Smart Greenhouse Monitoring System

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Abstract— **The aim of our project is to create a IOT system that uses various sensors to measure and monitor the growth of plants inside a greenhouse environment, There are various parameters like humidity, temperature, soil moisture, light sensor and gas sensor that have been used to monitor the environment and surrounding of the plant. With the use of appropriate actuators like sprinklers, air vent controller and lighting mechanisms have been set up to stimuli a response to the thresholds of the sensors, Additional features which are included in the system also include storing the in a database, making a collection of the data base, using the accumulated data, to perform predictions and analytics. This project is done with the aim to make improvements in the current agricultural practices by making use of modern technology and thereby increasing the yield to make the agriculture system more efficient. This is the model for a smart Greenhouse system. The aim of it is to enhance the current agricultural practices being used by the farmers and help them earn more. The model reduces the amount of manual inspection required alongside the benefits of a greenhouse which include, providing a close and safe structure which can protect the plants from the extreme weather conditions ultraviolet radiations, wind, hailstorm and insect and pest attacks. For the irrigation of fields in agriculture it is carried out using an automatic drip irrigation, which operated according to the soil moisture threshold which is set before, so that optimal amount of water is applied to the plants. Based on the data from a soil health card, a proper amount of nitrogen, potassium, phosphorus and minerals are applied to the crop using a drip system technique. By making the use of ultrasonic sensors, a proper water management tanks are constructed and are filled with water after measuring the current water level by making use of an sensor which is ultrasonic, The plants are also provided with the requisite amount of wavelength during the night by making use of growing light, The air humidity and temperature are controlled by humidity and temperature sensors along with a fogger to control the same. Other than that we are willing to predict whether a plat will exist in a given condition or not. For that we are going to use data which we receive by the various sensors and use to train a machine learning model and to predict the existence.**

Keywords— **Smart Greenhouse Monitoring System, Modern Greenhouse, Fully Automatic Greenhouse, Moisture Control**

Problem Statement:

To automate the monitoring process of the plant inside a greenhouse with respect to its surrounding.

To ensure that the plant grows in an optimum temperature and if it is too hot or too cold we can take necessary action.
To measure greenhouse gases such as CO2 and water vapour sensing. This will help us to open the shed if too much CO2 is trapped inside and start the air vent or fan.

To measure intensity of light inside the greenhouse and fire up the bulb if the surroundings become dark. to pour water into the soil in case of low moisture content.

I. INTRODUCTION

The structure of a greenhouse consists of walls along with a roof made primarily of material that is transparent in nature, like glass. Inside of a greenhouse the plants which require a special regulated condition of the climate are grown. The size of the structure range in size from sheds which are small to large buildings which are industrial-sized. The greenhouse is also called as a glasshouse, with large amounts of heating also known as hothouse. The smaller version of a greenhouse is known as a cold frame. The functioning of a greenhouse involves the inner part of it to be exposed to sunlight, this part becomes significantly warmer than the temperature of the outside, this protects the content in the cold weathers.

The greenhouse also serve as a high tech facility for production for vegetables, fruits and flowers. The glasshouses or hothouse are filled up with equipment that includes installation for screening, cooling, heating, lighting and can be controlled by a computer to enhance the conditions of the plant growth. Different techniques are then used to evaluate optimal temperature and comfort ratio of the greenhouse in order to reduce production risk before the cultivation of a specific crop. Theory of operation of Green House: The higher temperature in a greenhouse occurs because incident solar radiation passes through the transparent roof and walls and is absorbed by the floor, earth, and contents, which become warmer. As the structure of the greenhouse is not open to the atmosphere, the warmed air cannot escape via convection, so the temperature inside the greenhouse rises. This is different from the earth-oriented theory known as the "greenhouse effect".

The various quantitative studies suggest that the effect of infrared radioactive cooling is not negligibly small, and may have economic implications in a heated greenhouse. The various analysis of issues of near-infrared radiation in a greenhouse with screens of a high coefficient of reflection concluded that installation of such screens reduced heat demand by almost about 8%, and application of dyes to transparent surfaces was suggested. The Composite less reflective glass, or less effective but cheaper anti-reflective coated simple glass, also produced savings. Enhanced Greenhouse effect: The problem is faced is that human activities – particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing – are increasing the concentrations of greenhouse gases. It is due to this is enhanced greenhouse effect, which is contributing to warming of the Earth. In this project, the Design had been aimed data acquisition in greenhouse for multiple sensors to use data for simulation or processing to achieve the better enhancement of growth in greenhouse, this data has effect on the climate of greenhouse.

A Graphical User Interfaces (GUI) had been used through LabVIEW, firmware of arduino as software and arduino board and sensors as hardware. by making use of an arduino mega board provides multiple inputs analogs and I/O digitals to made read data sensor easy to take temperature, humidity, CO2 gas, also measuring the soil moisture that needs irrigation plants and the intensity of lights that applied for greenhouse. These factors have the major effect on increase in growth of plants as seen from above analysis. Greenhouse environment monitors different changes to parameters, the system for this purpose had been provided and given ability to control on climate of greenhouse. In greenhouse the crop agriculture is higher affected by the surrounding conditions. The environmental factors have significant affect for the quality and better productivity of the plant’s growth are temperature, relative humidity, Lighting, moisture soil, and the CO2 amount in greenhouse. The continuous monitoring of these factors gives relevant information pertaining to the individual effects of the various factors towards obtaining maximum crop production.

An Arduino is an open-source system comprising of electronics which provides prototyping platform based on flexible, easy-to-use hardware and software. It is intended for artists, hobbyists, designers and anyone interested in creating interactive objects or environments. Arduino can detect and sense the surroundings by receiving input signal from different sensors and can affect its environment via controlling heater, Water pump, and other actuators. The AVR at mega on the board is programmed using the Arduino programming language (depended on Wiring) and the Arduino development environment (depended on processing). Arduino projects could be stand-alone or they can communicate with other software running on a computer.

