iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VII **Month of publication:** July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45266

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

AI Driven Smart Homes Energy Efficiency and Model

Miss. Sneha Mugalakhod[1], Miss. Shweta M Nirmanik[2]
[1]*Dept. of CSE, REC, Hulkoti*
[2]*Assistant Professor, Dept. of CSE, REC, Hulkoti*

Abstract: ***Artificial intelligence (AI) has received immense attention from the research community and the industry, leading to AI being adopted in many real-world applications. The growing trend of deploying AI has dramatically changed the ergonomics of modern-day practices in many realms, including smart homes, healthcare, insurance, investment and banking, social services, infrastructure, and marketing. A smart home, often referred to as an intelligent home, comprises smart technologies supported by AI.***

Smart home has its applications in household appliances, home safety and security, lighting and entertainment. Key industries have started integrating artificial intelligence with smart devices to enable connectivity among these devices. Smart meters could capture utility usage and track indoor temperatures and then deploy that information for action, which is where AI step in. The presented conceptual model will significantly facilitate future research regarding smart homes in the context of energy efficiency. The efficiency, flexibility, and resilience of building-integrated energy systems are challenged by unpredicted changes in operational environments due to climate change and its consequences.

I. INTRODUCTION

A smart home is not referring to how well a home is built or how effectively space is utilized or how environment friendly it is. Indeed, a smart home encompasses all these attributes but it is the use of different interactive and intelligent technologies that make it smart. The energy system is one of the many sectors that are significantly transformed by Industry 4.0. In this context, the digital transformation of the energy industry is referred to as Energy 4.0. One of the examples of the said is the smart home. In recent years, the development of smart technologies contributed to the transitions of the home from traditional to smart internet-connected one. A smart home is a residence equipped with technologies that include sensors, wired and wireless networks, actuators and intelligent systems. Smart home technology collects and analyse data from the domestic environment. Artificial intelligence describes any device that perceives its environment and takes actions and maximize its chance of successfully achieving its goals. The ideal state of artificial intelligence is thinking humanly, thinking rationally, acting humanly and acting rationally. The advancement and rapid innovation in AI-driven engineering technologies, as well as information and communication technologies, led to the growing trend of utilizing AI beyond manufacturing. This paper presents a comprehensive overview of AI driven smart home applications particularly in the context of energy efficiency. Moreover, this paper also proposes a conceptual framework model for AI-driven smart home aimed to enhance the users' comfort and energy efficiency phenomenon.

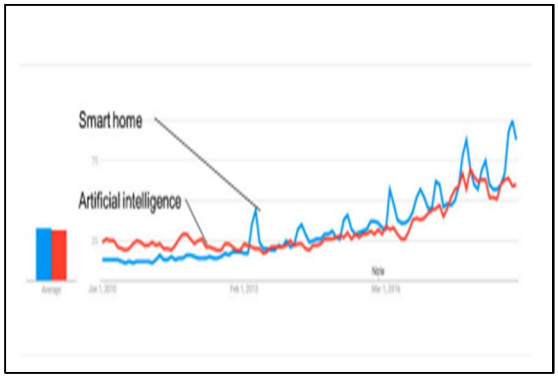


Fig 1. Interest over time in smart homes and artificial intelligence

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

II. OVERVIEW OF ARTIFICIAL INTELLIGENCE TECHNIQUES

A. Artificial Neural Network

Artificial neural network (ANN) is a computational network inspired by biological nervous systems, i.e., brain. Generally, ANN comprises three layers: input (independent variables), hidden, and output (dependent variables). The input layer receives information to be processed by the hidden layer, and the output layer presents the final output. The hidden layer consists of a computational processing unit known as artificial neurons that mimics the biological neurons of a nervous system. Each independent input variable relates to a neuron through a synaptic weight. The output is scaled further with an activation function to limit the output to a reasonable limit. Initially, the synaptic weights and the threshold of its neurons are tuned based on the relationship between the input and output. An ANN can be trained through supervised, unsupervised, reinforcement, offline/batch, and online learning mechanisms. ANNs are nonlinear statistical models which display a complex relationship between the inputs and outputs to discover a new pattern. A variety of tasks such as image recognition, speech recognition, machine translation as well as medical diagnosis makes use of these artificial neural networks. This process of setting up an ANN with generalized solutions for a given input and given output is known as a learning or training process, and this is completed with a given learning algorithm.

