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Smart Farming: The IoT based Future Agriculture

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***Abstract*— Agriculture is backbone of any country. About 60% of our country's population works in agriculture or the primary sector. It contributes more to our country's GDP. It employs the majority of India's population. The internet of things research presents a framework in which farmers may obtain extensive information on the soil, crops growing in specific areas, and agricultural yield and productivity. By utilizing resource optimization and smart planning, this technology-based farming solution will assist farmers in making wise agricultural decisions. The development of IOT based intelligent Smart Farming using smart devices is changing the agriculture production by not only increasing the quality and yield but also to make farming cost effective. The goal of this smart Agriculture or farming is to get live data like temperature, soil moisture and humidity to monitor the surrounding environment. All of this is accomplished with the use of temperature, humidity, and moisture sensors. The system being proposed by this paper is done using microcontroller and various sensors. This system is capable of monitoring the parameters in various soil conditions.**

***Keywords*—** *Internet of Things (IOT), Smart Farming, Arduino, Micro-Controller, Sensors, ThingsBoard.*

I. INTRODUCTION

In recent years, the increased use of Internet of Things (IoT) has played an important role in changing traditional technology from homes to farms and workplaces. IoT enables not only human-to-human engagement, but also human-to-device and device-to-device interaction. Smart farming is managing farming using emerging technologies to increase the produce and quality of the products. This system includes aspects such as the internet of things (IOT), Soil Scanning, recording temperature and humidity and storing the data. The increasing use of smart farming is helping both small and large scale farmers by giving them access to devices and latest technologies that help maximize the crops quality and quantity by reducing the cost of production. Folks staying at home, occupied with their household tasks or people busy with their office responsibilities had no notion about the environmental conditions outside their home when there was no IOT. They have no notion whether the temperature outside is very high, very low, or normal, whether it is raining or not, or what the humidity level is in the outside world. In these circumstances, this device can be extremely useful. It will alert us if the temperature is too high or too low. For example, with the help of smart farming, the farmer will get a chance to monitor the needs of the crop and soil by selective and effective use of fertilizers and pesticides. This smart farming practice will also help in yielding healthy crop. The smart farming application provides farmers with information or data such as temperature, humidity, soil moisture level, and farm water level and instructs the farmers to follow traditional agriculture to improve the yield, quality of crops, and also the overall production rate. Smart farming ensures a scintillating future with the introduction of farming technologies whose main goal is to reduce costs, improve efficiency of farming, and quality and high products. There are number of other benefits of smart farming like: reducing the strain on the environment, increasing the safety of farmers and workers, lowering the disposal of chemicals into rivers, limit and control the usage of water.

II. RELATED WORK

As indicated in [1], the monitoring and control system consists of sensors and an Android app. The analyzed data provided by the database system to the hardware as input this gives the farmer recommendation. Like, which crop is best suited for this soil, its organic farming methods and irrigation methods, etc. This system uses separate android application which may not be understand by the farmers.

Guiding the farmers by the updating the data to increase the overall productivity of crops is referenced in [2]. This system updates the information of the soil for farmers. As this project runs with the Internet connection, there is no availability of proper internet connections in the villages.

The paper cited in the [3] project describes a technology-based smart system for predicting a field's irrigation needs by monitoring ground parameters such as soil moisture and temperature, as well as environmental variables. Parameters such as weather forecast data can be accessed via the internet. This type of smart irrigation technology can help farmers use the least amount of water possible while still getting the job done. This system does not make advantage of all sensor kinds.

A system that protects the plants from the fire by using the results is mentioned in [4] with which we can be careful before the situation. This successively helps in reducing crop destruction. The system also contributes significantly to the reduction of global warming. This system used wireless sensor networks. Cameras are used to get the distant conditions and lot of technology used to get an accurate result which may not be possible in villages.

