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Smart Irrigation System using FPGA based Wireless Sensor Network

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Abstract - *This paper describes the design of a smart wireless sensor network (WSN) for an agricultural environment. For efficient water management in agricultural area proposed work develops sensor-based irrigation systems that offer a potential solution to support irrigation management in field. Field's moisture conditions will monitored by in-field sensor node distributed across the field interfaced with FPGA, these nodes send data wirelessly through Zigbee to central server, which collects the data, store it and allow it to control on/off action of motor. Thus smart irrigation system provides proper management of water in field allows former to maximize their productivity while saving water.*

Key Words: **WSN; Zigbee; FPGA; Irrigation**

1.INTRODUCTION

Agriculture has played a key role in the development of human civilization but we know agriculture is mostly dependent on climatic condition and hence climatic condition such as drought, flood, etc. badly affects the agricultural field hence cause loss in production. That is in drought deficiency of water cause loss in yield and on other hand in over-irrigated area loss in yield is due to access of water. To avoid such loss in production proper water management must be needed. Thus efficiently designed irrigation system is required to properly distribute the water in field. This system must be environmental friendly and distributed water in irrigation field in smart way that is water is provided to those areas of field where it is needed so that wastage of water can avoided and provide proper management of water in field.

In our system mainly two modules are designed one is field module and other is control module as shown in Fig.1. The both modules have Spartan3A FPGA board as control unit. This board has inbuilt analog to digital converter (ADC) and digital to analog converter (DAC) as well as onboard LCD. In field modules analog moisture sensors are interfaced with Spartan3A board through onboard ADC these sensors are used to collect moisture data from agricultural field. In control module motor interfaced with FPGA through inbuilt DAC whose speed is controlled according to acquired sensor data from field module this data also displayed on onboard LCD. The FPGA based irrigation system provides system to sense and monitor real time agricultural environment. It has two RS232 serial port having UART serial communication which allows us to design ZigBee network to established communication between field and control module.

The remaining paper present as, In Section II we describes literature survey on this topic, then in section III current capabilities of FPGA with its features and comparison between different communication technologies explained, further in section V complete hardware system architecture including interfacing of ADC, DAC, Sensor and required software are explored. At last section VI presents all results and conclusions.

2.RELATED WORK

After the research on Agriculture, researchers found that due to unpredictable climatic conditions and mismanagement of water, yield of agricultural field get suffered and its quality goes on decreasing day by day. To improve its quality and increasing the production as well as reducing the water scarcity related problems the technology in the field of agriculture plays an important role. Some of the technologies are described by researchers are summarized below.

R. G. Evans and W. M. Iversen et. al [10] designed a site-specific precision linear-move irrigation system where six in-field sensor station implemented across agricultural field. These station monitored field condition based on soil property map then periodically sampled it and transmit wirelessly to the base station. In this system Bluetooth is use for Wireless communication. The most important thing of smart agriculture is to monitor environmental condition and other is water management and for this wireless sensor network based system is much simpler and cheaper Hence AVR microcontroller based smart irrigation system is developed where four type of sensors including soil moisture, air temperature, air humidity and underground water level in the pipe are interfaced with microcontroller to monitor environmental conditions is explained by [1] Nattapol Kaewmard, Saiyan Saiyod further, they describe how ZigBee with mesh protocol and AT command mode can work for communication. The irrigation system based on FPGA designed by K.Sindhu, Y.Sri chakrapani, M. Kamaraju, [2] where various sensors are interfaced with FPGA to sense the field conditions and stored it in memory. So that farmer can then use required data and take necessary precaution for

field. The complete architecture was designed using HDL language. Zhiyong Lai et.al [6] Irrigation is a most important aspect in agriculture and effects on production yield hence irrigation system must be intelligent and efficient. Here also FPGA based irrigation system was developed and also give comparison between microcontroller and FPGA then also said that irrigation system based on FPGA having fast speed, small size and can debug easily.

3. WIRELESS COMMUNICATION TECHNOLOGY

Nowadays automation is frequently used in every field hence system based on sensor are also become popular due to their real time transmission and reception of data and intelligent performance. The radio frequency wireless communication offer best solution for such systems since communication between sensor node and control node is take place in real time with low power consumption. There are various communication technology described in Table I which provide communication differently based on requirement.

