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Controlling and Monitoring Greenhouse Temperature using IoT

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ABSTRACT
Current agricultural practices modern technologies for better yields. It provides a model of a smart greenhouse, which helps the farmers to carry out the work in a farm automatically without the use of much manual inspection. Greenhouse, being a closed structure protects the plants from extreme weather conditions namely: The Temperature, Humidity, Air and, Soil Moisture and is accessed by the authorities. The technique works on the strategies of IOT that may be a rising technology supported the fusion of natural philosophy and applied science. The concept of IOT helps to access data from remote locations. Greenhouse system provides the ability for specific people to monitor and manage their systems remotely, using a web application.

Keywords : IOT, Temperature, Humidity, Air, Soil Moisture

I. INTRODUCTION

Smart greenhouse monitoring system based on the Internet of things (IOT) plays the role of an expert's technical tool by empowering physical resources into smart entities through existing network infrastructures. The IOT paradigm is aimed at formulating a complex information system with the combination of sensor data acquisition, efficient data exchange through networking, machine learning, artificial intelligence, big data, and clouds. Conversely, collecting information and maintaining the confidentiality of an independent entity, and then running together with privacy and security provision in IOT is the main concerning issue.It is the technical approach in which the farmers in the rural areas will be benefited by automatic monitoring and control of greenhouse environment. It replaces the direct supervision of the human. Greenhouse is a building where plants are grown in a controlled manner. Nowadays due to urbanization and lack of land availability there is a great need to construct the Greenhouses which will be reserved mainly for growing crops. With the advancement of technology, we can control and monitor the multiple Greenhouses using IoT from the central location.

Greenhouse farming is a technique that enhances the yield of crops, vegetables, fruits etc. Greenhouses control environmental parameters in two ways; either through manual intervention or a proportional control mechanism. However, since manual intervention has disadvantages such as production loss, energy loss, and labor cost, these methods are less effective. A smart greenhouse through IoT embedded systems not only monitors intelligently but also controls the climate. Thereby eliminating any need for human intervention. IoT allows the system using the sensors and programming to detect and control other devices remotely, creating a good interaction between the

physical and computer world in order to improve efficiency and accuracy while achieving financial benefits. End-users can access these data from any active internet device and gain benefits of the generated knowledge regarding their greenhouse crops production, energy consumption, and other related issues associated to it. The system is considered as smart because it is able autonomously to monitor the outside temperature and the energy consumption in order to accurately generate the suitable reference temperature, and ensure that thegreenhouse temperature reaches this reference temperature.

With this framework, users can distantly screen the Greenhouse climatic conditions from any place which could save human costs. Climatic condition monitoring is one type ofrecorder, it monitors the temperature, water level, moisture level, rain, soil moisture, humidity and light in a greenhouse room and stores the data into a database and display the current temperature on the website through a web server. A greenhouse provides an environment to grow plants all year round, even on cold and cloudy days. However, extreme environmental factors inside the greenhouse such as high temperatures and high humidity can negatively impact the plants. The system consists of various sensors, namely soil moisture, temperature, water level and light sensors.

Maintaining a controlled temperature within a greenhouse environment is crucial. Temperature fluctuations can damage or kill your plants in only a few hours. Remote monitoring systems protect valuable plants from extreme temperature fluctuations. Watch to learn more about these cost-effective systems. Keeping plants healthy and prosperous requires the best possible growing environment. But staying on top of all environmental changes and equipment statuses or failures can be a challenge. Watch to learn how you can monitor conditions like humidity fluctuations, security breaches, heater, fan, equipment and power failures. When your plants are at risk, every second counts. The sooner you discover a drop in temperature or anequipment failure, the more inventory you can save. Remote monitoring systems provide real-time updates, so you can take action fast.

Temperature sensor is used to detect the temperature inside the greenhouse, reading from the sensor is sent to the microcontroller. The microcontroller is connected to different relays. Light sensor is used to detect the amount of sunlight is above the threshold value, most of the time to differentiate between day and night time, measuring light from sunlight is essential.

Similarly, the humidity sensor is used to detect the humidity and Soil moisture sensor is used to detect the moisture level in the soil. If the humidity value detected by the sensor is high or if the soil moisture reduces, the microcontroller would turn on the blower to decrease the humidity and will open the water outlet to increase the moisture in the soil.

The crop agriculture in greenhouse is higher affected by the surrounding conditions. The significant environmental factors for the quality and better productivity of the plant's growth are temperature, relative humidity, Lighting, moisture of soil in the greenhouse. Continuous monitoring of these factors gives relevant information pertaining to the individual effects of the various factors towards obtaining maximum crop production.

Relative humidity has a great impact on the development of greenhouse crops, and it is important to comprehensively understand how it is currently being approached from the perspective of fuzzy inference systems. It is to determine the various relationships within fuzzy inference systems and their variations through optimization algorithms currently used for modelling, prediction, and control of humidity in greenhouses. The degree of interpretation and precision will be considered, as well as how it has

changed over time to be able to develop more robust and simpler to understand models for the modelling and control of the variable in greenhouses.

Greenhouse Cultivation facility agriculture consists of using certain engineering facilities and technology, according to particular requirements for plant growth and development, in order to enhance or create environmental meteorological factors by providing a good environment for plant growth conditions and thus eliminate, to some extent, dependence on the natural environment. Greenhouse cultivation then has the fundamental objective of protecting plantations from bad weather and diseases. It is a complex system that in recent years has become a means to achieve controlled agricultural production by providing a strictly controlled climate.

