The Emergence of Artificial Intelligence in the Home: Products, Services, and Broader Developments of Consumer Oriented AI

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The Emergence of Artificial Intelligence in the Home: Products, Services, and Broader Developments of Consumer Oriented AI

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IS642 MIS Graduate Project
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March 15, 2017
Abstract

Current home automation system merges a family's lifestyle with the latest technology & energy management tools to simplify people's lives. It allows users to easily manipulate a variety of home systems, including appliances, security systems, and environmental systems. Setting up a home automation system confuses many consumers. Multiple product lines and platforms make choosing the best system difficult. Basic requirements of setting up a home automations system and the comparison between different platforms are explained.

An intelligent home automation system makes intelligent decisions to control a home. This type system might use a weather report to adjust a home's lawn watering schedule, as well as adjust the thermostat for temperature control in the home. Traditional home automation systems require human decision making to control the home system. The future intelligent home will require less human interactions, that can do things automatically after it learns patterns from us. A new generation requires more developed AI to control the smart home automation. Based on the technology we have now, the possible consumer-oriented AI technology is predicted in this paper.

When the market is growing rapidly, companies are supposed to have better opportunities to make money. Due to the increasing popularity of home automation systems, the competition is very intense. Companies try the best to take the first mover advantage. Three suggestions are made to help those companies to build their strategies.
Index Terms—smart home, home automation, artificial intelligence, virtual assistant, machine learning.
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1.0 Introduction

Artificial intelligence has been changing our lives for decades, and has been used in several fields. The most recognizable one is probably robotics in manufacturing in the auto industry. Although the first home automation device was invented 50 years ago it didn’t thrive, and the idea of AI in home automation is not really familiar to us and seems brand new. Today a smart home enables us to control our house remotely and natively. The cloud-connected home hub or the home app on the smartphone that has AI, plays a central role in a smart home. AI in the home can help us do routine daily tasks more easily. In one case we may have a smart home hub like Amazon Echo Alexa, to control an array of devices in the home such as smart lights, thermostats, locks, and an ever expanding range of applications. Or, instead of a hub, we could use a virtual assistant app on a smartphone as a control. To operate smart devices, consumers speak and give the command. The commands are operated by the devices through their connection to the cloud.

The market for remotely controlling home automation is at the beginning stage and it keeps growing rapidly. Data from PR Newswire shows the installed base of home automation or smart home systems in the United States in 2012 was only 3.5 million, but it increases three times to 10.2 million in 2014. We expect further growth in this market, and the number is expected to reach 30 million in 2017.¹

Since the market is a new and rapidly growing market, companies try to get the first-mover advantage. So companies in the marketplace need to be clear about the general condition of the market, the position where they are in the market, the advantages they have
compared with their rivals, and the right direction to go before they can move forward. Looking into the general ecosystem around home automation helps them to be clear about the general condition of the market. Having discussions on the strengths and strategies that rival companies have helps them to figure out their current position in the market and the advantages they have compared to their rivals. Examining current technology, predicting the future of intelligent home automation based on currently available but as yet unused technology, and suggesting strategies based on those technologies can help companies find productive directions in which to to move forward.

Many consumers have been slowed in buying home automation systems by confusions and concerns. Letting consumers know background and current comparison information on home automation platforms before they make purchase decisions can help them be more willing to accept the new idea of adopting the home automation system. Discussing the capabilities of home automation and the requirements for building a home automation system helps consumers know what they need to use home automation.

2.0 Background

2.1 Definition of Artificial Intelligence

According to the article from Stanford University, “It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.”

2
2.2 Highlights of Home Automation

Artificial intelligence in the home is an essential part of the smart home. The smart home concept has been around for several decades. It now enables people to control their home remotely through apps and specific devices. An increasing number of individuals are adopting smart home options because more and more people are aware of the limitations of the earth's resources and home automation can be quite helpful in making a home truly smart and green. Although the concept has been around for a while, the real smart home has only taken shape in recent years.

In April, 2014, Drew Hendricks wrote an article The History of Smart Homes, discussed that during 1901-1920, many home appliances were invented, such as the gas oven, the refrigerator, dishwasher, the electric washing machine, dryer and so on. Although the home appliance is not a typical consideration in thinking of smart homes, the invention was a remarkable achievement during early twentieth century and was the first automation of household chores.

The first smart devices, ECHO IV and the Kitchen Computer, emerged 50 years later, although the products were never commercially sold. Jim Sutherland, an engineer, who is also a family man in Pittsburgh, Penn. made the ECHO IV Home Computer. He developed this computer to control many aspects of his home and with the permission of his employer, Westinghouse, he took modules home and built the ECHO IV. ECHO IV is an acronym for Electronic Computing Home Operator. It comprised four large cabinets (6'x2'x6') weighing approximately 800 lbs in total and a CPU with program panel on it, magnetic core memory, I/O circuitry and power supplies.
According to the April 1968 issue of Popular Mechanics, the Sutherlands were extending the system to store recipes, compute and create shopping lists, track family inventory, control home temperature, turn appliances on and off, and predict the weather. Moreover, ECHO IV was able to act as a family message center, a place where people could leave notes to each other. One year later, the Kitchen Computer came out. The original advertisement for Honeywell is "If she can only cook as well as Honeywell can compute." People were not likely or able to afford at least $10,000 in 1969 to buy a machine which could store recipes without being able to cook.\(^5\)

Both the ECHO IV and Kitchen Computer reveal the desire of people wanting to have more control of their home, get more leisure time and enhance their lives. Homemakers long ago realized that claims of increased leisure time are illusory.

