

Vision Document
[SmartHome+]
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1. Introduction

1.1 Purpose of the Vision Document

A vision document is a document that describes a convincing idea, project, or other future states of a particular organization, product, or service[1]. The vision document is established early in the project process and is revised as the understanding of requirements, architecture, plans, and technology develops. The main purpose of the vision document is to collect, analyze and define the user's key needs and product features. It provides a systematic overview for stakeholders. At the same time, it is also a basis for the technical requirements and a standard that can be used to verify future decisions.

1.2 Product Overview

The product called SmartHome+ is a smart-home platform for home users to automatically perform daily home tasks, reduce energy waste, facilitate media entertainment, provide home security protection, and issue alarms in the event of water leakage and fire. Its main purpose is to realize the interconnection control system between home appliances, to achieve the automation of home tasks, and to provide users with a high-quality, easy, safe, and environmentally friendly living environment. It can be accessed easily by the indoor panel, remote mobile terminal and voice, which saves users time, effort and resources, and brings them an intelligent, convenient and comfortable lifestyle.

2. Positioning

2.1. Problem Statement

The problem of	the absence of high-quality smart home application
Affects	middle-income homeowners
The impact of which is	uncertainty in the safety and security of the home, waste of energy, inefficient daily home tasks and low quality of overall home applications control
A successful solution would be	a flexible, cost-effective smart home system that can be easily configured by the homeowner. The product would provide safety and security protection, facilitate media entertainment and daily home tasks automation for the homeowners. This can involve adjusting indoor and outdoor lighting, and turning air conditioners, radio, music players, and televisions on and off. In addition, home security and safety systems can have a rich variety of sensors to coordinate, monitor and control as well as emergency notification features. The user would be able to access the system either locally or remotely. It will be able to utilize existing alarm monitoring networks.[3]

2.2. Product Position Statement

For	middle income homeowners
Who	feel the need for a smart home system that provides services like security protection, media entertainment and reduce energy waste
The SmartHome	is a software product
That	provide safety and security protection, facilitate media entertainment and daily home tasks automation for the homeowners. This can involve adjusting indoor and outdoor lighting, and turning radio, music players, and televisions on and off. In addition, home security and safety systems can have a rich variety of sensors to coordinate, monitor and control as well as emergency notification features. The user would be able to access the system either locally or remotely.
Unlike	current available home systems that do not support the remote control of home media, lights and daily home tasks automation. And lack of home security and safety protection for water leak and fire.
Our product	monitors, controls, and coordinates a wide variety of home appliances such as the air conditioner, microwave oven, radios, televisions, music players, indoor and outdoor lighting, water sprinkler, water and smoke alarm, pet health monitor, air conditioning control, baby care, and home security and safety systems. The system supports local access through a keypad and remote access through landline phones, cell phones or handheld computers (e.g., palm-top, personal digital assistant).

Stakeholder Descriptions

2.3. Stakeholder Summary

Name	Description	Responsibilities
Regulators	The regulators are outer entities overseeing business services or specific industry sectors.	This can include certification and accreditation bodies belonging to quality, security, and protection. An instance of this could be a privacy regulator that develops laws for protection of personally identifiable information from inappropriate exploitation. Presumably, this entity may affect the entire spectrum of industry stakeholders.
platform providers	Entities supplying mechanisms, tools, and frameworks help.	Overcoming integration challenges and facilitating convenient assess, customization, and automation support. Generally, various device manufacturers work with various platform providers for third-party integration. Some organizations serving this role are Apply, Google, and Amazon.
Service providers	The application service providers and utility companies.	Provide end-users with hardware equipment to support or enable various smart connected home services. Three examples of service providers are AT&T, verisure, and Leak Defense.
Network providers	The telecommunication providers supply and handle the network infrastructure.	Supply and handle the network infrastructure like core network, radio access network, and interconnectivity, network to service providers that want to proposal smart home services. Effectively they are the stakeholders that connect the householders to the Internet. For instance, Verizon, Bell, Videotron.
Device manufacturers	The appliance manufacturers, including smart product suppliers like smart meter and entertainment device	Householders may purchase devices directly from manufacturers, but oftentimes via retailers or service providers. Instances of manufacturers companies are Honeywell, Samsung,

	manufacturers.	and LG.
End users	The end-user is the stakeholder that uses the services.	Usually, end uses represent the home residents that purchase and operate the different smart, connected home devices and services etc.