In [5] observing the temperature and pressure of the crop while transporting from one place to another is shown, also it can be used to get the updates from retail and wholesale stores about the consumption of crop to farmer. The analytics of the product can guide the farmer that which crop can give the optimal price at what period of the year. Undesirable effects in parts of the hardware may cause negative effect on the results.

In [6], a separate module called GSM is fixed with the Arduino to provide message service and alerts the farmer about the weather every 10 seconds. This system also does soil and plant Ph value tracking and the moisture of the soil and the temperature. This works on continuous GPS service. This may not be possible in remote areas.

In [7] challenges while controlling electronic devices using networks are shown. The data provided by the sensors can be accessible for monitoring and analyzing from anywhere in the world through internet. This system also provides a correct movement or decision-making system. It uses cloud provisioning which is not necessary .The information about that field is necessary to that particular farmer not to everyone.

The installation of sensor to each and every plant in that field to get the updates of the soil and the plant is shown in [8]. This system only checks the moisture content in the soil and not about all the parameters. This is expensive if it is used on a large scale because it has to be installed for every plant on the field.

The techniques that have to be implemented for stopping the usage of water resources is referenced in [9].The main objective is to work on the areas which are having scarcity of water about what crop they can cultivate and how much water are required to grow that crop etc., .For the usage of this system farmer should have knowledge on the microcontroller which may not be there for some farmers.

[10] Assists farmers in performing smart farming by boosting agricultural output and conserving resources like as water, fertilizers, and pesticides. It will also reduce crop wastage while being cost effective. It sends signals to the farmer via several channels informing him of the crop's status. It forecasts the live data of the field to the farmer optimally. Less number of sensors are used to detect all required conditions of the field to get the accurate results.

In [11] we get to know about the challenges that will arise when we integrate the IOT technology into the traditional farming techniques. The challenges like what if sensors fails then wrong data forecasts and the ratio of the input to the field by the farmer also may go wrong which affects the yield of the crop .This is just about the challenges that have to be faced but it is not the real time working system that updates the data and gives the output to the farmer.

Soil characteristics like moisture, Ph, acidity etc., and provides the output which crop is suitable for that kind of soil characteristics and which crop leads to higher yield when it is cultivated this is mentioned in [12]. This also helps the farmer in reducing the input costs for farmer and reduces the environmental impact that leads the decrease of the yield or damage the crop. There is no color differentiation in the output generated by the system. This may lead confusion to farmer who is not good at the education to know the difference between and to supply the good input to the crop to produce high yield.

The automation of the work of the farmer by watering the plants according to the climatic conditions sensed by the sensors inserted is used in [13][26][27]. The advantage or the additional feature of this system is it monitors each stage of harvesting or cultivating the crop differently. For Example In harvesting phase specified amount of water is required and in cultivating phase specified amount of water is required. Hence it monitors the phase and climatic conditions it waters the plants in the field. This system automates only the watering part the fertilizers and all has to be done manually and the farmer will not be even notified about which fertilizer to be used and which nutrient deficiency occurred in the crop.

Prediction of the moisture content in the soil and waters the plant is shown in [14]. This reduces the usage of the water resources because it is the main component of the farming process. This is easy to use in rural areas and it has low maintenance in the small scale applications. This is not cost efficient because it is difficult in installing the system in large scale applications. It requires a lot of technology to install in large applications and difficult to store the information of large unit .

In [15] we get to know the challenges that have to be faced due to the internet connections. Due to the internet connection the communication between the sensors and the other electronic devices will also get disturbed and provides the wrong information about the field conditions and soil characteristics. These all will be discussed in this paper . This is just about the discussions of the challenges that have to be faced but the real time application is not built to determine the soil characteristics.

