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Wireless Sensor Networks for Indoor Agriculture Based on the Internet of Things

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Abstract: Unusual globetrotters will find automated agricultural systems to be an excellent and trustworthy companion. Automated farming systems, if well-maintained and programmed, may save costs significantly, provide guidance, and immediately notify you of any irregularities, allowing you to take corrective measures. The cost of replacing dying plants, grass, and other greenery may add up quickly, and the data collected by automated farming systems can have far-reaching implications. A system on a chip (SoC), transceivers, and analog-to-digital converters would all work together to gather and process data in the suggested automated agricultural system. When detected sensor values, such as temperature, rainfall, moisture, or pH, are out of the ordinary, the processed data may be seen on a computer or mobile device with a Wi-Fi connection, allowing for prompt action to be taken. The following setup allows for the operation of automated irrigation with restricted ecological access.

Keywords: Interconnected Agriculture, IoT, The Raspberry Pi (with the Cortex A-53 CPU), a plethora of sensors, and the MCP3008

1. Introduction

When you consider that 86% of India's GDP comes from agriculture, you can see why automating the sector is crucial. In order for the economy to grow, agricultural output must also rise. To achieve this goal, farming must be mechanized so that humans are no longer needed. This will lead to more efficient use of water, pesticides, fertilizers, and other resources. Smart farming and smart irrigation are the only ways to boost agricultural output as they allow for the monitoring and management of critical farming parameters without the need for human involvement. In greenhouse farming, a controlled environment is created by manipulating a number of factors, including temperature, humidity, soil moisture, and many more, all of which are necessary for the development of the crop in question. Open fields host almost 95% of the world's agricultural production. We humans have known how to cultivate food from the ground up for a very long time. Humans have figured out ways to cultivate crops year-round in areas with very harsh climates, shielding them from things like freezing temperatures and other disasters. To sum up, greenhouse farming is a method of cultivating crops in an artificial setting that is optimal for their growth. Consequently, it shields the crop from harsh environmental factors such as heat, rain, fertilizers, pesticides, and so forth. As a result, the agricultural industry may benefit from the use of contemporary science and pertinent technology, which can increase agricultural output. A wide variety of uses have detailed the inner workings of wireless sensor networks (WSNs), which collect data from a number of sensors and transmit it to a central server using a variety of wireless technologies. The gathered data helps with system monitoring and management by providing information about various environmental conditions. There are a number of other elements that have a significant impact on agricultural production.

academic credential. These include pest and insect attacks that might be controlled with the right sprays. Therefore, in order to provide answers to such issues, it is crucial to establish an integrated system that would monitor all the factors impacting output at each step, including cultivation, harvesting, and production. Important for the growth of any crop, this project intends to use a variety of sensors to remotely monitor and adjust variables such soil moisture, temperature, rainfall, and humidity. Through the automation of agricultural tasks, which results in increased production with less human involvement, the agricultural domain may be transformed from a static and manual one into a smart and dynamic one. The Internet of Things (IoT) is a sophisticated network of interconnected computing devices, services, and products that can collect and analyze data via sensors, communicate with one another, and draw conclusions from those results using artificial intelligence (AI) technologies. More clarity, output, and

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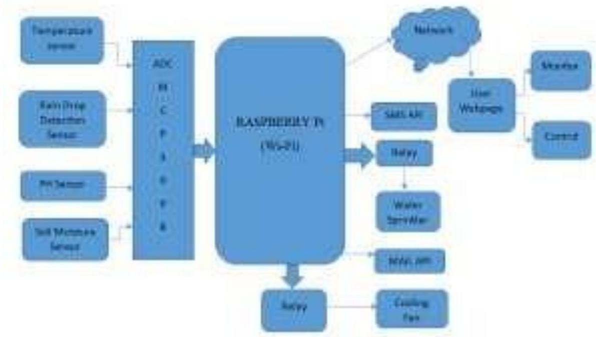
command may be achieved by applying these methods to any system, industry, or enterprise. Through the use of intelligent devices and powerful enabling technologies, the Internet of Things (IoT) may improve data collecting, automation, operations, and many other areas. Thus, a linked greenhouse is an agricultural space that uses sensors, systems of control, and other devices and apps to coordinate with various agricultural technology approaches, such

