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Research Article

A Process Of Implementing Zigbee Protocol With Machine Learning Algorithm For Greenhouse Set-Up

E Mercy Beulah[1], Dr. S Radha Rammohan[2]

[1]Research Scholor, Department of Computer Science and Engineering
[2]Professor, Department of Computer Applications Dr.M.G.R Eductational and Research Institute, Chennai (India)

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Abstract : The greenhouse effect is considered as the natural process used for warming the earth's surface. When energy from the sun reaches the earth's atmosphere, some of its power will be reflected in space, and the remaining energy will be absorbed. The greenhouse gases will redirect it. One of the main advantages of greenhouse gas is that it has a protective benefit in agro-system compared to open-air cultivation and unprotected cultivation. But monitoring of greenhouse in agricultural and other environments seems to be a difficult task in the present time. Because it will be used for regulated environmental aspects such as temperature, humidity, light, gas, pH-level, and soil, Green House operation has been incorporated with IoT protocols in this research paper. The Zigbee 3.0 protocol helps in increasing the effectiveness of monitoring the greenhouse system. This paper aims to present a novel wireless Internet of Things network-based ZigBee technology for monitoring and controlling greenhouse climate. Because they are some significant parameter need to be monitored in the Greenhouse system, this protocol starts monitoring the Internet of Things connected to the wireless Internet of Things network.Along with protocol, In this research, a Cloud and Internet of Internet of Things-based algorithms such as the Reinforcement Learning- (RL), RF(Random Forest), and EAD(enhanced AdaBoost has been implemented to monitor the GH parameter. The performance evolution of the Algorithm is compared to show which Algorithm is capable of monitoring the GH parameter. This research aims to produce a real-time module for monitoring and controlling the parameter because it can measure the Execution time, memory, energy consumption, and overall accuracy.

Keywords: Greenhouse Effect, WSN, GH parameters, Scheduling, real-time data, Zigbee 3.0

1. Introduction

[1] GH industry is the one that is overgrowing in this present time. GH helps separate the crop from the environment from which it provides a way for direct weather condition for the cultivation of crop growth. Crop production takes place in all geographic locations; otherwise, crop production will be suited to a particular area. GH makes all kinds of a site suitable for crop growth. It is beneficial for farmers to cultivate plants according to their needs. GH effects lead to a more extended production period, use of protective chemicals, higher crop yield. The value per unit area in GH crops is higher than that of open-field cultivation.

[2] proposed a framework using a real-time Scheduling algorithm for the GH effect in the Cloud system. The cloud-based system allows real-time valuation of parameters to meet the requirement of the GH effect. The Cloud system also ensures that storage, bandwidth, and computing processes will be generated at a lower cost.

[3] real-time Scheduling algorithm in GH using a cloud-based system can be done through 3 steps

1. Discovering of data resource
2. Selection of the resource.'
3. Submitting the task

[4] Data-driven models are used in the cloud-based for GH effect. The most commonly used models are the ANN, SVM, generalized linear model, etc.; because these models are made of special characters, only fewer restrictions are found in the model, excellent predicting ability, [5] having the flexibility to adapt to inputs.

[6] states that ML, Wavelet-based filtering, linear polarization, and a regression model are the most commonly used techniques for analyzing agricultural data. The deep learning method is also gaining more popularity for dealing with agrarian data along with this technique.

[7,8] DL also belongs to the machine learning approach, which is a form of a deeper neural network that is very useful for providing hierarchical representation of GH. If the Deep learning method is used for real-time scheduling algorithms, it gives higher performance and precision. One of the most significant advantages of using DL for real-time Scheduling is that it helps extract features from raw data through which hierarchy can be formed using low-level features. The deep learning method provides the classification and regression of the data model with higher accuracy.

[9] proposed a framework utilizing SVR, KN, multiple linear Regression, ANN, M5-prime, etc. a comparative study was carried out using these algorithms for crop datasets. The accuracy metric used for validating the data is RMS, RRSE, MAE, R, etc. from the outcome of this result, the M5-prime model yields better results than other models. [11,12] proposed a framework for analyzing the stem diameter, an essential parameter for plant growth.

