Digital Home

Version 1.1

Document Control

Approval

The Guidance Team and the Customer will approve this document.

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Change Summary

The following table details changes made between versions of this document

|  |  |  |  |
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| Version | Date | Modifier | Description |
| 1.0 | 03/03/14 | NP-Soft | Entire team created report and filled out sections 1-7. |
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# 1. Introduction

The following section lays out in subsections the Purpose of the Feasibility Report, the Justification of the system, a summary of the Requirements Definition Document, a level one Use Case diagram as well as the actors involved, the description of the use case events, and finally any and all assumptions that we have made.

## Purpose of the Feasibility Report

The purpose of this document is to determine if creating such a system within the scope given to us is possible to be developed. We will also be analyzing any considerations that we feel are important in the development of this system, possible solutions that we feel will meet these considerations, and finally the recommended solution that we feel would be the best solution to implement. Our intention is to provide our client, Dr. Salamah, with enough information to know whether the project could be done, whether the final product benefit its intended users, and finally to show the alternatives.

## Justification for the Proposed System

Given the advancement of technology over recent years there has been a demand to develop systems that help make people’s lives easier, and to provide a safer and more secure environment. With this in mind our client feel that the development of this system will give him, and his family the ability enjoy a better life knowing that his personal belongings as well as his family are safe and secure. The client feels that by being able to easily manage his daily life, he will be able to spend more time with his family and enjoy engaging in activities.

## Requirements Definition

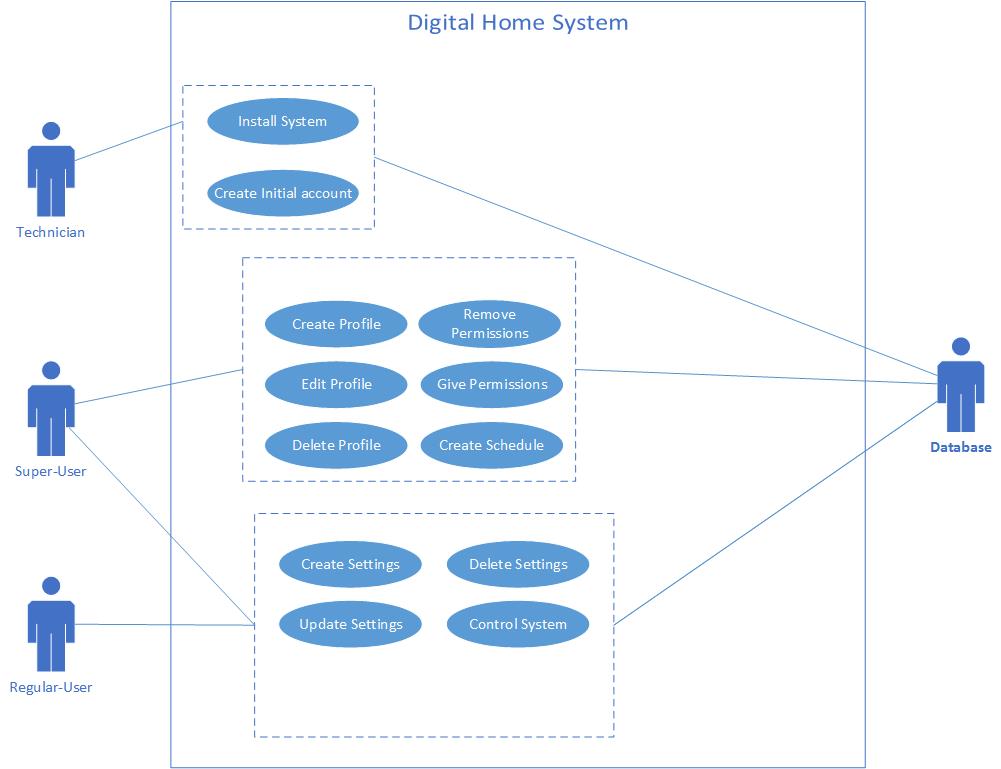
The following is a summary from the Requirements Definition Document. The full document is included in Appendix A. The Digital Home System provides the capability for home owners to easily manage their daily lives by bringing together security, environmental and energy management, as well as entertainment, and communications. The Digital Home system will allow the owner to use their own personal web page available on any web ready computer, cell phone or other device to control the house’s temperature, lighting, state of household appliances, and a planner that will allow the owner to set home parameters for specific periods of time. Through wireless communication the house will communicate with the various sensors, (e.g. temperature, power, contact, humidistat, light, and water sensors) installed thought the house. The security system of the Digital Home will consist of contact sensors that when triggered will communicate to the master control unit of the home, as well as sound both a light and sound alarm. The temperature and humidistat sensors will allow the home owner to control both the temperature and humidity of individual rooms, and the entire house. The power sensors will allow the home owners to control household appliances, control central lighting in each room, monitor the state of the appliance, and provide information on whether a light and/or appliance is on or off.

