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Smart Homes

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ABSTRACT

Smart homes, also known as "home automation" or "domotics" are homes with connected devices that can be controlled remotely using a smartphone or tablet. These devices are linked through a central hub or network. Smart homes make use of the Internet of Things (IoT) and information and communication technologies (ICT) protocols to communicate with devices. They can be set up with wireless or hardwired systems. A home automation system will remotely monitor and/or control home attributes like lighting, heating, security (such as access control and alarm systems), entertainment systems and appliances from anywhere. The paper looks at the pros and cons of smart homes and its future prospects/benefits to man.

KEYWORDS: *Smart homes, Internet of Things (IoT), information and communication technologies (ICT), automation, artificial intelligence (AI)*

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INTRODUCTION

A smart home, also known as eHome, intelligent home, or connected home is a convenient home setup where appliances and devices can be automatically controlled remotely from anywhere with an internet connection using a mobile or other networked device allowing the user to control functions such as security, access to the home, temperature, lighting, home theater, door locks, television, thermostats, home monitors, cameras through one home automation system, as shown in Figures 1, 2, 3, and 4. The system can be installed on a mobile or other networked device, and the user can schedule the performance of tasks and devices. Smart home appliances come with self-learning skills. They can learn the homeowner's schedules and make adjustments as needed.

Smart homes enabled with lighting control allow homeowners to reduce electricity use and benefit from energy-related cost savings. It can also alert the homeowners of any motion detected in the home when they are away. Others can call the authorities – the police or the fire department – if dangerous situations arise. The smart homes can feature either wireless or hardwired systems, or both [1].

HISTORY

The history of the smart home is still very young. Just about 60 years ago and developed largely from the commercial sector. The history of smart home is from 1963 – 2025. 1939 was seen as the Electric house of the future; 1963 was the first smart industrial buildings; 1973 – building with PLC central computer; 1991 EIB – independent standard for houses/apartments; 2002 – first upscale and luxury homes with KNX; 2005 – House of the Present in Munich; 2008 – House V in the district of Munich; 2015 – Smart home with KNX for all generations; 2023 – Over 2 percent of single-family homes in new construction. Electric doors/gates: everything integrated and controllable. High smart homes 2025: Houses and apartments [2]

Early home automation began with labor-saving machines. It was in 1900s that the self-contained electric or gas powered home appliances became viable with the introduction of electric power

distribution [3] and the washing machines (1904), water heaters (1889), refrigerators (1913), sewing machines, dishwashers, and clothes dryers [4].

It was in 1975 that the first general purpose home automation network technology, X10, was developed – which was a communication protocol for electronic devices, as shown in Figure 5. It primarily uses electric power transmission wiring for signaling and control, where the signals involve brief radio frequency bursts of digital data, and remains the most widely available [5].

By 2012, in the United States, according to ABI Research, 1.5 million home automation systems were installed [6]. Per research firm Statista [7] more than 45 million smart home devices will be installed in U. S. homes by the end of the year 2018 [8].

- 2005: Insteon combined electric wiring with wireless signals.
- 2007: The first smart TVs were released.
- 2011: Nest Labs released the Nest Learning Thermostat
- 2014: Amazon Echo, Apple Homekit, and Amazon Alexa were introduced.
- 2016-2018: Smart speakers like Google Home, Goooogle Nest, Apple HomePod, and Sonos became popular, as shown in Figure 6.

The word "domotics" is a contraction of the Latin word for a home (domus) and the word robotics [9]. The word "smart" in "smart home" refers to the system being aware of the state of its devices, which is done through the information and communication technologies (ICT) protocol and the Internet of Things (IoT) [10], as shown in Figure 7.

The evolution of smart home technology is said to be driven by advancements in connectivity, the Internet of Things (IoT), artificial intelligence (AI), and the increasing demand for convenience, energy efficiency, and home automation. Paving the way for automated lighting in homes was triggered by Thomas Edison's work on the electric bulb in the late 19th century and has taken a greater shape as seen in the 20th century with simple systems for lighting and appliance control [11].

To also enhance the capabilities of smart home devices it is said that the rollout of 5G networks, combined with other technologies like augmented reality (AR) and virtual reality (VR) can be used for immersive home automation experiences [11].

HOW DOES SMART HOMES WORK

A smart home's devices are connected with each other and can be accessed through one central point - a smartphone, tablet, laptop, or game console. Door locks, televisions, thermostats, home monitors, cameras, lights, and appliances like the refrigerator can be controlled through one home automation system - which can be installed on a mobile or other networked device and can be used to schedule the performance of user's tasks and devices. The smart home appliances come with self-learning skills, and hence they can learn the homeowner's schedules and make adjustments as needed. They can as well allow homeowners to reduce electricity use and benefit from energy-related cost savings [1].