2.4. Stakeholder diagram

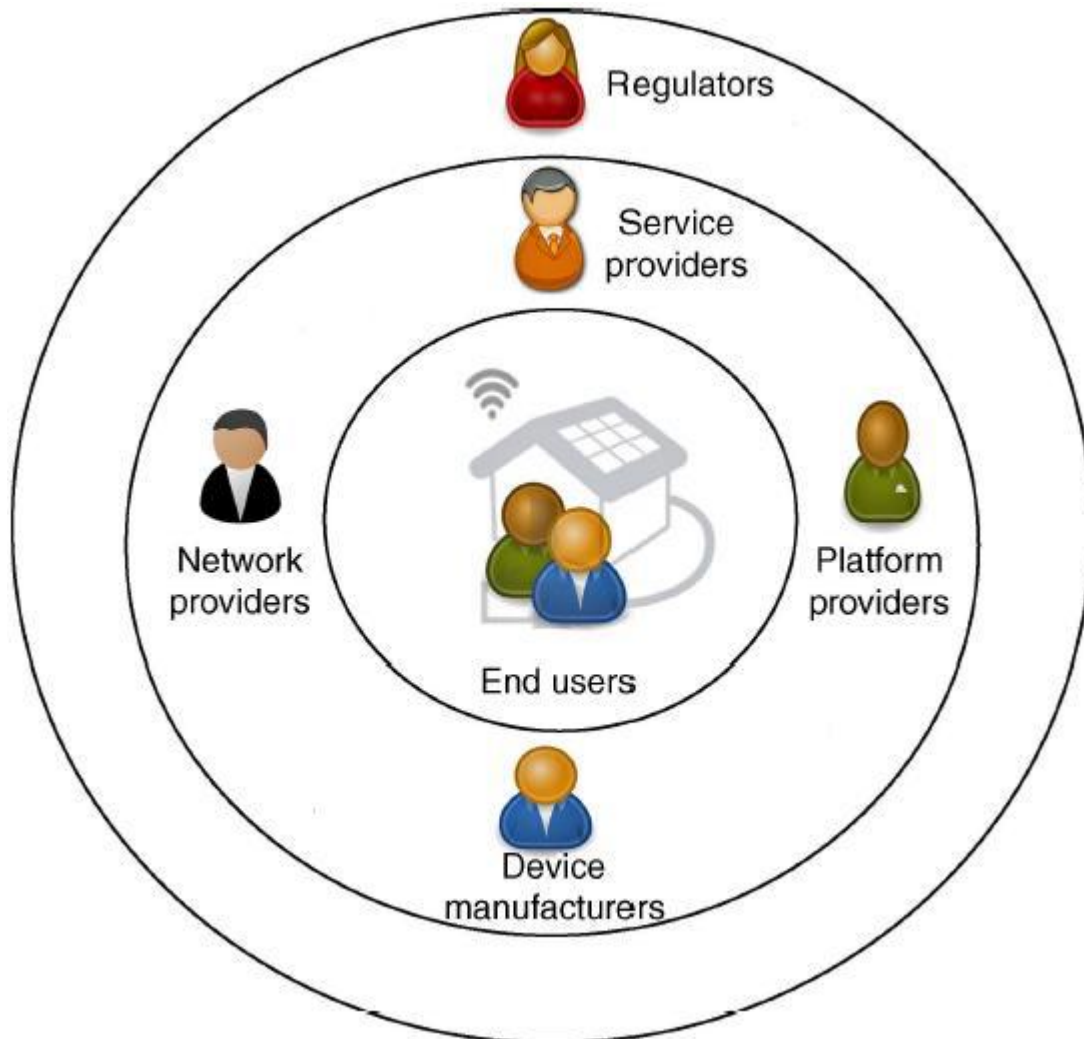


Figure 3.2

3. User Environment

3.3.1 Number of end users involved in completing the task? Is this changing?

The number of people involved in completing the task depends on the complexity of SmartHome+ function and its participants. For most parts of the function that our SmartHome+ provided, it only requires one person to manage the jobs, software in areas like kitchen, garage, living room, bathroom and

bedroom could be done by one person. However, some functions like camera, baby care and pet health may need extra help from the other one or more people since it involves more participants.

