IoT Based Polyhouse Farming with Controlled Environment and Monitoring

Jose Reena K
Assistant Professor
Department of Computer Science
VISTAS

***Abstract*:- The growth potential of the embedded industry is enormous and the way forward becomes clear every day. It's time to start building our own IoT system which will add value to you. IoT is supposed to connect 28 billion things [3] from smartwatches and other wearable devices to cars, home appliances and industrial equipment on the Internet by 2020. Agriculture plays an important role in the development of farmland. In India, about 70% of the population depends on agriculture, and one third of the country's capital [4] is engaged in agriculture. Henceforth agricultural problems have always hindered the development of the country. The most possible and only solution to this problem is intelligent farming by modernizing current traditional farming methods. The paper therefore aims to make agriculture intelligent using automation and IoT technology. All these operations are controlled by any remote smart device or computer connected to the Internet, and the operations are performed by the interface sensors.**

Keywords: Polyhouse farming, Naturally ventilated polyhouse, Fully climate controlled polyhouse, Automation, IoT

INTRODUCTION

A polyhouse is a specific kind of building that uses a regulated temperature for the growth of various plants and other agricultural requirements[1]. To cover the building and divide the interior atmosphere from the exterior, we utilise polythene sheets. All sorts of polyhouse farming, from small farmers to commercial farming, can benefit by using IoT-based polyhouse farming technology. By monitoring and managing the temperature, humidity, light, and CO2 in the polyhouse, a grower may maximise crop quality, production and minimising impact of environmental factors such as climate, rainfall etc. IoT-based polyhouse farming systems are incredibly simple to use and can be accessed from any location using a smartphone, tablet, or computer with Internet.

Many people, who are in the field of agriculture are unaware about the benefits of IoT based polyhouse farming that although polyhouses offer excellent shelter from bad weather, external elements still have a big impact on how our plants are doing within the polyhouse. When we take into account all the climatic factors, such as light and solar radiation, wind, air pressure, relative humidity, as well as rain and precipitation, it might be challenging to discover the sweet spot where plants thrive.

BENEFITS OF IoT BASED POLYHOUSE FARMING

The automating of any process or operation [6] can provide enormous benefits with current available technologies, the same be obtained in the field of agriculture which is considered as the back bone of our country development. Regardless of how we are looking to develop our growing enterprise, automation offers universal benefits that allow us to achieve the goals and then some. The most important factors that has influence on the IoT based polyhouse farming are discussed [4]. The first and foremost factor is reduces labour cost, by reducing the amount of work that needs to be done manually, we can decrease our labour costs or allow us to free up workers to focus on other areas of importance. Perfect if we are looking to expand the business or introduce new skills to the workers to make more profit.

As we deploy sensors and smart devices, be Accurate always, by knowing exactly what’s happening in the Polyhouse and make data-driven decisions based on facts and not assumptions. The Polyhouse automation systems technology and equipment exist to benefit the farmers, as the grower. Another important advantage of polyhouse farming is to increase quality and yield of the crops. The main concepts underlies is that if we start measuring then we thought of improving. This polyhouse automation systems will provide knowledge of the current yield and also ways to increase quality and yield based on the previous crop cycles which in turn gives us better returns on investments.

TYPES OF POLYHOUSES

Due to the availability of different structures and technologies the polyhouse farming can be categories into many ways based on the environmental factor in that particular area, soil nature and so forth.

Low cost or naturally ventilated polyhouses

Naturally ventilated polyhouse farming[7] is very easy to construct with locally available materials such as bamboos, timber, coloured or plain polythene sheets which is shown in figure 1. Since the materials and structure construction does not need much skilled or technical person to construct, hence initial investment for this type of polyhouse is very less. It does not need any specific sensors or control devices for regulating the environmental parameters inside the polyhouse. This type of polyhouse farming are well suitable in the cold weather regions, especially in hilly areas. In this polyhouse the durability or lifetime of the structure is less since materials can get damaged easily.

Figure1: Naturally Ventilated Polyhouse

Medium cost or Partial climate-controlled polyhouses

Partial climate - controlled polyhouse [8] type needs some basic materials like galvanized iron pipes to make the structural frames, thermostatically controlled exhausted fans to provide ventilation to the polyhouse. Cooling pads are used in this type for humidifying the air entering the polyhouse. Henceforth the cost or investment for constructing this type of polyhouses will be high when compared to the previous type. These are suitable for vegetable cultivation during mild winter and mild summer for the low hills in NW Himalayas. The figure 2 shows the example structure of this medium cost polyhouse farming. In this case the lifetime or durability is improved since iron pipes are used

Figure 2: Partially Climate Controlled Polyhouse

High cost or Fully climate-controlled polyhouses

This fully climate-controlled polyhouse[9] type needs more sophisticated sensors and materials for structure constructions are iron or aluminium. This structure can be constructed over large area with the shape as dome or cone for efficient utilization of the sensors and area for growing crops as shown if figure 3. As sophisticated sensors are used the cost of the polyhouse constructure will increase 5 – 6 times more than the naturally ventilated polyhouses. Durability is considered, it provide high durability. In these polyhouses uses the Peat, Perlite, Vermiculite, Rock wool as the growing medium in other places, but in India coco fibres and rice husks are used as growing media as these materials are cheaper. Fertigation and pesticide sprays are done by fogging machines. These types of polyhouses are controlled by smart devices and fully automated to provide high yield and better quality.

