A Project Report

On

IoT based Smart Farming System

A Project Work Submitted in Partial Fulfilment of

the requirements for DEGREE in

COMPUTER SCIENCE AND ENGINEERING

By

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CERTIFICATE OF APPROVAL

This is to certify that the work embodied in this project entitled IoT based SMART FARMING SYSTEM submitted by Arsh Goyal, Jayanarayanan J and Vivek N to the Department of Computer Science and Engineering, have carried out under my direct supervisions and guidance.

The project work has been prepared as per the regulations of PES University and I strongly recommend that this project work be accepted in partial fulfilment of the requirement for Degree.

Supervisor

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CERTIFICATE BY THE BOARD OF EXAMINERS

This is to be certified that the project work entitled **IoT based SMART FARMING SYSTEM** submitted by Arsh Goyal, Jayanarayanan J and Vivek N to the Department of Computer Science and Engineering of PES University, Bangalore has been examined and evaluated.

The project work has been prepared as per the regulations of PES University and qualifies to be accepted in partial fulfilment of the requirements for the Degree.

ACKNOWLEDGEMENT

We students of Degree 3rd year, Computer Science and Engineering, have successfully completed the project under the guidance of esteemed faculties of this very institute.

We would like to thank Prof. Nagegowda (Assistant Professor, Dept., of CSE) for his valuable guidance and advice in completion of our project and providing us all possible assistance. He has been extremely motivating and helps us during the project work. We are also grateful to him for providing us necessary books and journals.

TABLE OF CONTENTS

1. CHAPTER I: INTRODUCTION

1.1 OVERVIEW

In IOT Smart Farming System, a system is built for monitoring the plants with the help of various sensors such as temperature, humidity, oxygen and soil moisture sensors. These sensors help in the live monitoring of the plants and remote control at a very low cost.

This project is specifically designed for plant monitoring and greenhouse's in people's homes. The temperature and humidity sensors turn of fans and humidifiers respectively to keep their levels to a certain range. Through the plotting of values on graphs, better analysis can be done, and future decisions can be taken based on these results. Our project aims to encourage more people to start their own greenhouse. 24/7 monitoring will no longer be required the use of these sensors and actuators which can be remotely controlled.

1.2 IOT TECHNOLOGY AND AGRICULTURE

1.2.1 IOT: CONCEPT AND DEFINITION

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

1.2.2 IOT ENABLING TECHNOLOGIES

A. BIG DATA

Big data is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis. But it's not the amount of data that's important. It's what organizations do with the data that matters

Further compounding the technical challenges of big data is the fact that IoT systems must deal with not only the data collected from smart objects, but also ancillary data that is needed to properly perform such analytics. Thus, as more smart objects come online, at least three metrics are typically used by IoT operators to describe the big data they handle: volume velocity and variety.

B. DIGITAL TWIN

Another consequence of the growing and evolving IoT is the concept of a “digital twin,” The concept refers to a digital copy of a physical asset (i.e., a smart object within the IoT), that lives and evolves in a virtual environment over the physical asset’s lifetime. That is, as the sensors within the object collect real-time data, a set of models forming the digital twin is updated with all of the same information. Thus, an inspection of the digital twin would reveal the same information as a physical inspection of the smart object itself – albeit remotely.

C. CLOUD COMPUTING

As the word “cloud” is often used as a metaphor for the Internet, “cloud computing” refers to being able to access computing resources via the Internet rather than traditional systems where computing hardware is physically located on the premises of the user and any software applications are installed on such local hardware.

Cloud computing – and its three service models of Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) – are important to the IoT because it allows any user with a browser and an Internet connection to transform smart object data into actionable intelligence.

D. SENSORS

Central to the functionality and utility of the IoT are sensors embedded in smart objects. Such sensors are capable of detecting events or changes in a specific quantity, communicating the event or change data to the cloud and, in some circumstances, receiving data back from the cloud .Technological improvements created microscopic scale sensors, leading to the use of technologies like Microelectromechanical systems (MEMS). This meant that sensors were now small enough to be embedded into unique places like clothing or other smart objects.

