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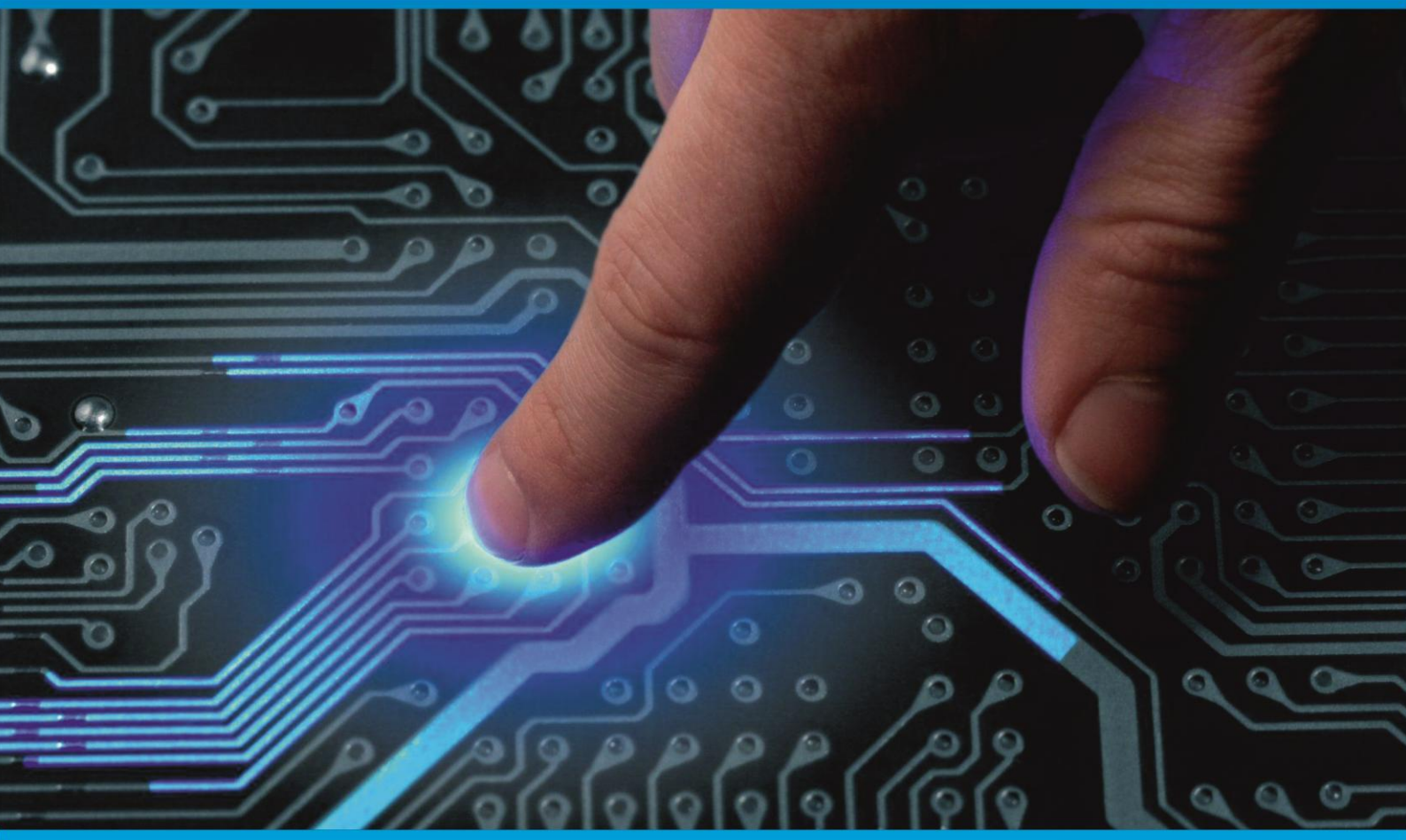

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Development of Prototype Smart Agriculture System by using IOT

Sudhindra.F.[1] Omprakash Jadhav[2], Vani.R.M[3]

Technical Officer-I, University Science Instrumentation Centre, Gulbarga University, Kalaburagi, India[1,2]

Prof & Head University Science Instrumentation Centre, Gulbarga University, Kalaburagi, India[3]

ABSTRACT: This is digital era; every thing is in digital form. All the day to day activities are now being controlled by the information digitally. This is due to advanced Information, Communication and engineering technology. This digital technology made our life easier & simpler. Internet is ground for these modern engineering technologies. One of the most widely user of this internet is, Internet of thing. The application of IOT includes a variety of field like home, aerospace, medical science, agriculture, industrial automation, home security systems etc. In IOT things/objects which are capable of doing computation and sensing are connected together to access the Internet service, for remote monitoring of parameters for remote sensing of real time data and transfer across the network. In IOT, things connected in groups can be accessed from anywhere in the world. Here the idea of IOT, is applied to smart agriculture. In smart agriculture it is required to use scientific approach for optimal use of natural resources & natural environmental conditions. Here we have presented an IOT based prototype smart agriculture system; we can monitor/control some environmental condition like soil moisture, ambient light etc. by using our android cell phone in a controlled environment.

