INT-404 ARTIFICIAL INTELLIGENCE

SUBMISSION REPORT

AI IN SMART HOMES

SUBMITTED BY

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1.0 INTRODUCTION

In recent years, the development of smart home technologies contributed to the transition of the home from traditional to a smart internet-connected one. A smart home is a residence equipped with technologies that include sensors, wired and wireless networks, actuators, and intelligent systems. Equipped with highly advanced automatic systems, smart homes can monitor and control home activities for convenience, provide occupants with better comfort, and possibly reduce energy use. Smart home technology collects and analyzes data from the domestic environment. It also relays information to users and enhances the potential of managing different domestic systems. Artificial intelligence (AI) describes any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. The ideal state of artificial intelligence is thinking humanly, thinking rationally, acting humanly, and acting rationally.

Several comprehensive review articles were published on applying AI technology to smart homes. Rho et al. selected nine manuscripts related to intelligent surveillance systems in the smart home environment to indicate that many researchers in the image processing and AI community focused on developing image and video analysis and understanding. Researchers like Dermody et al. reviewed philosophical underpinnings and explained how this framework can guide nurse scientists collaborating with engineers to develop intelligent health-assistive smart homes. They also noted that it is critical to integrate clinical nursing knowledge into smart homes and artificial intelligence features. The types of home automation systems and how these systems can utilize AI tools were discussed by Kumar et al. They defined the major applications of these systems as comfort ability, remote control, optimal resource utilization, and security.

In these systems, AI plays the role of a knowledge and rule database, decision-maker, action implementor, and appliance controller. There are some publications discussing the application of AI technology in smart homes. Huh et al. attached Raspberry Pi to a shoe cabinet at home to see the list of shoes, to store shoes automatically, and to recommend the right shoes for occasions. The most appropriate shoes would be recommended when information on the type of clothes worn and the destination was put in. The automatic storage of shoes was realized by controlling the input sensor and x– y floater with the Raspberry Pi attached to the shoe cabinet. A house simulator was developed and

used as an “expert system shell” to assist with the implementation and verification of the observe, learn, and adapt (OLA) algorithm by Qela et al. for better energy management and conservation in smart homes. Al technology is also used in smart home products. For easy understanding, we defined six core clusters of AI functions in smart homes, i.e., activity recognition, data processing, voice recognition, image recognition, decision-making, and prediction-making. In the aspect of activity recognition, smart home devices can recognize human activity with the help of AI. It analyzes sensor data to detect people’s actions and raises an alarm if there is abnormal activity.

Activity recognition is used in Hive Link and Essence Care Home. In the aspect of data processing, AI is based on data analysis techniques, extracting information from a variety of data sources and identifying intrinsic relationships. It is used in August Smart Lock + Connect and Nest Protect. In the aspect of voice recognition, AI works based on voice-driven technologies, and allows people to interact with it simply by having a conversation, for instance, asking about the weather, or Dering products online, or calling a cab. Voice recognition is used in Amazon Alexa, Google Home, Ivie Sleek, Jibe, Ahom Homey, Apple Home Pod, Josh Micro, etc. In the aspect of image recognition, AI is used to achieve facial recognition, emotion recognition, biometrics, and scene understanding.

It can measure and analyze human behavior, as well as physical aspects of the body’s structure and form. It is used in Lighthouse, Nest Cam, Honeywell Smart Home Security System, Tend Secure Lynx Indoor Camera, Canary All-In-One, Netatmo Welcome Indoor Security Camera, etc. In the aspect of decision-making, AI plays the role of the decision-maker. It can decide what action should be taken in response to the input data. For example, in a smart security system, if the camera detects a stranger breaking into the house, it triggers a loud alarm and gives an alert to the user’s smart phone, or it can call 911 automatically. These systems should be fast enough in response and effectiveness. It is used in Arlo Ultra, Ecobee4, VELUX roof windows/blinds, etc. In the aspect of prediction-making, sensors are embedded in the home which generate data while residents perform their daily routines. The sensor data are collected by a computer network and stored in a database to be processed by an intelligent agent generating useful knowledge such as patterns, predictions, and trends. On the basis of this information, a smart home can select and automate actions to achieve the goals of the smart home application. It is used in Nest Thermostat, Olly, Varoom home, etc.

1.1 SMART HOMES

A smart home is a modern and advanced home automation system that utilizes various internet-connected devices, sensors, and appliances to enable remote monitoring, control, and automation of home functions and services. This can include lighting, heating, air conditioning, security systems, entertainment systems, and more. With a smart home system, users can remotely control and monitor their homes using smartphones, tablets, or other devices. They can program and automate their devices to adjust to their lifestyle and preferences, which can improve their comfort, convenience, and energy efficiency.

