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ORIGINAL ARTICLE

IoT SENSOR DATA RETRIEVAL AND ANALYSIS THROUGH CLOUD ENVIRONMENT FOR EFFECTIVE POWER MANAGEMENT

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Abstract
Due to the massive growth in numbers of Internet of Things (IoT) gadgets, there is an unprecedented rise in sensor-generated data, which presents new challenges in the effective data retrieval, processing, and use in energy-conscious applications. In smart environments like smart grids, smart buildings and industrial automation, where constant monitoring and smart decision-making are required, effective power management has become a critical need. Conventional power management systems tend to be poor in delays in processing data, scalability, and the efficient use of sensor data, which leads to wastage of energy and poor functionality of such systems. This paper introduces a model of retrieving and analyzing data through an IoT sensor using a cloud environment as an effective power management model. The system suggests distributed IoT sensors used to constantly track electrical parameters, including voltage, current, power consumption, and environmental conditions. The sensor data is sent safely into a cloud-based platform where it is stored, accessed and the data processed in real time. Heavy data analytics are used to derive meaningful insights, identify abnormal power consumption patterns, and can be used to support energy optimization plans. The cloud architecture allows scalable storage and high-performance computation, which allows the system to effectively process large quantities of heterogeneous sensor data. The visualization tools and real-time dashboards give users and administrators an actionable insight into the trend in energy consumption and system behavior. As well, the framework promotes automated control systems which regulate the power consumption according to the demand, load conditions and pre-established policies. Through experimental assessment, the proposed solution is proven to be efficient in data retrieval, decreasing the response time, and increasing the overall energy usage compared to the standard power management systems. The findings outline the efficiency of IoT sensing combined with cloud-based analytics in implementing intelligent, large-scale, and scalable power management solutions.

Keywords: *internet of things; sensor; power efficiency; data management*

1. Introduction
The IoT word came about very fast because of the significant developments in information and communication technologies, which appear to be immense additions to the virtual world. IoT is an acronym that is pronounced like a rapidly expanding sector. After all, it is common knowledge that some individuals consider an assessment of technology since the Internet of Things (IoT) influences the daily life of the population [1]. It has affected displacement, study and even completely transformed cities to the extent of being transformed. Everything becomes smarter because of the capability of the devices to communicate with one another, independently do tasks, and even provide measurements and results. It is also necessary to state that IoT is emerging to be critical to track and control smart structures. Big Data appears to be another name which defines a massive size of the information produced by all this related equipment. The most popular type of IoT-Big Data BD is the type called BD. The other argument is that DB and IoT must be developed jointly due to the fact that they are linked technologies [2]. In this article, we attempt to gather, transfer and analyze the large quantities of information uploaded to the cloud platform, and over the Internet. Each of all the technologies above may be used in complex systems that facilitate and implement effective Smart City solutions. Some of these ideas included cost cuts as well as a more

relaxed, healthier and less harsh environment. Smart city components include Smart grid, Smart structures, Intelligent people, Smart facilities, Smart technologies, and many others. This essay will focus on Smart Building and other projects. Such a structure will enable a better surveillance of the neighborhood sensor network. The information available in the proposed master unit is collected via the network of the sensors deployed, which have been distributed throughout the house and its environs, and it is automatically identified that the sensors are interdependent [34]. Moreover, to minimize redundancy use and wastage of energy, the sensors were operated in real-time so that they could extract knowledge instantly. A candid and transparent review of the pros and cons of a building fully connected and controlled by IoT in terms of cost-effective energy consumption in contrast to the conventional and old-fashioned automated systems has been presented. There exist continuous plans to have an interoperative, intelligent, current architecture that would combine the power of the current automation with future enhancement to generate better building management systems [5]. In such a manner, the researchers amalgamated consistent information as fundamental attributes. Integration would work towards controlling the behavior of the interior building safety and management systems [6].

The aspect that the proposed framework has been articulated in seems to be a full site named City Explorer which provides safety and exploration. To create a simple simulation of the pervasive environment, the researcher offered a model and independent generation of characters which supervise our activities in intelligent homes [7]. The proposed simulation model provided a 3D interactive interface. This 3D-GUI interface would activate virtual detectors which will work as an actual sensor and relative position [8]. The simulators also offer an agent that is artificially effective in terms of facilitating smart homes. This is a behavioral planning methodology [9]. One way of reducing the total structures that generate projections of this usage [10]. A typical format is also applied to research whereby researchers will have a year of reliable information to justify the proposed alternative. These measures are the protective measures and the schemes of power measurement in the structure suggested by the authors towards the conclusion [11]. A system of monitoring and detection of IoT that would be wirelessly linked was proposed in order to measure the temperature, moisture and light in a building [12]. There is also an android application developed that contains the information to be transferred out of the infrastructure and programmer developed known as Laboratories Digital Instrumentation Architecture Workspace to an intelligent smartphone to enable it be viewed remotely [13]. The fast development of the Internet of Things (IoT) has changed the conventional power management systems and allowed their continuity in sensing, real-time monitoring, as well as making intelligent decisions with the help of IoT technology. The importance of efficient retrieval and analysis of this sensor data is fundamental in enhancing energy efficiency, low cost of operations and reliability of the modern power infrastructures. Traditional methods of power management are based on the collection and analysis of data periodically, which in many cases cannot reflect the dynamic pattern of consumption and unexpected variations in demand. Such restrictions cause poor use of energy, slow fault detection, and loss of power. On the contrary, IoT-based systems facilitate continuous data collection of distant sensors that provide the opportunity to have fine-grained insight into power utilization in residential, industrial, and smart grid frameworks.

Cloud computing is also critical in solving the storage, scaling, and calculations issues of a large scale of IoT sensor data. It is possible to send sensor data using cloud platforms and IoT networks to transmit, store, and process data in real time, safely. Such advanced data processing methods as aggregation, pattern recognition, and predictive modeling are supported by cloud-based analytics and are critical to the smart management of power and proactive control policies. It is possible to perform accurate load forecasting, detect anomalies and optimize energy with the help of effective analysis of IoT sensor data. The machine learning and data analytics methods implemented on the cloud environment are capable of detecting the hidden patterns of consumption, forecasting the peak demand, and providing energy-saving measures. The use of this data-driven methodology improves the accuracy of decisions and contributes to automated power management systems that dynamically react to the changing environment. Although these have a number of benefits, there are a number of challenges facing the IoT-based power management systems, such as the latency in data transmission, security concerns, interoperability and energy limitations of sensor nodes. It needs efficient data retrieval protocols and low-weight communication protocols to ensure timely and reliable data transmission and require minimum power usage. These issues must be addressed to come up with sustainable and scalable IoT-enabled power management solutions. In that regard, incorporation of IoT sensor networks with cloud-based data retrieval and analytical systems provide an opportunity to successfully manage power issues. Such systems can greatly improve energy efficiency, system reliability and operational sustainability by taking advantage of real-time sensing, scalable cloud infrastructure and smart analytics. The present study aims at developing and evaluating an IoT-cloud architecture that facilitates effective sensor data retrieval and smart power control of the contemporary energy networks.