KEYWORDS: Internet enabled PC/Laptop/Cell phone, Atmega326 MC, ESP8266 Microcontroller, Soil Moisture & Illumination Sensors.

I. INTRODUCTION

In this modern era, one most important and noticeable filed of Engineering, Science and Technology is Internet of Things, revolutionized the world and because of its simplicity, became important part of our life. In IOT, objects with computational and sensing ability are connected in groups to access the Internet service. Such connected devices are capable of remote monitoring of various parameters like physical, physiological and environmental. With the help of sensing devices capable of sensing the data of real time and converting them into suitable form and send across the network. The application of IOT includes agriculture, where heavy use of IOT is expected in coming days. Basically, India is agricultural country, it is a proved that the use of scientific technologies & optimum use of resources like water, manure, moisture, humidity & temperature in agriculture have always yielded more production. The main aim of the project work is to use the idea of IOT, for environmental parameters monitoring & control in agricultural. Each individual sensor devices collects the data from the system and controls the device by feeding signals to the actuators/sensors. Such an IOT based system facilitates the user to remotely monitor environmental conditions and crop production process. In this work the realization of idea of IOT is done on Arduino platform and compatible sensors. we have considered water content of the soil or soil moisture & ambient light as controlling parameters which are useful in agriculture/farming sector.

II. RELATED WORK

The literature survey shows that, the use of advanced technologies such as internet, wireless communication, cloud computing & IOT's been used for control of various electrical & electronics devices by many researchers. Home automation system based on IOT with Intel Galileo & wireless communication & cloud computing for remote control of various electrical appliances is reported by Vinay Sagar et al [1]. Similar application also be applied by the use of cell phone & Arduino mega controller for monitoring the few electrical devices as clamed by Tejal Deshpande et al [2]. Even Raspberry PI method can also be implemented for home automation as reported by Prof B.P Kulkarni et al [3]. The increased features of Home automation & Security of smart home it is essential to use the combination of techniques such as RFID, SMS, Email & real-time algorithm based IOT is claimed by Khushal Shingala [4]. The use of Raspberry PI method with a android cell phone for home automation is reported by Kalyani Pampattiwar et al [5]. R.A.Jain et al authored the application of IOT for Women's safety, which includes many methods like transmitter,

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receiver, GSM, GPS, temperature sensor, heart beat sensor with ARM-7 microcontroller [6]. The Raspberry PI method also used for theft detection device with additional techniques such as image processing, camera, motion recognition etc as reported by Umera Anjum et al [7]. Anandkrishanan S et al implemented IOT application for LPG gas leakage & monitoring with SMS alert by applying GSM technique [8]. Some authors used the same IOT technique for smart city underground water leakage detection, Vehicle theft detection, smart parking system and smart agriculture system [9][10][12][13]. The another important application of IOT is healthcare devices for remote monitoring of patients as mentioned by Prashant Salunke et. al [14]. The measurement of electrical signals of muscles is called as Electromyogram (EMG) is a physiological parameter, and the measurement of EMG by using sensors & IOT claimed by Gaurav Raj et al [15]. I have implemented the IOT for Home automation and smart agriculture wherein some electrical devices & environmental parameters are controlled by smart phone [16, 17].

III. THE SYSTEM OUTLINE

The main ambition of this work is to present the use of IOT as a basis for controlling & monitoring of environmental parameters that are necessarily required in farming & agriculture sector. Autonomous sensor devices gather data from the system and control the process by feeding signals to the sensors/actuators. Such a system facilitates the users to remotely monitor environmental conditions. The realization of this work is on Arduino board with shields and suitable sensors, recognized by library. This system design was implemented on Arduino board using Atmega 328 controller and the use of IOT features enabling the sensors to be accessed from Wi-Fi LAN or the Internet or cell phone. Sensor devices based on Arduino gives accessibility by connecting to the internet. It is achieved by combining Ethernet or Wi-Fi modules to sensors, thus establishing their interconnection. Hence, Arduino and ESP8266 Module is used for wireless networking. This prototype design monitors two environmental parameters soil moisture & intensity of ambient sun light. The design assures the user to gain savings in resources, cost reduction and increase the agriculture production.