A smart home system typically uses a central hub or gateway device that connects all the smart devices in the home to the internet, and which can be controlled through a mobile app or voice-activated assistant. These devices can communicate with each other and with the user, and can perform tasks based on sensors, schedules, or voice commands. Smart home systems are constantly evolving, and new devices and technologies are being developed to make homes even smarter, more connected, and more convenient

1.2 AI IN SMART HOMES

Smart homes are no longer a luxury. They are becoming a natural choice for people who want to enjoy more comfortable, convenient, and safe living spaces. In recent years, artificial intelligence has become a constant and welcomed presence in houses around the world. AI technology has added an extra level of safety and security while allowing people to enjoy a more pleasant way of living. Due to the increased demand for smart homes, home automation tools are now more affordable, and smart household appliances are a must for technology aficionados. Many AI technologies have emerged that come equipped with learning and decision-making capabilities in recent years. AI essentially mimics human intelligence using vast amounts of data.

AI-powered smart home devices can interact and communicate with each other, allowing them to learn human habits. Data collected by AI smart home technologies predict user behavior and even develop situational awareness. Companies in the United States and across the globe have developed AI tech to allow industries to innovate and consumers to benefit from its features. For example, Amazon Alexa, Siri, and Google Assistant rely on AI to work properly.AI brings standard smart home technology to the next level. AI can convert raw data from interconnected devices into a design of behavior. In other words, it can automate tasks based on a homeowner's preferences. Smart homes can feature either wireless or hardwired systems—or both. Wireless systems are easier to install. Putting in a wireless home automation system with features such as smart lighting, climate control, and security can cost several thousand dollars, making it very cost-friendly.

1.3 APPLICATIONS ON AI IN SMART HOMES

AI for more secure houses

One of the most popular uses people have found for artificial intelligence when designing homes is its capability to improve home security. The technology is encapsulated in devices equipped with a variety of features, including facial recognition and threat analysis. The system can recognize objects and faces and send notifications regarding the people standing at the front door. Facial recognition allows for advanced AI devices to recognize the faces of family members, friends, and even pets. It won't be long until AI-powered smart cameras will monitor the activity in the neighborhood and identify potential threats based on artificial intelligence logic. Moreover, artificial intelligence has also been used to create smart locks activated through mobile devices.

AI for safer houses

AI-powered smoke alarms are already available on the market. Equipped with smart features, they can speak, alert, and even think on their own, all to prevent fires and carbon monoxide leaks. Smart smoke alarms communicate with owners through mobile apps installed on their smartphones. They can send various notifications regarding battery level, smoke, carbon monoxide leaks, and even pinpoint locations where they may be a fire or smoke outbreak.

AI for automated household activities

Artificial intelligence is designed to mimic human abilities. This feature can be applied to smart homes to make our lives a lot easier. Smart homes can help humans save time and effort and focus on the things that matter to them. When your AI devices can take care running the robotic vacuum, wash and dry the clothes for you, adjust the interior temperature according to the preferences of the people present in the house, play music, adjust car temperatures, and turn on and off the lights, you will have more time to focus on the bigger things. LG has already developed the DeepThinQ 1.0 technology that can handle everything we just mentioned above based on voice and video recognition and cloud connection. And so have Samsung and Viaroom Home!

AI for smart kitchens

Smart kitchens help people avoid mishaps related to food being cooked for too long or not enough. Smart ovens and stoves are no longer just a concept. They have entered our homes and are helping us cook better and faster. Smart ovens and stoves are now equipped with AI systems that can assess the temperature of the food being cooked and bring it down if it proves to be high. Moreover, apps can inform users when the food needs to be removed from the oven or stove. It can even start the preheating process before the user comes home.

