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Smart System for Irrigation and Fertigation in Modern Agriculture

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ABSTRACT:A smart system for irrigation and fertigation is a system designed for the easy and efficient use of the water as well as fertilizers. The automation system is designed with the help of ARM7 and the Raspberry-pi. The xbee modules make the connection between the field section and the control section also the relays operate the pumps.The system stated here is the effective also cost scalable and having robust implementation. The soil moisture, temperature and humidity sensors are interfaced with the ARM7 controller. So according to the threshold values of soil moisture and the temperature the irrigation pump will be made ON/OFF automatically. When the fertigation is necessary the e-mail with a particular subject line is sent and the fertigation pump will be started using raspberry-pi functions. The user can get the current status of the field via e-mail continuously. The ARM7 uses the embedded c and the raspberry-pi uses python as the programming language. The system is very useful for the farmers to use in the greenhouses as well as the small or large agriculture fields also one can use it in the home gardening.

KEYWORDS: Raspberry-pi, ARM7, Zigbee, Xbee, Fertigation, Automatic drip irrigation

I.INTRODUCTION

Day by day there is lacking of water resources in India. There are the drought like conditions in the country after gap of certain years. So efficient use of the water is became necessary. Also the chemical fertilizers used in the excess amount are harmful for the health of the soil, so need of the optimum use of the fertilizers. These causes lead to the automation of the irrigation and the fertilizer application i.e. the fertigation.
Drip and sprinkler irrigation saves water as well as the having efficiency to get this water to plants is higher than conventional method. Fertigationis nothing but the irrigation but the fertilizers are the water soluble fertilizers. Many times soil nutrition product and the other water soluble products are provided to the plants. This is done through the injection from the same buried drip line hence reducing the cost of the system.
We have considered the parameters like temperature, moisture in the soil and humidity to design the system. This paper presents a smart system for drip irrigation and fertigation to water the plants using devices raspberry pi, ARM7. Xbee plays the role of wireless communication between short ranges. Python is the standard programming language for raspberry-pi programming. This system provides a cheap and efficient automation system also after installation it has minimum maintenance as well as it is user friendly.

II.RASPBERRY PI

Raspberry pi is often known as the pocket computer having Linux OS. Raspberry pi is having easy experimenting and innovation because of its easy python programming. Also it is cheaper than others. It is similar to motherboard and having port connections for storage, inputs and outputs [6]. We are using Broadcom BCM2835 System.

1. ARM CPU/GPU: It is on a Chip that's made up of an ARM central processing unit (CPU) and a Videocore 4 graphics processing unit (GPU)[6]
2. GPIO: GPIO are the general purpose input/output connection points used to connect the external I/O devices.
3. RCA: This port allows connection of pi with analog TV or other similar points
4. Audio Out: Audio out is the point provided for the connection of audio out devices like headsets.
5. LED: The LED is used as an indicator for the user to indicate the results or warnings.
6. USB: Universal serial BUS is the Common connection port for plug and play devices like mouse, keyboard etc.
7. HDMI: This port allows connection with compatible devices such as HD TV using HDMI cable.
8. Power: This is a 5V USB micro connector for power supply.

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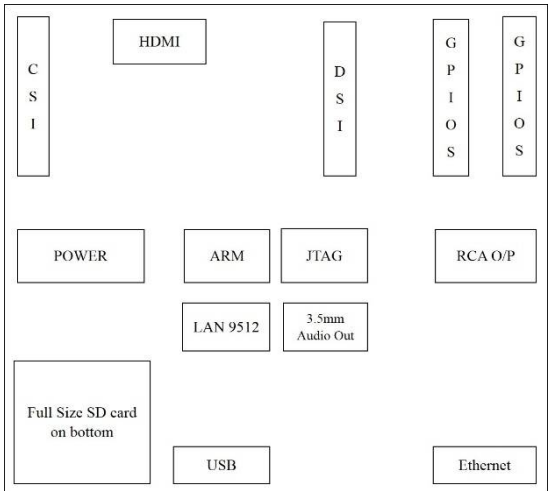

Fig. 1. Block Diagram of Raspberry Pi

9. Slot for SD card: Here the full size SD slot is provided for the card. The LINUX operating system is on the SD card. This is required for booting purpose.
10. Ethernet: This is used for wired network mainly. If other features wanted them can be added with the help of USB port or the USB hub if required.