## Use Cases

The following subsections contain the Use Case Diagram (first-level abstraction), the description of the actors involved, description of the Use Case events, and finally any and all assumptions we have made.

### Use Case Diagram (first-level abstraction)

Below is a first level abstraction Use Case Diagram, which we feel would best model the system.

Fig. 1

### Actors (descriptions)

The following section describes the actors involved in our use case diagram. The organization of the list will be the actor, followed by functionalities that the actor has in the system.

* Super-User
  + Can create regular users for the system.
  + Overrides any setting that is created/planned by a regular-user.
  + Can give permissions to regular users to control home system.
  + Can control alarms, temperature, sensors, humidity, and lights.
  + Can delete regular users.
  + Can create new daily planners.
  + Can decide when to back up the power consumption history in the database.
* Regular User
  + Can control the home system within permissions given to them by Super-user.
  + Can also create their own settings (always overwritten by Super-user)
  + Can delete their settings.
  + Can update their settings.
* Database
  + Stores the planner data set up by any kind of user (super-user gets priority.)
  + Keeps a log of the activity within the house (when a light or appliance is on/off).
  + Stores regular users created by Super-user or Technician.
  + Stores Password for Super-user and Regular user.
  + Stores profile for Super-user and Regular user.
  + Stores power consumption history to be made into reports as per the Super-User.
* Technician
  + Can create Regular-users.
  + Can create Super-users.
  + Can install new sensors and add them to the system

### Use Case Descriptions

The following section describes the use cases involved in our use case diagram, the organization of the list will be the use case, followed by the purpose of the use case.

* Install System
  + Installation of sensors, alarm system, wiring home to master control box.
* Create Initial Account
  + Used to create new Super-user account for new homeowners, as well as other Regular-users of the home system.
  + Can also be used to remove old Super-user in the event the house becomes sold.
* Create Profile
  + Create a new Regular-user by the Super-user.
* Edit Profile
  + Allows Regular-user and Super-users to change password as well as other information relevant to signing into the system.
* Delete Profile
  + Allows Super-users to delete Regular-users.
* Remove Permissions
  + Action used by the Super-user to remove certain functions of the home to Regular-users.
* Give Permission
  + Actions used by the Super-user to add home functionalities to Regular-users.
* Create Schedule
  + Allows the Super-user the ability to set up parameters for specific periods of time.
* Create Settings\*
  + Allows Regular-users, as well as the Super-user to create a new setting.
  + Can be used to set temperature, humidity, lighting, etc. in Regular or Super-users’ room.
* Update Settings\*
  + Allows Regular-users and Super-users the ability to update existing settings they have made.
* Delete Settings\*
  + Allows Regular-users and Super-users the ability to delete existing settings
* Control System\*
  + Allows both Regular-users and Super-users to control alarms, lights, door and window sensors, entertainment centers, ect. Note: For Regular-users control of system depends on the permissions given to them by the Super-User.

\* Note: Super-user settings and control of the system overwrite all Regular-user settings.

### Use Case Assumptions

The following section states any and all assumptions that we have for the use case; our assumptions are presented in list format.

1. The system will have its own dedicated Wi-Fi separate from the owner’s personal Wi-Fi, which will be used for the sensors, and all of the functionalities.
2. The homeowner will not have permission to use the system’s Wi-Fi for personal reasons (e.g. surfing the internet, using phone apps, etc.)

# Considerations

## This section observes potential problems, related to the system, that need to be considered. For each consideration, various options are proposed as potential solutions to the given problem. For example, a consideration may be “The programming language for the system,” where the options given would delve in to the pros and cons of languages such as Java, C, and more.

As stated before, the options given are potential solutions to a given consideration, but not to the system as a whole. Section 3 will attempt to provide solutions to the entire Digital Home problem by selecting options for each consideration in this section.

## Existing Systems

There are many smart home systems available in the market currently. Most systems currently available lack features wanted in Digital Home. Next, we explore some systems that assimilate the needs of Digital Home found in the market currently.