E. COMMUNICATIONS

With respect to sending and receiving data, wired and wireless communication technologies have also improved such that nearly every type of electronic equipment can provide data connectivity. This has allowed the ever-shrinking sensors embedded in smart objects to send and receive data over the cloud for collection, storage and eventual analysis.

The protocols for allowing IoT sensors to relay data include wireless technologies such as RFID, NFC, Wi-Fi, Bluetooth, Bluetooth Low Energy (BLE), XBee, ZigBee, Z-Wave, Wireless M-Bus, SIGFOX and NuelNET, as well as satellite connections and mobile networks using GSM, GPRS, 3G, LTE, or WiMAX.

F. ANALYTICS SOFTWARE

Within the IoT ecosystem, Application Service Providers which may or may not differ from the companies who sell and service the smart objects – provide software to companies that can transform “raw” machine (big) data collected from smart objects into actionable intelligence (or insight). Generally speaking, such software performs data mining and employs mathematical models and statistical techniques to provide insight to users. That is, events, trends and patterns are extracted from big data sets in order to present the software’s end-users with insight in the form of portfolio analysis, predictions, risk analysis, automations and corrective, maintenance and optimization recommendations. In many cases, the ASPs may provide general analytical software or software targeting specific industries or types of smart objects.

G. EDGE DEVICES

Not shown in our simplistic IoT ecosystem of Figure 1 is exactly how the smart objects embedded with sensors connect via the Internet to the various service provider systems. The answer is via “edge devices” – any device such

as a router, routing switch, integrated access device (IAD), multiplexer, or metropolitan area network (MAN) and wide area network (WAN) access device which provides an entry point from the global, public Internet into an ASP’s or other enterprise’s private network. In Industry 4.0, these edge devices are becoming smarter at processing data before such data even reaches an enterprise network’s backbone (i.e., its core devices and cloud data centers). For example, edge devices may translate between di erent network protocols, and provide first-hop security, initial quality of service (QoS) and access/ distribution policy functionality.

1.2.3 IOT APPLICATIONS IN AGRICULTURE

MONITORING OF CLIMATE CONDITIONS -

Probably the most popular smart agriculture gadgets are weather stations, combining various smart farming sensors. Located across the field, they collect various data from the environment and send it to the cloud. The provided measurements can be used to map the climate conditions, choose the appropriate crops, and take the required measures to improve their capacity (i.e. precision farming).

GREENHOUSE AUTOMATION -

Typically, farmers use manual intervention to control the greenhouse environment. The use of IoT sensors enables them to get accurate real-time information on greenhouse conditions such as lighting, temperature, soil condition, and humidity.

CATTLE MONITORING AND MANAGEMENT -

There are IoT agriculture sensors that can be attached to the animals on a farm to monitor their health and log performance. Livestock tracking and monitoring help collect data on stock health, well-being, and physical location.

PRECISION FARMING -

Also known as precision agriculture, precision farming is all about efficiency and making accurate data-driven decisions. It's also one of the most widespread and effective applications of IoT in agriculture.

By using IoT sensors, farmers can collect a vast array of metrics on every facet of the field microclimate and ecosystem: lighting, temperature, soil condition, humidity, CO_2 levels, and pest infections. This data enables farmers to estimate optimal amounts of water, fertilizers, and pesticides that their crops need, reduce expenses, and raise better and healthier crops.

PREDICTIVE ANALYTICS FOR SMART FARMING -

Precision agriculture and predictive data analytics go hand in hand. While IoT and smart sensor technology are a goldmine for highly relevant real-time data, the use of data analytics helps farmers make sense of it and come up with important predictions: crop harvesting time, the risks of diseases and infestations, yield volume, etc. Data analytics tools help make farming, which is inherently highly dependent on weather conditions, more manageable, and predictable.

1.2.4 BENEFITS OF IOT IN AGRICULTURE

DATA COLLECTION:

All data can be collected with the help of installed sensors. Data like weather conditions, health conditions of cattle, crops, etc. can be gathered. Data is stored in the cloud, and farmers can easily check it and analyse the data to make the right decisions.

