Real Cases of Sensor Networks for Smart Homes

(Αληθινές Περιπτώσεις Αισθητήρων Δικτύων για Έξυπνα Σπίτια)

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18/05/2018

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ABSTRACT

When you're not home, nagging little doubts can start to crowd your mind. Did I turn the coffee maker off? Did I set the security alarm? Are the kids doing their homework or watching television? With a smart home, you could quiet all of these worries with a quick glance at your smartphone or tablet. You could connect the devices and appliances in your home so they can communicate with each other and with you. The goal of this particular paper is to show the full potential of the possibilities that you can benefit from the Smart Home Technology, and all the little details, opportunities, strengths, dangers and even weaknesses that this technology offers.

ΠΕΡΙΛΗΨΗ

Όταν δεν είστε σπίτι, μικρές αμφιβολίες μπορεί να αρχίσουν να γεμίζουν το μυαλό σας. Μήπως απενεργοποίησα την καφετιέρα?Ενεργοποίησα τον συναγερμό ασφαλείας; Τα παιδιά κάνουν την εργασία τους ή παρακολουθούν τηλεόραση; Με ένα έξυπνο σπίτι, μπορείτε να αποφύγετε όλες αυτές τις ανησυχίες με μια γρήγορη ματιά στο smartphone ή το tablet σας. Μπορείτε να συνδέσετε τις συσκευές και τις συσκευές στο σπίτι σας, ώστε να μπορούν να επικοινωνούν μεταξύ τους και μαζί σας. Ο στόχος αυτής της εργασίας είναι να δείξει το πλήρες δυναμικό των δυνατοτήτων που προσφέρει ενα «έξυπνο σπίτι» και όλες τις μικρές λεπτομέρειες, ευκαιρίες, δυνατά σημεία, κινδύνους, ακόμη και αδυναμίες που εγκυμονεί αυτή η τεχνολογία.

1. SUBJECT PRESENTATION

Exactly how Smart Home Works? Any device in your home that uses electricity can be put on your home network and at your command. Whether you give that command by voice, remote control, tablet or smartphone, the home reacts. Most applications relate to lighting, home security, home theater and entertainment, and thermostat regulation. The idea of a smart home might make you think of George J. and his futuristic abode or maybe Bill Gates, who spent more than $100 million building his smart home. Once a draw for the tech-savvy or the wealthy, smart homes and home automation are becoming more common. [1]

What used to be a quirky industry that churned out hard-to-use and frilly products is finally maturing into a full-blown consumer trend. Instead of start-up companies, more established tech organizations are launching new smart home products. Sales of automation systems could grow to around $9.5 billion by 2018.

By 2020, that number could balloon to $44 billion. Much of this is due to the jaw-dropping success of smartphones and tablet computers. These ultra-portable computers are everywhere, and their constant Internet connections means they can be configured to control myriad other online devices. It's all about the Internet of Things.

The Internet of Things is a phrase that refers to the objects and products that are interconnected and identifiable through digital networks. This web-like sprawl of products is getting bigger and better every day. All of the electronics in your home are fair game for this tech revolution, from your fridge to your furnace. [2]

2. SMART HOMES SOFTWARE AND TECHNOLOGY

Home automation has a long and fitful history. For many years, tech trends have come and gone, but one of the first companies to find success is still around.

2.1. X10 Devices

The genesis of many smart home products was 1975, when a company in Scotland developed X10. X10 allows compatible products to talk to each other over the already existing electrical wires of a home. All the appliances and devices are receivers, and the means of controlling the system, such as remote controls or keypads, are transmitters. If you want to turn off a lamp in another room, the transmitter will issue a message in numerical code that includes the following:

- An alert to the system that it's issuing a command,
- An identifying unit number for the device that should receive the command and
- A code that contains the actual command, such as "turn off."