2. Proposed Methodology

In this paper, GH monitoring is done with the help of a WSN network that contains the DC-power supply, a Microcontroller, along with Zigbee version 3 protocol to send the data to the cloud system without any traffic. Also, the model is incorporated with temperature, humidity, gas Internet of Things array, and URL reputation. The URL Reputation feature lets you block access to the web addresses identified as known sources of malicious content. Initially, the hardware connection of the prototype will be configured to the proposed protocol to make the components communicate with each other. The Internet of Thingss such as the temperature Internet of Things, humidity Internet of Things, and gas Internet of Things will be connected to the PIC. Then, testing will be conducted to know the working principle of the Internet of Thingss. Fig 1 shows the block diagram of the wireless Internet of Things network incorporated with Zigbee 3.0 for GH monitoring.

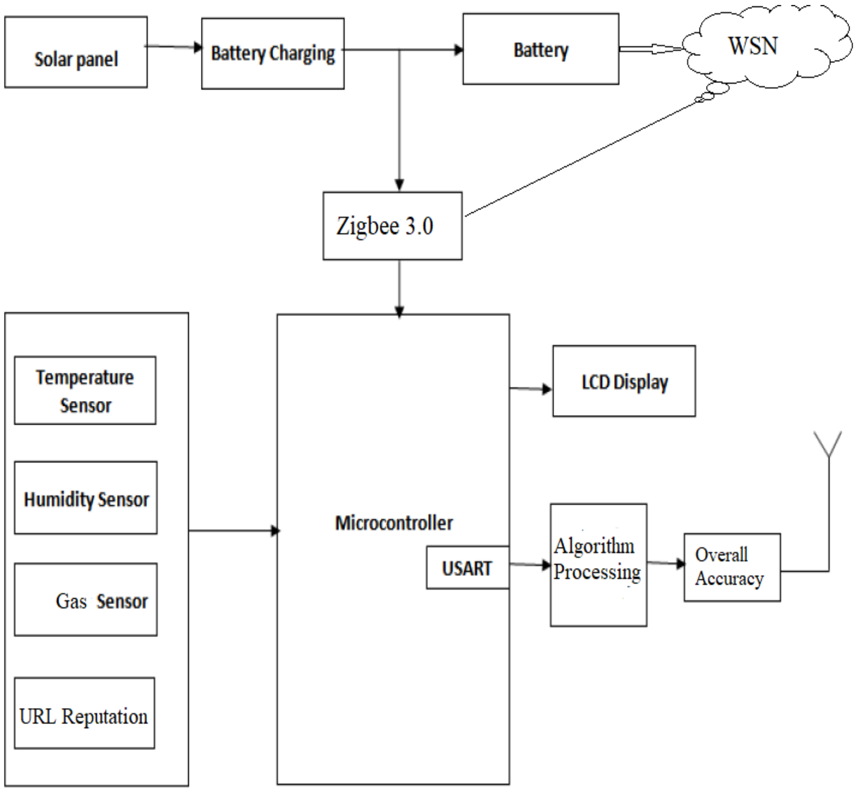

Fig.1 Block diagram of the wireless Internet of Things network incorporated with Zigbee 3.0 for GH monitoring

The temperature, gas, and humidity Internet of Things will collect the careful reading of the Greenhouse effect. The collected data will be converted to an Analog-to-digital process (A2D). The data will be sent to the Zigbee 3.0 protocol. The temperature, humidity, and gas Internet of Things reading will be displayed in the Wireless Internet of Things Network with the help of the LCD screen for the user to monitor the data carefully. A hardware development process is a structure imposed on developing a hardware product that includes a Printed Circuit Board (PCB) design using Proteus software. The Internet of Thingss present in the hardware system collect data from the GH system's surroundings like the humidity, temperature, gas leakage, light intensity, moisture, and soil range, etc. Through ubidots, the data will be uploaded to the cloud system in real-time. For the user to access and monitor the data from any place at any time. If the GH parameter crosses the threshold point, the cloud system will notify the change and report it to the user through an app present in the user's smartphone.