Traditional and inefficient agricultural production methods cannot meet the modern agriculture requirements of safe, high quality, efficiency and productivity. The technology of Internet of Things is introduced into the field of agriculture, and the agricultural industrialization and information technology has an unprecedented opportunity. The relevant literature is read, the actual scene is investigated and the needs of agricultural field monitoring are identified. In the meanwhile, the development trend of Internet of Things and facility agricultural monitoring system is analyzed and system performance indicators that meet the actual requirements are developed.

Moreover, the overall program of the system is designed and the three-tier architecture of Internet of Things system based on sensor technology, wireless communication technology, and configuration monitoring technology is constructed. The results showed that the system is reasonable, the structure is compact, the network layer is reliable, and the performance is stable. Meanwhile, the application layer is rich in functionality, the interface is beautiful, the data processing is intelligent and the operability is strong. As last, it is concluded that the system meets system design requirements and expected performance specifications.

The practice of controlling climatic environments through the use of greenhouses has lately received considerable attention due to agronomic and financial interests: extending the growing season and potential yield, managing climate in order to achieve higher levels of quality and develop low-cost production systems compatible with the scarcity of resources and the low capacity of producers to invest, aiming towards food self-sufficiency. Building aremotely monitored and controlled Greenhouse which enable users to grow crop while keeping the user inform. Allowing the users to take control of the Greenhouse remotely, manually the users are always face with problem of when is the best time to grow crop and what is the best condition for certain crops.

The goal is to implement a system that will allows the users to remotely control all condition necessary for crop grow. It was built a working prototype to monitor and control this problem. We call it a Smart Greenhouse because it will operate automatic while control all this condition. It can be monitored and controlled from anywhere the plant parameters such as soil temperature, soil humidity, environment temperature, humidity, pH value of soil.

Automation of green house also implemented by connecting actuators like fan for providing ventilation, pump and motor for automatic watering, connecting lights also provides necessary heat for plants during winter season. Based on the data collected from sensors the controller unit will switch on or off the necessary actuators. It is known that IoT is interconnection of objects, with internet infrastructure, through which objects are allowed to transfer and receive data using the internet and those data gets transferred to other

device within the internet infrastructure utilized by device which is connected to it for further evaluation. Agriculture sector faces several constraints, including extreme temperatures, water scarcity, sea water desalination and non-fertile soil. To overcome this hostile environment and ensure agricultural self-sufficiency, multiple government agricultural programs were launched to ensure food security. Indeed, agricultural self-sufficiency is a sign of a country's stability and strength. It can be achieved by introducing innovative environmentally suitable solutions and modern agricultural technologies necessary for improving productivity and decreasing production costs. Greenhouse farming is interesting in the sense that it succeeds in isolating the yield of nature, and allowing the protection of plants against the immediate impact of external climatic conditions.

II. Literature Survey

"Energy Consumption Prediction of a Greenhouse and Optimization of Daily Average Temperature - Yongtao Shen ID, Ruihua Wei and Lihong Xu. Published: 2018" Greenhouses represent a trend in agricultural development that indicates the level of agricultural modernization of a region. It is necessary to regulate the greenhouse environment to obtain high yields. The energy consumption of light-supplementation, dehumidification, heating, cooling and other measures in a greenhouse, is known as the basic energy consumption. Another part of the energy consumption is for driving the actuators. The basic energy consumption could account for more than 90% of the total energy consumption in the greenhouse. In order to improve the management level of the greenhouse, it is of greatimportance to study the prediction of greenhouse energy consumption.

Mature prediction models of greenhouse energy consumption have been established both at home and abroad. De Zwart used the greenhouse climate and control model KASPRO to simulate the greenhouse microclimate and predict the greenhouse energy consumption. Gupta and Chandra studied the effect of various energy conservation measures to arrive at a set of design features for an energy efficient greenhouse. Su et al. used fuzzy logic systems to track the temperature and humidity in the greenhouse. Spanomitsios studied the efficiency and estimation of energy consumption in thin film greenhouses under different strategies. Based on the greenhouse microclimate model, Dai et al. analyzed the influence of canopy transpiration and established a greenhouse energy consumption prediction model. Xu et al took glass-type greenhouses as the research object, analyzed the greenhouse radiation, convection, heat and mass exchange caused by crop transpiration, to establish a greenhouse temperature and humidity model. Combing with weather forecast information for the outdoor temperature, Ren et al.used CFD methods, taking wet curtain-fan, solar radiation and other factors of greenhouse into consideration, and established a temperature prediction model of a large multi-span plastic greenhouse located in southern Jiangsu (China). However, there is great uncertainty about the selection of model parameters in the traditional greenhouse modeling process, and the model is not universal once it is established. It should be noted that the most commonly used method of black-box modeling for a nonlinear system was based on neural network, which was applied to establish the greenhouse model by Patil et al. Ferreira et al. Nabavi-Pelesaraei et al. Kavga and Kappatos, Fourati and Frausto and Pieters. Trejoperea et al.estimated greenhouse energy consumption by using neural networks, and proved that the model gave a better estimation of energy consumption, with an accuracy of 95%. However, neural networks are easily over-trained when the training data is inadequate. Since plant-related parameters in the energy model of greenhouse can be considered as constants only within a few days, it is almost impossible to collect all possible data to develop an accurate energy model.

