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Greenhouse Parameters Monitoring and Controlling System Using Arduino and Android

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Abstract: -Greenhouse parameter monitoring and controlling system is basically designed to monitor and control various parameters of a greenhouse for efficient growth of plants. The system has been designed using Arduino, GSM, ZigBee and Sensors. The temperature, light and soil moisture sensors are used to measure the respective parameters of the greenhouse, further these measured values will be sent to Android app via GSM. As different plants require different moisture, by analyzing the values from the app the user can control the moisture by turning on the water pump via message to GSM. The objective of this project is to provide user full access to greenhouse on a single click through Android.

Keywords: - *Greenhouse, Arduino, ZigBee, Sensors, Android app.*

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I.INTRODUCTION

Greenhouse is an artificial climate controlled structure made-up of a glass or translucent plastic roof which is used for varied applications such as off-season growing of vegetables, floriculture, planting material acclimatization, fruit crop growing and plant breeding etc. Greenhouse helps plants to grow in their required climatic condition.

Growth of the plants directly depends on the water and nutrients of the soil in which it is grown. The water content, soil and salts form a soil solution which will provide nutrients to plants. Temperature and light intensity plays an important role in plants respiration and photosynthesis process.

Traditional agriculture techniques sometimes leads to water logging in field which makes the soil unfertile or saline. The required soil moisture for a crop depends on the type of soil and the climate. The upper and lower limits of soil moisture majorly depends on field capacity and permanent wilting percentage respectively [7].Thismodule works on the same principle and gives user full access to mold the system according to different crops grown in different soils.It also provide temperature and light intensity values to user. In this particular module we used Android operating system so that the user can access the greenhouse by seating in any corner of the world.

II. SYSTEM DESIGN

A. Hardware Enactment

In hardware enactment, it has wired and wireless components like Sensors, ZigBee, Arduino, GSM module, Water pump as shown in figure 1.

The hardware of this module is divided into two parts:

1) *On-field circuitry:* It consist of sensors, ZigBee (router) and water pump as shown in figure 2. This circuitry will be present on – field near plants to acquire real time values of the required parameters through sensors.

2) *Off-field circuitry:* It consists of Arduino which is the heart of the module and GSM, ZigBee (coordinator) as shown in figure 3. This circuitry is placed inside the office.
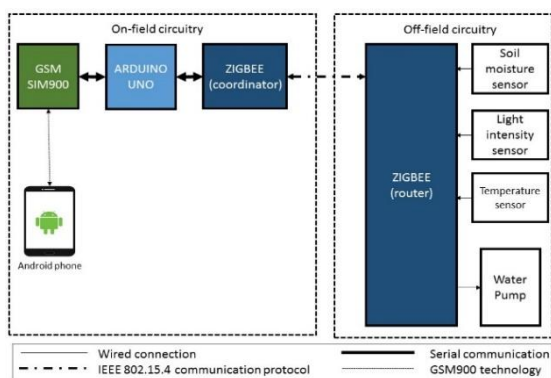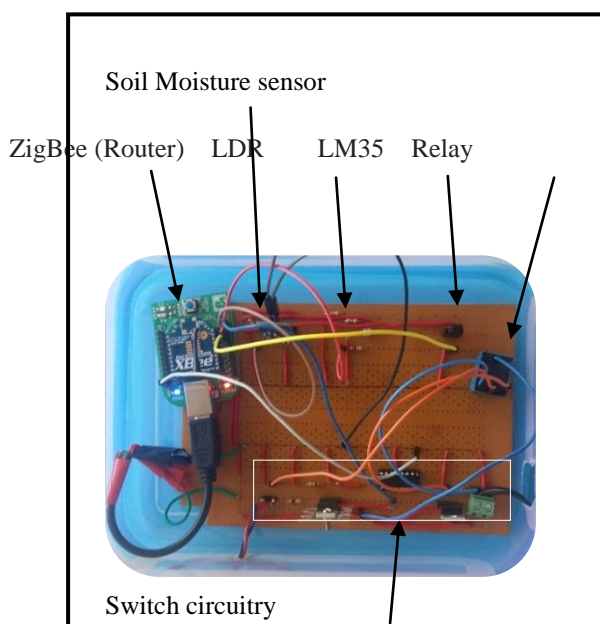
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Figure 1. System Design of module
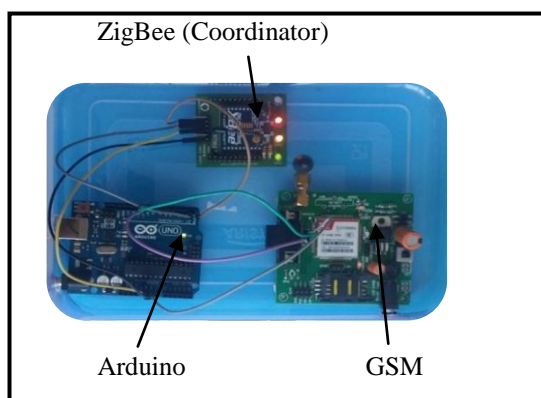