2. Related Works

Cloud-based IoT-based information storage technologies need to strike 3 pairs of conflicting needs, namely multi-tenant collection and isolation efficiency, scaling with flexibility, and decentralized executions with unified control of infrastructure services. Bespoke requirements were also provided in the case of massive, true, and including unstructured data preparation that involves numerous steps, including collected data, storage systems, and analysis methods [14 -16], through the application of cloud applications to exchange, process, and integrate the IoT data. This paper initially proposes a pragmatic framework which specifies the areas of collection, administration, disposal, and extraction of information based on the information processing role. In regard to their critical attributes and power, a number of related business units have been identified and explained [17]. The challenges involving the corresponding functional categories were subsequently determined through the study of the recent developments in the use of IoT. The stored information could be accessed by the consumers through the terminals that the cloud service provider offered. This type of architecture appears to have a drawback in the form of the long lag nature of cloud-based digital storage methods, yet [18]. In order to integrate, without any difficulties, the approaches of storing files in the IoT with the existing information systems deployed in enterprises, a paradigm consisting of front, middle and back layers was offered. With the current advanced technologies in data technology, this strategy would be embraced by the data processors [19].

To store a lot of various information, a hybrid approach of text approach and object-oriented strategy were suggested in order to maximize information storage and retrieval. Moreover, some technical specifications were also mentioned [20]. A system of downloading software to the IoT systems through the cloud can be done in a polynomial-time method developed by scientists. In order to achieve high efficiency levels, this approach can be used to determine the quantity of energy that will be distributed depending on the buffer order book and also the state of network communications [21]. The relationship between the components of a city of the future turns out to be the foundation of a distinctive survey methodology [22]. In particular, they were the smart consumers and the smart building. Scholars employed Edison, Raspberry Pi, Arduino and other cheap devices [23]. Can also plan and examine the data on residents and buildings which have been collected through smart mobile devices and sensors, respectively, to create the most efficient communities [24]. The localized approach is based on the strength of power received by neighbors to establish a system of identifying hand gestures. He also encourages a model of Markov [25-26] to predict the position of walkers. Also, history can be utilized in order to carry out another survey on unforeseen signal variation. The findings were outstanding due to the fact that although there are issues of heterogeneity and differences in the Wi-Fi signal, the scheme that was suggested seems to be better than the rest upon testing. Other studies in the field of IoT-powered power management have investigated the opportunity of applying sensor network and data processing models to optimize energy consumption and system stability. Conventional systems of monitoring based on manual measurements periodically and centralized information recording have been found to be insufficient in managing the magnitude and complexity of modern power infrastructure. Identified the necessity of continuous sensor-based measurements in the smart grid and suggested the basic IoT-supported energy system architecture. These works showed the possible potential of real-time data collection to be aware of the system but they were not fully equipped with analytics to make intelligent decisions regarding power.

With the development of IoT, scholars started to concentrate on the topic of cloud integration to deal with the growing amounts of sensor-generated data. Proposed cloud-based systems that facilitate scalability of storage and processing of IoT data gathered by dispersed electrical sensing nodes. The use of cloud allowed centralized analytics, historical trend analysis, and remote access but the limitations associated with data latency and network overhead were recognized. This body of work showed that monitoring energy systems in the cloud are possible but emphasized the necessity of streamlined data retrieval mechanisms to address real-time needs. To resolve issues related to data transmission and scalability, more recent designs investigated edge–cloud hybrid designs in which the initial processing is done nearer to the sensor layer. Developed an edge-based cloud architecture in smart metering systems which minimizes the latency and offloads the centralized servers with computing tasks. On the same note, suggested a framework of monitoring of the distributed energy resources as a fog-cloud framework, which enhanced responsiveness and minimized the use of bandwidth. Even though they worked in controlling communication overhead, they frequently necessitated complex coordination between edge and cloud layers, which made the need to have smooth data retrieval and synchronization practices. IoT-enabled power management systems have also implemented machine learning and predictive analytics methods to improve the quality of forecasting and detecting anomalies. Used time-series forecasting models on IoT data kept on the cloud to forecast load demand patterns, which allows optimization of energy in advance. Simultaneously, investigated and applied anomaly detection on a deep learning environment to recognize abnormal power consumption in residential networks. These papers have shown how useful analytics models can be in optimizing energy consumption but also have shown how the usefulness of these methods depends strongly on the quality and time of sensor data retrieval. Security, privacy, and reliability have received much attention to the IoT-cloud power systems because of the sensitivity of energy infrastructures. Reviewed safe communication protocols and authentication systems to avoid alterations of the data and unauthorized access. These publications highlighted the idea that the strong IoT data streams should not only be effective but also secure, especially in the situation when they are implemented in the context of critical power management. Nonetheless, there is still a problem of data integrity and a low-latency retrieval. Irrespective of these developments, current literature tends to concentrate on one of the facets of cloud storage, edge processing, predictive analytics, or security separately. There are not many detailed models, which combine efficient IoT sensor data retrieval, cloud analytics, and real-time power management. Following these gaps, the proposed study brings in a unified system that improves the efficiency of data retrieval, facilitates intelligent analysis in the cloud, and makes power management decisions that can be taken. In this integration, the framework will enhance energy use, responsiveness of a system and scalability to a greater extent than the existing methods.

3. Proposed System

The proposed framework IoT Sensor Data Retrieval and Analysis through Cloud Environment on Effective Power Management is established based on a multi-layered framework that entails sensing, communication, cloud processing, and application layers. The materials encompass IoT-based power sensors which are smart energy meters, voltage sensors, current transformers, and environmental sensors that continuously determine electrical parameters like voltage, current, power consumption, power factor, and frequency. They are connected to low-power embedded control units like ESP32 or Raspberry Pi which process data locally and read it into the system. They utilize wireless communication technologies, such as Wi-Fi, LoRaWAN or ZigBee to send sensor data to the cloud gateway via lightweight protocols like MQTT or HTTP. Raw sensor data are raw data, which are initially timestamped, scaled and filtered at the edge device to eliminate noise and redundant readings to reduce transmission overhead. The processed data are subsequently stored in a cloud environment where they can be scaled in terms of storage and computational capabilities. AWS IoT, Google Cloud IoT, or Microsoft Azure are cloud solutions used to control network connectivity, data ingestion and real-time streaming of devices. The real-time and historical power data is stored in the cloud layer in structured databases and distributed file systems to be analyzed further.

