Open Access

Smart technologies/systems in home automation: a review and guideline to implement for smart real estate projects

Abstract

In this era, the smart home is not a new name, Smart home technology started for more than a decade to introduce the advanced technological systems that allow the automation of domestic tasks are developing rapidly. New technologies and applications which enable communication between the household applications and users, thereby improving the monitoring and control capabilities can now be installed in Smart Homes today. This review article takes a look at the concept of Smart Homes and emerging technologies that can be installed in these Smart Homes.

Keywords: smart homes, smart grid, automation, technologies

Girish Santosh Bagale,[1] Neel Shah[2]

[1]Department of Mechanical/Mechatronics, NMIMS University, India
[2]Department of Mechatronics, NMIMS University, India

Correspondence: Girish Santosh Bagale, Department of Mechanical/Mechatronics, NMIMS University, India, Email Girish.Bagale@nmims.edu

Introduction

Smart home implies an extension of the existing building automation systems but limited to individual homes. This involves control and automation of lighting, smart thermostats, air conditioning and even security systems. Smart home is not an isolated case but also depends on:

i. The development within the society.

ii. Focus is on smart home environment and not the used technologies.

iii. Created environment helps every individual human i.e. Elderly and disabled individuals also.

iv. Various technologies related to Smart Homes are emerging. In this review paper, we take a look at smart home systems and its related emerging technologies.

Smart home system

Smart Home defines a residence which uses a controller to integrate home appliances. These appliances are connected to Windows based PC or iOS system through a wireless networking system. These appliances are programmed to work on stand-alone basis. The home network includes but is not limited to communications, entertainment, comfort, security, and information systems.

There are various technologies for home automation such as

a. Integrated Wireless Technology (IWT).

b. Home Energy Management System (HEMS).

c. Smart Home Micro-computers (SHMC).

d. Home Automation (SHS/HA).

e. However, the discussion is limited to Integrated Wireless Technology (IWT).

Integrated wireless technology

Introduction

IWT is used for internal and external short-range communication throughout smart home technology within a private home. They are more preferred to wired technologies. It gives benefits of lower cost of equipment and installation, faster deployment, extensive access and improved flexibility. It is implemented with the help of Graphic-User Interface (GUI) which enables easier monitor and control of appliances. There are various existing wireless communication technologies and network protocols which are discussed in 1.2 and compared in 1.3.

The Figure 1 given below shows a basic smart home. The contents are defined in the table following the figure. Types of IWT

a. 6LoWPAN

I. Its full name is IPv6 over Low-Power Wireless Personal Area Networks.

II. It is a networking technology that allows IPv6 packets to be carried efficiently within small link layer frames, such as those defined by IEEE 802.15.4.

III. It enables IEEE 802.15.4 (IEEE *subcommittee for low rate WPAN) and IPv6to work together in order to achieve IP enabled low-power networks of small devices including sensors, controllers etc.

IV. The standard IETF RFC 4944 describes the mechanism of combining IP and WPAN technologies.

b. Bluetooth

i. It is wireless communications system used to exchange data over short distances.

ii. It employs short-wave length radio transmission in the Industrial, scientific and medical (ISM) band (2400-2480MHz).

iii.   Its main features are low energy usage and fast data exchange as well as widespread availability.

c. DASH7

i.   It is an open source wireless network protocol for sensors and actuators, which operates in the 433MHz. 868MHz and 915MHz unlicensed ISM band/SRD band; It provides multi-year battery life.

ii.   It ranges of up to 2km.

iii.   It has low latency for connecting with moving things.

iv.   It has a very small open source protocol stack.

v.   It has AES 128-bit shared key encryption support.

vi.   It has a data transfer of upto 167kbit/s.

vii.   DASH7 Alliance Protocol is the name of the technology promoted by the non-profit consortium called the DASH7 Alliance.

viii.   En Ocean Technology.

I.   It is an innovative energy harvesting wireless technology with the smallest amount of energy from their environment.

II.   It consists of wireless technology components for self-powered wireless control, signalling and monitoring of systems.

d. GSM

i.   Global system mobile (GSM/GPRS) is a mobile phone communication that operates in geographical cells. The size of these cells depends on the required need for traffic distribution and demand.

ii.   It is better known as a mobile wireless system and it operates at either 900MHz or1800MHz frequency band.

e. Myrianed

I.   It is a self-organizing, gossiping wireless sensor network (WSN) platform.

II.   It uses an epidemic communication style based on standard radio broadcasting.

III.   It is inspired by biological processes where many nodes (e.g., birds, ants, cells) operate in large distributed systems (flocks, organized colonies, organisms).

IV.   Its technology is a decentralized system based on bottom up approach, where the behaviour of a single element (node) will result in emerging behaviour of the system (application).

f. RFID

a.   Radio frequency identification (RFID) is a system that transmits the objects identity wirelessly by radio waves.

b.   It can be categorized based on its used frequency range: low (124-135KHz), high (13.56MHz) and ultra-high frequency (860-960MHz).[1–8]

Conclusion

In this paper, Smart homes and the existing technologies have been reviewed. Figure 1 shows a basic smart home and the following Table 1 shows the basic components of a smart home. Table 2 shows the existing technologies and network protocols in the Integrated Wireless Technology. The work done in this paper is expected to take efforts towards a user friendly system for smart home. These systems offer benefits to elderly and disabled human by making the accessibility easier. The following is the guideline to help implement:

a.   Do Your Home Design Homework.

b.   Create Your Home Design List.

c.   Check Local Zoning Law.

d.   Design with Your Budget.

e.   Design to Fit Your Plot.

f.   Maximize Your Space Efficiency.

g.   Plan for Expansion.

