Precision Agriculture Based on Wireless Sensor Network

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Abstract: **Satellite farming or precision agriculture is a concept based on measurement, observations and response to the inter and intra farm variations in the crops. The growth and advancements in wireless sensor network (WSN) technology has directed agriculture sector into a new trend of smart agriculture. WSN technology provides processing of real time data from field. This is obtained through the sensors which are physically deployed into the fields. These smart agriculture approaches by the help of WSN reduces wastage of resources in farming unlike the conventional practice, and contribute in effectively utilizing the necessary resources resulting in increased crop yields. In this paper wireless agriculture and environment sensing system for crop monitoring is presented. The system test is implemented using the real time agricultural data and from the historical data. The system precisely acquires data and the information from the environment.**

Keywords:- **WSN, Precision Agriculture, Relative Humidity (RH), Humidity Sensors, Irrigation controller, NRF24L01.**

I. INTRODUCTION

Agriculture and farming plays a dominant role in the economy of s country. As India is mainly a agricultural country, more than 60% of Indian population depends on agriculture for sustaining their life and agriculture is the most important occupation for most of the families in India. But in present scenarios it has been observed that the contribution of Agriculture to GDP is declining nowadays and we are in urge to increase the crop productivity with effectiveness and with fine efficiency. In agriculture the irrigation is the most important factor as the monsoon rainfalls are very unpredictable and uncertain hence water scarcity is a big challenge in agriculture sector. Due to this reason there exists a demand for technical knowledge to make the irrigation system more efficient.[1]. The term precision agriculture (PA) is an approach to the farm which pinpoints the important parameters in which crop production yield is bounded by variable parameters, and figure out integral spatial variability [6].

Much conventional irrigation system has been practiced from the past. In order to improve these conventional methods there has been developed many system using advanced technologies in wireless sensor network which helps in reducing crop wastes, prevents excess watering to crops and helps in increasing crop yields. In this paper a system developed using sensors to monitor crop-field and automate irrigation system is studied and overviewed. This system gives an idea about the wireless transmission of sensor data from fields to coordinator, storing it in a database, and controlling required field parameters from mobile application.

II. AGRICULTURE SYSTEM BASED ON WSN

An effective precision agriculture system has the function that the terminal node can acquire soil moisture content, humidity, temperature, conductivity and light intensity through self- organized network. The collected information are transmitted to the gateway wirelessly using modes like LAN or WAN. The systems embrace the cluster topologies & hierarchical routing protocols for this purpose. Every sensing node are split into several clusters and each cluster is analogous to a kind of immovable self-systemizing network. The nodes are then further split in common & the cluster-head nodes. Work of the common nodes is to accumulate the facts which are sent to the cluster head nodes. The received facts are banked into the memory unit. Then expert decision support system analyzes & processes facts. The network node must be on bulk-scale, and high density deploying method for monitoring of the coverage sector and connectivity [10].

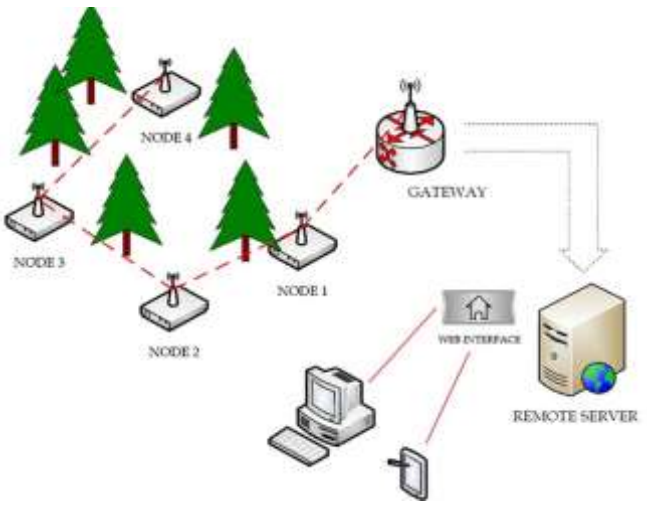

Fig: 1 WSN Network

A. Hardware Design of Sensor Nodes

For reducing the bad-effects of the overmuch and lower than upper limit use of the inputs, the new stereotype of P.A has introduced [9]. The P.A system architecture dependent on WSN technology comprises six basic sub units:- (1) sensor unit, (2) amplifier unit,(3) analog to digital converter(ADC), (4) transceiver, (5) processor unit and power unit in addition with base stations, Internet access , hardware and software systems. From Fig2, it shows the node network structures which boosts system scalability [2]. Sensor is basically a transducer which functions to convert the physical quantity to be measured into an equivalent analog electrical signal. The transducer output may not be appropriate to fanout ADC, so it is amplified to proper level and digitally converted by ADC. The processing unit control the operation of the sensing nodes, and processes the collected facts raw information. The processor unit is generally a microcontroller which manages local processing operation on the sensed data. Also microcontroller is programmed to carryout different communication protocols for transmission of locally sensed data to the nodes in neighborhood. For multihop controller is also responsible to relay the sensed data by a different node to next node in direction to coordinator node. Transceiver unit is for communication among WSN nodes. Wireless communication module as the name suggests, communicates to another nodes, swap controlling information and transmit and collect data .Sensor nodes, routers and gateway are used to develop the WSN platform for the precision agriculture. Using multiple routers allows wide coverage of network for the precision agriculture.[3]