In the 1970s, X10, the grandfather of automation was established. According to Smart Home Tech\(^6\), it was a simple system that used home power lines to foster communication between multiple appliances. Due to the system's reliance on power lines, it was highly susceptible to the electrical interface issues.

In 2010 the Nest Learning Thermostat enters the picture. Two men who created the iPod and iPhone founded Nest. It was created to control energy consumption by adjusting home temperature automatically through a sensor. According to Nest, since 2011 the Nest Learning Thermostat has saved over 8 billion kWh of energy in millions of homes worldwide\(^7\).

Independent studies showed that it saved people average of 10-12% on heating bills and 15% on cooling bills.

The first personal assistant, a system that has many similarities to a home automation system and can in fact become part of than kind of system, could be said to be Siri, a voice
activated “servant” embedded in Apple iOS software in their iPhones in 2010. It allowed consumers to place phone calls, search the web, write notes and do other activities on their phones without using their hands. Siri has become more sophisticated since its introduction. In 2016, Amazon Echo – a hands-free speaker that you control with your voice came into the market. Later, as competition, Google released Google Home. Both of them are personal assistants used in the home. You can search the web, get a personalized daily briefing, check traffic, add items to the calendar, create shopping lists, track a package and many other activities by saying a command to the devices. These devices also are used to control devices for home automation.

2.3 Market Conditions

Data from PR Newswire shows that the installed base of home automation or smart home systems in the United States in 2012 was only 3.5 million, but that it went up remarkably to 10.2 million in 2014, almost three times that in 2012. Further growth in this market is expected and the number may reach 30 million in 2017\(^1\). The sales of smart home devices and controllers increased from 22.1 million to 32.4 million during 2014 to 2016 according to data from Consumer Technology Association\(^8\). The global intelligent virtual assistant (IVA) market could garner revenue of $3.6 billion by 2020, registering a CAGR of 35.2% during the forecast period of 2015-2020. North America dominates the world intelligent virtual assistant market\(^9\). As a result, the growth of this area is rapidly increasing and it has huge potential.

2.4 Basic Introduction to the Main Products Currently Available
<table>
<thead>
<tr>
<th>Feature</th>
<th>Amazon Echo</th>
<th>Amazon Echo Dot</th>
<th>Google Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>9.3&quot;×3.3&quot;×3.3.&quot;</td>
<td>1.3&quot;×3.3&quot;×3.3.&quot;</td>
<td>5.62&quot;×3.79&quot;×3.79.&quot;</td>
</tr>
<tr>
<td>Weight</td>
<td>37.5 oz.</td>
<td>5.7 oz.</td>
<td>16.8 oz.</td>
</tr>
<tr>
<td>Retail Price</td>
<td>$179.99</td>
<td>$49.99</td>
<td>$129</td>
</tr>
<tr>
<td>Always Listening</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Wake-up-word</td>
<td>Alexa</td>
<td>Alexa</td>
<td>Ok Google</td>
</tr>
<tr>
<td>Customizable Appearance</td>
<td>No Black/White</td>
<td>No Black/White</td>
<td>Yes 7 Colors Fabric ×3 Metal ×3</td>
</tr>
<tr>
<td>Features</td>
<td>- Echo is Bluetooth-enabled so that you can stream other popular music services like iTunes from your phone or tablet. - Answers questions, reads audiobooks and the news, reports traffic and weather, gives info on local businesses, provides sports scores and schedules, and more - Using the Alexa</td>
<td>- Echo Dot has all the features the Amazon ECHO has, besides it is a hands-free, voice-controlled device with a small built-in speaker. You also could connect to your speakers using line-in or Bluetooth.</td>
<td>- Alarm, calculator, calendar, dictionary, light control, music, news, radio, shopping list, traffic, TV streaming, weather, delight, provide information - Google Home could answer followed up questions - Music can play on multiple Google Home and Google Cast speakers in your house at once</td>
</tr>
</tbody>
</table>
Voice Service
Controls lights,
switches, and
thermostats
- Uber, Domino's
- Over 100 new skills
  from third-party
devlopers

Compatible partners

| Audio: Amazon Prime Music, Spotify, Pandora, Tunein, iHeartRADIO, Audible audiobooks, text-to-speech for Kindle eBooks |
| Smart Home: Wemo, Nest, Philips Hue, Samsung SmartThings, Insteon, TP-Link, Ecobee, IFTTT |
| Tasks: Google Calendar, Yelp, movie showtimes |

| Audio: YouTube Music, Spotify, Pandora, Google Play Music, Tunein |
| Smart Home: Google Chromecast, Nest, Philips Hue, Samsung SmartThings, IFTTT |
| Video: YouTube (Chromecast required) |
| Tasks: Google Calendar, Google Keep |

Table 2.1 Main Hubs on the Market

There are several voice-activated hub products on the market that allow you to control the home. Amazon Echo Dot, compared with Amazon Echo and Google Home, is designed to be the easiest portable device due to its lightweight and small size. However, its battery does not last long, so it does not always have the listening feature. The always listening feature operates during stand by and as long as someone says the wake-up word, it will conduct your command.

