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Design and implementation of automated smart irrigation system based on clustering in WSN

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***Abstract*: Site-specific agriculture may be a farming management idea supported perceptive, measurement and responding to inter and intra-field variability in crops. The goal of site-specific agriculture analysis is to outline a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs whereas protective resources. the expansion and advancements in wireless sensing element network (WSN) technology has directed agriculture sector into a brand new trend of sensible agriculture. WSN technology provides process of real time information from field. this is often obtained through the sensors that square measure physically deployed into the fields. during this paper wireless agriculture and setting sensing system for crop observance is given. This paper introduces the idea of the period observation system, and discusses the side of hardware and software system style of the composed modules, network topology, network communication protocol, IoT idea. Experiments show that the node can do agricultural environmental info collection and transmission. This method reduces wastage of water, protects agricultural fields kind accidental fires. It greatly improves the automated level and agricultural production capability drastically.**

***Keywords*- Site-specific agriculture; WSN; Star Topology; automatic irrigation;IOT; sensors; android app;**

I. INTRODUCTION

Till recent past before independence our agriculture trusted rains. As a result our agriculture turn out was terribly little. just in case the monsoons were sensible, we have a tendency to got a sensible harvest and just in case the monsoons weren't good, the crops failed and there was famine in some parts of the country. in the past irrigation facilities weren't sufficient . Farmers depended primarily on rain water for irrigation. Canals and tube-wells were only a few. Our farmers are exploitation recent ways and recent implements for farming. Irrigation is that the methodology within which a controlled quantity of water is provided to plants at regular intervals for agriculture. it's accustomed assist within the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and through periods of inadequate downfall. in addition, irrigation additionally features a few alternative uses in crop production, that embrace protective plants against frost, suppressing weed growth in grain fields and preventing soil consolidation. In distinction, agriculture that depends solely on direct downfall is brought up as rain-fed or objects farming. an automatic irrigation system refers to the operation of the system with no or simply a minimum of manual intervention beside the police investigation. nearly each system (drip, sprinkler, surface) is automatic with facilitate of timers, sensors or computers or mechanical appliances. It makes the irrigation method additional economical and employees will consider alternative necessary farming tasks .Automated irrigation system as many benefits like preventing wet stress of trees, decreasing of excessive water usage, making certain of speedy growing weeds and derogating salinization, save water from wastage. If totally different types of sensors (that is, temperature, humidity, and wet etc.) square measure concerned in irrigation, it should be potential that a web based mostly remote of irrigation automation are potential. we will additionally transfers plant food and therefore the alternative agricultural chemicals (calcium, sodium, ammonium, zinc) to the sphere by adding new sensors and valves. so it's terribly essential to possess an automatic irrigation system for higher productivity and effective utilization of water for surplus production.

II. PROPOSED SYSTEM

In this paper we have proposed a site specific automated irrigation system where large agricultural fields are divides into several small field plots. In Each of these small plots, several low cost sensor nodes are placed ,sensors are spread across the entire plot, these sensor nodes form a cluster of wireless sensor network. Each sensor node collets data from the surrounding and the value is sent to the coordinating node where the decision making process takes place. The

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coordinating node compares the value from with the predefined threshold value and reacts accordingly(to switch ON or OFF the motor).the data from the coordinating node is sent to the mobile of the farmers. The farmer receives a aggregated values from the sensors, these values are displayed in the mobile app and also in the app the farmer can also control the switching ON and OFF motor manually with just a click of a button.The sensors that are used in the proposed system are soil moisture sensor, temperature-humidity sensor these sensors collect data (like water content of the soil, humidity in air) from the field plots and Sends it to coordinating node through cluster heads wirelessly. Coordinating node makes the decision If the soil in one plot of the filed holds water better, crops can be planted more densely and irrigation can be sparing and any other plot of the field holds less water then more water can be pumped to that plot .in the proposed system we are also using fire sensor in case there is any accidental fire in the fields an alarm is triggered and water pump is switched on.. Automate field management by incorporating a Decision Support System (DSS) in this site specific environment the best conditions for the specific soil and plant species will be automatically optimized based on the data obtained by the sensors. The DSS will suggest the best moment for watering (or whether there is need or not), the need to irrigate to wash the salt content due to an excess in the radicular area, the need to fertilize, etc.we have connected a camera to monitor the actions and view the fields from the mobile The proposed system is represented in Figure.1.