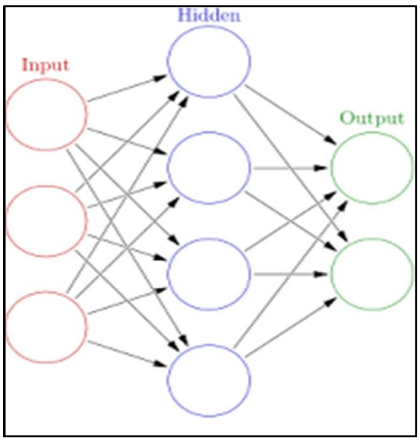


Fig 2. Two Hidden Layer Artificial Neural Network

B. Machine Learning

Machine learning is a branch of artificial intelligence and computer science which focuses on the use of data and Algorithms. This process of setting up an ANN with generalized solutions for a given input and given output is known as a learning or training process, and this is completed with a given learning algorithm.

1) *Supervised Learning:* Supervised learning requires an extensive training set of data for the independent variables, as well as the corresponding correct values for the dependant variables. These correct values are known as labels. After the training process, a mapping from the independent variables to the dependant variable has been established, so the model is able to receive a previously unseen combination of independent variables and predict the value of the dependant variable. IT works on a set of labelled data which is a set of data containing detailed input features and their corresponding output, i.e., Labels.IT also used some algorithms like e Naïve Bayes, Decision Trees etc.
2) *Unsupervised Learning:* Unsupervised learning can be applied when a labelled training set does not exist. A common application of unsupervised learning is anomaly detection. The machine learning model is trained with data in normal conditions, after which it is able to detect whether the system is in a normal condition or not. However, it will not be able to diagnose the type of failure condition. The purpose of unsupervised machine learning is to detect distinct patterns by exploring the structure of information and using the extracted information towards improving the decision-making process.
3) *Semi-supervised Learning:* Semi Supervised learning is an approach to a machine learning that combines a small amount of labelled data with a large amount of unable the data during training. IT falls between unsupervised and supervised learning.
4) *Reinforcement Learning:* Reinforcement learning is the training of machine learning models to make a sequence of decisions. The agent learns to achieve a goal in an uncertain, potentially complex environment. The environment provides state information, which the agent uses to select the action. The applications to these concepts to building energy management are discussed further in Section. Trial and error search and rewards are the key characteristics of reinforcement machine learning in which the agent is rewarded for actions that increase efficiency and are penalized for actions that reduce it.