The greenhouse is seen as a multivariable process presents a nonlinear nature and is influenced by biological processes. The 5 most important parameters must be considered when design a greenhouse are temperature, relative humidity, ground water, illumination intensity and CO2 concentration. This parameter is important to realize that the five parameters mentioned above are nonlinear and extremely interdependent. The computer control system for the greenhouse involves the various series of steps:

1. Acquisition of data through sensors.
2. The processing of the data, comparing it with desired states and finally deciding what must be done to change the state of system.
3. Actuation component carrying out the necessary and desired action. After performing the Acquisition of data from the sensors we are using that data to train our Machine Learning Model and to predict whether a plant can exist or may die with maximum accuracy via the Decision Tree Approach and can also help us to recognize the apt temperature, Humidity and Light Intensity required keeping a particular plant alive.

II. LITERATURE SURVEY

When it comes to watching the hydroponic plants in greenhouses, the farmers usually experience difficulties because they still do it manually. Activities such as checking the temperature, air humidity, and also water quality in hydroponic plants by coming directly to the greenhouse are still ineffective. In this paper “The prototype Of the Greenhouse Smart Control and Monitoring System in Hydroponic Plants” we use MFT method and an Arduino kit along with Humidification Control Testing that can control humidification with an upper temperature limit of 35C, the sensors deployed in this paper have a very high accuracy and hence we have chosen this as our base paper.

1) In the paper Greenhouse Monitoring System Based on Android Platform by Zhao, R., et al. , the authors propose a greenhouse remote monitoring system based on Internet of Things technology and Android platform, real-time monitoring of greenhouse environment (temperature, humidity, CO2 content and PH value). The framework utilizes the MSP430 microcontroller as the base layer processing chip and coordinates various sensors and communication modules to form the informational data securing and control part of the greenhouse. Through the communication network, the collected data is transmitted to the PC, the cloud reads the PC database, and finally performs data pre-processing and analysis in the cloud. The android application displays the data on the mobile phone by accessing the cloud database.

2) IoT-Based Smart Greenhouse Farming System described by Reka, S. S., et al. [2], a relatively new technology, LoRa, is studied and implemented in a farming scenario. The prototype model system consists of sensors and actuators which are interfaced using STM NucleoMbed Board. Additionally, the sensor values will be uploaded into the Tata server cloud in HEX format and as a JSON string. But to enable easy comprehension of data, this would be converted to decimal values. This makes it easier for farmer to the monitor the greenhouse remotely.

3) In IOT based Automated Greenhouse Monitoring System published by Danita, M., et al. [3], a formula is derived which defines a threshold value for that greenhouse. The factors on which this system works include Soil humidity, Air humidity and the temperature of the greenhouse. The threshold expression proposed is “Temperature + (Air Humidity*0.1)”. If the value of this expression exceeds its threshold for a plant, the sensors in the proposed system will get active to maintain the humidity and temperature.

4) In IOT Based Environment change Monitoring & Controlling in Greenhouse using WSN by Shinde, D., &Siddiqui, N. [4] the authors have presented a specific formula or expression like the previous paper instead they are using a simple approach. This paper uses the range method. They have defined the optimum value for a plant that in this there will be highest growth and if the value exceeds or decrease the actuators get active. The proposal in the paper turns a conventional greenhouse to a portable and

little maintenance system to the rural people and especially for low area agriculturalists.

5) In Internet of Things Based Smart Greenhouse: Remote Monitoring and Automatic Control by Ullah, M. W., et al. [5], the authors have proposed a system that monitors temperature and humidity, soil moisture and takes action according to results. The systems do not need any kind of human interaction. It also includes a database helpful for future analysis and reports. This system is very suitable to be deployed at places like the North Pole and winter climate countries where people live but the plant does not grow due to heavy winter. If this system is used in those countries, one person can manage multiple Green-houses at a time to grow a vast number of plants due to its efficient use of time and automatic controlling capacity. That person will only need to monitor the condition of the green-houses and fix something that cannot be fixed by the proposed system such as cutting off any infected leaves of the plants, uprooting any infected trees, and so on.
6) In the paper IOT Based Smart Greenhouse Automation Using Arduino published by Shirsath, D. O., et al. [6], the authors have reviewed and developed the proposed system based on the restriction in the present monitoring system. It also focuses on the Generic Architecture which can be used for other different Automation Application. The greenhouse is a building where plants are grown in a controlled manner. With the technology the proposed system can control and monitor the multiple Greenhouses using IOT from the central location wirelessly.

7) In the paper, IoT based Smart Greenhouse published by Kodali, Ravi & Jain, Vishal ., et al (2016)[7]. This work is primarily about the improvement of current agricultural practices by the use of modern technologies for better yield. This work provides a model of a smart greenhouse, which helps the farmers to carry out the work on a farm automatically without the use of much manual inspection. Greenhouse being a closed structure protects the plants from extreme weather conditions namely: wind, hailstorm, ultraviolet radiations, and insect and pest attacks. The irrigation of the agriculture field is carried out using automatic drip irrigation, which operates according to the soil moisture threshold set accordingly so as the optimal amount of water is applied to the plants. Based on data from soil health cards, the proper amount of nitrogen, phosphorus, potassium, and other minerals can be applied by using drip fertigation techniques. According to this paper, proper water management tanks are constructed and they are filled with water after measuring the appropriate current water level using an ultrasonic sensor. The required wavelength light is provided to the plants during the night using growing lights. Temperature and air humidity are controlled by humidity and temperature sensors and a fogger is used to control the same. A tube well is controlled using the GSM module (missed call or SMS).

