

Web Based Automation of Farm Irrigation System Using Wireless Sensor Network and Embedded Linux Board (March2016)

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Abstract:- This paper presents an automatic farm irrigation system using a wireless sensor network (WSN) and embedded Linux board. The system provides web interface to the user so that the user can control and monitor the system remotely. In this paper, Raspberry Pi is used as embedded Linux board which is designed based on the arm 11 microcontroller architecture. Embedded Linux board makes a communication with all distributed sensor nodes placed in the farm through ZigBee protocol and itself act as coordinated node in the wireless sensor network. The goal of coordinator node is to collect the parameters like soil moisture and soil temperature wireless. Each sensor node consists of soil moisture and soil temperature sensor and ZigBee RF antenna device for communication with a coordinator node. Raspberry Pi stores collected data in a database and analyzes the stored data. The system will work according to the algorithm developed for watering the crop. The board has a Ethernet interface and runs the simple data web server. Hence coordinator collects the data over ZigBee wireless communication protocols and allow user to monitor the data from a web browser. User can make the irrigation system ON or OFF remotely. The system will reduces the water consumptions and giving uniform water to the crop results on increasing yield.

Keywords—Wireless sensor network(WSN); Raspberry Pi (Rpi);
Zigbee ; Embedded Linux .Web Design; Irrigation.

I. INTRODUCTION

Irrigation is a process of watering the soil. The requirement of water to the soil depends on the soil properties like soil moisture and the soil temperature. It also depends upon the crop which grows in a soil. From last decade, few existing system working for reduce the agriculture water consumption, but these system have some limitations. These systems, watering is done without analyzing the soil propertie,

due to which systems apply non uniform water to soil results in less yields. Also systems required more human intervention and time consume.

So we require modern technology to resolves this problem and support better irrigation management. For that we have proposed system which is a Web based automatic irrigation system using wireless sensor network and embedded Linux board. The wireless sensor network creates the networks of multiple devices having the capable of computation, communication and sensing. It provides bridge between the real physical world and virtual worlds and having a wide range of potential applications of Agriculture, home automations, science, civil infrastructure and security. In this proposed systems WSN is consists of two nodes, coordinator

nodes and Router/End device nodes. Each node mainly consists of memory, processor and RF transceiver. The coordinator node is based on Raspberry Pi (Rpi) embedded Linux board and End device is based on the Arduino UNO Atmega328 platform. The function of coordinator node in the system is initiate the communication with distributed End device nodes via the ZigBee wireless communication protocol and continuously collects the soil moisture and soil temperature data and store collected data in database. The database is created on the raspberry Pi board which is MySQL database. Coordinate node analyzes the received data and decides the water required for a soil. If the analyzed data shows that water is required, the coordinator node send commands to water pump controller make Irrigation on. Rpi has an Ethernet interface and it run an simple data web server. Hence coordinator node allows data collection over ZigBee, and data monitoring and system control from web browser remotely.

Agriculture is the worldwide prime occupation of human being, 64% of total available land is an occupied by the agriculture, and it consumes 85 % of available fresh waters. This figure of water consumption increase every year due to globalization and population growth. There is challenge in front of every country to sustain the fresh food requirement and reducing the farm water consumption.

II. AUTOMATED IRRIGATION SYSTEM

A. Basic Irrigation System

We are using MCP3008 as a data converter. This ADC converts analog input from different sensors in to digital output which is fed to ARM11 which in turn to be displayed on web page. MCP3004/3008 devices are successive approximation 10-bit Analog to- Digital converters (ADC) with on-board sample and hold circuitry.

The MCP3004 is a programmable to provide two pseudo-differential input pairs or four single-ended inputs. The MCP3008 is programmable provide four pseudo-differential input pairs or eight Single-ended inputs.

