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SMART BUILDING ENERGY MANAGEMENT USING MACHINE LEARNING AND IOT

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ABSTRACT—The lifeblood of contemporary cultures is energy. Due to population growth and rising luxury demands, the world's energy consumption and related CO2 emissions have rapidly increased in recent decades. Predicting building energy use is crucial for energy management, planning, and conservation. The objective of the project is to create a machine learning model to lower building emissions and energy use by utilising smart sensors in either residential or commercial buildings. In this project, a smart sensor will be used to develop a machine learning model, method, design, or appliance to reduce energy consumption and emissions in residential or commercial buildings. The sensor uses real-time occupancy sensor networks, changing space schedules, weather forecasts, and other environmental conditions to accurately estimate room occupancy. Set points and schedules can be successfully adjusted by a skilled operator.The sensor detects various things, including CO2 levels, sound levels, ambient light, and door status. Using machine learning methods, these may be used to precisely estimate how many people are in each room. The amount of knowledge that a human being can process,however good it may be, limits their abilities. There are numerous chances to utilise external data sources, such as real-time occupancy sensors. This technology can be used to predict future occupancy, reduce energy management, plan energy management, and conserve energy by predicting future occupancy and consuming less energy.

Keywords: RaspberryPi,CloudServer,PIR,MQ2, DTH11,LDR.

I. INTRODUCTION

As people become wealthier and populations rise, there is an increase in the need for energy in many nations around the world. When energy is created but not used, or when it is used inefficiently, energy waste occurs. The end effect is frequently the production of greenhouse gases and other forms of environmental devastation. Energy can be wasted in a variety of ways; however, the following are some of the more prevalent ones: Turning on the lights and not turning them off Keeping electronic gadgets plugged in, Regular replacement of the HVAC system's air filters, among other things. The world's energy consumption has increased significantly if we compare it with the last few decades, and it is predicted that this demand will continue to rise above current levels. Since buildings absorb the majority of the energy used in the production of electricity, it is imperative that building energy be efficiently controlled. A large portion of energy is also responsible for greenhouse gas emissions. The gases like CO2 that are released into the upper layers of the atmosphere are the primary cause of global warming, and this has been declared by numerous studies. A strong awareness of utilizing environmentally friendly products, such as avoiding plastic, and reducing the usage of unwanted gases is required in order to reduce the amount of greenhouse gases released into the atmosphere. Accordingly, we have chosen to construct a smart building energy management system for HVAC (heating, ventilation, and air conditioning) systems that adjust on their own andalso maximize energy consumption while meeting users' satisfaction standards.

II. RELATED WORK

[1]S. L. Arun et al (2017) has experience working with Intelligent Residential Energy Management Systems (IREMS) to create well-planned home structures. The fundamental goal of IREMS is to reduce electricity costs while maintaining power levels below the maximum demand limit while taking into account a number of different limitations, including home demand and renewable energy resources (RER). [2]]Mario Collotta et al (2017) presents a system proposal that uses an Artificial Neural Network (ANN) to manage a Bluetooth low energy-based Home Energy Management (HEM) setup known as BluHEMS. In order to reduce greenhouse gas emissions and achieve effective ecological security in a number of contexts, including infrastructure, developed areas, transportation, buildings, and the production and distribution of

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electricity, infrastructure technology aims to achieve significant energy savings. [3]KeMeng et al (2017) suggested that the task of setting up many groups of aggregator air conditioners for delivery system load management be organized. The goal of this proposed solution is to provide a challenge for the Virtual Power Storage Space Scheme (VPSSS) compound group synchronization in order to handle complex loads.4]Siyun Chen et al (2017) With the goal of creating a mechanism at the "butler" level, Siyun Chen et al. (2017) provide a human-centric Smart Home Energy Management System (SHEM).This system's suggested approach creates a human-centric smart house by taking into account people's habits, estimating user preferences for weight and usage, and managing energy plans in smart homes as efficiently as possible. Based on the people-centric architecture, the system can be comprehensive in responding to a range of required response signals and costly to maintain for programming and result making at all levels of usefulness.