Figure 2. On-field circuitry

Figure 3. Off-Field circuitry

ATMega 328 (on Arduino board) is the microcontroller used in this module. It is an open source electronic prototyping device which is flexible, easy-to use. It is the most popular, ready-to-use microcontroller which is loaded with features like simple and clear programming,

open source extendible hardware and software. They are available in different types of boards like Lily pad, Leonardo, Mega, Uno with different features. Arduino Uno is the most commonly used board among these all. The heart of Arduino Uno is Atmega328. Atmega328 has 32KB of flash memory to store the code and 2KB of SRAM and 1KB of EEPROM, which is readable and writable with the EEPROM library [2]. Uno has 14 digital input/output pins out of which pin number 1 and 2 serial pins are used to communicate with ZigBee(coordinator) and pin number 9 and 10 are used to communicate with GSM which are configured as serial pins using SoftwareSerial library. Out of 14 digital pins, 6 can be used as PWM outputs. [2]. Uno doesnot use the FTDI- USB to serial driver chip like other Arduino boards, instead its controller is programmed as USB to serial converter. It is the best suitable controller hardware programming and controlling devices [6].

GSM is a communicating device between the user and Arduino. It is a mini-mobile prototype circuit which is suitable for SMS as well as data transfer application in M2M interface. Its baud rate is configurable from 9600-115200 through AT command [4]. In this module the GSM is configured with 9600 baud rate to synchronize with the Arduino baud rate. The modem is designed with RS232 level converter circuitry, which helps user to directly interface PC serial port from which the modem can be configured and monitored. It is widely used inthree digital wireless telephony technologies they are: TDMA, GSM, and CDMA. In particular to this system, GSM SIM900 has been used. It particularly works on 900 MHz band as signal propagation is better for this band in India. It has three connections except power supply to interface with Arduino i.e. TX, RX (connected to pin number 9 and 10 of Arduino respectively using SoftwareSerial library) and GND. It has SIM card socket attached on the wall of module. It also consists of an analog interface, an Analog to digital converter, an RTC, an SPI bus, an I²C, and a PWM module.It provides Point to Point MO and MT, SMS cell broadcast, Text and PDU modes. It has Stub antenna connected for transmitting and receiving purpose.

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According to the system design, ZigBee pair is the source of communication between on-field and off-field circuitry. A survey was conducted in order to find out the popularity of each wireless technology and the outcome was the exploited wireless technologies in modern day industries are Wi-Fi, Bluetooth, and ZigBee. ZigBee is a cost efficient device for automation [3]. Compared to devices like Wi-Fi and Bluetooth, ZigBee devices provide reliable data transmission up to 100 meters or more while consuming a very small amount of power. It works on wireless protocol which uses IEEE 802.15.4 standards that have been designed for low power devices. These devices also support different topologies, which make them ideal for applications that are portable and require low power consumption.It is capable of providing a secure communication with the help of 128-bit cryptographic keys.

In this particular module one of the ZigBee is playing the role of coordinator; which is responsible for forming the network and another ZigBee is acting as router; which is responsible for routing the traffic between different nodes. This module can be extended by connecting number of end devices to the router as shown in figure 4.
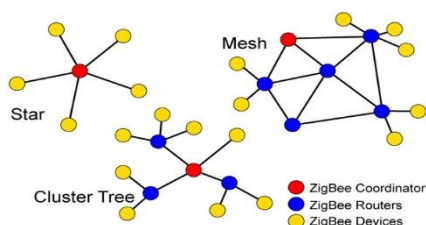

Figure 4. ZigBee Topologies

In design, ZigBee (router) is connected to a submersible water pump unit which is a pump and a motor in an enclosed unit, suitable for submerged installation. It is acting as water feeding element for greenhouse. It is a DC pump which is highly efficient, convenient, portable, easy to control, less noisy compared to AC pumps. It has soft start and low power feature that enhances the control via ZigBee. It has two opening; one will act as inlet and other will act as outlet. It can pump water up to 300ft. It is most reliable for small-scale applications.