### Savant Systems

Savant Systems offers custom Apple-based smart home technologies. These systems offer automation & control over: audio, video, Internet devices, media, lighting systems, climate, security, and surveillance among others. These systems also feature an HVAC scheduler that allows users to create different temperature and humidity schedules. Savant smart homes also feature intelligent lighting control that uses sensors to turn off lights when a room is unoccupied [2].

### Iris

The Iris smart home system kits offer a variety of things, these kits need to be set up and customized by the customer. Some of the features offered by Iris are: Iris Hub (connects to Internet connection in order to control smart devices, contact and motion sensors, keypad (conveniently mounted near entry/exit point for easy control), smart plug (allows control of power outlets), smart thermostat.

All of Iris’ features are customizable and monitored easily from computers, tablets, or smartphones. Through the use of Iris, users are able to: adjust the lights, control the climate, arm the security system, and unlock doors among other things – these activities are also controlled via voice control using Iris app [3].

### IntelligentHome

The IntelligentHome system by Time Warner Cable is one of the many smart home system solutions in the market. This particular system offers security measures to the house (alerts) triggered by events. It also employs a planner and remote access to lights and thermostat settings among others. Furthermore, the IntelligentHome’s controller is available in computers and smartphones. Finally, the IntelligentHome system is energy efficient [1].

## General

This section will cover the considerations for the problems that are typically broad and do not fit in to any of the categories found below.

### Programming Language for the System

The choice of programming language that will be used for the majority of the system is an important problem to discuss. The chosen programming language will be used to manage the feedback from the sensors, manage the settings, and more. In essence, it will be the backbone for the entire system and choosing a poor language could result in low readability, writability, and reliability. The following are the top 4 options for the overall programming language for the system.

#### Java

Java, taken at face value, would be the obvious option for a chosen programming language for this project. The languages that every member in this team knows the best is Java, so there would be little to no learning involved to begin coding. Potentially the largest plus for Java, however, is the large built in library, which provides many tools for many different problems. On top of this, Java is known for its high reliability which extends to portability, garbage collection, and error handling. This is especially helpful since user input will be constant throughout the lifetime of the system. [4]

#### C

Though Java seems to be the obvious choice, C still stands as a good potential candidate. C excels by being close to the hardware and close to the memory through its explicit memory transfers and allocations. This leaves room for optimization if we were to take the time to learn the hardware. The fact that C is one of the most common languages still seen today greatly improves its maintainability for new members to the project. In terms of experience, all the NP-Soft members have some experience with C and our skills range from working knowledge to proficient. [5]

#### C++

C++ benefits from all the previously mentioned benefits of C, minus the experience of the team members. However, C++ also gains the benefits of being object oriented, which will improve writability and readability through abstraction and modularity. As stated, though, the NP-Soft team members have little to no experience with C++, however, being closely related to C means the time it would take to learn the language would be minimal. [5]

#### Objective-C

Objective-C is a strict superset of the C language meaning that we could compile any program written in C with a compiler for Objective-C. Although only two of our team members are proficient with Objective-C the fact that all our team members are proficient with C means that the rest of team could learn the language if need it be. The main draw for using Objective-C language would be in case we wanted to repurpose a tablet to be used as the user interface as discussed in solution 2.5.1.1, specifically if we were to use an Ipad we would need to use Objective-C to write the application. [6]

### Scripting Language for the Website

The personal website for the home is an important part of the overall project as it interacts with the Digital Home by accessing the database and providing many of the same features to the house that people inside the house have. Similar to the previous Section (2.3.1. Programming Language for the System), the chosen language will greatly affect the readability, writability, and reliability of the system’s code. The following are the top 2 options for the scripting language for the website.

#### PHP

As Java is with Section 2.3.1., PHP is the obvious option for a scripting language for the website. In terms of range of use, PHP happens to be one of the most used scripting languages around, powering websites such as Facebook and Wikipedia. This is with good reason. It is a server-side language, which is a strong component to consider when security is one of your top priorities. On top of this, every team member in NP-Soft has some experience in programming with PHP. [7]

#### Ruby

Ruby excels at ease of learning and use. The high readability and writability of the language makes it a contender for possible scripting language. Though, Ruby is not inherently a server-side scripting language, which may cause security concerns, a framework is available that offers server-side scripting. In terms of experience, no NP-Soft team members have experience with Ruby, but the time to learn should not be long due to the previously stated reasons. [8]

### Home Server Operating System

The home server operating system is another concern to analyze. The chosen operating system will affect the cost, potential compatibility, and maintainability for the website and database.

