Controlling the Growth of Sugarcane Plant in the Nursery during Germination Process by Detecting and Changing Temperature and Humidity through IoT - A Review

Suraj M. Sande[1], Sharad D. Patil[2]

[1]*UG student, Rajarambapu Institute of Technology, Rajaramnagar, Affiliated to Shivaji University Kolhapur, Maharashtra, 415414 India.*
[2]*Assoc. Professor, Rajarambapu Institute of Technology, Rajaramnagar, Affiliated to Shivaji University Kolhapur, Maharashtra, 415414 India.*

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Abstract - *Internet of Things (IoT) is about extending the power of the internet beyond computers and smartphones to a whole range of other things, processes, and the environment. Those "connected" things are used to gather information, send information back, or both. In today's world IoT has been envisioned in the future of every field such as industry, agriculture, medical, space, etc. IoT helps in agriculture by reducing the drudgery in activities and provides significant knowledge for doing smart agriculture. In sugarcane farming, farmers are facing a lot of challenges regarding the germination process where crops are not cultivated as per expectations, due to a lack of knowledge about water, temperature and humidity monitoring. The paper introduces IoT which helps to monitor the sugarcane field. Furthermore, farmers get a lot of information on crop parameters like humidity, temperature, pH of the soil, crop height, soil ingredients and fertilizers; which will further help to enhance the profit margin. The article gives a variety of knowledge about IoT technology and its implementation in various agriculture fields and environments. The paper provides information on different types of systems, which are based on various concepts like Bluetooth, fuzzy logic, algorithms, etc along with different types of sensors and their information. The paper also addresses the various kinds of microcontrollers such as Arduino UNO and ESP8266 and one chip computers like Raspberry Pi.*

Key Words: IoT, Arduino, Raspberry Pi, Temperature-Humidity Sensor, Cloud, Protocol, ESP 8266, Actuators.

1. INTRODUCTION

India is an agriculture-based country, where more than 50% of the population is dependent on agriculture. With more demand among consumers improvement in productivity and a protective level in agriculture are required. Hence, new, efficient and robust smart tools and equipment should be introduced. IoT will help the farmers to realize the controlling parameters which are very important for the suitable growth of the sugarcane plant especially in the germination process of crops. The IoT includes working with components like sensors, actuators, microprocessors, microcontrollers, etc where data is sensed from various environmental conditions. Further, it is sent to the microprocessor as an electric signal where the data is analyzed and according to the requirement of a crop, the particular range of humidity and temperature are provided to crop through the actuators like water-pump and fan. These actuators are controlled by microprocessors. After that, all data is shown to the farmer through internet service or other communication protocols and it is called smart agriculture through IoT. This system helps to enhance the growth of sugarcane plants within the expected time and eliminates ill-grown plants, thus making farming efficient. Thus, this helps the farmers to make more money.

2. LITERATURE REVIEW

There are many microcontrollers which are used for data acquisition, data analysis and control actuators, etc. Arduino UNO is suitable and cheap for experimental purposes [1,2,7,14,16,26,38], other microcontrollers Arduino UNO R3[33], Arduino Nano[40] and AVR[10] are also used. In addition, real-time monitoring concept like Global System for Mobile Communication(GSM) operates effectively on Arduino UNO[23]. Furthermore, accuracy becomes the main factor to resolve the error and it is easy to do live monitoring by using the ESP8266 wifi module. Also, the requirement tends towards the designing of the system based on Cloud with adding microcontroller NODEMCU8266 (Adafruit IO) to collaboration with some sensors[2,22,36,38,39,41,44,45]. Additionally, the other microprocessor is introduced to verify the parameter like humidity and temperature. Also, the new version of Raspberry Pi 3B is very effective; it has more space and efficiency to monitor the plants. It can maintain the signal acquiring consistency more than the Arduino and it is comparatively expensive hardware[17,3133,35,37,39]. These controllers are connected with various sensors which detects the agricultural parameters like humidity, temperature, air pressure, soil moisture etc with the help of some sensors like Digital Temperature and Humidity Sensor(DHT-22)[3,6,8,20,22,23,27] mesh-protected weatherproof Temperature and Humidity Sensor(SHT-10)[2], Temperature Sensor (TMO 100)[2], Luminosity sensor(TL52561)[6], Digital Temperature and Humidity

Sensor(DHT11)[7,11,13,22,28,29,33,35,43], Temperature sensor(D518B20)[7], Light-dependent resistor (LDR)[7,35], Temperature sensor(LM-35)[10,15,16], temperature output (HTU 211D) element[21], Soil moisture sensor(YL-38& YL-69)[22, 30, 33], Light sensor(TEMT6000), humidity sensor (EDC-274921)[31], Pressure Sensor(BMP180)[35] and light sensor (BH1750)[43]. The architecture of these components is based on some platforms like Zigbee[10], Blynk^TM[6], ThingSpeak[7,32] and putty[40,41].

2.1 Study related to Germination Process

The germination process is a significant stage as it is the initial stage of the plant life cycle. Water, air, temperature and light are all essential parameters for this process. Nowadays, IoT has come to resolve the problem related to these parameters and helps to provide the appropriate germination to the crops. There are several IoT methods that are established to yield crop productivity.