AI for electricity storage

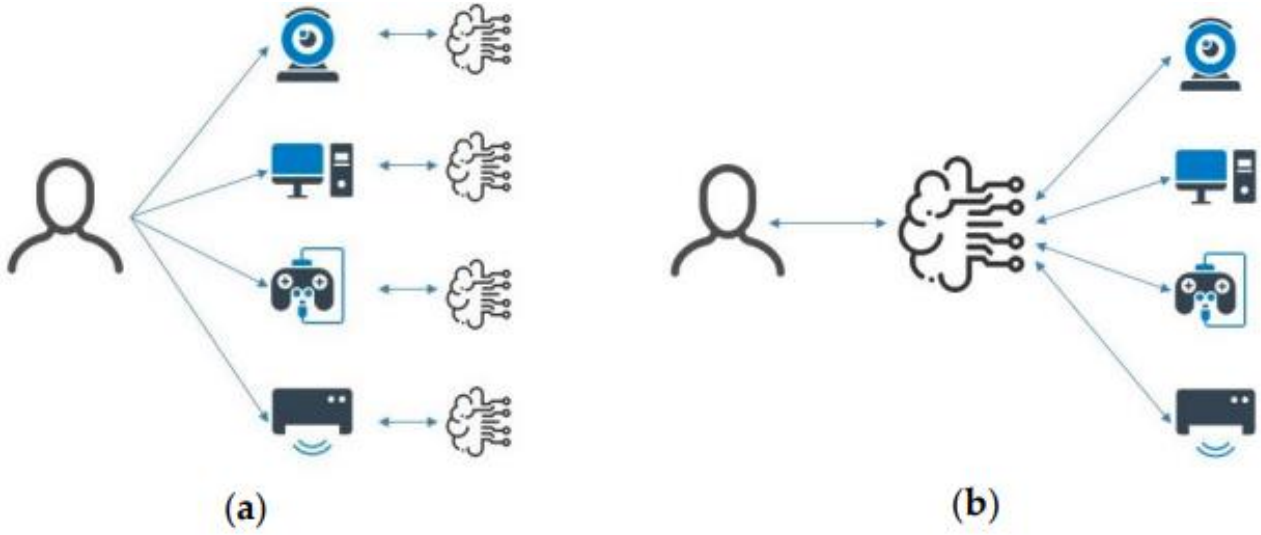
Artificial intelligence has a role to play in distributed energy generation. That's because it integrates automatic energy storage systems with distributed energy sources to store and use electricity. Moreover, due to the technology's capability to store electricity in energy storage systems, smart homes can benefit from energy even if there is a power outage. In other words, due to energy storage enabled by AI technology, smart homes will find it easier to gain independence from the electricity grid and save money on electricity bills.

AI and smart voice assistants

Alexa, Siri, and Google Assistant are AI-enabled units used to control various smart home systems through voice commands. The interesting fact is that every time one of your AI-enabled assistants makes a mistake, it will learn from it. And it will evolve! Your voice assistant takes the data associated with the query, learns from the error, and tries to provide a favorable response. Everything is stored, analyzed, and improved in time. That's because your digital voice assistant relies on data and machine learning to help you control your smart home features. Moreover, Google Assistant can now understand and speak more than one language at a time, which has proved to be a great improvement in bilingual home. Artificial Intelligence (AI) is the backbone of smart assistants like Amazon's Alexa, Google Assistant, and Apple's Siri. These digital assistants are designed to respond to voice commands and perform a wide range of tasks, from answering questions and setting reminders to controlling smart home devices and making phone calls. There are some ways these smart assistants used in AI they are like natural language processing, machine learning, contextual understanding, personalization, third party integrations etc.