3.0 Statement of the Problem
3.1 What is home automation?

Home automation allows users to easily manipulate a variety of home systems, including appliances, security systems, and environmental systems. Setting up a home automation system confuses many consumers. Multiple product lines and platforms make choosing the best system difficult. Examining basic system requirements and comparing platforms helps explain basic home automation.

3.2 What would the future intelligent home automation systems be?

An intelligent home automation system makes intelligent decisions to control a home. This type of system might use a weather report to adjust a home's lawn watering schedule, as well as adjust the thermostat for temperature control in the home.

Traditional home automation systems require human decision making to control the home system. A new generation requires more developed AI to control the smart home automation.

Future trends analysis would be used to predict the intelligent home automation system.

3.3 What do companies need to do if they want to stand out among their rivals?

When the market is growing rapidly, companies are supposed to have better opportunities to make more money.
Due to the increasing popularity of home automation systems, the competition is very intense. The more companies jump into the market the more difficult it is to win the war among the rivals.

Solving this problem requires looking at the ecosystem of the smart home market, examining the strengths and the strategies of current companies in the field and then, drawing conclusions of the suggestions that will direct companies future actions.

4.0 Business Components

4.1 The ecosystems

![Figure 4.1 The Ecosystems](image)
Home AI market belongs to the ecosystem showed above. All the markets, including home AI, personal computers, tablets, mobile phones, automobile infotainment systems, services (media and cloud services) and advertising all influence each other.

According to the market analysis from Statista, the predicted future of smart home automation will increase from $2.76 billion to $9.21 billion during 2015 to 2021. The annual growth rate is 38% during this 6-year period. Many famous companies such as Amazon, Google, Microsoft, Apple, Intel, Samsung, and Facebook have been developing their own AI products for years. Since Home AI market is new and growing market, many companies try to gain the first mover advantage to be the market leader. Being the first mover as early as possible is
essential for them because if they do not take action, other companies will probably take the opportunity from them. Those who use one home automation system tend to use the same software in their car or mobile phone. If companies do not get the market share as soon as possible, it is harder for them to get it when the users have adopted other systems already. The high market growth rate should lead to the low rivalry. Since the high growth rate will lead to more space for each companies, they tend to fight less with each other. However, the potential impacts of Home AI market to the whole ecosystems increase the rivalry.

Figure 4.3 Apple’s Revenue from iTunes, Software and Services from 1st Quarter 2013 to 1st Quarter 2017 (in billion U.S. dollars)

Additional Information:
Worldwide; Apple; 2013 to 2017

Source: Apple; Statista 2017
For example Apple, a delay in entering the home AI market may affect sales of iPhones, iTunes music and movies, apps and services. According to data from Apple, revenue from iTunes, software and services grew steadily during 2013 to 2017\textsuperscript{11}. The media sales revenue is 18.4\% of Apple’s total revenue. In addition, according to the research by Sensor Tower, the average U.S. iPhone user spent $40 on apps and in-app purchases in 2016 and this was up from $35 the previous year\textsuperscript{12}. Apple wants to protect the stable growth of the iOS ecosystem it has already achieved from being influenced by the growth of the smart home market. If iPhone user buys a Google Home for his house, he will probably purchase music from Google for streaming on that device. Users may also prefer using the same music streaming app both in their house and on their smartphone. Importantly, the profit margin in software and services such as music and movies are much higher than selling hardware. Protecting this market is more urgent than hardware markets, to some extent.

Moreover, because of consumer’s preferences for using one system, sales in this area influence the broader ecosystems. If companies cannot take advantage of the smart home part, they will lose the market share in the other parts of the technology device market. For example, if a person has already bought an iPhone, when he considers buying a tablet, he will probably buy an iPad. Picking an operating system is also an important factor when they make other purchase decisions. Buyers are more willing to choose a system that can gives them more convenience. For instance, by staying with Apple products they do not have to convert all their files in the iOS system to other systems. As a result, the two impacts increase the rivalry from low to high.
As part of the ecosystem, putting the artificial intelligence in automobiles is also an essential action companies will have to take to keep customers in their circle. It allows people using the same systems not only on their smartphone or in their home, but also in the car. The more people interact with a system that has artificial intelligence, the more it will learn from us. As a result, people do not want to switch from one system to another one since that would cause starting over on the learning process. This is also the reason why many companies have been partnered with automobile manufacturers.

Another part of the ecosystem would be advertising market. Through the hub, companies are able to sell ads to their users from the advertisers. They know more about the customers’ buying and living behavior through customers’ daily use of the hub; shopping lists, purchases through amazon prime, pizza orders, and more, all help the company to provide personalized recommendations for advertisers to address to customers. Some local businesses would benefit from cooperating with them. These companies sell their user's digital footprints to advertisers by tracking their searching behavior.