The cloud implements advanced data analytics and machine learning methods to derive significant insights to the collected sensor data. The consumption trends and peak load conditions are identified by statistical analysis, and the future power demand is estimated by predictive models. Anomaly detection algorithms track the unusual patterns of power consumption and possible errors in the power system. Its analysis outcomes are represented in dashboards that allow real time monitoring, alerts and decision support in power management. The extended approach of combining effective data retrieval systems and cloud analytics can be applied to ensure that the proposed methodology can achieve maximum energy savings, minimize power waste, and enhance the reliability of system operation in the environments of power management using the IoT. In order to offer a strong response by exploiting the information gathered and administered by the devices, the researchers developed and emulated topology-architecture systems to a smart city through attendant studies and parts of information.

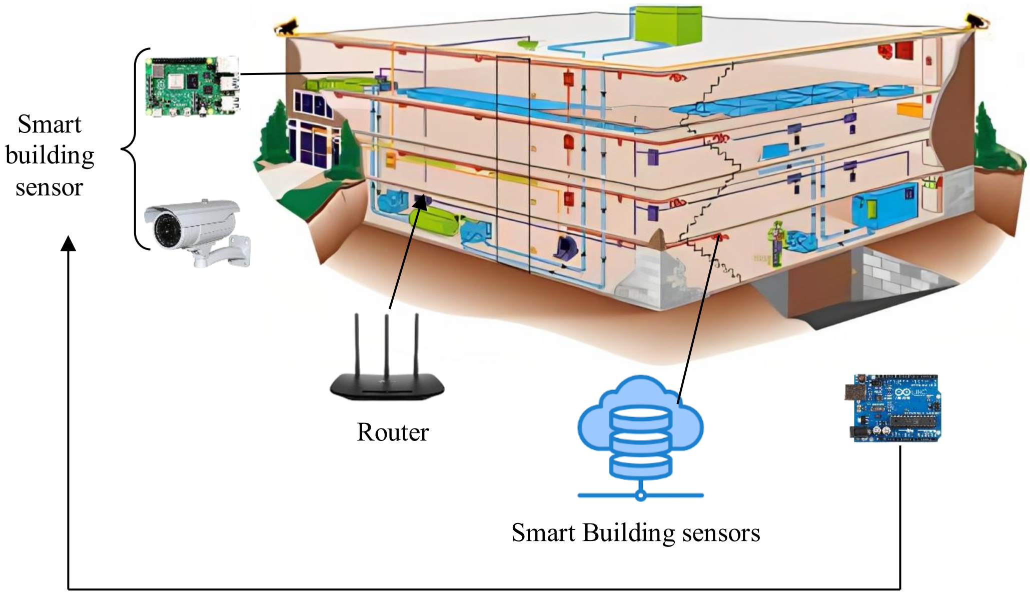

Figure 1: Elements of smart buildings

In order to enhance construction administration and transform the building to be smart and efficient, we designed a system described in Figure 1 that includes sensors that monitor temperatures, movements, sunlight and wetness. As indicated in Figure 1, it is possible to have a cloud server in a basement of the structure which would help in managing the structure as well as storing precise sensor data. The depicted architecture is a smart building power monitoring and management system that is IoT-enabled and can be integrated with a cloud environment. Electrical and environmental parameters including energy consumption, voltage, current, and lighting conditions, occupancy and security conditions are constantly monitored by different sensing devices installed on various floors of the building. Smart meters, cameras, embedded IoT controllers, and appliances, lighting, and HVAC systems all glean real-time data. Such sensor nodes are linked with a local gateway or router that consolidates the data and ensures healthy communication. The router is a middle communication; this is where the sensor data collected is sent to the cloud platform via the secure internet server. The data is passed through centralized storage and analytics engines in the cloud layer to carry out load analysis, consumption profiling, anomaly detection, and demand prediction. According to the analysis of the results, an intelligent control decision can be made in the form of load scheduling, energy optimization, fault alerts, and automated switching. The processed information is availed to building administrators in the form of dashboards to monitor in real-time and make informed decisions. In sum, this architecture allows effective power control, less energy waste, and further automation of smart buildings with the help of IoT and cloud-based data analytics.

3. 1 Dataset Description

The data of this paper is a time-series of the measurements which are made by a variety of IoT sensors put on various electrical appliances. In each record, the sensor identifier is peculiar and a time stamp to identify the particular time of the data acquisition is contained in Table 1. Important readings registered include voltage, current, and instant power that are computed to obtain energy consumption with time. Other environmental conditions, including ambient temperature and humidity, are also measured to determine their effect on the operation of the appliances. It provides device status indicators to determine the operational conditions and anomaly labels to denote the abnormal or defective readings. This holistic dataset is the basis of real-time, machine learning-based prediction, and efficient power management.

Attribute / Column	Data Type	Description
Sensor_ID	String / Int	Unique identifier for each IoT sensor
Timestamp	Datetime	Date and time of data recording
Voltage	Float	Measured voltage at the sensor
Current	Float	Measured current at the sensor

Power	Float	Instantaneous `power consumption
Energy_Consumption	Float	Cumulative energy consumption over a period
Device_Status	String / Int	Operational state of the appliance
Ambient_Temperature	Float	Surrounding temperature near the sensor
Ambient_Humidity	Float	Relative humidity around the sensor
Anomaly_Label	Int / Boolean	Indicator for abnormal or faulty readings

Table 1: Dataset description

Sensor_ID	Timestamp	Voltage	Current	Power	Energy_Consumption	Device_Status	Ambient_Temperature	Ambient_Humidity	Anomaly_Label
S01	2026-01-16 07:00:00	230.1	1.5	345.2	0.345	On	25.3	45.2	0
S02	2026-01-16 07:00:00	228.7	0.8	182.9	0.183	On	24.8	47.1	0
S01	2026-01-16 07:01:00	229.9	1.6	367.8	0.712	On	25.3	45.3	0
S03	2026-01-16 07:01:00	231.2	2.1	485.5	0.485	On	26.0	44.8	0
S02	2026-01-16 07:01:00	228.5	0.9	205.7	0.388	On	24.9	47.0	0
S01	2026-01-16 07:02:00	230.0	1.4	322.0	1.034	On	25.4	45.1	0
S03	2026-01-16 07:02:00	231.0	2.2	508.2	0.993	On	26.1	44.7	0

Table 2: Sample Data

The sample data is a demonstration of time-stamped readings of various IoT sensors used to monitor electrical appliances as seen in Table 2. A single sensor reading at a particular time is denoted by a unique sensor ID, which is represented by a row. Electrical parameters that are measured by the dataset include voltage and current and are used to calculate instant power and total energy consumption. The appliance status reports on whether an appliance is in operation in addition to the environmental conditions of ambient temperature and humidity offering more context in understanding the changes in performance. There is the presence of anomaly labels to identify the normal operating conditions and abnormal or faulty behavior. The following sample data portrays how sensor readings are organized and continuous to monitor, analyze and manage effective power using the cloud environment in real-time.