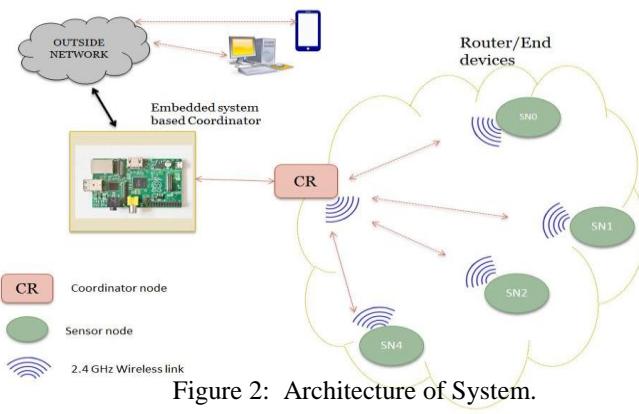


Figure 2: Architecture of System.

1) Raspberry Pi

In this proposed system we have used the Raspberry Pi as the controller of coordinator node. Rpi is the small, cheap minicomputer. It continuously collects the information to send by sensor nodes through ZigBee protocol and processing large quantity of data timely and available for users to view.

2) End device sensor node

The soil parameters are sensed by Sensor node used here. It is designed using Arduino UNO microcontroller board. It consists of the ZigBee based radio transceiver, power supply unit, moisture and soil temperature sensors, and data logger for temporary storage. It senses the soil parameter at one-minute intervals and will be send back to the coordinator node via the ZigBee protocol.

3) ZigBee

The ZigBee protocol for wireless communication is based on the underlying protocol IEEE 802.15.4, which defines the controlling layer for media access and network physical layer, while ZigBee defines the network layer, application layer and specifications of the network security services.

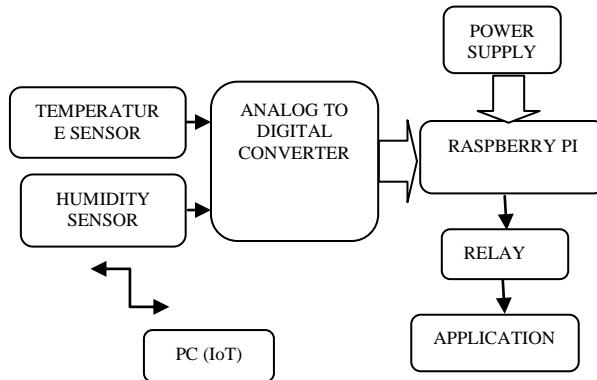


Figure 1: Basic Block Diagram.

ARM 11 is important system in our project. This is used to control, monitor and make decisions for application. For ARM 11 we are using raspberry pi. Raspberry Pi hardware has various versions that feature variations in hardware performance, memory capacity, and peripheral device support.

B. Proposed architecture used for automated irrigation

Design of automated irrigation is as shown in Fig.2, Coordinator node manages the multiple Router/End device node. The system consists of Coordinator node, Router/End device sensor node and web server design. radio transceiver is used to link Coordinator node and End device sensor node. It will allow transmit soil parameters from End device sensor node to coordinator node and controlling signal from coordinator node to water pump node. The wireless communication is based on ZigBee protocol (2.4 GHz wireless link). The web server is designed on Rpi to monitor and control irrigation. Any device which have capability to access the web services are used here to monitor the data like PC, laptop, smart phone etc.

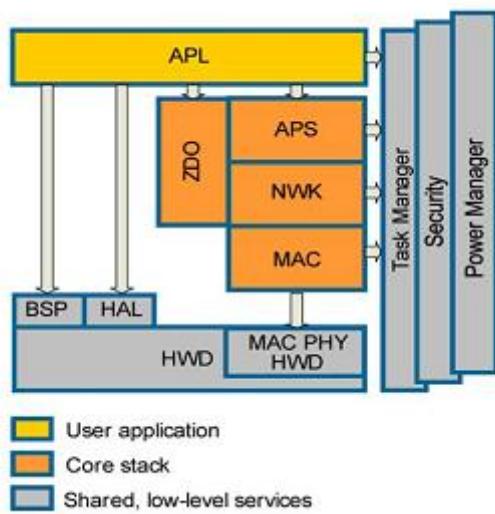


Figure. 3: IEEE 802.15.4 ZigBee stack standard.