III.DESIGN, IMPLEMENTATION AND THE FLOW

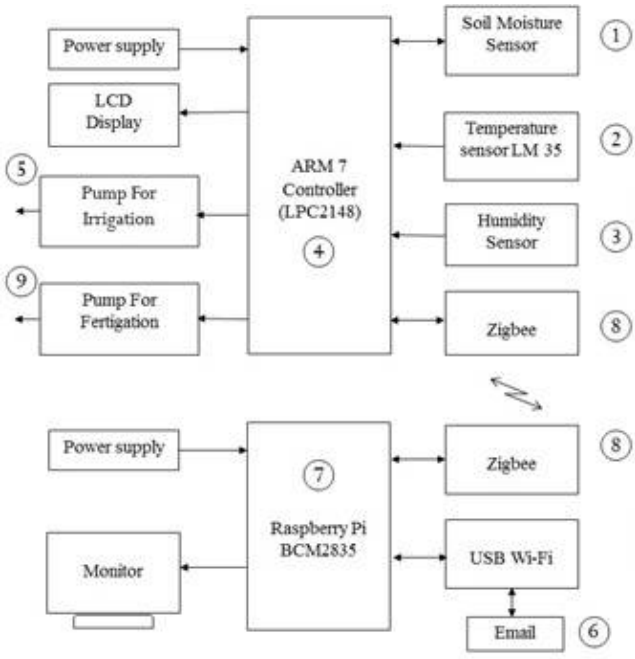

Fig. 2.Block Diagram of Proposed System

The block diagram of the Smart irrigation and fertigation system is as shown in the Fig.2. The meaning and functionality in short w.r.t. block diagram is as follows also the flow of the system is represented by numbering:

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1. Soil moisture sensor: This sensor gives the voltage output according to the conducting capacity of the soil. It depends on the moisture present in the soil of the particular land plot. The output voltage is taken at the transmitter end which is connected to a variable resistance. This variable resistance adjusts the sensitivity of the sensor.
2. Temperature sensor: Here LM35 is used. The LM35 is a sensor of integrated circuit type. LM35 is the sensor which measures atmospheric temperature and output is represented as the voltage. The voltage is relative to the temperature in degree Celsius.
3. Humidity sensor: It gives the humidity in the atmosphere.
4. ARM 7: ARM7 is 32-bit microcontroller architecture. It offers very low power consumption and low price for the high performance devices. The ARM7 architecture is actually based on principles of(RISC) Reduced Instruction Set Computer. Here, the sensors are connected to the ARM7 and according to the threshold values the irrigation pump will be controlled. ARM having facilities like simpler instruction set and decode mechanism related with them, which is only seen in ARM7.
5. Pumps: We are using 19 watt submersible motor, both the same. It is low voltage fully submersible motor having no noise, small size and no maintenance. The sensors are placed in the fields to collect the data from the environment and send it to the controller. After processing the data, if the value is above the threshold then the pump will be off and if it is below the threshold then it will be started feeding water to the field.
6. Email: To start the fertigation system we send an email to a defined Gmail account [2]. Raspberry-pi does the function of polling for emails in this defined email account. We are using Gmail account here with subject line PUMPON or PUMPOFF to ON or OFF the pump respectively
7. Raspberry pi: Model B of Raspberry is used here. As soon as the email is received, one of the GPIO is turned high. A program written in Python programming language is used to receive email. After receiving the mail GPIO pin is turned high for the further processing. The same program also sends the status updates to user's email address. Pi uses zigbee module to send and receive commands from controller. Zigbee uses the python language.

Figure 2 shown here explains the communication circuitry between the raspberry pi and zigbee module. It is shown that pi uses USB to TTL converter to talk to the zigbee module

8.Zigbee: Zigee is transceiver. Here it is used for the data transfer between the field section to the control section and vice-versa.Zigbee modules having feature of a UART interface. This feature of UART allows any controller to immediately use the services of the Zigbee protocol.