3.3.2 How long is a task cycle?

The cycle of each task depends on the task's difficulty including different steps like defining a task purpose, the platform provides a wide range of services like human body water analysis, Environmental temperature control devices, Air Conditioning devices, Baby care system.

In the SmartHome+ software system, events can be timed or triggered. Each task's completion time can be based on the clock. For example, check pets' health conditions every 6 hours.[6]

3.3.3 Amount of time spent in each activity. Is this changing?

It depends on what kinds of activity the user wishes to complete. For example, turning on lights only takes seconds to complete by accessing SmartHome through Voice Control. Meanwhile, for the dishwasher in the kitchen, it could take 45 minutes to 1 hour to finish the job.

3.3.4 Any unique environmental constraints: mobile, outdoors, in-flight, and so on?

Mobile inside:

- When there are people inside the room, the human body water replenishment analysis system will automatically startup and keep monitoring people inside the house unless the user shut down the system manually.
- When there are pets inside the room, the pet health software will automatically turn on and check the pets health condition every 6 hours.

Outdoors:

- When there is no one in rooms, the human body water replenishment analysis system, the baby care system and pets health system will not work until someone comes home.
- The softwares for the living room, bedroom and bathroom should cut off its function and power to avoid waste of energy when detecting no one in the house. The SmartHome will connect to Users mobile through the internet and can be managed by users on SmartHome App GUI.
- The water alarm, fire alarm and door alarm should connect to User mobile through the internet, in case of the safety events emergency while the users can also monitor the inside of the house and its surrounding area through the door alarm.

In-flight:

When the users are in-flight where the conditions for users are impossible to connect the SmartHome system through the internet, the SmartHome system will try to call 911 when a safety emergency happens, such as a water alarm, smoke alarm, or door alarm.

3.3.5 Which system platforms are in use today?

Microsoft, Apple, Google, Amazon.

3.3.6 Future platforms?

User Environment The system compiles and runs on the Microsoft Windows platform, but with growth it is natural to accommodate other platforms, such as Linux and Mac OS X. The Softbody Simulation System is written in C++, and is source-code portable. The user's environment should have their video

drivers up to date in order to handle the latest version of Open GL. Hardware specs are not entirely clear yet, but will require minimal specifications to handle the computation to render complex visuals. [7]

3.3.7 What other applications are in use?

The SmartHome software system App can be distributed applied for PC, laptops, mobile, Tablet PC, and smart wear devices like iwatch.

3.3.8 Does your application need to integrate with them?

The answer is Yes. Family households may have more than one smart device to handle the daily tasks. In this era, Amazon Alexa, Google Assistant and Apple HomeKit are the centre of a smart home system platform. When we develop smart Home devices, we need to consider the compatibility and integration of our application to these platforms. [5]

