A Project/Dissertation ETE Report

on

Plant Health Monitoring System using IOT

Submitted in partial fulfilment of the requirement for the award of the degree of

Bachelor of Technology in Computer Science

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Under The Supervision of
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December, 2021-22

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CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled **"PLANT HEALTH MONITORING SYSTEM USING IOT"** in partial fulfillment of the requirements for the award of the **BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING** submitted in the School of Computing Science and Engineering of Galgotias University, Greater Noida, is an original work carried out during the period **June 2021-December 2021**, under the supervision of **Mr. N. Parthiban, Department of Computer Science and Engineering** of School of Computing Science and Engineering , Galgotias University, Greater Noida

The matter presented in the thesis/project/dissertation has not been submitted by me/us for the award of any other degree of this or any other places.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

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CERTIFICATE

The Final Thesis/Project/ Dissertation Viva-Voce examination of **AYUSH MISRA - 19SCSE1010655, ABHIJEET KUMAR GHOSH - 19SCSE1010507** has been held on ___24 December 2021_______________ and his/her work is recommended for the award of **Bachelor of Technology in Computer Science and Engineering**

Signature of Examiner(s) **Signature of Supervisor(s)**

Signature of Project Coordinator **Signature of Dean**

Date: December 2021

Place: Greater Noida

Abstract

In this project we will show the implementation of plant health monitoring system. Ignorance towards the plant has used DHTII sensor for temperature and humidity monitoring YL-38+ YL-69 for a soil moisture sensor TEMT6000 sensor to measure the light intensity so that we can know that how much light the plant is receiving these data will be collected send to Arduino dev board and then Arduino Rest API will be used to exchange data from Arduino to other external device. Now to configure the ubidot so that Arduino client can send data while configuring variable id and token will be created. By authentication token connection will be created with cloud. Once the data like sensor value is stored in cloud. It can be easily be accessed on phones. In Adcon station consist of anemometer sensor which is used for data gathering and these data are sent to the cloud using MQTT and these data will be send back to the farmers after certain algorithm to improve the agriculture process.

Table of Contents

Acronyms

RFID	Radio Frequency Identification
IP	Internet Protocol
IOT	Internet Of Things
ADCON	Advise All Concerned
MQTT	MQ Telemetry Transport
HTTP	Hypertext Transfer Protocol

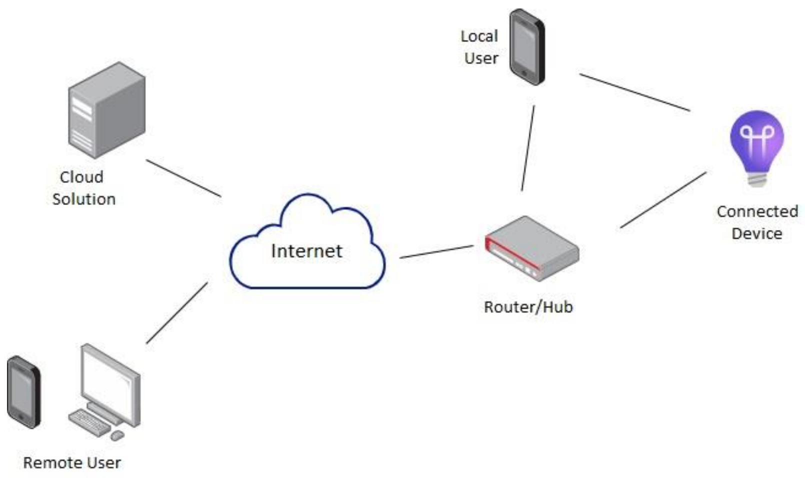
Chapter-1

Introduction

Introduction:

The concept of IoT was developed by a member of the development community of Radio Frequency Identification (RFID) in 1999, and has recently become very popular in the active world mainly due to the growth of mobile devices, Embedded and ubiquitous communication, cloud computing and data analysis. Imagine a world where billions of objects are heard, connected and shared information, all connected to a public or private Internet Protocol (IP) network. These data-related materials are regularly collected, analysed and used to initiate action, providing a wealth of intelligence in planning, management and decision-making. This is the world of Internet of Things (IoT). The Internet of Things is a new version of the Internet. Things make themselves visible and gain intelligence by making or enabling contextual-related decisions because they cannot communicate information about them. They may be able to access information integrated with other objects, or they may be able to be part of complex tasks. This change is accompanied by the emergence of cloud computing capabilities and the Internet's transition to IPv6 with unlimited power of speech. The purpose of the Internet of Things is to enable objects to be connected anytime, anywhere, anywhere and anyone using any method / network or any service.