Figure 3: Fully Climate Controlled Polyhouse

Plastic Low Tunnels

This type is the miniature form of polyhouse which protect the plants from rains, winds, low temperature, frost and other vagaries of weather. This plastic low tunnel [10] method provide the best way for off season vegetable nursery production by modifying the microclimate around the plants. Mainly the nursery bed of size 3x1x0.15 m most commonly used in this type of tunnels. Another advantages of this is a portable low plastic tunnel of 3.5x1.20x1.0 m size with polythene sheet of 120 GSM is put on the nursery bed.

Figure 4: Plastic Low Tunnels

Net Houses

This type are structures are very simple framed structure or small row[11] like structure with nets of 40 and higher mesh are effective. The main advantage of this type of polyhouse farming is to control entry of flying and insect

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

which helps to save crop from viral disease. Netting to maintain an environment which also provide isolation from insect borne pollen.

Figure 5: Net Houses

CONDITIONS MAINTAINED IN POLYHOUSE

The environmental parameters plays a vital role in the polyhouse farming. The most important parameters need to be maintained in a polyhouse are five different types. They are carbon-di-oxide, temperature, Light, Humidity and air flow. Their importance and the effect of these parameters are discussed in detail in the below section.

CO_2

In our surrounding atmosphere CO2 [12] conc. is 0.03% means 300ppm. Plants use this CO2 for photosynthesis. In poly house, during night time there is no photosynthesis but CO2 is given out by respiration. This CO2 remain accumulated around plants hence in night compare to outside, polyhouse always have more CO2 conc. This CO2 is again used by plants growing in poly house for rapid photosynthesis. It has been proved that if poly house having 1000ppm of CO2, then herbs, vegetables and flower production increases to 4 to 5 times more compare to normal conditions.

Temperature

For flowers and vegetables healthy and maximum growth, the temp [13] requirement is between 26'C to 30'C during day time and 15'C to 18'C in night. The steel frame work of poly house is covered by polythene hence inner temp. can rise up to 40'C. To control the temp inside the poly house, the ventilation as well as cooling pads and fans are used. Because of this we can have continuous quality production of herbs throughout the year.

Light

Light [14] is a most critical factor for poly house. The brightness of light is measured in LUX. For healthy growth of crop in poly house, minimum requirement of LUX is 50,000 to 60,000. In India, light LUX varies from 40,000 to 1,40, 000 hence in many parts of our country such as Maharashtra, Karnataka, M.P. the sunlight is bright and has to be reduced by using shed net. We can reduce sunlight 30%, 50%, 75%. The 50% shed net are common in India. Along with the LUX, the wavelength of light is also important. On the basis of wavelength, Light is classified into three types Ultra violate light wavelength 0-400nm, Visible light wavelength 400-700nm, Infra light wavelength 700 onwards. From these three types, plants use only visible light for photosynthesis. In polyhouse technology light is controlled in such a way that plant receive maximum visible light and remaining light get reflected back i.e. outside the polyhouse

Humidity

For flowers and vegetables, and their healthy and maximum growth, we should have proper humidity[15]. Requirement of humidity for flower production is 65% to 80% and for vegetables it is 60% to 65%Because of controlled humidity plant growth remain continue, flower grow with attractive colours and after cutting, their shelf life also increases. Humidity helps in colour combination of herbs, vegetable and flowers.

Air Flow

If humidity is more in polyhouse, then chances of diseases and pest increases. Under such condition, side vents of polyhouse are opened to promote wind movement in polyhouse. Because of wind movement the humidity decreases and chances of diseases also reduced[16].

PROPOSED WORK

The salient feature of our proposed work to address to most important factors that have major impact on the polyhouse farming to give high and quality products. In this section selection of site for placing the polyhouse, needed direction for installation, proposed process architecture, and sensors needed are discussed.

Selection of site for polyhouse

- The selection Site should be free from pollution.
- Water should be available regularly
- Supply of electricity (Three phase) should be regular
- Soil should be properly levelled and drained
- Poly house should be near to road side means proper approachable road must be there to go to poly house
- Some space should be there nearby for further extension
- Expertise and labours should be available when required.

Direction of Polyhouse

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

- Poly house should have light from all sides and wind current should not damage the polyhouse.
- To overcome these problems, Poly house should be preferably South-North in direction.