In proposed work our requirement is to develop simple, low cost system which consume low power that is long battery life which can provide high coverage thus Zigbee is considered for communication medium between field module and control module in smart water distribution system. In comparison by using Wi-Fi as communication medium we can obtain high data rate communication but on other hand it is costlier and power consumption is also high. Similarly as given in table 3rd communication technology that is Bluetooth which is mostly use in small network and providing low range and low data rate communication. Hence Zigbee is most preferable communication technology for our simple, cheap, long range network.

TABLE I-COMPARISON BETWEEN WI-FI,ZIGBEE AND BLUETOOTH

Features	Wi-Fi	Bluetooth	ZigBee
Frequency band	2.4GHz	2.4GHz	2.4GHz
Data rate	>11Mbps	1Mbps	250kbps
Range(m)	100	10	70
Power consumption	High	Medium	Low
Battery life	Hours	1 week	>1 Year
cost	High	Low	Low

4. BLOCK DIAGRAM AND WORKING

Here complete architecture of FPGA based smart water distribution system is explained. The block diagram of this system is shown in Fig. 1.

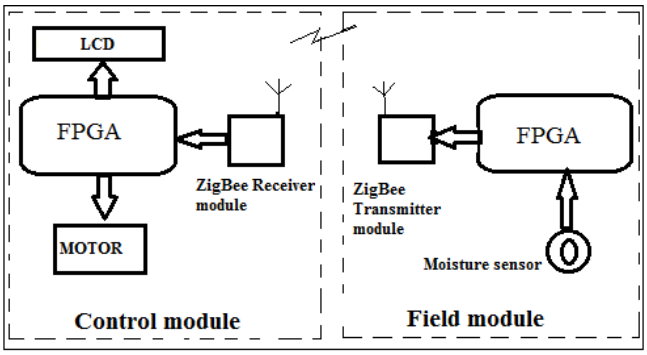

Fig -1: Block diagram of proposed system

4.1 Field module

The field module is sensor based system distributed over agricultural field. Here the moisture sensor interfaced with FPGA board to collect information of moisture of agricultural field. The Fig. 2 gives pin diagram of moisture sensor FC-28. This sensor give output in two format digital as well as analog, In both mode in case of absence of moisture in soil output of sensor is highest i.e. 3.4V,but in analog mode moisture of soil determined accurately. Hence in our system to get exact percentage of moisture in soil we use analog output of moisture sensor.

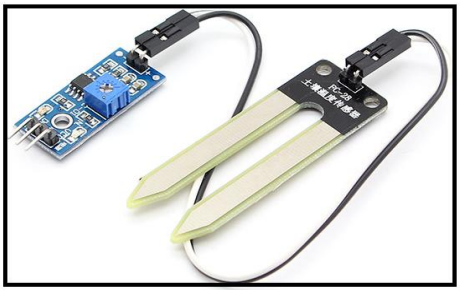

Fig-2: Pin diagram of soil moisture sensor (FC-28)

Here control unit is FPGA Spartan 3A board where all processing is took place on digital data. Hence the analog data pin of FC-28 is interfaced with channel 4 of inbuilt ADC i.e. MCP3004 device with 10 bit resolution means sensor value is converted to 10bit equivalent digital output. SPI protocol is used in this communication with device.

4.2 Control module

The control module is developed to control irrigation over field based on moisture data received from field module.

Here motor is interfaced with Spartan3A FPGA board shown in Fig.1 and its flow diagram of motor action is given in Fig.3.But for motor action, analog voltage is necessary hence digital to analog converter (DAC) is required. This board has inbuilt DAC i.e. DAC084S085 give QUAD 8-bit equivalent analog voltage output to motor.

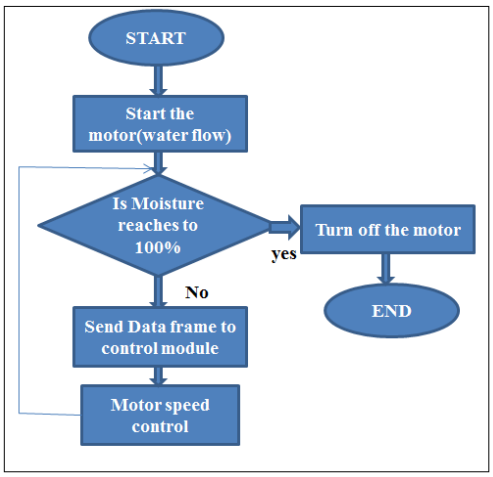

Fig-3: Flow chart for motor control

4.3 Zigbee network

Zigbee communication network between field module and control module is wireless personal area network provide low cost, low power and high range network of nodes. The first step for forming zigbee network is the configuration of zigbee using X-CTU software.