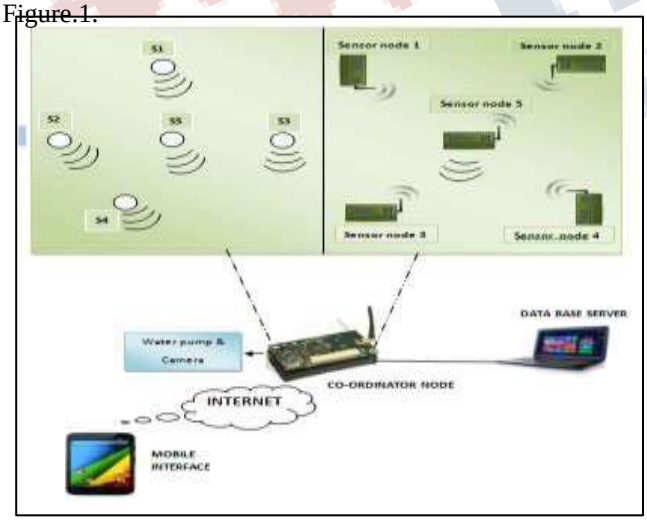

Figure.1.The Proposed system

III. SYSTEM BASED ON WSN

A powerful site specific agricultural framework has the capability that the terminal node will secure soil wet content, moistness, temperature, through self-sorted out system. The gathered information are transmitted to the coordinating node remotely utilizing modes like local area network or WAN. The frameworks grasp the cluster topologies and progressive steering conventions for this reason each sensing node are split into variety of clusters and every cluster is analogous to a sort of immobile self-systemizing network.

The nodes are then in addition part in like manner and also the cluster head node. Work of the regular hubs is to collect the realities that are sent to the cluster head nodes. The received information are keep within the memory unit. Then the professional decision support system starts to analyzes & processes facts. The network node should be on bulk-scale, and high density deploying methodology for observation of the massive coverage and connectivity.

A. WSN Topology

The development and readying of WSNs have taken ancient network topologies in new directions. Totally different Wireless sensing element network topologies are Bus, Star, Ring, and Grid. The portals and hubs cooperate to frame a work arrange. The entryway keeps up a rundown of hubs (by serial number) that have been approved for arrange get to. At the point when a hub controls up, it examines for accessible systems, finds either a passage or switch, and endeavors to go along with it. On the off chance that the door has the hub in its rundown, the hub joins the system, downloads the most recent setup from the passage, and starts its ordinary operation of getting estimation information and controlling DIO..

B. Hardware Design Of Nodes

For reducing the bad-effects of the overmuch and less than upper limit use of the inputs, the new stereotype of site specific agriculture has introduced. The positioning specific agricultural systems hardware contains Associate in Nursing Arduino UNO,ESP8266 Wi-Fi module, sensors ,power offer additionally with base stations, net access , hardware and software system systems. Sensing element is largely a electrical device that functions to convert the physical amount to be measured into a similar analog electrical signal. Arduino UNO is the processing unit that controls the operation of the sensing nodes, and processes the collected facts raw info and that manages native processing

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operation on the detected information. conjointly microcontroller in Arduino UNO is programmed to carryout totally different communication protocols for transmission of domestically detected information to the nodes in neighborhood. For multi hop controller is additionally accountable to relay the detected information by a distinct node to next node in direction to organiser node. ESP8266 is that the Transceiver unit used for communication among WSN nodes. Wireless communication module because the name suggests, communicates to a different nodes, swap dominant info and transmit and collect information .Sensor nodes, routers and entree ar wont to develop the WSN platform for the site-specific agriculture. Sensing element module functions for gathering temperature, humidity, light intensity and alternative parameters and data changing module. The power unit supply power needed for the sensor unit, the processor unit and also the wireless communication unit. Structure of hardware of node is shown in Figure.2