IV. METHODS AND MATERIALS

The developed prototype smart agriculture system block diagram is as in the fig 4.1.This consists of following blocks

1. ATmega328 Microcontroller
2. ESP8266 is a Wi-Fi Module
3. Soil Moisture Sensor
4. Illumination Sensor
5. Signal Conditioning Circuit
6. LCD Display Unit
7. Buzzer & Drive Circuit
8. Relays & Relay Driver Circuit
9. Power Supply Circuit

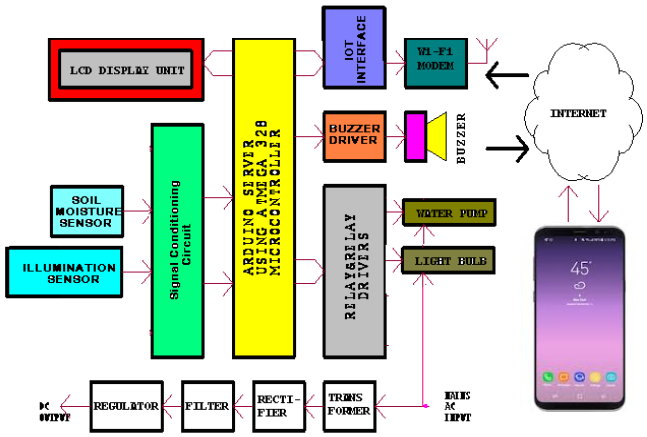

Fig.1. System Block Diagram

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4.1 ATmega328 Microcontroller: It is central part of the system design. A microcontroller is a one - chip computer that contains the CPU, non-volatile memory for the program (ROM or Flash), volatile memory for data I/O (RAM), a clock and an i/o control unit, also known as "computer on chip," It is a single chip microcontroller created by Atmel and belongs to the mega-AVR series. It is an 8-bit AVR RISC-based microcontroller having 32 KB ISP flash memory with R/W facility. The microcontroller is taged with ESP8266 which is a Wi-Fi Module, Soil Moisture Sensor & Illumination Sensor, Display Unit, Buzzer & Drive Circuit, Relays & Relay Driver Circuit etc. are used in this work.

4.2 ESP8266 Microcontroller: It is a Wi-Fi networking device & it is used for establishing the connection between microcontroller & the Wi-Fi (Figure 2.). It is also has ability to execute separate applications independently. It has the following features: power supply=3.3v, RAM = 32K + 80K, speed = 80-160MHz. When fully charged, the current consumption is = 170mA and in sleep mode it is 10uA. It can be powered by solar panel also for recharging the battery.

Fig.2. Image of ESP8266 Processor (curtsey)

4.3 Soil Moisture Sensor: This sensor measures the moisture in the soil. Measurement of water content present in the soil is important activity in agriculture/farming which helps the farmers to monitor their irrigation systems more efficiently. With this activity not only the farmers can use less water to grow crop, but also able to enhance productivity and the quality of the crop by better management of during crucial growth stages. Water is required for the basic growth and maintenance of crop. When a sufficient amount of water is not present for crop, then stress can occurs due to which reduction in quality or dieing plant. The soil moisture lead is consists of many moisture sensors. Soil electrical conductivity is simply measured using two metal conductors spaced apart in the soil except that dissolved salts greatly alter the water conductivity and can confound the measurements. It is used to measure the water content of soil volumetrically. Most sensors are designed to estimate volumetric water content based on the dielectric constant/bulk permittivity of the soil. The dielectric constant is defined as it is soil's ability to transmit electricity. This dielectric constant increases as the water content of the soil increases. This response is because of the fact that the dielectric constant of water is larger than the other soil components, even including air. Thus, it gives a predictable estimation of water content accurately. Only one sensing device can be used to control the irrigation for many zones or multiple sensors can also be used to irrigate individual zones. Sensors should be buried in the root zone of the crop to be irrigated, because this is where crop will extract water. In this work, we have used the moisture sensors which can be inserted in the soil, in order to measure the moisture content of the soil. SMS comes with a pair of probes that can be inserted in the soil. Little current flow through the wire and the level of resistance will be measured. The resistance increases if the soil is dryer & decreases as the soil is wet. The output is an analogue that should be connected to analogue to digital converter. Apart from agriculture, other fields like horticulture, small farmers, sports stadiums etc also uses soil moisture sensor..