Precision agriculture is introduced to increase crop productivity where the robots take charge to perform work for agricultural applications. The environment-friendly ground mobile robots like spherical, mobile and ROSPHERE were developed to monitor efficiently and closely the temperature and humidity in agricultural fields. These robots are useful to determine zones of the crop with bad irrigation or under germination risks and take corrective actions on time, providing better growing conditions like adequate germination time, faster growth, and higher efficiency. Furthermore, the software and hardware architecture is important for the system to work accurately and perform applications like data transferring and establishing communication between two components. The next step to check the efficiency of the system, the new external modules are used in two experiments such as cornfield which is based on CAR-UPM-CSIC facility and orchard. It shows that the temperature and humidity are measured properly[1]. The Wireless Sensor Network (WSN) is one of the best solutions to provide effective and economic solutions to a variety of applications ranging from agriculture. To establish the Wireless Sensor Network (WSN) circuit for the tomato plant experiment. It is observed from this experiment, the data in the system is compared with outdoor samples and it showed that the plants in the system are healthier and in large quantities[2]. IoT with Image processing is a new method to monitor crops accurately. An experiment was conducted on a banana leaf to detect disease and to provide satisfactory solutions. The experiment was carried out on different edge detection techniques such as Sobel, Prewitt, canny algorithm, etc. through the MATLAB software. The experiment uses a microcontroller, which collects the data from temperature and humidity sensors and sends it to farmers through IoT. Also, it helps to find the optimal temperature range for the banana tree, which is about 25°C to 30°C and for Paddy crops, it is 20°C to 27°C [3]. The paper-based on the IoT has designed the set of sugarcane growth monitoring systems. The system result showed that it can effectively monitor the growing environment of sugarcane such as humidity, temperature and plant height. Overview of intelligent agricultural techniques like IoT with wireless sensors, Zigbee, Radio Frequency IDentification(RFID), Image Processing, 3S, etc. defines the importance of these techniques and a proposal of a design to calculate the value by image processing using Charged Coupled Device (CCD) cameras and visual cameras for collecting the data is required for height measurement. There was a 0-3 cm error in the height measurement of sugarcane plant measured by the system when compared to actual crop height [4]. Muhammad Nazrul Islam, Mahmuda Rawnak Jahan, Abid Ali, Shamsuzzaman Rony, Tasmiah Tamzid Anannya, Faisal Ibn Aziz, Moin Bayzed, Anika Yeazdani, and Md Fazle Rabbi, et al designed a system called "Smart Seed Germination Assistant". In this, the database stores the names of different seeds and the ideal values of each parameter. The data is collected from sensors and compared with ideal values of specific seed and necessary actions are taken to maintain the values of parameters. The system is designed in a closed chamber, the Arduino controls the actuator. The result obtained shows that Seed Germination System (SGA) is more beneficial than natural processes of seed germination as it increases the success rate in the seed germination process, reduction of the death rate of seedlings, and increases the growth of the seedlings[5]. Deisiane Santos da Cruz, Caio Castro Rodrigues, Otavio A Chase, Dênmora Gomes de Araújo, and José Felipe Souza de Almeida designed a prototype model of a smart mini greenhouse.The germination process of samples is carried out for 7-15 days. The germination has increased by about 75%. Out of 120, 90 seeds are germinated[6]. Nowadays, Artificial Intelligence (AI) and Internet of things (IoT) based germination monitoring systems are in great demand to solve agricultural problems. ThingSpeak platform is used to share and publish the result through Hypertext Transfer Protocol (HTTP) & Message Queuing Telemetry Transport (MQTT) protocol. The system used to find the height of the crop by using a camera, their CV library is used which forms a Comma-Separated Values (CSV) file, which is stored in the cloud. The data is analyzed through algorithms such as Gaussian naive Bayes, Linear support vector classifier, Decision Tree, Random Forest, Gradient Boosting Classifier, Logistic Regression & Stochastic Gradient Descent. In this, Logistic Regression, Linear SVC and Gradient Boosting Classifier were found to be the best-fit algorithms with 83.33% accuracy. These are suitable to find the favorable conditions of the plant [7].

2.2 Study related to Temperature & Humidity

The main factors like temperature and humidity can create an impact on the crop fertility in which both these parameters determine the development and consequently affect the length of the total growing period of the plant, photosynthesis is interdependent on these factors. Iot established some methods which accurately measure the temperature and humidity of crops.

The intelligent humidity sensor is an electrical capacitance sensor used to measure soil water & transfer the data to an embedded processor. Data collection was done by applying the formulas of the capacitance and relative humidity. In this paper, sensing elements measure the humidity. Computation elements contain Microcontroller 8051 for analyzing the data and the post-processing interface allows the sharing of information with other systems on (SPICE) simulation software. The obtained result shows that the intelligent humidity sensor saves the data in bulk form and works with the accuracy of the intelligent humidity sensor which is 1% and is considered better than the other conventional methods[8]. A few years ago, greenhouse technology was started to create an impact on agriculture. A greenhouse is an enclosed structure in which plants are grown protectively by controlling climatic conditions. This structure includes sensors such as Temperature sensor (LM35D2), temp.5., humidity sensor (SY-H523), Humi-5, etc. The lamp and fan are used for heating and cooling purposes and fogger & roofing for humidification and ventilation. Drip irrigation is also used for soil Humidity and temperature. Furthermore, the hybrid distributed system fuzzy Logix 5000 Hybrid D.C.S. is used in Rs-Logix 5000 & Rs-Logix 5000 fuzzy designer software. The communication protocol is used for real-time monitoring and controlling actuators(external and internal). Due to some errors & complexities, the model works for only 4-5 hr.[9]. A transmitter in the system transmits the data between sensor and controller. In the receiver, Zigbee is used to transfer the received data to the controller which controls the humidity and temperature parameters with the help of actuators. This system is comparatively cheaper and power efficient. The graph format reflects the real-time results of the soil moisture, temperature and relative humidity[10]. Laksono, Jauhari, Iftadi, Christina Ayu K, and Pandu designed a fuzzy logic system which controls humidity and temperature for better fungus cultivation and is applied for maintaining the temperature range 20-88 °C and humidity range 80-90% through the lamp and water pump by controlling LADWiEW software, that acts as the integrating platform for acquiring, processing and transmitting the data via graphical language programming[11]. IoT has a great influence on the soil monitoring system. The STM32 NUCLEO platform-based system contains a microcontroller (STM32L152RE), sensing, and communication. Bluetooth helps to transfer the data from the microcontroller to smartphones. In this setup, sensors were used to measure the soil pH, temperature and moisture efficiently with minimum errors obtained when the voltage deviation was equal to or greater than 4MV. The relationship between the moisture sensor error and the degree of wetness can be better understood with the help of the graphical representation. In which the increase in soil results in reducing the error to zero.[12]