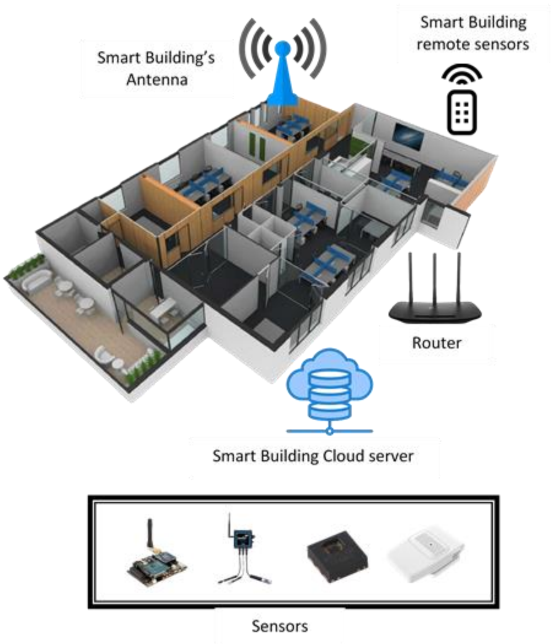

Figure 2: Link between smart buildings

Specifically, Figure 2 could be used to view how the Cloud Server and the clients would then interact with the numerous sensors that may be installed in the building. Clients would remotely gain access to sensory information and regulate the metadata of the information to act accordingly. As an illustration, an example is that a customer is able to receive a notification on the weather being too much to enable air conditioning to be turned on before coming home using the remote connection [27]. In addition, the user can also assess whether there is another person in the house that utilizes the measures of the motion device that has been processed through a cloud server, which may offer some sort of safety. The described scheme represents a cloud-based IoT smart building system that is aimed at the effective monitoring and management of power and environmental parameters. There are several sensors installed all over the building that constantly take data concerning energy usage, temperature, the state of lights, people, and machine activity. These sensors are attached to embedded IoT modules that relay the data gathered via wirelessly communicating with the central antenna of the building, which allows smooth communication between various rooms and floors without the need of debilitating wiring. The smart building antenna and router respectively are as the gateway layer, which binds the sensor data and transmits it to cloud servers using secure internet connectivity. The router guarantees the reliability of data transmission, device authentication and network management. After the data is received by the smart building cloud server, it is stored, processed, and analyzed based on cloud-based analytics and machine learning models. This analysis helps in the real-time monitoring and identification of the usage pattern, anomaly detection and predictive power management. Remote access and control is also possible via the cloud platform, which allows the building administrators to visualize the status of the system, get alerts and take automated control measures. In general, the architecture improves the energy consumption, operational intelligence, and scalability in smart building environments by using IoT-based cloud analytics.

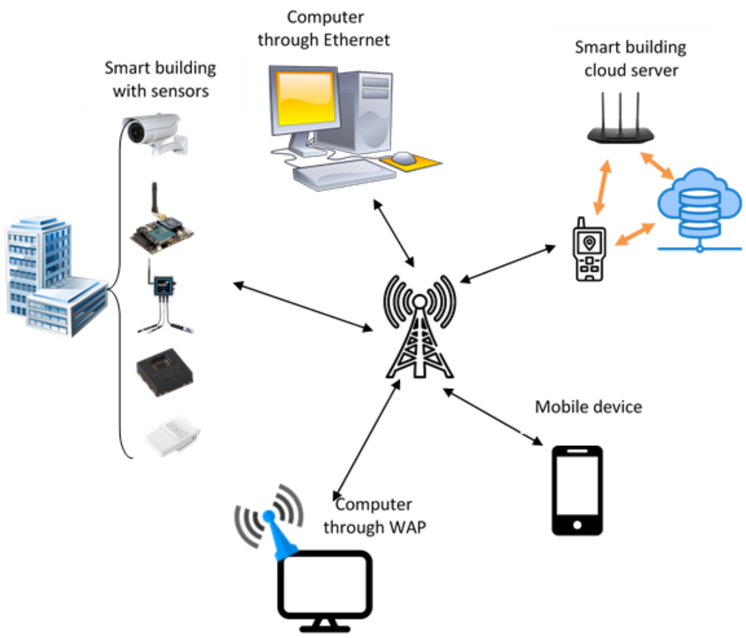

Figure 3: Proposed System

Figure 3 presents the design of the proposed system besides the customer communication ideas, the device, and the overall smart infrastructure. The network would have been hybrid and based on grid and stellar topology. This may offer a dependable connection that may appear simple to administer in regards to identifying and sustaining failures. Mesh topology possesses a number of strengths and can be expected to gain even more popularity in the future [28]. One of these advantages is its tolerance to errors. In the process of having the intermediate connection point in action, the stellar network, which would gain popularity in residential networks, provides an automatic failover. Moreover, the connected cloud server would be connected with a power stabilizer to allow managing it automatically and prevent some issues. All users were able to connect to the network without any issues because of the Wi-Fi and remote accessibility of the building due to their mobile phone service providers. A Networks Adapted Multiple Sensory True Broadcasting System and also the IPv6 outcome demonstrates that both might be accommodated by the new network. This method can be used to reliably transmit real time multi-sensor information in the virtual space to databases.

3.1 Simulation Study

Figure 4 presents the proposed network simulation in terms of Finders Operating System (FOS) and its programs. It derives values of registered and transferred information on network nodes. Moreover, such information could be stored in separate files to be studied in the future. The Finders OS is an open-source operating system designed to run on low-cost, small, and smart devices that consume little energy. Also, it is utilized in the immense data gathering process. Also, we have replaced the absence of material resources with Finders Simulator. The Cooja emulation is being used to simulate our system in real-time by researchers.