**4.2 Strengths of each companies**

Amazon has advantages in its online retailing business and its cloud services. As a big online retailer, it is easy for Amazon to promote its Echo devices by putting it on the official webpage. Increasing the sales performance of Echo also can empower its retailing business. Forrester Principal Analyst Thomas Husson said, “The more people use Alexa devices, the more likely they are to spend money on Amazon.” According to the statistics from Experian Information Solutions shown above, Echo owners buy products on Amazon Prime 32% of the
time they use the Amazon Echo, which is quite impressive since the first Echo was just released 4 years ago and people are not so familiar with the new way of buying things.

![Figure 4.4 Revenue of Amazon Web Services (in millions)](image)

Figure 4.4 Revenue of Amazon Web Services (in millions)

Another strength of Amazon is its cloud service, Amazon Web Services (AWS), which contributes more than half of their net income. Since both the control-hub and the home app build all the artificial intelligence in the cloud, it is advantage for Amazon to build its own AI.

Apple has great reputation in its iOS system’s security and ease-of-use. Since Apple restricts third-party apps, it protects the iOS system from being easily attacked. Many consumers regard iOS system as easier to use than Android, they prefer to pay more to buy Apple’s product.
Figure 4.5 Familiarly with Virtual Digital Assistants (VDAs) in the United States, as of September 2016, by use

Apple also has a great reputation for its AI assistant, Siri. According to the data from Vantiv and Socratic Technologies, people are most familiar with Siri. This is probably because of the huge sales volume of iOS embedded devices like iPhone and iPad. Although Apple does not have the device for home use, Apple can use the iPhone as its device. More importantly, Siri can speak over 20 languages and Siri can speak Chinese. As it is reported by GFK that, 75% of consumers in China are expecting to adopt smart home technology.\textsuperscript{13}

Google had 80.52% of the desktop search engine market in February, 2017. Google’s huge search inventory and PageRank algorithm delivers the most relevant and correct high quality answers. According to the report from The Economist, “Apple Siri handles over 2 billion
commands a week and 20% of Google searches on Android-powered handsets in America are input by voice. One of the most important functions for the voice-activated control hub is to answer user questions with high quality.

Besides, according to the Business Insider, there are estimated to be over 1.5 billion Android users out there in the world, all of whom have phones that could theoretically get upgraded with Google Assistant. Plus, Assistant is built into Google Allo, the company’s latest messaging app, and Google Pixel, the company’s flagship app. As a result, those Android users tend to use Google’s systems.

![Worldwide Smartphone Vendor Market Share](image)

Figure 4.6 Worldwide Smartphone Vendor Market Share (Share in Unit Shipments)

Samsung, as a big smartphone company could also use the smartphone as their home device, just like Apple. Samsung’s market share in smartphone market is about 20%; higher than Apple. Moreover, Samsung has developed consumer electronic markets which are the devices already in people’s homes. If Samsung has its own home system, people would prefer to adopt it
since they’ve already has all those devices in the homes, and the same-brand system will work with those devices well.

![Market Share of Each Computer Operating Systems](image)

Figure 4.7 Market Share of Each Computer Operating Systems

Microsoft Windows has about 90% of the market share in the operating systems market. It is a great advantage for Microsoft to spread its personal assistant Cortana out.

### 4.3 Strategies of each companies

Different companies have various approaches to make themselves more broadly competitive. The main way they make themselves more powerful is to cooperate with other companies. With partners, the power of the companies increases.

Amazon’s Alexa is open-source, which allows users to develop their own Alexa functions when they have an idea. Developers and programmers can use Amazon Web Service (AWS) to develop their own “skills.” It enables them to add their own functionalities by writing simple coding and then Amazon allows other users to download those skills. The skills created by those who use the hub everyday would be more helpful and thoughtful. It benefits Amazon by making the Alexa functions and features more complete and keeps their customers’ loyalty.
Amazon has two approaches to make Alexa everywhere: sell cheap devices and cooperate with other companies. The price of Amazon Echo Dot is $50 and $180 for Alexa. Since the price level is lower than a high quality bluetooth speaker alone, many new adopters are interested in trying the new technology. Cooperating with other companies to make Alexa everywhere lets them keep their customers in their circle. Alexa Voice Service (AVS) is Amazon's intelligent cloud-based service. It allows developers to voice-enable any connected product with a microphone and speaker. Amazon is willing to add AVS to other devices, and other companies' devices and services are encouraged to connect to it.

According to the article from Twice newspaper, Alexa adds voice control technology to LG's SmartThinQ Smart Home system, and SmartThinQ's remote sensors are also compatible with Amazon's automatic product-ordering dash technology. Imbued with AVS technology, the Echo-like SmartThinQ Bluetooth speaker/hub can now respond and control LG's varying SmartThinQ devices and appliances. For instance a hub can instruct an LG appliance to function. A washing machine with the sensor attached not only can notify a user when a laundry cycle is complete, but also place an order at Amazon for more detergent.