Furthermore, some home automation systems can alert the homeowner if any motion is detected in the home when they are away or even call the police or the fire department, in case of dangerous situations. Once they are connected, all services such as a smart doorbell, smart security system, and smart appliances become part of the internet of things (IoT) technology, a network of physical objects that can gather and share electronic information [1]. Smart homes are residences with interconnected devices which are controlled remotely, but while a "smart grid" is said to be an advanced electricity network which uses digital technology to monitor and manage energy usage in real-time, optimizing supply and demand based on changing conditions, as shown in Figure 8.

SMART HOME SYSTEMS

Smart homes can be either wireless or hardwired systems, or both.

Wireless: Wireless systems are easier to install since it is limited in cost, making it relatively cost-friendly. The downside to wireless systems is the need for strong Wi-Fi coverage and broadband service throughout your entire house. This is more appropriate for smaller existing homes or rental properties.

Hardwired: Hardwired systems are said to be more reliable and more difficult to hack. It increases the resale value of a home. Hardwired smart home systems can be scaled easily. Therefore, it is often the default method when designing a new build or performing a major renovation. The drawback is that it is fairly expensive. There is also the need to have space for network hardware equipment including Ethernet cables [1].

The components of a smart home include [1]:

1. Heating
2. Lighting
3. Audio/visual
4. Security
5. Digital assistants or home hubs.

Advantages are:

- It offers convenience to homeowners
- It enhances security as it gives users notifications and updates on issues in their homes when they are away e.g. smart doorbells allow homeowners to see and communicate with people who come to their doors when they are not around or at home.
- Homeowners can benefit significantly from cost savings, as appliances and electronics can be used more efficiently, lowering energy costs.

Disadvantages are:

- Security risks and bugs, as adept hackers can gain access to a smart home's internet-enabled appliances [12].
- Risk mitigation involves the added effort of maintaining and periodically changing strong passwords, using encryption when available, and only connecting trusted devices to one's network.
- The cost of installing a smart technology can be a few thousand dollars for a wireless system to tens of thousands of dollars for a hardwired system.
- Learning to use the home system may involve a steep learning curve.

CONCLUSION

Considering the pros and cons of smart homes, they tend to offer significant advantages in terms of energy efficiency, convenience, security and personalized living experiences by allowing users to remotely control various home systems, automate tasks, and monitor their property, ultimately improving the overall quality of home life. Required for a smart home could include a good starter kit such as an Amazon Echo device, a Nest Learning Thermostat, and a Ring Video Doorbell - allowing you to control your lights, thermostats, and security systems from anywhere in the world using voice commands. Nonetheless, consideration and concerns regarding privacy, technical complexity, and potential costs need to be well considered when implementing smart home technology.

More information on smart homes can be found in the books [13, 14].

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Figure 1. Home automation

Source:https://www.google.com/search?sca_esv=6089cc9941d56e4e&sxsrf=AHTn8zr_Qz-0H3MWVe_tVN3iEYmX0NAhyA:1739864249615&q=images+on+smart+homes+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpA-dk4wpBWOGsoR7DG5zJBjLjqIC1CYKD9D-DQAQS3Z5NmlRTZM9mMZwadeXOSzf-MOuJ9MVOHDHVayNtOyOCEREm3RXZuZWpCKSNf1HgZ9GY_3s6mbwIMPgr4-rsBKOtXrDRbh7ZTQllzMsxzAahWmrrBeh2A4_7NFFlJVSECdlabxCH&sa=X&ved=2ahUKEwjD2ri028yLAxWaQEEAHQx4L48QtKgLegQIERAB&biw=1036&bih=539&dpr=1#vhid=zctA41uxevStbM&vssid=mosaic

Figure 2. Smart home

Source:https://www.google.com/search?sca_esv=6089cc9941d56e4e&sxsrf=AHTn8zr_Qz-0H3MWVe_tVN3iEYmX0NAhyA:1739864249615&q=images+on+smart+homes+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpA-dk4wpBWOGsoR7DG5zJBjLjqIC1CYKD9D-DQAQS3Z5NmlRTZM9mMZwadeXOSzf-MOuJ9MVOHDHVayNtOyOCEREm3RXZuZWpCKSNf1HgZ9GY_3s6mbwIMPgr4-rsBKOtXrDRbh7ZTQllzMsxzAahWmrrBeh2A4_7NFFlJVSECdlabxCH&sa=X&ved=2ahUKEwjD2ri028yLAxWaQEEAHQx4L48QtKgLegQIERAB&biw=1036&bih=539&dpr=1#vhid=ubkEDYlQcytGzM&vssid=mosaic