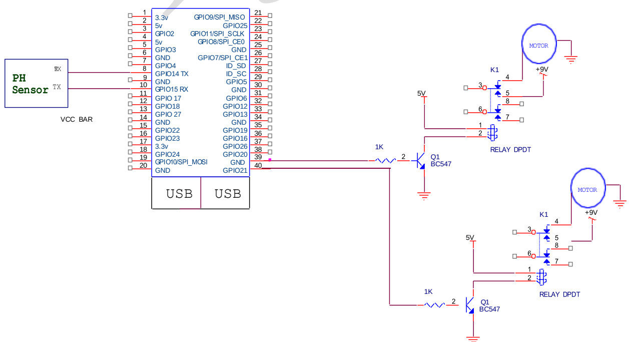
as smart irrigation and HVAC systems. A web admin console allows farmers to adjust the system's parameters and integrate it with other mobile technologies; a mobile app notifies users of problems and provides information about greenhouse performance; and sensors collect data on crop development, pest usage, and lighting, which is then sent to a server either on-site or in the cloud.

2. Architecture



3. Schematic Diagram

The design which is being implemented is in python and the program will run in an infinite loop so that it will keep on updating the values of the sensor. Now first according to the atmospheric conditions of the greenhouse farm concerned, first we have to test the threshold values for every sensor which we are using. The values will keep updating, if any abnormality in the sensor value is observed like in temperature sensor if the value exceeds 400 or 32 degree centigrade SMS and MAIL will be sent automatically, ifRain level is greater than the threshold value say more than 2cm at the same time MAIL and SMS will be sent and Motor will switch OFF , in the case of soil moisture if the moisture is less it will automatically ON the motor to sprinkle water and also send the SMS and MAIL, Web page is designed in such a way that it will be used to update the values at the same time we can control the Motor also. And for PH sensor if the value lies in between 6 and 6.8 then no abnormality is observed but if it is more than 6.8, it means that the soil is alkaline in nature and hence fertilizer has tobe sprinkled and hence we will receive an SMS and a mail alert and also the value will be displayed on the webpage. Similarly, if the value is less than 6 then the soil is more acidic and hence to neutralize it water has to be sprinkledand hence DC motor will switch on and we will receive an SMS and mail alert on the web page. All these sensors are analogue sensors and as our Raspberry Pi3 is a single board computer which is programmed in python programming language doesn’t have the inbuilt ADC, an external ADC called MCP3008 is used to convert analogue values to digital values. Now our Raspberry Pi3 will update all the sensor values in the server accordingly and automatically on/off the cooling fan and Motor according to the change in the WSN. And a webpage is programmed using HTML and PHP which is saved in the server i.e. Apache server and also SMS API is built to send SMS with the MAIL API to send the mails.



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5. Hardware Arrangement

Cortex-A53 Processor:
The Cortex-A53 processor on Raspberry Pi is a moderate; low-power consumption digital signal processor which implements the ARMv8-Architecture.The proposed plan uses a Raspberry Pi 3 model B SoC. The Raspberry Pi is a smart card sized, low price SoC (System on Chip) which canbe plugged into a desktop computer or television, and astandard keyboard and mouse can be used with the Pi 3 Model B just like any other desktop computer. In otherwords you can replace the conventional CPU used with yourdesktop computer by a Raspberry Pi SoC. It is a chip like device that allows anyone to exploit calculations, and toacquire knowledge and understand the ways of programming in languages like scratch and Python.

The Cortex-A53 processor has up to 4 cores, each with an L1 memory system and a single shared L2 cache [22]. Usinga wide range of ARM technologies, the Cortex-A53processor can be integrated into a SoC [23].This processor provides a very high performance along with having very high power efficiency and is used in many mainstream and real time mobile platforms.