A Remote plant watering and monitoring system are based on Amazon Web Services (AWS) IoT, where the Arduino is connected with the water level sensor & soil moisture sensor. The Arduino converts analog signals from the sensor to digital and then sends the data to Raspberry Pi. A detailed description of DynamoDM & AWS IoT implementation contributes to stored data in DynamoDM and collected data easily displayed in chart form. with the help of the web application, the water pump operates remotely and maintains the humidity and temperature [13]. The appropriate amount of water always fulfills the crop nourishment demand. This system works on this basic objective by implementing automatic crop monitoring techniques, data is collected from sensors such as humidity, temperature and light sensors. Also, this data is sent to farmers through the Global system for mobile communication (GSM) module and control the data by actuators. Farmers get alerts immediately and further actions are carried out efficiently. According to the result graph, the temperature increases respectively with time and after the evening it will become constant. Moisture level also decreases after the water pump is turned off. On the basis of this, the system will maintain the level of the parameters and will help to enhance the growth of the crop[14]. Raspberry Pi platform is used in tomen garden to provide a range of continuous moisture and sensors such as Temperature, Humidity, Moisture and Light Dependent Resistor (LDR) are interfaced with Raspberry Pi, all data is uploaded through the cloud. Displayed values are refreshed every 2 min. Basically in this system, data is sent to mobile by cloud in 2 directions i.e. data is stored on the cloud and commands are passed from the controller to the actuators. Besides, Hypertext Preprocessor (PHP), Cascading Style Sheets(CSS), Hypertext Markup Language (HTML), Apache 2, python and Structured query language (SQL) languages and software are used to develop web pages. Several parameters such as temperature, light, humidity and moisture are obtained on the screen. On the basis of that android application provides suitable actions via using the internet from a long-distance[15]. The sensors like Temperature Sensor(LM35), Humidity sensor & moisture sensor give the value to an analog-to-digital converter(ADC) to get processed by Arduino. The system works as a controlling medium as per the requirement of the environmental conditions created through actuators through Arduino commands[16]. The cost-effective and Raspberry Pi 3B with internet and Digital Temperature and Humidity Sensor(DHT-11) interface with the processor. Data is stored in the processor and displayed on the screen by using a python programming language as per the requirements the data will be monitored[17].

Anusha K and Mahadevaswamy proposed a system with Raspberry Pi connected to sensors, python code is provided by using mcp3008. In this system, putty software is used to create the application-oriented web page. The data will be displayed following certain conditions: if moisture sensor==1 then data display as land is wet and the motor will be off, otherwise data display as land is dry and the motor will be on. Another condition, if for Infrared (IR) sensor==1, the buzzer will be on and intruder detected, otherwise the buzzer is off and intruder not detected. All parameters are continuously displayed on the monitor[18]. S Kumar, N. Kushal Kumar, Sourabh Kumar Sinha proposed the Smart Sugarcane Crop Growth Monitoring System, where soil moisture ranging from 0 to 1025 is provided by using a formula to a microcontroller and tried to maintain this range. Also, soil parameters like pH ranging from 0 to 14 provided for identification of soil forms such as acidic, neutral and basic; which is sent to the farmer. Then, disease identification is done by image processing. This system reduces 80% water consumption and helps to maintain nutrients levels in the soil which can increase the growth rate of the plant [19]. This paper introduced the Automated Hypotonic farming technology which has some factors like controlling temperature, humidity, light, etc. in dry regions. All these factors are controlled by fuzzy logic. Fuzzification and its rules are demonstrated for controlling fan mediums like slow, medium, and high. After that, defuzzification is performed which defines Pulse Width Modification(PWM). After that, the data posted on the cloud using hypertext transfer protocol (HTTP) through the Things-Speak cloud service. The System achieved a precise speed of the motor by a particular required range of temperature. Ten experiments were done using the system in that tenth experiment having a maximum temperature is about 87 degrees F and the motor speed will be increased about 13529 rpm. Therefore the speed of the motor is effectively achieved by using fuzzy logic[20].