The International Telecommunication Union defines IoT as “the global infrastructure of the Information Society, enabling advanced services by integrating based (physical and virtual) objects based on, existing and flexible, information and communication technologies.” IoT is also defined as “A network of material objects - devices, cars, buildings and other objects - embedded. Electronics, software, sensors, and network communication that allows these objects to collect and exchange data. IoT allows objects to be seen and remotely controlled across existing network infrastructure. The development of the agricultural field has become a major challenge in countries such as India, so new technologies must be used. We have implemented a new method of visual parameter monitoring, cloud compilation, warning generation and predicting future values. These sensors are embedded in the agricultural sector for data collection, and thus data is stored in the cloud using the Ubidot IoT cloud platform.



At its very basic level, IoT refers to the connection of everyday objects to the Internet and to one another, with the goal being to provide users with smarter, more efficient experiences. Some recent examples of IoT products include the Nest Protect smoke detector, August door locks and Nest thermostat. One of the known examples is the Nest thermostat. This Wi-Fi connected thermostat allows you to remotely adjust the temperature via mobile device. The potential value is that we can save money on utility bill by being able to remotely turn off air condition, which we forget to do before leaving the house.

Certain important factors such as temperature, humidity, light and the level of carbon dioxide has an impact on the productivity of plant growth. Therefore, continuous monitoring of these environmental factors gives information to the user, how each factor affects growth and how to maximize the growth of plants. In recent years, precision agriculture has become the trend in agriculture. Here the focus is mainly on understanding the environment through the interpretation of wide variety of data. The main idea of the system is to monitor the plants whether they get required amount of water and light. If there is enough moisture in the soil, the same will be reported to the user. This will help the user to give the resources to the plants every day without much manual effort and constantly monitor the health of a plant from a remote location.

How does IOT works:

Devices and objects with built in sensors are connected to an Internet of Things platform, which integrates data from the different devices and applies analytics to share the most valuable information with applications built to address specific needs.

These powerful IoT platforms can pinpoint exactly what information is useful and what can safely be ignored. This information can be used to detect patterns, make recommendations, and detect possible problems before they occur.

For example, if I own a car manufacturing business, I might want to know which optional components (leather seats or alloy wheels, for example) are the most popular. Using Internet of Things technology, I can:

- Use sensors to detect which areas in a showroom are the most popular, and where customers linger longest;
- Drill down into the available sales data to identify which components are selling fastest;
- Automatically align sales data with supply, so that popular items don’t go out of stock.

The information picked up by connected devices enables me to make smart decisions about which components to stock up on, based on real-time information, which helps me save time and money.

With the insight provided by advanced analytics comes the power to make processes more efficient. Smart objects and systems mean you can automate certain tasks, particularly when these are repetitive, mundane, time-consuming or even dangerous. Let’s look at some examples to see what this looks like in real life.

Problem Formulation:

Time is one of the valuable things to a person thus people cannot afford to waste the time. Therefore, people often forgot to spend time on taking care of the plants and monitor their health. Although there are many environmental campaigns by which the people get influenced and plant many trees or plants but are unable to give them proper care and monitor their health thus resulting in the plant dying after few weeks. During a survey it is found that 19% people said they'd rather get a root canal than be responsible for a plant. Thus, the issue of plant being ignored after planting them must be addressed and some solution must be prepared to overcome this. We have proposed a system that can solve these issues using IOT. By monitoring different factors affecting the growth of the plant such as humidity, temperature, soil moisture etc. we can monitor the growth of the plant and can take necessary action if any anomaly in the data is found.

Chapter-2

Literature Survey

IOT Solution for Plant Monitoring in Smart Agriculture

In this paper author has used ADCON-based system which is used for telemonitoring purposes in vineyard area. The user of this system can either individual owner or an employee or average group of people that can own such vineyard. They can command theses system to perform several tasks like productivity enhancement and efficient management of crops. In ADCON station consist of anemometer sensor which is used for data gathering and these data are sent to the cloud using MQTT and these data will be send back to the farmers after certain algorithm to improve the agriculture process.