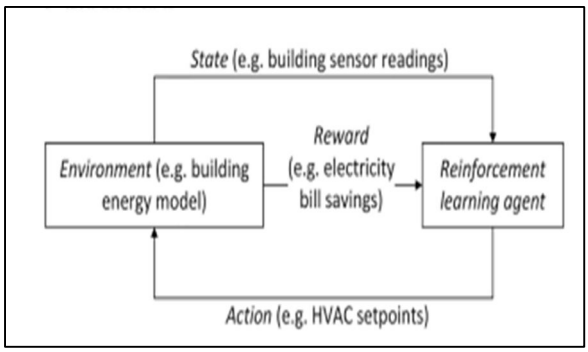


Fig 3. Key concepts of reinforcement learning

III. AI DRIVEN SMART HOME

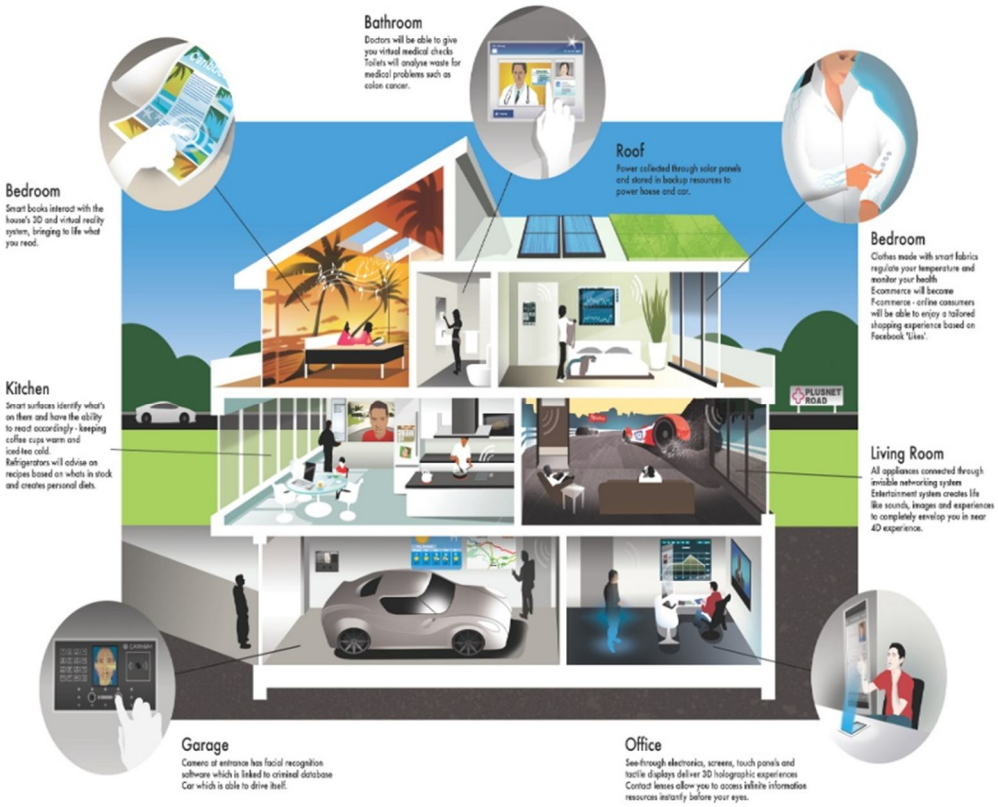


Fig 4. Smart Home Model

The proposed AI-driven smart home is also connected to utilities, renewable energy sources, Battery storage, and different electrical load. AI technologies significantly contribute numerous energy efficiency applications. For example, machine learning and neural networks are extensively employed in the domain of load disaggregation. In this context, AI-driven smart homes play a significant role in energy efficient systems, as the residential sector is one of the major contributors to world energy consumption. Consequently, the AI driven smart homes can analyse information in connection with the intermittent nature of renewable energies and the stochastic behaviour of consumers, to make intelligent decisions to operate smart home appliances in a more effective and energy-efficient manner. smart homes are utilized more in energy management, intelligent interaction, and security with AI functions of voice recognition and image recognition. It is also noted that most of the energy efficiency applications are proposed in a standalone approach. It is also noted that most of the energy efficiency applications are proposed in a standalone approach.

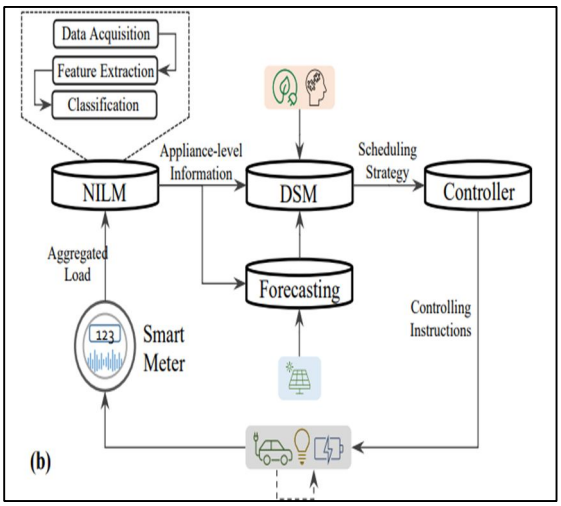


Fig 5. Frame work of AI Manager

In this figure NILM, DSM, and forecasting are interlinked. The NILM outcome can facilitate the DSM in numerous ways, e.g., identifying the potential appliances for load shifting strategies using the appliance-level information, i.e., corresponding operation status and timing. Moreover, the extracted appliances' consumption pattern can also facilitate DSM towards more robust and effective energy scheduling. The NILM assisted appliance-level feedback can also facilitate the forecasting models towards effective energy management, consequently, leading towards energy efficiency. However, the said processes revolve around many stochastic variables that increase the model complexity. To tackle these complexities, the proposed model is backed by artificial intelligence technologies. AI driven controller is introduced that coordinated all the scheduling and controlling strategies among the concerned stakeholders. The proposed conceptual model of an AI-driven smart home is intended to enhance inhabitants' comfort level along with energy efficiency. smart home is not just a consumer, but it also acts as a prosumer; generates electricity, and can also utilize an electric vehicle, battery storage. However, uncertainty is a common factor in the system due to the stochastic nature of energy demands and the intermittent nature of renewable energy resources. Various economic factors also place uncertainty on its generation in the future.