Another co-operative venture is with a wearable device-making company Pebble according to eWEEK. The Pebble Core is a fitness tracker, music player, and GPS tracker. Consumers can use it without a smartphone, and it launched in January 2017. The Pebble Core allows users to employ voice control for a wide variety of tasks, from ordering pizza, to getting weather and traffic updates, or even to shop for products on Amazon.com. The Core is a small Android device with a button that can be hacked to perform just about any function for users. It also includes an SOS capability that can report the user's location in an emergency.
Smartphone company Huawei announced a smartphone with Amazon Alexa. 300 million smartphones will have machine learning ability, says Deloitte. In 2016, all the intelligence is in the cloud, but in 2017, faster processors will enable machine learning natively\(^\text{18}\).

TechRepublic, at CES 2017, Ford announced that it would be bringing Amazon’s voice service Alexa to certain cars in 2017 and high speed Wi-Fi hotspot capability to some models in 2018. Users will be able to start, stop, lock, unlock, and even check the fuel levels, mileage of the vehicle using Alexa.

Amazon allows individual developers to create their own Alexa Skills to quickly complete many features, while Apple focuses more on control over their technology in order to assure security and ease-of-use. Security & privacy problem is a big concern which makes people hesitate, even stops some customers from adopting smart home solutions. Apple uses this concern to be its advantage. It has presented itself as a safer system and hardware manufacturer for years. The Apple iOS has achieved a great reputation as a stable and reliable operating system. Apple’s restricting third-party applications in the iOS app store prevents many unsafe attacks from happening. Apple also uses the same strategy in solving the security and privacy problem when people use the home-control app-HomeKit. According to the article from Computerworld, Apple offers tough security and privacy protection with the HomeKit. It includes end-to-end encryption, secure chips and a range of other security measures\(^\text{19}\). To be Homekit-certified, gadget makers must include special chips to work with Apple’s system. Apple also requires developers to buy specific WiFi and Bluetooth networking chips. Apple might win more trust from the customers but this action increases the difficulties for vendors to develop home products for them.
According to Apple, there are 44 automobile manufacturers that have partnered with them in supporting Carplay for over 200 models. It enables people to take what they want to do on their iPhone and put them on their car’s built-in display while driving.

Google has invested a huge amount of funds to develop their AI research. According to the news from Gamenguide, Google has invested $4.5 million with Montreal AI Research and hired Hugo Larochelle who was a top scientist at Twitter and part of the central Artificial Intelligence team. In 2014, Google acquired British company DeepMind Technologies for $600M.

Samsung is creating its new assistant Bixby uses technology developed by Viv. Viv was started by the creators of Siri back in 2012. Bixby is expected to be more intelligent than Apple Siri. According to the report from Cult of Mac, there are several reasons. Firstly, Bixby was built by AI experts and the machine learning ability is better than Siri because it can handle more complex queries. Secondly, it has the ability to control all native applications installed on the Galaxy S8. For instance, people are able to start and end workout tracking in S Health. Since Samsung does not restrict third-party developers like Apple does, Bixby has greater control over third-party apps as well. Thirdly, Bixby has the visual search and text recognition feature. Bixby will have the ability to analyze the image, identify objects and read text via the camera app. Fourthly, it has the feature that allows sending payments both between Bixby Pay users and third-party services like PayPal and Venmo.

While, Amazon focuses on using Alexa to drive commerce, and Google focuses on search, Microsoft wants Cortana to stand out from the crowd as a productivity tool. Like the Amazon Echo, Cortana will be able to control select smart home gear. Also, Microsoft is
spreading Cortana out from the Windows 10 PC to devices like Harman Kardon speaker and next generation cars from companies like Nissan.
5.0 Technology Components

5.1 Network

Homeowners need to build the network for their smart home devices. How to use Google Home to install the lights controlled by voice-activated hub in homes will be explained step by step.

There are three parts to set up. The first part is connecting the network of the Philips Hue light bulbs, the second part is setting up Google Home, and third part is to connect the Google Home with Philips Hue bridge. Google Home only cooperates with some home automation companies, so there are limited choices for each type of automated system a homeowner might want to install.

To set up the Philips Hue Light, there are three steps. Step 1: Users need to screw the light bulbs into existing lamps and turn them on. Step 2: Set up the bridge. Plug in the bridge and it will automatically power up. Connect it to your Wi-Fi router using the network cable provided.
Wait for the three lights to come on as shown above. Step 3: Download the Philips Hue App to let the bridge detect and connect all the light bulbs available.

![Figure 5.2 Philip Hue App Interface](image)

After setting up all the three steps, users are able to control the lights through the App on the smartphone. Then, they need to set up the Google Home. First, plug in Google Home device to let it power on. Install the Google Home app and follow the steps to set up the device.
Choose the Wi-Fi network you want to connect to your Google Home. Make sure to connect your mobile device/tablet to the same Wi-Fi network that you intend to use to set up your Google Home device. If you're attempting to set up Google Home on 5GHz WiFi connection, your mobile device must support 5GHz. Since we need to connect Google Home with Philips Hue bridge, we’d better connect both of them under the same network so that they can be paired later.
The last step is to pair Google Home hub with Philips Hue bridge. Go to the Home Control and add devices via brands. Press the link button on the bridge when pairing. After pairing successfully, there is a list of the home devices that are connected to the Google Home. Users are able to control all the gadgets through voice and their mobile app.

5.2 Cloud

How does the cloud work? The Amazon Web Service (AWS), which is the cloud service hosted by Amazon, show you the specific process when Amazon Echo gets a command.

Figure 5.4 Google Home App Interface
Amazon hosts its own cloud service called the Amazon Alexa Service. So, how does the cloud actually work? Developers register a skill through Amazon’s developer portal by defining metadata about their skills such as the name, logo, what keywords they want to activate, and what kind of queries to respond to. The metadata about that skill gets deployed onto Amazon Alexa Service. The costumed code that implements the skill is actually not deployed onto the Alexa Service itself but it is deployed separately. However, the developer puts a reference to where the implementation lives as part of the metadata they deployed onto the Amazon Alexa Service. This lets them update the implementation for their skill whenever they want to without having everything get into the hardware every time. It is really a great workflow since it essentially lets the developer and the consumer use the Echo device like a live report to test
changes with. The simplest way to write an implementation for a skill is using AWS Lambda function which is an AWS service that enables you to deploy functions without worrying about creating a runtime environment for the code executive.

5.3 APIs

Application Programming Interface(API) is a set of subroutine definitions, protocols, and tools for building application software. Alexa, the voice service that powers Amazon Echo, provides capabilities, or skills, that enable customers to interact with devices in a more intuitive way using their voice. Alexa skill APIs are designed to support the Amazon Voice Service. Three APIs which are Smart Home Skill API, List Skill API, and Flash Briefing Skill API will be explained.

5.3.1 Smart Home Skill API
According to Amazon.com, the Smart Home Skill API is to allow the smart home to function easily. Users just need to give the Echo device their command and the home devices will be controlled through the hub.

5.3.2 List Skill API

The List Skill API ensures lists are updated across all channels. That means the API notifies developers when a customer tells Alexa to add something to their list or makes a change.
to an existing item. Alexa understands the user’s speech request, converts it to a To-do or Shopping item, and sends the user a notification with the new item that was added to the list. The List Skill API also updates the lists for Alexa when users make changes to their lists online or in their mobile applications.

5.3.3 Flash Briefing Skill API

A Flash Briefing skill API provides a quick overview of news and other content such as comedy, interviews, and lists that a customer discovers and enables in the Skills section of the Alexa app. Customers receive their Flash Briefing by asking their Alexa-enabled device things like, “Alexa, give me my Flash Briefing” or “Alexa, tell me the news”. Alexa either reads text
content or plays audio content that is provided by each enabled skill. Typically a Flash Briefing becomes a part of a customer’s daily routine as they get ready for work or school, or wind down after their day.

There are thousands of Alexa Skills developed by programmers available in the Alexa Skill Store. Different categories and customer ratings provide the Alexa users with the most relevant and useful skills.

![Alexa Skills](image)

Figure 5.8 Amazon Echo Alexa Skills
6.0 Results

6.1 What is home automation?

A smart home is not a fantasy anymore. It merges a family's lifestyle with the latest technology & energy management tools to simplify people's lives. Home automation allows homeowners to control their home either remotely or natively. Using a smartphone, tablet or voice-activated hub to integrate and control all the gadgets in the home brings a lot of convenience to people. The reason that people initially adopt smart home technology is mainly to save the energy and money. For instance, according to the data posted on the Nest smart thermostat, on average, the Nest Thermostat saved 10-12% on heating and 15% on cooling. Based on typical energy costs, they have estimated average savings of $131 to $145 a year. As a result, these home automation devices do help homeowners to save money and bring them convenience.

The core of the home automation system requires artificial intelligence in the home-hub, which understands people’s command and conducts their commands from them in the cloud. People did need to open up different apps to control the household appliances. They had one app to turn on the light and another app to adjust the heating. That was inconvenient when they tried to control their homes. Instead, they wanted all the gadgets and appliances to be controlled and made to function at the same time. For now, all this can be done by directing the commands through artificial intelligence in the cloud. To do that, all the gadgets and the control hub must be connected to Wi-Fi and they also need to be linked to each other in a local area network.
The simplest system requirements are the self contained units that allow direct connection to the internet. They can be from multiple vendors. The next level is where you have chosen a protocol and all of the devices share that protocol. Compare the protocols.

The way introduced in the 5.0 part is to set up a voice-activated home automation system requires either a hub or a smartphone and some smart gadgets. The hub and the smartphone have to be connected to the Internet. All the smart gadgets need to be able to connect to the same network as the control hub. Both the voice-activated hub and the smart gadgets need to be under the same network so that they can talk to each other.
6.2 What would the future intelligent home automation system be?

Nowadays, home automation is more about being able to control our house remotely and natively. It still needs human interaction most of the time. The intelligent home automation system will require very little human interaction and the devices will do things automatically according to the established patterns of use that customers follow. The home hub will control all your smart devices. By simply talking to the devices or pointing to an object the devices will appear to function by themselves, controlled by the hub. Intelligent home automation is able to learn the routines in people’s daily lives to get better at helping them. It will know when to start making coffee, when to turn on the lights, or heat water for a shower. It can have the cognitive ability to know the actions which save on electricity and heating bills with amazing precision.