ZigBee is described by referring to the 7-layers of the OSI model for layered communication systems. The Alliance specifies the bottom three layers Physical, Network, and Data link , as well as Application Programming Interface that allows end developers have the ability to design custom applications that use the services provided by the lower layers.

4) Database and web server

In this system we have designed the database based on MySQL which is installed on Rpi. MySQL is popular choice of database in web application. MySQL is the relational database management system. It is open source software. Database stores the soil parameter information sent by sensor node. It provides information to web page for monitoring the system.

5) Sensors

a) Soil temperature sensor

The temperature sensor used is DS1822 digital thermometer with $\pm 2^\circ\text{C}$ accuracy over -10°C to $+85^\circ\text{C}$ range. Data is read over 1 wire serial bus in 2's complement format with 9 to 12 bits of resolution. The DS1822 requires one data line for communication with a central microprocessor. It having operating temperature range of -55°C to $+125^\circ\text{C}$. The DS1822 can also derive power directly from the data line, eliminating the need for external power supply. Each DS1822 has unique 64-bit serial code, which allows many DS1822s to function on the 1-Wirebus; hence, it is simple to use single microprocessor to control many DS1822s distributed over large area. Applications that can benefit from this feature include temperature monitor systems inside buildings and process monitoring and control.

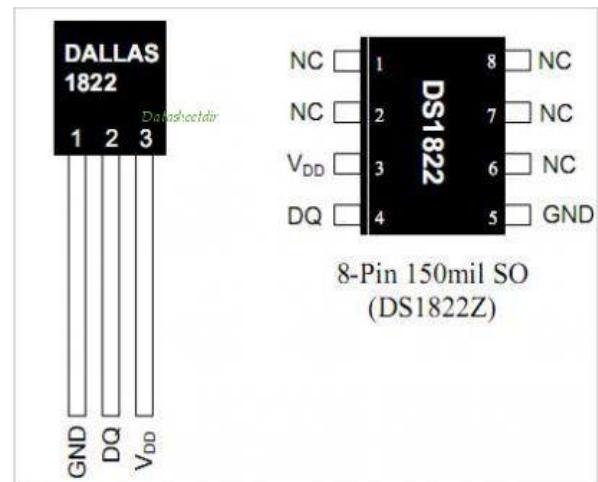


Figure 4: Pin diagram of DS1822.

b) Soil moisture sensor

The module consists of detection probe and sensor board. It is having three output mode, digital, analog, and serial with accurate readings. The sensor detects the moisture of the soil surrounding it, that is shortage of water content of the soil. If the soil contents are low the module output will be high then the output will remain in neutral conditions. This moisture sensor consist of two probes used to pass the current into the soil, and then it reads that resistance between two probes to get the water level in Soil. More water present in the soil makes the soil conduct electricity more easily show less resistance; while dry soil having less water conducts electricity and more resistance.

C. Introduction to Raspberry pi

The Raspberry Pi has low cost credit size minicomputer which has now become popular. The Raspberry is the cheap low power arm 11 based microcontroller operating at 700MHz frequency and having the 512 megabytes (MB) of RAM memory. Fig.5. shows the picture of Raspberry Pi.

Features of the Raspberry Pi

- Raspberry Pi(Model B+) has Mounting Points and 512MB RAM.
- Integrated Video core 4 Graphics GPU capable of playing Full 1080p HD Video.
- 4 x USB Ports.
- Board Power Draw: 600mA.
- HDMI Video Output.
- 10/100Mb Ethernet Port for Internet.

- Flash Memory Card Slot (Micro SD).
- 40-pin 2.54mm Header Expansion Slot, Which allow for peripherals and expansion boards
- Dimensions 85 x 56 x 17mm.
- The Raspberry Pi is boot by external memory card with rasbian wheezy images.

