IOT and Raspberry-Pi Based Smart Irrigation System

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***Abstract*—** Agriculture is an important factor especially for developing countries like India. Issues related to agriculture have been always hindering the county's growth. The solution for this problem is using smart agriculture by modernizing the traditional methods of agriculture. Hence the proposed system aims to make agriculture smart using automation and IoT technologies. Internet of Things(IoT) based proposed system helps to check crop growth and irrigation support. A Raspberry Pi used automatic irrigation IoT system is proposed to improves the productivity of the crop. The main aim of this work is to provide crop development at less water consumption, To provide water to the plants at the required time, farmers waste a lot of time in the fields. So for efficient management of water the proposed system developed on the information sent from the sensors and estimate the quantity of water needed. Sensors are used to get the data to the base station, the humidity and the temperature of the soil, and the duration of sunshine per day. Based on these values the proposed system will calculate the water quantity for irrigation when it is required. Implementation of Precision Agriculture (PA) with cloud computing, will reduce the usage of water fertilizers and maximize the production of the crops and also will help in analyzing the weather conditions of the field.

***Keywords*—** Smart farming, Irrigation system, IoT, Raspberry-pi, cloud computing.

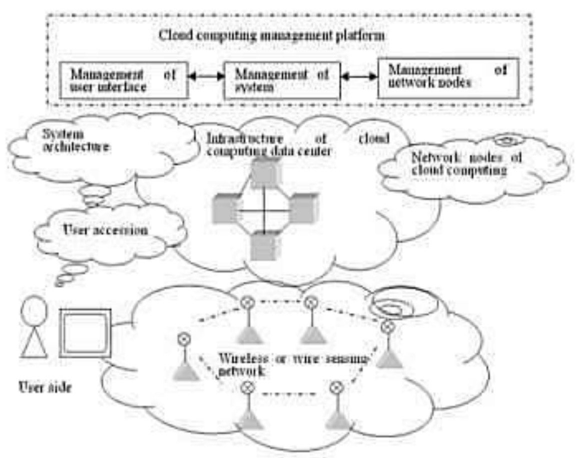
I. INTRODUCTION

In India major population depends on agriculture approx 70% of farmers and general people depend on agriculture. The farmers are doing most of the irrigation works manually such as drip, terraced. [1-5]. To improve crop productivity its an urgent need to change the manual method to automation [6]. water availability throughout India is at an alarming position and it should be utilized appropriately and save for future needs. The IoT-based automatic irrigation system is available for the farmer at a low cost easily [7].

The proposed system should help the farmers and it will provide the water to crop at adequate time and quantity. This irrigation system monitors the temperature and moisture variations using sensors that are set around the crop area that enables the motor on/off accordingly. So the proposed system avoid the human errors and check soil moisture level[8,9].

Internet of things (IoT) provides control to the system from the remote area. It controls the sensors which are present in the crop field. By this, it can avoid human errors and errors that occur during operation [11]. IoT connects more devices to the internet and other area and made them so efficient. The system developed by adding RF-based communication, new sensors, and sensor network shows smart intelligence, accurate sensing along good identification. With IoT and mobile-based technology, the developed system is so smart that it operates in remote places [12,13].

The principle of cloud computing for IOT is shown in below fig:1.



II. BACKGROUND

S. Vigneshwarane et.al [1] has given an automated system that has been designed and implemented for crop field monitoring. This system helps in maintaining the water levels in the crop field with low power consumption. The developed system is useful in the irrigation system. Juaa Francisco et.al [2] have given an automated irrigation system that reduces the water resources more effectively by considering the timing of water scarcity and minimized water utilization. They Developed a solar power system to reduce power consumption. This system was developed by using a smart phone and considering the sensor's data via the internet. Ashok Kumar b et.al [3] focuses on monitoring the data in farming. The system used GSM operated sensor using an ATMEL microcontroller and is used to monitors windmill temperature variation and the PH level of water. An Arduino-based IoT system has been used but when we have to monitor the huge number of data, the Raspberry pi system is more suitable. Michael G. Williams [4] has shown an irrigation system based on raspberry pi. Raspberry pi systems are used for home automation, entertainment systems, security. Raspberry systems are more interesting when used in much-needed environments [10]

