

Conceptualising Internet of Things and Artificial Intelligence Enabled Smart Homes

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Abstract

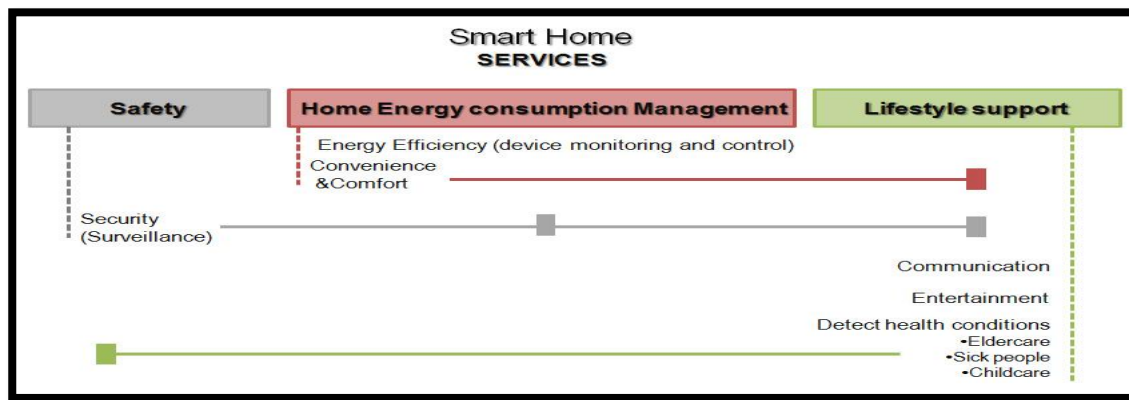
“Can machines think?” Alan Turing (1950). The answer is yes. Today machines have ability to understand, process external inputs, learn from these inputs and use those inputs to achieve specific goal or task. Since 1956, when the term “Artificial Intelligence” was coined first by John McCarthy and Marvin Minsky, the world has made significant progress in the field of Artificial Intelligence (AI). It is being used to solve various problems either beyond human control or difficult for humans to solve. It has disrupted business operations, health infrastructure, entertainment and above all the human experience. Machines can be equipped with ability not only to learn and apply but also to interact with other machines and get a task completed. Development in IT and telecom infrastructure has facilitated this interaction between the machines which is called Internet of Things (IoT). AI and IoT is being used together to solve critical aspects of human life. Smart home built with AI and IoT will make human life more convenient and simple. However, the concept of smart home is still in nascent stage and has not been completely developed. Various authors and researchers discussed services provided by smart homes but no researcher came up with comprehensive list of services that a smart home can offer. Also, role of artificial intelligence has been neglected by almost all researchers.

Objective of this study is to understand and define Smart Homes comprehensively. This study is focused on studying previous literatures and available technologies that can be used to make a full-fledged smart home providing all services possible in current technological environment. This research is mainly focused on analysing research papers and articles published recently. Qualitative research tool is used to analyse the literature.

Keywords: Smart homes, artificial intelligence, Internet of things, Sensors.

INTRODUCTION

Smart home is home equipped with a network of sensors, devices and appliances which can be remotely controlled and accessed with smart phone applications. It allow user to control home appliances, enhance security and human comforts. Following are few basic services a smart home can provide.