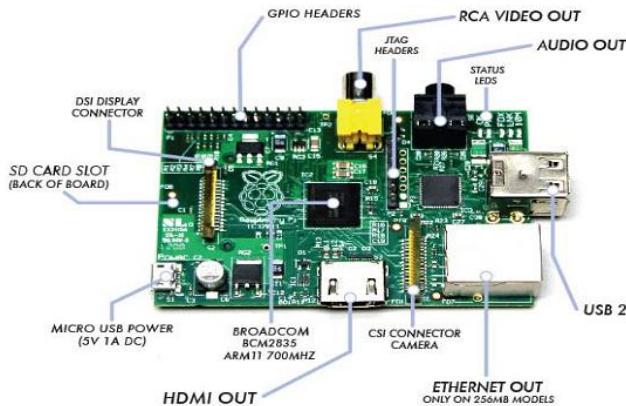


Figure 5:Raspberry Pi.

C. Introduction of Arduino UNO

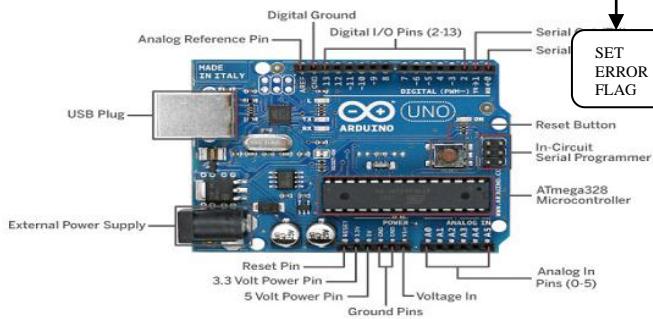


Figure 6: Arduino UNO R3

The Arduino UNO R3 is the microcontroller board based on ATmega328. It has 14 digital i/o pins, 6 analog inputs, 16MHz ceramic resonator, power jack ,USB connection. Arduino consists of a microcontroller and Integrated Development Environment . Using IDE computer code can be written and uploaded to the microcontroller. It can be powered by USB cable or power jack of 5v. It contains everything needed to support the microcontroller.

III. IRRIGATION SYSTEM OPERATION

We have developed two sensor node separated from each other. The space between the two nodes depends on the type of soil. The soil having the same water holding capacity requires only one sensor node. Each sensor node contains one

soil moisture and soil temperature sensors, and single ZigBee transceiver. The programming on the Arduino board is such way that after a minute sensor node sends soil parameter data to coordinator node through the ZigBee wireless communication protocol. The ZigBee transceiver device has a unique 16 bit personal area network address and 64 bit serial address. PAN ID is same for every Zigbee device working on the similar network.