This paper aims at a high precision monitored data and control agriculture system using IoT technologies. A cloud-based IoT system and Raspberry pi are used to monitor the real-time data which is coming from the crop field. The system mainly focuses on moisture variations and also correlates with temperature changes getting data by smart sensors and controls irrigation system. The precision level has increases to provide cloud-based computing system which is suitable to use by farmer. The papers contain an introduction part, Hardware description, system design, proposed algorithm, results & discussions followed by conclusions.

III. HARDWARE DESCRIPTION

RASPBERRY PI 3 - MODEL

The Raspberry Pi 3 Model B is an upgraded ARMv7 multi-core processor with Gigabytes of RAM, this looks like a pocket computer and able to be moved to a real desktop PC when such requirements are needed. figure:2 shows the circuit board diagram of the raspberry pi. It upgrades from BCM2836 (single core ARMv6) to BCM2837 (quad-core ARMv7). Its speed increases by 2 times. This speed may increase from 4 to 7.5 times. Web browsing and game playing performance can be increased by using this model. It will run with all other daughter boards at 99 % efficiency [4].

Fig:2 Raspberry PI 3 Model B

Pi 3 Model B works on 'Sudo apt upgrade. It has a quad-core 64-bit CPU and onboard Bluetooth and wifi. The RAM, USB, and Ethernet ports remain the same in this model. However, the power management upgrades can make use of more power-hungry USB devices [11,12].

Software used

Python is used with this Raspberry pi model. The main advantage of this programming language is that programmers can write a fewer number of codes as compared to C++ or JAVA and is the best suitable programming language used by Raspberry pi. Python is not a web programming language but works also like a web programming language and comfortable for server programming languages. [4].

Power Supply:

Every circuit requires a regulated power supply. In this article, we are going to learn how to get a regulated positive supply from the main supply.

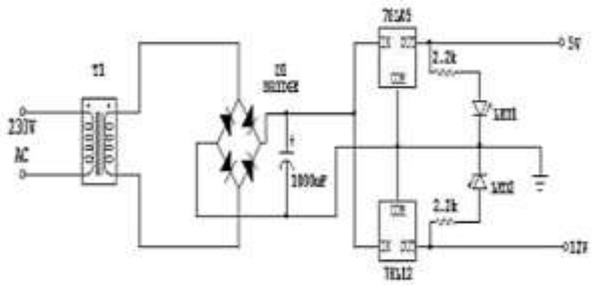


Fig:3 Power supply

Figure:3 shows the basic circuit diagram of a fixed regulated power supply.

Let us go through each block.

Data acquisition system:

Data acquisition can be done by choosing an advance single chip that includes sample and holds circuitry. fig:4 shows MCP 3208 which is one of the advanced IC which converts analog to 12-bit digital signals. It can be programmable either in single or differential pair inputs. Differential nonlinearity accuracy is specified at ±1 LSB and integral nonlinearity is ±1 LSB. It architecture used is SAR. A sample and hold capacitor is used which gives output in 12 bit and conversion speed of 100ksps. A 4 wire SPI communication interface is compatible with this device and operating at minimum clock rates.

Fig:4 data acquisition chip

Soil moisture sensor

The fig:5 shows Precision soil moisture which consists of two probes that are inserted into the soil. When the current passes through the probes, the soil contains less moisture offers less resistance, and passes high current. That variable resistance is the parameter to identify the level of soil moisture [20].

Fig. 5 soil moisture sensor

Temperature sensor (LM35)

The LM35 sensor is used to the precise temperature as shown in fig:6, this precision integrated-circuit temperature sensor shows output voltage is linearly proportional to the Celsius temperature. [15]

Fig:6 temperature sensor

LM 358

LM 358 IC operates over high range of voltages. It contains a dual high gain and band width product operational amplifiers. This device is used in instrumentation applications at low power values. LM358 is applied at DC gain blocks and other types of conventional circuits. The main advantage of this is to easily operate and implements at single power supply circuits.