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2.1 Components Used:

2.1.1 DHT22 Temperature and Humidity Internet of Things:

The DH22 is the temperature and humidity Internet of Things used for monitoring the temperature and humidity values. This is one of the basic Internet of Things monitors available at a low cost. It contains a capacitive humidity Internet of Things and a thermistor used for measuring the environmental air. After measuring the air value, it then spits the data in digital form. This Internet of Things can be accessed quickly, but it also requires accurate timing. This Internet of Things notifies new reading every 2 seconds. Compared to DHT11, this Internet of Things is more accurate, more precise, and works in a more significant range.

2.1.2 KG003 Gas Leakage Internet of Things:

This Internet of Things helps detect the leakage or predict the reason for gas leakage, especially due to the source of the surrounding. Carbon Monoxide can be ultimate reason for the increase in gas leakage. Thi Internet of Things notifies the user of the HIGH or the LOW means of gas leakage than the threshold set by the potentiometer. This Internet of Things works with 3.2 to 5 operational voltage. It has an onboard LM393 comparator, a power indicator LED — and a digital switching indicator.

2.1.3 MCP3008 ADC (Analog to Digital converter):

The MCP3008 is a minimal effort 8-channel 10-cycle simple to advanced converter. Fig.2 shows the MCP3008 Analog-2-Digital Converter. The accuracy of this ADC is like that of an Arduino Uno, and with 8 channels, you can peruse many simple signs from the Pi. This chip is an extraordinary choice on the off chance that you simply need to peruse basic simple signs, as from a temperature or light Internet of Things—the MCP3008 associates with the Raspberry Pi utilizing an SPI sequential association. You can use either the equipment SPI transport or any four GPIO pins and programming SPI to converse with the MCP3008. Programming SPI is somewhat more adaptable since it can work with any pins on the Pi, while equipment SPI is marginally quicker yet less adaptable in light of the fact that it just works with explicit pins.

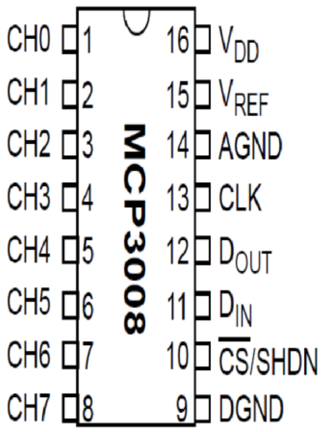

Fig.2 MCP3008 Analog-2-Digital Converter

2.2 Proposed algorithm for GH monitoring

A. Reinforced Learning [RL]

[12] It is challenging for the GH industries to find an automatic system for monitoring and controlling the GH parameters. The RL is one of the powerful tools used for autonomous decision-making. The fig (3) shows the schematic diagram of Reinforced Learning. The RL can help monitor the multiple factors such as the CO_2 and the temperature reason for the system.

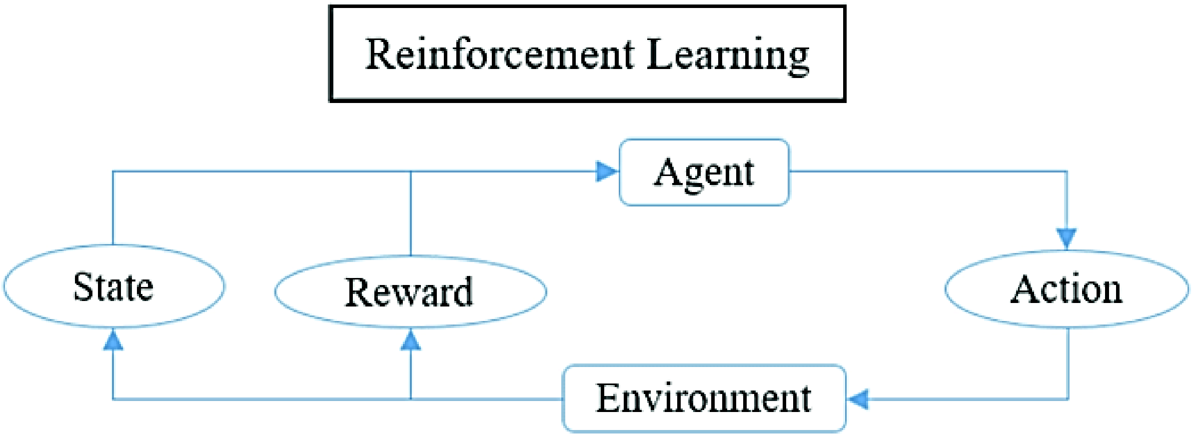

Fig.3 Schematic diagram of Reinforced Learning for GH monitoring

[13] Reinforcement learning tries to explore the simulation in the outcome process. This research paper tries to provide an application for effective monitoring of the Greenhouse climate control and monitoring process.