#### Windows Home Server 2011

Windows Home Server 2011 (WHS11) is the most widely used home server operating system. It is popular for its backing up of data and its ease of set up and use. Installation is handled by installation disc and requires little knowledge of the set up process. As stated, WHS11 is known for its data backup, which the client is interested in. In terms of cost, WHS11 costs about $60, which is not costly overall. [9]

#### Ubuntu Server Edition

Ubuntu is an equally powerful operating system that also excels in data backup. The difference is that set up may require more knowledge of the set up process, yet is completely free. [10]

## Security

This section will be concerned with considerations pertaining to password protections and intrusion alerts.

### Cameras

The Digital Home will be monitored by cameras constantly throughout the house. Because of this, the quality and connectivity of the cameras make an important difference.

#### Dropcam Pro Wi-Fi Wireless Video Monitoring Camera

The Dropcam wifi camera provides all the necessary security camera essentials such as night vision, recording, and streaming, however, recorded videos store straight on the cloud with Dropcam. As the name notes, each camera uses Wi-Fi, which could potentially reduce bandwidth when considering 15+ cameras. These cameras can be viewed via phone or computer and recording schedules can be created. The company boasts a 60 second installation for ease of us. Each camera costs roughly $200. [11]

#### Foscam FI9821W

The Foscam camera sports similar features to the Dropcam, but video recordings can be stored on site and network security encryptions such as WEP, WPA, and WPA2. Each camera costs roughly $200. [12]

## Sensors

This section consists of considerations that pertain to the thermostats, humidistats, and any related sensors to monitoring the status of the Digital Home.

### Thermostats and Humidistats

The thermostats and humidistats are the driving force of comfort in the Digital Home and are 2 of the main sensors throughout the home. The following options are existing thermostats and humidistats to potentially be used for the Digital Home.

#### Honeywell Prestige 2.0 Comfort System

This Honeywell comfort system contains a thermostat, humidistat, and even air filtration sensing. It contains a few languages and can be scheduled for 7 days. This system connects to the internet and can be monitored and controlled via internet. The entire system runs for roughly $370. [13]

#### Aprilaire Model 8910 Home Comfort Control

The aprilaire model 8910 offers similar benefits as the Honeywell counterpart, but does not consist of internet connection. The system costs roughly $220[14]

## User Interface

Since comfort and everyday use is essential to the Digital Home project, the User Interface is one of the most important aspects of the system. This section provides solutions to considerations revolving on how the users interact with the system.

### Local Interface

The local interface of the system is the panel that users control inside of the home to adjust settings and more. This will deal with the primary way in which the users access the system from room to room.

#### Repurposed Tablet

One possible solution to the user interface would be to use a wall mounted tablet that only runs one application: the Digital Home application. This would act as a touch screen user interface and could be useful in that it simply accesses the website. The application would have to be a mobile application, which the NP-Soft team is not familiar with and would take some time to learn. The main issues with this solution are the cost of the tablets and the wasted resources of the tablets. Tablets contain many assets and processing power that may never need to be used, such as the gyroscope. The cost and language would vary depending on the tablet chosen.

#### Repurposed All-In-One PC

A similar option would be to use an All-In-One PC as the local user interface. This option gains the same benefits as the tablets, however may work better than the Tablet option as it is easier to run a single start up application that runs forever on PCs. However, the All-In-One PC runs in to the same issues that the Tablet does in that it may be too powerful. In the end, it may be too expensive and waste too many resources to be a viable option. The cost and language would vary depending on PC chosen.

### Touch Sensor

Touch Sensor is a company that develops touch screen interface for other companies looking to meet a user interface standard. Their work consists of, but is not limited to, touch screens for work out machines, ovens, and thermostats. This company could be contacted to work on the user interface for this project. For this project, our team was tasked with creating the user interface, so this is not a realistic option at this stage; however this could be a potential solution in future stages of the project. [15]

# Solutions

## The following section will propose possible solutions for the entire system as a whole. This includes solving the considerations posed in Section 2 with specific options proposed in Section 2.

## The Obvious Solution

This solution consists of picking all the obvious options to the considerations posed in Section 2. These “obvious” options consist of seemingly overwhelming benefits at first glance. NP-Soft team members’ experience with each option is a large factor in analyzing these benefits. The following solution will describe the solution and its options, then explain the resources needed and discuss the limitations of this approach.