Pipelining methods are active because of which all locations of the processing and anamnesis systems can accomplish work in parallel. The ARMV8-A architecture brings a number of new features. These include:

- 64-bit data processing
- The enlarged virtual addressing
- 64-bit general purpose registers
- 8-stage dual issue pipeline
- FPU and Memory performance

There are two execution states in Cortex-A53 processor [23]. They are AArch32 and AArch64. The AAarch64 state allows the Cortex-A53 to execute 64-bit applications, while the AArch32 permits the processor to implement the existingARMv7-Aapplications [23]. All these powerful features of the cortex-A53 processor allow it to be implemented in signal processing, graphics, data processing and many other applications.

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SPI MCP3008:

The Serial Peripheral Interface (MCP3008) is a 10-bit, 8- channel Analogue-to-digital converter (ADC). It is a low cost, easy to connect ADC which does not have need of any other extra modules. The Raspberry Pi's GPIO header whichsupports the SPI bus protocol is used by this ADC making it very easy to interface. The circuit below shows how the MCP3008 can be used to read the values of different sensors. The initial step is to activate the SPI interface present on the Raspberry Pi that is in general disabled by default. It is normally suggested to make use of the manual provided for MCP3008 in order to configure SPI and set up the SPI Python wrapper. The table below illustrates how the connections on MCP3008 can be made using the various pins present on it. The connection with MCP3008 needs fourGPIO pins on the Raspberry Pi GPIO Header.

Name	Function
V_{DD}	+2.7V to 5.5V Power Supply
DGND	Digital Ground
AGND	Analog Ground
CH0-CH7	Analog Inputs
CLK	Serial Clock
D_{IN}	Serial Data In
D_{OUT}	Serial Data Out
$\overline{CS}$/SHDN	Chip Select/Shutdown Input
V_{REF}	Reference Voltage Input

Figure 2: Pin Function of MCP3008

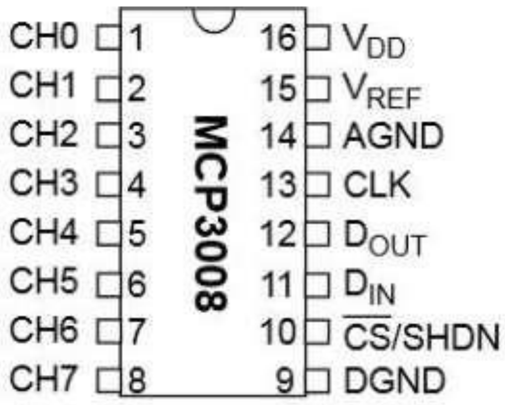

Figure 3: Pin Diagram of MCP3008

Temperature sensor

DHT11 is a sensor that is embedded with both temperature & humidity sensor that comes with a standardized output with digital values. This sensor package makes use of the specially designed digital-signal-acquisition procedure and temperature & humidity detecting methodology which inturn results in more dependability and outstanding long- lasting consistency [10]. This package comprises of a resistive-type clamminess computing module and an NTC temperature computing module which links to a high throughput SoC or any microcontroller, providing exceptional quality, very quick reaction, non-interventioncapacity and also reducing the overall price. This package is additionally factory standardized and thereby easy to connect with other microcontrollers. The temperature sensor is capable of sensing temperature between 0°C to 50°C and moisture sensor senses clamminess from 20% to 90% with an accuracy of ±1°C and ±1% respectively. Therefore thissensor is the best option if one wants to determine thetemperature or humidity in this limit.