B. Random Forest (RF)

[19] It is one of the vital algorithms for the GH effect and Scheduling of real-time data. It uses sub-space for constructing the model. This was initially developed by Ho in the year 1988. The RF uses a decision tree. In this single algorithm predictor is not enough for predicting the value of the dataset. The critical reason for that is due to sampling data; the single predictor is not having the capability of differentiating the patterns and noise. In RF various individualistic regression trees, bootstrap is used in each regression tree.. the regression in this process reaches maximum size.

C. EAD

This Algorithm in Greenhouse effects mainly focuses on the classification process. The process involved in classification is training the weak learner using an updated version of trained data. Through which the weak learner helps in promoting better results [20]. The boosting procedure in this Algorithm mainly focuses on the Machine learning process. Statistical boosting is also one of the boosting methods preferred for booting the weak learning data's performance. Adaboost sometimes acts as an additive logistic regression model. It is the most potent classification model which is mainly used in the field of computer vision, biology, and speech processing. When compared to the support vector machine, AdaBoost can achieve the same classification result with fewer tweaking parameters. Fig. 4 illustrates the Schematic diagram of EAD for GH monitoring.

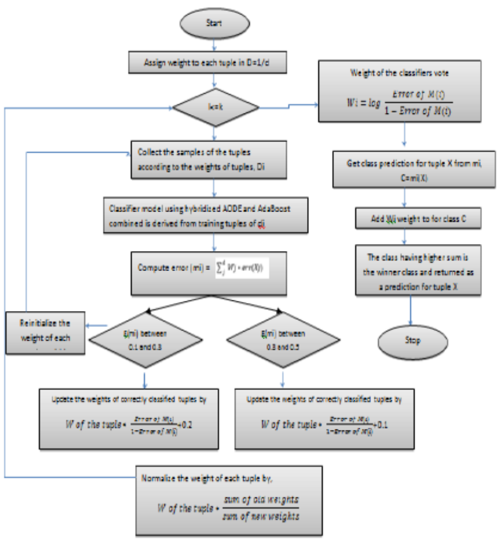

Fig.4 Schematic diagram of EAD for GH monitoring

3. Experimentation

3.1 HARDWARE IMPLEMENTATION AND WORKING

The Wireless Internet of Things network incorporated with the Zigbee 3.0 monitors the critical parameter of the GH effect, namely the gas leakage, temperature, and humidity. The DHT22 Internet of Things is used for monitoring the temperature and humidity value. The KG003 Internet of Things is used for monitoring gas leakage due to the environmental situation around the GH system. Table 1 shows the reading determined by the corresponding Internet of Things with a number of trails. The gas Internet of Things takes 12 rounds of trials to recordings the values. The DHT22 takes about 11 and 14 trails for recording the temperature and humidity value.

Table.1 DATABASE obtained from actuation system

Gas Internet of Things –arrays	21,00,938	24,10,322	12	3.1GB
Temperature Internet of Things-arrays	20,10,312	23,66,878	11	2.9GB
Humidity Internet of Things-arrays	22,00,012	25,43,767	14	3.1GB
URL reputations	19,33,003	23,54,543	18	2.8GB