REDUCTION OF RISKS:

When live data is collected by the sensors, the farmers can predict the scenario in the future, and potential problems that may arise. Moreover, farmers can use this collected data to improve their sales and change business models.

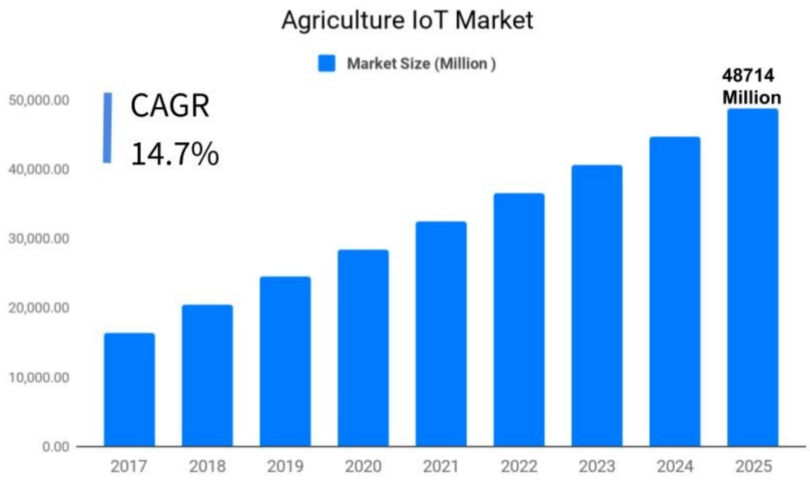
BUSINESS GOES AUTOMATED:

Many business processes become automated with the implementation of IoT, because of which the efficiency can greatly increase. This can let farmers pay more attention to other important processes. Going automated also reduces labour costs and allows the farmer to spend the money elsewhere.

HIGHER QUALITY:

Smart agriculture makes it possible to avoid challenges and remove all issues that may arise during farming processes. If done right, it can completely eliminate any human errors. So the quality of the product increases, and consumers get a good product of high quality.

1.2.5 IOT AND AGRICULTURE CURRENT SCENARIO & FORECAST



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CHAPTER 2: OVERVIEW OF THE PROJECT

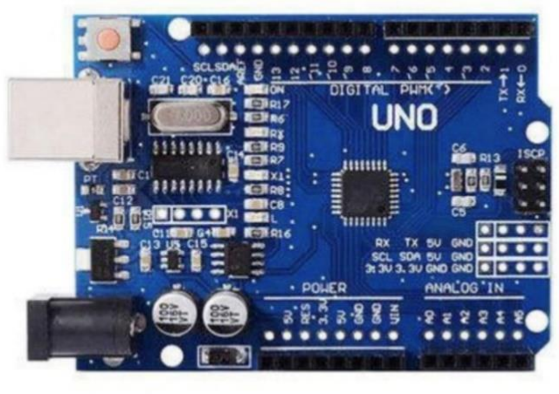
2.1 DEFINITION:

IoT based SMART FARMING SYSTEM is regarded as an IoT gadget focusing on Live Monitoring of Environmental data in terms of Temperature, Moisture and other types depending on the sensors integrated with it. The model is supposed to work in such a way that the farmers can analyse the live data gathered by the sensors, stored in the cloud, conveniently from their phones/laptops, and the data generated via sensors can be easily shared and viewed by agriculture consultants anywhere remotely via Cloud Computing technology integration. Upon analysis of the gathered data, the farmers can modify the way the sensors work, like change the interval of humidifier or exhaust fans. Integrating IoT in the farming sector can hugely reduce labour costs, and can prove to be a sustainable method in the agricultural sector.