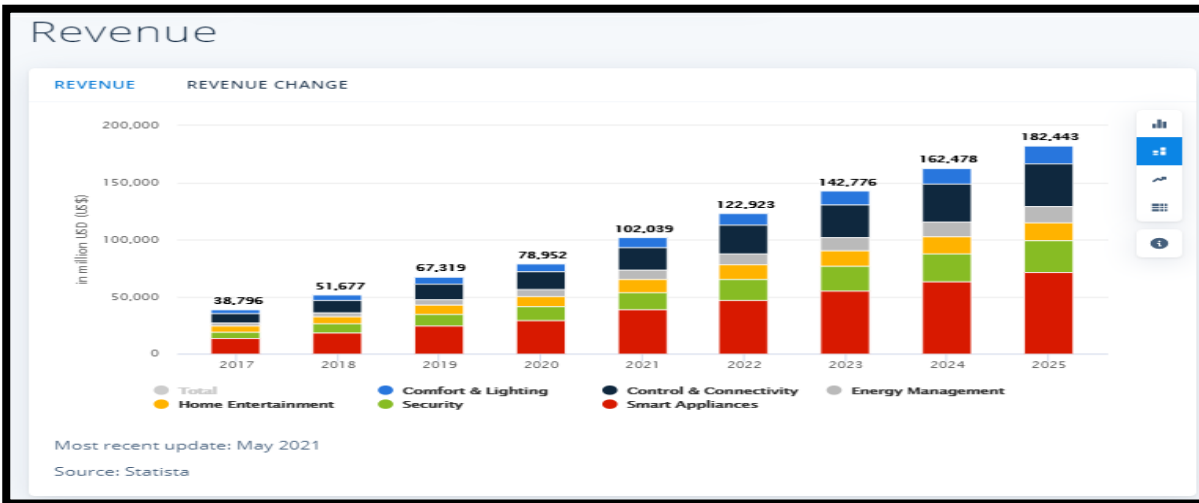


Smart Home Services

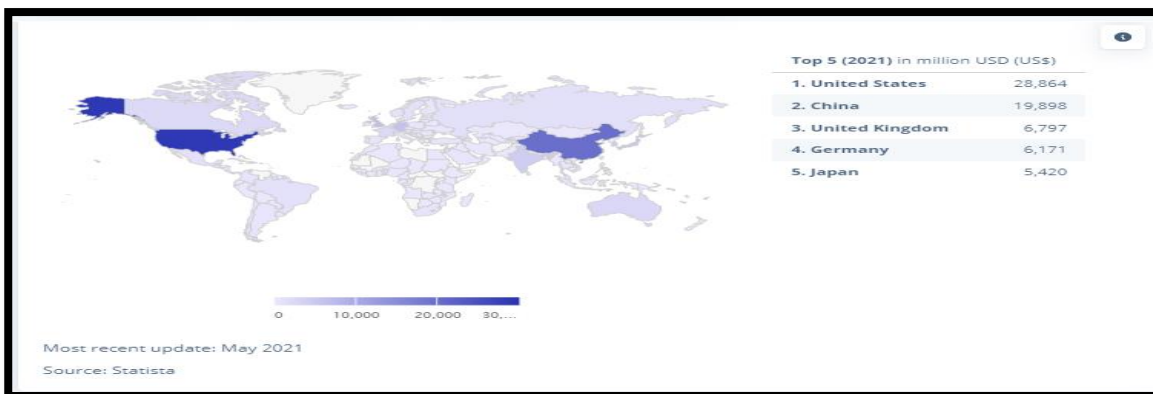
Source - Valentina Fabi, Giorgia Spigiantini, Stefano Paolo Corgnati (2016).

Smart Home Market

Smart home market is rapidly expanding worldwide. Expansion of smart home market is directly linked for penetration of 5G network. Revenue in the Smart Home market is projected to reach US\$4,309m in 2021 world-wide.