8) In this paper, Implementation IoT in System Monitoring Hydroponic Plant Water Circulation and Control published by Nurhasan, Usman & Prasetyo, Arief & Lazuardi, Gilang & Erfan, ROHADI & Pradibta, Hendra. (2018)[8]. Hydroponics is the process of cultivation of plants by utilizing water without using soil by instead using mineral nutrient solutions in a water solvent. Deep Flow Technic (DFT) is a kind of hydroponics that implements a continuous flow of nutrients and there is a pool of half of the diameter of the pipe that deluges the roots of the plant. A common barrier experienced by DFT is the lack of maintenance of plant growth elements such as water circulation, light intensity, temperature, humidity, and pH of the water which causes these plants not to grow perfectly. It is very necessary to monitor and control the circulation of water on DFT-based IoT hydroponics to predict changes in plant growth elements. Information on plant development components is acquired by sensors integrated with Raspberry Pi. In the monitoring process using the website will display the data on plant growth elements in the form of pH, temperature, humidity, and water level in the hydroponic pool. For water circulation control temperature and humidity are used as the parameters that are processed using the Fuzzy Sugeno Method. The conclusion from the obtained results of the tests that have been carried out, the system can monitor plant growth elements displayed on the website in real- time and control

water circulation automatically. The system applied in the hydroponics of mustard greens also produces significant development in leaf number and plant height.

9) In this paper published by Shreyas Bhujbal, Yash Deshpande, Arpit Gupta, Ojas Bhelsekar(2018) [9]. In this era of digitization and automation, human life is getting simpler as almost everything is automatic, replacing the old manual systems. Nowadays as the internet has become an integral part of day to day life, all the devices also need to be brought on the network. This is basically the motive of the Internet of Things. Internet of Things (IoT) is one of the promising technologies which can be used for connecting, controlling, and managing intelligent objects which are connected to the Internet using various protocols and means. This paper discusses about IoT and how it can be used for realizing smart greenhouse parameters monitoring system using Raspberry pi 3 (microprocessor) and various sensors connected over the internet. The various parameters are monitored and the data can be sent to different devices like PC, smartphones, etc.

10) This paper published by E. Gutiérrez, S. Gutiérrez, J. A. Becerril and F. Rodríguez, "Low-Cost Prototype for Monitoring and Remote Control in Greenhouse for Homes," 2018 IEEE International Autumn Meeting on Power, Electronics and Computing (ROPEC), Ixtapa, Mexico, 2018[10],.The emergence of new technologies and the opening of hardware and software platforms for the development of embedded systems, has facilitated the design, integration, and development of new communication monitoring and control systems. In recent years, the world population has grown rapidly, so the demand for fresh and healthy foods has increased its demand. Besides that, there is a widespread search for a more natural and healthy alimentation, that is why there is a tendency for people to start growing and harvesting their own food. The main objective of this paper is to design and develop the automation of a greenhouse for self-consumption using a free development platform, which accelerates the integration process, reducing time and execution costs.

11) This paper published M. A. Elashiri and A. T. Shawky, "Fuzzy Smart Greenhouses Using IoT," 2018 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)[11],.This paper propose a fuzzy computational algorithm for one of the applications of internet of things (IoT) in agriculture is fuzzy smart greenhouses using IoT for crop system. The hardware part contains some of the sensors, actuators and microcontrollers, the functions of these sensors are perpetually recording the natural biometrics measures such as temperature, ground wet, soil moisture sensor for detecting the temperature degree, amount of water in the soil and humidity. According to the data collected from this equipment the software part will applying a fuzzy computational algorithm to help the farmers with the decision to ascertain acceptable performance.

12) This paper published by Zamora-Izquierdo, Miguel & Santa, José & Martinez, Juan & Martínez, Vicente & Skarmeta, Antonio. (2019). Smart farming IoT platform based on edge and cloud computing Bio system Engineering. 2019[11] Precision Agriculture (PA), as the integration of information, communication, and control technologies in agriculture, is extending day by day. The Internet of Things (IoT) and cloud computing paradigms offer advances to upgrade PA connectivity. Nevertheless, their usage in this field is usually limited to specific scenarios of high cost, and they are not adapted to semi-arid conditions or do not cover all PA management in an efficient way. Due to this reason, we present a flexible platform able to cope with soilless culture needs in full recirculation greenhouses using moderately saline water.

It is based on substitutable low-cost hardware and supported by a three-tier open-source software platform at local, edge, and cloud planes. At the local plane, Cyber- Physical Systems (CPS) cooperate with crop devices to gather information and perform real-time atomic control actions. The edge plane of the platform is in charge of monitoring and managing main PA tasks near the access network to increase system accuracy against network access failures. Finally, the cloud platform assembles current and past records and hosts data analytics modules in a FIWARE deployment. IoT protocols like Message Queue Telemetry Transport (MQTT) or Constrained Application Protocol (CoAP) are used to communicate with CPS, while Next-Generation Service Interface (NGSI) is enrolled for southbound and northbound access to the cloud. The system has been entirely instantiated in a real prototype in frames of the EU DrainUse project, allowing the control of a real hydroponic closed system through managing software for final farmers connected to the platform.

13) This paper published by Yazar, Selçuk & Taşkin, Deniz & Taşkın, Cem. (2018)[12]. Developing a Bluetooth Low Energy Sensor Node for Greenhouse in Precision Agriculture as the Internet of Things Application. Advances in Science and Technology Research Journal. The Internet of Things (IoT) paradigm is referring to the underlying constituents of the 4th Industrial Revolution that will also affect the use of the internet in industrial production in the future. More than 50 billion smart devices will be able to communicate with each other and internet services over the increasing network capabilities of wireless sensor networks nodes on IoT applications in the next ten years. One of the major production areas using IoT within wireless sensor networks is precision agricultural practices. In this paper, a new sensor node is designed, which includes ambient light and temperature sensors employing Bluetooth Low Energy (BLE) communication protocol, which is used as an IoT application. Next to this, sensor node power consumption and management cost was investigated. The test results show that the developed sensor node lifetime is about 8 years and the total cost of nodes and gateway model is below $50 per year per 0.1 hectares.
14) This paper proposed by Danita, M. & Mathew, Blessy & Shereen, Nithila & Sharon, Namrata & Paul, J.. (2018). IoT Based Automated Greenhouse Monitoring System.[13] using the methodology that Greenhouse is divided into sections with each having moisture sensor, By Using ThingSpeak data transfer is easy and fast and using Raspberry PI 3, Moisture Sensor (YL69), Temperature and Humidity Sensor (DHT11), Motor Driver (ICL293D), Cooling and Sliding Windows, ThingSpeak having advantage Automated Greenhouse by using Rasberry PI 3, some sensors and ThingSpeak with Webpage implementation makes Remote Monitoring easy.