III. SYSTEMMODEL

The essential elements of the system are the software and hardware that together comprise it. In contrast, the hardware element is divided into two sections: the transmitter and the receiver, the former of which is created by sensors. Additionally, Python software is used in this project to dump the code.

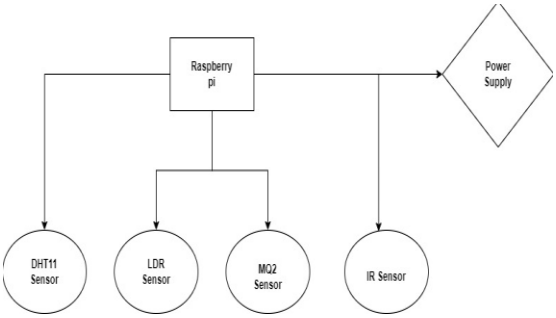

Fig.1. Blockdiagram of the system

A. Raspberry Pi

Raspberry Pi is the name of a series of single-board computers made by Raspberry Pi Foundation, a UK charity that aims to educate people in computing and create easier access to computing education.The Raspberry Pi is a very cheap computer that runs Linux, but it also provides a set of GPIO (general purpose input/output) pins, allowing you to control electronic components for physical computing and explore the Internet of Things (IoT).

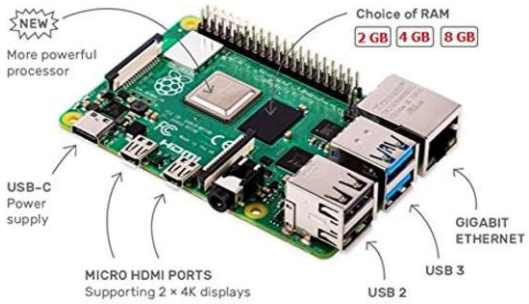

Fig.2Raspberry pi

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B. MQ2 sensor

MQ2 gas sensor can be used to detect the presence of LPG, Propane and Hydrogen, also could be used to detect Methane and other combustible steam, it is low cost and suitable for different application. Sensor is sensitive to flammable gas and smoke. Smoke sensor is given 5volt to power it. Smoke sensor indicate smoke by the voltage that it outputs. More smoke more output. A potentiometer is provided to adjust the sensitivity. Sn02 is the sensor used which is of low conductivity when the air is clean. But when smoke exist sensor provides an analog resistive output based on concentration of smoke. The circuit has a heater. Power is given to heater by VCC and GND from power supply. The circuit has a variable resistor. The resistance across the pin depends on the smoke in air in the sensor. The resistance will be lowered if the content is more. And voltage is increased between the sensor and load resistor.

Fig.3 MQ2 sensor

C. Light dependent resistor(LDR sensor)

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light. It is often used as a light sensor, light meter, Automatic street light, and in areas where we need to have light sensitivity. LDR is also known as a Light Sensor. LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

Fig5. LDR sensor

D. Temperature and humidity sensor(DTH11 sensor)

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includesa resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability andcost-effectivenes.

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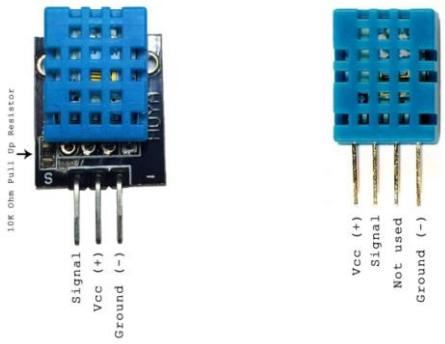

Fig6. DTH11 sensor

E. Passive infrared sensor(PIR sensor)

A PIR sensor is an electronic sensor used in motion detectors such as automatically triggered lighting devices and protection systems that measure devices emitting infrared light in their field of view. Each body with a temperature above zero releases heat energy, which is in the form of radiation. PIR sensors detect infrared radiation that is reflected or released from the target instead of measuring or sensing heat. If the sensor detects an animal, insect, or a person, the temperature at that point in the sensor's field of view increases to the body temperature of the intruder from the ambient temperature and then back accordingly. The resulting change in the received infrared radiation is translated by the sensor into a change in the output voltage, which activates detection.