A novel Approach to IOT plant health monitoring system

In this paper, author has described the implementation of plant health monitoring system author has used DHTII sensor for temperature and humidity monitoring YL-38+ YL-69 for a soil moisture sensor TEMT6000 sensor to measure the light intensity so that we can know that how much light the plant is receiving these data will be collected send to Arduino dev board and then Arduino Rest API will be used to exchange data from Arduino to other external device. Now to configure the ubidot so that Arduino client can send data while configuring variable id and token will be created. By authentication token connection will be created with cloud. Once the data like sensor value is stored in cloud. It can be easily be accessed on phones.

A Game based learning system for plant Monitoring based on IOT.

In this author has used game based Learning for plant monitoring in which user will enjoy with plant caring & advice how to take care of plant which will be monitored on plant via smartphones Author has also used IOT technology which will be sending & receiving from Raspberry pie to the game application and last is plant caring in which development of plant will be done depending upon temperature, water, moisture using raspberry pie to collect data from light intensity sensor in enough or not .If not enough Raspberry pie will send signal to the cloud server in order to send a notification to the game application and then player can turn on light, Another is watering plant when the deficiency is high then plant need to be watered, Raspberry pie to control the water pump to ensure that plant will have suitable environment for caring.

Chapter-3

Project Design

Technologies and Sensors Used:

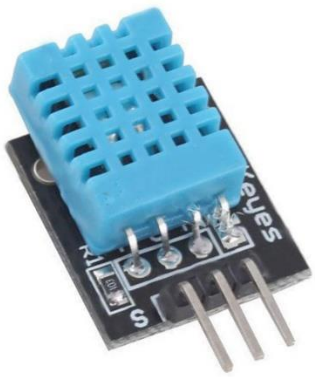
1. **DTH11**

   DHT11 is a temperature and humidity sensor that uses a digital signal detection system and temperature and humidity sensor technology. This sensor consists of a moisture-proof measurement component and an NTC temperature measurement component, connected to the high performance of an 8-bit microcontroller, which provides excellent quality, fast response, anti-inter interference, low power consumption, cheap and efficient sensor. for Arduino. It has the following characteristics of a humidity range of 20% to 90% RH with an accuracy of 5.0% RH and a temperature range of 0 to 50 C with an accuracy of 2.0C.

   DHT11 Specifications:

   - Operating Voltage: 3.5V to 5.5V
   - Operating current: 0.3mA (measuring) 60uA (standby)
   - Output: Serial data
   - Temperature Range: 0°C to 50°C
   - Humidity Range: 20% to 90%
   - Resolution: Temperature and Humidity both are 16-bit

- Accuracy: ±1°C and ±1%

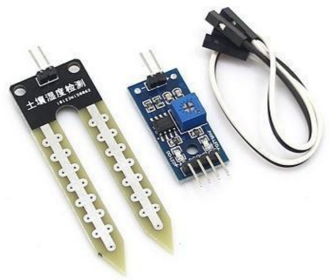


2. **YL-38 + YL-69**

YL-38 + YL-69 is a soil moisture sensor also known as a hygrometer used to detect soil moisture. Helping to monitor the soil moisture of plants or to build an automatic plant irrigation system. The sensor is made up of two parts, an electronic board and a two-pad probe, which detects how much water is in the ground. When the soil is wet the output voltage drops and when the soil is dry the output voltage rises. Output can be low or high digital signal, depending on water content. If the soil moisture exceeds a specified amount, the modules produce a lower effect, otherwise they produce higher effect.

Notes

- Operating voltage: 3.3V~5V.
- Adjustable sensitivity (blue digital potentiometer adjustment) affects digital signal
- Dual output mode, analog output more accurate.



3. **TEMT6000**

The TEMT6000 is a sensor for measuring light intensity so that we know how much light a plant receives. The sensor acts like a transistor larger than the incoming light; the height will be the voltage at the signal pin. It detects light intensity and displays an analog voltage signal back to the Arduino controller. It mimics the human eye, which responds well to IR or UV light. The TEMT6000 has the following specifications such as supply voltage range from 3.3V to 5.5V, operating temperature 40 to 85 C and light range 1 to 1000Lux.

