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Designing A System For Intelligent Irrigation Monitoring For Smart Agriculture Using Raspberry Pi Processor, Gsm

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ABSTRACT:

There has been much research and various attempts to apply new technology to agricultural areas. However, for the agriculture should be considered differently against the same areas such as industrial, logistics. This paper presents the agricultural production system for stabilizing supply and demand of agricultural products while developing the environment sensors and prediction system for the growth and production number of crops by gathering its environmental information. Currently, the demand by consumption of agricultural products could be predicted quantitatively, however, the variation of harvest and production by the change of farm's cultivated area, weather change, disease and insect damage etc. could not be predicted, so that the supply and demand of agricultural products has not been controlled properly. To overcome it, this paper designed the GSM-based monitoring system to analyze crop environment, and the method to improve the efficiency of decision making by analyzing harvest statistics. Therefore, this paper developed the real time monitoring of healthiness of the crops in the agriculture field and updates the status and also providing necessary water to crop at required time.

Keywords—Agriculture, Irrigation, Raspberry Pi Processor, GSM.

I. INTRODUCTION

In many agricultural cropping systems irrigations is necessary. In semiarid and arid areas, efficient water applications and management are of major concerns [1]. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Large amount of water goes waste due to improper planning of water usage. The demand for new water saving techniques in irrigation is increasing rapidly right now [2]. The aim of farmer is to produce "more crop per drop", hence there is need to find the irrigation techniques which consumes less fresh water. These techniques are helpful in the regions where there is a scarcity of fresh water. In the modern drip irrigation systems, the most significant advantage is that water is supplied near the root zone of the plants drip by drip due to which a large quantity of water is saved. At the present era, the farmers have been using irrigation technique in India through the manual control in which the farmers irrigate the land from time to time. This process

sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Water deficiency can be hazardous to plants before wilting becomes visible. This problem can be perfectly solved if automatic controller-based drip irrigation system is used in which irrigation will take place only when there is intense requirement of water. Irrigation system uses valves to turn ON or OFF automatically. Automatic Drip Irrigation is a valuable tool for accurate soil moisture control in highly specialized greenhouse vegetable production and it is a simple, precise method for irrigation. It also helps in time saving, removal of human error in adjusting available soil moisture levels and to maximize their net profits. Along with water the other important resources to the crop are the nutrients. If the nutrients are available in the right amount for the growth of crops then the yield of the crops also increases. Thus, the productivity can be raised with the proper management of water resources and nutrients.

II. IRRIGATION

There have been technological advancements in agriculture sector from the last decades and growth of the irrigated areas. But the traditional irrigation methods are still predominant when it comes to try and correct the natural rain distribution [3]. The artificial application of water to the soil for growing crops is called as irrigation. Irrigation is mainly used in dry areas and in periods of rainfall shortfalls to increase crop production. The detail analysis of the conditions must be done while providing irrigation to the land.