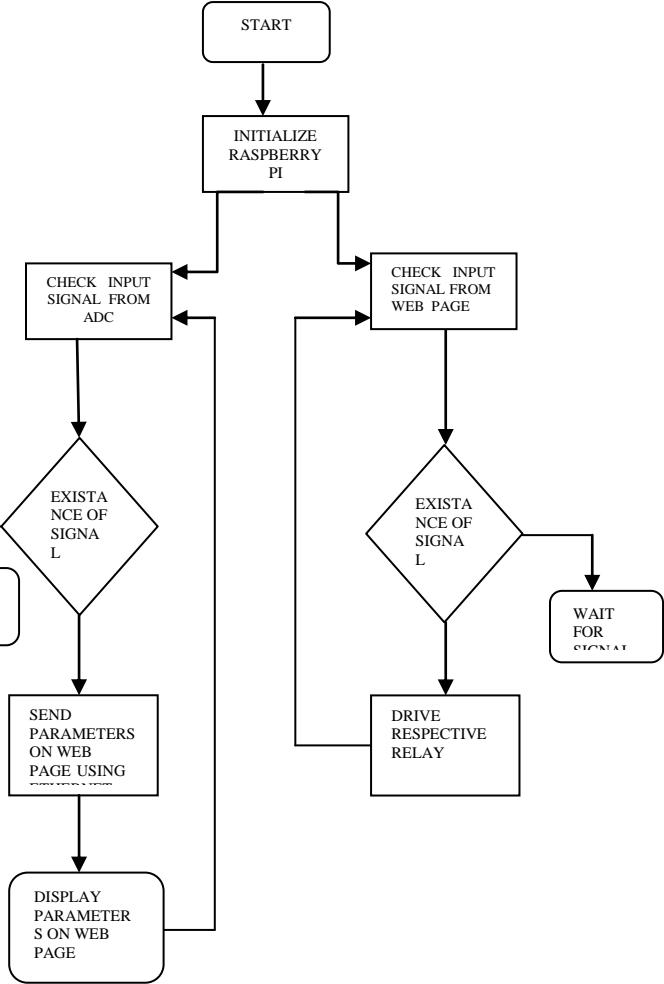


Figure 7: system flowchart

IV. EXPERIMENTAL TEST RESULTS

First the sensors are deployed(mount) in the farm. The distance between the two sensor node is depends on the type of soil.

The combination of the Arduino, ZigBee, and moisture sensor is responsible for capturing the moisture present in soil. Depending on the moisture contain and temperature of soil the watering to the crop is given.

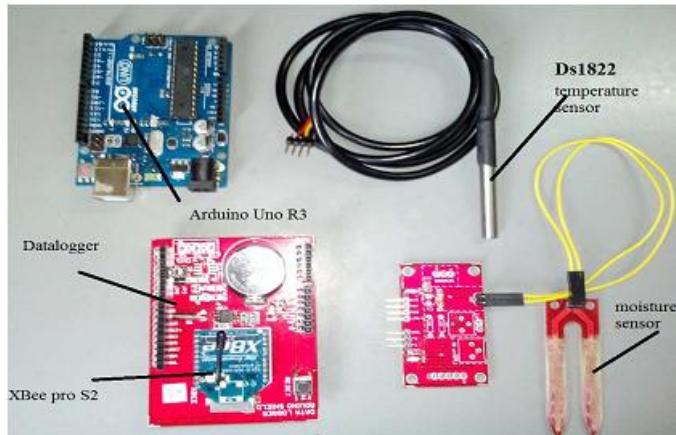


Figure 8: WSN node.

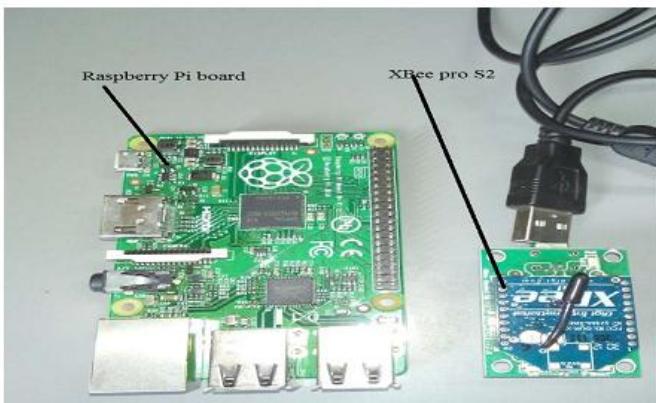


Figure 9: Coordinator node

V. CONCLUSION

This paper designs the automatic wireless irrigation system using WSN and embedded Linux board. In this we have used raspberry Pi as embedded Linux board which allows collecting the sensor information from sensor node consistently, store it in database and providing the web interface to user. The system is watering to crop uniform by analyzing the soil parameters, it will help to reducing the fresh water consumption. By providing the web interface and automation user can easily monitoring the system and it will minimize the human intervention. The ZigBee is used here for wireless communication it create network easily and combination of Arduino, zigbee and sensor create a low power cheap sensor node. The Apache web server crated on Raspberry Pi easily display the contents of sensor data.

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