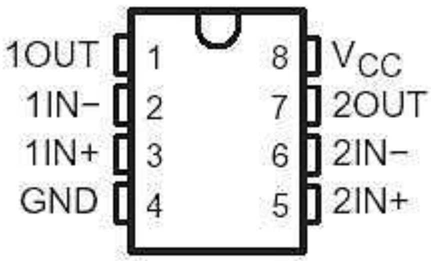


Fig: 7 pin diagram of lm358

RELAY

To control the A.C motors from the controlled DC signal here we use a Relay. It isolates one operated electrical circuit to another. The principle behind the electromagnet operates the close and opens the circuit. Relays are used in different electronic circuits such as industrial control circuits, telephone exchanges, etc. Advanced rating relay is used in this work as shown in figure below.

Fig:8 relay

BEEPER

A beeper or buzzer as shown in fig:9 is used to give a warning signal that the motor is turn on/off. This beeper provides an audio warning signal either by mechanical, electrical, or electronics operated. A beeper or buzzer is an audio signaling device, which may be mechanical, electromechanical, or electronic. Various types of buzzers presently available such as alarms, timers, mouse click, or keystroke.

Fig:9 beeper

IV. BLOCK DIAGRAM DESCRIPTION

Block diagram of Proposed System

Block diagram of the proposed system is shown in fig.10. Before the operation initialization makes sure all the connections are connected properly. We have to connect two sensors,1) temperature sensor 2) soil moisture sensor. To get more accurate data we have to follow previous data. The quantity of water used in the previous period is considered to adjust the quantity of water that is needed for the current period.

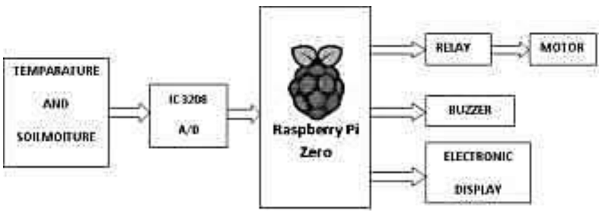


Fig:10 Block diagram of Proposed System

Circuit Diagram:

The two sensors are placed in the crop field, and then data will be collected from these sensors, these data are in analog form, so to change that analog value we use IC3208 that changes analog values into 12-bit digital values, these digital values are given as input to the

Raspberry-pi and this data will be sent to the database using wifi, the sensors calibrated so that the minimum wet condition in the field 2.4v is taken, The threshold voltage changes according to different crops in the field in different seasons. In that 2.4v, according to the threshold voltage the Raspberry-pi operates the relay, the relay is also placed on that, the data comes from the controller and that value is compared with 2.4v, when the value is less than 2.4 volts it shows the field is in dry conditions then it sends a signal to ON the motor for irrigation when the value is greater than 2.4 volts it shows the field is in wet conditions. The temperature variation is calculated through the temperature sensor, by considering the calibrating value and sensors data. With the help of this data, the proposed system sends a signal to Switch-off the motor automatically and a buzzer is placed there to indicates a change from "off state to on state" and "on state to off state".This system is based on raspberry pi as shown in fig: 11 flowcharts. Python programing language is used to implement the proposed algorithm on LINUX operating system

Data processing and decision making

The system is completely automated and the condition of the crop field can be monitored by mobile phone, PC through IP address. All the data will instantly store in a cloud database. By seeing this information on mobile or PC, the farmers identify the change. The raspberry system using python code will generate the IP address, all the sensors data is available in that address and also motor condition, at any place these IP address will be searched in Google by using a laptop, mobile and system the data will display on our device.