2.2 COMPONENTS AND MODULES

In this section, the different components used for IOT for agriculture and gardening development is discussed:

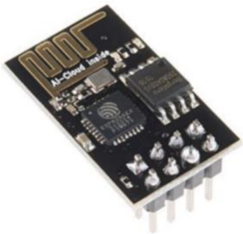
2.2.1 Arduino Uno



Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

2.2.2 Wi-Fi MODULE-ESP 8266:

ESP8266 Wi-Fi Module is SOC with TCP/IP protocol stack integrated which facilitates any microcontroller to access Wi-Fi network. ESP8266 module is cost effective module and supports APSD for VOIP Applications and Bluetooth co-existence interfaces. Technical Specifications: 802.11b/g/n; Wi-Fi Direct, 1MB Flash Memory, SDIO 1.1/2.0, SPI, UART, Standby Power Consumption of <1.0mW.



2.2.3 RTC DS3231

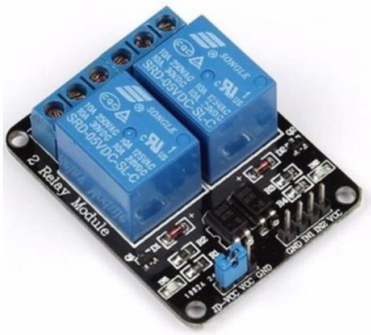
The DS3231 is a low-cost, extremely accurate I2C real-time clock (RTC) with an integrated temperature- compensated crystal oscillator (TCXO) and crystal. The device incorporates a battery input and maintains accurate timekeeping when main power to the device is interrupted.

2.2.4. 5V2 channel relay

5V 2-Channel Relay interface board and each one needs 15-20mA Driver Current.

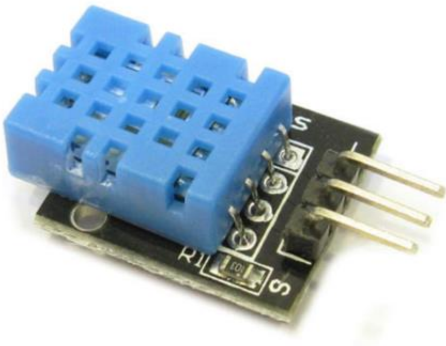
It is equipped with high-current relay, AC250V 10A; DC30V 10A.

Standard interface that can be controlled directly by microcontroller.



2.2.5. DHT 11

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed)

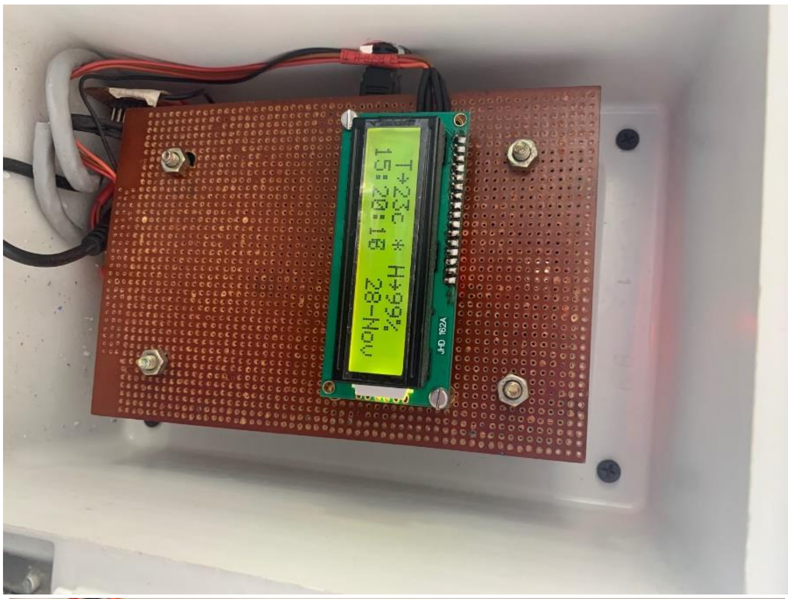


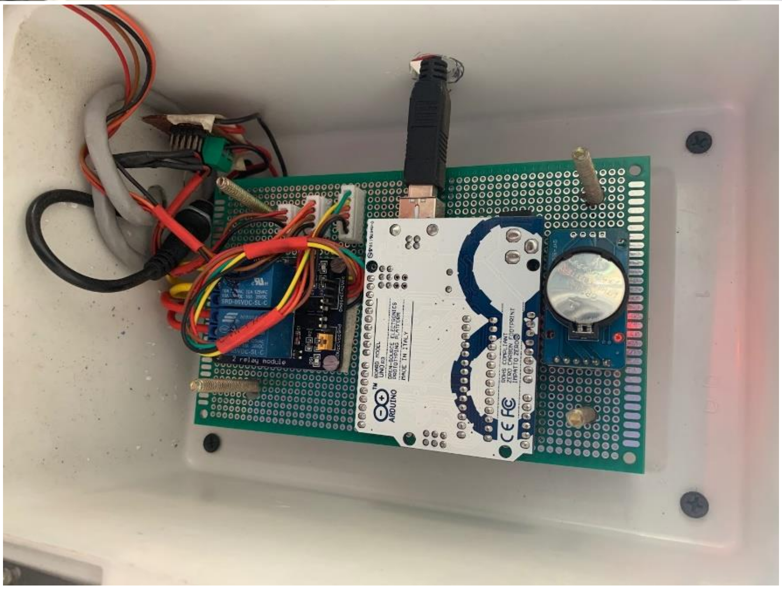
2.2.6 16x2 LCD display with I2C

In the circuit we're also using the LCD display in order to display the temperature, time and humidity values. The I2C is also used for parallel to serial communication.

2.3 CIRCUIT DESCRIPTION & WORKING PRINCIPLE

The circuit designed as shown below is used to detect the temperature and humidity values and upload the data to Google's firebase storage using which, data analysis has been performed which has been reported in the further sections of the paper. Arduino Uno has been also used to set pre-set the timings during which the foggers and Exhaust fans should be turned on. Also, the readings from the temperature and humidity sensors is used to make sure that the temperature inside the greenhouse does not increase to a level at which the plants will suffer and die. If the temperature increases a particular threshold, the exhaust fans also the foggers turn on automatically in order to bring down the temperature.





3. CHAPTER-III: ALGORITHMS & FLOWCHART & OUTPUT GRAPHS

3.1 ALGORITHM

STEP 1: START THE PROCESS

STEP 2: CONNECTED TO WIFI USING ESP 8266

STEP 3: START THE REAL TIME CLOCK

STEP 4: READ TEMERATURE AND HUMIDITY SENSOR VALUES

STEP 5: START FANS AND FOGGERS IF VALUES NOT IN RANGE

STEP 6: SEND DATA TO THE CLOUD

STEP 7: DELAY FOR 15 MINUTES

STEP 8: REPEAT STEP 4, 5 , 6 AND 7 UNTIL THE PROCESS END

STEP 9: END

3.2 OUTPUT GRAPHS

HOW DOES HUMIDITY VARY ACCORDING TO THE TIME OF THE DAY?

Humidity is the amount of moisture in the air. The most important thing to note here is that warm air holds more moisture than cold air and difference in the amounts is drastic.

So, during the day the sun warms things up and the warm air can absorb moisture readily from grass, the ground, any bodies of water. The humidity will be low as the temperatures warm up.