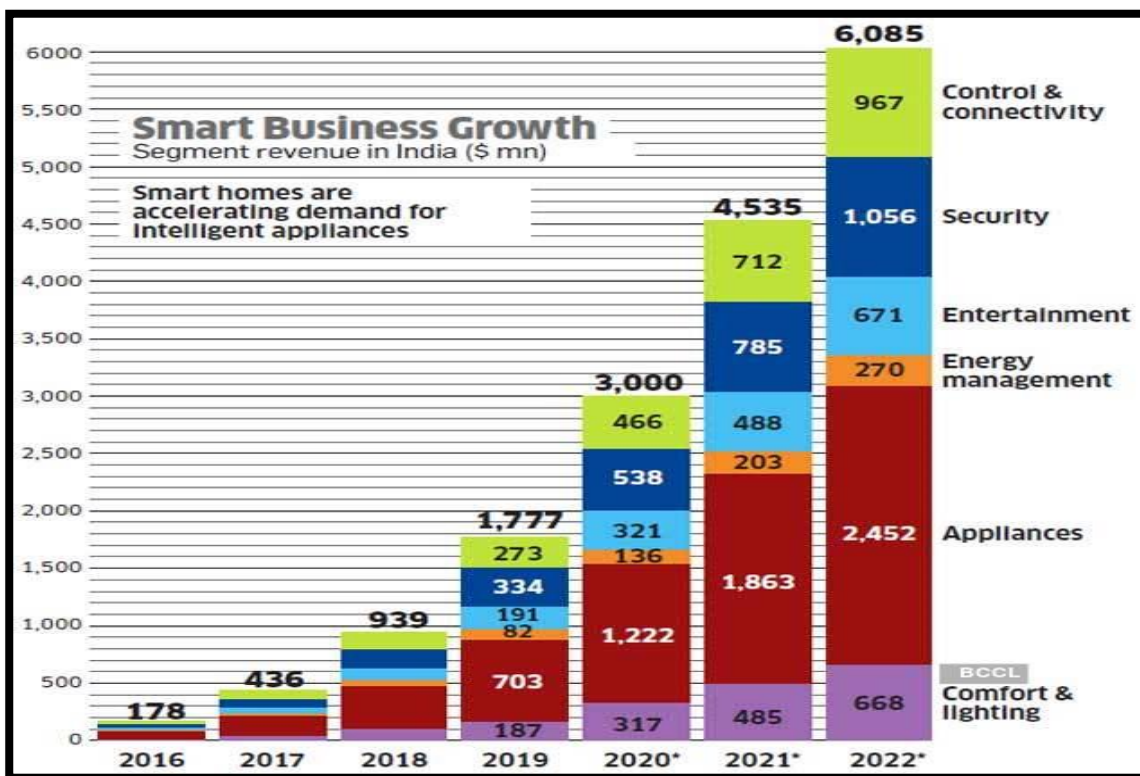


In the Smart Home market, the number of active households worldwide is expected to amount to 44.2m users by 2025. Smart home market is also growing in India rapidly. But India's share in smart home market is still very low. United States of America, China, United Kingdom,



Germany and Japan are major markets for smart homes.

Being 2nd most populated country in the world, companies developing Smart home appliances, applications and equipment are looking at India as a potential market. India's highly ambitious middle class is target population for these tech-companies. Smart home market in India has grown rapidly in three years from 2014 to year 2017 (India Smart Home Outlook -2021). India's smart home market grew from \$ 178 mn in year 2016 to \$ 1776 mn in the year 2019. It is expected to grow \$ 6000 mn by 2022 (Economic Times).



Source: Economic Times

In this scenario, it is imperative to study what drives customers' perception towards smart homes. The concept of smart home is still evolving. Application of artificial intelligence has provided new meaning to this area. Researcher studying smart home technologies has not covered all of its aspects. This study is aim to understand customers' perception and expectation to build a model smart home considering all its aspects. Internet of Things and Artificial Intelligence are evolving technologies. There are limitless possibilities of its applications in Smart homes. Understanding & defining smart home will help tech-companies to design and introduce new products.

Literature Review

The idea of smart homes is still in developing stage. There is no uniformity amongst the researcher about its definition. No research has covered all possible applications of IoT and AI in building smart homes. An attempt has been made to cover all possible services a smart home can provide based on research conducted by earlier researchers.

Energy Efficiency - Nazmiye Balta-Ozkan, Oscar Amerighi, and Benjamin Boteler (2014) majorly focused on energy consumption, remote control of appliances, and interconnected devices and stated that cost was the primary consideration affecting the perception of smart home consumers of the UK, Germany, and Italy. Zahrah A. Almusaylim, Noor Zaman(2018) focuses on the Internet of Things and use sensors to collect data, interoperability of devices, security, energy efficiency, and privacy.

Elderly Care & Health Care -Tae Hee Jo, Jae Hoon Ma, and Seung Hyun Cha (2021) investigated the perception of elderly consumers of wearable health sensors and environmental sensors. Elderly participants showed negative perceptions of wearable smart home sensors as they are inconvenient to them; however, participants of this study positively perceived privacy issues. The study majorly focused on the health and environmental aspect of smart homes, which other researchers neglected. Smart homes can majorly benefit the aging population leaving alone. Smart home devices can monitor their health conditions and send data to hospitals in case of medical emergencies. Remote control of devices will be convenient to elderly consumers. Veralia Gabriela Sanchez, Carlos F. Pfeiffer, and Nils-Olav Skeie(2017) analyzed smart homes from the perspective of older people living alone. A well-built smart home can assist older people in their daily activities, improve access to home care, and make everyday life easier.

Covid 19 proved a catalyst in using the Internet of Things (IoT) in the healthcare sector and smart homes. Muhammad Umair,

Muhammad Aamir Cheema, Omer Cheema (2021).

Awareness -

Ibrahim Mashal, Ahmed Shuhaiber(2018) considered personal, social, and device-related factors affecting Jordanian consumers' purchase intentions. Trust, awareness and perceived enjoyment are personal factors. Social influence is a social factor, and personalization, cost, and availability are device-related factors. All these factors influence consumers' purchase decisions.

Security & Privacy - Omar Almutair, Khalid Almarhab(2021) mainly focused on security and privacy concerns affecting Saudi Arabian consumers' perception. The research addressed security concerns like information storage, copyright infringement, attack probabilities, physical security, and lack of control and awareness. Muneer Bani Yassein, Ismail Hmeidi, Farah Shatnawi, Wail Mardini, Yaser Khamayseh (2019) discussed security aspects of smart home appliances from technical point of view and concluded that security issues exist in all layers of IoT design.