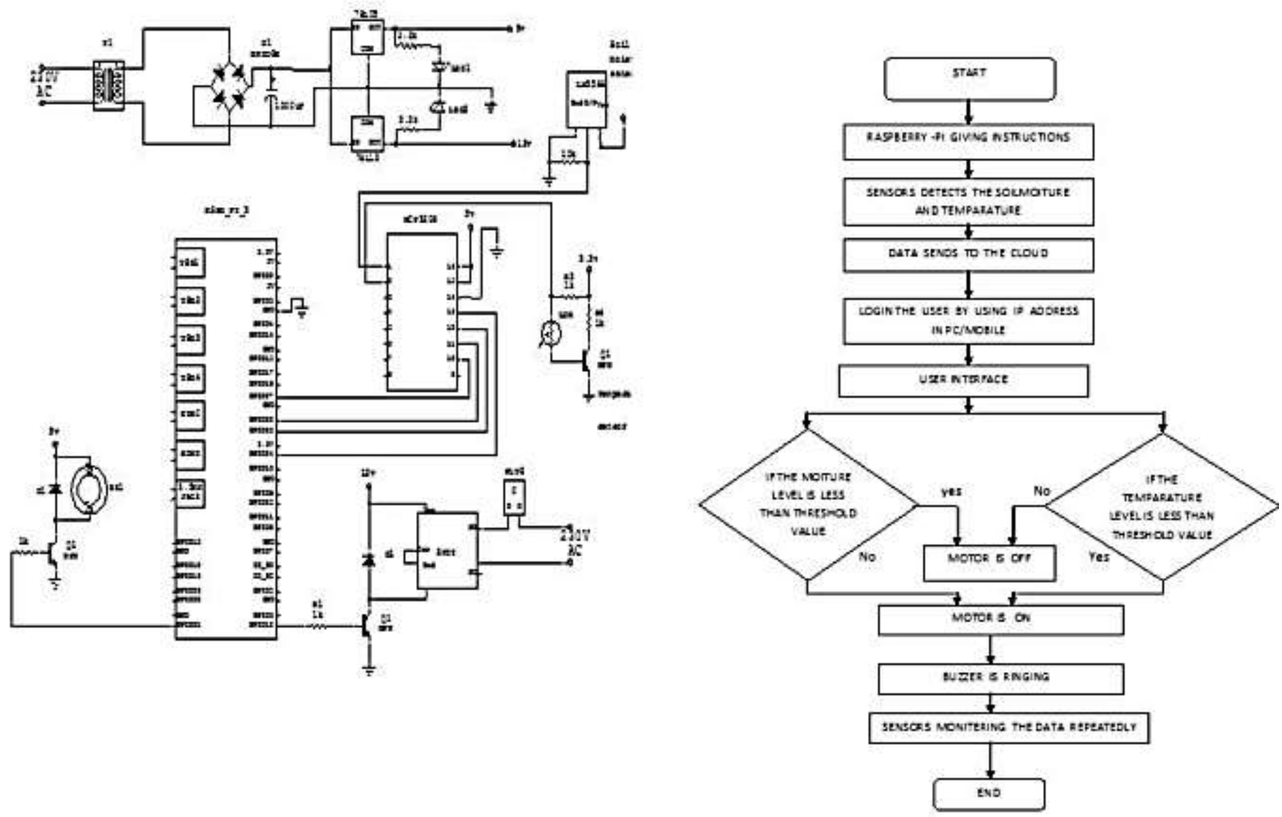


Fig:11 Circuit diagram

V. RESULTS AND DISCUSSION

The hardware kit for the design of the proposed system is shown in fig:13. The real-time results with the status of the system have taken on 4G mobile system is shown in the fig:14. The data obtained from sensors are stored in the cloud and can be monitored by the farmer through his mobile/ PC.

The accurate value which is changing frequently can be observed by the farmer; with his intervention at his crop fields, the smart irrigation system ran automatically. The data obtained from the sensors will check the threshold values every time. In this calibration of the sensors, the system is so important.

It displays temperature value and condition of soil moisture, based on the two sensors the condition of the motor.

The status of the system can able to check at a remote place and the complexity of the system is less so we can do trouble shooting easily in firmware.