Fig7. PIR sensor

F. Cloud Server

A cloud server is powerful physical or virtual infrastructure that delivers applications, processes information or provides data storage. Some cloud servers are created using virtualization software that divides a single physical (bare metal) server into multiple virtual servers. Cloud service providers usean infrastructure-as-a-service(IaaS)model to make virtual or bare metal servers available to customers.

Fig.8 Cloud server

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G. Internet Of Things (IOT)

The internet of things, or IoT, is a network of interrelated devices that connect and exchange data with other IoT devices and the cloud. IoT devices are typically embedded with technology such as sensors and software and can include mechanical and digital machines and consumer objects.Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, deliver enhanced customer service, improve decision-making and increase the value of the business.With IoT, data is transferable over a network without requiring human-to-human or human-to-computer interactions. A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low, or any other natural or man-made object that can be assigned an Internet Protocol address and is able to transfer data over a network.

Fig9. Internet of Things(IOT)

H. Software Methology

Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, and to uncover key insights in data mining projects. These insights subsequently drive decision making within applications and businesses, ideally impacting key growth metrics. As big data continues to expand and grow, the market demand for data scientists will increase. Machine learning algorithms are typically created using frameworks that accelerate solution development, such as TensorFlow and PyTorch.

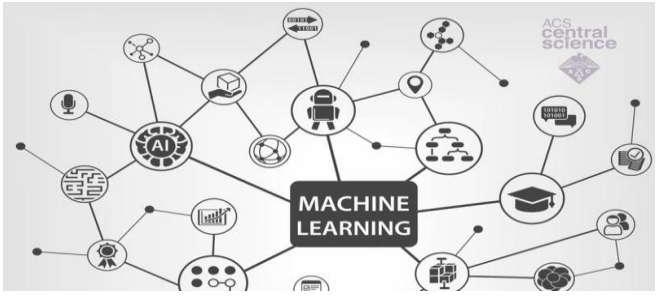

Fig10. Machine learning Model

IV. MODELLING

To gather the necessary features, the sensors are positioned in the right locations within the buildings. The Raspberry Pi processor should receive the input from the sensors. The Internet of Things allows access to

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the processor from any location. Using a Bluetooth or Wi-Fi module, this data is saved to the cloud.The support vector machine (SVM) method of machine learning (ML) will be used to train this data, which were gathered over the course of a month.Using adjusted SVM parameters, the trained model is derived from the input characteristics. The occupancy pattern and daily schedule of a facility are known thanks to this data analysis. This is beneficial for future use with relays and switches to automatically turn on, off, and manage electrical appliances in buildings. Thus, our intelligent building automatically conserves energy without personal interruption.

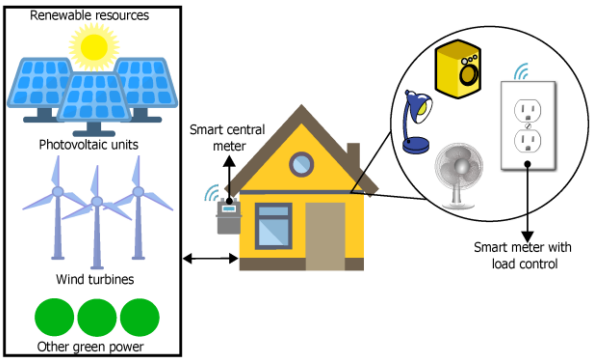

Fig11. Modelling of smart building energy management

V. RESULTS

TYPES OF SENSORS	OPERATION	RANGE
DHT11 Sensor	Fan ON Fan OFF	Temp>=33 deg cel Temp<33 deg cel
LDR Sensor	Light OFF Light ON	<100 ohms >100 ohms
MQ2 Sensor	Ventilation(OFF) Ventilation(ON)	0 1
IR Sensor	Light OFF Light ON	Object not detected Object detected

Table1:shows the information about the sensors used in the project and the operation of the sensor which we have given to the machine for prediction and range of appliances after the prediction.

VI. CONCLUSION

Using less energy and automating the building's functions were the primary goals of our endeavor. One important aspect of building intelligence is the ability to cut costs and fix issues so they don't happen again. Repetitive problems become laborious to solve, which can reduce the need for human labor and eliminate speculation. Every system requires sensors in order to be monitored and data-gathered. We may decide how to allocate resources and minimize energy loss in each room with the use of this data. We have used IOT and machine learning to construct an SB model in this work.