IV. ADVANTEGES AND DISADVANTAGES OF SMART HOMES

A. *Advantages*

1) *Easier To Lock and Unlock The Doors:* With help of smart home devices such as smart security cameras, you will be able to take care of the security of your home. Even when you are not at home, you can lock the door of your house.
2) *Save Energy With Smart Energy Consumption:* With smart home products, you can ensure that there is no waste of energy usage. The machines, devices and appliances can all be managed and turned of immediately after usage, when you have a smart home product. Solar power smart houses have brought a big relief for energy consumption these days also for bills.
3) *Know the About Maintenance And Service:* When your devices and appliances need servicing for maintaining its performance, must be known in advance. However, monitoring this is not always easy. This will notify you whenever you need take care of the appliances and devices.
4) *Ease to using Smart Home Technology:* Along with all these facilities and benefits, another important smart technology advantage is the ease of using this. With smart home tech you can feel connected home 24/7 even if you are not at home. Here are some important future technologies you should know about.

B. *Disadvantages*

1) *Cost:* Once installing energy saving appliances into your homes, you may start saving after a while. Compared to traditional homes, smart home technology requires a higher investment.
2) *Dependency of Internet:* The basic requirement of every smart technology is the internet, without a good and strong internet connection, you will not able to take control of this. If there is no internet connection for some reason, there is no other way through which you can access and control your system.

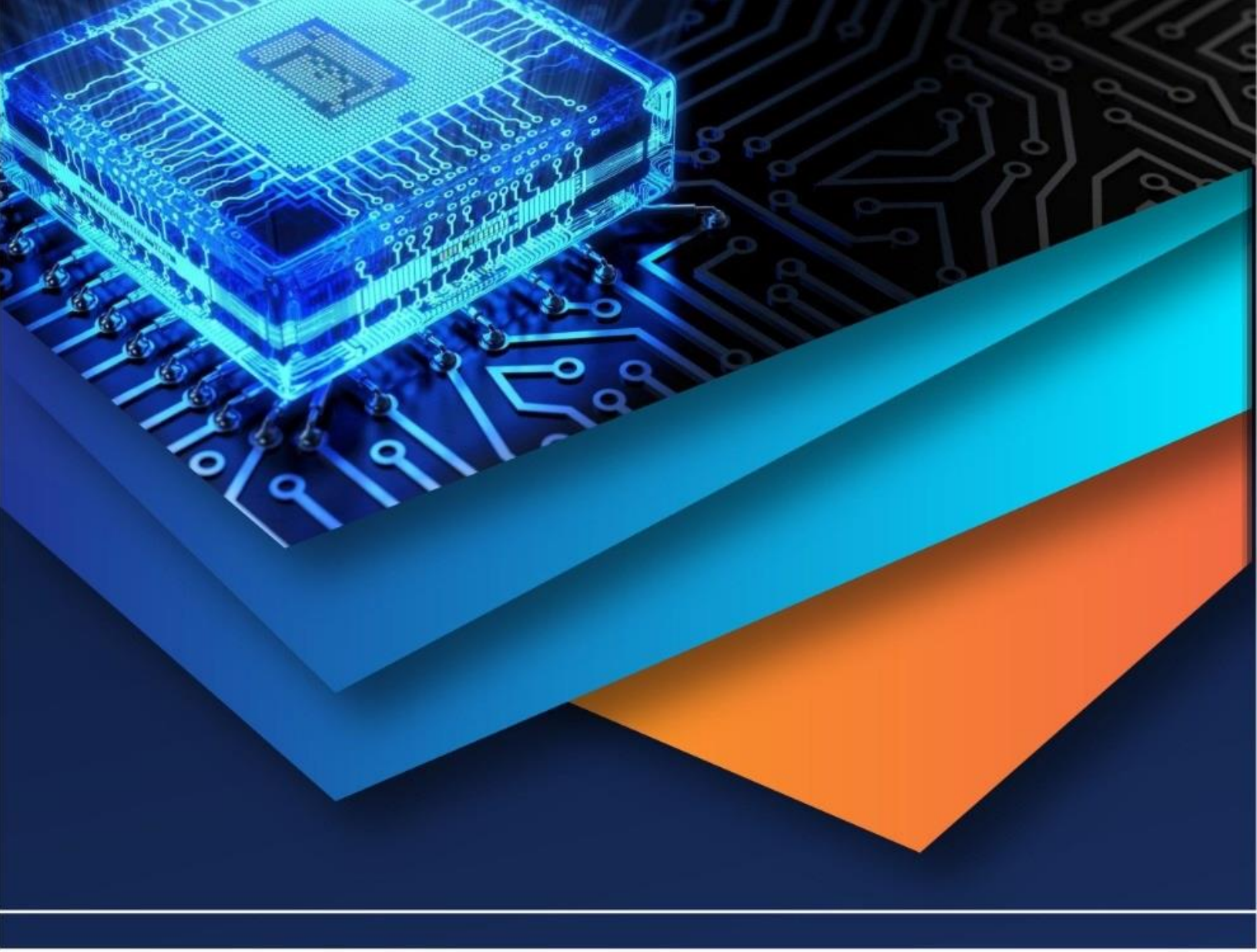
3) *Dependency of Professionals:* From installation to maintenance, you'll need a team of professional to deals with settings and management. handyman to sort it out. You can't call plumber to sort it out. You repair or fix a bug; You'll need to have an expert available.