15) This paper proposed by Kang, Mengzhen & Fan, Xing-Rong & Hua, Jing & Wang, Haoyu & Wang, Xiujuan. (2018). Managing Traditional Solar Greenhouse With CPSS: A Just-for-Fit Philosophy. IEEE Transactions on Cybernetics.[14]. The profit of greenhouse production is affected by management activities as well as social conditions. In China, the current horticultural facility is the traditional solar greenhouse. The only existing problem is the lack of knowledge of growers, which in turn leads to ineffective management, low production, or unsalable products. For securing effective greenhouse management, the production planning system must take care of the crop growing environment, grower's activities, and the market. This paper presents an agricultural cyber-physical-social system (CPSS) helping agricultural production management, with a case study on the solar greenhouse. The system inputs are obtained from social and physical sensors, with the former collecting the price of agricultural products in a wholesale market, and the latter collecting the required environmental data in the solar greenhouse. Decision support for the cropping plan is given by the artificial system, computational experiment, and parallel execution-based method, with description intelligence for estimating the crop development and harvest time, prediction intelligence for optimizing the planting time and area according to the expected targets ,and prescription intelligence for online system training. The presented system fits the present technical and economic condition of horticulture in China. The application of agricultural CPSS could decrease waste in labor or fertilizer and support feasible agricultural production.

16) This paper proposed by C. Bozchalui, Mohammad & Canizares, Claudio & Bhattacharya, Kankar. (2015). Optimal Energy Management of Greenhouses in Smart Grids. Smart Grid, IEEE Transactions on.[15] presents a novel hierarchical control approach and new mathematical optimization models of greenhouses, which can be readily incorporated into energy hub management systems (EHMSs) in this context of smart grids to

develop the operation of their energy systems. In greenhouses, artificial lighting, CO2 production, and climate control systems consume substantial energy; thus, a mathematical model of greenhouses appropriate for their optimal operation is proposed, so that it can be executed as an authoritative control in existing greenhouse control systems. The main goal is to minimize total energy costs and demand charges while considering important parameters of greenhouses; in specific, inside temperature and humidity, CO2 concentration, and lighting levels should be kept within acceptable ranges. Therefore, the proposed model includes weather forecasts, electricity price information, and the end-user preferences to ideally operate existing control systems in greenhouses. Effects of unpredictability in electricity price and weather forecast on optimal operation of the storage facilities are studied through Monte Carlo simulations. The obtained simulation results show the effectiveness of the presented model to reduce total energy costs while maintaining the required operational controls.

17) This paper proposed by Kong, Fanxin& Dong, Chuansheng & Liu, Xue & Zeng, Haibo. (2014). Quantity Versus Quality: Optimal Harvesting Wind Power for the Smart Grid. Proceedings of the IEEE.[16] proposes need to reduce greenhouse gases from our present power systems accelerates the integration of renewable energy sources. A basic difficulty is that renewable energy is usually of high variability. The numerous evolution in technologies and methods for the smart grid are required to mitigate and absorb this variability. In this paper, we are going to focus on one of them: how to manage wind farms with high capacity and low variability locally and distributedly. First, we study the characteristics of both wind resources and wind turbines and propose a novel wind power estimation method based on Gaussian regression.

The experimental result shows that our method achieves a more accurate estimation compared to other ones and has a nearly zero error for most of the turbine types. Then, we analyze a trade off between wind power's quantity and quality for large-scale wind farms and find that there is an optimal turbine type for each location as to either the quantity or the quality. We propose an approach to optimally combine different types of wind turbines to balance the trade off. Eventually, we explore geographical diversity among different locations and develop an extended approach that mutually optimizes the mixture of locations and turbine types. Besides applying to plan new wind farms, we also discuss how to adapt the two approaches to decide an improved plan for a wind farm and a network of wind farms, respectively. We conducted considerable experiments using two different wind resource data traces for both local and distributed cases. The result shows that the presented approaches significantly surpass those approaches using a single turbine type and those separately optimizing locations and turbine types. We also provide an interesting perception of quantity balancing.

18) This paper proposed by Mirabella, O. & Brischetto, Michele. (2011). A Hybrid Wired/Wireless Networking Infrastructure for Greenhouse Management. Instrumentation and Measurement, IEEE Transactions on.[17] proposes the drawbacks related to the management of a farm made up of different greenhouses are discussed. The management of this kind of farm requires data accession in each greenhouse and their transfer to a control unit which is usually located in a control room, separated from the production area. In the current situation, the data transfer between the greenhouses and the control system is mainly provided by a suitable wired communication system, such as a Fieldbus. In such conditions, even though the substitution of the wired system with a fully wireless one can appear very attractive, a fully wireless system can introduce some demerits. A solution based on a hybrid wired/wireless network, where Controller Area Network and ZigBee protocols are used, is introduced along with all the related problems that this integration involves. In certain, in order to integrate at the Data Link Layer the wireless section with the wired one, a suitable multiprotocol bridge has been applied. Moreover, at the Application Layer, porting of Smart Distributed System services on ZigBee, called ZSDS, allows one to approach the network resources independently from the network segment they are connected to.

19) This paper proposed by Gonzalez-Amarillo, Carlos & Corrales, Juan & Mendoza Moreno, Miguel & Amarillo, Angela &Faeq Hussein, Ahmed & N., Arunkumar& Ramirez-Gonzalez, Gustavo. (2018). A Traceability System To Crop Of Seedlings In Greenhouse, Based IoT. IEEE Access. [18] document presents the design of a greenhouse model for trace and record seedling and agricultural products in the germination and growth stage. The detected products are high in quality and trade value, for this reason, the voluntary traceability process to manufactured products market and trade in fresh, it is more common today. The transmission of diseases and chemist poisoning to humans motivated a change in the country's trade relation and the shape of asses consumer's safety. The model allows the following made to these variables; luminosity, moisture, temperature, and water consumption. The system allows an automated control manner in the greenhouse inner environment with the irrigation system or the temperature control. The model allows known the water use, the plant growth pattern, and the timeline for product harvest. The system provides the primary scheme for the internal traceability of the agricultural products, from seed to production state. This greenhouse design allows analyzing the species behavior of local agriculture in a Colombian region through a platform The Internet of things (IoT).