III. TYPES OF IRRIGATION

1. Surface Irrigation (conventional irrigation)
2. Drip Irrigation
3. Sprinkler Irrigation

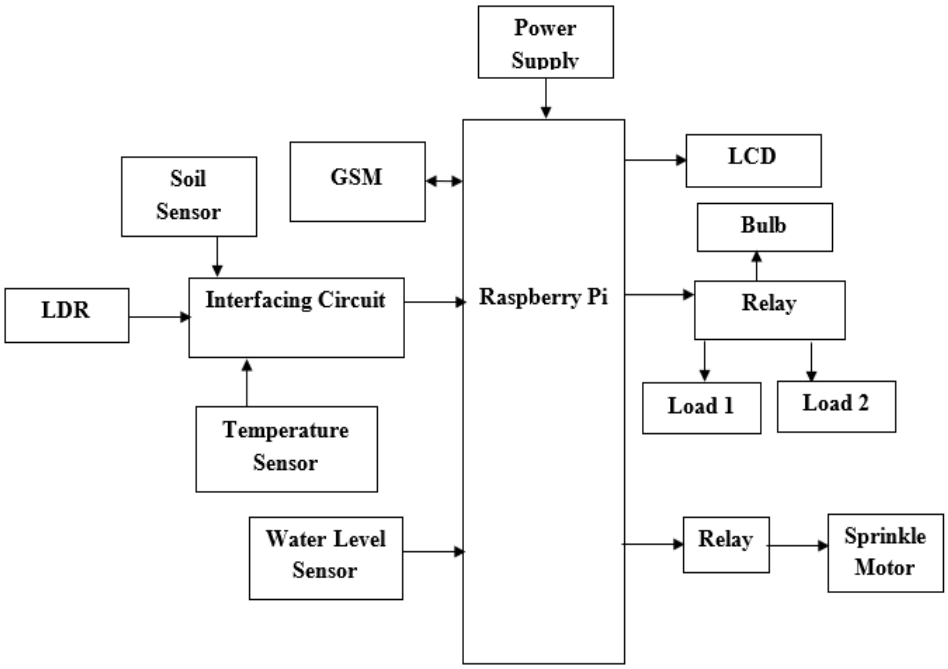
The conventional methods of irrigation like sprinklers of overhead type, flood type irrigation systems wets the lower leaves and stem of the plants. When irrigation is done by using such methods the soil surface is often saturated and stays wet for long time after irrigation is completed. These conditions leads to infections by leaf mould fungi. The flood type methods consume large amount of water and the intermediate area between crop rows remains dry and receives water only from incidental rainfall. In order to solve this problem the drip or trickle irrigation is used which is a type of modern irrigation technique that slowly applies small amounts of water to part of plant root zone [4]. Water is supplied frequently, often daily to maintain favorable soil moisture condition and prevent moisture stress in the plant with proper use of water resources. Drip irrigation at plant's root zone is shown in Figure 1. Its shape depends on soil characteristics. Drip irrigation system saves water because only the plant's root zone receives moisture and helps to conserve water resources. Small amount of water is lost through deep percolation if the proper amount is applied.

IV. SYSTEM ARCHITECTURE

Automation of the irrigation system is gaining importance as there is need to use water resources efficiently and also to increase the field productivity. The system is used to turn the valves ON or OFF automatically as per the water requirement of the plants. The system is used for sensing, monitoring, controlling and for

communication purpose. Different sensors are used to detect the different parameters of the soil like moisture, temperature, humidity, pH of soil and nitrogen content of the soil. Depending upon the sensors output the ARM9 processor will take the necessary action. The moisture sensor output will help to determine whether to irrigate the land or not depending upon the moisture content. Along with moisture sensor the temperature sensor output can also be taken into consideration while irrigating the land. If the moisture content of soil is very low and the temperature is very high then there is need of irrigation for plants, but the time for which irrigation will be provided is different for different temperature range. Because if the temperature is very high then the evaporation rate is also very high and hence, we have to provide water for more time in order to attain the proper moisture level in the soil. Hence for different temperature range and moisture content level in the soil the land will be irrigated for different time interval. Soil pH is also detected and measured. pH of the soil is also important factor which will affect the plant growth. Acidic or basic nature of the soil will affect the nutrient availability in the soil. Soil nutrients i.e. macronutrients or micronutrients are helpful for plant growth and their availability depends on the pH of the soil [6]. Hence there is need to measure soil pH. Depending upon the measured pH of the soil, suggestions can be given to the farmer to add various chemicals in order to achieve the desired pH of the soil for good plant growth. Nitrogen is one of the important macronutrients which is required for plant growth. In the system the nitrogen content of the soil is also detected. According to the available nitrogen content in the soil suggestions can be given to the farmer to add the fertilizers containing nitrogen for healthy plant growth. In the system LCD display is used to display various measured parameter of the soil and also the required suggestions. Solenoid valves are used in the system which are controlled through the relay bank. The data is transmitted wirelessly by using Si4432 ISM transceiver and the data is fetched by using PC and which will be used for analyzing purpose. The keypad is used to choose the soil type in which the system will work and accordingly we can set the threshold points. Keypad is also used for manual operation. Thus, the system will help to monitor, control and communicate. The system consists of following blocks:

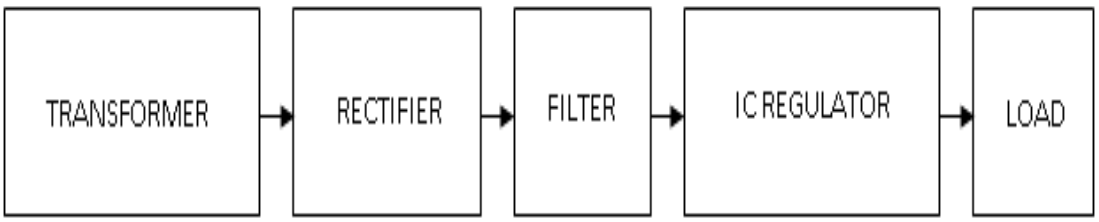
BLOCK DIAGRAM:



A. POWER SUPPLY

The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.