Due to the large number of parameters in the greenhouse mathematical model, some parameters are difficult to determine. In order to increase the accuracy of greenhouse physical models, three optimization algorithms are applied to adjust uncertain parameters of energy model. In this paper, taking better performance of computation speed and accuracy as the goal, an optimized model prediction methodology is presented. According to the best result of our optimized model, the energy consumption of the greenhouse under different weather conditions is predicted and this provides a theoretical reference for decision-making about heating in a greenhouse. Furthermore, this study provides a detailed description of how to use this model in practical situations and validates the energy efficiency in the field. Compared with the abovementioned references, the main contribution of this work is the comparison of three algorithms to estimate the parameters of a mathematical greenhouse model, and the application of the resulting prediction model to optimize the daily average temperature for one week to improve the energy efficiency in a Greenhouse.

Merit: Combining with accumulated temperature theory, when the accuracy of the weather forecast is guaranteed, the daily temperature averages will be optimized in the current week.
Demerit: Accuracy level is low and works only with temperature.

[2]. “Analysis and design of greenhouse temperature control using adaptive neuro-fuzzy inference system-Doaa M. Atia, Hanaa T. El-madany. Published: 2016”

The greenhouse is a complicated nonlinear system, which provides the plants with appropriate environmental conditions for growing. This paper presents a design of a control system for a greenhouse using geothermal energy as a power source for heating system. The greenhouse climate control problem is to create a favourable environment for the crop in order to reach predetermined results for high yield, high quality and low costs. Four controller techniques; PI control, fuzzy logic control, artificial neural network control and adaptive neuro- fuzzy control are used to adjust the greenhouse indoor temperature at the required value. MATLAB/SIMULINK is used to simulate the different types of controller techniques. Finally a comparative study between different control strategies is carried out.

A greenhouse is an enclosed construction that provides plants with optimally controlled environment for regulation of plants growth conditions, to decrease cost of production and increase crop revenues (Coelho et al., 2005). The greenhouse environment can be improved by adding heating, ventilation and CO2 supply systems, in order to provide the best environmental conditions. Numerous greenhouses use a conventional control, but this control strategy may not be suitable to guarantee the desired performance (Ghoumari et al., 2002). The recent techniques of artificial intelligence have found application in almost fields of the human knowledge. However, a great emphasis is given to the accurate sciences areas; perhapsthe major expression of the success of these techniquesisin engineering field. Fuzzy and neural networks are two types of AI techniques. These two techniques neural networks and fuzzy logic are many times applied together which is called adaptive neuro-fuzzy inference system (ANFIS) for solving engineering problems where the classic techniques do not supply an informal and accurate solution.

Modelling and control problem of greenhouse indoor temperature are studied. Various control techniques (PI control, fuzzy logic control (FLC), artificial neural network control (ANNC) and ANFIS) are presented. Moreover MATLAB/SIMULINK is used to validate the proposed types of controller techniques. Finally a comparison study between the controllers performance is carried out.

Merit: Training data for the present study for artificial neural network and ANFIS control was randomly collected from several simulations in MATLAB/SIMULINK. The simulation results proved that ANFIS controller can be applied successfully to control the greenhouse indoor temperature because of its effectiveness and fast response time.

Demerit: Useful tools for solving the nonlinearity problem of greenhouse modeling and not applicable for linearity.

[3]. "Intelligent Control of the Microclimate of an Agricultural Greenhouse Powered by a Supporting PV System -Jamel Riahi, Silvano Vergura, Dhafer Mezghani and Abdelkader Mami. Published: 2020"
An agricultural greenhouse is a complex and Multi-Input Multi-Output MIMO system in which the internal parameters create a favorable microclimate for agricultural production. Temperature and internal humidity are two parameters that have a major impact on greenhouse yield.

The objective of this study was to propose a simulated dynamic model in MATLAB/Simulink environment for experimental validation. Moreover, a fuzzy controller was designed to manage greenhouse indoor climate by means of an asynchronous motor for ventilation, heating, humidification, etc. An intelligent system to control these actuators for an optimal inside climate was implemented in the model. The dynamic model was validated by comparing the simulation results to experimental measurements. These results showed the effectiveness of the control strategy in regulating the greenhouse indoor climate. Finally, a photovoltaic generator was modeled, with the aim of reducing the costs of agricultural production. It feeds the asynchronous motor with a vector control optimized by fuzzy logic that drives a variable speed fan.
Due to the enormous increase and instability of oil and derivatives markets, countries are constantly looking for alternative sources of energy to ensure the independence of their economies from fluctuations in oil prices. Photovoltaic energy can have undeniable advantages, especially due to its cleanliness and low cost. In addition, it can be used in various applications such as in agronomy, where different variables, e.g., temperature and humidity, have to be monitored and controlled. These include temperature and humidity. A greenhouse is a known solution for protecting plant cover from diseases and bad weather.