4. Product Overview

4.1. Product Perspective

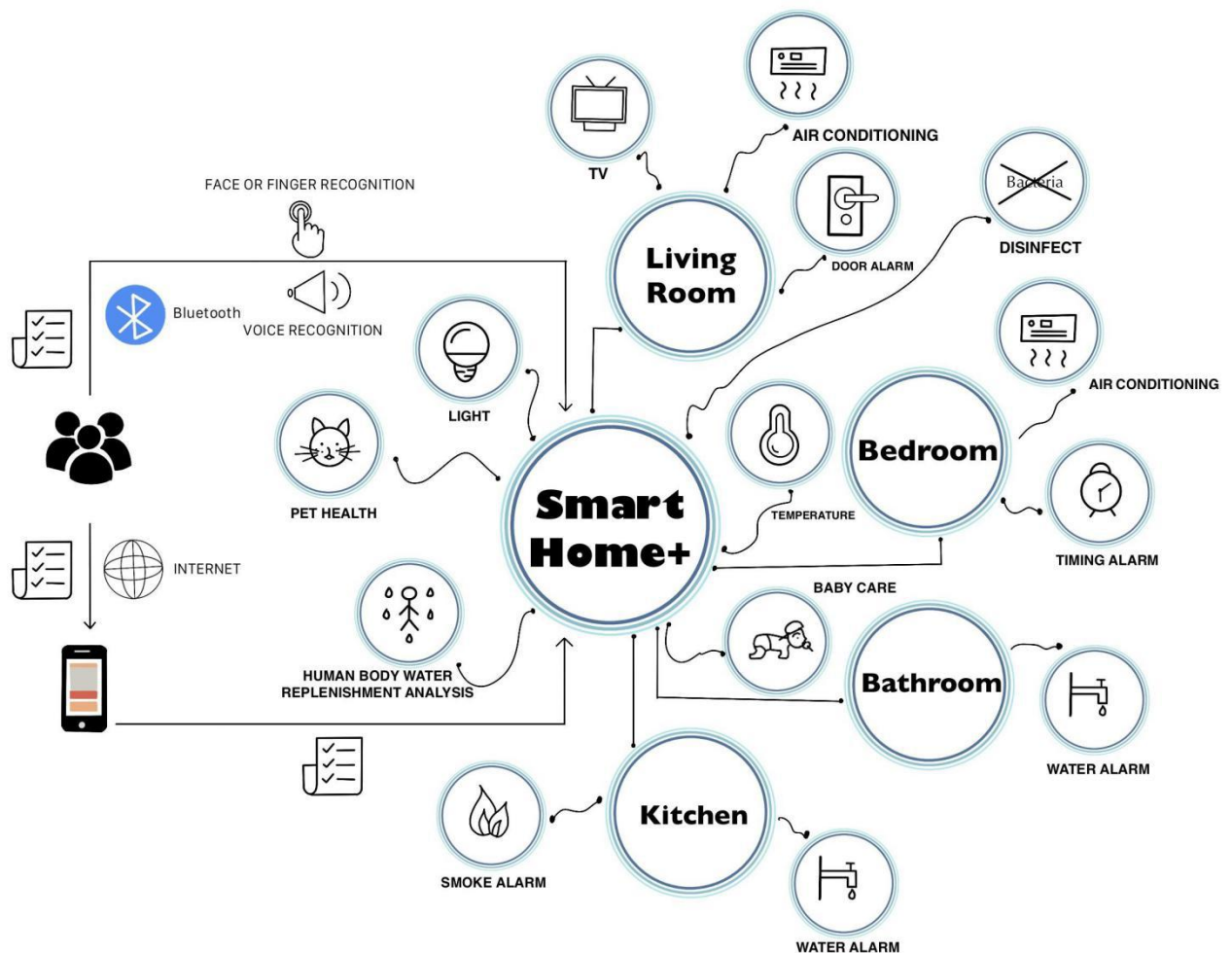


Figure 4.1 Block diagram of this product

This subsection of the Vision document puts the product in perspective to other related products and the user's environment. This product is a component of home appliances. For example, SmartHome+ connects the air conditioner to itself, so that users can control the air conditioner remotely by using voice control, touch screen control on SmartHome+ product and so on. The details have been shown on the block diagram above.