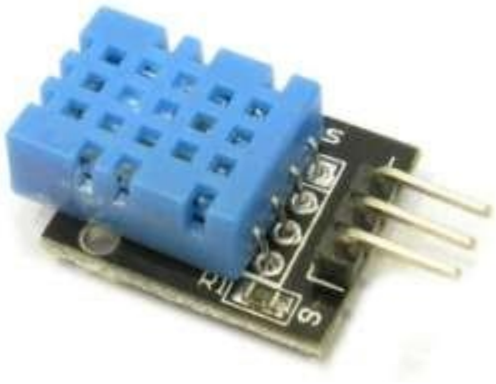

Figure 4: DHT11Sensor

```
if(temp > 30):
print("*** High Temperature ***")f=open("data.txt",'w')
f.write("\n*** High Temperature ***\n")f.write(data)
f.close time.sleep(2)
subprocess.Popen("sudo python sms.py",shell=True).communicate
```

Rain Drop sensor:

Rain drops can be detected using a rain drop sensor [11].Theintensity of rainfall can be measured using rain drop sensor and also is used as a switch when a rain drop falls on the raindetecting board. This sensor contains a potentiometer where sensitivity can be modified, an LED for indicating power, a partitioned rain board and control board for easier use. Drops are measured from the analog output and provided in terms of the amount of the rainfall. If there are no rain drops on the induction board and also when the digital output is high, the LED connected to the 5V power supply will light up. The digital output is low even if there is minimal rain drops falling on the board which in turn will turn on the switch indicator. The outputs become high again when the water drops are removed from the induction board and brought back to the initial state.

Figure 5: FC-37 Rain Drop sensorif(humi> 60):

```
print("*** High Humidity ***")f=open("data.txt",'w')
f.write("\n*** High Humidity ***\n")f.write(data)
f.close

time.sleep(2) subprocess.Popen("sudo python sms.py",shell=True).communicate
```

Soil Moisture Sensor (SKU-STH1052)

The amount of water present in the soil is measured by the Soil moisture sensor. Farmers can manage their irrigation systems in a more efficient manner when they have the data pertaining to soil moisture. Farmers can not only make judicious use of water for crop cultivation, but they can also increase the efficiency of crop production and the quality of the crop by enhanced understanding or knowledge regardingsoil moisture during crucial stages of crop growth**.** LM393 comparator is used by the model in order to relate the existing soil moisture value with the previously defined threshold. There are two binary state outputs with modifiable sensitivity which is a key feature of this soilmoisture sensor. The operating voltage range for the input lies between 3.3V and 5V.

Figure 6: Soil Moisture Sensor

```
if(ldr< 50):
print("*** Low Light ***")f=open("data.txt",'w')
f.write("\n*** Low Light ***\n")f.write(data)
f.close time.sleep(2)
subprocess.Popen("sudo pythonsms.py",shell=True).communicate
```

PH Sensor

The variations of PHare very significant for the soil, water used for irrigating the crops and water tank solutions. The amount of PH in the water tanks help in knowing the concentration of pesticides present. The amount of PH in thetest solutions can be measured using the PH sensors, by determining the activity of the hydrogen ions in the solutions. The activity of these hydrogen ions is collatedwith the activity of hydrogen ions in clean water which is a neutral solution by means of a pH scale of zero to fourteen in order to identify the acidity or basicity of the test solution.This module works at a baud rate of 9600.

Figure 7: PH Sensorif((6 >ph) or (16 >ph> 9)):

```
print("*** PH value ***")f=open("data.txt",'w')
f.write("\n*** PH value ***\n")f.write(data)
f.close time.sleep (2)
subprocess.Popen ("sudo python sms.py",shell=True).communicate
```

DC motor:

The proposed plan uses a DC motor. DC motors are integrated in abundantvarieties and sizes that alsocomprisereduced besom, servo, and accessory motor varieties. The DC motor consists of a rotating part called as rotor and an abiding alluring acreage stator. The stator is made of either abiding magnets or electromagnetic windings.In any mechanical device,motors are the accessories which accommodate the absolute accelerationand torque. The ancestors include AC motor types likesingle and multiphase motors, universal, servo motors, induction, synchronous, accessory motors and DC motors (brush-less, servo motor and accessory motor) as able- bodied and linear, stepper and air motors.

IEEE 802.11 Protocol

The Wi-Fi is based on the 802.11 family of standards and isa LAN technology and is used in the altered needs of minimum budget, reduced power requirements for wireless sensor networks. The modules crave basal ability and accommodate definitive supply of abstracts amid limited devices. It provides a data rate of 54Mbps and has coverage of 100 feet. It operates in the frequency band of ISM 2.4GHz.