IV.RESULTS AND OBSERVATIONS

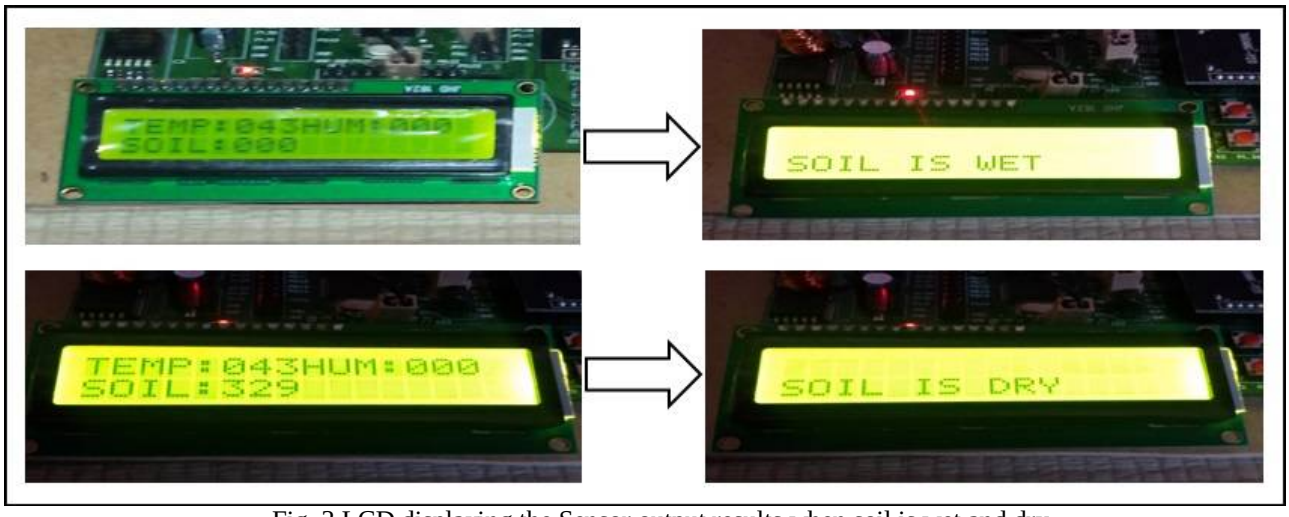

Fig. 3.LCD displaying the Sensor output results when soil is wet and dry.

The figure 3 showing the output results displaying on the LCD. The temperature, Humidity and the Soil moisture are displayed on the LCD continuously.

The figures 4, 5, 6 show the screenshots of the E-mail operations. The first is the received status of the sensors. The other two are the screenshots with the subject line PUMPON and PUMPOFF.

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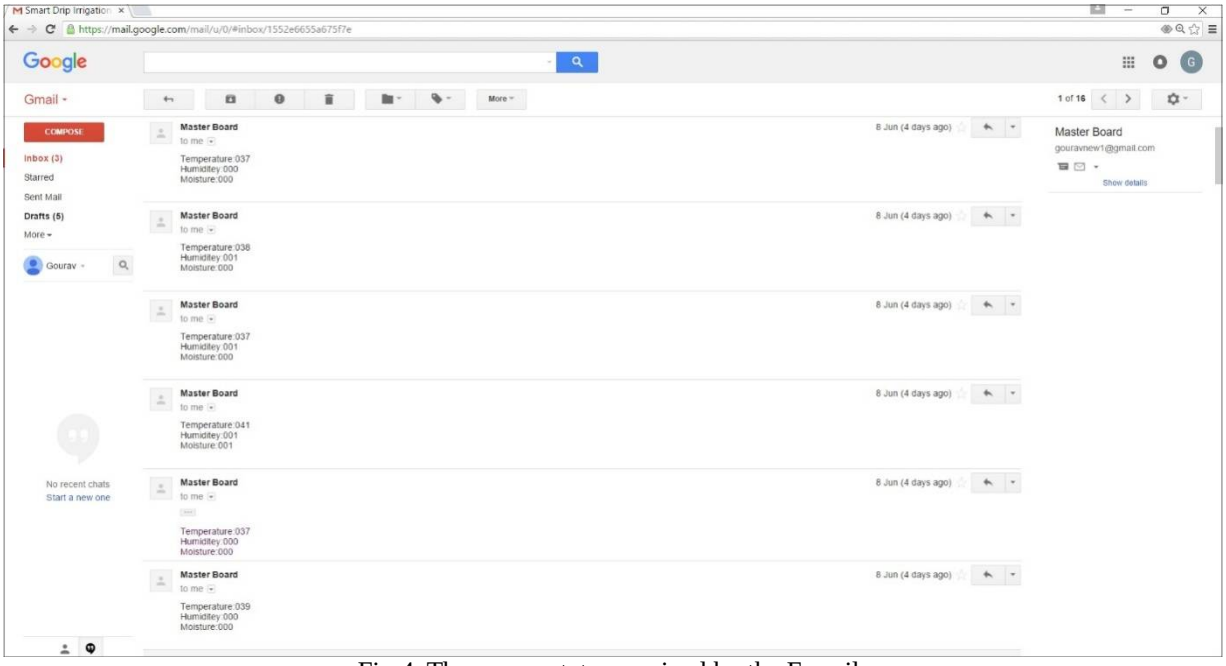