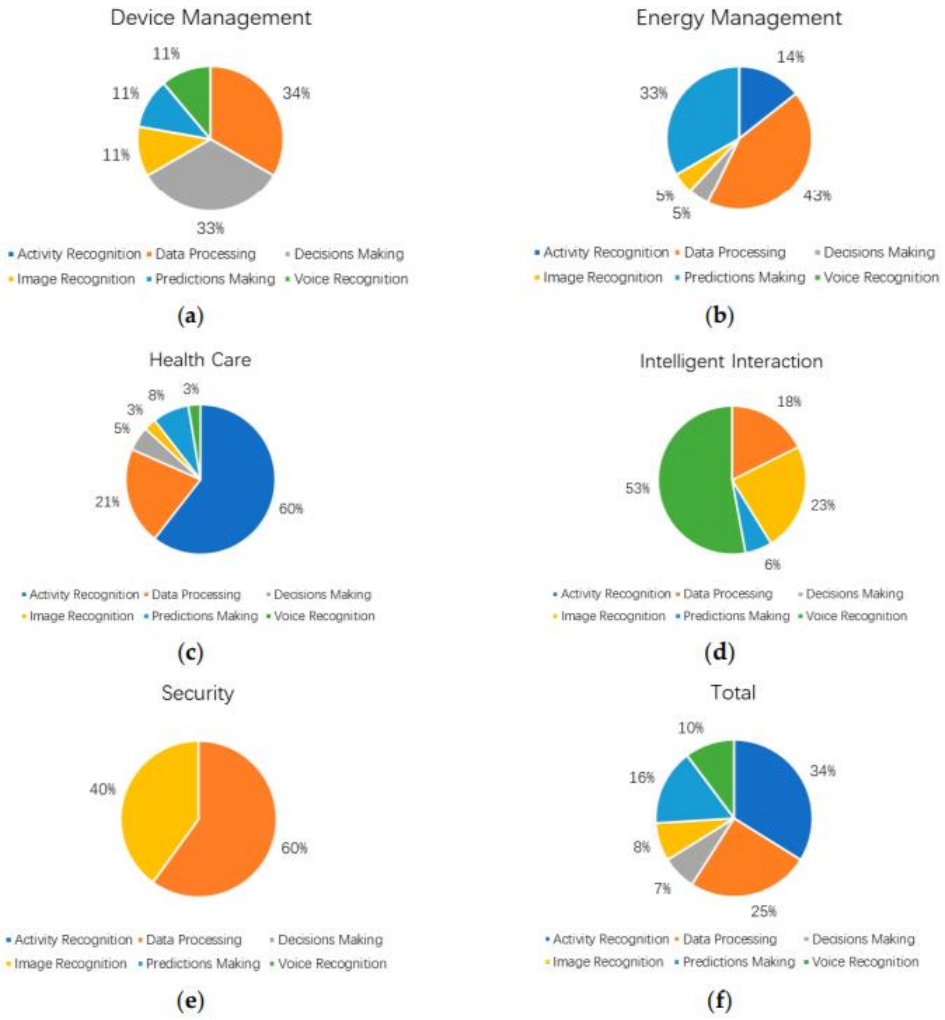
1.4 USE CASES FOR AI IN SMART HOMES

As both AI and smart home technologies advance, more use cases emerge. It seems as though more possibilities present themselves for home automation, so it's exciting to see how they can make life easier for homeowners. For example, suppose someone is cooking on a smart stovetop. In that case, an AI device can monitor the temperature of the food being cooked and raise or lower the temperature for optimal cooking. In another example, if AI devices recognize no one is home, they will have the intelligence and ability to keep the air conditioner and lighting systems turned off until the garage door opens.



The first is shown in figure a, where users directly give commands to each smart home device, and the AI embedded in each device benefits the specific device itself. Smart home energy management, healthcare, and security prefer this pattern. The second is shown figure b, where users give instructions to the AI, and the AI controls each device. Smart home device management and intelligent interaction work using this pattern. Then, AI devices will sense the homeowner has returned and turn these units on. Combining AI and smart home technology can create optimal living conditions for homeowners, automate tasks, and even make decisions. AI devices act as an external brain that can manage various daily activities in a home. Here are some AI-driven smart home technologies that may emerge: A household robot that can sort dishes, pick up and move various items, and even pour a glass of water. An AI-enabled refrigerator that monitors available food ingredients to help homeowners decide what to cook based on dietary restrictions and favorite recipes.

1.5 ANALYSIS OF APPLICATION OF AI IN SMART HOMES



a. Artificial Intelligence functions in device management
b. Artificial Intelligence functions in energy management
c. Artificial Intelligence functions in healthcare
d. Artificial Intelligence functions in intelligent interaction
e. Artificial Intelligence functions in security
f. Artificial Intelligence in all functions of Smart homes

For device management, energy management, security data processing is high, for health care activity recognition is high, for interaction voice recognition is high, for all functions of smart homes in total activity recognition is high.

1.6 COST ANALYSIS FOR AI IN SMART HOMES

On one hand, more and more smart home products being brought to market will continually put pressure on manufacturers, competition, and product prices. On the other hand, these incredible innovations are continually expanding what they are capable of and may be assessed price premiums. When considering smart home products, perform a cost-benefit analysis to determine whether the price exceeds the convenience.

According to HomeAdvisor, it may cost up to $15,000 to fully automate a four-bedroom, three-bath home. Average total home automation costs is just under $800, though fully-connected luxury homes may run into the six figures. In general, a smart home can start by being very focused on a specific product or room. This strategy allows individuals to invest in smart technology for minimal capital.

Consider the following options priced at less than $100 as of September 2022:

- Google Nest Mini, the home audio and assistant device
- Amazon Smart Plug, a method of automating appliances
- Ring Smart Doorbell, a video-enabled camera for home security
- Wyse Thermostat, a digital, wireless, programmable heating device

On the other hand, larger smart home technologies (with more capabilities) often cost thousands of dollars. For example, Vivant's Premium Plus Package for home security cost over $2,300 at writing. Alternatively, the LG 30.8 cubic foot Door-in-Door smart refrigerator could be had for a little over $7,000. Overall, the cost of implementing AI in a smart home can range from a few thousand dollars to tens of thousands of dollars depending on the specific technology and level of automation desired. However, the benefits of increased efficiency, security, and convenience can outweigh the costs in the long run, making AI a worthwhile investment for many homeowners.

The cost of implementing AI in a smart home can vary greatly depending on the level of automation desired and the specific AI technologies used. There are some factors that can influence the cost of AI in smart homes like hardware, installation, connectivity, maintenance, customization etc.

1.7 ADVANTAGES

There are several advantages of using AI in smart homes, some of them are:

1. Increased Efficiency: AI-powered smart homes can automate routine tasks such as adjusting the temperature, turning on/off lights, and locking/unlocking doors, thus saving homeowners time and effort.
2. Improved Security: AI-powered security systems can detect unusual activity and alert homeowners in real-time. They can also learn to distinguish between regular activities and suspicious behavior and adjust their response accordingly.
3. Enhanced Comfort: AI can learn the preferences of individual occupants and adjust the lighting, temperature, and other settings accordingly. This makes the home more personalized and intuitive, providing a better living experience for its occupants.
4. Energy Savings: AI algorithms can analyze energy consumption patterns in a home and suggest ways to reduce energy usage. Smart thermostats can learn the temperature preferences of individual occupants and adjust the temperature accordingly to maximize comfort and energy savings.
5. Predictive Maintenance: AI algorithms can analyze sensor data from various home appliances and predict when they are likely to fail. This allows homeowners to schedule maintenance before a breakdown occurs, avoiding costly repairs and inconvenience.
6. Cost Savings: By automating routine tasks and optimizing energy consumption, AI-powered smart homes can reduce energy bills and overall maintenance costs.

Overall, the advantages of AI in smart homes can significantly improve the quality of life of homeowners. AI technology can provide personalized and intuitive experiences, increased efficiency, enhanced security, energy savings, and cost savings. Like easy to lock and unlock doors, saving energy with smart consumption, customization as per convenience, we are able to know the maintenance and service, we can also experience the ease of using smart house technology as our smart home technologies are smart here the cost savings depends upon the customization of each customer it may vary from one to another.

1.8 DISADVANTAGES

While there are several advantages of using AI in smart homes, there are also some potential disadvantages that homeowners should be aware of. These include:

1. Privacy Concerns: AI-powered smart homes collect large amounts of data on the activities and habits of their occupants, raising concerns about privacy and data security. Homeowners must ensure that their personal information is protected and that their data is not misused.
2. Cost: Implementing AI in a smart home can be expensive, and the cost may be prohibitive for some homeowners. Additionally, maintaining and upgrading the AI system can add to the overall cost.
3. Dependence on Technology: AI-powered smart homes rely heavily on technology and can be vulnerable to technology failures, such as power outages or internet connectivity issues. Homeowners must be prepared to deal with these potential disruptions.
4. Complexity: AI-powered smart homes can be complex and require specialized knowledge and expertise to install and maintain. Homeowners may need to rely on third-party service providers for installation and maintenance, adding to the overall cost.
5. Potential for Malfunction: As with any technology, AI-powered smart homes are not immune to malfunctions. If the system malfunctions, it could cause inconvenience or even harm to the occupants.

Overall, the disadvantages of AI in smart homes must be weighed against the potential benefits. Homeowners must carefully consider the potential privacy concerns, cost, and complexity of AI-powered smart homes before making a decision to implement this technology. Measures to mitigate the risks of such attacks include protecting smart appliances and devices with a strong password, using encryption when available, and only connecting trusted devices to one's network. As noted above, the costs of installing smart technology can run anywhere from a few thousand dollars for a wireless system to tens of thousands of dollars for a hardwired system. It's fairly expensive. Installing a luxury and hardwired smart system can cost homeowners tens of thousands of dollars. In addition, you must have space for network hardware equipment including ethernet cables. When budgeting for smart home products, consider any required or necessary labor/installation costs from professionals.

1.9 LITERATURE REVIEW METHOD

Publications about applying artificial intelligence to smart homes were identified through three search engines, i.e., Web of Science, Elsevier's Science Direct, and Scopus, from 2011 (the rise of deep learning, big data, and artificial intelligence) through 2019. The content included magazine articles, scientific papers, and conference papers. With the concept of smart homes, three online databases were used to search by using common search keywords, namely. "smart home", "smart building", "smart house", "intelligent building". and "home automation".

With the concept of artificial intelligence, we used "artificial intelligence", "artificial intelligent". and "AI". The terms "intelligent house", "intelligent home", "machine learning", "artificial agent", "artificial neural network". and "multi-agent system" were also allowed. Specifically, we searched the Scopus database using the search string (TITLE (smart home*) AND TITLE-ABS-KEY (artificial intelligen*)).

Here, * represents different possible word endings. For example, "intelligen*" means "intelligence" or "intelligent". Publications from a wide variety of academic publishers, such as Springer, Institute of Electrical and Electronics Engineers (IEEE), Blackwell, MDPI AG, and Institute of Physics and Elsevier B.V., were identified. However, there was a large overlap between search databases and publications. On one hand, the same publication was identified using same search terms in different databases; on the other hand, different search terms resulted in an overlapping set of publications. To deal with the overlap and select relevant publications in accordance with previously discussed research goals, two rounds of publication selection were conducted.

After the first-round selection, 116 publications were chosen for research purposes. The selected data were then analyzed by adopting a qualitative inductive method. As the next step, we conducted a second-round selection to analyze the specific technology of AI and the function of smart homes. After the second-round selection, 20 publications were chosen for research purposes. In addition, we searched based on the international standards of ISO and not yet collected international standards related to applying AI to smart homes.

2.0 PRODUCT REVIEW METHOD

There are three main smart home product databases, namely, Google search engine, iotlist.co, and smarthomedb.com (SmartHomeDB). Although the amount of data in the Google search engine is huge, it is not well organized. The platform, iotlist.co, has a very clean and elegant interface to show the list of Internet of things (IoT) devices on the market, but this platform is not restricted to smart home products and does not have a well-structured category. SmartHomeDB is another online platform that focuses on smart home devices and provides a detailed description of products. For these reasons, we chose SmartHomeDB as our product review data source. We also found some state-of-the-art cases in the Google search engine. For product data from previous years, we used the Wayback Machine website. It is a digital archive of the World Wide Web and other information on the Internet. The selected data were then analyzed by adopting a qualitative inductive method.

The qualitative inductive method included several steps. In the aspect of the literature review, we extracted five core functions of smart homes, i.e., device management, energy management, healthcare, intelligent interaction, and security. Tang explained that expert systems, artificial neural networks, and intelligent decision-making systems were applied to intelligent buildings [11]. Based on that, we divided the AI functions in smart homes into six clusters, i.e., activity recognition, data processing, decision-making, image recognition, prediction-making, and voice recognition. In this article, data processing includes data mining, semantic analysis, and rule-based technologies. In the aspect of the product review, we extracted six functions of products with AI in smart homes, i.e., energy management, entertainment system, healthcare, personal robot, intelligent interaction, and security. Next, we divided them into six clusters, i.e., activity recognition, data processing, decision-making, image recognition, prediction-making, and voice recognition.

The distribution of smart homes with the AI application field is shown in analysis. Taken together, these results show that, as time went on, more and more application fields were discussed, and both diversity and quantity increased over time. Since 2015, the research on healthcare decreased year by year, while the research on intelligent interaction increased year by year. Energy management research is also increasing.

2.1 RELATIONSHIP BETWEEN LITERATURE AND PRODUCTS

At first glance, the disproportionate distribution of functions of AI in smart homes between the literature and products attracts much attention. We compared the distribution of each technology and function in the literature and products. The result is shown in **Figure 6**. As we can see, there are not many studies on voice recognition and image recognition in publications, while the number of products is large. There are relatively many studies on prediction-making and data processing in publications, while not so many products utilize these technologies. These data are consistent with the notion in practice, whereby AI is more often used in the identification and recognition of the primary stage, while activity recognition, data processing, decision-making, and prediction-making require further development of artificial intelligence technology.
From **Figure 6**, we can see the relationship between literature and products, that is, no one is in an absolute leading position. Literature is leading the way in complex technology of AI in recent years, while products are more subject to the market. Therefore, once a technology is relatively mature, there are more products using this technology.

As shown in **Figure 7**, in the aspect of the function in our house, energy management and healthcare are discussed in many publications, whereas not so many smart home products associated with AI are applied in this field. This may be explained by it not being necessary to use AI technology to help us in energy and resource management. The products of healthcare may not commonly be used in an ordinary house, or there are potentially some gaps in SmartHomeDB. More products focus on intelligent interaction and entertainment systems. Generally, there is room for further improvement of AI in smart homes. Currently, smart homes are utilized more in energy management, intelligent interaction, and security with AI functions of voice recognition and image recognition. In the foreseeable future, more and more products will use activity recognition, data processing, and prediction-making.

There may be some possible limitations in this study. Firstly, our subcategories for AI were not be chosen in a very systematic way. Secondly, the smart home product database we chose does not cover the newest products.

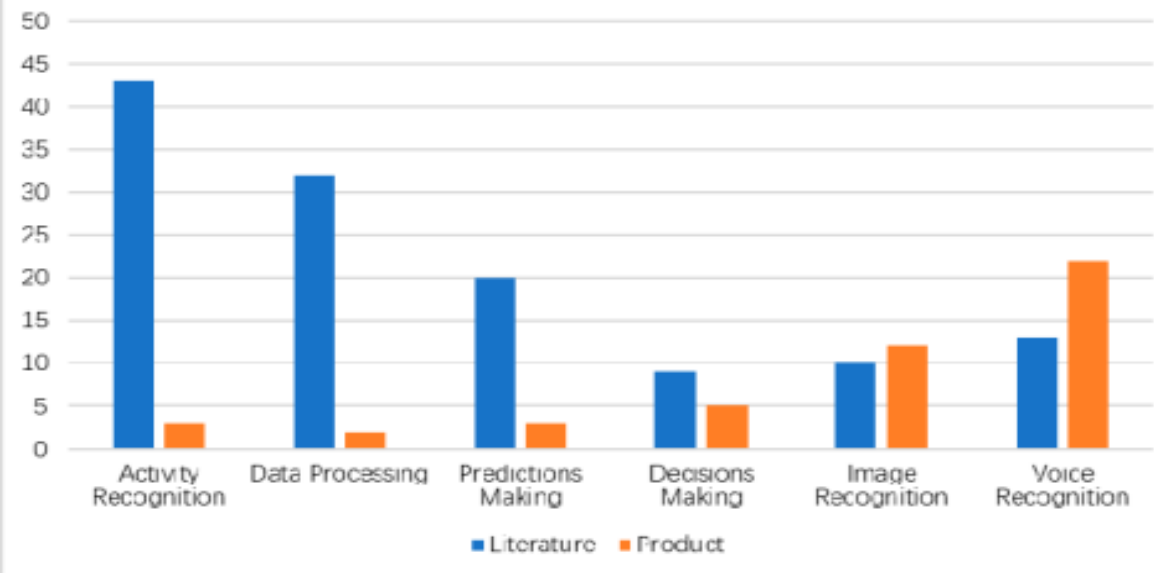


Figure-6. Comparison of the technology of AI in smart homes in literature and products