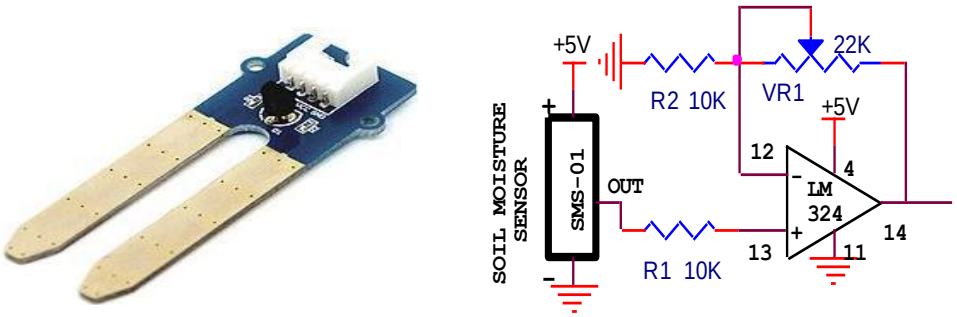

Fig.3. Soil Moisture Sensor SMS-01 (curtsey)

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4.4 Illumination Sensor The illumination can be sensed by electro optical sensors, either photoconductive cells (light dependent resistor LDR) or by photovoltaic cells. An electro optical sensor is an electronic component that responds in some way or another to either light or the electromagnetic waves in the infrared ultraviolet and x-ray bands close to the visible light band. Photosensitive elements are versatile tools for detecting (radiant energy) light. "Photo conductive cells" also known as 'Photo Resistors' or "Light Dependent Resistors" are one among the photosensitive devices that are mostly used in electronics applications. Such LDR is used for sensing illumination. The LDR is connected in series with resistor to form a voltage divider's biasing voltage is applied across this network. The voltage of this resistor depends on the illumination level incident on the LDR. This voltage is fed to one more ADC input channel of the controller. The illumination sensor is used to know the sunlight or artificial light condition in farm. It indicates whether the climate is cloudy or bright light. The sensors are made up of semiconductor materials having high resistance. The active region of a photoconductive cell is a thin film of silicon, germanium, selenium, a metallic sulfide (e.g., cadmium sulphide, cds). When there is light, the electrons in the valence band are excited to the conduction band. Because increased illumination creates additional free electrons, the resistance of the photoconductive cell decreases with increases in illumination level. They are often used as light sensors. These type of sensors are also used when it is required to detect absences or presences of light. The applications are; camera light meter, Light controlled street lamps, Light operated Audio switch alarm clock, burglar alarm, light intensity meters etc.

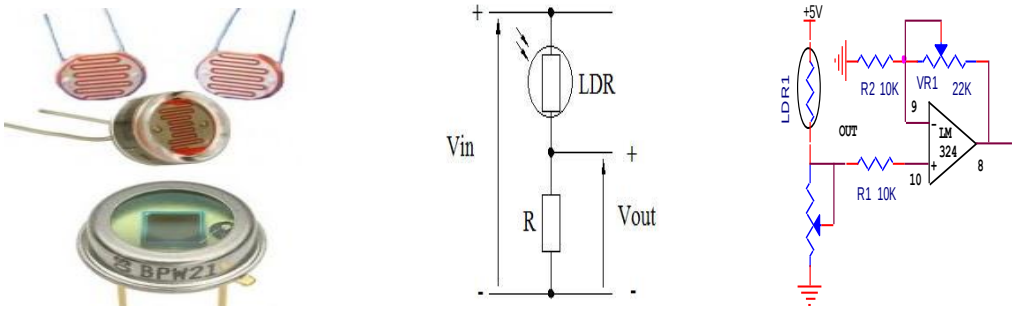

Fig.4. Illumination Sensor LDR (curtsey)

4.5 Signal Conditioning circuit: If you consider any type of sensor, the output signal is very small in amplitude. Therefore it has to be amplified. This is done with the help of signal conditioner. It depends on the type of transducer/sensor connected to it. It is usually an instrumentation amplifier. It has a filter to remove the unwanted signal from the original signal.

4.6 LCD Display Unit: It is a simple LCD display module for displaying various prompts and status information of the system at on site. This LCD display module has 2-line, 16 characters. The output port pins of microcontroller sends the signals to LCD. It can be put on 6 pins of any port. Since 4-bit interface mode is used, because in program we have configured to work on 4-bit mode, hence requires only 4-bits for data/commands transfer and two handshake signals enable (En) and register select (RS)..

4.7 Buzzer & Driver Circuit: Abnormality is somewhat not a normal condition where there is a change in the signal with respect to set values recognized by the controller through the sensors. An audio tone used to alert/know the people around produced by the buzzer. This audio tone is controlled by the controller through a driving transistor which is a NPN transistor operated in CE configuration.