The experimental results show the live temperature and humidity of the surroundings and the soil moisture of any plant using Arduino UNO with Raspberry Pi and it is comparatively more beneficial than the existing system. The sensors and wifi module (ESP8266) are used for measuring the temperatures from the surroundings and storing displayed information with different devices. In this application, the system is powered by a solar panel. Moreover, the DC motor is switched on or off based on the soil water content level and the weather forecasting, where humidity and temperature are maintained with 90% efficiency. The water level is plotted in the Thing-Speak Software, the output showed that the temperature is inversely proportional to humidity. Real-time data shows the temperature variation is about 2 degrees celsius per 2 hr[21]. An Android application-based system is monitoring parameters like humidity and temperature at live mode and finds the behavior of the plant according to environmental conditions and provides a complete solution to monitor the health of the plant[22]. It is necessary to control the moisture and temperature, which is provided for achieving the required growth of the plant and is done by applying the system based on the real-time monitoring method. The microcontroller compares the data by using the moisture level and pump controlling is carried out as per the moisture requirements of the plant. This information is provided to the user through the Global system for mobile communication(GSM) module and is displayed on 16*2 LCD controlled by Arduino Uno. The system successfully maintains the moisture level range 55-66. According to this range, the fan will be switched on and off and it will help plants to grow effectively[23].

2.3 Study related to Internet-Based Networking

Most agriculture IoT products aim to enable the farmer to use insights to make an operational decision around planting, irrigating, harvesting and more. Furthermore, smart agriculture concepts have come out of the shell which performs various applications in agriculture like monitoring, automation through the Internet. For instant, the Zigbee-based system comes into the market. During the implementation of the IoT system, it faces problems related to climate changes and power requirements. The system also faces the challenge of maintaining control on the actuators. The structure of the system contains layers like Media Access Control Address(MAC)layer, Ply layer, Network-medium access layer and Network layer, which works with the sensors and various types of protocols. This medium access through IEEE802.154.4radio.csmamacprotocol. Besides, the paper provides an overview of the Agriculture application using Zigbee[24]. The proposed system of monitoring contains the humidity and temperature sensor connected to Advanced Risc Machines(ARM11) processor which senses a signal that is passed to the destination through the Internet Cloud. The paper gives a detailed description of Cloud computing architecture such as Software as a service(SaaS), Platform as a Service(PaaS) and Infrastructure as a service (IaaS). In this article, the greenhouse control system problems which are related to environmental climatic variables and resources like fertilizers and water, etc. are introduced which are resolved by the system. Also, applications and importance of temperature and humidity parameters in various industries are introduced[25]. Arduino Microcontroller senses the data from humidity and temperature sensor and soil moisture sensor. Then, data is sent to Raspberry Pi over the serial port and Raspberry Pi accepts data and displays it on the screen in form of a graphical user interface(GUI). Data is sent to real-time database service through the internet[26]. Another type of microprocessor is Raspberry Pi 3B with wireless sensor network provided by wifi router that contains a Digital Temperature and Humidity Sensor (DHT22) and soil moisture sensor. In this, the sensor calibration was done by using the two-point calibration of standardized values. This system accurately controls the temperature values from 18°C to 25°C; humidity from 50% to 80% relative humidity and soil moisture from 40% to 80% water content. In addition, data is collected in a group form. The Wi-Fi technology 802.11n was used for wireless communication, which operated at 2.4 GHz with a 600 Mbps data rate[27]. As per enhancing technology, the IoT is expanding in the environmental monitoring field, various sensors such as Digital Temperature and Humidity Sensor(DHT11), Light Dependent Resistor(LDR), rainwater level sensor(ULN2803), pressure and altitude sensor(BMD180) are used. For establishing a continuous network over the system, Ethernet is a good option for live monitoring applications, which also builds a strong connection in the system through Python programming on the Raspbian Software. Furthermore, the stored data in Raspberry Pi is sent to clients in the form of graphical format on ThinkSpeak by using the Hypertext Transfer Protocol(HTTP). The system is taking the data for six different fields of different positions with respect to time and without losing network [28].

This paper attempts to monitor sugarcane crops and continuously monitor parameters like temperature, humidity and moisture. The author uses k-Nearest Neighbors (KNN) clustering along with Support Vector Machines (SVM) classifier for infection identification. This model consists of a control unit data acquisition and processing unit and helps in monitoring and maintaining favorable conditions for crop growth. The algorithms in sequence with image process algorithms have been used to detect and feed to control units. Data provides the suggestion to the farmer regarding disease types. In implementation part analysis of the data using sensors like Digital Temperature and Humidity Sensor(DHT11) and control units Arduino Uno and Atmega 8266. Data is transmitted wirelessly to a control unit, where data is analyzed and suggestions are sent to the farmer by mobile number. This model System was tested for 200 sample images and an accuracy of 96% was achieved[29]. Using suitable components is more important to achieve better efficiency. So, the paper provides brief information and functions of Raspberry Pi 3 with the (DS18B20) temperature sensor, Digital Temperature and Humidity Sensor(DHT 11), soil moisture sensor (YL69) and LDR transducer, which are suitable for the application of automatic greenhouse controller through creating a web site which will allow the user to interact with an actuator like a fan and a pump[30]. The data is sensed by the sensors such as humidity sensor(EDC-274921), temperature sensor and moisture sensors through the algorithms already uploaded on the Arduino mega 2500 board, collected data is transferred to Raspberry Pi by using Zigbee. Their readings generated through monitoring are displayed on the display panel. Also, the CPU identifies crop infection by image processing, which is passed through the classification algorithms. Additionally, obtained records are saved in google sheets and displayed on a website. The risky analysis like over-irrigation or under irrigation happens due to failure of the water pump [31].