20) This paper proposed by Lekbangpong, Narongsak & Muangprathub, Jirapond & Srisawat, Theera & Wanichsombat, Apirat. (2019). Precise Automation and Analysis of Environmental Factor Effecting on Growth of St. John’s Wort. IEEE Access.[19] main goal of this study was to allow cultivating St. John’s wort not only in Europe and West Asia but also in Thailand, Southeast Asia in spite of warmer climate than in the natural growth regions. The main challenge then was to control environmental factors with an automated system. The Internet of Things (IoT) was applied in the sensor devices to control and collect appropriate environmental data from the designed greenhouse. Moreover, data analysis by multiple linear regression was applied to allow the control of the designed greenhouse environment. It was used to discover interesting relationships between variables. The proposed system was implemented with hardware, a web application, and a mobile application. The hardware was designed to gather data and implement control of air temperature, air relative humidity, soil moisture, and light from sensors in the field. The web and mobile applications were developed to manipulate the collected data, for intelligent control, and for real-time monitoring of environmental aspects. The control system comprised of an evaporative cooling system, fogging system, irrigation system, and artificial light system. The results show that the presented system to assist and support the growth of St. John’s wort was successful. Moreover, the data obtained from this research can be used to culture St. John’s wort, in order to produce medicines that are beneficial and helpful to human health in regions with the tropical climate.

21) This paper proposed by Murugan, Deepak &Garg, Akanksha & Singh, Dharmendra. (2017). Development of an Adaptive Approach for Precision Agriculture Monitoring with Drone and Satellite Data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing[20] proposes better agricultural productivity and food management, there is an acute need for accurate agriculture monitoring at larger scales. In recent years, drones have been employed for precision agriculture monitoring at smaller scales, and for the past few decades, satellite data are being used for land cover classification and agriculture monitoring at larger scales. The monitoring of agriculture precisely over a large scale is a challenging task. In this paper, an approach has been presented for precision agriculture monitoring, i.e., the classification of sparse and dense fields, which is implemented using freely available satellite data (Landsat 8) along with drone data. Repeated usage of drones has to be minimized and hence an adaptive classification approach is developed, which works with image statistics of the selected region. The proposed idea is successfully tested and validated on different spatial and temporal Landsat 8 data.

22) This paper proposed by Singh, Tinu & Jayaraman, Chandra. (2018). IOT based Green House monitoring system. Journal of Computer Science. [21] talks about continuous

industrialization and continuously evolving climatic conditions, the urge to practice agriculture with the fusion of technology have become a necessity. In the era of the Internet of Things where all eyes are witnessing the evolution of machine to machine interaction, there is also a lack of clarity in considering the type of protocol to be used in producing a certain system like Green House. A greenhouse is a regulated environment for agriculture where critical parameters like temperature, light, humidity, ph level of soil can be monitored with the help of sensor systems using Internet of Things protocols. Message Queue Telemetry Transfer protocol was chosen over Constrained Application Protocol and Extensible Messaging and Presence Protocol in the experiment conducted in terms of its lightweight transmission, resource consumption and effectively providing the different quality of services to detect the temperature and humidity as well as the gas leaks come across in a greenhouse environment.

23) This paper proposed by Yuquan, Ma & Shufen, Han & Qingzhu, Wang. (2010). New environment parameters monitoring and control system for greenhouse based on master-slave distributed. CCTAE 2010 - 2010 International Conference on Computer and Communication Technologies in Agriculture Engineering[22]. According to the actual need for monitoring and control of greenhouse environment parameters in rural areas, a master-slave distributed measurement and control system is designed, in which PC is taken as the host. The system comprises of PC, soil moisture measurement and control module, temperature and humidity, and CO2 monitoring and control module. In the system, PC has a large amount of data storage which is easy to make use of a fuzzy control expert system, configuration software-KingView is used to develop software for PC, by which the development cycle is shortened and friendly human computer interaction is provided. Each monitoring and control module consists of the STC12 series of microcontrollers, sensors, relays, etc. Different modules are select based on the need for a system to achieve control of the greenhouse in partition and block.

24) This paper proposed by Pahuja, Roop &V erma, Harish &Uddin, Moin. (2013). A Wireless Sensor Network for Greenhouse Climate Control. Pervasive Computing, IEEE.[23]. Wireless sensor networks are an important pervasive computing technology invading the earth's environment. A greenhouse is a complex, multivariable interactive system. Because of local weather variations, the plant- growing process and its interaction with internal climatic conditions, and the use of different climate control equipment, the greenhouse environment is highly dynamic and varies geographically, thus creating microclimate zones. Climatic conditions vary from the greenhouse center to its sidewalls, and from the canopy to the aerial levels. The crop VPD is defined as the difference between the saturated vapor pressure at the canopy level at a particular temperature and the actual vapor pressure present in the air at that temperature and relative humidity. The effect of having different temperatures at the canopy and aerial levels and relative humidity in a greenhouse is quantized as the greenhouse-crop VPD, which controls the transpiration rate and thus plant growth, health, and yield.

25) This paper proposed by R. Li, X. Sha and K. Lin, "Smart greenhouse: A real-time mobile intelligent monitoring system based on WSN," 2014 International Wireless Communications and Mobile Computing Conference (IWCMC), Nicosia [24] presents wireless sensor networks (WSN) which is one of the most promising technologies in the 21st century. Applying WSN to life or production environment is becoming increasingly usual. Incorporating the environment-sensing ability of wireless sensor networks into mobile monitoring systems can provide appropriate control of the greenhouses anywhere, anytime. This paper designs and implements a real-time mobile intelligent monitoring system, which can collect data real-time, transfer data automatically and provide remote control via a mobile device. The system consists of acquisition and transmission systems, control centers, and a mobile control terminal. It comprises temperature, humidity, light sensors, a sink node, server, and mobile client. We distributed this system in the actual environment and demonstrate the effectiveness of the system.