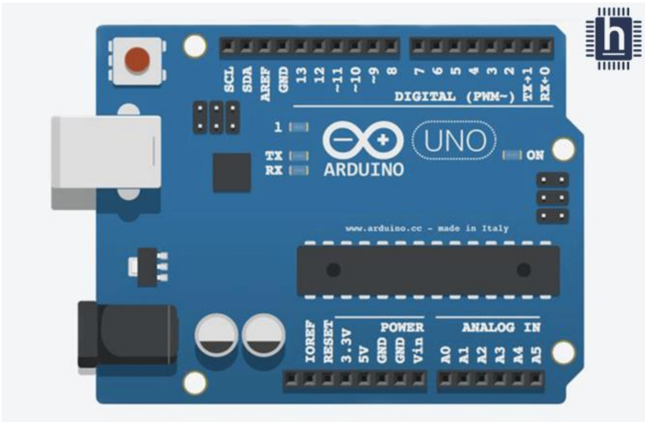
4. Arduino

Arduino board can be instructed by sending a set of instructions to the microcontroller on the board. Instructions are written in Arduino programming language and the Arduino software is used as Integrated development environment (IDE) for processing these instructions. Arduino offers many advantages over other microcontrollers such as cross platform – Arduino IDE runs on Windows, Macintosh OSX and Linux operating systems, inexpensive, simple programming environment.

Technical specifications

- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)

- UART: 1
- I2C: 1
- SPI: 1
- Analog Input Pins: 6



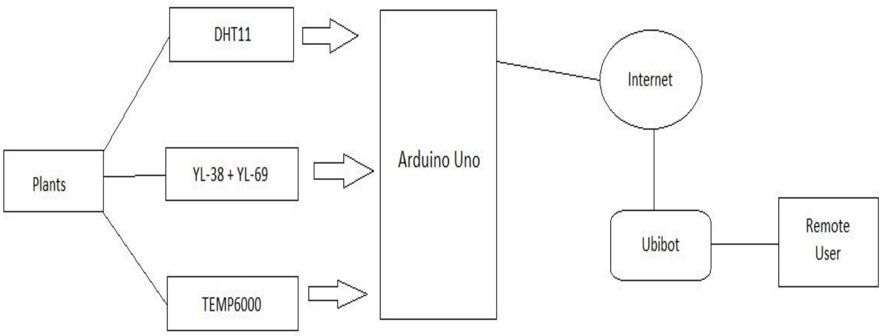
5. Ubidot IoT Cloud platform

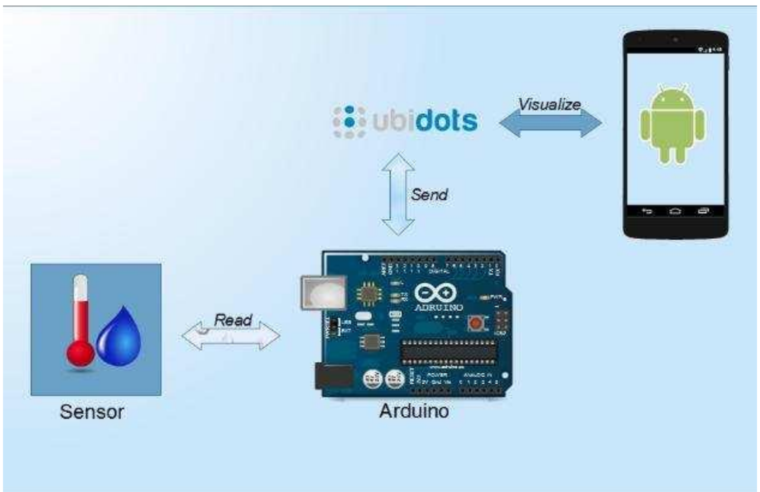
Ubidots are an important part of a plant health monitoring system. When you create a sensor-based IoT system, the dev board sends data to a cloud platform. These forums store data and use it to create charts. The Ubidots IoT cloud platform is similar to PaaS (Platform as a service) which provides some useful services to the IoT ecosystem. These services enable dev boards to connect to remote services or other service providers. It will cost to connect Arduino to a remote service. These forums work hard.

They use a set of custom rules based on incoming events from Arduino sensors. These events open an external action such as sending a short message. Most of these platforms have a free account that is useful for building an IoT Project.