4.2. Assumptions and Dependencies

Assumptions	Dependencies
Users can access and control the system through indoor touch screens, remote devices and voice.	If there are indoor touch screens, remote devices and voice control systems in SmartHome+.
The temperature control system shall turn on the air conditioning and close all the windows, if the temperature is not between 19 and 25 degrees, and the default temperature can be set by the user manually.	Air conditioning, air monitoring equipment, air purification equipment.
if the humidity is under 30% or more than 50%, the SmartHome+ would adjust the humidity.	Fog system in SmartHome+.
The SmartHome+ will always purified the air if people want.	Clear air system in SmartHome+.
The SmartHome+ will always turn on the water purification equipment once people open taps at home.	Water purification equipment, human health monitoring equipment with Bluetooth
When the SmartHome+ receives the guides from users or when the user is at home and not sleeping, it should turn on the light directly.	Lights, human condition monitoring equipment with WiFi or Bluetooth.
When the SmartHome+ monitors the door is open, it should send alarms to the people at home.	Monitor equipment, doors with WiFi or Bluetooth.
When the smoke alarm or water leak alarm is activated, the user will not only hear the alarm sound but also receive a reminder from the remote device.	Alarms with WiFi or Bluetooth
When the users change their status(going to sleep/reading/exercising) on SmartHome+, the appropriate background music is played(white noise/music).	Smart TV, smart audios, human condition monitoring equipment, WiFi or wired network
The sweeping robot cleans the ground regularly according to the time set on the SmartHome+ by the user.	Sweeping robot with WiFi or Bluetooth
The SmartHome+ can control washing machines to select the washing mode according to the number and material of clothes then dry them according to users instructions..	Washing and drying machine with WiFi or Bluetooth
The SmartHome+ can record the normal pets' activity track and store the data. Once the pet's track is abnormal according to the	Pet wearable monitoring equipment,AI analysis system. Camera systems.

SmartHome+'s AI analysis, SmartHome+ will have the conclusions and send a report to users.	
When the abnormal temperature of the baby, bedwetting, crying is detected, the user will be reminded.	Baby wearable smart device, smart crib, monitor with WiFi or Bluetooth
Make coffee for the user every morning according to the user's taste.	Smart coffee machine, timer with WiFi or Bluetooth
When the outdoor lighting is sufficient in the morning and the user is not in a sleeping state, the curtain is opened; when the user falls asleep or the outdoor lighting is dim at night, the curtain is closed.	Curtain controller, light sensor, timer, human condition monitoring equipment with WiFi or Bluetooth
When the user's heart rate is too fast, blood pressure is too high, sleep time is insufficient, the body lacks water, etc., the user will be prompted.	Human condition monitoring equipment, human health monitoring equipment with WiFi or Bluetooth
The security system shall make an alarm and notify the user and authorized third parties when a related illegal break-in is detected.	Alarm, video monitor, Telecommunication devices

4.3. Needs and Features

Need	Priority	Features	Planned Release
I want to control this system with an indoor touch screen, remote equipment and voice.	High	Multilingual speech recognition instructions; Indoor tablet and remote mobile phone operation.	Release 1
I need a Virus-free living environment indoors.	High	Internal sterilization and disinfection function; Particulate purification	Release 1
I need the product to remind me to drink enough water.	Low	Intelligent human body water replenishment analysis	Release 3
I need a comfortable environment with suitable temperature and humidity, and good air quality	High	Manual Control of temperature and humidity Automatic temperature and humidity control mode Automatic odour detecting and controlling	Release 1
I hope this product can help me save energy.	Normal	Water-saving mode in laundry Power-saving mode in lighting and air conditioning	Release 2
I need easier ways to monitor and I hope my pet	Normal	Intelligent monitoring wearable devices: detect the pet's exercise amount, sleep, health value, eating	Release 2

can be fed automatically.		and other data. Food supply reminder. Automatic feeding based on pet hunger status, drinking time and meal time.	
I need easier ways to monitor my babies' health.	Normal	Remote companionship; voice interaction; crying reminder; urination reminder; temperature detection; tracking the baby's heart rate, skin temperature, sleep status and other data.	Release 2
I need help if there is somebody else coming to my home.	High	illegal break-in the entrance(windows, doors) alarming, and make notifications to users and enabled third party	Release 1
I need help or alarm if there are any dangers at home.	High	gas, odour and water leakage monitoring and make notification to users and enabled third party	Release 1
I need to be alert if my windows, doors are not locked when I leave home.	High	Monitor the status of door locks and window locks and make alarm when users are going to leave if the windows or doors are still open.	Release 1
I need to be able to hear music anytime, anywhere at home.	Low	Music playback device required multiple modes:karaoke, background music, etc	Release 3
I want to be able to play video games and VR games at home.	Low	Large screen and related devices required, recommending games according to the preference of users automatically	Release 3
I need a home theater.	Low	High-definition video playback; 3D stereo sound surround; theater lighting atmosphere	Release 3
I need the floor at home to be clean.	Normal	Sweeping robot regular cleaning function	Release 2
I hope the washing machine can automatically complete the entire laundry task.	Low	Fully automatic washing and drying function	Release 3