IOT is the current internet world's new revolution, which monitors live streaming of the entire world's status, such as temperature, moisture, rainstorms, earthquakes, cataracts, and other events that might cause mortal life to falter. [16] Offers a low-cost rainfall monitoring system that uses a basic database operation system to retrieve the rainfall situation of any location and displays it on an OLED display. The proposed solution is based on the Arduino platform and employs an ESP8266- Partner microcontroller grounded Wemos D1 board to recuperate data from the sink. The major goal of this study is to allow users to examine rainfall conditions from any location while also allowing them to pierce current data from any station.

The system suggested in [17] is a cutting-edge solution for rainfall monitoring that employs IoT to make real-time data easily accessible across a wide range of devices. This involves employing various detectors to monitor rainfall and climate changes such as temperature, moisture, wind speed, humidity, light intensity, UV radiation, and even carbon monoxide levels in the air. These detectors shoot the data to the web runner and the detector data is colluded as graphical statistics. The data uploaded to the web runner can fluently be accessible from anywhere. The Internet of Effects significantly facilitates the analysis of data collected from around the world in order to make decisions about the situation.

Security is a huge difficulty to cover it from colorful forms of attacks due to its comparable unique nature, as seen in [18] [22]. Various security improvement methods have been offered in the past to address the problem of multiple attacks, but there is no equivalent method that gives complete security because new attacks are discovered every day. The generals in this text are both colorful and cold-blooded.

When soil humidity fell below a threshold, the hygrometer detected it and sent an alert to producers' cell phones through GSM. In [19], an IoT-connected remote-controlled vehicle was created to monitor temperature, moisture, and soil conditions in order to make irrigation decisions. This project is designed to cover the entire field with a GPS-based vehicle that uses Zigbee, and to cover the storehouse with an AVR microcontroller and detectors to ensure the safety of the items.

The essential aspects of IoT grounded smart husbandry are explained in [20][21]. A thorough examination of network technologies utilized in IoT grounded husbandry, including network armature and levels, network topologies, and protocols, has been presented. Similarly, the integration of IoT-based husbandry systems with relevant technologies like as pall computing, big data storage, and analytics has been discussed. In addition, the need of security in IoT husbandry has been emphasized. There is also a list of smart phone grounded and detector grounded operations designed for various parts of ranch operation.

Few existing models require the farmer to install an application in-order to monitor the environment and few others require a constant internet connection. This may not be reliable as many of the farmers do not have smart mobile and may rural areas may not have proper and constant connectivity. Also with the internet comes the security issues [23][24][25] which farmers may not understand to act against it. Whereas few other systems display the results in form of text which every farmer may not be able to understand. These are the major drawbacks of the existing models.

III. PROPOSED WORK

A combination of hardware and software components make up the Smart Farm System. Embedded systems make up the hardware, and Arduino is the software. The Arduino is the device that displays data from sensors that have been plugged in with the help of hardware. Temperature and humidity sensors, as well as soil moisture sensors, are utilized as special sensors. The data collected by the sensors is forwarded to the RaspberryPi's Arduino UNO microcontroller.

The data gathered might be presented on an Arduino screen. The project is divided into four sections. It takes external temperature and humidity readings and sends the information to the software model. It detects the moisture in the soil around the sensor, making it suitable for monitoring the wetness of plants or soil.

We have presented the layout of modules that we have taken in Fig 1. Using the dht11 and YI-69 sensors, we first evaluated different types of sensors to obtain temperature, humidity, and moisture measurements. The temperature and humidity of the environment will be sensed by dht11, while the moisture levels of the soil will be sensed by YI-69. The sensors will then be linked to the Arduino's one side on both the north and south poles separately. The Raspberry Pie will be linked to the other side of the Arduino, which will receive data from both Arduinos and send the results to the ThingsBoard Server. The data will be converted to a Python file by ThingsBoard Server, making data visualization a breeze. We can represent the data in graphs for farmer convenience after converting to a python file.