System Architecture

System Architecture include gathering of the data based on various factors such as temperature, humidity, light etc. using the sensors which are connected with the Arduino board. The data then goes to the cloud through ubidot and then to an android phone. Thus, a person can monitor the data using an application. This is more explained by the below image.

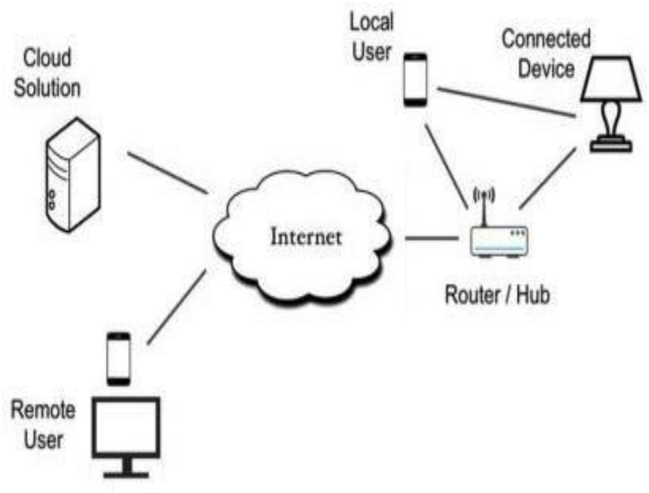




Chapter-4

Project Implementation

Implementation of the project include gathering of the sensors required for the monitoring and connecting the sensors with the Arduino Uno board. Different sensors are placed in the different places in the plants for better gathering of the data. Then the data from the sensors goes into the user's smartphone. These sensors are embedded in the agricultural sector for data collection, and thus data is stored in the cloud using the Ubidot IoT cloud platform. The IoT ecosystem uses a number of protocols to exchange information between components. Some of these protocols are widely used in other fields such as HTTP and this protocol is used in the IoT ecosystem as well. It is very useful if we want to integrate IoT components worldwide. Arduino Uno supports HTTP web server to host HTTP connections.



As shown in the figure the system consists of sensors like DTH11, YL-38 + YL-69 and TEMT6000 interfaced with Arduino Uno dev board. Arduino dev board is connected
to IoT based cloud platform known as Ubidots using Ethernet or Wi-Fi. Ubidots will allow users to create a dashboard and to represent stored data as graph. DTH11 will monitor temperature and humidity, YL-38+YL-69 will monitor soil moisture and TEMT6000 monitors light intensity. These sensors will gather environment information and send the information to Arduino.

IoT ecosystem uses several protocols to exchange information between components. Some of these protocols are widely used in other fields like HTTP and this protocol is used in IoT ecosystem too. It is very useful when we want to integrate IoT components to the rest of the world. Arduino Uno supports an HTTP Web server so that it handles HTTP connection. Arduino Rest API is used to exchange data from Arduino to other external systems. Arduino Rest API will read and send information to Arduino board. It will retrieve sensor values. Ubidots IoT cloud platform also uses Arduino Rest API mechanism, by using this mechanism
when client sends a request Arduino replies with some data. Arduino Rest API works over HTTP protocol plays an important role in a client server scenario where Arduino acts as a server. Arduino Rest API uses a library called a Rest. This library supports Rest services in
different dev boards. Its open source and easy to use. Using the library, we can

implement Arduino Rest API paradigm because it supports reading pin values and writing pin values. Sensor values are stored in Arduino.

Now we need to configure the Ubidots so that the Arduino client can send data. This can be done using Ubidots web interface. While configuring the cloud, variable id's and authentication token are created. Using authentication token Arduino establishes a connection to the cloud. Arduino HTTP client sends each sensor value assigned with a variable id using JSON (Java Script Object Notation) service. Arduino is connected to the Ubidots cloud using an Ethernet shield then the data is stored in cloud and analysed. Once the data, like sensor values, is stored in the cloud it is possible to access it using smart phones remotely.

CHAPTER 5

Result

The IoT ecosystem uses a number of protocols to exchange information between components. Some of these protocols are widely used in other fields such as HTTP and this protocol is used in the IoT ecosystem as well. It is very useful if we want to integrate IoT components worldwide. Arduino Uno supports HTTP web server to host HTTP connections.

Arduino Rest API is used to transfer data from Arduino to other external systems. The Arduino Rest API will read and send information to the Arduino board. It will return the sensor values. The Ubidots IoT cloud platform also uses the Arduino Rest API method, through this process when the client submits an Arduino application responds with other data. Arduino Rest API works with HTTP protocol, an important role in the client server environment where Arduino acts as a server. The Arduino Rest API uses a library called Relaxation. This library supports restless board devoted services. Its open source and easy to use. By using the library, we can use the Arduino Rest API paradigm because it supports reading pint numbers and pencil values. Nerve values are stored in Arduino.

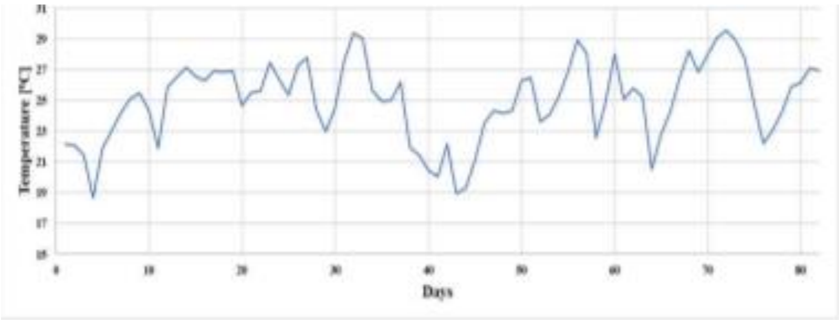
Each sensing node contains some low-cost sensors to collect the factors needed for the machine learning model which are: temperature, relative humidity, leaf wetness, and the soil moisture. These data are collected by nodes deployed in the field to be sent using the Wi-Fi module and MQTT protocol to the gateway on which the machine learning algorithm runs to output the predicted warning message. The predicted action or warning message is displayed on the website for the farmer. In the future work the system can be expanded to be fully automatically actuating as the proposed system in this paper needed human interference to apply the action but, in the future, the gateway can send actions by itself and spray the field when needed.

The platform system performs automatic and continuous monitoring of the air temperature and humidity, leaf wetness, soil temperature and moisture throughout seeding to harvesting. The existence of these data transmission systems highlights the knowledge of the soil-plant-atmosphere interactions needed to optimize agricultural production. One advantage of the system consists in the use of solar energy that powers the entire system, along with dedicated sensors. As future work, we envision testing the system for denial of service (DoS) attacks. We will focus on implementing DoS attacks to limit data transmission between ADCON and the server, and as well, to prevent a legitimate user, a farmer, accessing their data from the server.

Variation in Temperature

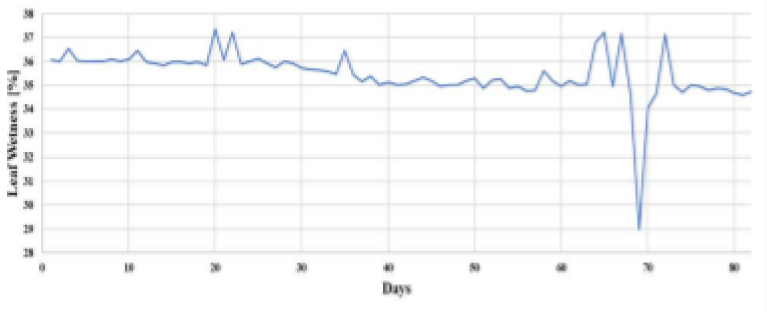
The analysis of the impact of meteorological parameters on agriculture was realized in a vineyard area located in a region close to Bucharest, using ADCON monitoring stations for summer season. The data acquired from the agricultural sensors (temperature, leaf wetness, relative humidity of air and soil and temperature of soil) were centralized into a database and were used to highlight the impact of measured parameters on crops.

There is a close connection between grape growth and temperature variation. Following several studies, it was found that the temperature range for the development of the vine is between 25°C and 32°C [23]. Any temperature below this optimum range causes the vegetative growth to be limited. Temperatures above the optimum range reduce the rate of photosynthesis of vines due to increased respiration. Considering the information from Fig. 2, the average daily temperatures (June, July and mid-August) were up to 32°C, which means that the quality of the grapes is not affected. Photosynthetic activity is optimal at 24°C for cool climates (explained more in-depth in the next chapter) grapes and 28°C for the warm climate grapes. As temperatures rise during the growing season, grapes become more susceptible to sunburn. The alteration of grapes can be influenced by the sun exposure, especially due to UV radiation which can impair the grape quality



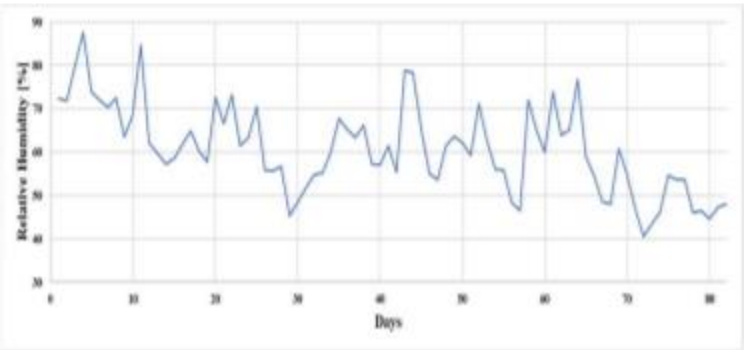
Variation in leaf

The leaf wetness describes the amount of dew and rain on the leaves. According to below figure, the peaks in days 20, 21, 65, 67 and 72 correspond to the time periods in which the atmosphere was loaded with rainfall, the rest were periods with reduced precipitation it can be stated that the maximum values for leaf wetness are reached whenever the air temperature increases.



Variation in Humidity

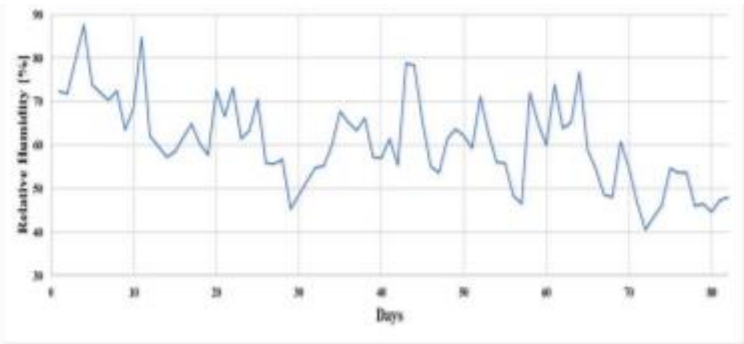
The relative humidity of air is dependent on the air temperature, so for 1 m3 of air, when the temperature is 0°C, 3.77 grams of water are needed to saturate it — that is, to raise its relative humidity to 100%. The air temperature at 20°C with a relative humidity of 100 percent contains 10 times more water than air at 0°C degrees with a relative humidity of 100%.



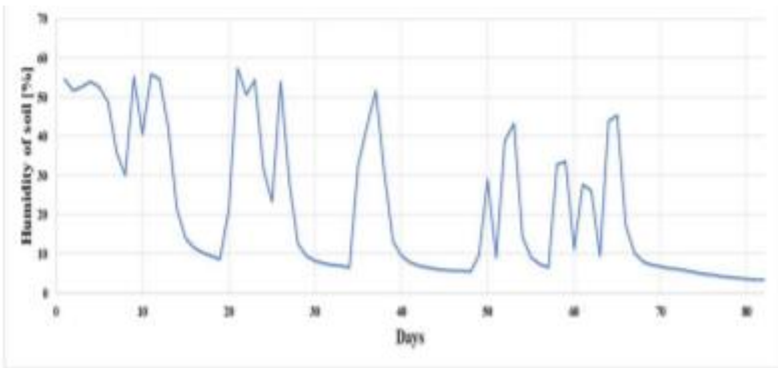
Variation in Relative Humidity

The soil humidity (or moisture) and air relative humidity data affect the growing and the health of the leaves, the photosynthesis process and are very important in diseases occurrence. Using these data, the probability of disease occurrence can be found and mitigated.