Alexander proposed a system that contains a microcontroller to collect data from sensors such as soil moisture sensor, temperature sensor, humidity sensor and light sensor. These parameters are recorded on the open-source web server "ThingSpeak'' and LCD is used for displaying the data. Data could be viewed on both the web and smartphone. With help of a Wi-Fi module, the data is stored in the cloud, and the conditions are controlled according to experiment requirements[32]. Yimwadsana proposed a system that includes Raspberry Pi and Arduino UNO R3. In this system, data is collected by Arduino UNO R3 from sensors such as Digital Temperature, Humidity Sensor (DHT-11), soil moisture sensor (YL-69) and Light Dependent Resistor(GL5516). Data is passed to Raspberry Pi, furthermore to actuators such as a relay, water pump and Gear DC motor which are controlled by Raspberry Pi. Software implementation uses various programming languages such as Hypertext Markup Language (HTML), Hypertext Preprocessor (PHP), Cascading Style Sheets(CSS), Javascript and Python along with Apache web server. The database server is implemented using MySQL server interfacing through PHPMyAdmin installed on Apache web server. All results are calibrated in graphical format. The system found a growth rate of about 8.08 cm within 4 days at 90 lux for sunflower sprouts and for morning glory sprouts the growth rate is about 5.07 cm at 3000 lux. Thus, both crops have high growth rates at low light intensity level [33]. Lakhiar introduced the Aeroponic system. The system reduces wastage of water, nutrients, pesticides and increases the plant yields by 45% to 75%. The aeroponic system followed by the review of the related work includes the system with sensors, description of the application and various technologies for plant monitoring. Additionally, this paper includes a review of the working protocol of wireless system networks, cloud systems and their advantages and failed applications. Also, different types of IoT-based circuits with their components like sensors and actuators are demonstrated[34]. Vilayatkar used Raspberry Pi to control the system and send data to farmers in the form of SMS, E-Mail and on the webpage by using the cloud. Digital Temperature and Humidity Sensor (DHT11), Pressure Sensor(BMP180), Light Dependent Resistor(LDR), Level sensor, etc. 8-GB memory card is used to store the data. In addition, provides a detailed description of the Rasbian software which is operated on the Debian-based computer operating system[35]. Mathew designed an IoT kit with a 32-bit chip processor and wifi microcontroller used for the greenhouse. The data is received from sensors and seen on the computer. A DC motor is controlled in a clockwise and anticlockwise direction through the relay. Amazon Web Services(AWS) cloud is used to gather information for the farmers by signing in to the Amazon Web Services(AWS) account. Control systems work by positive and negative values. Negative means the plant's soil is wet and a positive value means the soil is dry. As a result, the control system closes the door and provides water[36]. Wedpathak proposed smart agricultural farming for Live-Monitoring of temperature, soil moisture, climate status and motor status by using Raspberry Pi and database. In this paper, an android application helps farmers for identifying a disease by uploading images of leaves to the system. Also taking the weather data. Image processing is used for measuring the growth and identification of diseases in the plant. This system helps to reduce the wastage of water[37]. Patil proposed an automated irrigation system that includes Arduino Atmega 328p which collects the data from sensors unit1: which contains Digital Humidity & Temperature(DHT-22), rain detection, soil moisture and unit 2: which contains water tank level sensor, microcontroller (Esp8266) is used for data transmission. The data processing task is to check the data and the motor will be controlled according to requirement[38]. Wudneh and Vanitha proposed a low-cost solution for controlling, identifying and classifying infected crops and automating the greenhouse. In this prototype development using

Raspberry Pi, NODE MCU ESP 8266, sensors. Furthermore, matlab programming is used for the identification of crop infection. This system controls actuators through a solid-state relay for a water drip system based on a cloud platform. The various sensors gather parameters such as humidity, temperature, leaf image, etc and are demonstrated through a Wireless sensor network(WSN) and interact with a processing unit. This data is analyzed, stored and processed as per the algorithms and further actions are performed accordingly. The sensor attached to the WiFi model sends data to the Raspberry Pi. It further analyses the data and controls the actuators. The system performed tasks like temperature and humidity detection and monitoring plants are done by image processing using Raspberry Pi via UART serial communication and clarify infected leaves by using MATLAB[39].

Lubis proposed a system that contains a water sensor to collect the data of water level, soil moisture, air humidity and a light sensor which serves to measure the intensity of light. This analog data is sent to Arduino nano to Raspberry pi. It works as a data processor with the help of a model that connects the Raspberry pi with the internet. This web server acts as a platform to process the data between Arduino, database and client. The data is displayed in the form of a Graph through Raspberry Pi. During implementation, system monitoring was conducted using the PHP programming language, while the monitoring of soil moisture, air humidity, light intensity and water level were using the C programming language. The hardware and software specifications used in making this system were Intel (R) Core Processors (TM) i5-3337U CPU @ 1.8GHz (4 CPUs), Windows 10 pro 64 bit Operating System, 4096MB RAM Memory, 500GB hard drive capacity, WinSCP version 5.13, Arduino 1.8.5., PuTTY 64 bit. Results found that the life of the Mekong rice variety is about 68 days old from seeding[40]. Kamble proposed the system consist of sensors such as air temperature and humidity sensor, soil pH sensor, humidity-temperature sensor. The sensors transfer the data from the Microcontroller to the WiFi module (ESP8266) which is further sent to the cloud. The microcontroller (ESP8266) sends an SMS to the farmer. The Cloud system provides suggestions to the farmers regarding the use of a particular fertilizer, water quantity, etc[41]. Wang designed the control system for the greenhouse based on Zigbee. The system consists of sensors, controllers, computers and actuators. Three layers such as the perception layer where comprehensive data is collected from the sensor and sent to the central computer. The transport layer is based on LAN where data acquisition and decision-making commands are provided from the remote user. Ethernet is used to increase the capacity for data transportation. Lastly, In the application layer, accurate information and guidance are provided. This system includes four modules: login management module, data display module, remote control module and system management module. The system maintained the temperature range of 19°C-23°C and humidity range 60RH-90RH effectively. The results are provided in the following diagrams. (Fig 1& Fig 2)[42].