26) Smart greenhouse fuzzy logic based control system enhanced with wireless data monitoring .This paper is presented by M. Azaza a,d,n , C. Tanougast b,d , E. Fabrizio c,d , A. Mami a. in Received 3 November 2015 Received in revised form 27 November 2015 Accepted 13 December 2015 Available online 31 December 2015 This paper was recommended for publication by Prof. A.B. Rad. Greenhouse climate control is complicated procedure since the number of variables involved on it and which are dependent on each other. This paper presents a contribution to integrate greenhouse inside climate key's parameters, leading to promote a comfortable micro- climate for the plants growth while saving energy and water resources. A smart fuzzy logic based control system was introduced and improved through specific measure to the temperature and humidity correlation. As well, the system control was enhanced with wireless data monitoring platform for data routing and logging, which provides real time data access. The proposed control system was experimentally validated. The efficiency of the system was evaluated showing important energy and watersaving.

27) The improvement of the sensor power supply system in intelligent greenhouse is a research hotspot at present. In intelligent greenhouse environment monitoring demand is high, the traditional cable power supply volume is big, poor security and inconvenient to the characteristics of the paper by using the principle of the wireless power supply, design a kind of orthogonal magnetic field, the Transmitting coil and Repeating coil to receive the mutual inductance coil superposition to satisfy the sensors in the power supply requirements of different spatial location, and greatly reduces the power supply equipment covers an area of. The theoretical circuit diagram is given and the theoretical analysis and formula derivation of uniform magnetic field are performed. Mathcad was employed to simulation analysis of Receiving coils in different states, and Maxwell was used for comparison of hypnotic field cloud images. At the same time, the influence of different relative positions on the receiving power of wireless power transmission system is tested and discussed, and the method to improve the wireless power supply transmission efficiency of smart greenhouse sensor is explored. Finally, the feasibility of the system is verified by simulation and experiment.

28) Design of an Intelligent Management System for Agricultural Greenhouses based on the Internet of Things.This paper is presented by Zhaochan Li1 , JinlongWang 1*, Russell Higgs 2*, Li Zhou 3 , Wenbin Yuan 4 in 2017 IEEE International Conference on Computational Science and Engineering (CSE) and IEEE International Conference on Embedded and Ubiquitous Computing (EUC)The study of high quality and highyielding crops. China's current agricultural production is sufficient to feed the nation; however, compared with developed countries agricultural farming is still lagging behind, mainly due to the fact that the system of growing agricultural crops is not based on maximizing output, the latter would include scientific sowing, irrigation and fertilization. In the past few years many seasonal fruits have been offered for sale in markets, but these crops are grown in traditional backward agricultural greenhouses and large scale changes are needed to modernize production. The reform of small- scale greenhouse agricultural production is relatively easy and could be implemented. The concept of the Agricultural Internet of Things utilizes networking technology in agricultural production, the hardware part of this agricultural IoT include temperature, humidity and light sensors and processors with a large data processing capability; these hardware devices are connected by short-distance wireless communication technology, such as Bluetooth, WIFI or Zigbee .In fact, Zigbee technology, because of its convenient networking and low power consumption, is widely used in the agricultural internet. The sensor network is combined with well-established web technology, in the form of a wireless sensor network ,to remotely control and monitor data from the sensors.

29) Realization of wireless charging in intelligent greenhouse with orthogonal coil system uniform magnetic field.This paper is presented by Li Wanga , Yuhui Xub , Jin Xua. The improvement of the sensor power supply system in intelligent greenhouse is a research hotspot at present. In intelligent greenhouse environment monitoring demand is high, the

traditional cable power supply volume is big, poor security and inconvenient to the characteristics of the paper by using the principle of the wireless power supply, design a kind of orthogonal magnetic field, the Transmitting coil and Repeating coil to receive the mutual inductance coil superposition to satisfy the sensors in the power supply requirements of different spatial location, and greatly reduces the power supply equipment covers an area of. The theoretical circuit diagram is given and the theoretical analysis and formula derivation of uniform magnetic field are performed. Mathcad was employed to simulation analysis of Receiving coils in different states, and Maxwell was used for comparison of hypnotic field cloud images. At the same time, the influence of different relative positions on the receiving power of wireless power transmission system is tested and discussed, and the method to improve the wireless power supply transmission efficiency of smart greenhouse sensor is explored. Finally, thefeasibility of the system is verified by simulation and experiment.

30) Smart Green House Automation Rahul Belsare1 Komal Deshmukh2 Mayuri Patil3 1,2,3Department of Computer Engineering 1,2,3ZES's Dnyanganga College of Engineering & Research, Narhe, Pune in IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 03, 2015 | ISSN (online): 2321-0613. Smart Green House Automation is a complete system to monitor and control the environment parameters inside a greenhouse. It is necessary to design a control system to monitor various parameters like Temperature, Humidity, Soil moisture, Light Intensity. Here controlling process takes place effectively by both manual and automatic manner. This software uses an Android mobile phone for monitoring as well as controlling green house, connected to a central server which is connected to a microcontroller via serial communication. Microcontroller communicates with the variety of sensor modules

III. PROPOSED METHODOLOGY

The sensors will collect data and depending on the threshold value coded for each sensor, the actuators will be initiated at appropriate time. Also the sensor data will be sent to the server through the Node MCU from where it can be used for remote monitoring, visualizations and analytics.

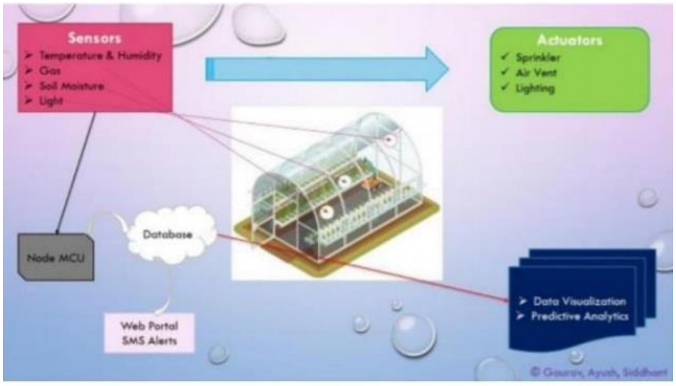

Figure 1 Methodology Diagram

IV. Existing Methods

Several methods are currently in form for Smart Greenhouse Monitoring but they simply lack the new technology and the need of IOT, it is been carried out manually or via an automated system that is programmed do an action if certain conditions are met, but with the use of IoT in this project we can have sensors to percept from the environment and actuators to act on the environment based on conditions best for the system.

