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Agricultural Monitoring System and Automation with Raspberry Pi and Arduino

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Abstract: The Internet of Things (IoT) plays a crucial role in smart agriculture. Farmers need agricultural information and pertinent knowledge to make knowledgeable decisions and to satisfy informational needs. IoT sensors are capable of providing information about their agriculture fields remotely. To meet the growing demand for irrigation in the world due to uncertain climatic conditions, it is necessary to focus on sustainable irrigation approaches and improving the efficiency of the existing irrigation systems. The aim is to give the farmers an efficient system with a good price so that they can easily use it for their lands. The farmer can monitor several parameters remotely using this device rather than using the laboratory instruments, and the farmer can monitor the entire system remotely via the internet.

Keywords: Agricultural Engineering, Robotics, Soil moisture, IoT, Raspberry Pi, Arduino, GSM

1. Introduction

In recent years, intelligent sensor techniques have achieved significant attention in agriculture to serve the world's people. This IoT-based Agriculture monitoring system makes use of wireless sensor networks that collects data fromdifferent sensors deployed at various nodes and send it through the wireless protocol. The IoT has also recently given a strong impression of the agriculture sector, with a wide range of sensors used for various smart agriculture targets. The IoT applications are increasing exceedingly year by year.

In accordance with World Bank data in the year 2013, it is calculated that the growth of 1% of GDP comes from agriculture. Again, according to FAO, 60% of people around the world directly depend on agriculture. At present, 11% or 1.4 billion of the world's land is used in crop production. Moreover, the recent census on world's population in 2019 shows that 7.7 billion people live around the world. The growth of population results in reduction of cultivated land. [1]

At the same time, the global smart agriculture market size is expected to triple by 2025, reaching $15.3 billion (compared to being slightly over $5 billion back in 2016) [3].

It is applied in agriculture to plan several activities and missions properly by utilizing limited resources with minor human interference to help the farmer to work smartly.

2. Methodology

This smart agriculture monitoring and automation system using IoT is powered by Raspberry Pi. It is a Soil moisture monitoring system and also Temperature, Air Quality and water level monitoring system and Barometric Pressure for monitoring the weather conditions it will send sensor data to the cloud, and anyone can see the data from anywhere in the world.

If the reading of barometric pressure falls between 100914.4–102268.9 Pa: Rising or steady pressure means present conditions will continue. Slowly falling pressure means little change in the weather. Rapidly falling pressure means that rain is likely, or snow if it is cold enough [2].

And for showing the values of Soil Moisture and Temperature, water level, Air Quality. I used an LCD with an I2c driver for showing the sensor values. And when the Soil Moisture is low, it will give water accordingly. I also used aServo motor for scattering the water in the soil. It will send a notification if there is low-level water detected in the water tank using a water sensor.

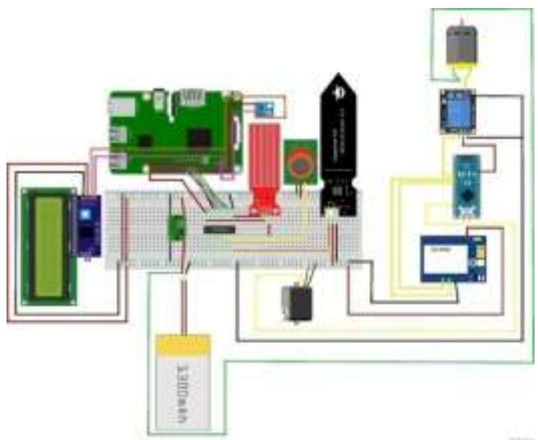

Figure 1: Circuit Diagram

Circuit Explanation [Figure 1]

The Relay Module, the GSM module and Servo are connected with Arduino nano. And the Arduino nano will be connected to the Raspberry Pi via USB cable for receiving serial commands. The LCD with an i2c driver and BMP-180 I2c sensor will be connected to Raspberry Pi via the i2c pins of Raspberry Pi. The SPI-based MCP3008 analog to digital converter module will be connected to Raspberry Pi via the SPI pins of Raspberry Pi. The Analog sensors (Water sensor, Capacitive Soil Moisture Sensor, Air Quality sensor) will be connected to the Channel 0 and Channel 1 and Channel 2 of the MCP3008 respectively. Raspberry Pi will read the sensor values through MCP3008.The Lipo battery will be connected to the buck module for converting the 7.4v to 5v. The Positive and Negative will be connected to the Positive and Negative pin of Raspberry Pi and also the GSM module and the Servo motor.