h.   Picture Interior Design.

i.   Don't Forget the Sun.

j.   Beautify All Sides of Your Home Design.
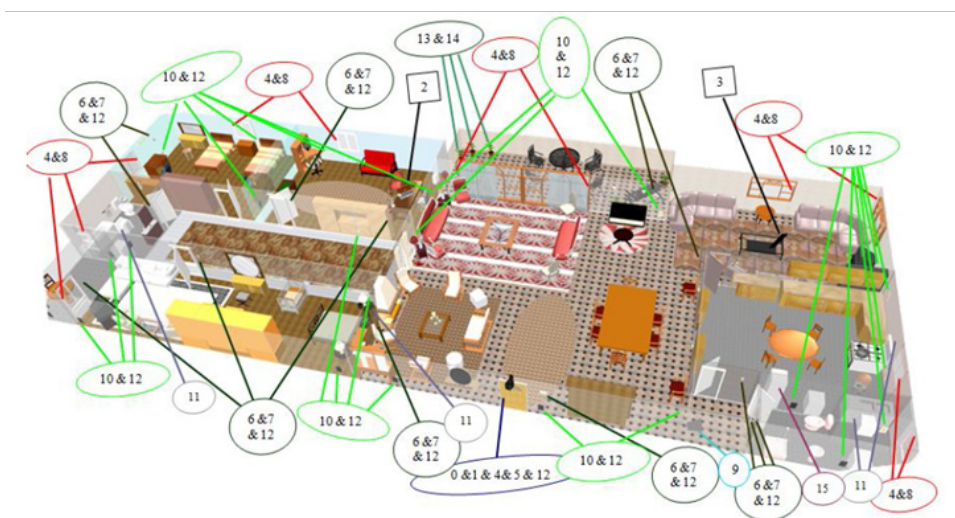

Figure 1 Smart home.[7]

Table 1 Components of Smart Home figure.[7]

Component	Representative number
Palm Vein and Fingerprint Stamp Reader	0
Electronic Knob and Bolt	1
Central Control Unit	2
Mobile remote Control Unit	3
A moti on Sensor	4
Front door alarm buzzer	5
Home part alarm buzzer	6
Electronic light switch	7
Electronic door/Window opener	8
Current Sensor	9
Electronic switchers at an electrical outlet	10
Smoke detector and gas detector	11
3-axis accel erometer	12
Temperature, humidity, and soil moisture sensors	13
LCD display	14
Light intensity sensor	15

Table 2 Comparison between various IWT technologies.[6]

IWT	Max transmission speed/operation range	Transmission distance	Standard	Internet protocol (ip) support	Adoption rate	strength
6LoWPAN	250kbps, 2.4GHz; 40kbps, 915MHz; 20kbps, 868MHz;	Up to 200m.	IETF RFC 4944; IEEE 802.15.4	IPv6	Medium	(1) Benefits of both IP and Bluetooth; (2) Low energy usage
Bluetooth	721kbps for v1; 2.1Mbps for v2.0 +EDR **; 24Mbps for v3 + HS ***; 25Mbps for v4	10m typical	IEEE 802.15.1	-	Extremely high	(1) Ease of access; (2) No configuration-requirement; Secure connection
DASH7	200kbps	0–500m and 0.3–1km	ISO/IEC 18000-7	Yes	Medium	(1) It penetrates concrete and water; (2) It transmits and receives over very long ranges without requiring a large power draw on a battery
En Ocean Technology	It is on the 868.3 or 315MHz frequency	30m (in-doors)	ISO/IEC 14543-3-1; IEEE 802.15.4	Yes	Medium	(1) Energy management and highly efficient energy storage; (2) It uses wireless standards optimized for solutions with ultra- low power consumption.
GSM	270kbps	Several kilometres	Gaussian Minimum Shift Keying (GMSK)	Yes, static and dynamic IP.	Widely adopted	(1) Low cost; (2) High-quality signal; (3) High compatibility
MyriaNed	2.4GHz radiofrequency;868 MHz radio frequency; Other frequencies are under development	Several Meters	MyriaNed GOSSIP protocol; MAC**** protocol	Yes	Medium/low; the system is developing	(1) Low energy usage; (2) Low cost; (3) Scalable; (4) Self-configuring
RFID	Low 124-135KHz; High 13.56MHz; Ultra-high 860–960MHz	Low 30cm; High 1.5m; Ultra-high 1–15m	Various standards	Yes	Widely adopted	(1) Stable technology; (2) Continue evolution; (3) Open architectures becoming increasingly available

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

References

1. Alam MR, Allaudin MA. A review of smart homes–past, present and future. IEEE Trans Syst, Man Cybern. *C Appl Rev*. 2012;42(6):1190–1203.

2. Chan M, Esteve D, Escriba C, et al. A review of smart homes–present state and future challenges. *Comput Methods Progr Biomed*. 2008;91(1):55–81.

3. Gallissot M, Gandit O. *From home automation to smart homes*. KNX Scientific Conference. 2010.

4. https://en.wikipedia.org/wiki/Home_automation

5. Kyas O. *How to smart home*. 1st ed. Germany: Key Concept Press e.K; 2013.

6. Lobaccaro G, Carlucci S, Lofstrom E. A review of systems and technologies for smart homes and smart grids. *Energies*. 2016;9(5):348.

7. Mohammad El–Basioni BM, Abd Al–kader SM, Fakhreldin MA. Smart home design using wireless sensor network and biometric technologies. *International Journal of Application or Innovation in Engineering & Management*. 2013;2(3):413–429.

8. Robles RJ, Kim T. Applications, systems and methods in smart home technology: A review. *International Journal of Advanced Science and Technology*. 2010;15:37–48.