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GSM and Web Application based Real-Time Automatic Irrigation System using Raspberry pi 2 and 8051

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Abstract

Background/Objectives: This paper presents an automatic irrigation system to provide water to the farms based on soil and temperature conditions. It can also control irrigation system through the web application and GSM by using Raspberry pi 2 and 8051 microcontroller. **Methods/Statical Analysis:** Number of sensor nodes will be placed on farm according to the area of the farm, each sensor node contains temperature sensor, moisture sensor, water level sensor and motor. 8051 microcontroller makes the communication with all sensors placed in the farm and it can collect the parameters like moisture, temperature and water level. Raspberry pi 2 is used to control the web application and GSM modem. Raspberry pi 2 takes data from 8051 microcontroller continuously using a wireless communication device. In this paper ZigBee transceiver is used as a wireless device for transmitting and receiving data from both devices. A threshold value is given for each sensor, if any sensor crosses its threshold value a message will be send to the user and display in web applications. **Findings**: This system uses Raspberry pi 2 for achieving high speed of operation. In real time farms which are remote areas, this system uses 8051 controller for collecting data from sensors and transfer it to Raspberry pi 2 using wireless sensor device. This system controls the motor automatically when soil or temperature crosses its threshold and manually whenever user wants. **Conclusion:** This irrigation system works efficiently and speeds. This system sends message to the users whenever sensors exceed its threshold value. This system offers every user to understand the soil conditions and amenable manually.

Keywords: GSM, 8051 Microcontroller, Moisture and Water Level Sensor, Raspberry pi 2, Temperature, Web Application

1. Introduction

In worldwide, nearly 60 percent of the land is covered with agriculture and it requires 80 percent of available water in the earth. The water consumption is going high and the usage of fresh water from 1950 onwards for different purpose are shown in Figure 1.

So, it is important to use the water economically[1] and this paper describes an automatic irrigation system with the use of Raspberry pi 2 and 8051 microcontroller. Previously, many systems[2–4] have been described for reducing of water consumption in irrigation system by means of automatic devices[5], but none developed for real time applications.

This paper describes about the real time irrigation system. The main problem in real time system is data cannot be transmitted on web directly because of the farm in remote locations[6].

So, in this paper we are using two controllers, one controller tracks the data from each sensor and transmit this data to another controller using a wireless communication device. For tracking data from sensors we are using 8051 microcontroller. The data is transmitted from one to another controller using ZigBee transceiver[7,8]. Raspberry pi 2 is another controller used for controlling GSM and web application[9]. This system gives threshold value to each sensor when the sensor crosses its threshold value,

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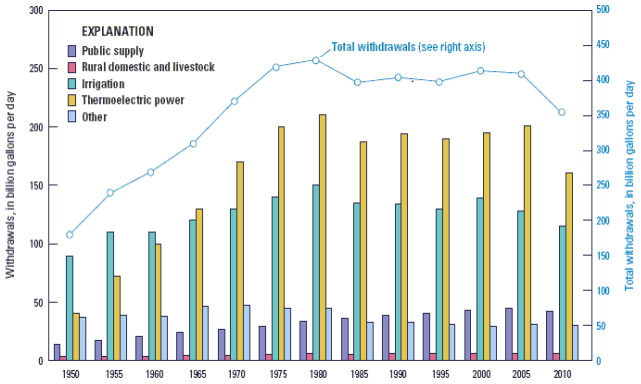

Figure 1. Usage of water from 1950 to 2010.

then message will be sent to the user using GSM modem. The user has to login into the web application[10] to control the motor or sending messages to the controller to stop the motor. This system provides control of motor by the user in any one way either web[11,12] based or through message. It contains a number of sensor nodes, each node contains temperature sensor, moisture sensor, water level sensor and motor. Each sensor node will be placed based on range of sensors and motor.

By using this type of irrigation system we can save the fresh water. These types of systems are necessary to use in those days for reducing water consumption and growing the crops. Nearly 10 percent of fresh water using for farms is reduced using this system. This paper contains mainly three sections like overview of the system, operation and implementation of the system.

2. System Overview

2.1 Raspberry pi 2

The Raspberry pi 2 acts like a CPU and is connected with monitor, keyboard or touch display and with the peripherals used. In the Raspberry pi 2 number of models will be available. In this paper model B is used and it gives six times the processing speed of other previous models. The Raspberry pi 2 model B has a Broadcom BCM2836 processor. BCM2836 is high powered ARM cortex-A7 based quad-core processor and operates at a frequency of 900 MHz with memory capacity to 1 Gbyte. It has 40 pin GPIO Header for interfacing the external devices to communicate with the processor. The communication media are like I2C, CAN, SPI and in this project GSM is used in direct connection with the TRX and RXI pins in GPIO. It has quad USB ports, 10/100 BaseT Ethernet socket, DSI Display connector, Micro SD card slot, 5 v Micro USB, HDMI port, CSI camera connector and 4-pole 3.5 mm jack. All of these are shown in Figure 2.