Block Diagram of Power Supply

B.RASPBERRY PI

The Raspberry Pi is a series of credit card–sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools and developing countries. The original Raspberry Pi and Raspberry Pi 2 are manufactured in several board configurations through licensed manufacturing agreements with Newark element14 (Premier Farnell), RS Components and Egoman. The hardware is the same across all manufacturers As the latest Pi to be released, the Raspberry Pi 3 Model B+ contains a wide range of improvements and features that will benefit the designers, developers, and even engineers who are looking to integrate Pi systems into their products. Here are some of the new Pi's specs:

- Quad core 64-bit processor clocked at 1.4GHz
- 1GB LPDDR2 SRAM
- Dual-band 2.4GHz and 5GHz wireless LAN
- Bluetooth 4.2 / BLE
- Higher speed Ethernet up to 300Mbps
- Power-over-Ethernet capability

Physical Features

While the mechanical layout of the Pi has not changed (GPIO location, drill holes, etc.), the PCB itself has clearly undergone some physical changes. The main processor is no longer housed in a plastic package. Instead, it has a metal package, which may be beneficial for those who want to keep the temperature of the Pi as low as possible (with the aid of a heat sink). The top side also shows fewer components, and a four-pin header (used for PoE) has been included in the top right of the PCB.

C. GSM SIM900A MODEM

RS232 based **GSM** modem is built using SIM900. It works on frequencies of 850MHz, 900MHz, 1800MHz and 1900MHz. The size of it is compact and is basically designed with RS232 level converter circuitry. Here the baud rate range is 9600-115200.

At initial stage, the modem is in Auto baud mode. The modem has internal TCP/IP stack via GPRS. Also, the modem is good for SMS and transfer of data. Here, only three wires Tx, Rx, GND is present and it also consists of a built-in voltage regulator. With the help of simple AT commands, one can read and send SMS.

Features

- Power supply: 9 to 12V DC
- Onboard power ON and network indicator LED
- Onboard DB9 connector for connecting modem directly to computers serial port
- 3 pin male header (TTL) interface for connecting SIM900 directly with microcontroller
- Onboard PWM and ADC channels
- TCP/IP protocol
- Built in RS232 Level Converter (MAX3232)

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- Quad-Band GSM/GPRS 850/ 900/ 1800/ 1900 MHz
- Built in Network Status LED
- Built in SIM Card holder.
- Voltage:5V-12V DC
- Baud rate 9600 - 115200 bps

Specifications

- Quad-Band 850/ 900/ 1800/ 1900 MHz
- Weight: 3.4g
- GPRS multi-slot class 10/8
- GPRS mobile station class B
- Control via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands)
- Dimensions: 24*24*3mm
- Compliant to GSM phase 2/2+ , Class 4 (2 W @850/ 900 MHz) , Class 1 (1 W @ 1800/1900MHz)
- Operation temperature: -40°C to +85 °C
- Low power consumption: 1.0mA (sleep mode).

D. SOIL MOISTURE SENSOR

The **Moisture sensor** is used to measure the water content (moisture) of soil. When the soil is having water shortage, the module output is at high level, else the output is at low level. This sensor reminds the user to water their plants and also monitors the moisture content of soil. It has been widely used in agriculture, land irrigation and botanical gardening.

Specifications

- Working Voltage:**5V**
- Working Current:**<20mA**
- Interface type: **Analog**
- Working Temperature:**10°C~30°C**

The Soil Moisture Sensor 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. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges.The Soil Moisture Sensor is used to measure the loss of moisture over time due to evaporation and plant uptake, evaluate optimum soil moisture contents for various species of plants, monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments.

E. LIGHT DEPENDENT RESISTOR (LDR)

Light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity or vice versa. As the name suggests, LDR is a type of resistor whose working depends upon only on the light falling on it. The resistor behaves as per amount of light and its output directly varies with it. In general, LDR resistance is minimum (ideally zero) when it receives maximum amount of light and goes to maximum (ideally infinite) when there is no light falling on it.