I hope different areas of the house have different lighting at different times.	Normal	Multiple light themes: romantic, soft, reading, etc Automatic switches with the time and natural lights	Release 2
I need to have a comfortable sleeping environment that can help me fall asleep quickly.	Normal	Open and close curtains automatically according to time and natural lights Sleeping mode with suitable air temperature, humidity and white noise background sound	Release 2
I need to get a cup of coffee that matches my taste every morning.	Low	Brew coffee regularly according to user's taste Coffee beans supply reminder	Release 3
I hope to have automated cooking, such as making cakes, baking pizza, etc.	Low	Scheduled cooking by food type	Release 3

4.4. Alternatives and Competition

The following are the current product alternatives and competitiveness analysis.

4.4.1 The product of competitors

There are some smart home devices on the market now. One of the famous ones is Google Home, which is a smart home device launched in 2016[2] and is controlled mainly by voice. It can control smart home devices, use hands-free calling, turn on and off the TV, play music, remind users to exercise, etc.

Strengths and weaknesses:

Products with large company background, such as Google Home, are often more prestigious, have better after-sales services, and attract more buyers. Besides, the time to market for this product is earlier, so the product is already relatively mature.

However, this alternative product can only be controlled by voice, and SmartHome+ can be accessed through three ways: indoor touch screen, remote device, and voice, which provides convenience for customers who are not able to use voice. In addition, it needs to rely on a WiFi connection[2] and the smart home system covered by Google Home is not sufficient.

4.4.2 Multiple small intelligent system collections

Users can purchase multiple small smart devices to realize various functions of SmartHome+. For example, purchase air conditioners and air purifiers to replace the functions of SmartHome+'s air control system, use smart door locks such as SimpliSafe, Nest Secure to replace SmartHome+'s door lock security system, buy floor cleaning robots to complete the floor cleaning, and so on.

Strengths and weaknesses:

The price of each small device will be much lower than the entire SmartHome+ system. When users only need a few functions of home intelligence, this alternative solution can save money.

But this series of small smart devices do not interact with each other, and they need to be controlled separately. When these devices are too scattered or excessive, it is time-consuming and inconvenient for

users. SmartHome+ combines all equipment systems on one platform, which greatly improves controllability and convenience.

4.4.3 Maintain the status

Users maintain the status quo and do not purchase any smart home products.

Strengths and weaknesses:

Maintaining the status quo is the most cost-effective way for home users. And they don't have to spend time learning how to operate a smart home system.

Users cannot experience a smart, convenient, healthy, and energy-saving living environment. They need to manually complete many daily household tasks, such as cleaning the ground, laundry, feeding pets, etc. And their living environment is not healthy and safe enough, such as the inability to purify air and drinking water, and intruders who cannot know doors and windows in real-time. At the same time, they are not able to save water and electricity intelligently, which is also an expense in the long run.

5. Other Product Requirements

5.1 Hardware Requirements

All the appliances should conform to the required standards with Wi-Fi, Bluetooth and ZigBee functions. The hardware devices such as sensors are required to conform to related techniques standards to ensure the accuracy.

SmartHome+ devices can coordinate with other third-party smart devices. without incompatible problems, to provide customized services.

5.2 Robustness and Fault Tolerance

Fault tolerance is important for smart home devices to provide gas and water leakage detection and preparations. With fault tolerance, a smart home system can react in the event of some disaster. SmartHome+ incorporates evolutionary computation algorithms, and communication protocols, to provide users with context awareness and fault tolerance. [8]To develop fault tolerance configuration in central control, there are some solutions below:

- Recovering from the mistakes or erroneous operations initiated by users.
- Daily feedback automatically of the operation of the whole system and every independent appliance to update the system regularly.