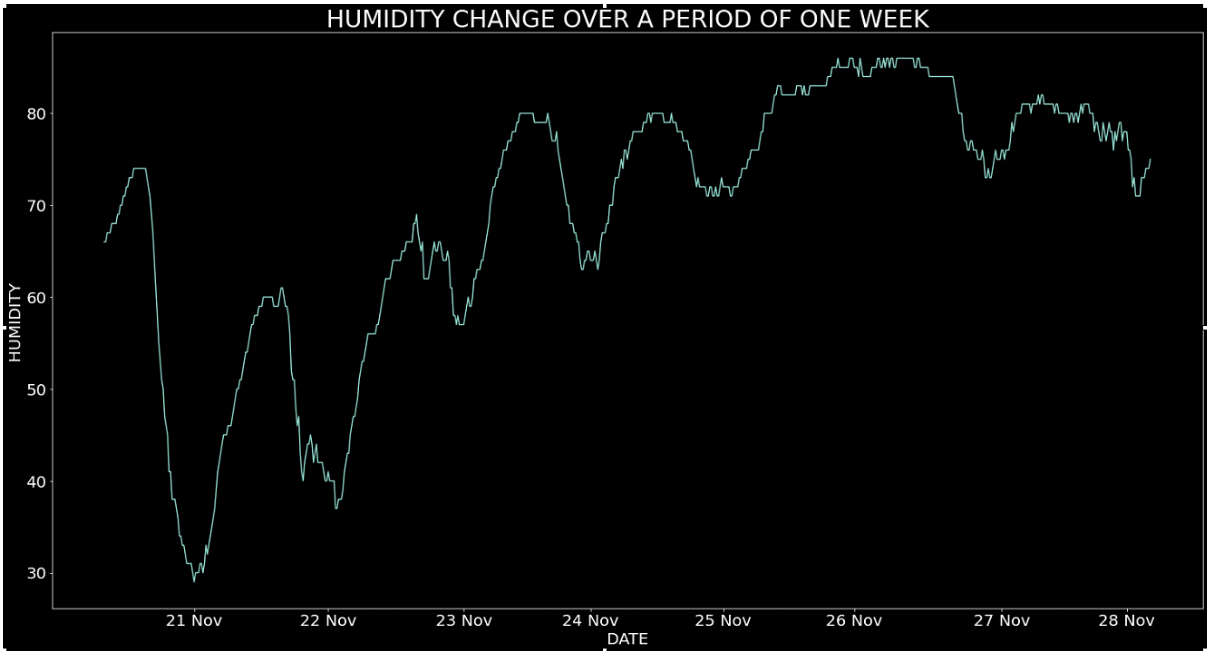
The moisture in the air will rise even if the humidity stays the same.

Now at night as the temperature reduces and when things cool down the air can/will reach its saturation point. Now the humidity will likely read close to 100% If it hits 100% and tries to exceed that fog will form. This phenomenon is what causes rain and snow as well.

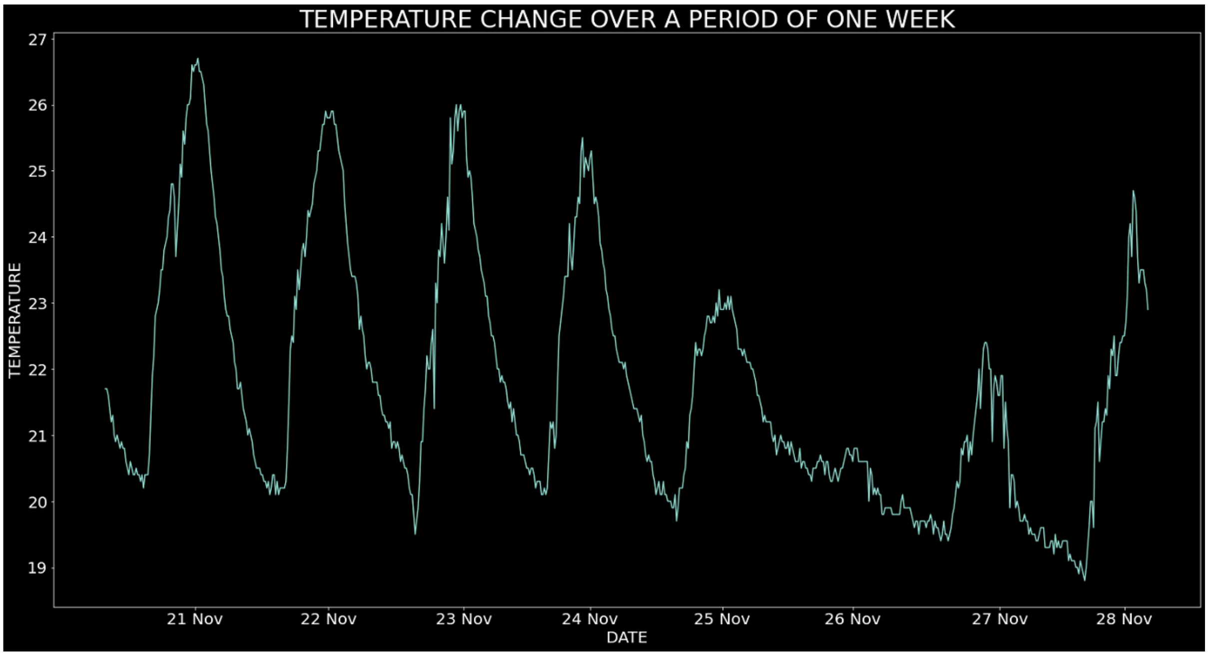
Thus, the humidity in the atmosphere increases at night as the temperature drops and reduces during the day as the temperature rises.