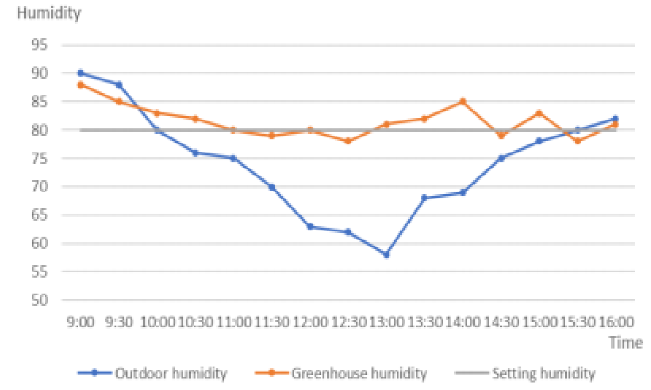

Fig -1: Humidity Indoor-Outdoor Result [42]

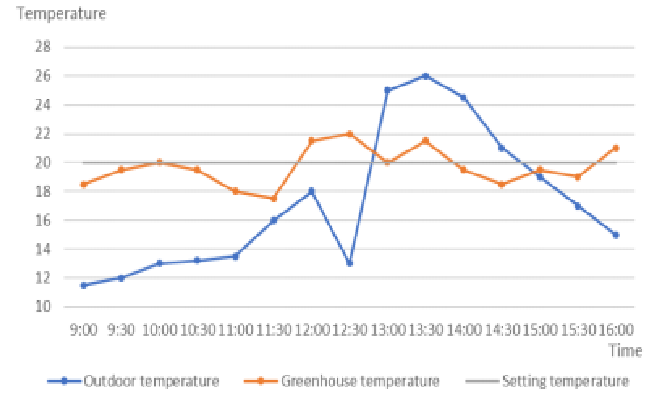

Fig -2: Temperature Indoor- Outdoor Result[42]

Rawal proposed the smart pot for monitoring and controlling moisture and humidity. The Arduino nano collects data from sensors such as light sensor (BH1750), soil moisture sensor, Digital Humidity and Temperature sensor(DHT-11), water level sensor, pH sensor, etc. Data is sent to ESP8266 through the internet. Furthermore, data is sent to the cloud using the ThingSpeak platform. Thingspeak Android application is used for data sending and receiving. As a result, sufficient water and power are provided by the water pump and lithium polymer battery(LIPO) battery. The architecture of the third-party tool contains four layers like the first layer consisting of the core Android operating system with a series of apps. The second layer consists of the API which is in contact to develop apps. The third layer which is called the hardware abstraction layer contains multiple libraries which are used to implement an interface with hardware components and the last stage where Linux Kernel allows to take advantage of crucial security features to help to develop the hardware drives like audio, camera and driver[43]. Rahim proposed a smart app for garden monitoring systems. In this system, the hardware part is Arduino UNO used to collect data from sensors. The (ESP8266) WiFi module is a self-contained system on a chip with a Transmission Control Protocol/Internet Protocol that provides access to the board. Cloud technique is used for real-time monitoring of humidity, soil, ultrasonic, temperature. The system achieved great ventilation but faces challenges like a failure of sensors, which provide inaccurate data[44]. Aman Jaiswal et al designed the system consisting of an (ESP-32

)microcontroller that collects data from sensors such as Digital Humidity and Temperature sensor (DHT-22), water level sensor, moisture sensor, etc. Data will be available on the ThingSpeak server and sent to the website page which is based on WordPress. Graphical User Interface (GUI) based on LabVIEW GUI displays the information of infected crops. The overall system is based on solar power. As a result, the water pump is controlled by a Microcontroller to yield crop productivity[45].

3. CONCLUSIONS

This paper provides a lot of information on recent technologies in Smart Agriculture related to some essential concepts like internet-based sensor data monitoring, client-server architecture, internet-based automation, Image processing. This paper reviews help to understand the working of the various types of circuits and components like sensors, microcontrollers, actuators, wifi modules, cameras, etc. There are many methods used for measuring the height of the plant in the germination process such as ROSPHERE Robot, SGM method, Seedbed system, Video image processing. But IoT-based systems closely monitor the plant and increase the yield efficiency up to 90%. Furthermore, different types of network services such as Bluetooth and Cloud are introduced. Raspberry Pi accurately monitors parameters like temperature, Humidity and pH of soil more effectively as compared to Arduino. Also, helps to accurately monitor real-time data and control the range of the parameters. Digital Humidity and Temperature sensor (DHT22) is used with minimum energy and has good reliability. Some best protocols such as HyperText Transfer Protocol(HTTP) and Message Queuing Telemetry Transport (MQTT) are used for creating a good network between components. Moreover, data analysis and further operations were taken to inform the client. Thing-Speak Software is best to show the data in graphical form and data easily accessible by smartphones. Therefore, it is easy to manipulate the actuators through the internet. This past research work contributes to enhancing the efficiency of the system and increases the growth of crops.

4. REFERENCES

[1] L.Cancar, D.Sanz, J.D. Hern´andez, J. del Cerro, and A.Barrientos,"Precision humidity and temperature measuring in farming using newer ground mobile robots" ResearchGate, ROBOT2013: First Iberian Robotics Conference (pp. 443-456), volume 252, (January 2014).