The serial interfacing of zigbee module with Spartan 3A board is required to send and receive data to/from Spartan 3A FPGA board respectively by connecting RS232 port with serial TX, RX pin on board.

5. RESULTS

The results of proposed system is explained in this section

5.1 Field module

In smart irrigation system to measure moisture in field accurately we are using analog output from sensor. At 0 % moisture in soil, analog output from sensor is highest i.e. 3.4V then as soil moisture percent increases this analog output voltage start decreasing and when moisture reaches to 100% then analog output from sensor reaches to 0V.

5.2 Control module

The main aim of smart irrigation system is to proper management of water in agricultural field and reduce water wastage and also reduces manpower in irrigation control. The zigbee configured as receiver, receive moisture data from field module analyze it for decision making then that will convert into equivalent analog voltage for controlling motor action With respect to graph in Fig. 3 when agricultural field is completely dry motor will start at full speed and distribute water in that particular area as water distributed over that area in required quantity moisture percent reaches to 100% and motor get off automatically.

This control module is implemented on base station hence moisture content in soil is displayed on LCD display in the form of soil moisture percent.

6. CONCLUSION

In this paper the smart irrigation system based on FPGA describes the intelligent irrigation system with powerful and real time processing methodologies, This system will help in efficient water distribution in agricultural field. Up till now irrigation system are designed using microcontroller having low processing speed and complex structure some of them using FPGA board but only for monitoring environmental condition but in proposed system we are designed field module to monitor moisture in field and control module for irrigation control based on FPGA. In combination with this zigbee is use as communication technology for obtaining long range communication with low power consumption. Hence this system is simpler and provides efficient water distribution. Further we can form database of moisture percent in soil from display and use this information to know quality and requirement of field.

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REFERENCES

[1] Nattapol Kaewmard, Saiyan Saiyod, "Sensor Data Collection and Irrigation Control on Vegetable Crop Using Smart Phone and Wireless Sensor Networks for Smart Farm", *2014 IEEE Conference on Wireless Sensors (ICWiSE)*, October, 26-28 2014.

[2] K.Sindhu, Y.Sri chakrapani, M. Kamaraju,"FPGA Implementation Of Irrigation Control System ," *International Journal of Scientific & Engineering*

Research, Volume 5, Issue 12, December-2014.

[3] Sujit P. Jagtap, Dr. S. D. Shelke,"Wireless Automatic Irrigation System Based On WSN and GSM ," *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)*,Volume 9, Issue 6, Ver. III,PP 13-17,Nov - Dec. 2014.

[4] Aniket H. Hade, Dr. M.K. Sengupta ,"Automatic control of Drip Irrigation System & Monitoring Of Soil by Wireless," *IOSR Journal of Agriculture and Veterinary Science (IOSR JAVS)* , Volume 7, Issue 4 Ver. III , PP 57-61,Apr. 2014.

[5] N.Krishna Chaitanya ,G.Anand Kumar and P.Aruna Kumari ,"Zigbee based Wireless Sensing Platform for Monitoring Agriculture Environment ," *International Journal of Computer Applications (0975 – 8887)*, Volume 83 – No 11, December 2013

[6] Zhiyong Lai and Yongli Dai, "An Irrigation Control System Based On An FPGA,"2012 IEEE.

[7] Aqeel-ur-Rehman, Abu Zafar Abbasi , Noman Islam , Zubair Ahmed Shaikh, "A review of wireless sensors and networks' applications in agriculture," Computer Standards & Interfaces 2011

[8] Wei Wang, Guangyu He, Junli Wan, "Research on Zigbee wireless communication technology," 2011 IEEE.

[9] Soil Moisture Sensor fc-28, User-Manual,

[10] ZigBee datasheet,

[11] Spartan3A datasheet - www.FPGARESOLUTION.COM