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Design and Implementation of Modern Automated Real Time Monitoring System for Agriculture using Internet of Things (IoT)

[1]Paparao Nalajala, [2]D. Hemanth Kumar, [3]P. Ramesh and [1]Bhavana Godavarthi
[1]Department of Electronics and Communication Engineering,
Institute of Aeronautical Engineering, Hyderabad, India
[2]Department of Electronics and Communication Engineering,
Nalla Mallareddy Engineering College, Hyderabad, India
[3]Department of Electronics and Communication Engineering, MLR Institute of Technology,
Hyderabad, India

Abstract: This research study presents the technological development in Wireless Sensor Networks (WSN) made it possible to use in monitoring and control of green house measurable factors in precision agriculture. Due to uneven natural distribution of rain water it is very crucial for farmers to monitor and control the equal distribution of water to all crops in the whole farm or as per the requirement of the crop. All the parameters of greenhouse require a detailed analysis in order to choose the correct method. With the evolution in wireless sensor technologies and miniaturized sensor devices, it is possible to use them for automatic environment monitoring and controlling the parameters of greenhouse, for Precision Agriculture (PA) application. In the field bus concept, the data transfer is mainly controlled by a suitable wired communication system, now can be replaced with the hybrid system (wired and wireless) to extract the benefits of both and to automate the system performance and throughput. ZigBee protocols based on IEEE 802.15.4-2003 for wireless system are used. The atmospheric conditions are monitored and controlled online by using Ethernet IEEE 802.3. Partial root zone drying process can be implemented to save water at the maximum extent. Online interaction can be made with the farmers by the consultant to give them the knowledge about this technique and implement it effectively in their farms to extract more yields with advanced technology.

Key words: Greenhouse monitoring, hybrid network, Wireless Sensor Networks (WSNs), ZigBee, partial root zone technique, IoT, ARM7

INTRODUCTION

Agriculture is considered as the basis of life for the human species as it is the main source of food grains and other raw materials. It plays vital role in the growth of country‘s economy. It also provides large ample employment opportunities to the people. Growth in agricultural sector is necessary for the development of economic condition of the country. Unfortunately, many farmers still use the traditional methods of farming which results in low yielding of crops and fruits. But wherever automation had been implemented and human beings had been replaced by automatic machineries, the yield has been improved. Hence, there is need to implement modern science and technology in the agriculture sector for increasing the yield.

The implementation of a wireless backbone which contains several nodes should be high enough in number to provide a certain level of redundancy for both fault tolerance and performances to allow multiple paths and to avoid bottlenecks. An integrated wired/wireless solution allows one to exploit the positive aspects of both technologies by improving performances and productivity. While moving on to the wired study a Controller Area Network (CAN) type network has been chosen because of its simplicity, robustness, flexibility, cheapness and good performances. For the wireless study, a ZigBee (Sung *et al*., 2010; Chavan *et al*., 2012) type network has been chosen because it resembles the modern art of wireless sensor network (Sudharsan and Mohanasundaram, 2012).

India‘s major source of income is from agriculture sector and 70% of farmers and general people depend on the agriculture. Internet of Things (IoT) is a cloud of interconnected physical devices which can communicate with each other over the internet. Physical devices such

Corresponding Author: Paparao Nalajala, Department of Electronics and Communication Engineering,
Institute of Aeronautical Engineering, Hyderabad, India

as microcontrollers and sensors will not directly communicate with the internet, they do so by using an IOT gateway (Godavarthi *et al*., 2016). This entire infrastructure is known as IOT infrastructure. For example, we can take a home lighting system where all the switches are been connected to the main controller which is connected to the internet.

The smart farm, embedded with IOT (Godavarthi *et al*., 2016; Chaudhary *et al*., 2011) systems, could be called a connected farm which can support a wide range of devices from diverse agricultural device manufacturers. Also, connected farms could provide more intelligent agriculture services based on shared expert knowledge. Improvement of agriculture field has become biggest challenging for the countries like India, so, new technologies have to be adopted.

MATERIALS AND METHODS

System architecture: Earlier GMH was designed in either fully wired or wireless systems. As the wireless systems are battery operated, they should be checked periodically for battery life to avoid the failure of the system. Also, these wireless components will cover a minimum area or distance due to limited bandwidth range of communication. By the time, if fully wired system is considered, the installation and the maintenance cost will be more compared to the other. Also, wiring is not possible in all the area like plants growing in fully wet area. There should be a person always to monitor the farm from the control room. The real-time automation and monitoring system consist of sensors for measuring different parameters, number of nodes, ARM controller, communication mediums like CAN bus for wired system, ZigBee for wireless system, Ethernet for controlling and monitoring the parameters online and solenoid valves to control the water flow for the plants (Fig. 1).