All of this is designed to happen in less than a second, but X10 does have some limitations. Communicating over electrical lines is not always reliable because the lines get "noisy" from powering other devices. An X10 device could interpret electronic interference as a command and react, or it might not receive the command at all. While X10 devices are still around, other technologies have emerged to compete for your networking dollar. Instead of going through the power lines, many new systems use radio waves to communicate. That's how Bluetooth, wifi and cell phone signals operate. [3]

2.2. Z-Wave and Zig Bee

Two of the most prominent radio networks in home automation are Zig Bee and Z-Wave. Both of these technologies are mesh networks, meaning there's more than one way for the message to get to its destination. Z-Wave uses a Source Routing Algorithm to determine the fastest route for messages. Each Z-Wave device is embedded with a code, and when the device is plugged into the system, the network controller recognizes the code, determines its location and adds it to the network. When a command comes through, the controller uses the algorithm to

determine how the message should be sent. Because this routing can take up a lot of memory on a network, Z-Wave has developed a hierarchy between devices: Some controllers initiate messages, and some are "slaves," which means they can only carry and respond to messages. Zig Bee's name illustrates the mesh networking concept because messages from the transmitter zigzag like bees, looking for the best path to the receiver. While Z-Wave uses a proprietary technology for operating its system, Zig Bee's platform is based on the standard set by the Institute for Electrical and Electronics Engineers (IEEE) for wireless personal networks. This means any company can build a Zig Bee-compatible product without paying licensing fees for the technology behind it, which may eventually give Zig Bee an advantage in the marketplace. Like Z-Wave, Zig Bee has fully functional devices (or those that route the message) and reduced function devices (or those that don't). [4]

2.3. Insteon

Using a wireless network provides more flexibility for placing devices, but like electrical lines, they might have interference. Insteon offers a way for your home network to communicate over both electrical wires and radio waves, making it a dual-mesh network. If the message isn't getting through on one platform, it will try the other. Instead of routing the message, an Insteon device will broadcast the message, and all devices pick up the message and broadcast it until the command is performed. The devices act like peers, as opposed to one serving as an instigator and another as a receptor. This means that the more Insteon devices that are installed on a network, the stronger the message will be. The best example of a Smart Home Technology is Bill Gate’s home. Microsoft Chairman Bill Gate’ s just outside of Seattle, Wash, might be the most famous smart home to date. Everyone in the home is pinned with an electronic tracking chip. As you move throughout the rooms, lights come on ahead of you and fade behind you. Your favorite song will follow you throughout the house, as will whatever you watch on the television. You can entertain yourself by looking at Gate’s extensive electronic collection of still images, all available on demand. The chip keeps track of all that you do and makes adjustments as it learns your preferences. When two different chips enter, the system tries to compromise on something that both people will like. [5]

3. SETTING UP A SMART HOME

X10, Insteon, ZigBee and Z-Wave provide only the fundamental technology, called **protocols**, for smart home communication. They've created alliances with electronics manufacturers who actually build the end-user devices. Here are some examples of smart home products and their functions.

- Cameras will track your home's exterior even if it's pitch-black outside.
- You can control a thermostat from your bed, the airport anywhere your smartphone has a signal.
- LED lights let you program color and brightness right from your smartphone.
- Motion Sensors will send an alert when there's motion around your house, and they can even tell the difference between pets and burglars.
- Smartphone integration lets you turn lights and appliances on or off from your mobile device.
- Door locks and garage doors can open automatically as your smartphone approaches.
- Auto alerts from your security system will immediately go to your smartphone, so you instantly know if there's a problem at home.
- Many devices also come with built-in web servers that allow you to access their information online.

These products are available at home improvement stores, electronics stores, from installation technicians or online. Before buying, check to see what technology is associated with the product. Products using the same technology should work together despite different manufacturers, but connecting an X10 and a Z-Wave product requires a bridging device, and often, extreme patience and some technical skills on your part. In designing a smart home, you can do as much or as little home automation as you want. For starters, it may be best to think of tasks you already routinely do and then find a way to automate them.

You could begin with a lighting starter kit and add on security devices later. If you want to start with a more expansive system with many features, it's a good idea to carefully design how the home will work, particularly if rewiring or renovation will be required. In addition, you'll

want to strategically place the nodes of the wireless networks so that they have a good routing range.