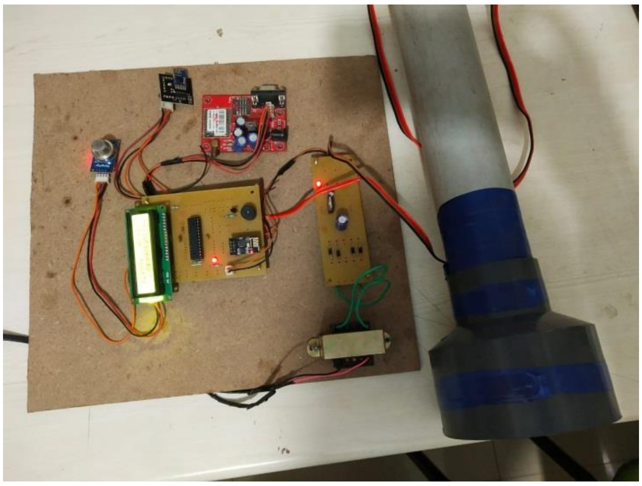

Fig.5 Overall Experimental Set-up

Fig 5 shows the overall experimental set-up of the Greenhouse monitoring system incorporating the Zigbee 3.0 WSN protocol. Where the primary server is connected with the Internet of Things. Once the reading is taken from the Internet of Things, it displays the value on the LCD screen. Through which the user can monitor the value.

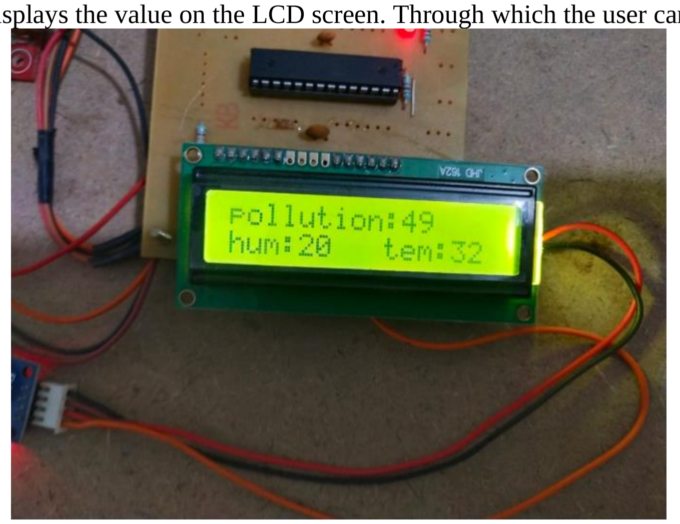

Fig.6 illustration of humidity and temperature Internet of Things

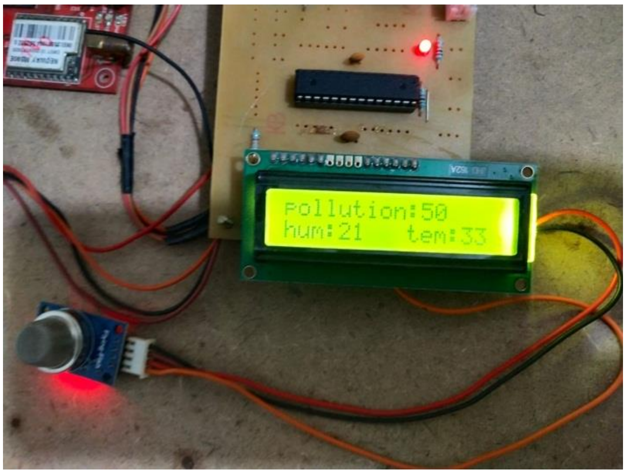

Fig.7 illustration of humidity and temperature Internet of Things

Fig 6 and 7 show the reading from the DHT22 Temperature and Humidity Internet of Things. Fig 6 shows the temperature at the range of 32 and humidity at the range of 20 with the pollution from the surrounding as 49. Fig 7 shows the temperature at the range of 33 and humidity at the range of 21 with the pollution from the surrounding as 50. More trails have been taken for monitoring the GH parameter at different sequences based on the environment. This data can be accessed by the user on the ubidots dashboard directly or using an android app which will show the results of continuous monitoring of various parameters.

3. Result and Discussion

This experiment of monitoring the Green House effect and its corresponding parameters such as the temperature, humidity, and gas level is observed with the performance of the nodes and the Internet of Things of the related parameters. As well, as performance evolution of the GH set-up is done with the help of the three proposed algorithms. It helps identify the overall energy consumed for monitoring the system, execution time, memory, and the overall accurate performance evolution.

4.1 Performance evolution from the Internet of Things nodes

This experiment is conducted with the help of the WSN based Zigbee 3.0 protocol on the could system.