Sensor module functions for gathering temperature, humidity, light intensity and other parameters and information converting module. The power unit supply power required for the sensor unit, the processor unit and the wireless communication unit. Structure of hardware of node is shown in Fig.2

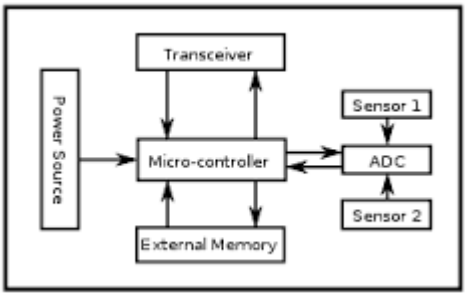

Fig.2 Hardware structure of node.

B. Cluster-Head Node's Hardware Design

Environment facts are acquired by the cluster-head nodes itself. Signals from the deployed sensor nodes are received by it which further integrate them and stores the data automatically [4]. Node or cluster-head node hardware is branched further in units like the , the analog to digital converter (ADC) module, moisture sensor, the Wireless communication unit, Liquid crystal display module, memory unit and the power supplies. The sensed sensor signals are sent to the signal processing circuit via cluster-head nodes. Post analog to digital conversion, data is then sent to the Microprocessor [5]. In case when Cluster-head node enquires to self-systemized nodes , then cluster-head node get in return the information from the concerned node regarding the enquiry. Received data by the cluster-head node is then stored automatically in the regular universal serial bus device. The processor, sensors, Radio frequency transceiver in addition with other parts consuming energy of the state control is supported by the power management module which is battery [8].

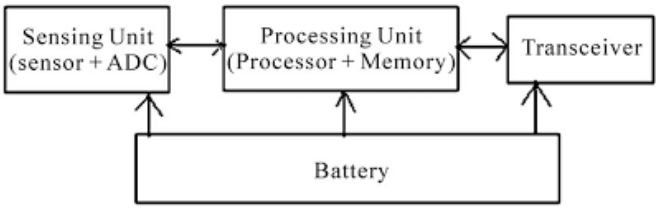

Fig.3 Cluster-head node unit[15]

III. SYSTEM DESIGN

In this system, low cost soil moisture sensors, humidity and temperature sensors are used which continuously monitors the field and send it to the web server using NRF24LO1 transceiver. Sensors are used to create wireless sensor networks to monitor crops and automate irrigation[6]. Wireless sensor network acquires few technical supremacy on a distributed multi-dimensional and multi-angle information processing [7]. The sensor data are stored into database and the web application is designed to analyze the data received and also to check with the threshold value of the parameters to be monitored like moisture, humidity and temperature. After that the decision making is done at server end to automate the irrigation process. In case of measurement of soil moisture if the moisture is less than the threshold value then the motor is switched ON and if it exceeds the threshold value the motor is switch OFF. The system design is represented in fig.4.

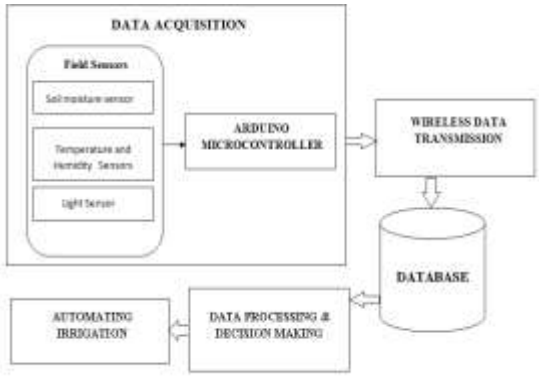

Fig. 4. System design using wireless transmission

A. Sensors Data Acquisition

The data acquisition in done through the various deployed sensors in the system. Here In this system the sensors are interfaced with the Arduino microcontroller and programmed.

- *Soil Moisture Sensor*

Once programmed the moisture sensors are placed inside the box and kept in the field. This soil moisture sensor has two probes which is inserted in the soil. These probes are used to pass the current through the soil. The moist soil has less resistance hence passes large current whereas dry soil has more resistance hence passes small current. This resistance value help in detecting the soil moisture. Fig 5 shows the soil moisture sensor.

Fig. 5. Soil moisture sensor.

- *Temperature and Humidity sensors*

The DHT11 temperature and humidity sensor is used in this system. The total amount of water vapor present in the air is measured as humidity. The relative humidity is calculated as when there is change in temperature the relative humidity also changes. In agriculture the temperature and humidity changes occur before and after irrigation. The water droplets in the air after irrigation increases leading to the decrease in temperature which in turns increases the humidity of the surroundings. Hence the temperature and humidity readings are often notified by the sensors to the user by the sensors so that users can know the field conditions of every time. DHT11 temperature and humidity sensor are shown in fig.6.