Figure.2. Block of sensor node

IV.AUTOMATED IRRIGATION SYSTEM

This strategy contains of 2 modes. Manual mode and automatic mode. In manual mode pump ON time and OFF time are send to the coordinative node unit from the android application by means of web through the appointed information processing address. In automated mode that is employed to manage turning ON and OFF of the pump automatically. The temperature, humidness and wetness device esteems are perpetually observed and readings are send to the coordinative node. If the temperature, humidness and wetness esteems ar past the predefined threshold value decision making} process takes place and pump motor is switched ON or OFF relying upon the threshold values. we've conjointly used a flame device just in case there are in accidental fires once the device senses the fire the info is shipped to the coordinative node and pump motor is switched ON and a alarm is trigged.The automated irrigation system is represented in figure 3.

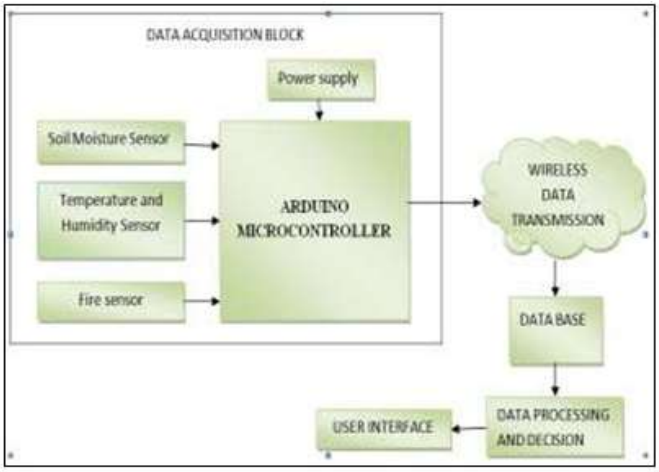

Figure.3. Automated irrigation system

A. *Hardware Components Used*

The data acquisition in done through the varied deployed sensors within the system. in this system the sensors are interfaced with the Arduino microcontroller and programmed. the info from the device nodes ar sent to RASPBERRY PI that controls the specified action.

1) Dh11 Temperature And Humidity Sensor

This DF robot DHT11 Temperature & humidity sensor options a temperature & humidity sensor advanced with a calibrated digital signal output. By exploitation the exclusive digital-signal-acquisition technique and temperature
& humidness sensing technology, it ensures high dependableness and wonderful long stability. This device includes a resistive-type humidness activity element and an NTC temperature activity element, and connects to a high performance 8-bit microcontroller, providing wonderful quality, quick response, anti-interference ability and cost-effectiveness. DHT11 activity range is 20-90%RH (humidity)and 0-50 ℃(temperature), humidness Accuracy is ±5%RH Temperature Accuracy is ±2℃, Resolution is one ,Package is four Pin Single Row.

2) Soil Moisture Sensor YL-69

The soil moisture sensor or the measuring system is sometimes used to detect the humidness of the soil. So, it's excellent to create an automatic watering system or to observe the soil wetness of your plants. The sensor is about up by 2 pieces: the electronic board and also the probe with 2 pads,

that detects the water content. Once programmed the wetness sensors are placed within the box and unbroken within the field. This soil wetness device has 2 probes that is inserted within the soil. These probes are accustomed pass the present through the soil. The dampish soil has less resistance therefore passes massive current whereas dry soil has additional resistance therefore passes small current. This resistance value help in detection the soil moisture.

3)Fire sensor

The Fire sensor is used to detect fire flames . The module makes use of Fire sensor and comparator to detect fire up to a range of 1 meters. Feature of fire sensor are Allows your robot to detect flames from up to 1 M away; Typical Maximum Range :1 m;Calibration preset for range adjustment; Indicator LED with 3 pin easy interface connector; Input Voltage
+5VDC

4) Raspberry Pi

A Raspberry Pi is the coordinating node in the proposed system.It is a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro.The Raspberry Pi is slower than a modern laptop or desktop but is still a complete Linux computer and can provide all the expected abilities that implies, at a low-power consumption level The Raspberry Pi is open hardware, with the exception of the primary chip on the Raspberry Pi, the Broadcomm SOC (System on a Chip), which runs many of the main components of the board–CPU, graphics, memory, the USB controller, etc. Many of the projects made with a Raspberry Pi are open and well-documented as well and are things you can build and modify yourself.The Raspberry is the cheapest low power arm 11 based microcontroller operating at 700MHz frequency and having the 512 megabytes of RAM memory.