Table 2 represents the value of the DHT22 Temperature and Humidity Internet of Things, which recorded over 80 trails with temperature Internet of Things and 37 with humidity Internet of Things with the interval gap of 20 minutes in the temperature Internet of Things and 10 minutes gap in the humidity Internet of Things. The average value obtained from the experiment is used for plotting the graph. The following graph (a&b) describes the temperature and humidity values.

Table 2: DHT22 Temperature and Humidity Internet of Things Readings

Humidity (%)	Temperature (Celsius)
31	26
32	27
33	28
34	29
35	25
36	21
37	18
38	19
39	19
39	15

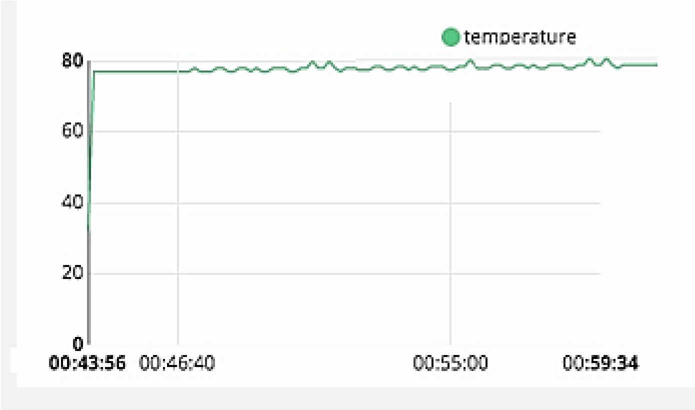

Fig.8 Temperature readings from the DHT22 Internet of Things

In the temperature graph, the time is taken on the x-axis, and the temperature value is taken on the y-axis.

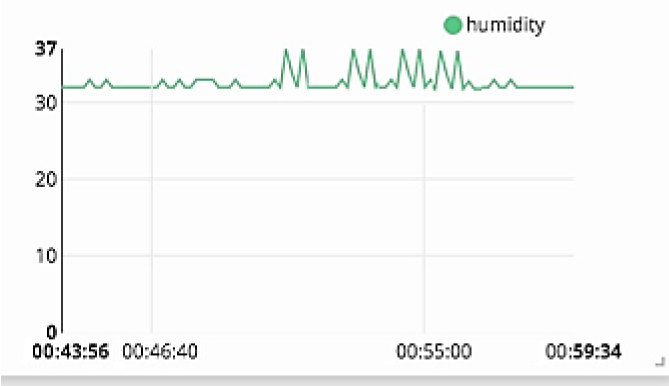

Fig. 9 Humidity readings from the DHT22 Internet of Things

Fig 9 shows the values obtained from the humidity Internet of Things where seconds were considered on the x-axis, and the humidity is shown along the y-axis. The humidity was found to be above 32 percent. The humidity reading fluctuates after 48 seconds. Also, there was no delay in the packet delivery, and no loss of packets was found in this process. The humidity reading was noted with the help of the DHT22 Temperature and Humidity Internet of Things. The packets will be delivered to the Zigbee 3.0 protocol from there; they will reach the clients.

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Table 3: KG003 Gas Internet of Things readings

Gas Leaks	Carbon Monoxide
81	111
83	113
89	113
93	115
96	118
189	181
531	223
515	207
268	320
222	316

Table 3 describes the readings of the KG003 Gas Internet of Things. The value obtained from the readings is plotted in the form of a graph. In the proposed, there was a sudden leakage of gas while burning woods. The readings recorded using the KG003 Gas Internet of Things also consider the gas present in the environment, including H2, Ch4, and LPG. The readings were noted with time intervals. CO (Carbon Monoxide) levels present in the gas increase with the time gap.