5.3 Usability

SmartHome+ is equipped with several controllers, including voice control, remote controllers and mobile software control to receive users' requests. Moreover, the alert system would also remind users of disasters or other messages by multiple ways such as alarm, voice guidance by speakers and phone call notifications to users and enabled third-party.

5.4 Design Constraints

- Multiple Devices and Multiple smart home Apps:

As already defined, a smart home-smart phone system is a set of sensors and devices monitored using a smart phone app. The heterogeneity of these devices and the different manufacturers form a complex system. [9]

The complexity of communication between all home devices may be a weak point for the security of the smart home smartphone system

- Hardware Limitation :

Many types of research have been dedicated to security approaches in smart home-smartphone systems. However, the hardware limitation (for example, low memory and CPU) of the home devices makes the system hard to perform precisely for a long time and vulnerable against attacks.

Due to the hardware limitations, security and maintenance issues still exist in a smart home even if many algorithms and mechanisms are developed.

5.5 External Constraints

The external constraint is mainly from financial cost for a secure SmartHome+ system.

The implementation of a secure smart home-smart system increases financial costs because it requires many devices and technologies using expensive sensors and secure mechanisms. Smart home users aim to have a secure system at a low cost, though smart home insurance is a benefit for the homeowner that ensures their safety and wellbeing.

5.6 SmartHome+ Security and Safety Requirements

The SmartHome+ would also involve security and safety standards in every single system especially in locking, monitoring systems, with corresponding default security requirements and timely alert and reminder messages.

5.6.1 SmartHome+ System Abnormal Statement Handling

The abnormal internal threats are listed below:

- Failure of home devices
- Internet malfunction
- Software failure

The security requirements to avoid internal threats at smart home systems are:

- **Physical Protection:** Physical protection is a vital security requirement against internal security threats. Home devices should be installed in a secure and easily monitored area and to use lights and cameras to secure smart home devices against physical attacks.[9]
- **User Authentication:** the users of the SmartHome+ system should be enabled in advance to avoid children changing some important parameters, such as air conditioner, cooking and water temperatures, which might affect health or even make kids injured when no adults are at home.
- **Multiple Connecting Choices:** To cope with Internet malfunction, backup connection means is vital like Bluetooth, ZigBee, etc.
- **Thresholds and Default System Mode Setting:** Setting secure thresholds for every device in the SmartHome+ system raises the security levels. Once abnormal data detected breaks the thresholds, the system would restore as the default mode which is set previously to guarantee a safe home environment.
- **Traditional controllers:** Traditional remote controllers would be reserved to cope with the circumstance of software failure.

5.6.2 SmartHome+ System Data Transmitting Protection

Due to vulnerabilities of the existing smart home systems or smart home App, the multiple attacks on these systems, many people are afraid to lose their confidentiality or personal data which can make a loss of security or even financial loss. Therefore we define comprehensive requirements to improve security communication between the smart home and the control platform remotely and the significant security standards for automatic control systems.[11]

In the SmartHome+ system, data exchange among the home appliance and smart platform would generally be transmitted via the Internet which suffers from many internal and external threats. There is a list of security problems below:

- Malicious codes injection
- Eavesdropping Attack
- Man-in-the-Middle attack[12]

The security requirements to cope with external threats at smart home systems are:

- Encryption data: Many types of research have been conducted for cryptographic techniques for smart home systems. Actually two categories of cryptographic algorithms: symmetric and asymmetric algorithms. Both of the types of algorithms are secure but the heterogeneous nature of the system device and their limitations requires a united algorithm standard or development of a new algorithm for better protection and secure data exchange.[11]
- Network Monitoring: Many academics and industrial researchers present mechanism supply for network monitoring. In [13], the security system is based on implementing Intrusion Detection Systems (IDS) and a smart gateway with firewalls for the smart home and also at the Internet Service Provider (ISP). The cooperation of these two-parts makes it easy to detect and react against attacks from within the smart home network.

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