LM35 is a temperature sensor used in this module. LM35 is a reliable temperature sensor as its output voltage is linearly proportional to temperature i.e. 10mV/°C. It has wide temperature range ranging from -55° to 150°C. This sensor works efficiently in the required temperature range of module. Compared to other temperature sensors it is more precise, low self-heating, low output impedance with accuracy of 0.5°C.

LDR is a light intensity sensor used in this module. Light Dependent Register is basically a resister whose resistivity is a function of incident electromagnetic visible lightradiation. As LDR is best suited for rugged environment and it has moderate response time compared to photodiode so it is ideal for this module.

The Soil Moisture Sensor are two conducting probes uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil.

Switch circuitry is used in this module to turn on and turn off motor. In this module 12V Relay is acting as a switch which switches the supply to DC motor. ZigBee is connected to this switching circuitry as the motor is commanded through ZigBee.

B. Software Enactment

1) Arduino programming

Arduino is programmed using Arduino IDE Tool. Arduino IDE is an open source tool which is user friendly while writing the code and uploading it to the board.It runs on Windows, Mac OS X, and Linux. The Tool is written in Java and based on Processing, avr-gcc, and other open source software. The program in IDE is called as 'Sketch'. Program can be written in C as well as C++ languages [1]. Basically, only two functions are to be defined 'void setup' and 'void loop' to make a program that continuously loop. It has variety of in-built library for interfacing devices.

2) ZigBee Configuration

ZigBee pair is configured into Router and Coordinator using XCTU. It is an open source, multiplatform application designed to enable developers to interact with Digi RF modules through a simple to use graphical interface. It is compatible with Windows, MacOS and Linux.

3) GSM configuration

GSM is configured using HyperTerminal software which is a communication and terminal emulation program. It is also used to set up dial –up connection to other computer through the internal modem using Telnet.

4) Android

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According to the survey conducted in 2013, 71% of mobile developers are using Android OS and the count is increasing day by day.Android also facilitates 1 million android apps which are readily available on Play store [5]. It is a stack of software components which is divided into layers shown in fig 5. This OS comes with set of core apps for email, SMS messaging, calendar, internet browsing and much more but these apps don't have special status so, a third party app can also be users default app which helps us to connect the module using our third party app "Farm Report". We have used this OS because it is most popular and user friendly operating system used worldwide as 85% of consumers prefer Android apps over websites,

Fig 5. Android Architecture

III.FUNCTIONALITY

Arduino is programmed according to the given flowchart (figure 6) using Arduino IDE. The user will send the STATUS message to the GSM and the GSM will forward the message to the Arduino. The Arduino and the ZigBee (which is acting as coordinator) are so programmed that they will fetch the values from ZigBee (which is acting as router) i.e.on-field ZigBee.
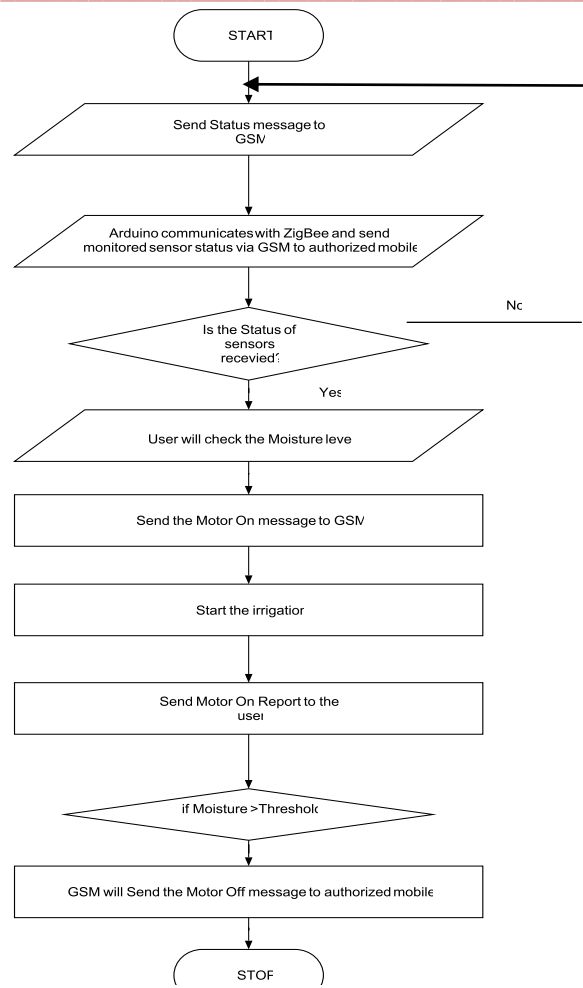