5) Arduino UNO

The Arduino UNO is the microcontroller board based on ATmega328. It has 14 digital input/output pins, 6 analog inputs, 16MHz ceramic resonator, USB connection, a power jack. Arduino consists of a microcontroller and Integrated Development Environment (IDE). IDE is used to write and upload computer code to the microcontroller. It can be powered by USB cable or power jack of 5v. It contains everything needed to support the microcontroller.

B. Wireless data Transmission

The data acquired from sensors are transmitted to the web server using wireless transmission.ESP8266 module is used for wireless transmission between the field and the web server. ESP8266EX offers a complete and self-contained WiFi networking solution; it can be used to host the application or to offload WiFi networking functions from another application processor ESP8266 uses 2.4GHz transceiver with support WPA/WPA2. The data rate of this module is 1 Mbps/11Mbps/54Mbps.The operating voltage 3.0~3.6V. ESP8266 is cheaper than other wireless transmission modules like Zigbee (IEEE 802.14).The transmitter and receiver modules are connected with arduino boards. The transmitter is place in the field and the receiver is placed in the system end. The transmitter and receiver is given a id while configuring it. All the transmitters in the field should know the receiver's id which is the destination address. The receiver will receive data from various transmitters kept in the field. Secure transfer of data is one of the main priority of wireless transmission.

C. Data Processing And Decision

The data from the sensors area unit transferred wirelessly through ESP8266.the information is hold on within the cloud in mysql data base through net. In mysql database the information is stored in table named readings within user name rakshith. Periodically the information are received at regular intervals and hold on in database. the information process is that the task of checking the assorted sensors data received from the sector with the already fixed threshold values. The soil moisture are completely different in summer and winter seasons. The temperature and humidness additionally varies in summer, winter and time of year. the edge values is fixed once considering all these environmental and weather conditions. The motor are switched on mechanically if the soil wet worth falls below the threshold and contrariwise. The farmer can even turn on the motor from mobile using mobile application. Mysql data base screenshot is represented in figure 4.

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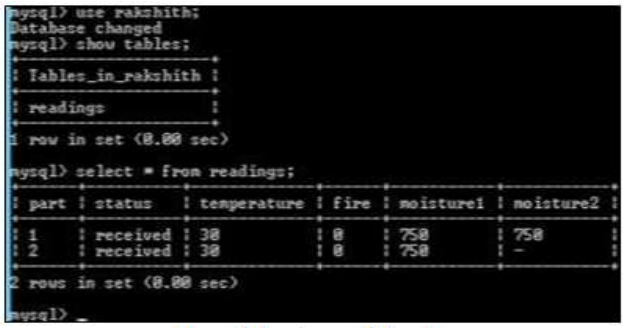

```
mysql> use rakshith;
Database changed
mysql> show tables;
+-------------------+
| Tables_in_rakshith |
+-------------------+
| readings          |
+-------------------+
1 row in set (0.00 sec)

mysql> select * from readings;
+------+----------+-------------+------+----------+----------+
| part | status   | temperature | fire | moisture1 | moisture2 |
+------+----------+-------------+------+----------+----------+
| 1    | received | 30          | 0    | 750      | 750      |
| 2    | received | 30          | 0    | 750      | -        |
+------+----------+-------------+------+----------+----------+
2 rows in set (0.00 sec)

mysql> _
```

Figure 4.data in mysql data base

D. User Interface: Mobile Application

The android software is employed to develop mobile application. The android app is formed using android studio tool. The mobile application helps to observe and management the sector from anyplace. The mobile app uses PHP script to fetch information from mysql database. As i discussed earlier in mysql database all the sensor data area unit hold on. The android fetches the information and code it in JSON format to be displayed in android device. The interface for the application is designed in a method that allows each the monitoring and management of field from the device. the net connection should be provided to monitor and control the field. The mobile application developed is shown in Figure 5.