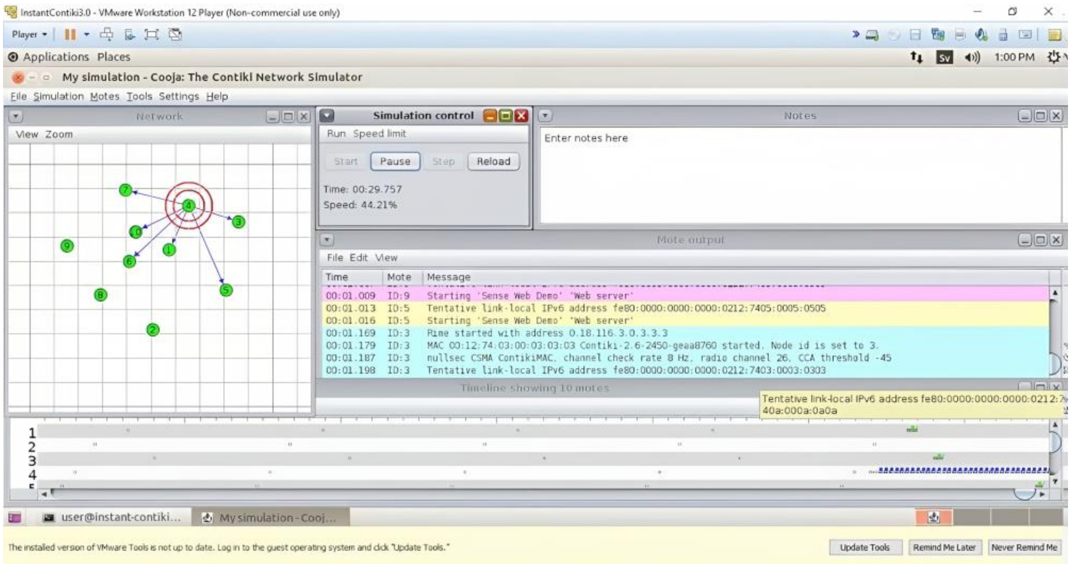

Figure 4: OS Cooja emulator

Motes	Radio on (%)	Radio TX (%)	Radio RX (%)
Sky Mote 1 (Border Router)	96. 72%	0. 67%	0. 28%
Sky Mote 2	1. 17%	0. 26%	0. 04%
Sky Mote 3	1. 56%	0. 59%	0. 03%
Sky Mote 4	1. 14%	0. 29%	0. 03%
Sky Mote 5	0. 83%	0. 06%	0. 03%
Sky Mote 6	0. 82%	0. 09%	0. 00%
AVERAGE	17. 20%	0. 35%	0. 03%

Table 1 Statistics force of each circuit

Specifically, they collect data on the power consumption of each node, the total average of all networks, and even the energy consumed during the transmission (TX) and reception (RX) of packets of data of each node, besides the average of all nodes as presented in Table 1. Then scholars must develop our system by developing our Internet in the Network pane. Also, these nodes have 2. 4GHz, IEEE 802.15.4, 250 Kbps, Chipcon Wireless Transmitter, humidity, temperatures, and lighting sensor, 16pin expansion capacity, and another SMA antenna connector. Since the Sky mote type has 6LoWPAN, we make use of them as well. But what is the reason why researchers choose 6LoWPAN? To enable IPv6 to operate with low-power radio waves at higher layers, this variant of the network was selected since it was virtually a dual IPv6 variant.

4. Experimental Results

The IoT-based power management system was tested in the following experimental configuration: several sensors of energy consumption, microcontroller devices and microcontrollers (MCUs), and a cloud-based data processing platform. Smart sensors were installed on the electrical appliances that constantly measure voltage, current, and power usage and send out the data wirelessly through Wi-Fi or LoRa modules to a centralized gateway. The sensor data was processed and sent to the cloud environment through the gateway, and through cloud-based services and IoT platforms, real-time storage, preprocessing, and analytics were conducted. A data visualization dashboard was added to track the pattern of consumption, and automated algorithms processed the data to maximize the power usage and detect anomalies. This system was subjected to testing within different load conditions to certify reliability, latency and accuracy in forecasting energy requirements and facilitating effective power management.

Component / Algorithm	Hyperparameter	Value / Setting	Description
Sensor Sampling	Sampling Rate	1 Hz	Frequency of data collection from each IoT sensor
Microcontroller / Gateway	Buffer Size	512 KB	Memory buffer for temporary data storage
Data Transmission	Protocol	MQTT / HTTP	Communication protocol between sensors and gateway
Cloud Database	Storage Interval	5 sec	Frequency of storing aggregated data in the cloud
Data Preprocessing	Missing Value Handling	Linear Interpolation	Method to handle missing sensor readings
Feature Extraction (ML)	Window Size	60 sec	Time window for computing statistical features
Random Forest / Decision Tree	Number of Trees	100	Number of decision trees in ensemble
	Max Depth	10	Maximum depth of each tree
Neural Network	Learning Rate	0.001	Step size for gradient descent
	Epochs	50	Number of full training iterations
	Batch Size	32	Number of samples per training batch
Anomaly Detection	Threshold	0.05	Sensitivity for detecting abnormal power usage

Table 3: Hyper-parameter settings

The hyperparameters of the proposed IoT-based power management system were selected cautiously so that the right data can be retrieved and the analysis of the energy effectively illustrated in Table 3. Sensors were set to sample data at 1 Hz, which would constantly monitor the voltage, current, and power consumption, and the gateway was also using a 512 KB buffer as a temporary data store before being transmitted to the cloud using either MQTT or HTTP protocol. The data in the cloud environment were aggregated and stored after a period of 5 seconds, and the data gaps were filled with linear interpolation. To extract features, a 60 seconds time window was used to calculate statistical metrics that were inputted into machine learning models. Random Forest models were trained using 100 trees and a maximum depth of 10, the most common neural networks trained were using a learning rate of 0.001, a batch size of 32, and an epoch of 50. The settings of the anomaly detection were made at 0.05 to determine the unusual power usage in order to have reliable and optimized power management. At this point, since our simulator was capable of starting up, any speech that would be linked to a network node could be found in another terminal. The given one in Figure 5, in which the hops of every node of routers are observable in the "TTL" field, as well as in the fields of time (ms). Precisely the border router has a time to live (TTL) of 64, nearest network of 63, second node with a two hopping distance had a TTL of 62, etc. It can be viewed in Figure 5 below. The same can be said of data as follows, which appear to be shorter at hops near the gateway.

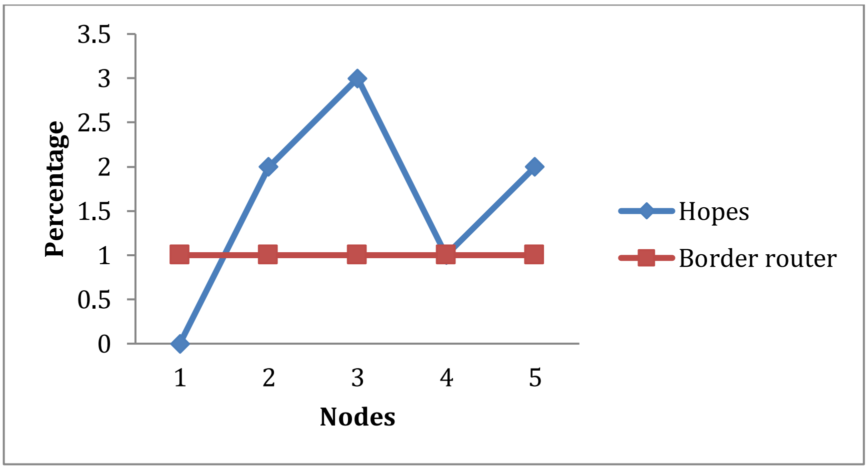

Figure 5: Border Router Breaks

Along with the data relevant to the transmission errors & transmission time, which would be defined by Equation (1) been performed.
$TDS = TDR + PL$ ---------------------- (1)