V. CONCLUSION

This paper presents a comprehensive overview of the existing literature in the context of energy-efficient smart homes backed by artificial intelligence technologies. Moreover, a conceptual model of an AI-driven smart home is proposed, that incorporates different energy efficiency applications. It is noted that AI technologies not only facilitate the provision of more efficient and accurate direct feedback from appliances to the consumers but also enable more sophisticated prediction modelling of energy generation and demand, leading to more sustainable energy systems. The rapid growth and incorporation of AI techniques like machine learning, artificial neural networks, deep learning, and optimization, enable unprecedented opportunities to facilitate the comfort and energy efficiency within the residential built environment. In this context, it is anticipated that the proposed conceptual model will significantly facilitate the smart home concept in terms of energy efficiency.

REFERENCES

[1] Attique Ur Rehman, Shafiqur Rahman Tito, Daud Ahmed, Pieter Nieuwoudt, Tek Tjing Lie and Brice Valles Auckland, New Zwaland "An Artificial Intelligence-Driven Smart Home Towards Energy Efficiency: An Overview and Conceptual Model"2020.
[2] Xiao Guo Zhenjiang Shen Yajing Zhang and Teng Wu "Review on the Application of Artificial Intelligence in Smart Homes" 2 August 2019
[3] www.ifc.org/thoughtleadership FEB 2020 "Artificial Intelligence and the Future for Smart Homes".
[4] Matteo Mendula Siayash Khodadadeh Salih Safa Bacanli Sharare Zehtabian Hassam Ullah Sheik, Ladislau Boloni "Interaction and Behavior Evaluation for Smart hHomes: Data Collection and Analytics in the Scaled Home project.
[5] Kari Alanne Seppo Sierla "An overview of machine learning applications for smart building"
[6] Google. (2020). Google Trends. Available: https://www.google.com/trends
[7] B. K. Sovacool and D. D. F. Del Rio, "Smart home technologies in Europe: A critical review of concepts, benefits, risks and policies," Renewable and Sustainable Energy Reviews, 2020.
[8] I. N. Da Silva, D. H. Spatti, R. A. Flauzino, L. H. B. Liboni, and S. F. dos Reis Alves, "Artificial neural networks," Cham: Springer International Publishing, 2017.
[9] Y.-H. Lin and Y.-C. Hu, "Electrical energy management based on a hybrid artificial neural network-particle swarm optimization-integrated two-stage non-intrusive load monitoring process in smart homes," Processes, vol. 6, no. 12, p. 236, 2018.
[10] A. Aboulian et al., "NILM dashboard: A power system monitor for electromechanical equipment diagnostics," IEEE Transactions on Industrial Informatics, vol. 15, no. 3, pp. 1405-1414, 2018.
[11] A. U. Rehman et al., "Applications of Non-Intrusive Load Monitoring Towards Smart and Sustainable Power Grids: A System Perspective," in 2019 29th Australasian Universities Power Engineering Conference (AUPEC), 2019, pp. 1-6.
[12] H. Rashid, P. Singh, V. Stankovic, and L. Stankovic, "Can nonintrusive load monitoring be used for identifying an appliance's anomalous behaviour?" Applied energy, vol. 238, pp. 796-805, 2019.
[13] N. A. N. M. Ashril, D. P. Dahnil, and S. Abdullah, "Wi-Fi Based Smart Home Prototype Development",in 2019 International Conference on Electrical Engineering and Informatics (ICEEI), 2019, pp. 540-543: IEEE. [12] C.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY