SMART HOME ENVIRONMENTS UTILIZING ARTIFICIAL INTELLIGENCE: A SURVEY

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***Abstract*:** Today's world is migrating towards smart world. The Artificial Intelligence (AI) is playing a crucial role in making smart and intelligent world. To get this in action, various cutting-edge technologies are supporting like- Artificial Intelligence (AI), Internet of Things (IoT), Cloud computing, Fog computing, Machine and Deep learning etc. These promising research fields are greatly affecting many applications including- Robotics, Computer vision, Automotive industry, Smart environments, Education and Research etc. The smart home is also one of the applications which has been influenced by aforementioned technologies since last decade. This paper mainly deals with the survey of smart home environments utilizing AI. It focuses on literature review of research work presented by various researchers and scientists. It mainly deals with smart home environments and utilization of AI in such scenarios.

***Index Terms* – Artificial Intelligence, Internet of Things, Home automation, Smart Home.**

I. INTRODUCTION

The smart home technology is growing with the advent of cutting-edge technologies like Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning (ML), Cloud computing etc. The smart home technology is playing a crucial role home automation. The smart home concept can also be utilized for various premises like office, school, college or university etc. The improved and secured life can be possible with Intelligent Smart Home. Basically this is current hot interdisciplinary research field. It interconnects different fields like AI, Cloud computing, Healthcare, Psychology, Communication and Networking etc. A smart home is an application in which home environment is monitored by intelligence. It is used to provide context-aware services and facilitate remote home control. The smart home comprises of healthcare, security, energy conservation, comfort and safety.

Home security is one of the most important safety systems. It is required for all social group of the society. Houses need to be monitored at all times such as from theft, short circuits, fire and any mishap. Nowadays, the rate of crimes involving robbery, murder and fires is increasing and worrying all of us. Hence, home surveillance system must be upgraded to be more effective to keep up with the increasing crime rate.

II. REVIEW OF LITERATURE

The design of lighting system is very crucial part of building. It is an important aspect when dealing with sustainability of buildings. The paper [1] demonstrated indoor lighting simulation in connection with the research of buildings. The main goal of this research is was to find out the popular simulation tool utilized for simulation of lighting in the buildings prototypes presented by various researchers. As per the review, the popular simulation tool is MATLAB followed by MATLAB/Simulink, MATLAB GUI, DOE, JAVA, LABVIEW, EnergyPlus, DaySim etc. The authors found popular integrated simulation tools for lighting simulation in buildings as- MATLAB-SIMULINK/LABVIEW followed by the DRIVE/OSGi, MATLAB/EnergyPlus/BCVTB, MATLAB/TRNSYS, TRNSYS/INSEL, EnergyPlus/Radiance, EnergyPlus/MATLAB, and EnergyPlus/MATLAB/GPE.

The paper [2] pointed out energy conservation through smart homes in a smart city. The smart home and smart technologies must work efficiently to provide efficient energy-saving solution. It must consider the occupants of the households. Hence artificial intelligence must be incorporated in smart home technologies to detect behavior models and usage patterns and adjust the energy usage accordingly. It becomes crucial to design the ideas and solutions for smart technologies with an understanding of living environments. This comprises of includes human behaviors, technology devices with automation, as well as artificial intelligence.

The research work [3] presented a MavHome (Managing An Intelligent Versatile Home) which aims to create a home that acts as an intelligent agent. The authors introduced the MavHome architecture. They demonstrated the effectiveness of the algorithms on smart home data. The MavHome smart home project deals with the creation of an environment that acts as an intelligent agent. The main goal of the agent is maximizes comfort and productivity of its inhabitants and minimizes operation cost.

With the advancement of smart homes or intelligent homes, home automation is giving smarter solutions and making smart and rational decisions. This makes inhabitant comfort and minimizes cost of operation. The authors [4] focused on the role of Prediction algorithms to recognize next events. The algorithm helps to find frequency of occurrence of the events and targeting

the particular events for automation. A smart home is a living or working space that adapts to the occupant of the smart home. Here, the adaption means to recognize and change itself depending on the identity and activity undertaken by the occupant. The aim of the smart home is to maximize comfort and safety and deals with the optimization of energy usage. With the help of these predictions, the home can route messages and multimedia information, and can automate activities. The various prediction algorithms are- IPAM, ONISI, Jacobs Blockeel Algorithm, LZ78, LeZi-Update, Active LeZi, FXl and Adaptive FXl. This paper utilizes the Active LeZi prediction algorithm in smart home implementation.

The authors [5] presented the goals of the Domoweb project. The authors reviewed the solutions adopted to achieve the project. It resulted into the development of smart home techniques and solutions. The authors discussed some basis related with smart environments methods. They suggested prediction algorithms for the smart home and smart environments.

The paper [6] presented a Multi-Agent System (MAS) for a Smart Home intelligent control. The presented solution integrated in a smart meter in order to alter the shape of the residential load curve. They presented an algorithm for scheduling appliances tasks, and designing a model for a direct load control which may accommodate customer preferences. A Fuzzy Logic Control (FLC) is the base for the direct load control. This paper aimed a compromise among habitant comfort and electric bills. The paper demonstrated simulation results and the results have proved the effectiveness of the proposed solution in energy savings.

Smart Home automation is becoming popular day-by-day due to its benefits. Basically it deals with controlling of home appliances by remote control or local networking. Artificial Intelligence plays a crucial role and gives the framework for real-time decision and automation for IoT. The paper [7] demonstrated on smart home automation. It focused on the monitoring and control operations of smart devices/appliances installed in smart home buildings. It also prsesented Heterogeneous home-automation systems and technologies based on Raspberry Pi, Arduino, Web, Email, Bluetooth, Mobile, Zigbee, SMS, DTMF, cloud etc. The basic block diagram of home automation is shown in Fig. 1 below. It comprises of Device/Things or machine, Sensors, Central controller, Controlling system and User interface. The communication type may be from Ethernet, Bluetooth, GSM and Wi-Fi etc [7].

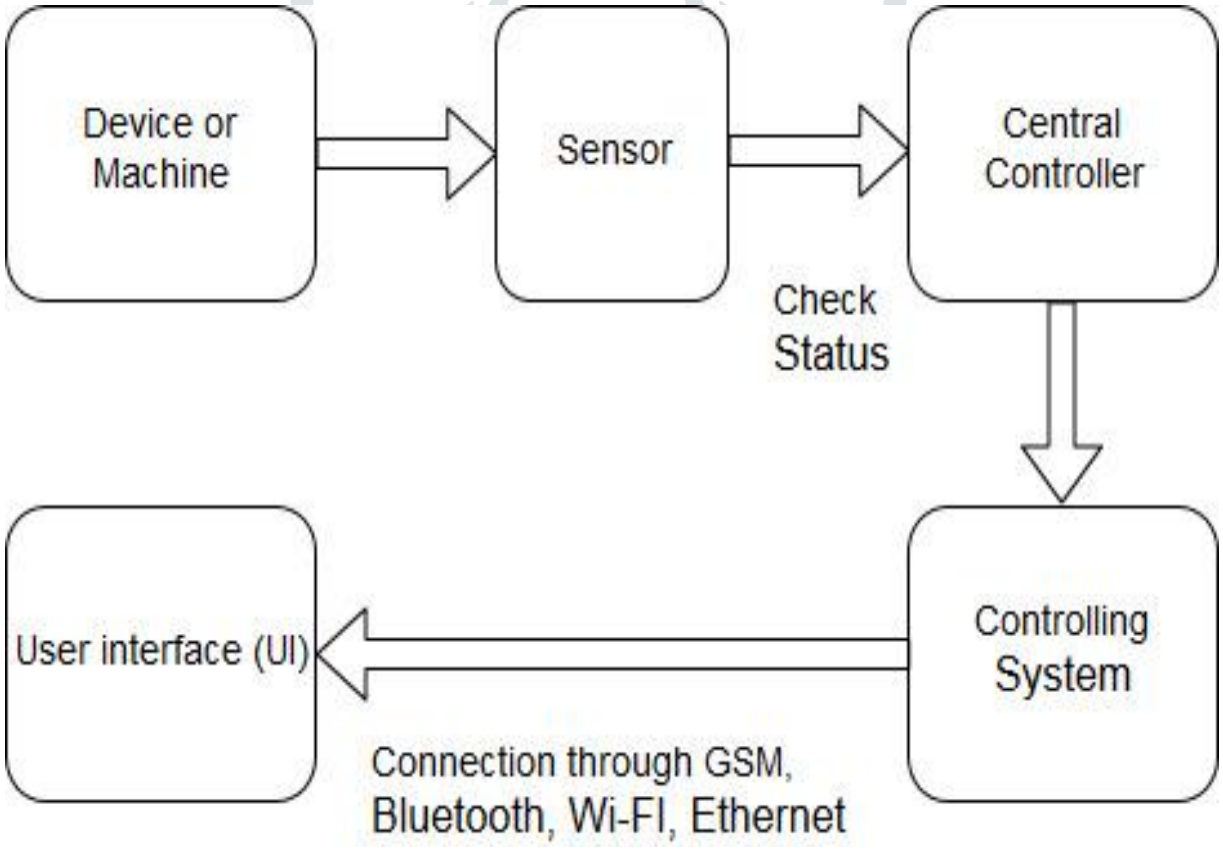

Fig. 1 Basic Block Diagram of Home Automation [7]

Artificial intelligence is increasingly used in day today life. AI is now grabbing every field of science, engineering banking etc. The research work [8] proposed to investigate the usefulness of AI methods in the concept of IoT. AI methods actually save time of operation. The Fig. 2 illustrates the idea of placing the AI methods in the architecture of IoT. Generally the AI is placed at servers because of their computing power.

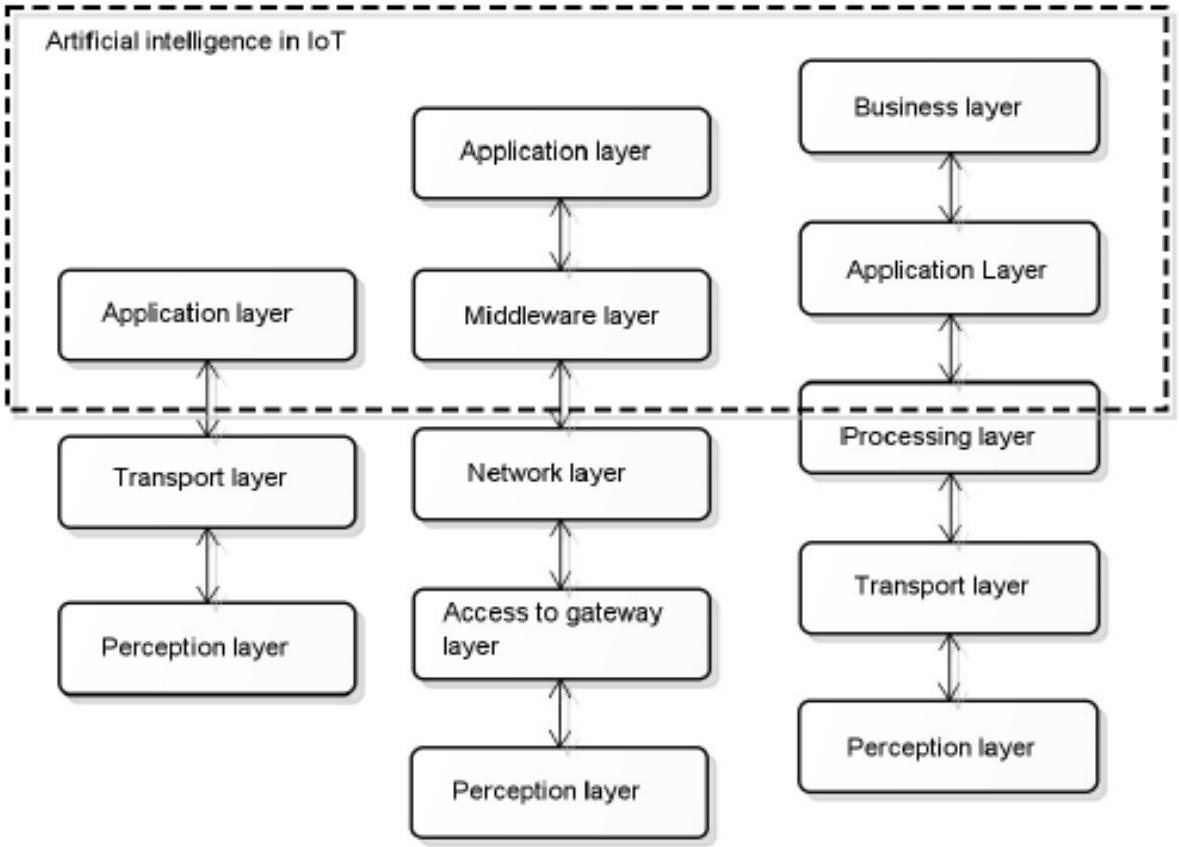

Fig. 2 The position of artificial intelligence in the background of IoT architectures [8]

The paper [9] proposed a voice based home automation system. The proposed system utilizes uses Artificial Intelligence (AI), Internet of Things (IoT), and Natural Language Processing (NLP). In the market, there are many smart home solutions available. They automate the basic operations of the home appliances utilizing GSM, NFC (Near-Field Communication) etc. The operation resembles to the basic operation of the electrical switch. The proposed solution does more than the electrical switch. In the system, the user sends a command through speech to the mobile device. Then the mobile device interprets the message and sends the command to the specific home appliances. In the project, authors demonstrated four basic home appliances as Fan, Coffee Machine, Light, and Door Alarms. The NLP is utilized for interpretation of the voice command. The system utilzes Arduino board for controlling the appliances and thus uses IoT concept.

The work [10] proposed a ThinkHome that utilizes artificial intelligence technology in smart home. Smart homes are becoming more popular now-a-days. The concept of energy efficient homes also attracted the attention due to contribution to the protection of the environment and reduction in the operational costs over the whole building lifecycle. The proposed system minimizes the energy consumption and gives user comfort at the same time. It utilizes automation systems and AI mechanisms to improve sustainability of buildings. It works towards energy efficiency and user comfort. It considers the residents desire by self-managing and adapting society of autonomous acting agents.

The paper [11] focused on home energy management system (HEMS) by considering DR (Demand Response) programs, smart technologies, and load scheduling controllers. Basically HEMS helps to reduce energy usage. This system prepares schedules of optimal consumption by considering various aspects like- energy costs, environmental concerns, load profiles, and consumer comfort. This work also reviewed the application of Artificial Intelligence (AI) for load scheduling controllers, like fuzzy logic, ANN (Artificial Neural Network), adaptive neural fuzzy inference system. This paper commented on types of communication protocols utilized for HEMS, such as Bluetooth, Wi-FI, and ZigBee. It also discussed mathematical and heuristic optimization techniques. Such techniques are used to develop the optimal schedules and consequently minimize the energy consumption.

The homes are becoming smart day-by-day with the advent of cutting edge technologies like IoT, Artificial Intelligence, Deep and machine learning, Cloud computing etc. Under certain aspects, the intelligence and controllability make contradiction. Also the intelligence and controllability vary from user to user. It becomes critical to provide appropriate solution towards intelligent smart home technology. The paper [12] proposed, examines the smart home service features that current users need. It practically proves the relationship between the critical factors and the adoption behavior with 216 samples from Korea. The effect of behavioral characteristics is also tested. The analytical results illustrate various theoretical and practical implications. The study empirically checked crucial aspects for the adoption and spread of smart home services.

The paper [13] proposed a neural fuzzy system controlling home-appliances. Home automation provides an efficient and convenient integration and inter-operation among home appliances. The authors also overviewed home automation using artificial intelligence methods. The proposed solution utilizes the power of fuzzy-system. They assumed an approach that the home system adapts itself the lifestyle of occupant. They proposed a neuro-fuzzy controller (NEFCON) and demonstrated implementation in MATALB.

The paper [14] discussed revolution in Consumer Electronics (CE) with the advent of Information and Communication Technology (ICT) and Artificial Intelligence (AI). Authors predicted some major developments and new business models and opportunities. The new trends set with the new technologies as smart home, smart devices, Internet of Things (IoT), smart residence management, connected CE, embedded systems, ambient intelligence and many others. The CE industry dramatically increased with new devices like drones, like virtual reality (VR), augmented reality (AR), wearables, home personal doctor, personal teacher etc.

III. Conclusion

The smart home environments have been developing with the help of cutting edge technologies. The artificial intelligence is one of the cutting edge technologies. This paper mainly focused on smart home environments utilizing artificial intelligence. This paper reviewed smart home environments based on artificial intelligence technology. There are numerous algorithms presented by different authors with promising results. In future, AI based smart home field will lead in the market. The future work of this work is to implement smart home application utilizing artificial intelligence algorithms to give better solution in the field of home automation.

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