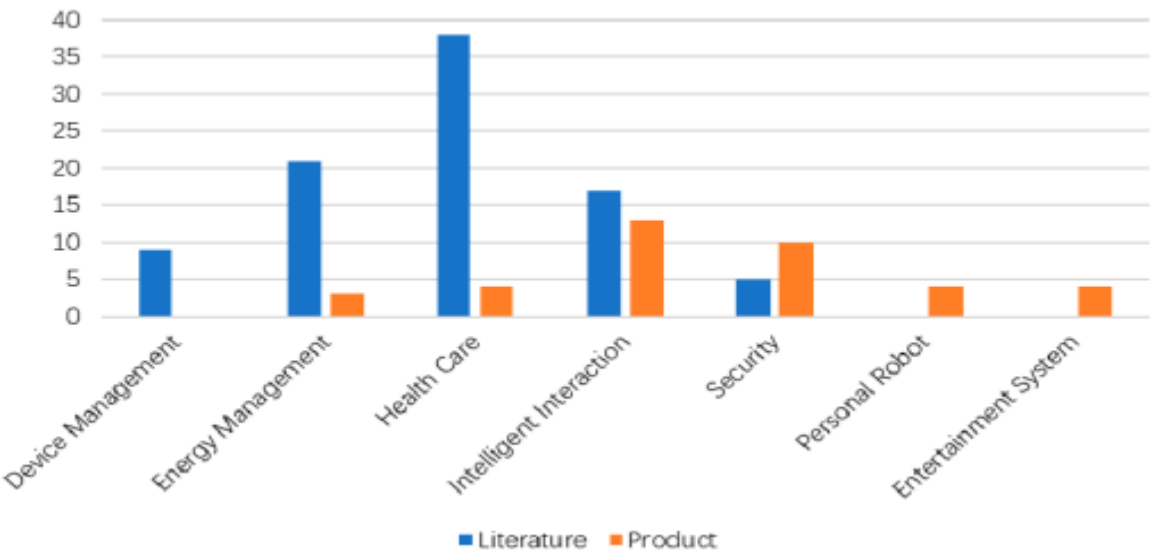


Figure-7. Comparison of the functions of smart homes in the literature and products

2.2 CODE ANALYSIS

Writing code for AI in a smart home can be a complex task, but here are some general steps you can follow to get started:

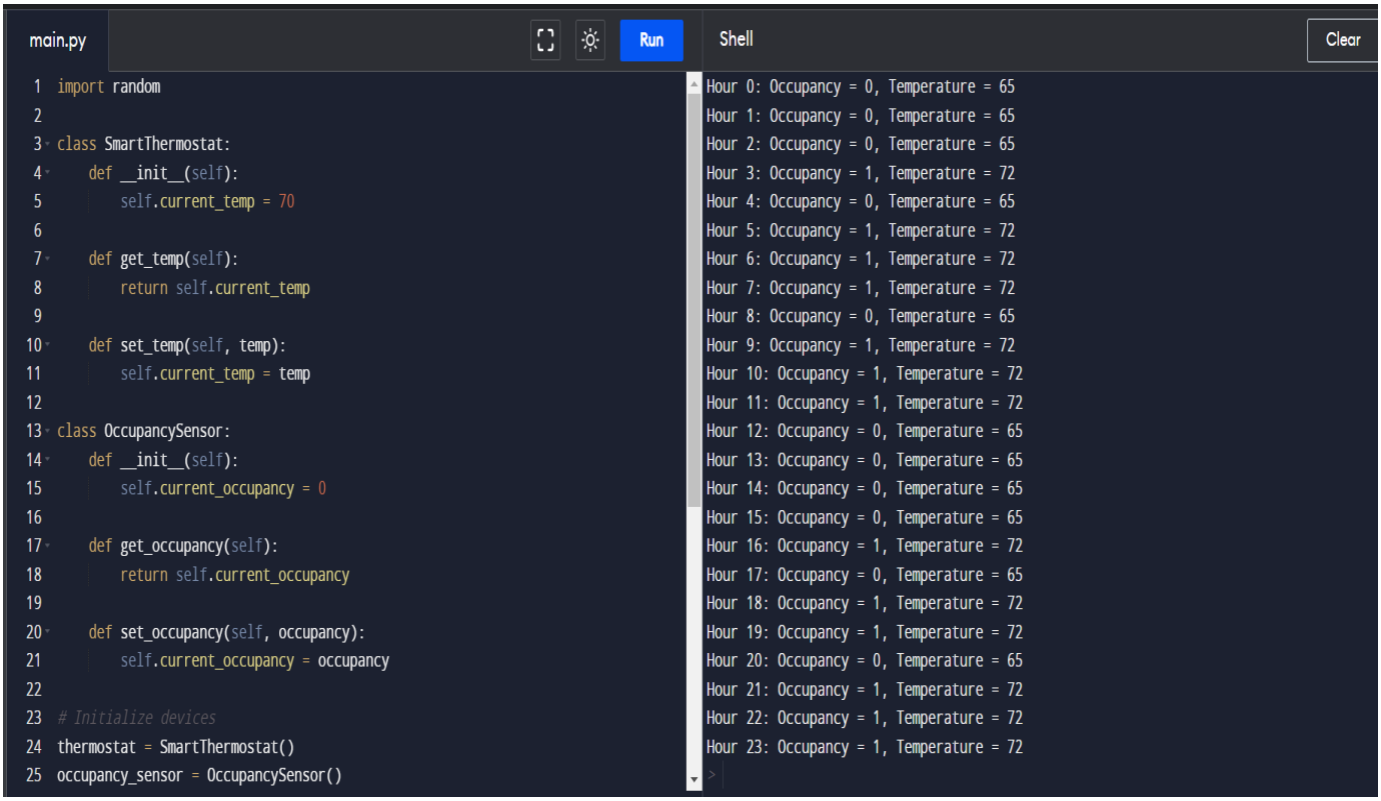
1. Define the problem: Determine what you want the AI to do in your smart home. For example, you may want to create a system that automatically adjusts the temperature based on the time of day or the number of people in the house.
2. Gather data: Collect data from sensors in your home to train your AI. For example, you may gather data on temperature, humidity, and occupancy.
3. Preprocess data: Before feeding the data into your AI model, you may need to preprocess it by cleaning it up and formatting it properly.
4. Build the AI model: Use a machine learning framework like TensorFlow or PyTorch to build your AI model. The specific architecture of your model will depend on the problem you are trying to solve.
5. Train the AI model: Use the preprocessed data to train your AI model. You may need to tweak the parameters of your model to optimize its performance.
6. Deploy the AI model: Once your model is trained, you can deploy it to your smart home. You may need to integrate it with other systems in your home, such as your thermostat or lighting system.

Here's some sample Python code for a simple smart home AI system that adjusts the temperature based on occupancy:

```
import random

class SmartThermostat:
    def _init_(self):
        self.current_temp = 70
    def get_temp(self):
        return self.current_temp
    def set_temp(self, temp):
        self.current_temp = temp
class OccupancySensor:
   def _init_(self):
```

```
        self.current_occupancy = 0
    def get_occupancy(self):
        return self.current_occupancy
    def set_occupancy(self, occupancy):
        self.current_occupancy = occupancy

# Initialize devices
thermostat = SmartThermostat()
occupancy_sensor = OccupancySensor()

# Simulate occupancy data
for i in range(24):
    occupancy_sensor.set_occupancy(random.randint(0, 1))
    current_occupancy = occupancy_sensor.get_occupancy()
    if current_occupancy == 0:
        # No one is home, set temperature to 65 degrees
        thermostat.set_temp(65)
    else:
        # Someone is home, set temperature to 72 degrees
        thermostat.set_temp(72)
 current_temp = thermostat.get_temp()
    print(f"Hour {i}: Occupancy = {current_occupancy}, Temperature =
{current_temp}")
```

2.3 SCREENSHOT OF CODE



Note that this code is just a simple example to illustrate the basic concepts involved in creating an AI for a smart home. In a real-world application, you would need to integrate the AI with other devices in your home and handle edge cases and error handling.

Git hub link-

https://github.com/Gayathrisai13/AI-IN-SMART-HOMES.git

2.4 CONCLUSION

This study aimed to reveal how AI makes homes smart. To achieve this goal, many studies in the literature and several products were reviewed. We found that AI technology helps smart homes in device management, energy management, healthcare, intelligent interaction, security, entertainment systems, and personal robots by utilizing activity recognition, data processing, decision-making, image recognition, prediction-making, and voice recognition. There is a delay between the literature and products, whereby the products concentrate on relatively simple methods like image recognition and voice recognition. The literature concentrates on relatively complicated methods like activity recognition and prediction-making. AI with voice and image recognition is widely used in smart home products, while the technologies of activity recognition, data processing, and prediction-making still need to be developed.

Furthermore, an interesting finding in this study was that intelligent interaction is becoming more and more important both in the literature and products. In the foreseeable future, smart homes will pay more attention to the interaction between people and the environment to make buildings more sustainable and personalized. One important future direction in applying AI to smart homes is considering both smart home technology and architecture design and developing relevant standards.

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