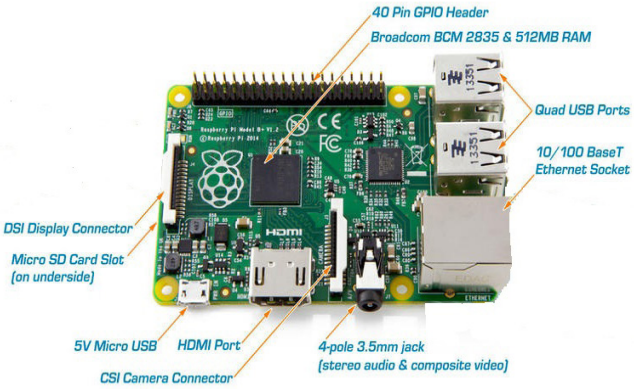

Figure 2. Raspberry pi 2.

This Raspberry pi 2 works on the basis of raspbian OS. Different types of Raspberry pi are working on different operating systems. Raspbian is an open source OS based on Debian optimize for the Raspberry Pi hardware. This Raspberry pi 2 contains an OpenCV based image processing library.

Qt Creator is used in this project to create the application. Qt creator has used C++, JavaScript and QML integrated development platform and which is part of the software development kit for the Qt graphical application development. It contains a visual debugger and farms designer. Qt Creator uses different compilers for different operating systems. For Linux C++ compiler from the GNU compiler is used and On Windows it can use MinGW or MSVC with the default install.

2.2 GSM

GSM (Global System for Mobile communications) is a digital cellular technology used for transition of voice and data services. GSM uses a Time Division Multiple Access (TDMA) and operates at two frequency bands i.e. 900 MHz or 1,800 MHz frequency band.

The data transmission and messages using GSM has done with the speed up to 9.6 Kbit/s. GSM connected to Raspberry pi 2 directly through the transmission and receiving pins (TXI, RXI) with common ground. GSM TXI pin connected to Raspberry pi 2 RXI pin and GSM receiver pin connected with Raspberry pi 2 transmission

pin. The GSM contain led for indication of signal of the sim. Number of ATtention commands will be written in software for data transmission. The interfacing of GSM with Raspberry pi 2 shown in Figure 3.

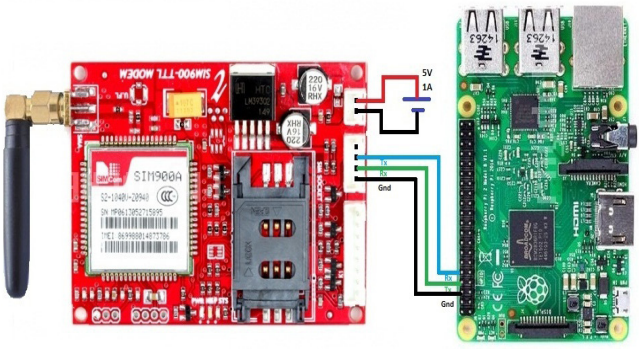

Figure 3. GSM modem interfacing with Raspberry pi 2.

2.3 Temperature Sensor

A sensor will convert one kind of energy into electrical energy and here we want to sense the temperature around the area. For this purpose, LM35 is used as temperature sensor. LM35 is integrated temperature sensor, varies its output voltage linearly with temperature. The output of the LM35 is in analog form, it is converted into digital using ADC. After conversion of ADC these digital data is given to 8051 microcontroller. Temperature sensor is interfaced to 8051 controller is shown in Figure 4.

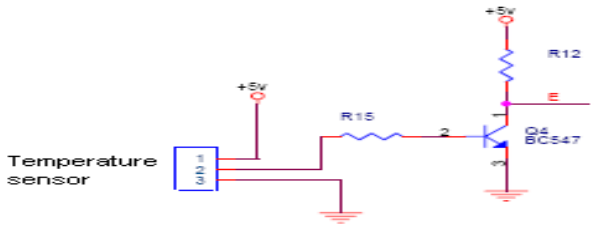

Figure 4. Temperature sensor.

2.4 Moisture Sensor

Soil moisture sensors are measure the soil wetness. Measuring soil moisture in agriculture is to help farmers to manage their irrigation systems more efficiently. In critical plant growth stages farmers use less water to grow the crop with high quality. The soil moisture sensor gives reliable readings in all soil types, installation at both the soil surface and at depth. This sensor measures volumetric soil moisture content with ±3% precision. How moisture sensor is connected to controller is shown in Figure 5.