A greenhouse is a complex system, the internal climate of which is influenced by many factors, such as wind speed, solar radiation, external temperature, and humidity. Two main problems have limited the expansion of greenhouse agricultural production. Firstly, control over the indoor climate is an important aspect in achieving microclimate comfort for plant growth. Many research activities have focused on controlling the indoor climate of a greenhouse with different strategies. Predictive neural control has been developed to optimize the greenhouse climate, while a fuzzy controller that was developed to describe a dynamic model in MATLAB/Simulink was described in Reference .

In addition, Reference studied several PI control structures that showed strong stationary performance. In Reference , the authors introduced a decentralized decoupled fuzzy logic controller (FLC), showing its usefulness in comparison to the conventional method, but they did not take into account the effect of ventilation on temperature. References proposed a neuro-fuzzy controller to identify the optimal conditions for plant production and to improve control over the indoor climate. Genetic algorithms implemented in a control system for irrigation in a greenhouse were proposed in References while Reference presented a comparative study of two types of fuzzy multivariate controllers to show their advantages and disadvantages, it developed four control techniques to adjust the air temperature inside

a greenhouse to a desired value: fuzzy logic control (FLC), an adaptive neuro-fuzzy inference system (ANFIS), artificial neural network control (ANNC), and IP Control. ANFIS and FLC are two of the best known and most used controllers for nonlinear and complex processes such as greenhouses. Presented a fuzzy controller with a correlation between the parameters.

An FLC was used, in this paper, for the dynamic model of an experimentally validated agricultural greenhouse, with the aim of promoting a suitable microclimate with appropriate actuators installed into the greenhouse. Secondly, the use of several controlled actuators, such as a ventilation system, a heating system, and a humidification/dehumidification system, makes a greenhouse an energy-intensive consumer. Therefore, it is mandatory to use efficient energy systems in order to reduce operating costs. Many researchers have studied control strategies for ventilation and heating systems, for humidification/dehumidification systems, and for the regulation of other agricultural greenhouse parameters. References proposed a ventilation system based on an on–off control, studied a natural ventilation system for an agricultural greenhouse, presented an evaluation of the use of various renewable energy sources to heat a greenhouse, and introduced different fields of application for renewable energy in buildings, in particular in the agricultural sector.

Merit: Thus, in our opinion, the proposed model can be useful both for greenhouse designers during the first design stage and for researchers who focus on greenhouse R&D.

Demerit: Indeed, it is worth noting that greenhouses are increasingly taking on a crucial role in circular economies and in sustainable social and economic development.

[4]. "High- Order Sliding Mode Control of Greenhouse Temperature- H.Oubehar, A. Ed- Dahhak, A. Selmani, M. Outanoute, A. Lachhab.Published: 2016"
It deals with the design and implementation of the high order sliding mode controller to control temperature greenhouse. The control objective aims to ensure a favorable microclimate for the culture development and to minimize the production cost. We propose performing regulation for the greenhouse internal temperature based on the second order sliding mode technique known as Super Twisting Algorithm (STA). This technique is able to ensure robustness with respect to bounded external disturbances. A successful feasibility study of the proposed controller is applied to maintain a desired temperature level under an experimental greenhouse. The obtained results show promising performances despite changes of the external meteorological conditions.

In this a higher order sliding mode control system (super twisting) has been implemented for temperature control under an experimental greenhouse. To design the controller, we have developed a simplified model, then we have elaborated the control law based on HOSM strategy. In the current study we opted for super twisting algorithm to implement the HOSM controller.

The control of the climatic environment in greenhouses has received considerable attention in these last years. The main reasons for this increasing interest are related to the following agronomic and financial objectives (i) to extend the growing season and the potential yield; (ii) to manage the climate in order to reach higher standards of quality; (iii) to develop low-cost production systems, compatible with the scarcity of resources and the low investment capacity of growers. However, the internal greenhouse climate is strongly influenced by meteorological conditions. Hence, agricultural greenhouses were computerized in order to ensure an automatic

microclimate control despite the external climate changes.

In fact, the automation of greenhouse is based on a personal computer that allows, via an acquisition card, not only to acquire measurements provided by sensors but also to command several actuators installed in greenhouse. Greenhouses are considered as complex processes. They are nonlinear, multi-input multi-output (MIMO) systems, they present time-varying behaviors and they are subject to pertinent disturbances depending generally on meteorological conditions . On the other hand, many previous studies have shown that the internal temperature is the most influential parameters on the greenhouse. Thus, inside greenhouse temperature regulation is a priority task for greenhouse growers .

Since a greenhouse is a nonlinear and complex plant whose parameters vary with the weather conditions, it turns out that a simple and high performance system control is still needed. One of the successful strategies for such plants is sliding mode control. The sliding mode controller is an attractive robust control algorithm thanks to its inherent insensitivity and robustness to plant uncertainties and external disturbances . The conventional sliding mode control (CSMC) scheme is known to be an effective robust nonlinear control approach for systems with uncertainties and/or disturbances.It has many advantages such as fast response, small sensitivity to system uncertainties and/or environmental disturbances, and being easily designed .Nevertheless, CSMC has a main drawback so-called chattering caused by the high-frequency control switching . This undesirable phenomenon could severely degrade the performance of the control system and may even lead to instability. To solve this problem, many methodologies have been proposed such as higher order sliding modes (HOSM). This technique can obviously reduce the chattering effect while preserving the advantages of the standard approach. The main disadvantage of the HOSM control design consists of information increasing demand. The only exception is the second order super twisting algorithm (STA) which needs the same amount of information as the original sliding mode. Based on these reasons, this paper is devoted to the design and implementation of STA controller to regulate the temperature under an experimental greenhouse.