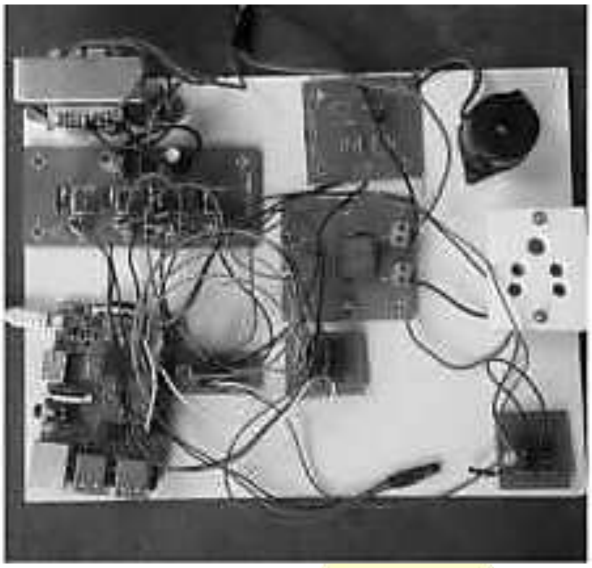


Fig:12 Hardware Kit

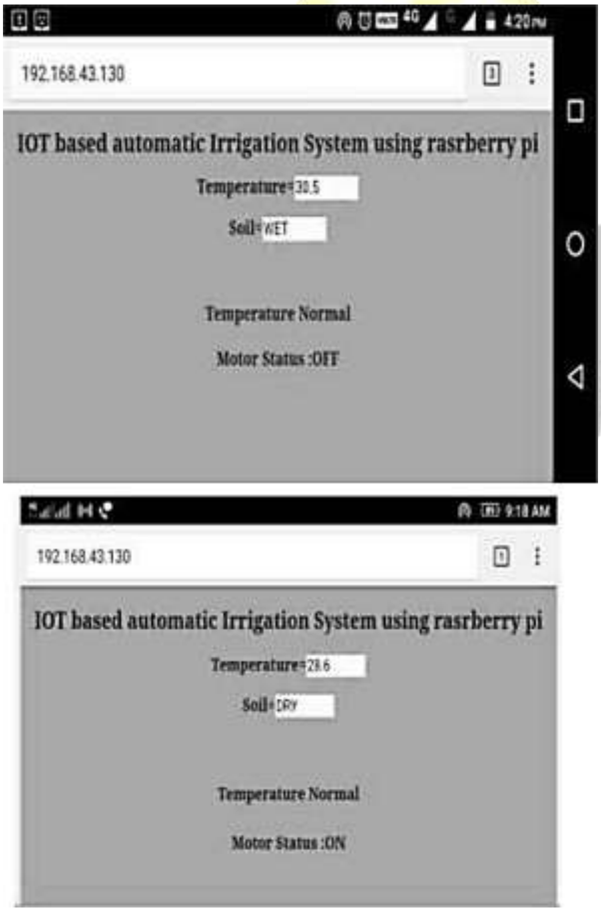


Fig:14 Mobile phone display the status of the system

VI. CONCLUSION

A smart agriculture irrigation system is developed with high accuracy. To obtain the calibrated information, two sensors are used efficiently to get the temperature and moisture value of soil. Raspberry pi microcontrollers and two sensors are successfully interfaced with various Nodes. The final results of experimental tests and observation prove that the proposed system is a better solution for farmers during field activities and irrigation etc., Implementation of the proposed system in the crop field can help to improve the crops productivity and overall production. This approach changes the irrigation system to completely automated and helps farmers to make the right decision by seeing real-time information about the lands and crops. Here two sensors are controlling the whole irrigation system, if any default will be there, farmers will do troubleshooting easily. The proposed system has less hardware complexity compared to the other proposed systems [13]. The data obtained from the sensors will check the threshold values every time, the threshold value will change depends on the crop and plantation. In the future, we can use a machine-learning algorithm to reduce the hardware complexity.

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