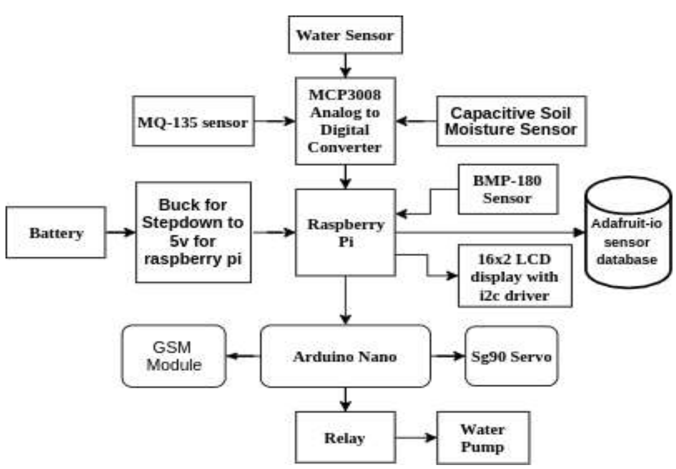

Figure 2: Working Diagram/ Flowchart

Novelty

1. The products which are available in the market that are higher in price.

2. My project will be useful for small farmers and will be less expensive.

3. If we combine the data of many small products, we will be able to show big-size statistics later for big area

4. Also, sometimes water in the tank becomes low so that the water pump cannot give water to the Plants and plants need nutrients from the soil, water, and light from the sun to grow and stay alive. If plants did not get water, they would die. So that's why my device will send a notification if there is low water in the tank so that we can refill the tank again.

5. In extreme weather conditions the field can be damaged heavily, so that's why the farmer can monitor the weather conditions and can take necessary precautions.

The Components that are used (Hardware Section)

1. Raspberry Pi is the main part of the whole project. It is a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, on-board 802.11n Wi-Fi, and Bluetooth with 1 GB RAM.

2. Arduino nano is an 8Bit 16Mhz microcontroller board which is used for turning on the motor and servo.

3. Water sensor (Analog) is used for measuring the water level in the tank

4. MCP3008 Analog to digital converter is used for converting the analog sensor values to digital.

5. Capacitive Soil Moisture (Analog) Sensor is used for measuring the soil moisture value.

6. 1000mah 2cell 7.4v Lipo battery for power.

7. A DC 3-6 V Mini Submersible based pump is a low-cost, limited size Submersible Pump Motor that may be operated with a 2.5 - 5V power supply. The tube pipe is just connected to the motor outlet, drowned in water, and gives power to it.

8. A Buck Module is used to give power to the components

9. A 16x2 LCD with I2c driver is used to show the Soil Moisture and Temperature, Altitude, Air Quality.

10. Servo Motor is used for scattering the water in the soil.

11. MQ-135 Air Quality Sensor (Analog) will measure the surrounding Air Quality.

12. BMP-180 sensor is an I2c based sensor that will measure the Temperature, using this sensor for better accuracy.

13. One channel relay module is used for turning on the water pump.

14. Ga6 GSM module is used for sending messages to phone number

The Components that are used (Software Section)

Arduino IDE For programming the Arduino nano.

Thonny Python IDE for programming Raspberry Pi

Adafruit-io sensor database for storing sensor values [Figure 3]

3. Result and Discussion

People are still working on different Smart Farming technology using IoT, so the anticipated benefits of this technology are, Remote monitoring for farmers, water and other natural resource conservation which are not visible to necked eye can be seen resulting is accurate farmland and crop evaluation, good quality as well as improved quantity, the facility to get the real-time data for useful insights (Jash *et al.*,2019). The test of the project was taken in a pot of soil and data was recorded from my device to the IoT cloud [Figure 3]. It is successfully watering and dispersing as the soil moisture decreases, and automatically turns off the water pump and servo motor after getting enough water. It is also successfully sending the data of the sensor to the cloud on the internet and showing it on the LCD. Furthermore, it is also sending notification when the amount of water decreases. But the air quality sensor (MQ-135) and capacitive soil moisture sensor need to update. So, we need to do better sensor calibration.

We have taken 3 samples from 3 pots where plants were growing, and experimental data are given in the following table. (Table 1).

Sample no	Soil moisture (%)	Sample no	Barometric pressure (hPa)
S-1 (Dry soil)	30-40	S-1 (Sunny Weather)	1000.76-1000.92 hPa
S-2 (Wet soil)	60-70	S-1 (Rainy Weather)	948-955 hPa
S-3 (Clay soil)	80-85	S-1 (Cloudy Weather)	967-988 hPa

Table 1: Data of soil moisture, barometric pressure

Figure 3: Obtained Result from Sensor Data

4. Conclusion

Farmers want help during distinctive degrees of crop growth, and guidance must be given at the right time. Farmers are struggling a lot economically, socially, and politically. Integrating statistics, automation, and smart methodologies into agriculture enable farmers to take higher care in their farms, mitigate dangers, reduce expenses, and increase profitability. So, we can conclude that our project will be a benefit for the farmer's level, if we can trainthem properly. From our results and literature survey of other papers, we saw that the hardware and materials we used to develop our prototype allowed us to make an efficient and accurate, as well as cheap product for farmers.Which was economical and easily installable for farmers as well.

5. Acknowledgement

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