Figure 6. Design flow

The on-field ZigBee is connected with Temperature, Light intensity and Soil Moisture sensors. The real time values will be sense by sensors and will be forwarded back to user as shown in figure 7.
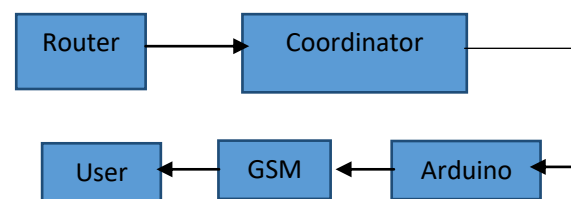

Figure 7. Path from Router to User

The user will receive the values of temperature, light intensity and soil moistureand will send the Motor On message by judging the soil moisture. The GSM will receive the message and the Arduino and ZigBee (coordinator) will command the on-field ZigBee (router) to turn on the motor through switch circuitry. The motor will be turned on by the same process and the drip irrigation will start. When the soil

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moisture will reach the threshold, the motor will be turned off automatically. The status of motor will be informed to user through message. "Farm Report" is the app used to access message and to control this module. It is the app specially designed for this module. It hastwo buttons which are command to send the Status and Motor On message to GSM.

IV. REAL TIME ANALYSIS

From Table 4.1 it is clear thatsensors have accurate response as recommended in datasheets. The sensors are highly susceptible to the real-time environmental changes with the average accuracy of 0.5%. Prolong exposure to extreme conditions may lead to fast ageing of sensors.

Table 4.1 Experimental results of sensors.

Trails	Temperature sensor readings (°C)	Light intensity (in %)	Soil moisture (in %)
1	29	100	48
2	29	100	48
3	29	100	48
4	29	78	46
5	30	78	50
6	30	77	44
7	30	77	42
8	30	78	42
9	30	77	42
10	30	78	42
Max. difference	1	33	8
Average value	29.6	84.3	45.2

From Table 4.2 the whole system requires fraction on seconds to complete the process. The system performance is highly dependent on the incoming and outgoing messages. The module is reliable in high network area.

Table 4.2 Time analysis of the system.

Trails	Time to receive message from user (in sec)	Time to sense status and send message to user (in sec)	Time for motor to turn on after receiving message (in sec)	Time for motor to turn off after sensing the threshold (in sec)
1	8	4	2	2
2	13	4	2	2
3	20	7	2	2
4	10	6	3	2
5	5	5	2	2
6	10	8	2	3
7	8	7	3	3
8	12	7	2	2
9	10	8	2	2
10	5	6	3	2
Max difference	15	3	1	1
Average time	10.1	6.2	2.3	2.2

V. CONCLUSION AND FUTURE-SCOPE

It is absolutely true that irrigation has been the backbone of human civilization since man has started agriculture. By continuously monitoring the status of the soil, we can control the flow of water and thereby reduce the wastage which helps to prevent the field from over irrigation, under irrigation, salination and soil erosion.

From the above results it is clear that the system works efficiently according to the analysis mentioned in the results.

Present work also helps to reduce the labor cost as the system is automatic. Whole greenhouse can be ONE MAN CONTROLLED as the user can access and monitor greenhouse through a single tap on the app. The system is versatile i.e. the user can use the system for different crop with different moisture levels. Thus the module contributes to tech-farming.

The present system can be used in Horticulture, Gardens and can be extended for big farms by forming mesh or star topologies of ZigBee.

VI. REFERENCES

[1] Ai, Q., Chen, C., "Green House Environment Monitor Technology Implementation Based on Android Mobile Platform", IEEE Conference Publications. Page(s): 5584 - 5587, 2011.

[2] Arduino. "What is Arduino?" Arduino Guide Introduction. Available[Accessed : 14 March 2017]: http://arduino.cc/en/Guide/Introduction

[3] Marko Paavola, "Wireless Technologies in Process Automation - A Review and an Application Example", University of Oulu, pp 63-69, 2007.

[4] Pavithra D. S, M. S .Srinath,"GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 4 Ver. I, PP 49-55, Jul- Aug. 2014.

[5] S Ayyaz, S Rehman, "The most secure smartphone operating system: A Survey.", World Academy of Science, Engineering and Technology International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol: 10, No: 2, 2016.

[6] S. V. Devika, Sk. Khamuruddeen, Sk. Khamurunnisa, JayanthThota, Khalesha Shai, "ArduinoBased Automatic Plant Watering System" , International Journal of Advanced Research in Computer Science and Software Engineering 4(10), pp. 449-456, October – 2014.

[7] Sykes, Dwane Jay, "The availability of soil moisture to plants" (1964).