Current smart devices in the home have all the AI happening in the cloud. One predictable future trend of smart home automation is that the AI will not be totally in the cloud. Companies currently build the intelligence in the cloud is because it is easy to control and manage and this helps them on costs. However, it also still leads to some stability and reliability problems.

According to the table 2.1, the two most popular home-control hubs on the market are the Amazon Echo Alexa and Google Home. Many people are confused by which one they should buy since these two products have similar features and functionalities. Each has their own strengths and weaknesses. Google Home offers more choice in appearance with two different materials and 7 different colors while Alexa Echo and Alexa Dot offer only two colors each. The price of Amazon Echo Alexa is $179.99 and the price of Amazon Alexa Dot is $49.99 while the
price of Google Home is $129. The price point for Google Home is at the middle of Amazon Alexa and Alexa Dot. Amazon Echo can be linked in by bluetooth, but Google Home has no bluetooth connection for smartphones. Answering questions is an important feature determine how intelligent the system is. Due to the powerful search engine and large search inventory, Google does a better job than Amazon Alexa on its answering question feature. Google Home is able to answer follow-up questions, but Alexa cannot. Compared with the Google home, however, Amazon Alexa has more compatible partners which enables Amazon to keep its customers tightly in its marketing, sales and outreach circle.

According to the report from ZDNet, in 2016, all the intelligence is in the cloud, but in 2017, faster processors will enable machine learning natively. Moreover, IBM has released tools for developers to plug its Watson AI into any device or thing. According to IBM, Project Intu is an experimental service that allows developers to quickly and seamlessly integrate various cognitive services, such as conversation and speech-to-text with the capabilities of different devices, spaces and physical objects. Developers need to have a Bluemix cloud account to allow them to build cognitive experiences for various platforms, including Raspberry PI, MacOS, Windows, and Linux.

An example of a deep learning device currently on the market is the Nvidia baby monitor. Studies have shown that the increasing risks of a baby suddenly dying during sleep is caused by infants sleeping on their stomachs. There are a lot of expensive baby monitors which are capable of tracking the baby's breathing and pulse. However, parents want to catch problems before they happen. As a result, the deep learning baby monitor by Nvidia was trained to determine if the child is present in its crib initially to improve the recognition ability by feeding it thousands of
downloaded images. Then, it was trained to distinguish whether the baby was on its stomach or not and other important information such as asleep, awake, crying or face covered. Parents then get alerts when there is an emergency situation. The device accuracy increases as parents allow deep learning on their devices and surveillance of their baby individually. Nvidia also works hard on advanced features such as facial emotion recognition, different types of crying and spit up. As a result, it is possible that, in the near future, AI will be built into the devices instead of the cloud. However, the retail price of a device that has real AI built-in is much higher than the price of the “dumb” devices running AI in the cloud that are on the market right now.

Regarding a report from PCWorld magazine, the basic functionality Watson would like to work on is making devices talk to each other. For example, a washing machine could tell the dryer which program it should use for the cloth just washed or tell its owner when to order detergent. “Project Intu is working with appliance makers Whirlpool, Panasonic, Bragi, and Nokia to demonstrate how Watson adds its cognitive computing capabilities to their products.” It appears that another possibility in the future, is that home appliances will talk to each other and do things according to the pattern they learned from the households pattern of use.

Since Google and Samsung has developed the ability of visual search which can identify objects through their cameras, then the home hub probably could integrate with the camera. For example, Google Home could have a camera built on the device which can identify who is in the front the camera.
6.3 What do companies need to do if they want to stand out among their rivals?

According to the market analysis from Statista, the projected annual growth rate of smart home automation is 38% during 6-year period\textsuperscript{27}. Since the market is growing rapidly, there are many companies that are interested in jumping in to make money. However, many famous companies, such as Amazon, Google, Microsoft, Apple, Intel Samsung, and Facebook have all been making contributions and developing their AI for years. The intense competition increase the difficulties for any company to win the battle or for a new company to enter the competition.

There are three suggestions based on the analysis of the ecosystem and the strategies big companies have. Firstly, if the companies do not want to be squeezed out automatically either on the smart home market or the technological devices market, they need to take action as early as possible.