LDR SPECIFICATIONS

- Resistance: 400ohm to 400Kohm
- Sensitivity: about 3msec
- Voltage ratings: I used it on 3V,5V and 12V

DESCRIPTION

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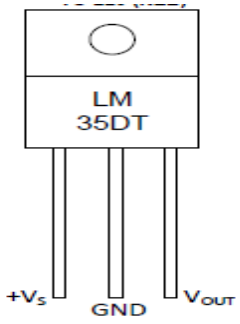
LDR, an acronym for light dependent resistor is a resistor whose resistance is dependent on light. In this when the light falls on LDR, the resistance of LDR becomes low and the entire voltage drop takes place across the variable resistance (VR) (10K Ω). When no light falls on LDR, the resistance of LDR becomes high so almost entire voltage drop takes place across it. The sensitivity of the circuit can be adjusted by varying the preset(VR).

F. TEMPERSTURE SENSOR

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

Temperature sensor (LM35)



Pin Definition

The definition of gray-scale sensor pin is

1. Signal Output
2. GND
3. Power

Features Of Temperature Sensor

- Calibrated directly in Celsius (centigrade)
- 0.5^0 C Ensured accuracy (at $+25^0$ C)
- Suitable for remote applications
- Operate from 4 to 30 V
- Low cost due to wafer-level trimming

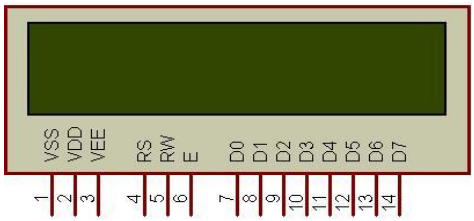
G. LIQUID CRYSTAL DISPLAY (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data

is the ASCII value of the character to be displayed on the LCD.



H. RELAY

INTRODUCTION

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

5. RASPBERRY PI SOFTWARE

Operating System

The Raspberry Pi primarily uses Linux kernel-based operating systems. The ARM11 is based on version 6 of the ARM which is no longer supported by several popular versions of Linux, including Ubuntu. The install manager for Raspberry Pi is NOOBS. The OSs included with NOOBS are:

- Archlinux ARM
- OpenELEC
- Pidora (Fedora Remix)
- Raspbmc and the XBMC open source digital media center
- RISC OS – The operating system of the first ARM-based computer
- Raspbian (recommended) – Maintained independently of the Foundation; based on ARM hard-float (armhf)-Debian 7 'Wheezy' architecture port, that was designed for a newer ARMv7 processor whose binaries would not work on the Raspberry Pi, but Raspbian is compiled for the ARMv6 instruction set of the Raspberry Pi making it work but with slower performance. It provides some available deb software packages, pre-compiled software bundles. A minimum size of 2 GB SD card is required, but a 4 GB SD card or above is recommended. There is a Pi Store for exchanging programs. The 'Raspbian Server
- Edition (RSEv2.4)', is a stripped version with other software packages bundled as compared to the usual desktop computer oriented Raspbian.

6. CONCLUSSION

The objective of this paper is to design a fully automated drip irrigation system using GSM and ARM processor. The system provides a real time feedback control module which monitors and controls all the activities of drip irrigation system efficiently. The system valves are turn ON or OFF

automatically depending upon the moisture content. This will also provide the efficient information regarding the soil pH and soil nutrients like nitrogen along with the proper suggestions. The data collected by the system can be sending for further analysis purpose. Finally, it is concluded that, with this proposed system one can save manpower and water to improve production which ultimately increases the profit.