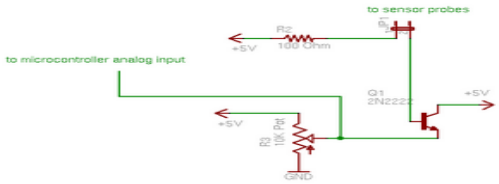

Figure 5. Moisture sensor.

2.5 ZigBee Transceiver

ZigBee transceiver is used for sends or receive data from one place to another wirelessly. In this project two ZigBee transceiver modules are used, one is connected with 8051 microcontroller for sending the tracked data from sensors to Raspberry pi 2 and vice versa. ZigBee sends data or receive with secure in the form of packets. It sends data based on IEEE 802.15.4 PHY and MAC layers. It transmits data with different speeds like 250 kbps (@ 2.4 GHz), 40 kbps (@ 915 MHz) and 20 kbps (@ 868 MHz).

3. Operation

The block diagram of the entire system is shown in Figure 6. This system is divided into two parts namely sensors part and controlling part. The sensor part consists of 8051 microcontroller. This controller reads the sensor values continuously from all the sensors connected to this controller. Here LM35 is used Temperature sensor, it gives analog value as output. So, ADC is used for converting the analog value into digital. Moisture sensor is used for knowing wetness of the soil and similarly water level sen-

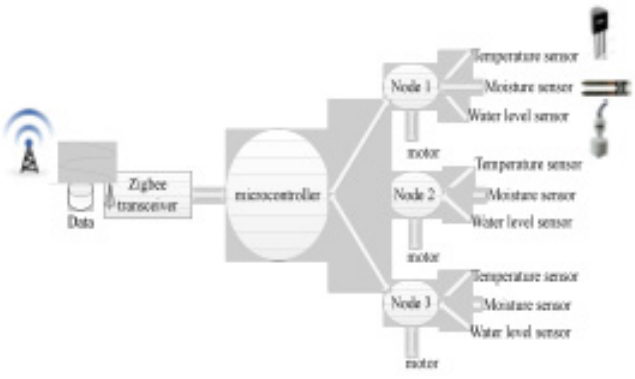

Figure 6. System block diagram.

sor is used for knowing water level in the soil when motor is in ON condition. The 8051 microcontroller reads the all sensors data continuously. This readied data is transmitted to the processor in the controller part through the use of ZigBee transceiver. We will send or receive the sensor data with high secure and fast by using the ZigBee transceiver.

The controller part consists of Raspberry pi 2 with BCM2836 processor and 1 GB RAM. It takes all the sensor data through the use of ZigBee transceiver connected to it. Raspberry pi 2 controls the motor in the farm by GSM message and web application. We place a threshold value for each sensor, whenever that particular sensor crosses its threshold value user gets message through GSM modem. At that time user can control the motor through the use of message sending or web options.

The operation of the entire system is explained by the flow chart shown in Figure 7. Initially all sensor reads its values at each sensor node. Microcontroller takes this sensor data and check for threshold for each sensor. If any sensor crosses its threshold value a message will be sent to the user through GSM. Motor ON at particular node mechanically without any human intervention. User can also control the motor at particular node through two ways: Through sending messages and by means of web applications. User sends message to GSM modem like mon or moff by any mobile. In the case of web application, user login through the IP address and control the motor.

4. Implementation of the System

The entire hardware kit of the system is shown in Figure 8. The Raspberry pi 2 is connected with mouse, keyboard, monitor and components are shown Figure 8. The implementation of the system is done through the use of Linux commands. While running this application, the value