About 60 percent of homebuilders who have installed home automation devices hired professional help. If you're looking for a technician, check if they have CEA-CompTIA certification. This certification is the result of a partnership between the Consumer Electronics Association (CEA) and the Computing Technology Industry Association (CompTIA), and it represents proficiency in installing, maintaining and troubleshooting any vendor's home networking equipment.

The cost of a smart home varies depending on how smart the home is. One builder estimates that his clients spend between $10,000 and $250,000 for sophisticated systems. If you build the smart home gradually, starting with a basic lighting system, it might only be a few hundred dollars. A more sophisticated system will be tens of thousands of dollars, and elements of home theater systems raise the cost of a system about 50 percent.

3.1. Smart Home Appliances

Here are some examples of smart home appliances. Those accessories are smart in their own right:

- Trash cans that monitor what you throw away and generate online orders for replacements.
- Refrigerators that create dinner recipes based on the ingredients stored inside.
- Washers and dryers that send text message alerts when their cycle has ended.

4. REAL CASES OF SMART HOME DEVICES

Home automation systems have struggled to find a mainstream audience, in part because they require a bit of technical savvy from their users. But these days, the fast proliferations of smartphones and tablets provide an easy way for even tech novices to communicate with home automation gadgets. And those gadgets are more numerous by the day.

4.1. Nest Thermostat

The Nest Thermostat comes with integrated Wi-Fi so that you can control, schedule and monitor your home's temperatures, from the porch or from a taxi. Nest learns your behaviors and automatically adjusts its settings for maximum efficiency and comfort. It will tell you how much energy you're using, remind you to change your filters, and even alter its functions to account for the differences between, say, a heat pump or radiant heaters. [6]

4.2. Philips' Hue Lights

Philips' Hue lights offer some concert lighting effects right in your own home. Screw these LED bulbs into your regular fixtures, install the app to your phone or tablet, and then you can turn the lights on or off, brighten or dim them, or perhaps best of all, change the color. Then you can even program the lights to perform just about any combination of color and brightness, and control up to 50 lights on one bridge (which links the lights to your phone). The more lights you have the more fun it will be. But it will cost you -- a starter pack with three bulbs and a bridge goes for around $200. [7]

4.3. Elgato Eve Energy

A smart power switch is one of the simplest ways to get into home automation. This device plugs into your wall socket and then you can plug your light or fan or kettle or whatever into the switch. It's easy to set up and it means you can turn the attached electrical device on and off remotely and monitors electrical consumption. Then it can calculate the cost of the switch's usage. [8]

5. SMART HOME BENEFITS

Smart homes may make life easier and more convenient. Who wouldn't love being able to control lighting, entertainment and temperature from their couch? Whether you're at work or on vacation, the smart home will alert you to what's going on, and security systems can be built to provide an immense amount of help in an emergency. For example, not only would a resident be woken with notification of a fire alarm, the smart home would also unlock doors, dial the fire department and light the path to safety. Here are a few more examples of cool smart home tricks:

- Light a path for nighttime bathroom trips.
- Unlock your door automatically as you approach.
- Feed your pets on a schedule with a preset amount of food.
- Instantly create mood lighting for any occasion.
- Program your television so that your children can watch only at certain times.
- Warm the bedroom before you get out of bed so that it's nice and toasty when you get up.
- Turn on the coffee maker from bed.[9]

5.1. Energy Savings

Smart homes also provide some energy efficiency savings. Because systems like Z-Wave and Zig Bee put some devices at a reduced level of functionality, they can go to sleep and wake up

when commands are given. Electric bills go down when lights are automatically turned off in empty rooms, and rooms can be heated or cooled based on who's there at any given moment. One homeowner boasted that her heating bill was about one-third less than a same-sized normal home. Some devices can track how much energy each appliance is using and command power hogs to use less. [10]