Variation of relative humidity of air



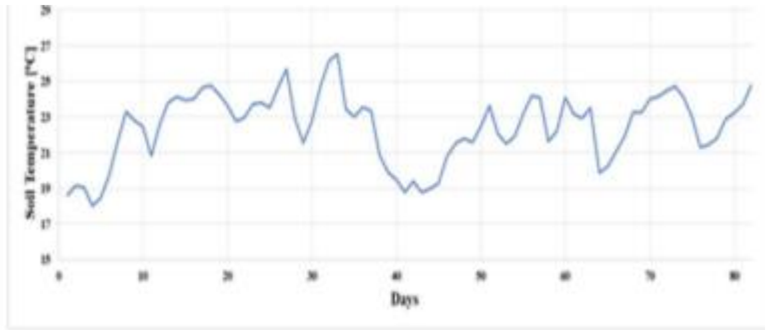
Variation of relative humidity of soil



Variation of soil Temperature

The soil humidity (or moisture) and air relative humidity data affect the growing and the health of the leaves, the photosynthesis process and are very important in diseases occurrence. Using these data, the probability of disease occurrence can be found and mitigated.

Finally, in given figure, the soil temperature variation is represented. We can see that the soil temperature ranges between approximatively 18°C and 27°C. The plant growing is affected by soil temperature which must be higher than 9°C and most not exceed 50°C.



The concept of IoT technology used to connect devices for collecting information. Improvements in agriculture for rural and urban areas are rising in recent decades with the help of digital technology. Presently available sensors are used to get possible outcome. The server based web app is developed which is free anytime and anywhere when system has connection with internet. This system will optimize the resources in plant area. The installation cost is tolerable as compared to large instruments. Totally this proposed system solves major issues of the agriculture field.

Chapter- 6

Testing

The complete hardware and software setup have been done to monitor the soil moisture of the field. We have tested in a small scale by inserting a moisture sensor and visualize the readings. In order to view the results in Losant platform, a dashboard is created named desk plant. A gauze block and a time series graph is being customized to view the moisture level over time as shown in fig: . We have import workflow in Losant platform to setup an alerts via SMS or an email to the intended person. This alerts will be active whenever the moisture level of the plants will be less and we are being notified by SMS or email as shown in fig:10 as well as the board will subscribe to the commands back from the losant to turn on the LED if the percentage of moisture in the soil is below the threshold value.

Circiut Connection

For all Losant IoT developer kits an environmental setup must be done before flashing the firmware into the device. An USB drivers is installed in the Arduino IDE. For this workshop a few libraries require to be installed. The required libraries are PubSubClient, ArduinoJson and Losant Arduino MQTT Client. After the environmental setup a Moisture Sensor firmware will be flashing to the device. In the kit source code few things need to be modified such as wifi SSID, wifi pass, Losant Device ID, Losant access Key, Losant access secret. Now upload the firmware to the device and after every 60 seconds the firmware is publishing the state of moisture value to the losant. The moisture values varies between 0-1024 that the micro-controller ADC is providing. Higher values means less moisture and lower values means more moisture.

Chapter-7

Acknowledgement

This research was partially funded by the Information Technology Industry Development Agency (ITIDA), National Telecommunications Regulatory Authority (NTRA), and ONE Lab at Cairo University, Zewail City of Science and Technology. The work presented in this paper was funded by SmartAgro project subsidiary contract no. 8592/08.05.2018, from the NETIO project ID: P_40_270, MySmis Code: 105976.

Chapter-8

Conclusion

The sensors and microcontroller are successfully interfaced with the cloud. The data is stored successfully and can be accessed remotely. All observations and experimental set up prove that this is a complete solution to monitor the health of a plant. User can have access to the data and can know if there are any deviations with respect to temperature, humidity, soil moisture and light intensity. Implementing this system will allow users like farmers to monitor and improve the yield of crops and overall production.

Chapter 9

Future work

Overwatering issue

Since now days many people are busy in their work and are not able to find time for watering the plants and even though many people don't know that in which plant, how much water should be given and after how many time due to which many plants leads to die to prevent this situation we are working on the implementation of idea in which the user will give water to the plant then the automatic sensor will alert the user that the watering of plant is not required and it will alert the user that water is required after certain days on the user’s Android device. Thus, this prevents the plants from overwatering which lead to a better growth of the plant.

Alerting System

This system will alert the user when any of the factors related to monitoring shows any non-uniform data. If any discrepancy in the data found then the user will get an alerting message on their android smartphone. Thus, it will prevent the plants from drying-up because it will remind the user to water the plants at a proper interval of time.

Chapter 10

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