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SYSTEM PHYSICAL MODEL

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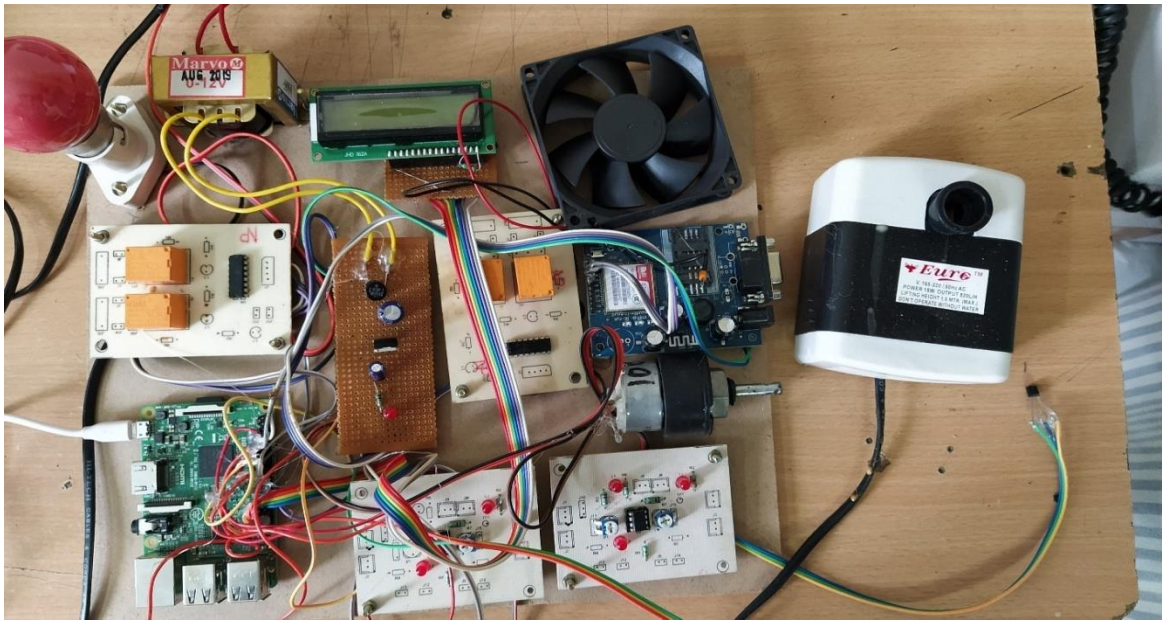
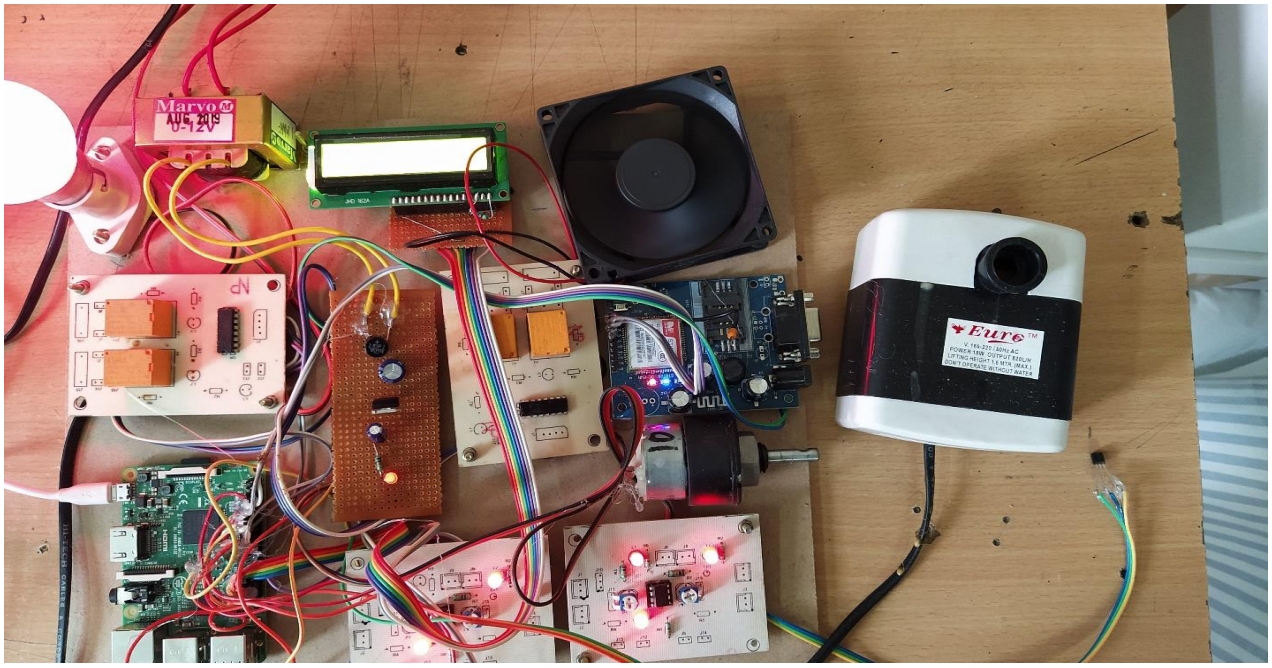


OUTPUT



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