Figure 5.Mobile Application

V.EXPERIMENTAL RESULTS AND DISCUSSION

First the sensors are deployed within the farm. the gap between the 2 detector node is depends on the sort of soil. the combination of Arduino, WiFi module, moisture sensor, temperature- humidness sensor and flame sensor is to blame for capturing the moisture present in soil ,temperature and humidness present in surrounding. Counting on the wet content and temperature of soil the watering to the crop is given. The projected system is developed and tested below varied conditions. The soil wetness is tested in all weather conditions and results area unit understood with success. The temperature-humidity reading was taken at completely different climatic conditions. the fire detector was tested with flame and therefore the results were successful as desired The wireless transmission was achieved using WiFi module. The information was stored in MySQL information using PHP script.The data was retrieved with success from MySQL database that is employed for monitoring purpose. In the android application the values of temperature moisture fire sensor where absorbed. The manual mode management of motor through android APP was tested with success. The live video streaming part was also successfully executed. Figure 6a and 6b reprensrnts the implementation of proposed system.

A. General Analysis of Requirement of Water And Power.

I did a general survey and referred several papers, when the careful analysis of enforced irrigation system and different environmental conditions were done, water demand per acre may be calculated as below :

Irrigation factor = 0.55
Evaporation rate = 0.4
Irrigation interval = 1 day Diameter of drip outlet = 3mm Thus,
Water=(irrigation factor)*(daily evaporation)*(irrigation interval)*(diameter of drip)*10/2.54*0.001 required
= 0.55*0.4*1*10*3/2.54
= 10.39 Cubic-meter/Acre

Water holding capacity for medium grade soil = 189 lit/24 hr. The total water demand for 600 m2 is 341 m3 for the traditional one and twenty nine m3 for the automatic one for the period of 2 months.
The power demand analysis of the system is as follows:
The power demand for one sensor system installed is mentioned. The arduino micro controller needs 5V power

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supply. the power provide is given with rechargeable AA batteries which may be used for a year.if we use solar power batteries the power consumed will be reduced to half. The power consumption of motors is incredibly a lot of reduced since it's operated for an accurate amount of your time based on soil moisture. The average power consumption as a result of the electronic components is eighty mAh in operational mode.

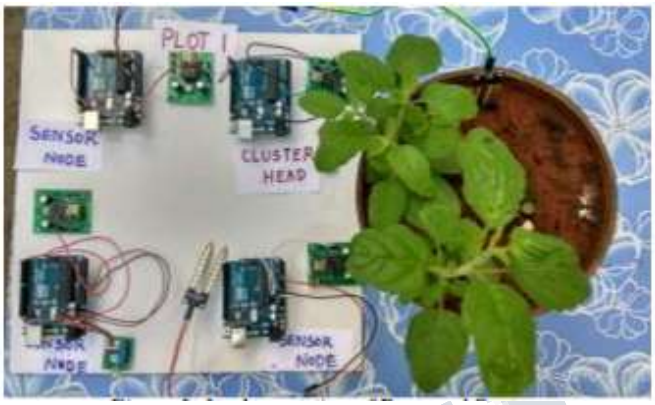

Figure 6a Implementation of Proposed System

Figure 6b Implementation of Proposed System

VI. CONCLUSION

This paper has described the design and implementation of a unique wireless sensor network for monitoring agricultural surroundings and evaluated the reactivity, robustness and longevity of the network within the field. These sensible agriculture approaches by the assistance of WSN reduces wastage of resources in farming in contrast to the standard follow, and contribute in effectively utilizing the required resources leading to increased crop yields .The automated irrigation system has been designed and implemented during this paper. The system developed is beneficia land works in price effective manner. Experiments show that the node can do agricultural environmental data collection and transmission. It reduces the water consumption to a larger extent. It wants minimal maintenance the power consumption has been reduced very much. The system may be employed in green homes. The System is very helpful in areas wherever water scarceness may be a major downside.The crop productivity will increase and therefore the wastage of crops is incredibly a lot of reduced using this irrigation system. The developed system is a lot of useful and provides a lot of possible results. This projected system helps farmers to spot, analyze, and manage the abstraction and temporal variability of soil and plants for optimum gain, sustainability, and protection of the surroundings

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