Merit: As mentioned previously, the internal temperature is the most important variable for the crops growth in greenhouse. However, it's correlated with other variables like relative humidity to define the internal climate state of greenhouse. This later is strongly sensitive to the external meteorological conditions. Hence, multivariable control seems to be more efficient.

Demerit: Need more energy to get the result so continues power supply is needed

[5]. "An IoT-based greenhouse monitoring system with Micaz motes -Mustafa Alper Akkaş, Radosveta Sokullu. Published: 2017"
The wireless sensor network (WSN) is one of the most significant technologies in the 21st century and they are very suitable for distributed data collecting and monitoring in tough environments such as greenhouses. The other most significant technologies in the 21st century is the Internet of Things (IoT) which has rapidly developed covering hundreds of applications in the civil, health, military and agriculture areas.

In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of a large scale greenhouse in order to ensure proper operation of the greenhouse automation system. Cabling would make the measurement system expensive, vulnerable and also difficult to relocate once installed. This paper presents a WSN prototype consisting of MicaZ nodes which are

used to measure greenhouses' temperature, light, pressure and humidity. Measurement data have been shared with the help of IoT. With this system farmers can control their greenhouse from their mobile phones or computers which have internet connection.
The most important factors for the quality and productivity of plant growth are temperature, humidity and light. Continuous monitoring of these environmental variables provides valuable information to the grower to better understand, how each factor affects growth and how to maximize crop productiveness . The optimal greenhouse micro climate adjustment can enable us to improve productivity and to achieve remarkable energy savings especially during the winter in northern countries . WSN, composed of hundreds of nodes which have ability of sensing, actuation and communicating, has great advantages in terms of high accuracy, fault tolerance, flexibility, cost, autonomy and robustness compared to wired ones. Moreover, with the onset of IoT and M2M communications, it is poised to become a very significant enabling technology in many sectors, like military, environment, health, home and other commercial areas. IoT is a general term, covering a number of technologies that allows devices to communicate with each other, with or without human intervention. An example application, presented in this paper, is the MicaZ node based greenhouse application, which in a timely manner provides a possibility for screen monitoring of detailed data about the conditions of the greenhouse. Furthermore, the suggested setup can be incorporated with other internet and messaging services (i.e. Web, WAP, SMS) to provide communication for farmers.

This system comprises frontend data acquisition, data processing, data transmission and data reception. The ambient temperature is real-time processed by the temperature sensor of the terminal node and is send to the intermediate node through a wireless ZigBee based network. Intermediate node aggregates all data, and then sends the data to the PC through a serial port. At the same time, staff may view, and analyze the data, storage of the data on a PC is also provide. The real-time data is used to control the operation of fans and other temperature control equipment, and achieve automatic temperature control in the greenhouse.

Merit: The long term collected data can be used by agriculture specialists to create more specific timetables and directions for growing specific crops. From the communication point of view, the suggested system provides a one-way flow of information – from the greenhouse to the end user.

Demerit: The system to include actuators as well, thus providing not only monitoring and data analysis but also precise control for greenhouse farming.

[6]. "Smart Petri Nets Temperature Control Framework for Reducing Building Energy Consumption-Kheir Eddine Bouazza and Wael Deabes. Published: 2019"

Energy consumption is steadily increasing in the Kingdom of Saudi Arabia (KSA), which imposes continuous strains on the electrical load. Furthermore, consumption rationalization measures do not seem to improve the situation in any way. Therefore, the implementation of energy saving policies become an urgent need. This paper targets developing a smart energy-saving framework for integrating new advanced technologies and conventional Air Conditioning (AC) systems to achieve a comfortable environment, optimum energy efficiency and profitability.

Here three-stage smart control framework, which allows controlling room temperature according to the user's preferences, is implemented. The first stage is a user identification process. In the second stage, a Petri Nets (PN) model monitors users and sends their preferred temperatures to the third stage. A PID controller is implemented in the third stage to regulate

room temperatures. The interconnected sensing and actuating devices in this smart environment are configured to provide users with comfort and energy saving functionality. Experimental results show the good performances and features of the proposed approach. The proposed smart framework reduces the energy consumption of the current ON/OFF controller (219.09 kW) by a significant amount which reaches (116.58 kW) by ratio about 46.79%. Reducing energy consumption is one of these important features in addition to system reactivity and user comfort.

A smart environment is considered as an intelligent agent that recognizes behavior of occupants and a state of physical surroundings using sensors. After that, the environment is adapted using controllers to optimize a specific measured performance. Recently, researchers were able to design smart environment test beds that track a location and activities of occupants and respond to hazardous situations. Diverse types of sensors are deployed in these test beds to classify different types of activities. Usually, attached sensors to the occupant's body are used to recognize the repetitive body activities, such as walking and running.