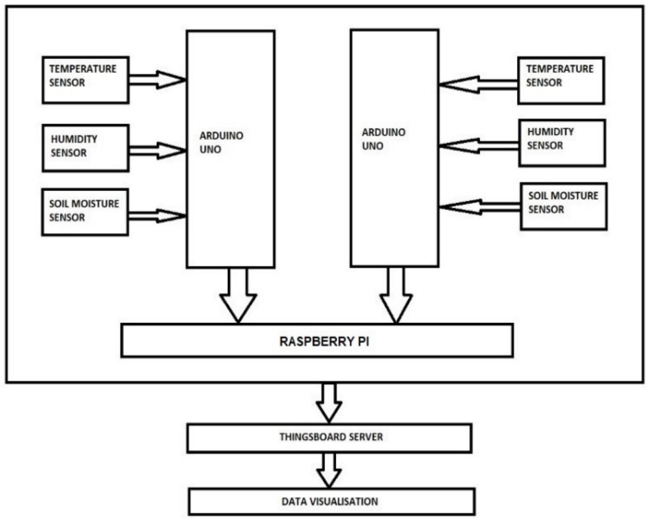

Fig. 1. Arrangement of Modules

A. *Component used to measure Temperature*

A dht11 is used in the first module to sense the current temperature. The temperature data will be published to the MQTT broker, which is the Raspberry Pi.

- Component that was used:
  Dht11:
  It's a temperature sensor that produces a calibrated digital temperature output. It measures the temperature of the environment with a thermistor. It has a quick response time and high quality.

B. *Component used to measure Humidity*

A dht11 is used in the second module to detect the current humidity level. The temperature data will be published to the MQTT broker, which is the Raspberry Pi.

- Component that was used:
  Dht11:
  It's a humidity sensor that produces a calibrated digital humidity output. It measures the surrounding atmosphere using a humidity sensor. It has a quick response time and high quality.

C. *Component used to measure Moisture*

We use an Arduino as a microcontroller in the THIRD module to obtain soil moisture from a moisture sensor and publish it to a MQTT broker.

- Component that was used:
  Yl-69:
  It's a soil moisture sensor that measures the amount of water in the soil. It can tell if the soil is too dry or too wet. The two probes are used to pass current through the soil, and the resistance is then read to determine the moisture level.

D. Component used to visualize the data

ThingsBoard, a terrific open-source IoT platform for data visualization in real-time, is what we're utilizing to visualize data. Data-Subscriber.

py: This script is used to subscribe to data from the broker in all locations and write it to various text files. Thingsboardnorth.py and Thingsboardsouth.py are two Python modules.

These scripts scrape data from text files and upload it to the ThingsBoard server in Python.

System Flow Process:

The temperature, humidity and soil moisture sensors are placed at both north and south poles to measure temperature, moisture content and humidity at two ends of the farm. All the collected values of humidity, temperature and moisture are sent to the arduino board which contains the software and processes the results accordingly. This is monitored using the ThingsBoard server and the data is then visualized to help the farmer understand the environmental conditions and act accordingly.

The temperature, moisture and humidity levels vary from place to place. Considering values from one particular spot in the farm will not give accurate or appropriate results. Hence in-order to obtain an average value we place all the three sensors in two opposite ends of a farm. The sensors along with arduino are placed at both north and south poles. The values from two poles are averaged to know the characteristics.

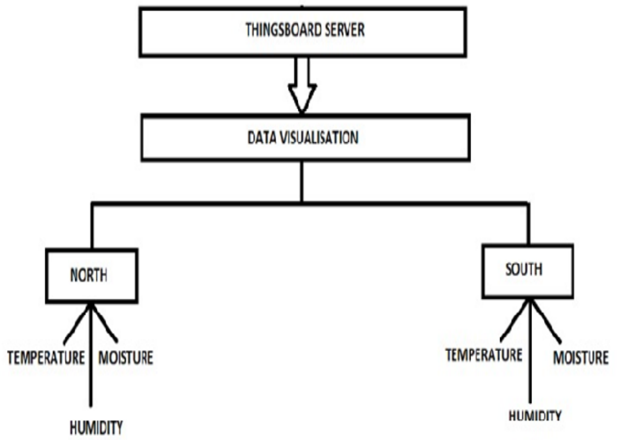

Fig. 2. Server Model Diagram

The Server model connections and responses were discussed in detail in Figure 2. We collect data such as temperature, wetness, and humidity at two separate points on the field, say north and south, and show it on the thingsboard server.