Advanced Networking & Security

- Permanent link between two end points
- P2MP topology
- Routing based on the destination address, self-healing andfault-tolerant
- mesh networking

Low Power

- TX Current: 295 mA
- RX Current: 45 mA
- Power-down Current: < 1 mA

7. Result

Figure 8: Prototype of Greenhouse Farming

8. Conclusion

One dependable, intelligent, and effective way to monitor and control the many environmental factors that impact a crop's growth is via an Internet of Things (IoT)-based greenhouse farming system. In response to the data picked up and reported by the sensors, the farmer may remotely implement necessary actions. In addition to reducing the need for human intervention, wireless greenhouse monitoring alerts the user to any discrepancies in the measured values. Not only does this technology use less electricity, but it also costs less. The agricultural sector's GDP per capita will also see an improvement.

9. Future Work

With the assistance of smart robots, the agricultural finance model may be changed. With the use of digital cameras for harvesting, as well as other technology-enabled pieces of agricultural machinery, automation of the harvesting process is within reach. Farmers may learn when their fruits and vegetables are mature enough to harvest by adding sensors that measure the size and degree of pigments like chlorophyll. This information is then utilized to determine when to harvest.

References

[1] The first source is http://www.agrifarming.in/greenhouse-farming-in-india/.
The second source is the following: [2] http://www.tutorialspoint.com/internet_of_things/inde x.htm.
[3] — How to Build a Smart Greenhouse: http://rstylelab.com/company/blog/iot/iot-agriculture.
[4]Internet of Things (IoT) uses in agriculture
[5]"Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network" (Y. Kim, R. Evans and W. Iversen, 2008, pp. 1379–1387, IEEE Transactions on Instrumentation and Measurement, page number: 1)

[6]“Wireless Monitoring of Soil Moisture, Temperature & Humidity” by Professor C. H. Chavan and Mr. P. V. Karande

Published in May 2014 in the International Journal of Engineering Trends and Technology (IJETT), this article discusses the use of Zigbee in agriculture.1st page
[7]URL: https://www.w3schools.com/nodejs/nodejs_raspberryp i.asp
[8]This is the link to the Raspberry Pi hardware documentation: https://www.raspberrypi.org/documentation/hardware/r aspberrypi/bcm2837/README.md.
[9]Check out this link: https://www.raspberrypi.org/products/raspberry-pi-3-model-b/.
[10]Pages 1, 13, and 15 of the LM35 Precision Centigrade Temperature Sensors (SNIS159H)—Accessed August 1999—Revised December 2017
[11]Page numbers 1, 2, and 3 of the 2017 RDWI Karisma rain sensor module.
[12].pdf manual: https://nexiot.com/wp-content/uploads/2017/08/manual.pdf
in [13]ph%20 sensor.pdf may be found at http://sensorembedded.com/product_extra_files/.
[14]Here is the link to the Liq ADS-43-002.pdf file: http://www2.emersonprocess.com/siteadmincenter/PM %20Rosemount%20Analytical%20Documents.
[15]Here is the link to the page you requested: https://www.traditionaloven.com/conversions_of_meas ures/ph-voltage.html.
[16]At the following URL: http://pdf1.alldatasheet.com/datasheet-pdf/view/194715/MICROCHIP/MCP3008.html!
[17]The Interconnected World of Things: "From Concept to Market Deployment," River Publishers, 2014, page 3, written by Ovidiu Vermesan and Peter Friess.
[18] inConnected Devices, Learning Center Learning Made Easy © Instructions Point (I) Pvt. Ltd., Page 1/7, holds the copyright for 2016.
The year 19"Learning to program with python" by Richard L. Halterman, 2011, page 4,
In [20],This is an excerpt from Kenneth Reitz's Python Guide Documentation 0.0.1 from 2015 [21]: https://www.w3schools.com/python/python_intro.asp.
[22] is aARM DDI 0487, the ARMv8-A architecture profile reference manual.
[23] TheYou can find processors at developer.arm.com.