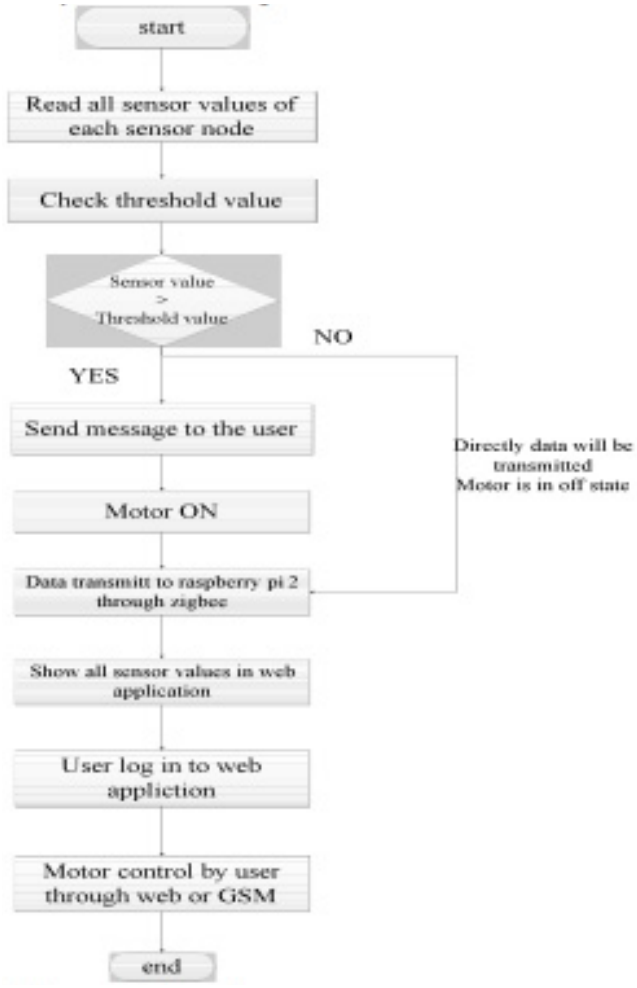

Figure 7. Flow chart.

of each sensor obtained is shown in Figure 9. The web application for this system is shown in Figure 10. The web application contains a server name with IP address. When user want to control the system then login into web app and control or user control through message sending to the sim placed in GSM modem.

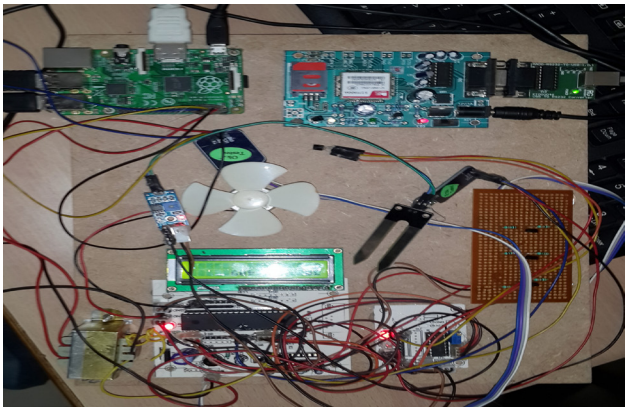

Figure 8. System hardware kit.

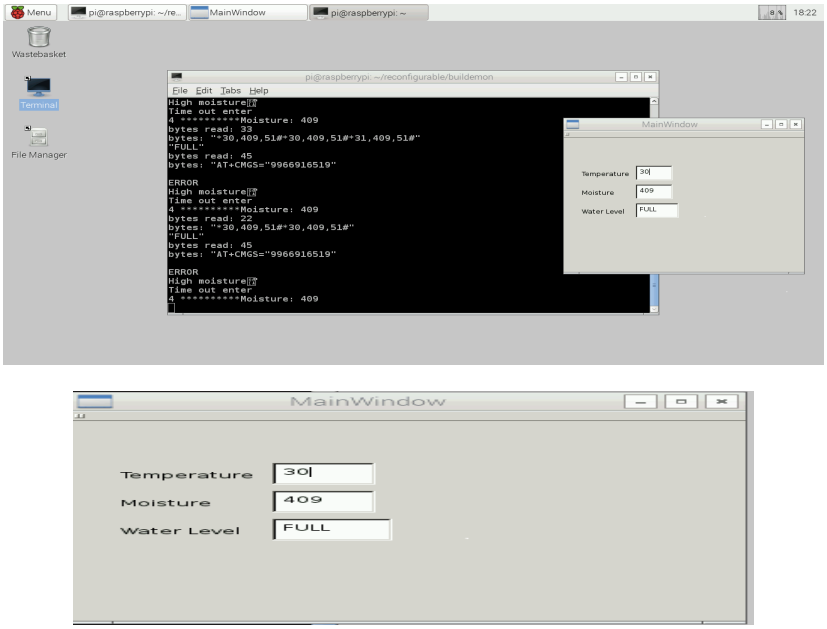

Figure 9. Application showing sensor values.

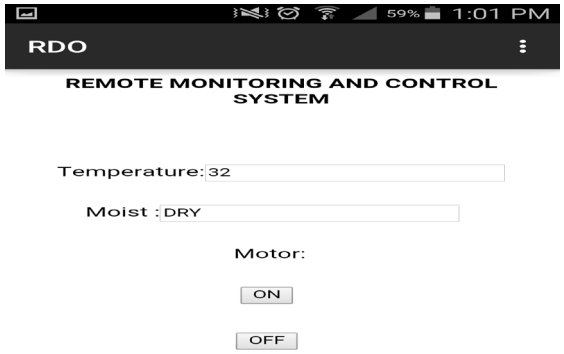

Figure 10. Application.

5. Conclusion

This GSM and web based real time irrigation system saves fresh water used for agriculture purpose. This system works in real time and efficient. Users easily operate the irrigation system through messages or web application. This system enables of watering the crop by understanding and analyzing of the soil parameters like moisture and temperature. It uses easily integral wireless ZigBee transceiver for sending or receiving data. The controllers, components and software used for this system are based are real time purposes.

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