In Fig.3 We monitor the results at both poles of the field at the north and the south pole to obtain the accurate results.

This system is extremely important for a farmer to have and utilise in their fields. The system, as well as the sensors, work well. It's simple to set up and maintain. It only requires development expenditures but has negligible maintenance costs. The sensors detect the nearby surroundings and communicate the information to the Arduino board.The Arduinos are placed at both poles of the field and get the average results to get accurate results of the sensors. The acquired data is processed by the Arduino and shown on the Arduino IDE. The information or values are also supplied to the Thingsboard sensor so that the farmer may see them. The farmer does not require a smartphone or a regular phone in this situation, the Thingsboard sensor which is a part and parcel of the system is just enough. The output is shown in the form of graphs and diagrams with color differentiation so that farmer can easily understand the results and responds accordingly. This is the most significant benefit of the suggested system.

In Proposed system we considered two points in the field to measure the soil characteristics i.e., one at the north pole and other at the south pole so that the values obtained are accurate . If there is any slope in the field and if we consider only one point to measure the characteristics then the values may differ for the whole field hence we considered two points and predicts the output on average . And the other comparision is we are not using any separate software for the output display which may not be understand by the farmers how to operate so by this system farmers may be benefitted . In this system we are presenting the output in graphs with colour differentiation hence there is no confusion for the farmers about the output displayed .

IV. RESULTS AND DISCUSSIONS

Using arduino and sensors, an IoT-based SMART FARMING SYSTEM for live monitoring of temperature, humidity, and soil moisture has been presented. The system retrieves real time temperature and soil moisture data with excellent efficiency and precision. The suggested iot-based smart farming system in this study would aid farmers in boosting agriculture produce and providing efficient care, as the system will always provide a helping hand to farmers in getting accurate live feed of environmental temperature and soil moisture with correct results.

Fig. 3. North and South poles Soil Characteristics

The bar graph in fig – 3 shows the characteristics of soil which is collected using the arduinos which are placed at the north pole and south poles. The green colour represts the north pole and the blue represents the south pole. These characteristics of soil include Temperature, Humidity and moisture contents present at north and south poles.

Fig. 4. Temperature report of the Soil

The graph shown above in Fig – 4 the variations in temperature in Celsius in a particular period of time given or considered. The green color represents the variation of temperature at the north pole and the blue graph shows the variation of temperature at the south pole. Also the minimum, maximum and average temperatures at both the poles during that time interval are obtained.

Fig. 5. Humidity report of the Soil

The next important characteristic is humidity and the graph in Fig – 5 shows the variation of humidity in percentage at north and south poles in a considered amount of time interval.