Nodal network: In the greenhouse management (Chaudhary *et al*., 2011), the network is defined as a collection of nodes and other hardware interconnected by communication channels that allow the sharing of resources and information where at least one process in one device is able to send/receive data to/from at least one process residing in a remote device. Node is a point in which the set of components like sensors, ARM microcontroller (Lee *et al*., 2010; Wu, 2009; Godavarthi and Nalajala, 2016) are all connected along with the bus. Each node is placed at different locations in the greenhouse farm so that all the parameters can be measured in that particular place which also covers certain space around it. Thus, the number of nodes used depends upon the area of farm (Fig. 2).

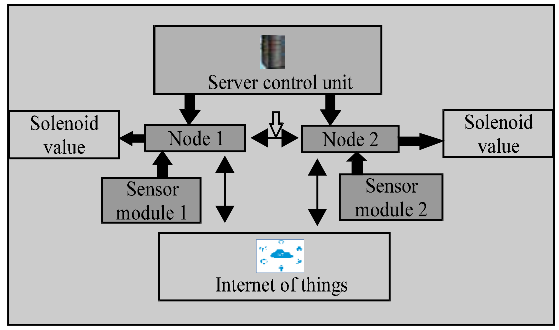

Fig. 1: Greenhouse controlling and monitoring system design

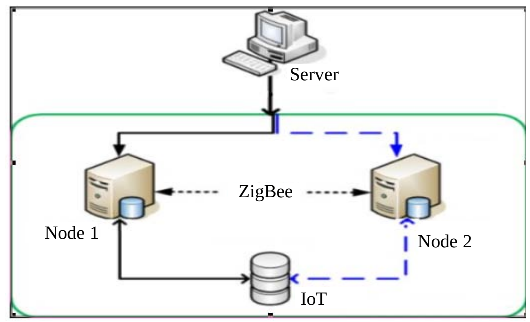

Fig. 2: Network setup

Functions of node: The sensors which are present on each node measures the parameters. They are then converted to digital form by the analog to digital converter which is present within the ARM microcontroller. A real time clock is set within the node. MAX232 which are present in each node is used for communicating with the serial port to the main control room. All nodes can be communicated with each other by ZigBee (Mirabella and Brischetto, 2011; Sonawane *et al*., 2008) finally, in the output of each node, solenoid valves are connected. Thus, according to the parameters and the requirement of water by the plants by analyzing the data, the water will be controlled and supplied to the farms through the valve. The components present in the main node and their functions will be the same as that of the other nodes. But an additional feature of Ethernet is present within this node. Thus, all the parameters from all other nodes which are fetched by the main node can be monitored online through Ethernet. Each nodes are connected to the main control room through CAN bus.

Hardware components description

Sensors: Many types of sensors are used to measure various parameters like temperature, humidity, light which are to be controlled for effective growth of greenhouse plants.

ARM controller: The ARM microcontroller used here is LPC2138 based on cortex M3. The ARM cortex-M3 CPU incorporates a 3 stage pipeline and uses a harvard architecture with separate local instruction and data buses as well as a third bus for peripherals. The ARM cortex-M3 CPU also includes an internal pre fetch unit that supports speculative branching. The peripheral complement of the LPC1768 includes up to 512 kB of flash memory up to 64 kB of data memory, Ethernet MAC, USB Device/Host/OTG interface, 8-channel general purpose DMA controller, 4 UARTs, 2 CAN channels, 2 SSP controllers, SPI interface, 2C bus, 3 Winterfaces, 2 input plus 2 output, 2S bus interface, 8 channel 12 bit ADC, 10 bit DAC, motor control PWM, quadrature encoder interface, four general purpose timers, 6 output general purpose PWM, ultra-low power Real-Time Clock (RTC) with separate battery supply and up to 70 general purpose I/O pins (Fig. 3).

Here, the ARM controller performs the entire controlling function. There are 8 analog to digital converters which are inbuilt within the ARM controller. Thus, the analog signals from the sensor are converted to digital form for further process. The communication medium like CAN and Ethernet are connected to the ARM controller which controls the data flow. Also, the relay connected to the ARM controller will be controlled for the flow of water through the solenoid valves according to the data give to the controller.

Fig. 3: ARM device

Fig. 4: Internet of Things (IoT)

Relay driver: Relays are simple switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. Here, relays are used for controlling the solenoid valves.

Solenoid valve: A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. A solenoid valve has two main parts, the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which in turn, opens or closes the valve mechanically. A direct acting valve has only a small flow circuit. A diaphragm piloted valve multiplies this small pilot flow by using it to control the flow through a much larger orifice.

Solenoid valves may use metal seals or rubber seals and may also have electrical interfaces to allow for easy control. A Spring may be usedto hold the valve opened (normally open) or closed (normally closed) while the valve is not activated. Here, it is used for controlling the flow of water to the plants in the green house farm.