Fig 4. The sensor status received by the E-mail.

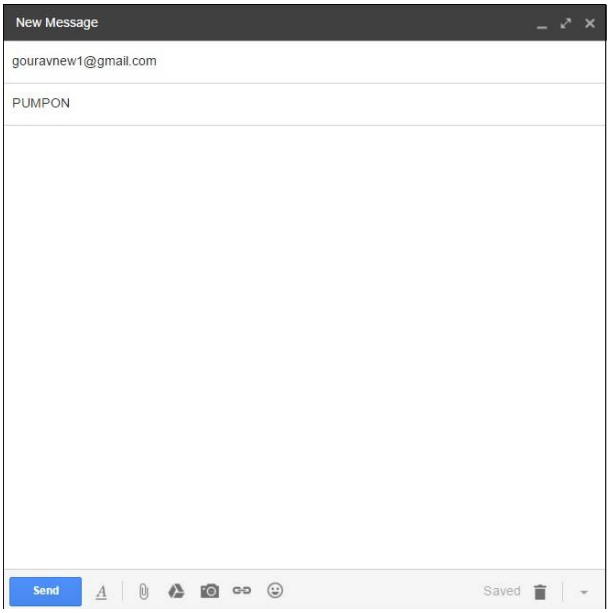

Fig 5. The screenshot of subject-line 'PUMPON'.

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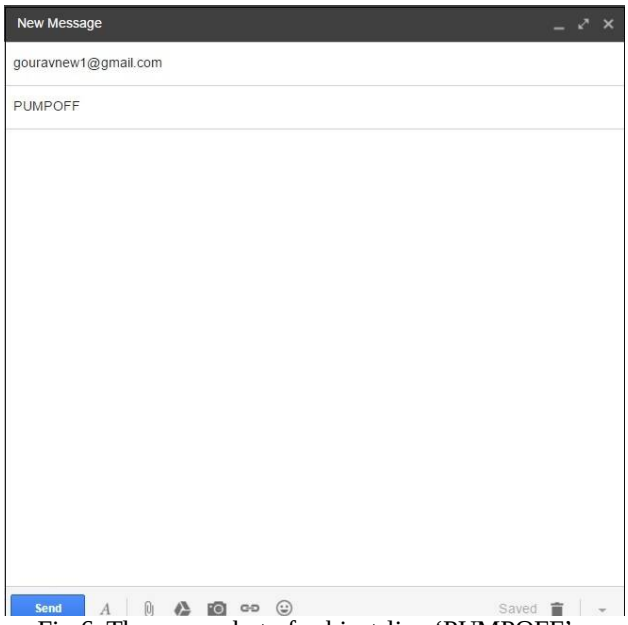

Fig 6. The screenshot of subject-line 'PUMPOFF'.

VI.CONCLUSION

This smart system for irrigation and fertigation proves to be a useful system because it automates and regulates the watering and fertilizer application without any manual intervention. The system we have designed is working automatically according to the thresholds of the sensors and water is provided to the field. After sending the emails to the system it will be automated according to the need for the fertilizers. Using this system relay board can be controlled remotely which get ON/OFF to control the water flow and the electrical flow.

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