V. Hardware Used

SENSORS:

a) DHT11 – Temperature and Humidity Sensor

Reason − This DHT11 Temperature & Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensors. Its technology ensures the high reliability and excellent long−term stability.

This sensor includes a resistive element and a sense of wet NTC temperature measuring devices. It has excellent quality, fast response, anti−interference ability and high-cost performance advantages. Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The single−wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters.

Purpose − To ensure that the plant grows in an optimum temperature and if it is too hot or too cold we can take necessary action.

b) MQ2

Reason –

1. Wide detecting scope
2. High sensitivity and fast response
3. Long life and stable
4. Simple drive circuit

Due to its fast response time and high sensitivity, measurements can be taken as soon as possible. The sensor sensitivity can be adjusted by using the potentiometer.

Purpose – To measure greenhouse gases such as CO2 and water vapour sensing. This will help us to open the shed if too much CO2 is trapped inside and start the air vent or fan.

c) Soil Moisture Sensor

Reason − Simple method of measurement.

It delivers the results immediately. Watermark sensors and tensiometers are very low in cost.Offers accurate results. Watermark sensors offer larger moisture reading range from 0 to 200 cb or kpa.

Purpose − It is the job of the soil moisture sensor to continuously check that there is enough water content in the soil. If the value falls below a particular limit sprinkler will be activated.

d) LDR

Reason − It is easy to integrate with lighting system such as automatic lighting system. It is used for energy consumption or energy management by automatic control of brightness level in mobile phones and auto ON∕OFF of street lights based on ambient light intensity. LDR (i.e. photoresistor) based light sensors are available in different shapes and sizes. Light sensors need small voltage and power for its operation.

Purpose – It is used to measure intensity of light inside the greenhouse and fire up the bulb if the surroundings become dark.

Actuators

a) Sprinkler
Purpose – It is used to pour water into the soil in case of low moisture content. The threshold value has been selected accordingly after observing multiple use cases.

b) Air vent controller.
Purpose – It is a fan which is turned on when the humidity is high inside the greenhouse or when the gas content is such that ventilation is required.

c) Lighting Systems
Purpose – A bulb will be switched on when the light sensor senses that surroundings are dark. It Will come into play at night time.

External Components

a) Arduino UNO
Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input∕output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC−to−DC adapter or battery to get started.

b) Relay Module
We can control high voltage electronic devices using relays. A Relay is actually a switch which is

electrically operated by an electromagnet. The electromagnet is activated with a low voltage, for example 5 volts from a microcontroller and it pulls a contact to make or break a high voltage circuit.

c) Node MCU

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 WiFi SoC from Espressif Systems, and hardware which is based on the ESP− 12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits.

The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non−OS SDK for ESP8266. It uses many open source projects, such as luacjson and SPIFFS.

d) NRF module

NRF24L01 transceiver module. It uses the 2.4 GHz band and it can operate with baud rates from 250 kbps up to 2 Mbps. If used in open space and with lower baud rate its range can reach up to 100 meters.

The module can use 125 different channels which gives a possibility to have a network of 125 independently working modems in one place. Each channel can have up to 6 addresses, or each unit can communicate with up to 6 other units at the same time.

VI. Software Used

1. Arduino 1.8.10

The open−source Arduino Software (IDE) makes it easy to write code and upload it to the board. The environment is written in Java.

2. Thingspeak

It is an IoT platform, that allows you to connect and save sensor data in the cloud and develop IoT applications. Also, the platform provides apps that let you analyze and visualize data. MATLAB support helps you act on data

3. PHP My Admin

Tool used for administering MySQL with a web browser. Typical operations such as the management of databases, tables, indexes, permissions, and so on are executed with the user interface.

Procedures for Proposed Method with an Machine Learning Algorithm

Several methods are currently in form for Smart Greenhouse Monitoring but they simply lack the new technology and the need of IOT, it is been carried out manually or via an automated system that is programmed do an action if certain conditions are met, but with the use of IoT in this project we can have sensors to percept from the environment and actuators to act on the environment based on conditions best for the system.

VII. Pseudo Code

ML Pseudo Coe:

1) Import Library
2) Read the datasets
3) Print the datasets
4) Print columns as parameters like temperature , humidity, light intensity and sample plant dies.
5) Encoded categorically in terms of all the parameters and target variable as sample plant dies.
6) We have done training and testing of data .
7) It will predict the samples
8) Print accuracy of the data that what data we have collected is accurate for a plant growth in greenhouse or no.