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 Volume 12, Iss 4, 2023

XI. REFERENCES

[1] D. Zhang, B. Guo, and Z. Yu, "The Emergence of Social and Community Intelligence," Computer, vol. 44, no. 7, pp. 21–28, Jul. 2011.

[2] N. Javaid, I. Khan, M. N. Ullah, A. Mahmood, and M. U. Farooq, "A Survey of Home Energy Management Systems in Future Smart Grid Communications," in 2013 Eighth International Conference on Broad- band and Wireless Computing, Communication and Applications, Oct. 2013, pp. 459–464.

[3] J. Al-Jaroodi and N. Mohamed, "Characteristics and Requirements of Big Data Analytics Applications," in 2016 IEEE 2nd International Con- ference on Collaboration and Internet Computing (CIC), Nov. 2016, pp. 426–432.

[4] A. Ali, J. Qadir, R. u. Rasool, A. Sathiaseelan, A. Zwitter, and I. Crowcroft, "Big data for development: applications and techniques," Big Data Analytics, vol. 1, no. 1, p. 2, Jul. 2016.

[5] D. Geesen, H. J. Appelrath, M. Grawunder, and D. Nicklas, "Challenges for Personal Data Stream Management in Smart Buildings," Creating Personal, Social, and Urban Awareness through Pervasive Computing, pp. 201–219, 2014.

[6] S. Talari, M. Shafie-khah, P. Siano, V. Loia, A. Tommasetti, and J. P. S. CatalÃc˘o, "A Review of Smart Cities Based on the Internet of Things Concept," Energies, vol. 10, no. 4, pp. 1–23, 2017.

[7] E. Al Nuaimi, H. Al Neyadi, N. Mohamed, and J. AlJaroodi, "Applications of big data to smart cities," Journal of Internet Services and Applications, vol. 6, no. 1, p. 25, Dec. 2015.

[8] D. Bandyopadhyay and J. Sen, "Internet of Things: Applications and Challenges in Technology and Standardization," Wireless Personal Communications, vol. 58, no. 1, pp. 49–69, May 2011.

[9] J. Bangali and A. Shaligram, "Design and Implementation of Security Systems for Smart Home based on GSM technology," International Journal of Smart Home, vol. 7, no. 6, pp. 201–208, Nov. 2013.

[10] RadhaKrishna Karne, Dr TK. "Review on vanet architecture and applications." *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 12.4 (2021): 1745-1749.

[11] Karne, RadhaKrishna, S. Mounika, and Dr Nookala Venu. "Applications of IoT on Intrusion Detection System with Deep Learning Analysis." *International Journal from Innovative Engineering and Management Research (IJIEMR)* (2022).

[12] RadhaKrishna Karne, Dr TK. "COINV-Chances and Obstacles Interpretation to Carry new approaches in the VANET Communications." *Design Engineering* (2021): 10346-10361.

[13] Karne, RadhaKrishna, et al. "Simulation of ACO for Shortest Path Finding Using NS2." (2021): 12866-12873.

[14] Karne, RadhaKrishna, and T. K. Sreeja. "Routing protocols in vehicular adhoc networks (VANETs)." *International Journal of Early Childhood* 14.03 (2022): 2022.

[15] Karne, Ms Archana, et al. "Convolutional Neural Networks for Object Detection and Recognition." *Journal of Artificial Intelligence, Machine Learning and Neural Network (JAIMLNN) ISSN: 2799-1172* 3.02 (2023): 1-13.

[16] Karne, Radhakrishna, and T. K. Sreeja. "Clustering Algorithms and Comparisons in Vehicular Ad Hoc Networks." *Mesopotamian Journal of Computer Science* 2023 (2023): 121-129.

[17] Kumar, A. Arun, and Radha Krishna Karne. "IIoT-IDS Network using Inception CNN Model." *Journal of Trends in Computer Science and Smart Technology* 4.3 (2022): 126-138.

[18] Bompelli, Nagaraju, Ramadevi Manchala, and RadhaKrishna Karne. "IoT Based Smart Sensor Soc Architecture for The Industrial Internet of Things." *The International journal of analytical and experimental modal analysis* 12: 491-496.