However, data collected from sensors attached to objects (doors, windows, appliances, and medicine containers) surrounding the occupant are applied to differentiate other activities. Today, the rapid growth of processors and network communication technologies has had a significant impact on the configuration of intelligent environments. Therefore, the three main factors that have affected the recent development of intelligent environments are, first, the availability of small, inexpensive, and easy-to-install network devices. Second, home accessibility of several networks technologies (Wi-Fi, Bluetooth, and Ethernet on-line), and, third, the dissemination of small computing devices such as smartphones, tablets, and netbooks. An intelligent controller based on a Random Neural Network (RNN) on an Internet-of-Things (IoT) platform integrated with cloud processing for the formation of the RNN was presented in. This IoT platform was integrated with cloud processing for RNN training. The proposed platform consumes 27.12% less energy than simple rule-based controllers. The authors tried to give new modeling of the smart home, to obtain greater flexibility to the user, which results in finer control of movable devices and thermostatic charge temperatures.

A power management controller to optimize power consumption and demand-side management was presented in . Reduction of energy consumption, and the cost of lighting in HVAC systems have been achieved using fuzzy logic. Authors have synthesized the relevant emerging themes of smart home technologies in crucial areas of users' lives. In a critical and reasonably comprehensive way, the review of the functions, services, smart home was done, as well as the presentation of the benefits and the implementation. Sensors 2019, 19, 2441 3 of 19 Petri Nets (PN) are a promising tool widely used in the supervision and control of the discrete event control systems because of their great ability to represent and model concurrent and parallel processes. Authors presented a survey on the techniques used in the forcing event approach based on Ladder diagram, PN, and Colored PN (CPN). In a real-time PN was used to provide a direct plant interface. An ordered CPN based controllers were also used to provide a direct plant interface.The modeling and analysis of manufacturing systems are one of the areas that have made extensive use of PN . Indeed, PNs have been used to model production systems with buffers, automated assembly chains and for performance analysis of competing systems.

Merit: Applying the proposed framework using the developed Petri Nets as well as more advanced regulation tools will undoubtedly improve performance. Typically, the improvement is due to the integration of more parameters from the controlled environment into the

framework. Second, the proposed framework will be extended to control all the administrative offices of the computer science department.

Demerit: Since it uses WSN it needs continues power supply if the power is down then the whole system will stop working.

[7]. "IoT based Automated Greenhouse Monitoring System- M. Danita, Blessy Mathew, Nithila Shereen, Namrata Sharon, J. John Paul . Published: 2018"
Greenhouses are climate controlled structures with walls and roof specially designed for offseason growing of plants. Most greenhouse systems use manual systems for monitoring the temperature and humidity which can cause discomfort to the worker as they are bound to visit the greenhouse every day and manually control them. Also, a lot of problems can occur as it affects the production rate because the temperature and humidity must be constantly monitored to ensure the good yield of the plants. Internet of Things is one of the latest advances in Information and Communication Technologies, providing global connectivity and management of sensors, devices, users with information. So the combination of IoT and embedded technology has helped in bringing solutions to many of the existing practical problems over the years. The sensors used here are YL69 moisture sensor and DHT11 (Temperature & Humidity sensor). From the data's received, Raspberry PI3 automatically controls Moisture, Temperature, Humidity efficiently inside the greenhouse by actuating an irrigating pipe, cooling fan, and sliding windows respectively according to the required conditions of the crops to achieve maximum growth and yield. The recorded temperature and humidity are stored in a cloud database , and the results are displayed in a webpage, from where the user can view them directly.
A greenhouse can be defined as a closed structure which is used to protect the plants from external factors such as climatic conditions, pollution, etc. It offers a sustainable and efficient development of the plants throughout the year. Basic factors affecting plant growth are sunlight, water content in soil, temperature, humidity etc. Numerous researchers have worked with water sprinkling and irrigation system. They opted for different methods for determining the soil moisture condition. An article on the automated water supply system for urban residential areas showed that their system can be used to effectively manage water resource. Required physical factors are hard to control manually inside a greenhouse so there is a need for the automated system. Many smart irrigation systems have been proposed and devised through Evapotranspiration (ET), thermal imaging, capacitive methods, and neutron scattering method and gypsum blocks are some of the technologies that enable moisture sensing. Capacitive sensors, however instantaneous are costly and need to be calibrated often with varying temperature and soil type. G. Parameswaran et al. proposed "Arduino based smart irrigation system using Internet of Things". Kim et.al published a work on control of irrigation with distributed wireless sensor network. K S. Nemali et al. Proposed irrigation systems which are also automated through information on volumetric water. Chandankumar Sahu et al. proposed a system on "A Low Cost Smart Irrigation Control System" where the sensors are integrated with ESP8266 and the data received by ATMEGA-318 microcontroller which is on the ARDUINO-UNO development board. Internet of things is a growing technology of the hour which enables us to access different data's from any remote location as well.

Merit: The major elements of IoT based greenhouse monitoring and automation systems are Raspberry PI, Relay as switch along with their driver circuits. This removes human interaction with machines and makes it technically possible and desirable in various domestic processes by replacing it with programmed electronic systems. Ultimately it is a system that aims

to increase the quality of life with the automation of appliances that may be controlled over the internet.

Demerit: If the temperature and humidity value exceeds the threshold value, then the cooling fan and sliding windows which are connected to l293d IC are automatically turned ON, thereby maintaining the humidity and temperature in the closed Green House system. The collected temperature and humidity data's are sent to a ThingSpeak cloud through Wi-Fi connectivity.