Process Architecture

The Sensor devices for various testing parameters will collect the data and IoT core is used to push the data to the cloud. Using DynamoDB we store the data and using Lambda we push the data to the web and mobile application. Amazon SNS is used for simple notification service. The results of the testing can be viewed by the client in mobile or web-based applications.

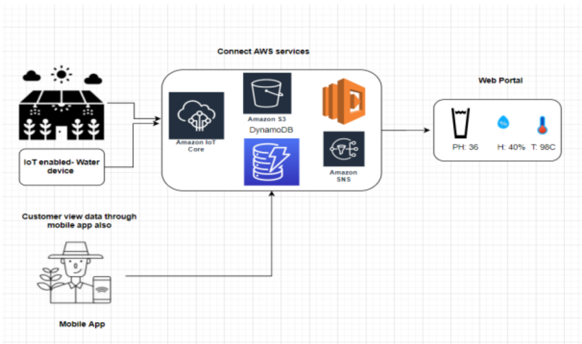

Figure 6: Technology or deployment architecture.

IoT layer contains various sensors and the data is pushed to the IoT core, that is the back end layer. Using Python and Django we process the data and through API gateway we display the data in the front end. Schedules is used to maintain the schedules like on and off of the water at a particular time etc. SNS is used to provide alerts such as PH value exceeded and so on. Angular is used in a frontend layer to display the values.

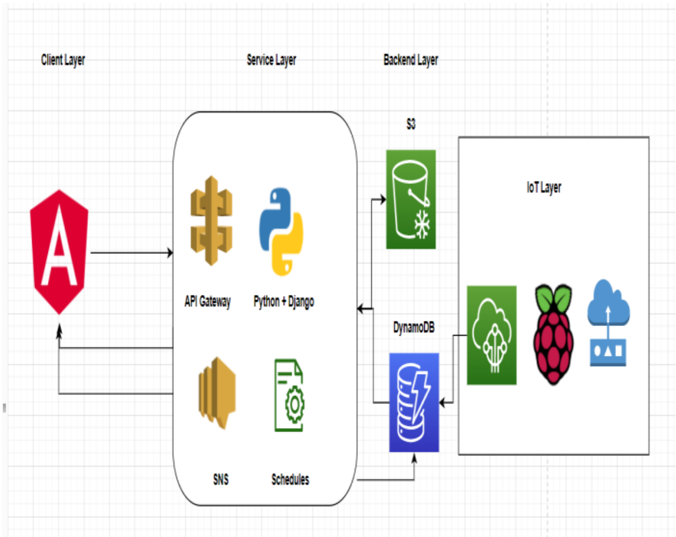

Figure 7: Process Architecture

Figure 8: Dash Board

The dashboards contain alerts, start, scheduled test reports, graphical view location and user profile. Alerts will be something like fan turned on or EC level exceeded, PH level exceeded and so on in start and schedule test. We can schedule the water test at a particular time duration. Reports tab will provide the reports of the water testing done and when we want to see it in a graphical view, we can see it using graphical view. The location tab will share the location of the client using this app and the user profile tab will contain the profile of the user.

Sensors

A sensor is a device which detects or measures a physical property and records, indicates, or otherwise responds to it. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. The sensors various sensors used are:

A. Temperature and humidity sensor:

A temperature sensor [17] is a device that provides the temperature measurement at a given time. It is a resistance temperature detector which detects the temperature changes. It provides high quality and quick acknowledgement. Being a mixed sensor, it provides with the values both of temperature and humidity. The sensor calibers digital signal output. Using this sensor gives greater stability and higher reliability. The sensor used is DHT11 Module temperature and humidity sensor module. The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin. It is fairly simple to use.

Figure 9: Temperature and Humidity Sensor

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

B. Light sensor:

The intensity of light in the polyhouse is measured through the Light sensor[18]. Light sensor is the device which is used to detect the current ambient level of the light i.e. how bright or dark it is. The sensor used is INVNT_10 Lm393 optical photosensitive LDR light sensitive sensor. It is associated with both analog output pin and digital output pin labelled as AO and DO respectively on the board. When there is light, the resistance of LDR will become low according to the intensity of light. The greater the intensity of light, the lower the resistance of LDR. The sensor has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards light. It is also planned to use map reduce framework in future so that the performance of opinion mining is improved.

Figure 10: Light Sensor

C. Soil Moisture sensor:

Soil moisture sensor[19] is the device which measures the content of water in the soil. Soil moisture measurement is important to help farmers manage their irrigation systems. It consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower.