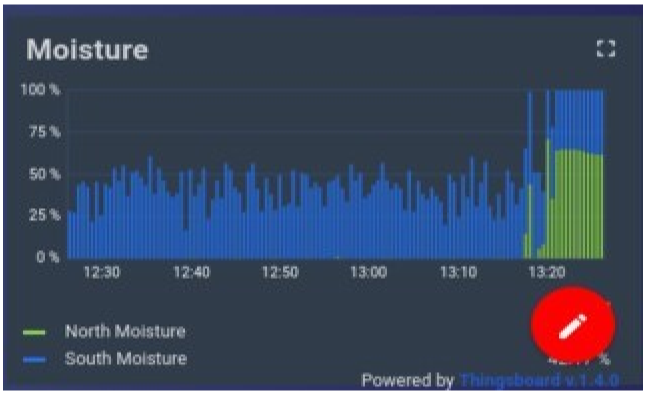

Fig. 6. Moisture report of the Soil

The green color bar graph shows the variation of humidity at north pole and the blue color shows the humidity variation at the south pole. This also shows the average humidity at north and south poles.
Moisture content in soil is very important for healthy growth of the crop. The graph in Fig – 6 shows the moisture content in percentage at both the poles in a particular or considered amount of time. The green color represents the north pole and the blue represents the south pole. In the above graph the moisture content is greater at the south pole as the water are flowing from higher region to lower region in the considered land area.
As it is bulit on already existing server , there is no broadcast communication via wifi or cellular network. Sensors are used mostly to measure the data so we can only obtain numerical digital values. No screening of crops leads to lack of image or picture data which in turns doen not specify plant related problems.Mostly centered around field conditions than plant conditions.

V. FUTURE SCOPE

All collected data can form a large data set which will be useful to train a learning model in order to predict future changes in the field attributes.Additional sensors and screening can be added around the field in order to collect image data and address plant related diseases and problems more accurately.WiFi module can be attached so that the data can be directly sent to farmer mobile not specifically smart phone. This system will include the intelligent system which will analyze the frequency of water supply to a specific crop on the basis of weather condition and will identify the amount of water required in the field to prevent the crop from damage and send this information to farmer via SMS or e-Mail to ensure the arrangement of enough water for healthy farming. Machine learning can be used to detect unidentified objects like to prevent crops from animals using Camera Motion Sensor and further an image can be sent via MMS to farmer as alert message.

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REFERENCES

[1] Sangeetha K, Karishma K, Smart Farming Using IoT ,*International Research Journal on Advanced Science Hub – 2021*

[2] Asadi Venkata Mutyalamma, Gopisetty Yoshitha, Althi Dakshyani, Bachala Venkata Padmavathi Smart Agriculture to Measure Humidity, Temperature, Moisture, Ph. of the Soil using IoT, International Journal of Engineering and Advanced Technology (IJEAT) – 2020

[3] Dr.S.Velmurugan, V. Balaji, T. Manoj Bharathi, K. Saravanan An IOT Based Smart Irrigation Using Soil Moisture and Weather Prediction, International Journal of Engineering and Advanced Technology (IJEAT) – 2020

[4] Swaraj C M ,K M Sowmyashree, IOT based Smart Agriculture Monitoring and Irrigation System, International Journal of Engineering and Advanced Technology (IJEAT) – 2020

[5] Ritika Srivastava,Vishal Jaiswal, A Research Paper On Smart Agriculture Using Iot, ciit research -2020

[6] R.Mythili, Meenakshi Kumari, IoT Based Smart Farm Monitoring System, International Journal of Recent Technology and Engineering (IJRTE) – 2019

[7] Lal Bihari Barik, IoT based Temperature and Humidity Controlling using Arduino and Raspberry Pi, (IJACSA) International Journal of Advanced Computer Science and Applications – 2019

[8] Sangeetha K,Karishma K, A study on smart irrigation system using IoT, Publisher of International Academic Journals – 2019

[9] JashDoshi, TirthkumarPatel, Santosh kumarBharti Smart Farming using IoT, a solution for optimally monitoring farming conditions, sceincedirect – 2019

[10] Nor Adni Mat Leh, Smart Irrigation System Using Internet of Things, Institute of Electrical and Electronics Engineers (IEEE) – 2019

[11] Muhammad Ayaz; Mohammad Ammad-Uddin- IoT –Based Smart Agriculture: Toward Making the Fields Talk, Research Gate – 2019

[12] Ferdin Joe John Joseph, IoT Based Weather Monitoring System for Effective Analytics, International Journal of Engineering and Advanced Technology(IJEAT) – 2019