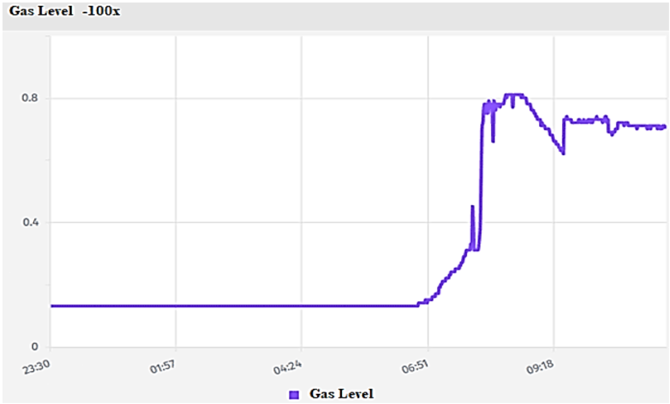


Fig. 10 Gas reading From the KG003 Gas Internet of Things

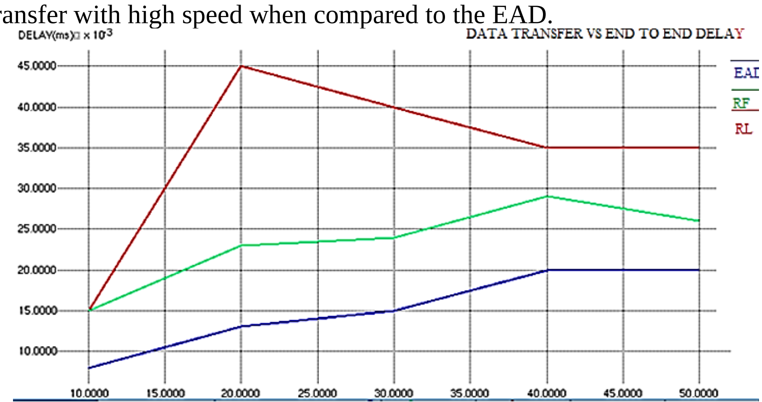
Fig. 10 shows the peak rise in the gas reading. It attained the peak level after the time gap of 6.51 seconds. The readings were immediately transferred to the Zigbee 3.0 to display them to the clients and the WSN network. So that the delay in the display could be avoided. To control gas leakage, immediate action is required from the client's side.

4.2 Performance evolution from the three-proposed Algorithm

The Internet of Things node collects data from the Zigbee 3.0 and sends it to the Wireless Internet of Things Network. The measured readings from the DH22 Internet of Things and the KG003 Internet of Things will be sent to the cloud system. From there, it will be monitored by the user. The proposed 3 algorithms, the [Random Forest, Reinforced Learning, and the Enhanced Adaboost], helps in transferring the data from the Zigbee 3.0 to the WSN. The following Graph 1 (a&b) show the data transfer by the proposed Algorithm with an end-2-end delay.

a

The above graph shows that the packet or the data is transferred at high speed with the help of EAD. The other Algorithm could not transfer with high speed when compared to the EAD.



b

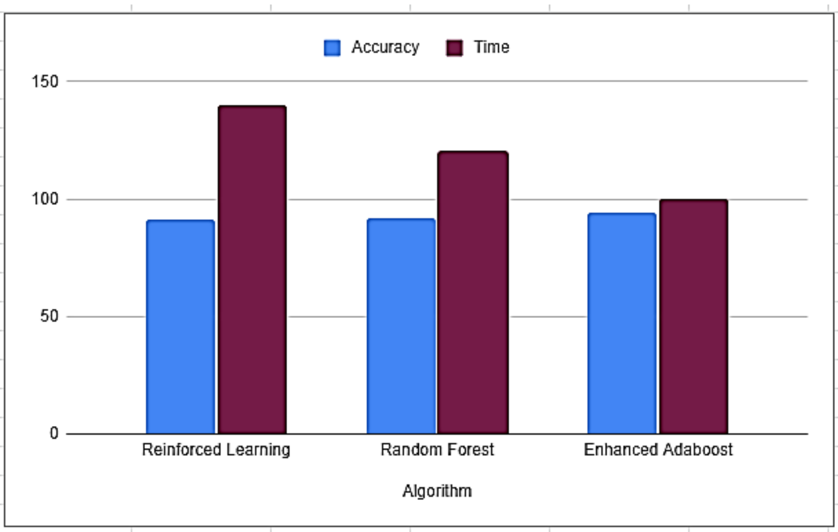
Graph 1 a and b DATA TRANSFER VS END TO END DELAY

The above graph shows the delay time while transferring the data to the Cloud system from Zigbee 3.0. the Reinforced Learning algorithm takes more time for transmitting the data. When compared to RL, the RF and EAD take lesser time. It is highly beneficial for the user to utilize Enhanced Adaboost for transmitting the data through which the data can be transferred within a short time to the entire network. The user can closely monitor the parameters of the Greenhouse set-up without any delay. Through the accuracy can be maintained at the maximum level.