4.8 Relays & relay driver circuit: The electromagnetic, single contact relay of 12V DC is for the on/off operation of mains operated loads like soil resistance (for Soil moisture) and LDR resistance (for Illumination). The driver circuit again consists of a NPN transistor operated in CE configuration.

4.9 Power Supply: Regulated D.C supply is used to give supply to all sections of the designed system. It will provide a constant voltage at 1 Amp current rating which is derived from AC mains and coverts it into DC power at low voltages. It is having a step-down transformer, rectifiers, filters and regulators. It supplies +5Volts to Microcontroller, LCD, EEPROM, Relay Drive Circuit and Buzzers.

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V. SYSTEM SOFTWARE

The program is written in Arduino Integrated Development Environment (IDE). It is an open source platform used for constructing electronics projects. It has both a programmable a microcontroller and software, or IDE that is used to write and upload program to the physical board. The Arduino IDE uses a simple C++, making it easier to learn the program. This platform has become very popular. It connects to the Arduino hardware to upload programs.

VI. SYSTEM OPERATION

Atmega 328 is used to develop this system with a Wi-Fi unit ESP8266, which will give internet connectivity to the system. The sensing devices that are used to sense the parameters like moisture of the soil & ambient sun light are 1) soil sensor SMS-01 & 2) Sun light sensor is a simple LDR. We have used cloud services of 'Thingspeak' web service & is a free to use API service that works as a main system for these sensors to monitor the recognized data and having a unique feature of sending the sensed data using a channel ID and read API key given by services and able to track data value at specific intervals. The controller, in the Arduino will collects data from these sensors & processes them, compares them with the set-point values and transfer sensed data to the ESP8266 Wi-Fi module for uploading to private channel on Thingspeak.com of Thingspeak Cloud service. This prototype model works from AC mains but it can also be out on solar charged batteries.

VII. EXPERIMENTAL RESULTS & DISCUSSIONS

The prototype model is thoroughly tested in the laboratory. The Wi-Fi and IOT capabilities are examined to the designed system for long & short range agriculture applications. This IOT-based system can readily be used on farms or agricultural fields for monitoring & control of parameters environment such as Soil moisture & Illumination. The independent sensors have very important role in collecting data for the system control, and send signals to the actuators in the control process. The system connected to sensors on the farm fields allows access through the Internet, thus provides the users to monitor environmental conditions remotely and hence increases the quantity of the crop. This system ensures farmers to achieve saving of the inputs, reduction in cost and trace the crop production on the fields. Following are the screenshots of results plotted for on Thingspeak Cloud platform

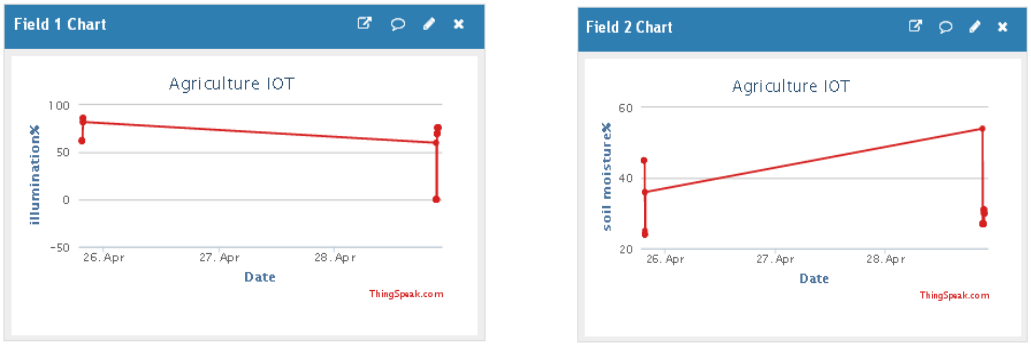

Fig.5. Screenshots of results plotted for on Thingspeak Cloud platform showing soil moisture in % & illumination in %

VIII. CONCLUSIONS

We have designed & developed an internet of things based Smart agriculture system. The system is very flexible, very accurate and worked reliably, it can be practically used. With the help of internet interface and automation user can monitor the parameters and will minimize human intervention. It is proved in the lab that the system itself is a reliable solution in providing remote sensing, controlling & monitoring of parameters for indoor/outdoor environmental parameters. The sensors are connected to the system to monitor and calculate the level of presence of moisture in the soil and ambient sun light using IOT technology. The developed system has ability including 1) display of soil moisture & ambient sun light 2) Will alert when weather conditions match using decision tree technique and 3) keep weather information statistics.

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