Where TDS, TDR and PL are the total information transferred, the total information retrieved and packet drop respectively. The communication between nodes methods used (including IEEE 802.15.4, IPv6 and 6LoWPAN and Constricted Defined Recruitment policy and numerous others) were outlined in detail, despite the fact that we have already mentioned [29]. Moreover, the neighbors and the paths were displayed as the output when the browser was opened and the IPv6 address of the main network was typed. When you enter the IPv6 address of any other network, the temperature and light were displayed. The temperatures of all bollards are the same and they are stable as indicated in Figure 6. This situation may be represented through equation (2):
$TT = T1 = T2 = T3 = T4 = T5 = T6$ --------------------(2)

Where T1 to T6 represents the values of knots 1 to 6, and TT represents the total temperatures. Figures 7, 8, 9, 10, and 11 illustrate the information gathered by these illuminations for every node, correspondingly.

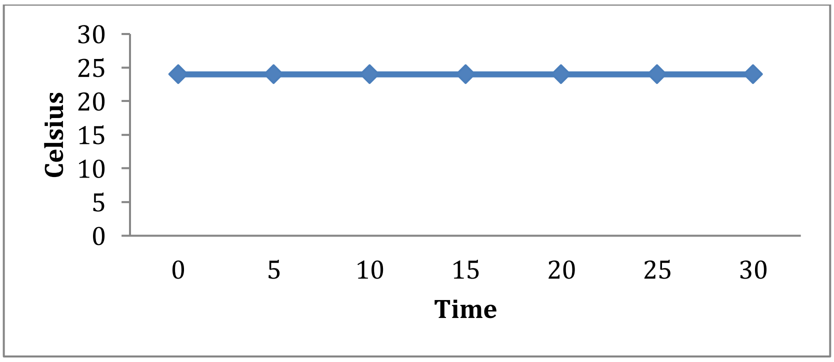

Figure 6: Temperature at each node.