Table.4 Comparative performance Evaluation of the proposed 3 algorithms.

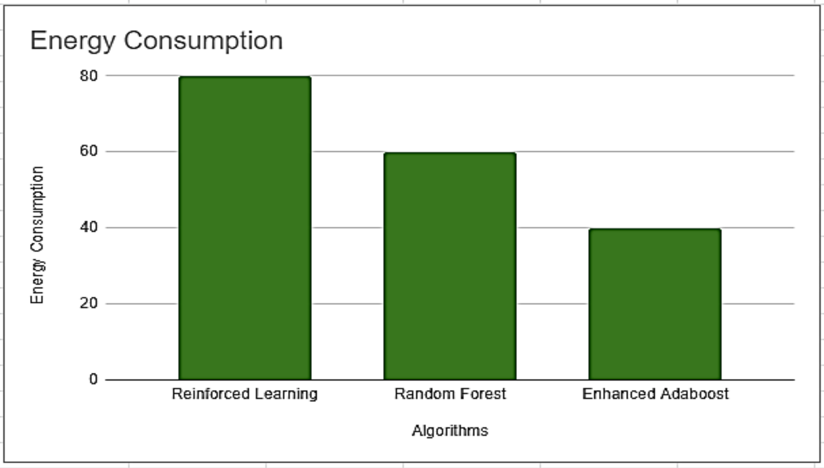
ALGORITHM	EXECUTION TIME	MEMORY	Energy Consumption watts	OVERALL ACCURACY
Reinforcement Learning (RL)	148	4334.0	185	91
RF(Random Forest)	124	3434.0	142	92.5
EAD(enhanced adaboost)	105	3231.0	123	94.6

Table 4 describes the performance of the proposed 3 algorithms. From the Algorithm, the execution time for transferring the data, the memory required for data transfer, energy consumed by them for transmitting the data can be evolved. As well as the overall performance accuracy of the proposed model is important to analyze. The proposed three algorithms, Enhanced Adaboost, showcase better performance using execution time, memory, and energy consumption (refer fig). The overall accuracy was obtained with the help of EAD. The overall accuracy found from RF was 91%, 92.5 percent from RF, and 94.6 % from EAD. It is clear that the Enhanced Adaboost serves better through accuracy for the Greenhouse system. The overall accuracy of the Algorithm is illustrated using the following graph.



Graph 2. Accuracy and Execution time

The above graph shows that the Enhanced Adaboost consumes less energy for storing the data and transmitting it to the Greenhouse WSN system from the Zigbee 3.0. at the same time, the remaining two algorithms the RL, and the RF, consume more energy for transferring the data.



Graph.3 Overall accuracy

The overall accuracy was obtained with the help of EAD. The overall accuracy found from RF was 91%, 92.5 percent from RF, and 94.6 % from EAD. It is clear that the Enhanced Adaboost serves better through accuracy for the Greenhouse system. The overall accuracy of the Algorithm is illustrated using the above graph.

4. Conclusion

This research work mainly focuses on providing effective solutions for the GH application. Green House operation has been incorporated with IoT protocols in this research paper. The Zigbee 3.0 protocol helps in increasing the effectiveness of monitoring the greenhouse system. Along with protocol, In this research, a Cloud and Internet of Internet of Things-based algorithms such as the Reinforcement Learning- (RL), RF(Random Forest), and EAD(enhanced AdaBoost has been implemented to monitor the GH parameter. The performance evolution of the Algorithm is compared to show which Algorithm is capable of monitoring the GH parameter. The overall accuracy was obtained with the help of EAD. The overall accuracy found from RF was 91%, 92.5 percent from RF, and 94.6 % from EAD. It is clear that the Enhanced Adaboost serves better through accuracy for the Greenhouse system. The Enhanced Adaboost seems to be a very promising algorithm for the Greenhouse monitoring system.

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