[8]. "Greenhouse Environment Monitoring and Automation using Intel Galileo gen and IoT-V. Sagar Reddy, Gujjula Ramya,V. Moneesh Reddy. Published: 2019"

The IoT and cloud computing technologies can be effectively used to combat threats posed to agriculture by global warming and climate change. This work mainly focuses on monitoring the internal parameters of a greenhouse which are its temperature, intensity of light

,moisture level of soil ,relative humidity and soil pH and upload them to a cloud to facilitate remote monitoring and enable autonomous survival of the crop by automating cooling fans, artificial lighting, heating and watering equipment. It will also enable agriculturists to grow a certain kind of crop year round irrespective of actual geographical location and realizing it in a low cost manner.

Another major concern is to reduce the physical workload on farmers and prevent loss to the crop which leads to food scarcity. Green houses are artificial structures that can be viewed as short term measures against adverse environmental conditions. When implemented on a large scale, green houses have the ability to address the problems of food scarcity, damage to the crop and its yield and consequent financial distress on the farmers. They also enable farmers to be more decisive in choosing the right type of crop to cultivate without geographical location being a hurdle. Automation is proposed to eliminate the needs for manual intervention in carrying out all the tasks smoothly which are often tedious and physically demanding. Remote monitoring gives the farmers the opportunity to be aware of what is happening on the field without having to travel to the actual location.

Industrial advancement has led to the prevalence of global warming on a significant scale. this along with other forms of climate change have resulted in unprecedented changes in the natural seasons leading to untimely droughts, floods, heat waves etc. which have substantially damaged conventional agricultural ventures across the world including India. The result is a huge loss of yield, resources and a financial burden on farmers. With the population across the world increasing in exponential manner, the amount of food produced by conventional methods will be rendered inadequate and any damage to the food or yield will only exacerbate the problem of food scarcity forcing a huge number of people into starvation. Hence, the concept of greenhouse can be expected to gain popularity as a conventional measure in the coming future. The internet of things refers to a digital environment in which physical objects are inter-connected and are accessible through the internet. A thing in IoT could be any physical object that is uniquely identified by methods like assigning IP addresses or any other unique identifiers and is capable of transferring the data over a network without manual intervention. Examples of such things could be any physical objects like a person with health monitors, cars with sensors or a network of sensors itself.

A green house is an artificial structure that shields the plants within from harsh environmental conditions like strong winds, pests, toxic gases etc. by automating the greenhouse environment and making its parameters available for remote monitoring through open source cloud platforms the need for human intervention can be eliminated thus giving the crop autonomy over its survival. By practising effective greenhouse hygiene, the amount of pests infesting the

crop can be reduced thereby reducing the amount of pesticides and insecticides which ensure longevity of soil fertility by maintain its pH. The primary goal is to develop a system that can accommodate plants and make them self-sustainable. The temperature, humidity, pH, moisture level, light intensity is continuously measured fromvarious sensors using an Intel Galileo gen2 board. The board will be programmed to maintain optimum conditions inside the greenhouse based on the type of crop and its requirement. The values from the sensor will be updated to thingspeak which is an open source cloud using Intel Centrinowifi card.

Merit: The concept of greenhouse itself can be expected to be quite popular because of its ability to provide a safe and regulated environment for the crops within and by automating the greenhouse functions; the amount of physical effort required by owners will be significantly reduced making the whole process more robust. It also saves valuable resources like power and water as the equipment is turned on only when needed and turned off later automatically.

Demerit: Even though the physical work is reduced but the system needs to monitors periodically

[9]. "IoT Based Intelligent Greenhouse Monitoring and Control System- Abbas A Jasim, Ali F Mahroon, Zaidon Faisal, Published: 2017"

Recently, Internet of Thing technology has been used to develop numerous applications, this paper compromising design and implementation of greenhouse prototype that integrated with the IoT to adjust the system's parameters and monitor the system status from any place in this world. This system involves three intelligent controllers that designed to stabilize the temperature degree, water level in soil, and light intensity inside the greenhouse prototype structure. These systems have been built by two important parts: the hardware and software. The hardware part could be achieved by designing and implementing the control circuits, actuators, and install the sensors as well as the devices. The second one is the software part which is involves implementing Fuzzy Inference Engine that represent the system's brain that monitor and manage the entire process in the system to ensure the best performance. This system has been built to contain three control systems that means there are three different Fuzzy controllers. In order to keep the system practicality, the fuzzy controllers should be aggregated in single code that resides in single microcontroller chip with additional codes that perform the IoT duties. The proposed IoT system provides the ability for specific people to monitor and manage their systems remotely, using a web application with cloud technology. The major contributions of the proposed system are started by downloading the controller's set-points from the web page, transfer the set-points to the controllers, and upload data that read from sensors to the same web page.

IoT Technology has been used to reduce the distance between the staff in the article "Things" and its digital impersonation in data frameworks. It's seen as the nextgeneration network (NGN) of the internet. The IoT is driven by an extension of the Internet through the incorporation of physical articles joined with a capacity to provide more quick-witted administrations to the earth as more information ends up noticeably accessible. Several application areas going from Green-IT and vitality effectiveness to coordination's are now beginning to profit by Internet of Things ideas. A Greenhouse provides basic methods for employment to its proprietor and must be financially pragmatic for the specific atmosphere in which it stands. Also, Greenhouse could be defined as advanced Innovation for Protected Horticulture addresses the major natural elements of light, temperature and irrigation.