[13] Yung- Chung Tsao, Yin Te Tsai, Yaw – Wen Kuo, An Implementation of Iot –Based Weather Monitoring System", IEEE International Conferences on Ubiquitous Computing and Communications (IUCC) and Data Science and Computational Intelligence (DSCI) and Smart Computing , Networking and Services (SmartCNS) – 2019

[14] AbdelRahman, H.Hussein, Internet of Things(IOT) : Research Challenges and Future Applications , International Journal of Advanced Computer Sceince and Applications(IJACSA) – 2019

[15] Mohd Javaid ,Ibrahim Haleem Khan, Internet of Things(IoT) enabled healthcare helps to take the challenges of COVID – 19 Pandemic, Journal of Oral Biology and Craniofacial Reasearch – 2019

[16] Abdullah Ahmad, William Isaac, An IoT based system for remote monitoring of soil characteristics, International Conference on Information Technology (InCITe) – 2018

[17] Nicolas Havar , Sean McGrath, Colin Flanagan, Ciaran MacNamee, Smart Building Based on Internet of Things Technology, Twelfth International Conference of Sensing Technology(ICST) -2018

[18] T.K.Rana, Smart Farming Using IOT, Institute of Electrical and Electronics Engineers (IEEE) – 2017

[19] Suhas Athani; C H Tejeshwar; Mayur M Patil, Soil moisture monitoring using IoT enabled arduino sensors with neural networks, Institute of Electrical and Electronics Engineers (IEEE) – 2017

[20] Ravi Kishore, Snehashish Mandal IoT based weather station, Institute of Electrical and Electronics Engineers (IEEE) – 2016

[21] Vijaya Saraswathi R., Nalluri S., Ramasubbareddy S., Govinda K., Swetha E. (2020) Brilliant Corp Yield Prediction Utilizing Internet of Things. In: Raju K., Senkerik R., Lanka S., Rajagopal V. (eds) Data Engineering and Communication Technology. Advances in Intelligent Systems and Computing, vol 1079. Springer, Singapore. https://doi.org/10.1007/978-981-15-1097-7_75

[22] R. V. Saraswathi, V. Bitla, P. Radhika and T. N. Kumar, "Leaf Disease Detection and Remedy Suggestion Using Convolutional Neural Networks," *2021 5th International Conference on Computing Methodologies and Communication (ICCMC)*, 2021, pp. 788-794, doi: 10.1109/ICCMC51019.2021.9418013.

[23] Rakhee, K. Ohri, R. V. Saraswathi and L. J. Vinita, "Performance Analysis of Wireless Body Area Sensor Analytics using Clustering Technique," *2019 International Conference on Communication and Signal Processing (ICCSP)*, 2019, pp. 0278-0281, doi: 10.1109/ICCSP.2019.8697963.

[24] R. V. Saraswathi, L. P. Sree and K. Anuradha, "Dynamic and probabilistic key management for distributed wireless sensor networks," *2016 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, 2016, pp. 1-6, doi: 10.1109/ICCIC.2016.7919666.

[25] R.V.Saraswathi, L. P. Sree, and K. Anuradha, "Multi-stage Key Management Scheme for Cluster based WSN,", International Journal of Communication Networks and Information Security, Vol. 10, No. 3, pp. 552, 2018.

[26] Vijaya Saraswathi R., Padma Sree L., Anuradha K. (2020) Secured Cluster-Based Distributed Dynamic Group Key Management for Wireless Sensor Networks. In: Pant M., Sharma T., Basterrech S., Banerjee C. (eds) Computational Network Application Tools for Performance Management. Asset Analytics (Performance and Safety Management). Springer, Singapore. https://doi.org/10.1007/978-981-32-9585-8_18

[27] Vijaya Saraswathi R., Padma Sree L., Anuradha K, "Dynamic group key management scheme for clustered wireless sensor networks" International Journal of Grid and Utility Computing(2020), Vol. 11, No.6.