5.2. Smart Home Benefits for the Elderly

Smart home technology promises tremendous benefits for elderly people living alone. A smart home could notify the resident when it's time to take medicine, alert the hospital if the resident falls and track how much the resident is eating. If an elderly person is a little forgetful, the smart home could perform tasks such as shutting off the water before a tub overflow or turning off the oven if the cook had wandered away. One builder estimates that a system like this could cost $20,000, which is less expensive than a full-time nursing home. It also allows adult children who might live elsewhere to participate in the care of their aging parent. Easy-to-control automated systems would provide similar benefits to those with disabilities or a limited range of movement. For instance, affordable smart homes now offer all kinds of automated emergency response systems, built in safety features, remote access and monitoring devices, fall prevention mechanisms, timers, lighting, locks and reminder alerts. [11]

6. DISADVTAGES AND CHALLENGES OF THE SMART HOME TECHNOLOGY

A smart home probably sounds like a nightmare to those people not comfortable with computers. Those who routinely fumble around with a remote control just trying to change the TV channel might have stopped reading by now.

6.1. Complexity Factors

One of the primary mental blocks of installing a smart home system is balancing the complexity of the system against the usability of the system. If it's downright exasperating, then it's actually making your life harder instead of easier. When planning the system, it's important to consider a few factors:

- What kinds of components is part of the system? Are they basic, such a light dimmer, or more imposing, like an alarm system or a video camera?
- How intuitive will the system be to a non-user?
- Is the device actually fulfilling a need or is it just a fancy and potentially frustrating toy?
- How many people will be required to use the system?
- Who will know how to operate the system? Who will know how to maintain the system and address failures?
- How easy is it to make changes to the interface? For example, if your house is programmed to wake you up at 7 a.m., how will you let it know that you're away overnight on business or sleeping in on a Saturday?

For these reasons, it may be easier to start with a very basic home network and expand as enhancements are needed or desired. Like many new technologies, smart homes require a significant investment in both cash and time to keep up, so if you're short on either, you may want to stick with your "dumb" old house.

Before you buy, check product reviews and avoid those that draw the ire of users. There are plenty of products making sky-high promises that fall flat in the real world. And if you're a smartphone user, strongly consider products that come with an equally well-reviewed smartphone app. Some apps are so unwieldy or convoluted that they cause more headaches than they relieve.

6.2. Security

Smart homes also come with some security concerns. Hackers who find a way to access the network may have the ability to turn off alarm systems and lights, leaving the home vulnerable to a break-in. They could also cause mischief like turning devices on and off rapidly, which could ruin some electronics or -- in an extreme case -- possibly cause a fire. [12]

Consumer electronics manufacturers are ramping up their product lines in the hope that home automation finally hits the mainstream. Thanks to smartphones and tablets, and the many home automation apps that are now available, there's a chance the trend will catch on ... but a full-on Jetson's - style home may still be years or decades off.

That's because, in spite of so many technological advances, there's still no standard system for automating all of these gadgets. Without such a standard, many consumers are left wondering if they're spending hundreds or thousands of dollars on products that will wind up obsolete or unusable in a short time.

Of course, there's also the question of whether an individual needs all this technology. Is our society really so lazy that we can't flip a light switch? The good news is that with all the time we save from home automation, we'll have time to work on other pursuits. Like developing robot guards.

7. SMART HOME SWOT ANALYSIS

Strengths

- Innovative Culture
- Size Advantages
- Cost Advantages
- Unique Products
- Customer Loyalty
- Technology

Innovative Culture: Helps Smart Home to produce unique products and services that meet their customer's needs.

Size Advantages: Size advantages lower Smart Home**'s** risks. The larger Smart Home gets, the more resources they have to pursue new markets and defend themselves against rivals.

Cost Advantages: Lower costs lead to higher profits for Smart Home. A low cost leader can undercut rivals on price.

Unique Products: Unique products help distinguish Smart Home from competitors. Smart Home can charge higher prices for their products, because consumers can't get those products elsewhere.

Customer Loyalty: When given a choice, customers are loyal to Smart Home. Instead of targeting all customers, Smart Home only needs to target new customers in order to grow their business.

Technology: Superior technology allows Smart Home to better meet the needs of their customers in ways that competitors can't imitate.