### Description

The obvious solution involves utilizing Java and PHP as the main languages for development. They are strong, common languages that the development team is familiar and comfortable with. Little to know learning will be involved with these 2 languages during development with our current team.

As for the home server operating system, Windows Home Server will be utilized for the system. Because our team has little to no experience with servers, the ease of installation and familiarity with the Windows operating system family will greatly foster our introduction in to server management. The strong data backup also combats the requirement of backing up all data periodically.

To solve the issue of what cameras to use, we believe the Foscam camera, discussed in Section 2.3.1.2., is a good candidate as it is able to store its video recordings on site, which handles the requirement of storing all data on site.

For thermostats and humidistats, the prestige system, discussed in Section 2.4.1.1., will be a good solution to manage humidity and temperature throughout the house. It is assumed that our system will be able to interact with this system. If not, other solutions will need to be explored.

The user interface will be best matched with a repurposed tablet; specifically, an android tablet. The android operating system uses Java, which works in conjunction with the proposed programming language.

This system, as a whole, utilizes “ease of learning” as the main criteria, so design and development can be focused on instead of wasting time for learning a new language or paradigm.

### Resources Needed

The resources needed to manage this solution are close to minimal as little training will be needed in the areas of the Windows Home Server Operating System management, the Foscam usage, the prestige system usage, and android mobile applications. In terms of financial cost, the entire solution’s equipment would cost under $750.

### Limitations

The limitations of the Obvious Solution lie in the cost and in the Humidity and Temperature system. $750 seems to be fairly cost efficient amount, but there are still cheaper solutions. As for the prestige system, discussed in 2.4.1.1., because this system is built as a standalone system, it will most likely not be easily integratable in to our system.

## The Cost Effective Solution

This solution consists of utilizing the best options to the listed considerations in Section 2 as opposed to the options made by the Obvious Solution, discussed in Section 3.1. The focus, this time, is not on choosing the options that the development team has the most experience with, but instead, on choosing practical options in terms of reliability and cost. The following subsections will describe the solution in detail by picking options from considerations, discussed in Section 2, then explaining the necessary resources and limitations to this solution.

### Description

When realizing the Effective Solution, we did not concern ourselves with learning times and instead, we focused more on the cost efficiency of an option.

To follow this trend, when deciding a programming language for the overall system, we have decided Objective-C would be the best candidate. Objective-C is the primary language for IOS and benefits from all the same criteria that C++ does, but puts more emphasis on readability. Though not the main criteria for selecting this language, it is an added bonus that 2 of our members are familiar and have experience with Objective-C.

As for a scripting language for the system, Ruby is the obvious choice, as it focuses on easy syntax, expressivity, and ease of learning: all important criteria when developing large systems. Both PHP and Ruby are free scripting languages that excel at security and so the decision came down to readability and writability.

The most cost efficient choice for a home server operating system is Ubuntu, as it is free and offers the same power as Windows Home Server, but is more easily and more often updated.

For cameras, we still choose the Foscam, as it is the only camera option that satisfies the requirement of storing recordings on site.

For a temperature and humidity sensor, we ended up choosing the Aprilaire system, discussed in Section 2.4.1.2., for its low cost and $150 difference over the prestige system. Though it does not have internet connectivity, we are assuming we can extract and input data from the overall system. If this is not the case, this section will have to be revisited and other alternatives will need to be discussed.

For the user interface, we will still be using a tablet, similar to the Obvious Solution. However, since our programming language of use will be centered on Objective-C, we will utilize Apple tablets, instead of Android, as this is their required language. While IOS tablets are typically more expensive than Android tablets, the benefits of Objective-C still hold benefits in terms of ease of use and therefore still holds a stand in cost efficiency.

This proposed system as a whole utilizes cost efficiency in terms of money and time, not exclusively one or the other so the process life cycle can be much shorter and maintainability can thrive.

### Resources Needed

As anticipated, learning times will be involved in developing the software, but not by a significant margin as all the proposed options have a slight learning curve or the team has some knowledge of the system already. The largest financial cost will lie in the thermostat and humidistat system and the repurposed tablet user interface. The estimated cost of the system is somewhere under $700, still making a potential improvement over the cost of the Obvious Solution.