It investigates the usefulness of using the IoT based on the greenhouse to utilize low- cost tools and decrease the effort of the Pleasants. This could be implemented

by including the automation in irrigation process, conserving temperature, and the degree of brightness inside the greenhouse structure. More recent attention has been focused on the provision of improvement on the Internet of things (IoT) and how to utilize it with the various applications. The IoT is interesting subject that recently whiteness very large number of papers that aimed to develop this technology. in next paragraphs, several papers about the greenhouse with IoT should be presented.

This paper has been written to show that IoT save peasants efforts and make the work much easier when the IoT used in Greenhouse applications. Also, this paper tries to provide a solution for some network problems such as dynamic Internet Protocol (IP) and global IP. The proposed greenhouse has been implemented with three intelligent control systems. These system could be controlled by an intelligent Fuzzy controllers that providing the best performance. The Fuzzy controllers must be resided completely inside Microcontroller chip without require any extra processing. This development feature leads to the more sophisticated improvements of fuzzy systems in practical environments.

Merit: Adjusting the set-points to accommodate any changes may affect on growing the plants. This work compromised attempts to found solutions for the Global IP, Dynamic IP, and blocking ports by ISP companies. The Global IP can come over it when using cloud technology, the dynamic IP can solve by using NO-IP or DDNS, etc.

Demerit: The IoT depend on the public internet to deliver its data, so that it could be effected directly by the internet problems such congestion. Also, the LDR has been used as lightintensity sensor. This tool may produce unprecise result and that may effect on the overall system performance such as the overshot.

[10]. “Environmental Parameters Monitoring for Greenhouse Farming Using Wireless Sensor Networks- Stephen Bassi Josepha*, Emmanuel Gbenga Dadab, Emmanuel Partha Musac, Muhammed Sadiq Abdullahia and Suleiman Fatima Unekwua. Published:2020 ”

Greenhouse climate monitoring and control creates enabling environment for production of crops at low cost and improves the quality of crops. Greenhouse farming can be seen as the art of science and advance technology to boost crop production. The main driving force for the development of greenhouse monitoring is wireless sensor network (WSN). Recent advancement in electronics and wireless communication technology have created an enabling environment for development and production of high communication sensors that are multi- functional at low cost and with low power consumption. These sensors have the ability to communicate at short distances and are portable (small size) in nature . Affordable connected smart sensors via wireless links and installed/connected in large numbers, offers colossal opportunities for automatic monitoring and control of homes, industries, cities and environment [1, 2]. Wireless sensor networks as a present-day technology, has capabilities of exploring the abilities of sensors, control, network transmission, data processing and storage The creation of WSNs in system platform for data capture, authentication, processing and visualization makes it promising for the enhancement of agricultural production at an affordable cost.

Several quantifiable environmental properties can be measured and stored by a network of distributed measuring sensors available during farming season. Some of these environmental parameters may include: temperature, humidity and soil moisture. WSNs are efficiently capable of providing, near real-time monitoring, capture and storage of measured environmental parameters. These captured and stored data can be explored for development of optimization tools or models for monitoring and control of agricultural crops production. Furthermore, captured

data could be analyzed for studying environmental impacts on crop production, production risk avoidance, adjustment of crop production techniques. Hence, the use of wireless sensor networks contributes eminently to crop production.

The concept of greenhouse farming is gaining lots of attention and interest recently despite its existence centuries ago. Greenhouse farming can be seen as a comprehensive system strategy for optimizing production of agricultural crops under a controlled environment. They could either be in the form of permanent or temporary structures covered with glass or plastic, and generally excluding simple high or low tunnels, shade houses, and others to the permanent structure requirement with climate controls, and "with computerized irrigation systems [4]. Greenhouse protects crops from too much heat or cold, shield plants from dust storms and blizzards, and help to keep out pests. Humidity and temperature control allow greenhouse to turn in non-arable land into arable land, thereby improving food production in marginal environments.

These proposals used different approaches towards the achievement of their set objectives. However, there is room for enhancements and also exploration of other strategies for measuring environmental parameters in greenhouse farming. The main objective of this work is to design a simple and affordable automatic monitoring and control system using Arduino microcontroller and GSM module for real time environmental parameters monitoring and control. Furthermore, the contributions of this work can be summarised as follows: development of a microcontroller based greenhouse monitoring and environmental parameters control; presentation of a comprehensive review of different strategies for greenhouse monitoring systems. A near real time automated alert system for green house monitoring. Highlights of some open research problems in relation to automated greenhouse monitoring and recommendation of proactive steps for development ofenhanced greenhouse monitoring techniques to address identified open problems is presented.

Merit: The proposed greenhouse management system has the advantage of lower installation with increased flexibility and reliability. Other advantages that the proposed system is its compatibility, compactness, portability and low power consumption.

Demerit : The greenhouse system cannot determine the soil moisture.

III. CONCLUSION

The system designed will help the farmers to avoid physical visit to the field, and increase the yield with the maintenance of Precise parameters such as air quality, soil moisture, temperature, and light in the greenhouse with the help of IoT. The project is carried out with the help of IoT kit and internet connection. The results are analyzed for the greenhouse parameters such as air quality, soil moisture, temperature, and light for plants with the help of graphical representation based on the practical values taken by the IoT kit. The comparative result shows the effectiveness of the proposed work.

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