IoT: The internet of things can be defined as a global, immersive, invisible ambient networked computing environment built through the continued proliferation of smart sensors, cameras, software, databases and massive data centers in a world-spanning information fabric known as the internet of things (Fig. 4 and 5). The basic idea of the IoT (Sung *et al*., 2010; Galgalikar, 2010) is that virtually every physical thing in this world can also become a computer that is connected to the internet. Internet of Things (IoT) aims to extend internet to large number of distributed.

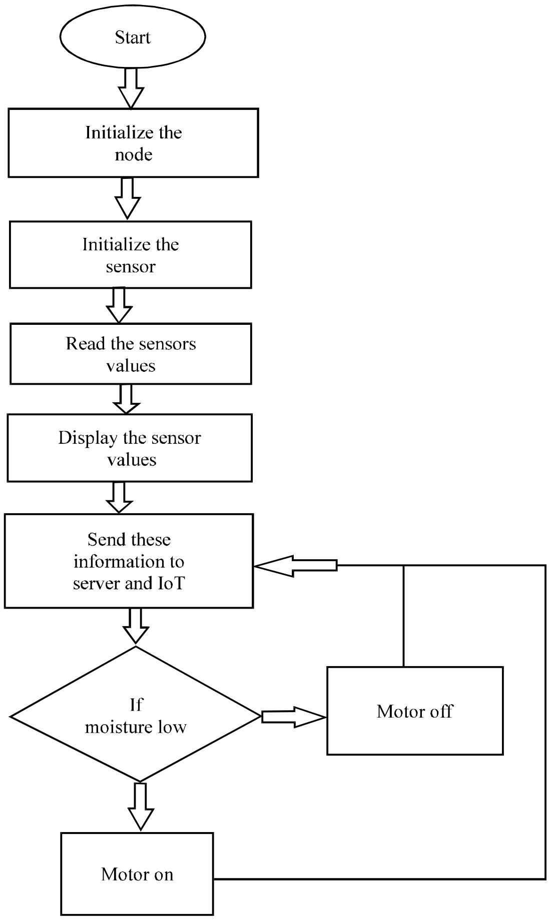

Fig. 5: Flow chart

devices by defining standard, interoperable communication protocols (Li *et al*., 2011; Nalajala and Hemanth, 2016).

RESULTS AND DISCUSSION

Initialize the entire sensor to the system by using the IoT. Check the sensor value is less or more, soil moisture sensor gives the moisture level reading from humidity sensor we get the reading of humidity level present in the atmosphere, also, temperature sensor gives the temperature present in soil and most important sensor is water level sensor which gives the water in the soil is less or more. If the water level and soil moisture levels the fixed criteria. There is no need to give to irrigation. If the soil moisture level or water level is less than the fixed criteria. We start the motor pump. After the, we need to initialize the all the sensor value. The process will be completed. After the process completed. It moves to the original state.

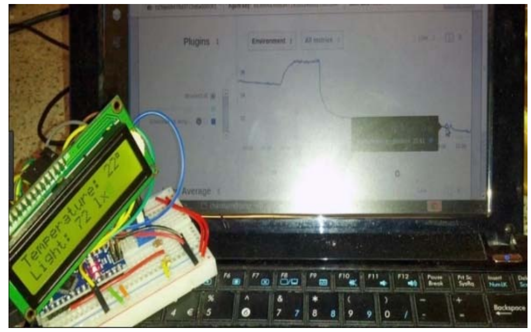

Fig. 6: Monitoring the plant through IoT and server

Fig. 7: ARM module interfaced with sensors

It in field sensing sensor monitor the field condition of soil moisture, soil temperature and humidity in air. We get monitors the information on the field, i.e., humidity, temperature of soil, etc. All in field sensor data are wirelessly transmitted to our system. In the day to day life atmospheric condition is change fastly and climate is change due to this type of the change that's effects on the agriculture or the production of the crops. Some time water in the agriculture field is over does of water given by the former also the production of crop is less due to the less rainfall or less does of the water. There are many types of the reason for the less production of crop for overcome fall this type of query this projects is designed and it is handled from any place (Fig. 6).

It consists of motion detector, temperature sensor, humidity senor, cooling fan, water pump, etc., connected to the microcontroller board. Experimental setup for node 1 consists of with central server, camera and other sensors. All sensors are successfully interfaced with microcontroller and the microcontroller is interfaced with the raspberry pi.GPS and camera is also connected to ARM (Fig. 7 and 8a, b).

(a)

(b)

Fig. 8: Experiment setup

CONCLUSION

The sensors and microcontrollers of all three nodes are successfully interfaced with ARM and wireless communication is achieved between various nodes. 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 respectively. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

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