Secondly, companies do not have to copy other companies’ steps totally. For example, Apple has been expected to launch their own home hub. But, Time.com notes, that it appears Apple is more interested in turning Siri into an omnipresent AI assistant across many devices, rather than designing a single device specifically to serve as a Siri machine. Apple made the decision not follow in Amazon’s footsteps to give themselves a different and more advantageous position over its rivals\textsuperscript{28}. There are 43.5\% of U.S. citizens using iPhones in 2016 according the data from EMarketer\textsuperscript{29}. Those who use the Apple iOS system on their mobile phone tend to choose the same system in their home to make all the devices connected. As a result, it looks like Apple is making a smart decision.
Thirdly, companies need to partner with a wide variety of companies to build their own ecosystem and keep the customers in their circle. Amazon Alexa, Apple CarPlay and Android Auto are embedded into different automobile manufacturers. Those companies all want to see their customers use the same operating systems as their smartphone so that they don’t lose customers.
7.0 Conclusions

Having the lamp turn on at sunset, or turning the lamp off remotely from bed are things a smart home can easily do. Artificial intelligence in the home helps people control and manage their homes with more efficiency. The cloud-connected home hub or the home app on the smartphone plays a central role in the home automation system. Artificial intelligence runs the hub or the app. A stand-alone home hub and the apps to control all the devices via voice are all connected under the same network, and the hub or smartphone must be connected to the Internet. Individual devices cannot talk to each other and function unless they are in the same local network and central home-control hub or smartphone apps must be connected to Wi-Fi because they work in the cloud.

There are several objectives of this research paper. Consumers need to know background and current comparison information on home automation before they make solid purchase decisions. Companies in the marketplace need to be clear about the general condition of the market, the position where they are in the market, the advantages they have compared with its rivals, and the right direction to go before they can move forward.

Many consumers have been slowed in buying home automation systems by confusions and concerns. Discussion on the background and capabilities of home automation helps consumers know the needed information about home automation. Listing all the capabilities of the two main voice-controlled hub systems on the market helps explain the features and functions of Amazon Echo Alexa and Google Home. Explaining the requirements of setting up a smart home minimizes their concern that the difficulty of installing the smart home is beyond
their capabilities. This information makes it easier for consumers to carry out their purchase decision if they are interested in adopting a home-automation system in their house.

For companies, looking into the general ecosystem around home automation helps them to be clear about the general condition of the market. Having discussions on the strategies and strengths that rivals have helps them to figure out their current position in the market and the advantages they have compared to their rivals. Examining current technology, predicting the future of intelligent home automation based on current available but as yet unused technology, and suggesting strategies based on those technologies can help companies find productive directions in which to move forward.

The requirements of a basic home automation system is a router which can be connected to the WiFi, a controlled-home smart device (either a voice-activated home hub, or a smartphone), a starter kit which consists of sensors and the bridge. For example, when letting the voice-control home hub to turn on the light, a home hub, a lamp, smart light bulbs, a bridge controlling the light bulbs, a smartphone, and a router are required.

Comparing the two popular home-control hub one the market, which are Amazon Echo Alexa and Google Home, they have similar features and functionalities in general. However, they still have some differences. Google Home offers more appearances for people to choose from than Amazon Echo. The price level of Google Home is at the middle of Amazon Echo Alexa and Dot. Amazon Echo could be linked in by bluetooth for streaming, but Google Home cannot. Google did better job than Amazon Alexa on answering question feature due to its outstanding search engine. Google Home is able to answer the follow-up questions, but Alexa
cannot. Amazon Alexa has more compatible partners which enables Amazon keep customers in the circle tightly.

Future intelligent home should require minimum human interaction and the devices will do things for us automatically when they start learning the patterns from us. Based on the current market conditions and the actions each big companies take. Three predictions have been made. Firstly, the intelligence does not have to be in the cloud totally. AI will be embedded in or built into the devices instead of in the cloud. Secondly, the home appliances will talk to each other and give command from one to another automatically. For example, the washing machine tells the dryer which program it should use for the cloth just washed or tell its owner when to order detergent. Thirdly, the home hub probably could integrate with the camera. For example, Google Home could have a camera built on the device which can identify who is in the front the camera.

The home automation market is a growing market and it has huge potential. However, the developed products on the market are still at the beginning stage. Many companies want to jump in and make money. However, the intense competition increases the difficulties. Companies all have their strengths and strategies. There are three suggestions for those companies. Firstly, companies need to take action as early as possible if they are interested in entering the market. Secondly, companies do not have to copy others step, they can have their own approach. Thirdly, companies need to partner with a variety of companies to build their own ecosystem and keep the customers in their circle.

There are some limitations of this paper. Firstly, since the technology is growing so fast, it may overestimate or underestimate technology trends. Secondly, the business suggestions tend
to focus more on the medium to large size companies. For small companies, it might not be as valuable. Thirdly, the information might not be up to date because of the rapid growth of technology.
8.0 Future Research

When home automation makes our home more intelligent, people benefit for managing their home easier and saving the electricity and heating bills. However, people cannot stand worrying about the side effect, which is the security problem.

According to the research of Home Automation Security System and Method, “Unfortunately, while current home automation systems may turn off, turn on, or adjust the setting of a device such systems have not generally been able to lock out or partially restrict access to the device. Usually the controller can be manually overridden by a user at the physical location of the device. Often the device can be separated from the home automation controller and operated independently from the home automation system. Thus, a home automation system is effective at controlling devices, but not effective at restricting access to the home automation devices.” It is possible that someone can hack into your home automation system and open your door locks.

As a result, future research needs to look at how to make the home automation system much more secure. It has already provided convenience to people, it now needs to provide reliable security. The related field would be IoT, local area network, and Zigbee which is the security standard used in the home automation field.
Works Cited


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