READINGS FOR A PERIOD OF ONE WEEK

The temperature and humidity readings were taken over one week from 21st November to 28th November in Bangalore.



These were the humidity values output by the sensor. The humidity was high during night and reduced drastically during the day. (the peaks denote the humidity at 12 AM around when its usually highest and the toughs denote midday around which it is usually lowest). Whenever the humidity value reached below the threshold of 40, we started the humidifier which helped increase the humidity levels over 40.

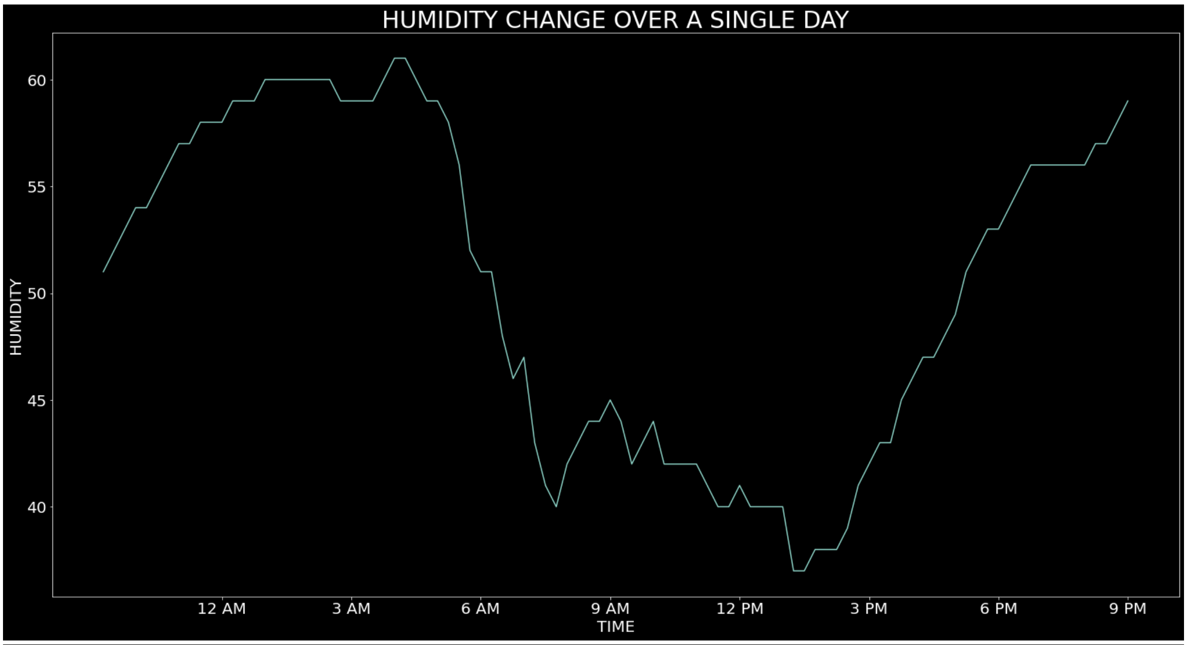


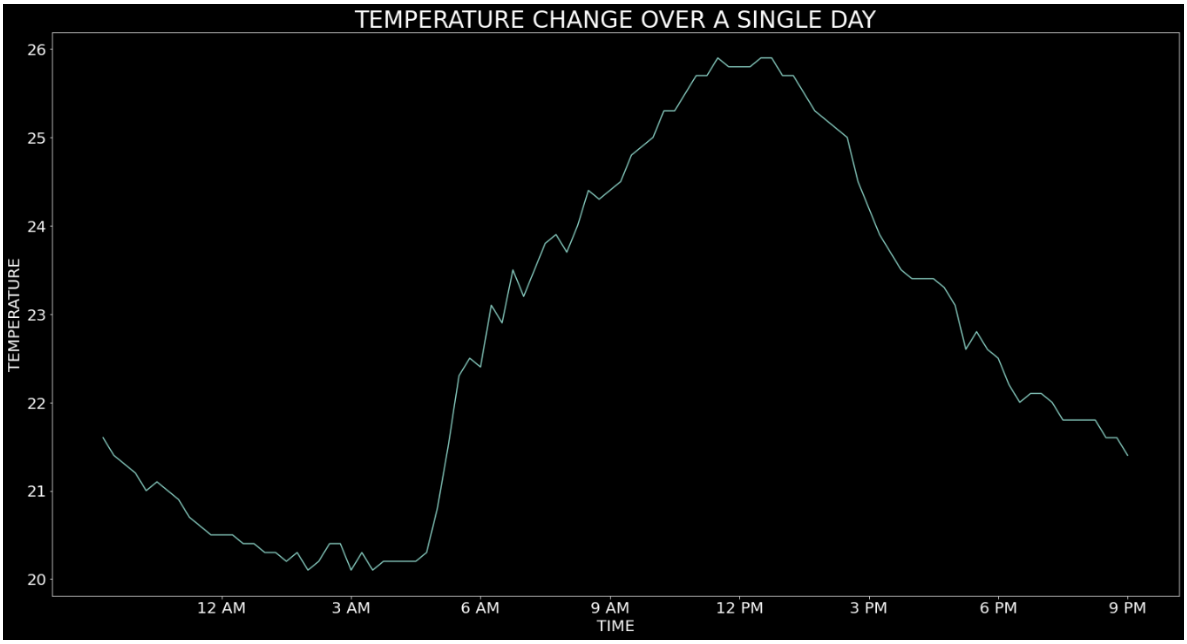
These were the temperature values output by the sensor. Here, the peaks denote around midday and the troughs denote around midnight. The fans were required to keep the temperature below a certain threshold.

INTERESTING ANALYSIS

Once interesting analysis to note here is that between 25th Nov and 27th Nov, the humidity, remained at a very high value throughout the day and night. The temperature on these days was also low throughout the day and night. The effects of cyclone Nivar which hit Chennai cost which caused consistent rains in Bangalore are seen here. Rains also cause high humidity and low temperature.

READINGS FOR A SINGLE DAY





These two graphs show the variation of the humidity and temperature during a single day. (22nd Nov)

As you can see during midday, temperature is at its highest point and humidity lowest. During midnight, it's the temperature which is low and humidity at its highest.

4. CHAPTER-IV: CONCLUSION & FUTURE SCOPE

4.1 CONCLUSION

Our IoT based Smart farming system for greenhouse consisted of the DHT11 temperature and humidity sensor and stored the values on cloud by using a NodeMCU. A real-time clock was maintained using the DS3231 RTC.

Our system had high efficiency in fetching the live data from the temperature sensor. We used fans and foggers to maintain the humidity and temperature levels in our greenhouse in a certain threshold range. This enabled remote monitoring of our greenhouse also which increased the life of the plants.

4.2 FUTURE SCOPE

The Smart Greenhouse can be further upgraded in many ways and can be used in wide agricultural applications. It can be placed and operated in any of the environmental conditions to grow any kind of vegetation. Non-conventional energy sources such as solar panels, wind-mills are used to supply power to the automatic greenhouse equipment and Peltier effect for cooling purpose. Soil-less farming can be performed to further improve the nutritional value. Integration of farming with IoT can make it much more efficient and profitable activity. Smart Greenhouse has a bright scope of future in agriculture field and it will create a revolution in the way agriculture is carried out in India.

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