Weaknesses

- High Debt Burden
- Weak Supply Chain
- Online Presence
- Weak Brand

High Debt Burden: A high debt burden increases the risk that Smart Home goes bankrupt if they make a poor business decision. Increasing risks can increase Smart Home's debt interest payments.

Weak Supply Chain: A weak supply chain can delay the arrival of products to Smart Home's customers. Unnecessary delays can hurt Smart Home over the long run, because customers will cancel orders.

Online Presence: The online market is essential for displaying information and selling products. A weak online presence can result in lost opportunities for Smart Home**.**

Weak Brand: A weak brand means Smart Home can't charge the same prices for goods and services as their competitors, because consumers don't value the brand.

Opportunities

- New Technology
- Innovation
- Emerging Market
- New Products
- New Markets
- International Expansion

New Technology: New technology helps Smart Home to better meet their customer's needs with new and improved products and services. Technology also builds competitive barriers against rivals.

Innovation: Greater innovation can help Smart Home to produce unique products and services that meet customer's needs.

Emerging Market: Emerging markets are fast growing regions of the world that enable Smart Home to quickly expand.

New Products: New products can help Smart Home to expand their business and diversity their customer base.

New Markets: New markets allow Smart Home to expand their business and diversify their portfolio of products and services.

International Expansion: International markets offer Smart Home new opportunities to expand the business and increase sales.

Threats

- Bad Economy
- Intense Competition
- Government Regulation
- Substitute Products

Bad Economy: A bad economy can hurt Smart Home's business by decreasing the number of potential customers.

Intense Competition: Intense completion can lower Smart Home's profits, because competitors can entice consumers away with superior products

Government Regulation: Changes to government rules and regulations can negatively affect Smart home.

Substitute Products: The availability of substitute products hurts Smart Home's ability to raise prices, because customers can easily switch to another product or service. [13]

8. SMART HOMES FUTURE OUTLOOK

8.1. Towards less price and Higher Awareness

The Home Automation integration of electric equipment in household is not new but it took time for people to accept this new technology and adapt in their lives. The reason for delay of home automation trend catching pace in the market has historically been primarily due to high price and consumer unawareness or disinterest. Today, with the evolution of mobile technology, technology awareness is becoming wider, and the cost is getting down with the continuous evolution of mobile devices like smart phones and tablets.

8.2. Building different Customer Base

And the same is true for home automation. It is and has been a luxury market. There is room for a small number of specialists who cater for the very high-end luxury market. But at the peak of this pyramid, there is very little space to breathe. It is also this focus, and consequently the business models that have been built around it, that prevents the industry from growing. There's a need for larger audience in order to grow the revenues and profits, and that means catering more to the masses with higher volumes but lower mean prices. And that means taking benefit of the off-the-shelf products where possible. [14]

8.3. DIY Automation

Based on the previous trend, targeting a new customer’s base will generate a new model for home automation business, which is the DIY (Do It Yourself). Smart Homes is expected to be based on the DIY business model which will grow the business dramatically. This is because of the ease of installation and operation of most smart home elements introduced by the DIY devices. Expectations indicate that the DIY devices will grow at a close to 30% between 2019 and 2020, but that their impact will extend beyond individual device sales. [15]

9. CONCLUSIONS

Smart Homes will one day be the way all homes are lived in. This however will take time. Similar to the introduction of electricity in the turn of the century, the smart home business needs time to grow and mature before it goes main-stream. That's because smart home gadgets tend to be pricey and luxury items especially if they don't feel a need yet. There are, however, many benefits to owning a smart home due to the flexibility and convenience it can provide. As more and more items, such as alarm systems, are introduced to the home, and items begin to work together, the rise of smart homes is definite. In a world that the need for energy saving is getting bigger every day, the Smart Home idea is the solution to this problem.

As for the human factor, especially the elderly ones, the smart home system is the one that should be user friendly and approachable, and not the other way around. The user must have full control of the smart home functionality, and be the one that makes all the choices, in order for him to have the life quality he deserves.

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