### Limitations

The same limitations that plagued the Obvious Solution affect this solution as well in that an assumption is being made that the system will be able to interact with the Thermostat/Humidistat system. However, the reality is that this may not be the case and different options may need to be explored in the future.

# 

# Comparison of Solutions

The following section will compare the solutions discussed in Section 3, based on relevant criteria which we will also proceed to describe. We also present a matrix (Table 1) comparing features and we assign a letter grade to the feature being scored. A grade of ‘A’ is an optimal grade and ‘F’ being the worst. The following list provides the criteria used to evaluate the solutions:

* **Training required**

Refers to the amount of time the members of NP-Soft will have to spend on learning how to implement the particular solution.

* **Cost**

This is the amount of money the solution will take to implement (a grade of A means less money to implement).

* **Reliability**

This is the expected dependability and correctness of the solution.

* **Ease of Use**

This deals with how easy to use the interface for the system will be.

* **Security**

This deals with the level of protection the given solution will provide for intrusion detection.

* **User Preference**

Refers to how robust the solution is in terms of addressing all the requirements laid out by the customer.

* **Time Constraints**

This is a measure on how much time it will take NP-Soft to implement the given solution.

**Table 1.** This table lists the grades assigned to each solution for the given feature.

|  |  |  |
| --- | --- | --- |
| Comparison of solutions | | |
|  | Obvious Solution | Cost Effective Solution |
| Training Required | A | B- |
| Cost | B- | A |
| Reliability | C | A |
| Ease of use | A | A |
| Security | B | B |
| User Preference | B | B |
| Time Constraints | C | B |

# 

# Conclusions

After researching existing systems and looking at the requirements, we started considering how feasible the Digital Home system is. First we had to consider what programming language(s) we should use to implement the system. We then had to consider security systems, which for our system will mostly just include cameras. We also considered what type of sensors we should integrate into the system. Lastly, we also had to consider the user interface in terms of control panels that will be installed within the house. Our recommendation is to use the more cost effective solution because it will be a more robust system and it also adheres more to the requirements of the system.

# References

[1] Intelligent Home, *Time Warner Cable,* [online] 2014, <http://intelligenthome-texas.aiprx.timewarnercable.com/intelligenthome/> (Accessed: February 26, 2014).

[2] Smart Home Technologies and Home Automation Control, *Savant Systems*, [online] 2014, <http://www.savantsystems.com/smart_home_solutions.aspx> (Accessed: February 26, 2014).

[3] Iris Smart Home Management System: Thermostats and More, *Lowe’s*, [online] 2014, <http://www.lowes.com/cd_Iris_239939199_> (Accessed: February 26, 2014).

[4] Oracle and Java, *Oracle*, [online], http://www.oracle.com/us/technologies/java/overview/index.html (Accessed: February 27, 2014).

[5] Learn C and C++ Programming, *Cprogramming*, [online] 2011, http://www.cprogramming.com/ (Accessed: February 27, 2014).

[6] iOS Developer Library, *Apple*, [online] 2014, https://developer.apple.com/library/ios/navigation/ (Accessed: February 27, 2014).

[7] PHP: Hypertext Preprocessor, *PHP*, [online] 2014, http://www.php.net/ (Accessed: February 27, 2014).

[8] Ruby Programming Language, *Ruby*, [online] 2014, https://www.ruby-lang.org/en/ (Accessed: February 27, 2014).

[9] Windows Home Server 2011, *Windows*, [online] 2014, http://windows.microsoft.com/en-us/windows/windows-home-server#T1=protect (Accessed: February 27, 2014).

[10] Download Ubuntu Server, *Ubuntu*, [online] 2014, http://www.ubuntu.com/download/server (Accessed: February 27, 2014).

[11] Wi-Fi Video Monitoring with Cloud Recording, *Dropcam*, [online] 2014, <https://www.dropcam.com/?gclid=CMS4mJmA9rwCFZTm7AodZhQAmg> (Accessed: February 28, 2014).

[12] Wireless IP Cameras, *Foscam*, [online] 2011, <http://foscam.us/#/page/1> (Accessed: February 28, 2014).

[13] Prestige 2.0, *Honeywell*, [online] 2014, <http://yourhome.honeywell.com/home/Products/Thermostats/7-Day-Programmable/Prestige+HD+7-Day+Programmable+Comfort+System.htm> (Accessed: February 28, 2014).