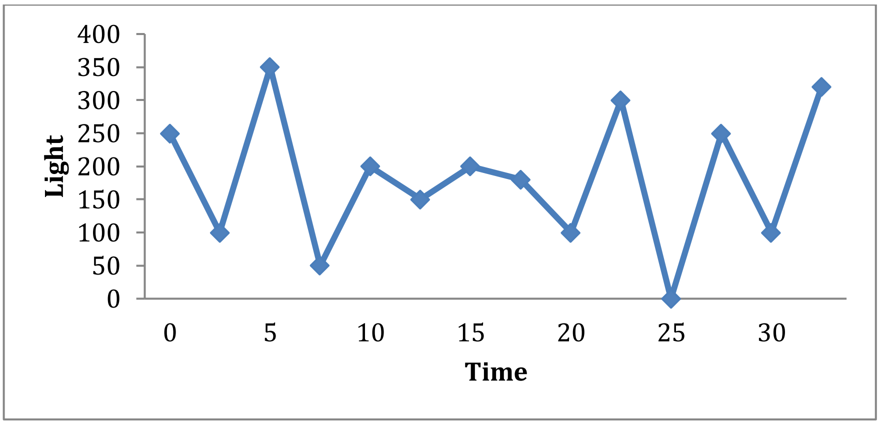

Figure 7: Light in Node 2

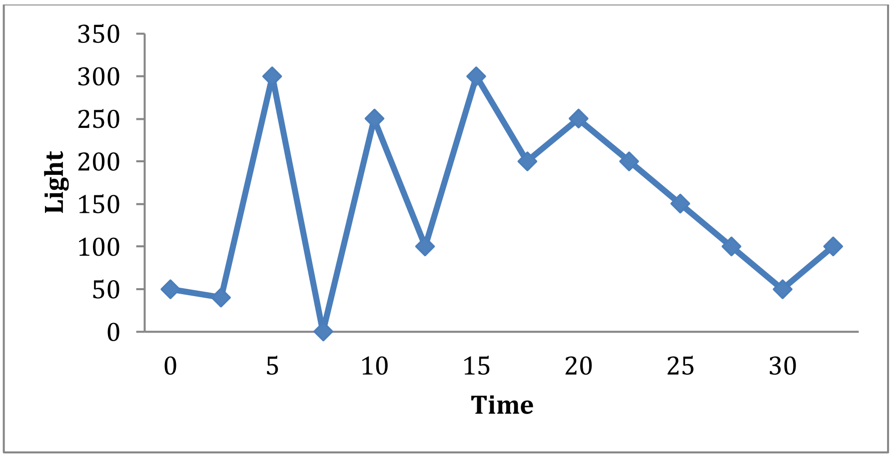

Figure 8: Light in Node 3

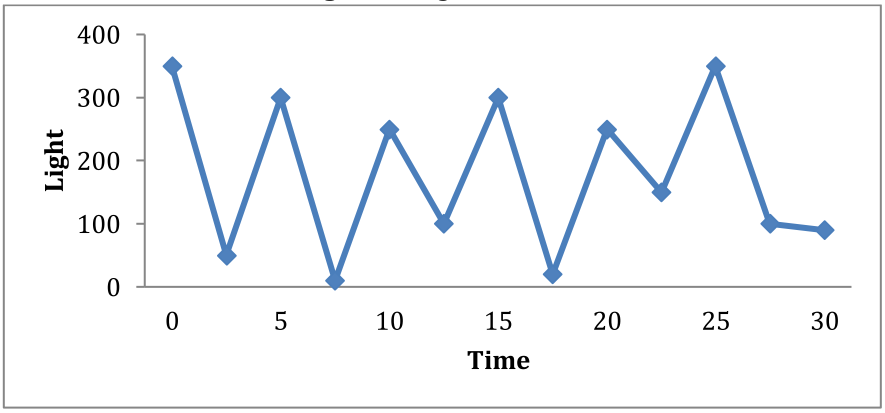

Figure 9: Light in Node 4

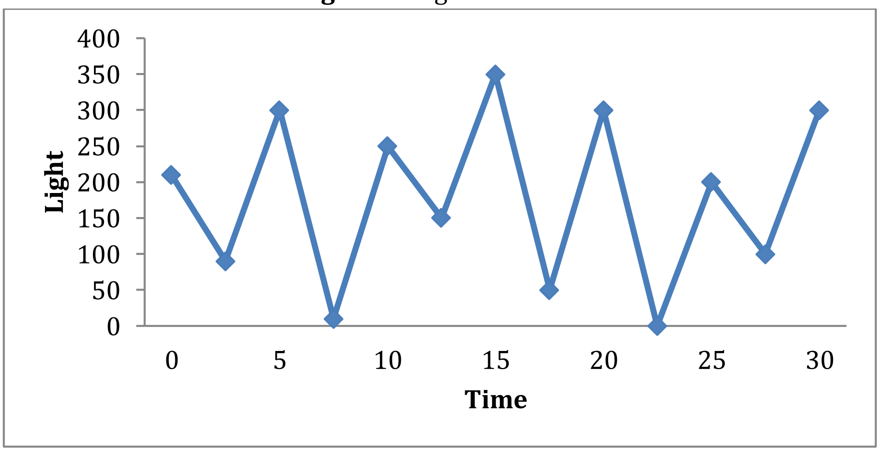

Figure 10: Light in Node 5

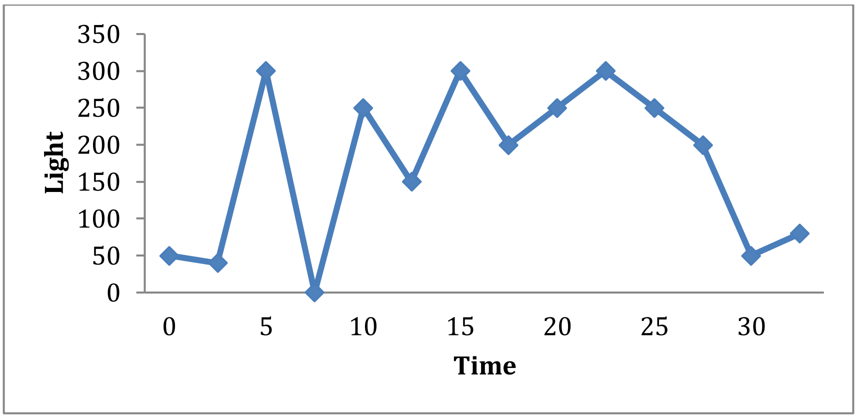

Figure 11: Light in Node 6

Once the experience is complete, the user is able to start the Wireshark and then open the file that has been generated as ". pcap". This is the folder that we have already encountered and in it there are all the packets that are sent. Wireshark provides us with the capability to view multiplicity of communications data. The researchers were able to realize power consumption with the system which we have described using the data collected and controlled by the devices. Our network customers would have remotely accessed sensor information and modified the metadata of the information to capture some activities. Also, the users would be in a position to decide whether an individual is inside the house by the processed information, and actions have been taken by the motion sensor which may give a feeling of security.

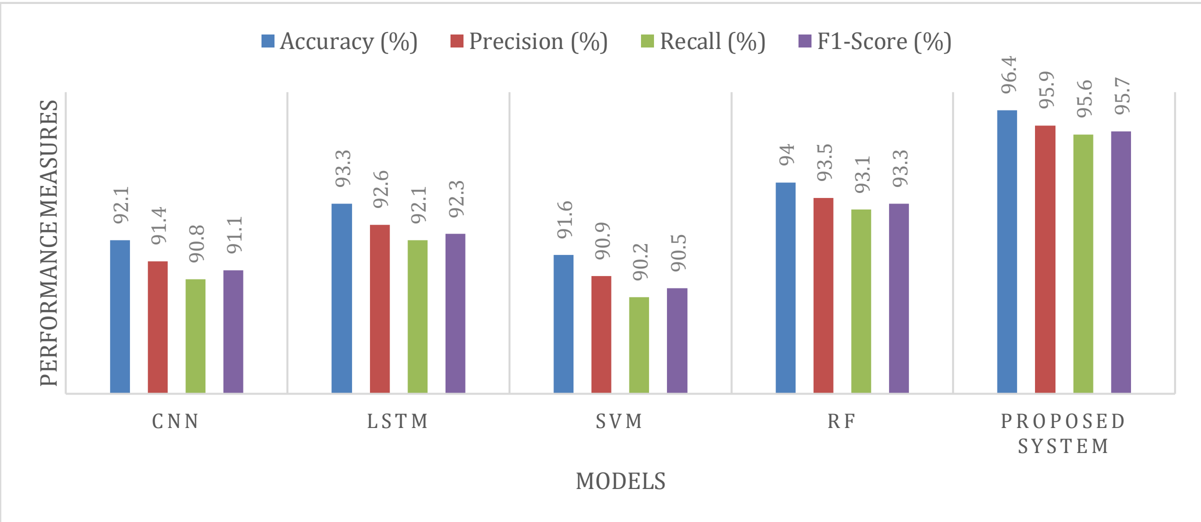

Figure 12: Comparison of performance measures

The comparison of performance proves that the suggested system is better than all the four existing models in all evaluation metrics presented in Figure 12. Although the classic methods, including CNN, LSTM, SVM, and Random Forest, have a decent accuracy and balanced precision-recall trade-offs, they have restrictions in the ability to capture the complicated patterns of power consumption. On the other hand, the proposed system has the highest accuracy of 96.4, which means that it has a better comprehensive ability to predict. The increased value of precision and recall represent lower false alarm and higher true power usage patterns, respectively. As a result, the improved F1-score guarantees balanced and more reliable performance, proving the appropriateness of the offered method to be implemented in the application of IoT-based power management.

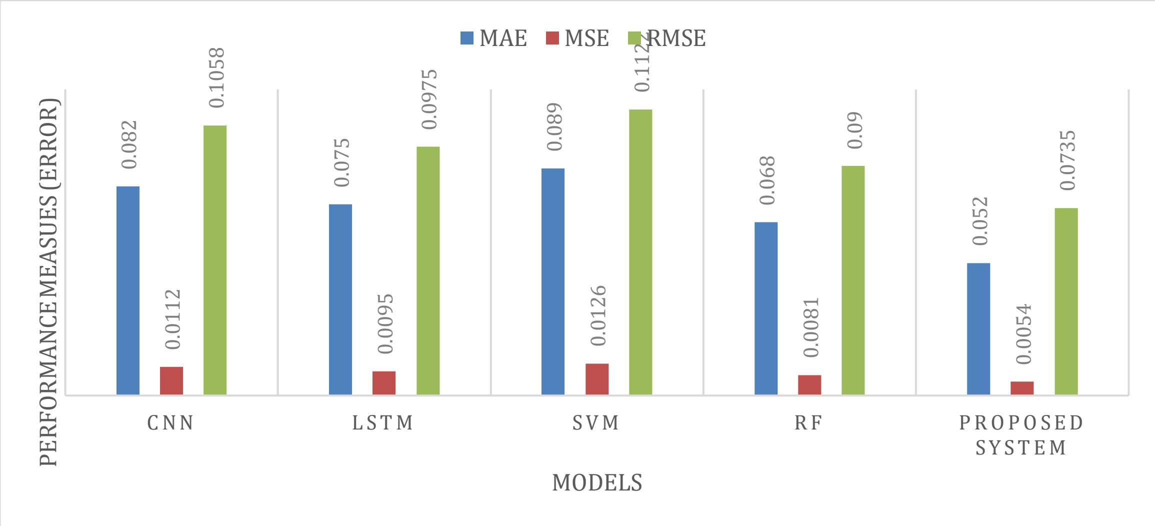

Figure 13: Comparison of performance measures (Error)