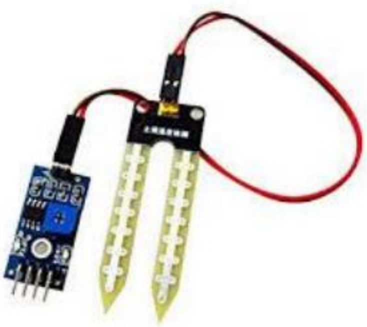

Figure 11: Soil Moisture Sensor

CONCLUSION

An IoT system Development for agriculture could resolve many real-time issues by increasing the quality and production management which enables the farmers to access huge amount of results from the real-time data from the crop field. The system is managing efficiently and effectively. The Architecture proposed in this paper, could provide a base for implementation of smart agriculture system using IoT. The layers used in this architecture is intended to store, manage and monitor the crop growth details and also provide the efficient decision making for the process of fertilizers utilization, water supply and plantation of crop basing on the data collected from the sensors connected to the ground of the field.

REFERENCES

[1] E. Upasani, S. B. Shrote and V. P. Wani, FPGA implementation of intelligent climate control for greenhouse, International Journal of Computer application, 1(18), 2010
[2] G.K. Banerjee and Rahul Singhal, Microcontroller based Polyhouse Automation Controller, International Symposium on Electronic System Design, 2010
[3] Rokade, Assistance and Control System for Polyhouse Plantation, M. Des. Thesis, IDC IIT Bombay, 2004.
[4] T. Ahonen, R. Virrankoski, M. Elmusrati, “Greenhouse Monitoring with Wireless Sensor Network”, IEEE /ASME International Conference on Mechatronic and Embedded Systems and Applications, 2008
[5] Dae-Heon P. and Jang-Woo P., 2011. Wireless sensor network-based greenhouse environment monitoring and automatic control system for dew condensation prevention. Journal of Sensors, Vol. 11, pp. 3640-3651.
[6] Dussion M. F., 1989. Greenhouse and energy. French Agency for Energy Management, p. 96.
[7] Eddahhak A., 2009. Development of a system for monitoring the climate and managing the drip fertilizing irrigation in greenhouse by using LabVIEW software. National PhD, Faculty of Sciences, Meknes, Moulay Ismail University, Morocco
[8] Eddahhak A., Lachhab A., Ezzine L. and Bouchikhi B., 2007. Performance evaluation of a developing greenhouse climate control with a computer system. AMSE Journal Modelling C, Vol. 68, No. 1, pp. 53-64.
[9] El-Fadl A., El Kherrak H., Claustriaux J. et Mounhim H., 1996. Computer aided management of greenhouse climate and influence on the culture of melon in the region of Souss. Choukr-Allah R. (ed.). Protected cultivation in the Mediterranean region. Notebooks Options Mediterranean Vol. 31, pp. 99-108.
[10] El Harzli M., 2009. Study and realization of a multifunctional sensor, heat flux, temperature and humidity. Application to the greenhouse control. National PhD , Faculty of Sciences, Meknes, Moulay Ismail University, Morocco.
[11] Hayat Khiyal M. S., Khan A. and Shehzadi E., 2009. SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security. Issues in Informing Science and Information Technology, Vol. 6, pp. 887-894.
[12] Lajara R., Alberola J. and Pelegrí-Sebastiá J., 2011. A Solar Energy Powered Autonomous Wireless Actuator Node for Irrigation Systems. Journal of Sensors. Vol. 11, pp. 329-340.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

[13] Laszewski, G., Younge, A., He, X., Kunze, M., Tao, J., Fu, C., and Wang, L. Cloud computing: a perspective study. New Generation Computing, 28(2):137–146.
[14] Li X. H., Cheng X., Yan K. and Gong P., 2010. A monitoring system for vegetable greenhouses based on a wireless sensor network. Journal of Sensors, Vol. 10, pp. 8963-8980.
[15] Ji-chun Zhao; Ju-feng Zhang; Yu Feng; Jian-xin Guo, "The study and application of the IOT technology in agriculture," Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on, vol.2, no., pp.462,465, 9-11 July 2010. International Journal of Trend in Scientific Research and Development (IJTSRD) ISSN: 2456-6470 @ IJTSRD | Available Online @ www.ijtsrd.com | Volume – 2 | Issue – 3 | Mar-Apr 2018 Page: 697
[16] J. W. Overstreet and A. Tzes, "An Internet-based real-time control engineering laboratory", IEEE Control Syst., Vol. 19, pp. 19-33, 1999.
[17] P. L. Regtien, M. Halaj, E. Kurekova and P. Gabko, "COMET: A multimedia internet-based platform for education in measurement", Measurements, Vol. 40, No. 2, pp. 171-182, 2007. TRAI's press release
[18] Agricultural Statistics at a Glance (2008), Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.
[19] 19. S. K. Sanwal, K. K. Patel and D. S. Yadav, "Vegetable Production under Protected Conditions in NEH Region", ENVIS Bulletin: Himalayan Ecology, Vol. 12, No. 2, 2004.