
3. Extract atmosphere humidity
4. Extract rain status
5. Return atmosphere temperature
6. Return atmosphere humidity
7. Return rain status

Soil node de (): Extracts the sensor data for soil temperature and moisture from the validated data packet.

Algorithm:

1. Take original soil node packet from validate ()
2. Extract soil temperature
3. Extract soil moisture
4. Return soil temperature
5. Return soil moisture

Save data (): Save the extracted data in the database

Algorithm:

1. Take input the atmosphere and soil node sensor data
2. Store the current local time
3. Extract year, month, day, hour information
4. Define storage path for each parameter from the time information in step 3
5. Open files using the defined storage path
6. Store atmosphere temperature and time stamp in opened storage database file in step 5
7. Store atmosphere humidity and time stamp in opened storage database file in step 5
8. Store rain status and time stamp in opened storage database file in step 5
9. Store soil temperature and time stamp in opened storage database file in step 5
10. Store soil moisture and time stamp in opened storage database file in step 5
11. Close database files
12. Open the time flag storage file
13. Save current time flag
14. Exit

Results and Discussions

Figure 3 shows the visualization of acquired data in a android application of farmers it consists hourly data of soil temperature and Moisture, also the atmospheric temperature and relative Humidity and status of the rain. In the results we have taken a report of intermediate data of one-hour data acquisition. The algorithms developed in such manner to keep the system up to date with latest agriculture field parameters and give the flexibility to overall control and monitoring of parameters. With the help of Android smart phone farmers can get the all details in the farm even from a remote place. The overall impact of research will result in technology-assisted sustainable agriculture by avoiding unnecessary conditions to occur and making a robust decision support system to enhance crop yield with low cost solution. Deploying this setup will make farmers happier by improving their crop.

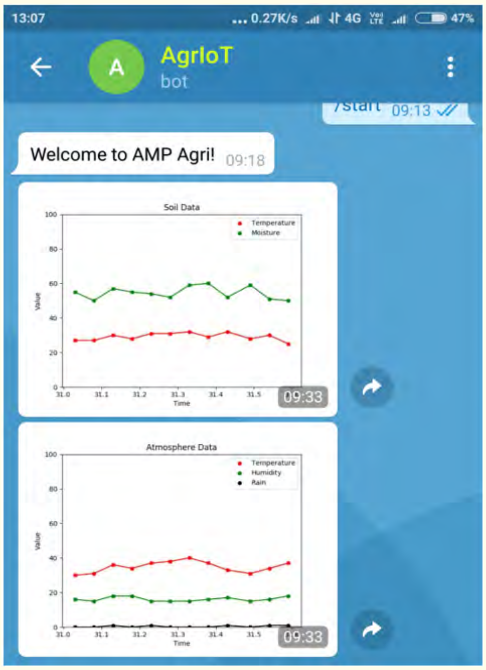

Figure 3: Data Visualization on Smart phone.

Conclusion

The overall impacts of research will result effortless monitoring of agriculture parameters with the help of technology-assisted sustainable agriculture. Deploying this setup will save wastage of water. The infrastructure proposed in this paper will be useful to monitor the agricultural parameters including the temperature, relative humidity, soil temperature and soil moisture along with rain falling status automatically and manage, control the irrigation. Hardware and software implementation are designed and evaluated. The aims to active the irrigation pump when the sensed relative humidity and temperature, moisture exceed a predefined threshold value. Arduino is adopted to develop the sensor node. In addition, Android software application is also developed to connect, monitor and control via zigbee connectivity. The results show that the proposed system improves the crop yields thus by decreasing the agricultural resources wastage.

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