The error measures comparison indicates that the proposed system has a higher predictive accuracy as compared to the four existing methods illustrated in Figure 13. The traditional approaches, which include CNN, LSTM, SVM, and Random Forest, have shown an increased mean absolute error (MAE), mean squared error (MSE), and root mean squared error (RMSE), which show higher deviations between the predicted and actual values of power consumption. Conversely, the proposed system has the lowest MAE, MSE, and RMSE, which indicate more accurate predictions and less sensitivity to huge errors. The drastic decrease of RMSE further validates the strength of the proposed model in disbursing the varying sensor data, and it is therefore more appropriate to accurately and reliably manage the IoT-based power management in cloud computing.

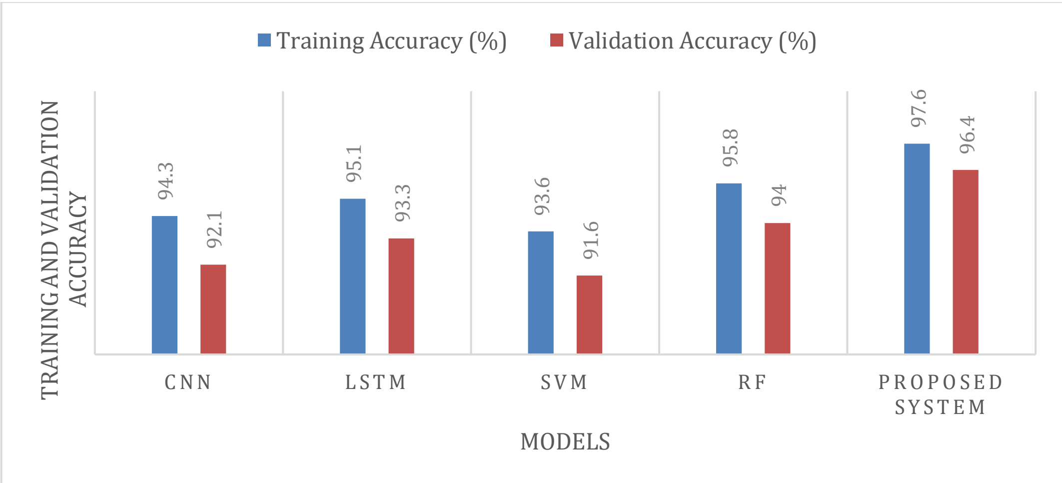

Figure 14: Comparison of training and validation accuracy

As demonstrated in the comparison of training and validation accuracy, the proposed system has the best performance of all the models tested as can be seen in Figure 14. The current systems, i.e., CNN, LSTM, SVM, and Random Forest, show decent training accuracy but report significant differences between training and validation performances, which would suggest overfitting. Contrary, the proposed system achieves a training precision of 97.6% and a validation precision of 96.4% indicating that the system has a high generalization capacity and is consistent in learning. The fact that the training and validation accuracy difference is smaller proves the fact that the proposed model successfully learns representative patterns in the context of the IoT sensor data, resulting in a more justified power consumption prediction and efficient power management on the basis of clouds..

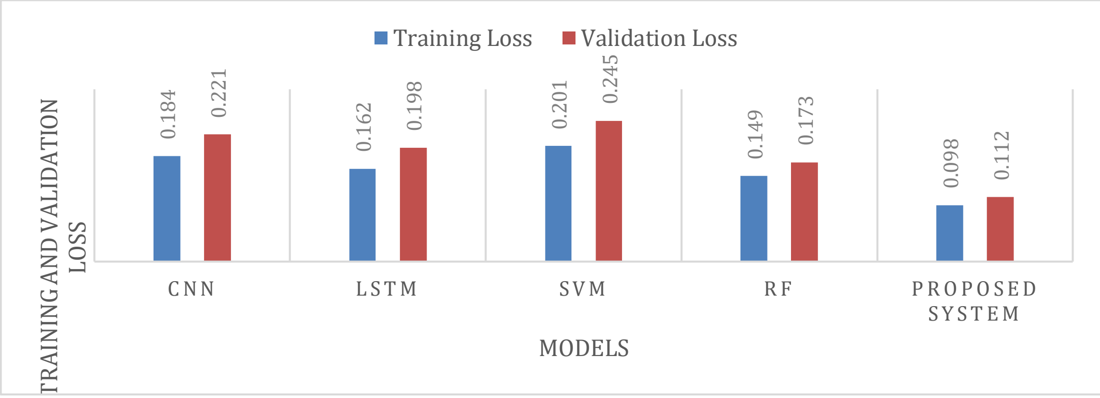

Figure 15: Comparison of training and validation loss

The training and the validation loss value comparison demonstrates that the proposed system performs well compared to the four models already available as observed in Figure 15. Traditional models such as CNN, LSTM, SVM, and Random Forest have greater values of losses with significant variations between training and validation losses implying weaker convergence and overfitting. Conversely, the proposed system has the minimum training loss (0.098) and validation loss (0.112) and this indicates the efficient learning and enhancement of its ability to generalize to the unseen data. This close correspondence between training and validation loss is another strong indicator of the strength of the proposed model as well as making it suitable for accurate and reliable management of the IoT-based power use in the cloud settings.

5. CONCLUSIONS

The technology examined in this article offers fresh and improved ways to improve the efficiency of Smart Cities. A solution that could fully utilize the capabilities of the technology researchers examined could lead to cost savings, a stable place, a user-friendly and enjoyable application, or other benefits. We could enhance surveillance of the entire home by installing multiple cameras in a smart building. The proposed systems were designed in a simulated Cooja Finders environment. Finally, the proposed approaches for collecting and processing sensory information in a smart building could help us create a smart green building that is energy efficient. To achieve the best outcomes in its application, under a Cloud infrastructure, researchers advise that in a future study, the IoT be combined with measures to ensure not withstanding the presence of sensors.

Conflict of Interest Statement

There is no conflict of interest

Data Availability Statement

Data not available due to commercial restrictions

Ethical Approval

Not applicable

Authors' contributions

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B: Visualization, Investigation, Supervision, Reviewing and Editing.

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