VIII. PIN Diagrams

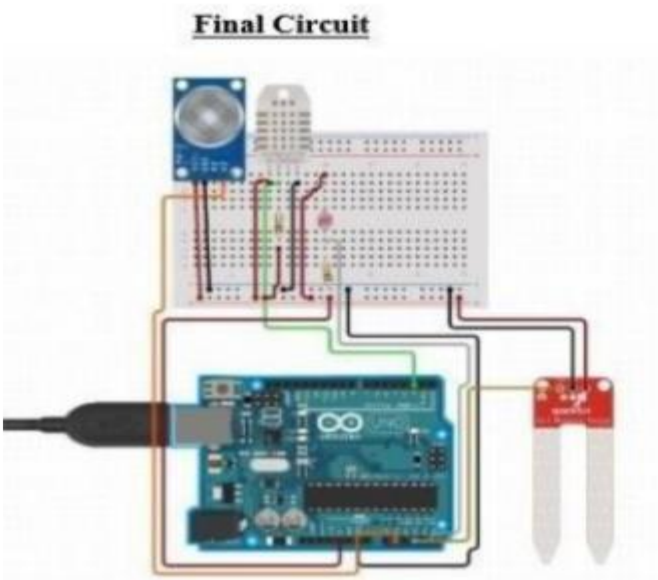

Figure 2. circuit diagram

IX. Flow Diagram

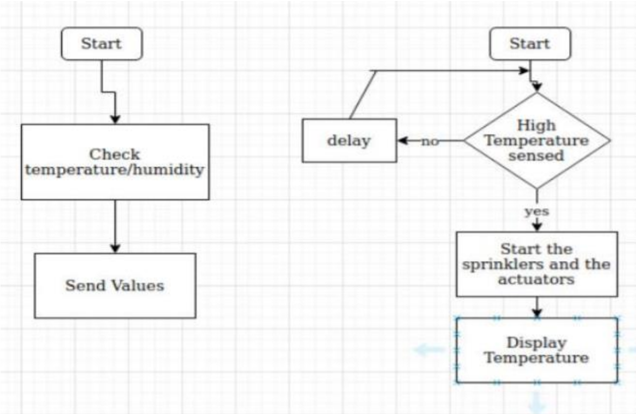

Figure 3. flow diagram

In this above diagram we are just trying to fetch temperature from the greenhouse site and sending value over the cloud.

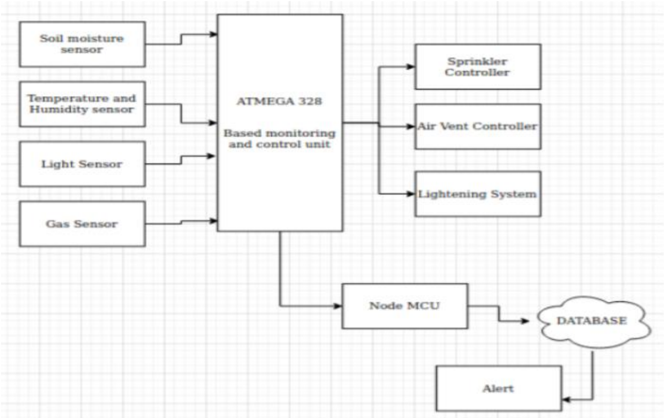

Figure 4. flow diagram 2

In the second flowchart above based on the values received the actuators such as sprinklers are activated. The sensors will collect data depending on the threshold value coded for each sensor, the actuators will be initiated at appropriate time.

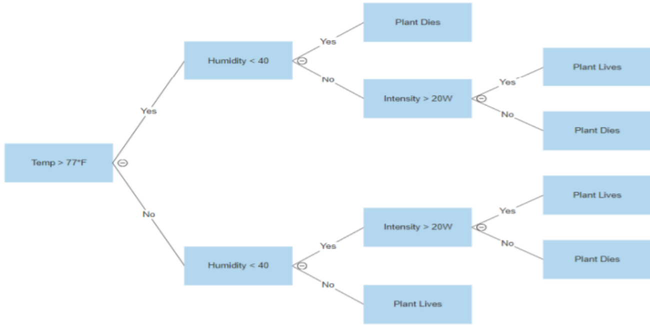

Figure 5. working model

Also the sensor data will be sent to the server through the Node MCU from where it can be used for remote monitoring, visualizations and analytics, after the sensors acquire data from various locations and places next step is to fetch the data for the purpose of training our model as shown in the above diagram.

X. Result & Discussion

As we connected and oriented our work according to the above proposed methodology and algorithms we got the data point regarding the various Greenhouse conditions and acting upon that we retrieved the data on one of the famous clouds called Think Speak and after retrieving data from the cloud we were able to perform and predict the result as we proposed a ML algorithm to predict whether a plant is going to survive the given condition and helped in establishing the actuators such as sprinklers etc. w.r.t the data received from the cloud also we were able to store the sensor data in a csv format which can be used for future references. Advantages of this project:

1. Able to predict the nature of greenhouse conditions.
2. Retrieve important data of temperature and humidity which can be used for future references.
3. Able to predict whether a plat is going to survive in a given condition or not.
4. Plants are very much necessity as other aspects of our lives so we from this project plants can be saved.

XI. **Conclusion**

In conclusion plants are as much essential as other aspects of our lives and we need to protect the ecosystem for our and others survival and the project helps in designing a very optimum model to protect the ecosystem from getting destroyed and also helps in making the world a better place to live.

Greenhouses may be evolving, but their purpose hasn't changed. They support crop growers in operating all year round by creating a controlled microclimate. While their purpose remains the same, greenhouses have gone through significant changes over the past decade, most notably being the introduction of automation. Modern greenhouses are capable of controlling and optimizing environmental factors that affect crops—like temperature, ventilation, light exposure, and more—ensuring optimal growing conditions and efficient use of energy. While the Internet of Things exists for many reasons, one of its biggest impacts is its potential to save people time and money. With a smart greenhouse, crop growers can reduce the amount of labor it takes to manage, monitor, and maintain a greenhouse.

The most modern smart greenhouses are automated, enabling crop growers to step away from their greenhouses but still control its climate with the touch of a button. Smart greenhouse range from semi-automatic to fully automated, with the fully automated option being a superior option for growers who want the freedom to come and go as they please without worrying about their crops. A smart greenhouse is automated—but its automation capabilities go well beyond just turning the lights on and off.

Smart greenhouses can control the most critical factors that affect crop yields, including temperature, ventilation, light exposure, moisture, and more. Smart greenhouses use machine learning to process and remember information about your crops and their ideal climate. These systems can then make recommendations based on their findings, or growers can use their mobile app to adjust key factors to achieve better yield rates. Either way, having the power to adjust your microclimate via a mobile device gives you a lot more control over your operations, as well as what you do with your time.

We don't need to have a commercial-level agriculture operation to take advantage of automation. Even the smallest greenhouses, gardens, and even in-house plant collections can leverage smart technology to achieve better results.

Our project is based majorly on actuators we installed in the field and the machine learning algorithm we are using

XII. **References**

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