[19] RadhaKrishna Karne, Dr TK. "ROUTING PROTOCOLS IN VEHICULAR ADHOC NETWORKS (VANETs)." *International Journal of Early Childhood Special Education (INT-JECS) ISSN*: 1308-5581.

[20] Mounika Siluveru, Dharavath Nanda, & RadhaKrishna Karne. (2022). Study and Analysis of OTFS and OFDM. *Journal of Artificial Intelligence,Machine Learning and Neural Network (JAIMLNN) ISSN: 2799-1172*, *2*(06), 13–23. https://doi.org/10.55529/jaimlnn.26.13.23

[21] Radha Krishna Karne and Dr. T. K. Sreeja (2022), A Novel Approach for Dynamic Stable Clustering in VANET Using Deep Learning (LSTM) Model. IJEER 10(4), 1092-1098. DOI: 10.37391/IJEER.100454.

[22] Karne, R. K. ., & Sreeja, T. K. . (2023). PMLC- Predictions of Mobility and Transmission in a Lane-Based Cluster VANET Validated on Machine Learning. International Journal on Recent and Innovation Trends in Computing and Communication, 11(5s), 477–483. https://doi.org/10.17762/ijritcc.v11i5s.7109

[23] R. Mohandas, N. Sivapriya, A. S. Rao, K. Radhakrishna and M. B. Sahaai, "Development of Machine Learning Framework for the Protection of IoT Devices," 2023 7th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2023, pp. 1394-1398, doi: 10.1109/ICCMC56507.2023.10083950.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **Volume 12, Iss 4, 2023**

[24] Vaigandla, Karthik Kumar, S. Bolla, and R. Karne. "A survey on future generation wireless communications-6G: requirements, technologies, challenges and applications." *International Journal* 10.5 (2021).

[25] Vaigandla, Karthik Kumar, Radha Krishna Karne, and Allanki Sanyasi Rao. "A Study on IoT Technologies, Standards and Protocols." *IBMRD's Journal of Management & Research* 10.2 (2021): 7-14.

[26] Vaigandla, Karthik Kumar, et al. "A Survey On Wireless Communications: 6g And 7g." *International Journal Of Science, Technology & Management* 2.6 (2021): 2018-2025.

[27] Vaigandla, Karthik Kumar, Sravani Thatipamula, and Radha Krishna Karne. "Investigation on unmanned aerial vehicle (uav): An overview." *IRO Journal on Sustainable Wireless Systems* 4.3 (2022): 130-148.

[28] Vaigandla, KarthikKumar, Nilofar Azmi, and RadhaKrishna Karne. "Investigation on intrusion detection systems (IDSs) in IoT." *International Journal of Emerging Trends in Engineering Research* 10.3 (2022).

[29] Vaigandla, Karthik Kumar, RadhaKrishna Karne, and Allanki Sanyasi Rao. "Analysis of MIMO-OFDM: Effect of Mutual Coupling, Frequency Response, SNR and Channel Capacity." *YMER Digital-ISSN* (2021): 0044-0477.

[30] Vaigandla, Karthik Kumar, et al. "Millimeter wave communications: Propagation characteristics, beamforming, architecture, standardization, challenges and applications." *Design Engineering* 9 (2021): 10144-10169.

[31] Vaigandla, Karthik Kumar, et al. "Review on Blockchain Technology: Architecture, Characteristics, Benefits, Algorithms, Challenges and Applications." *Mesopotamian Journal of CyberSecurity* 2023 (2023): 73-85.

[32] Vaigandla, Karthik Kumar, et al. "Investigation on Cognitive Radio Networks: Introduction, Spectrum Sensing, IEEE Standards, Challenges, Applications." *International Journal of Engineering Applied Sciences and Technology* 6.9 (2022): 91-103.

[33] Vaigandla, Karthik Kumar, Mounika Siluveru, and RadhaKrishna Karne. "Study and Comparative Analysis of OFDM and UFMC Modulation Schemes." *Journal of Electronics, Computer Networking and Applied Mathematics (JECNAM) ISSN: 2799-1156* 3.02 (2023): 41-50