Figure 3. Datel: Smart-Home.png

Source:https://www.google.com/search?q=images+on+smart+homes+wikipedia&sca_esv=6fe806cc0ee527f3&udm=2&biw=1036&bih=539&sxsrf=AHTn8zqkdNL5AKk7IynF6BHuRYawksaPBQ%3A1739905589191&ei=Ndq0Z5WwC6WhhbIPrIiB-A8&ved=0ahUKEwjVnti09c2LAxWlUEEAHSxEAP8Q4dUDCBE&oq=images+on+smart+homes+wikipedia&gs_lp=EgNpbWciH2ltYWdlcyBvbiBzbWFydCBob21lcyB3aWtpcGVkaWFI5owBUMUPWPpkcAF4AJABApgBpRqgAZJ1qgENMi0xLjMuNy0yLjAuNLgBDMgBAPgBAZgCAaACE8ICBxAjGCcYyQKYAwCIBgGSBwExoAfKAw&sclient=img#vhid=kQTpt_bbAjSNXM&vssid=mosaic

Figure 4. Smart thermostat

Source:https://www.google.com/search?q=images+on+smart+homes+wikipedia&sca_esv=6fe806cc0ee527f3&udm=2&biw=1036&bih=539&sxsrf=AHTn8zqkdNL5AKk7IynF6BHuRYawksaPBQ%3A1739905589191&ei=Ndq0Z5WwC6WhhbIPrIiB-A8&ved=0ahUKEwjVnti09c2LAxWlUEEAHSxEAP8Q4dUDCBE&oq=images+on+smart+homes+wikipedia&gs_lp=EgNpbWciH2ltYWdlcyBvbiBzbWFydCBob21lcyB3aWtpcGVkaWFI5owBUMUPWPpkcAF4AJABApgBpRqgAZJ1qgENMi0xLjMuNy0yLjAuNLgBDMgBAPgBAZgCAaACE8ICBxAjGCcYyQKYAwCIBgGSBwExoAfKAw&sclient=img#vhid=YkowumWJ6oLc-M&vssid=mosaic

Figure 5. Smart refrigerator

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Figure 6. X10 (Industry standard)

Source:https://www.google.com/search?q=images+on+smart+homes+wikipedia&sca_esv=6fe806cc0ee527f3&udm=2&biw=1036&bih=539&sxsrf=AHTn8zqkdNL5AKk7IynF6BHuRYawksaPBQ%3A1739905589191&ei=Ndq0Z5WwC6WhhbIPrIiB-A8&ved=0ahUKEwjVnti09c2LAxWlUEEAHSxEAP8Q4dUDCBE&oq=images+on+smart+homes+wikipedia&gs_lp=EgNpbWciH2ltYWdlcyBvbiBzbWFydCBob21lcyB3aWtpcGVkaWFI5owBUMUPWPpkcAF4AJABApgBpRqgAZJ1qgENMi0xLjMuNy0yLjAuNLgBDMgBAPgBAZgCAaACE8ICBxAjGCcYyQKYAwCIBgGSBwExoAfKAw&sclient=img#vhid=N6Hg39GuUgtV2M&vssid=mosaic

Figure 7. Google Nest (smart speakers)

Source:https://www.google.com/search?q=images+on+smart+homes+wikipedia&sca_esv=6fe806cc0ee527f3&udm=2&biw=1036&bih=539&sxsrf=AHTn8zqkdNL5AKk7IynF6BHuRYawksaPBQ%3A1739905589191&ei=Ndq0Z5WwC6WhhbIPrIiB-A8&ved=0ahUKEwjVnti09c2LAxWlUEEAHSxEAP8Q4dUDCBE&oq=images+on+smart+homes+wikipedia&gs_lp=EgNpbWciH2ltYWdlcyBvbiBzbWFydCBob21lcyB3aWtpcGVkaWFI5owBUMUPWPpkcAF4AJABApgBpRqgAZJ1qgENMi0xLjMuNy0yLjAuNLgBDMgBAPgBAZgCAaACE8ICBxAjGCcYyQKYAwCIBgGSBwExoAfKAw&sclient=img#vhid=XTEo8BkWjHXhoM&vssid=mosaic

Figure 8, Internet of Things

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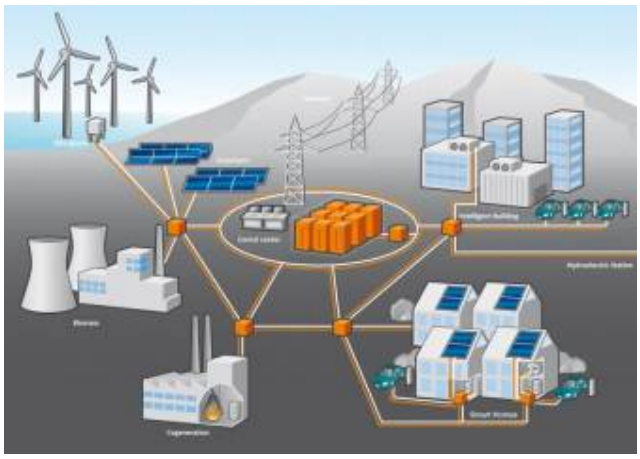

Figure 9. Smart grid.png

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