Renewable energy resources. As per the study, sustainable development significantly affects customers' perception towards smart homes. Pira(2020) also looks at smart home technologies as a solution to new challenges posed by rapid urbanisation. Smart homes can lead to smart living reducing environmental impact and leading to sustainable development.

Acceptability and Adoption - Ahmed Shuhaiber, Ibrahim Mashal,(2019) studied users' acceptance towards smart homes and found that customers' awareness and perceived enjoyment highly affect their acceptability. Perceived risk affects customers' acceptability negatively. Min Jeon, Jeon, Kim, Han, Mi Jeon, Gong, Kim, In Han, Kim (2019) also researched acceptability of Korean women and concluded that current provisions do not meet customers' expectations and most of the customers are not satisfied with current provisions and affordability of smart home equipment. Emilie Vrain, Charlie Wilson (2021) concluded that social networks and communication impact adoption of smart home technologies.

Research Gap

There is no comprehensive definition of smart homes. Researchers studied various aspects of the smart homes but no researcher came up with a comprehensive definition of smart homes and what it consists of. Internet of Things and Artificial Intelligence can be extensively used to build smart homes. However, the role of Artificial Intelligence has been neglected by the researchers. Previous researches are broadly revolving around Security, lightning, home appliances and control devices and mobile applications. There is no comprehensive list of services a smart home can offer. In India, research in smart homes is still in its initial stage. A study has been conducted by Schneider to understand consumer perception in India only covers comfort, convenience, energy efficiency, prestige and security. Factors like health and wellness, environment, water conservation, affordability are not covered. Most of the researcher covers technical aspects only.

Analysis

We propose a smart home with all possible services it can provide under one roof. From the earlier research conducted we can understand that what really matters when it comes to smart homes. Following word cloud shows which terms really matter in building a smart home.

13. Acceptable
14. IoT

Security is most important aspect of smart homes. A well-equipped smart home with devices like smart lock, face recognition device, sensors and surveillance cameras can ensure security of the user and it will notify user in case of any threat detected. Security of smart home itself of at-most importance. Developer should ensure the security of smart homes from cyber-attacks. Security of personal information of the user should be priority of the developer. Recent events related to data theft raised question on many social media and digital platforms. To get best user experience users are bound to share his/her personal information like user's preferences, his health conditionals, appointments etc. Developer of the smart homes should address this issue with necessary security arrangement. Developer must share privacy policy with user.

Quality and efficiency of the devices used to build smart homes going to affect overall user experience. Sensor used must be capable of collecting right data at right time. A system should be in place to record and process information gathered through devices.

A well-developed smart home can take care of health conditions of the users, elderly persons at the home and can be enabled to provide timely assistance. Wearable devices as well as sensors can be used to monitor health conditions. Some sensors are available in the market which are capable of detecting unusual moves and health conditions can be checked by scanning human waste. Pulse rate and O₂ can be measured with wearable devices. Daily activities and exercise can be monitored. Central device may advice user to achieve daily targets and offer sedentary reminders. Sensors are also capable of detecting viruses.

Assistants like Alexa, Google Assistant can provide assistance in day to activity, provide useful information, entertainment and access to unlimited information. Centrally controlled devices can be monitored with voice commands or remote control device, which will further add to convenience of the user. Smart curtains, voice controlled home appliances, lights, fans, air conditioner can improve ease of living for the user. With recent technological advancements, automation is possible in almost all electronics connectable devices.

Connecting people was ever so easy before. With internet and social media platforms, world has turned into a small village. Smart assistants can also help users to connect with people with same interest. Smart assistants are capable of providing unlimited information and services. Creating a comprehensive list of services can be offered is going to be most difficult process.

Rise in level of air pollution is major concern of today's urban society. Sensor can detect harmful pollutants in the air and air purifiers can be installed to remove pollutants from the environment surrounding the user. Efficient use of energy and water resources can reduce environmental impact and leads to sustainable development.

A smart home should be energy efficient and capable of switching of the appliances when not in use or not required. For example, air conditioner can automatically adjust the environment. The system can be programmed to switch off the lights when natural light is there.

Application of artificial intelligence can improve user experience with personalisation and customization. Things can act without command given by the user on the basis of past preferences and commands given by the user. There is an ample scope for imagination and development with regards to applications of artificial intelligence in building smart homes.

Conclusion

There are unlimited possibilities for applications of internet of things and artificial intelligence in building smart homes. Use of these technologies can make a home with customized user experience allowing user to enjoy ease of living. A well-developed smart home can take care of its host's daily needs, health conditions and entertainment and social needs. This study is just a small attempt to conceptualise possible applications of technologies in building smart homes. There is further scope for research in this area.

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