[14] Aprilaire Model 8910 Home Comfort Control, *Aprilaire*, [online] 2014, <http://www.aprilaire.com/index.php?znfAction=ProductDetails&category=23&sub=prog&item=8910> (Accessed: February 28, 2014).

[15] Touch-sensitive user interface design and manufacturing by TouchSensor, *TouchSensor*, [online] 2014, <http://www.touchsensor.com/> (Accessed: February 28, 2014).

# Appendix A

Requirements Definition for Digital Home

DigitalHomeOwner

Division of HomeOwner Inc.

**Introduction**

A “Smart House” is a home management system that allows home owners (or renters) to easily manage their daily lives by providing for a lifestyle that brings together security, environmental and energy management (e.g., temperature, humidity and lighting), entertainment, and communications. The Smart House components consist of household devices (e.g., a power and lighting system, an air conditioning unit, a sound system, a water sprinkler system, small appliances, and security system), sensors and controllers for the devices, communication links between the components, and a computer system that will manage the components.

The Requirements Definition Document describes the system‘s operational characteristics from the end-user’s viewpoint. It is made up of a list of the principal features of a prototype Digital Home system, and its main purpose is to support an effective project planning activity. The document was prepared by the Marketing Division of HomeOwner Inc, as part of a needs assessment for the DigitalHome project.

**DigitalHome Prototype Features**

* The DigitalHome System will allow any web-ready computer, cell phone or other device to control a home's temperature, humidity, lights, and the state of household appliances, e.g., coffee maker and microwave.
* The communication center of the system will be a personal home owner web page (maintained by DigitalHomeOwner - at http://www.DigitalHomeOwner.ccc ), through which a user can monitor and control home devices and systems.
* Each DigitalHome will contain a master control device that connects to the home’s broadband Internet connection, and uses wireless communication to send and receive communication between the DigitalHome system and the home devices and systems.
* The DigitalHome will be equipped with various environment sensors, e.g., temperature sensors, light sensors, humidity sensors, power sensors, contact sensors, and water sensors. Using wireless communication, sensor values can be read and saved in the home database.
* The DigitalHome security system will consist of a set of contact sensors and a set of security alarms, which are activated when there is a security breach.
* The security system will use wireless signals to communicate, through the master control unit.
* The system will use both sound and light alarms and will be able to manage up to thirty door and window sensors.
* The DigitalHome programmable thermostat will allow a user to easily monitor and control a home’s temperature from anywhere, using any web ready computer, cell phone, or other device.
* Thermostats can be placed throughout the home and can be controlled individually or collectively, so that temperature can be controlled at different levels in different home spaces.
* A thermostat unit will communicate, through wireless signals, with the master control unit.
* The system will support Fahrenheit and Celsius temperature values.
* The system will be compatible with most centralized HVAC (Heating, Ventilation and Air Conditioning) systems: gas, oil, electricity, solar, or a combination of two or more.
* The user will always be able to override the scheduled settings at any time.
* The DigitalHome programmable Humidistat will allow a user to easily monitor and control a home’s humidity from anywhere, using almost any web-ready computer, cell phone, or other device.
* Humidistats can be placed throughout the home and can be controlled individually or collectively, so that humidity can be controlled at different levels in different home spaces.
* A Humidistat unit will communicate, with wireless signals, through the master control unit.
* A Humidstad unit will manage humidity sensors and dehumidifiers/humidifiers located in a specified home space.
* The user will be able to select the humidity levels found most comfortable — from 30% to 60%.
* The DigitalHome programmable Power Switch will provide management of a home’s household appliances and will allow the user to turn appliances and lights on or off as desired.
* The Power Switch unit can control the central lighting in each room and up to forty 115 volt, 10 amp appliances that plug into a standard wall outlet.
* The system will be able to provide information about whether an appliance or a light is off/on.
* A user will be able to monitor the state of the appliance, and turn on or off any appliance through any web ready computer, cell phone or other device.
* The DigitalHome Planner will be able to provide a user with the capability to direct the system to set various home parameters (temperature, humidity, security level, and on/off appliance/light status) for specified time periods.
* DigitalHome provides a monthly planner on its web site.
* Parameter values can be scheduled on a daily or hourly basis.
* All planned parameter values can be overridden by a user.
* Various plan profiles (normal monthly profile, vacation profile, summer profile, holiday profile, etc.) may be stored and retrieved to assist in planning.
* The Digital Home Planner will be able to provide various reports on it management and control of the home (e.g., historical data on temperature, humidity, lighting, etc.).

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