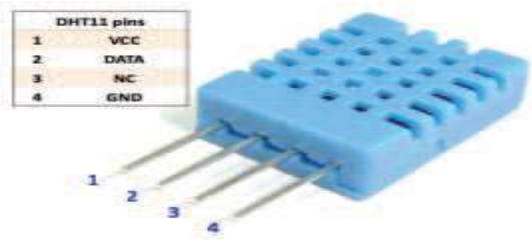

Fig. 6. Temperature and humidity sensor

B. Wireless Data Transmission

The acquired data from the sensors are transmitted to the web server using wirelessly. NRF24L01 module is used for wireless transmission between the field and web server. NRF24L01 is a single chip 2.4 GHz transceiver from Nordic semiconductor. The data rate of this module is 256Kbps and the required voltage is 1.9-3.6V. The transmitter and receiver modules are connected with arduino boards. The transmitter is placed in the field and receiver is placed at the system end. For configuring, both transmitter and receiver is given a ID. All transmitters must be known to the receiver's ID. The receiver will receive the data from the various transmitters placed into the field. The receiver at the system end is connected to the web server through the Ethernet 802.11.

The Ethernet is used for interfacing with the arduino microcontroller due to its fast connection establishment and low cost. When the receiver receives the data from transmitter, it sends request to the web server. The Ethernet able is connected to the arduino microcontroller using Ethernet shield for arduino. The arduino Ethernet will be assigned an IP address which should be in the network range. The arduino is provided with the web server address for sending he request. The web server is designed using PHP script to insert values in the appropriate table.the web server process the request and stores the received data into its database[1].

The wireless data transmission using NRF24L01 is shown in fig.7.

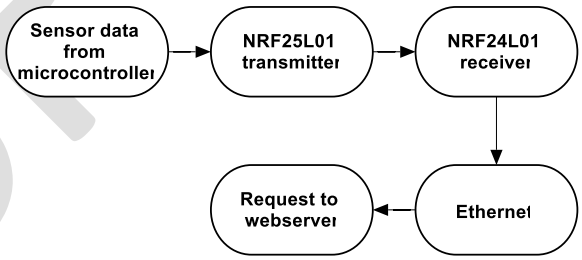

Fig.7. wireless data transmission using NRF24L01

C. Data Processing And Decision Making

Data processing is the task of checking data received from various sensors and comparing with the threshold values which is already fixed. The threshold value is set different for different crops. This is due to the fact that different crops needs different environment parameters. The decision making is based on the variations of the data received on comparison with the fixed threshold value. For instance, motor will be switched On automatically if the moisture in the soil falls below the threshold value and vice-versa. The farmer can even switch On or Off the motor from mobile using mobile application.

D. Automation of Irrigation system

The irrigation system is automated as soon as the control is received from the web application. The relay switches are used to pass the controls from the web application to electrical switches using Arduino microcontroller. Relay is an electrically operated switch. Low power circuits can be controlled using relay. When the external voltage is applied,

the relay switches on or off. Fig. 8 Show the flow chart for automatic control of the motor.

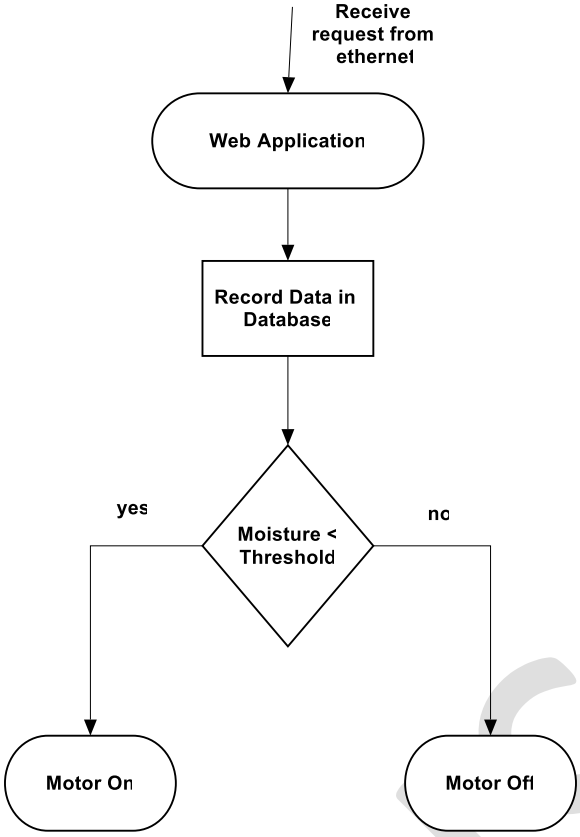

Fig.8. flow chart for automation system.

IV. CONCLUSION

The wireless transmission of the data from sensors using wireless sensor network has been studied and overviewed. Idea about the wireless transmission of sensor data from fields to coordinator, storing it in a database, and controlling required field parameters from mobile application has been reviewed. Also the automated irrigation system and design flow has been studied in this paper. The system is work efficient and beneficial in agriculture sector. It reduces the wastage of resources and increases the crop yield.

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