[2] J. Kalathas, D.V. Bandekas, A. Kosmidis and V. Kanakaris,"Seedbed based on IoT: A Case Study" Journal of Engineering Science and Technology Review 9 (2) (2016) 1-6.

[3] K.Lakshmi, S.Gayathri," Implementation of IoT with Image processing in plant growth monitoring system" Journal of Scientific and Innovative Research 2017; ISSN 2320-4818;6(2): 80-83.

[4] Li Biqing, Ling Yongfa, Tian Miao, Zheng Shiyong, " International Journal of Online Engineering(iJOE), iJOE – Vol. 14, No. 3, March 2018.

[5] Muhammad Nazrul Islam, Mahmuda Rawnak Jahan, Abid Ali, Shamsuzzaman Rony, Tasmiah Tamzid Anannya, Faisal Ibn Aziz, Moin Bayzed, Anika Yeazdani, and Md Fazle Rabbi, "Design and Development of an Intelligent Seed Germination System Based on IoT" ResearchGate(2018), Advances in Information and Communication Technologies for Adapting Agriculture to Climate Change II (pp.146-161)Edition: vol 893 Publisher: Advances in Intelligent Systems and Computing, Springer, Cham.

[6] Deisiane Santos da Cruz, Caio Castro Rodrigues, Otavio A Chase, Dênmora Gomes de Araújo, José Felipe Souza de Almeida,"IoT-based Smart Mini Greenhouse" International Journal for Innovation Education and Research Vol:-7 No-10, 2019.

[7] Richa Singh, Sarthak Srivastava, Rajan Mishra," AI and IoT Based Monitoring System for Increasing the Yield in Crop Production" 2020 International Conference on Electrical and Electronics Engineering (ICE3-2020).

[8] Kshitij Shinghal, Dr. Arti Noor, Dr. Neelam Srivastava, Dr. Raghuvir Singh." INTELLIGENT HUMIDITY SENSOR FOR-WIRELESS SENSOR NETWORK AGRICULTURAL APPLICATION" International Journal of Wireless & Mobile Networks (IJWMN) Vol. 3, No. 1, February 2011.

[9] Amit S. Kulkarni, Kunal N. Tiwari, and Rajesh G. Jamkar," Fuzzy Logic Control of Greenhouse Climate using Hybrid Distributed Control" Proceedings of 3rd National Conference on Electronics, Communication and Signal Processing - NCECS 2013.

[10] C. H. Chavan, P. V.Karande," Wireless Monitoring of Soil Moisture, Temperature & Humidity Using Zigbee in Agriculture" International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 10 - May 2014.

[11] Pringgo W. Laksono, Wakhid A. Jauhari., Irwan Iftadi, Christina Ayu K, Ibnu Pandu B. P. " A System based on Fuzzy Logic Approach to Control Humidity and Temperature in Fungus Cultivation" Joint International Conference on Electric Vehicular Technology and Industrial, Mechanical, Electrical and Chemical Engineering (ICEVT & IMECE) 2015.

[12] Abdullah Na, William Isaac, Shashank Varshney, Ekram Khan, "An IoT Based System for Remote Monitoring of Soil Characteristics",2016 International Conference on Information Technology (InCITe).

[13] Hemant Kuruva, Balumuri Sravani, "REMOTE PLANT WATERING AND MONITORING SYSTEM BASED ON IoT" International Journal For Technological Research In Engineering Volume 4, Issue 4, December-2016.

[14] A. Pravin, T. Prem Jacob and P. Asha, "Enhancement of Plant Monitoring Using IoT" International Journal of Engineering & Technology, 7 (3.27) (2018) 53-55.

[15] Ramkumar. E, Nagarani.S, Roger Rozario A. P, Arjuman Banu.S, "Tomen: A Plant monitoring and smart gardening system using IoT" International Journal of Pure and Applied Mathematics Volume 119 No. 7 2018, 703-710.

[16] Kawale Jayashri1, Sanjay More, Akshay Bankar, Ganesh Dongre4, Pooja Patil, "IOT BASED SMART PLANT MONITORING SYSTEM" International Journal of

Advanced Research in Science And Engineering, Volume No.07, Special Issue No.03 April 2018.

[17] S Praveen Kumar, N. Kushal Kumar, Sourabh Kumar Sinha," IoT-based Temperature and Humidity Monitoring System using Raspberry pi" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue IV, April 2018.

[18] Anusha k and U B Mahadevaswamy, "Automatic IoT Based Plant Monitoring and Watering System using Raspberry Pi " I.J. Engineering and Manufacturing, 2018, 6, 55-67.

[19] Someshwar Terkar, Saurabh Shinde, Sushma Potdar, Neha Chavan, K.S. Jadhav, " Smart Sugarcane Crop Growth Monitoring System using IOT and Image Processing" International Journal of Scientific Research & Engineering Trends Volume 5, Issue5, Sep-Oct-2019.

[20] Theint Thazin, Zaw Lin Aung, Tun Tun Win," IoT based Hydroponic Temperature and Humidity Control System using Fuzzy Logic" Conference ICSE Yangon (March 2019).

[21] Lalbihari Barik, "IoT based Temperature and Humidity Controlling using Arduino and Raspberry Pi" (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 10, No. 9, 2019.

[22] Gunjan Chauhan and Yash Sharma, "Cloud based Intelligent Plant Monitoring Device" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 06 Issue: 09, Sep 2019.

[23] Harsh Malde, Mihir Masekar, Devang Panchal, Praneet Walvekar," Automatic Plant Monitoring and Control System" International Research Journal of Engineering and Technology (IRJET), Volume:07, Issue: 04, April 2020.

[24] T.Kalaivani, AAllirani, P.Priya," A Survey on Zigbee Based Wireless Sensor Networks in Agriculture" 3rd International Conference on Trendz in Information Sciences & Computing (TISC2011) Publisher;IEEE Xplore.

[25] Mayur Randhir, R. R. Karhe." Monitoring Of Environmental Parameters by Using Cloud Computing" International Journal of Computer Science Trends and Technology (IJCST) – Volume 3 Issue 3, May-June 2015.

[26] Ruchika, Ruchi Taneja, "Smart Agriculture Monitoring Through IoT (Internet of Things)" International Journal for Scientific Research & Development| Vol. 3, Issue 05, 2015, ISSN (online): 2321-0613.

[27] Roselle B. Anire, Febus Reidj G. Cruz, Ireneo C. Agulto," Environmental Wireless Sensor Network using Raspberry Pi 3 for Greenhouse Monitoring System" 2017 IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM).

[28] S. D. Shewale, S. N. Gaikwad, "An IoT Based Real-Time Weather Monitoring System Using Raspberry Pi" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 6, Issue 6, June 2017 ISSN (Print): 2320 – 3765, ISSN (Online): 2278 – 8875.

[29] Sachin Kumar, Sumita Mishra, Pooja Khanna, Pragya, "Precision Sugarcane Monitoring Using SVM Classifier" ScienceDirect Computer Science 122(2017), 881-887.

[30] Kiran Ganesan, Uzma Walele, Namrata Hambire, Piyush Choughule, Deepthi Oommen, "Raspberry-Pi Based Automated Greenhouse" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03 | Mar-2018.

[31] Khan Mohd.Haris, Sachin Kumar, Sumita Mishra & Pragya, " PRECISION CROP MONITORING FOR SUGARCANE AND CORN" International Journal of Latest Trends in Engineering and Technology Vol.(9)Issue(3), pp.289-293.

[32] Prince Immanuel Alexander. S, Dineshkumar. J, Lavanya. G," IOT BASED GREENHOUSE MONITORING AND CONTROLLING" International Journal for Research Trends and Innovation Volume 3, Issue 8, ISSN: 2456-3315.

[33] Boonsit Yimwadsana, Pichamon Chanthapeth, Chanyanuch Lertthanyaphan, Antika Pornvechamnuay, "An IoT Controlled System for Plant Growth" 2018 Seventh ICT International Student Project Conference (ICT-ISPC).

[34] Imran Ali Lakhiar, Gao Jianmin, Tabinda Naz Syed, Farman Ali Chandio, Noman Ali Buttar, and Waqar Ahmed Qureshi, "Monitoring and Control Systems in Agriculture Using Intelligent Sensor Techniques: A Review of the Aeroponic System" Hindawi Journal of Sensors Volume 2018, Article ID 8672769, 18 pages https://doi.org/10.1155/2018/8672769.

[35] Shubham R. Vilayatkar, Vaibhav R. Wankhade, Pranjali G. Wangekar, Nikhil S. Mundane," IoT Based Weather Monitoring System using Raspberry Pi" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 06 Issue: 01, Jan 2019.

[36] Cina Mathew, Rinsu Mathukutty, Ponni, "Controlling of Greenhouse Parameters based on IoT and Remote SensingMadhanan," International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, NCACCT - 2019 Conference Proceedings.

[37] Ganesh Wedpathak, Vaishali Pawar, Swati Kadam, Sandhya Thigale, "IoT Based Farming with Live Monitoring of Temperature, Soil Moisture, Weather Conditions through Image Processing Techniques" International Journal of Recent Trends in Engineering & Research (IJRTER) Volume 05, Issue 03; March- 2019 [ISSN: 2455-1457].

[38] Sanjay N. Patil1, Madhuri B. Jadhav," Smart Agriculture Monitoring System Using IOT" International Journal of Advanced Research in Computer and Communication Engineering, Vol. 8, Issue 4, April 2019.

[39] Tariku Birhanu Wudneh and V.Vanitha, " Implementation of IoT With Image Processing in Greenhouse Monitoring System" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-9, July 2019.

[40] H Lubis, R F Rahmat, J Karansa, and S Purnamawati, "Monitoring System of Rice Plant Growth Using Microcontroller Sensor" 3rd International Conference on Computing and Applied Informatics 2018 IOP Conf. Series: Journal of Physics: Conf. Series 1235 (2019) 012116.

[41] Kaveri.S.Kamble, Mahender.G.Nakrani, Devendra.L.Bhuyar," A Review On IOT Based Smart Agriculture For Sugarcane" International Journal of Engineering Development and Research 2019 Volume 7, Issue 2, ISSN: 2321-9939.

[42] Xiaoxia Wang, Haibo Yu," Research on Control System of Intelligent Greenhouse of IoT Based on Zigbee" Journal of Physics: Conference Series 1345 (2019) 042036.

[43] Kush Rawala, Goldie Gabranib, "IoT based Computing to Monitor Indoor Plants by using Smart Pot" 3rd INTERNATIONAL CONFERENCE ON INNOVATIVE COMPUTING AND COMMUNICATION.

[44] N.H. Abd Rahim, F.N. Ahmad Zaki and A.S.M. Noor, "Smart App for Gardening Monitoring System using IoT Technology"International Journal of Advanced Science and Technology Vol. 29, No. 04, (2020), pp. 7375 – 7384.

[45] Aman Jaiswal1, Riju Jindal, Ayush Kumar Verma," Crop Health Monitoring System using IoT "International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 07, Issue: 06, June 2020.