

Appendix A: Software Requirements Specification for a Smart Home

1 Introduction

1.1 Purpose: Mission Statement

Making residential enhancements that will pave the way for an easy and relaxed transition into retired life.

Document prepared for the Smith family home, a pre-existing building.

1.2 Scope

The “smart home” system, herein referred to as “The System,” will be a combination of hardware and software that will provide an escape from daily routines and mundane tasks. This product seeks out the items that consume the most time but do not need to do so. The goal is to automate that which does not really need human interaction, to free the occupants to enjoy themselves in their retirement. The system will not free the mundane household chores from any human interaction, but it will require only as little as needed.

1.3 Definitions, Acronyms, and Abbreviations

PH: See <http://en.wikipedia.org/wiki/PH>
RFID: Radio Frequency Identification

SH: Smart Home

SAN: Storage Area Network

SRS: System Requirements Specification

WPA: Wi-Fi Protected Access

WEP: Wired Equivalent Privacy

USB: Universal Serial Bus

1.4 References

802.11 IEEE Specification <http://ieeexplore.ieee.org/servlet/opac?punumber=4248376>

1.5 Overview

Requirements have been divided into key functional areas, which are decomposed into features within those functional areas. Functional and nonfunctional requirements exist within the laid-out document format. The order of the leading sections and the corresponding requirements should be interpreted as priority.

2 Overall Description

2.1 Product Perspective

This system consists of many stand-alone devices. At this time it is not known whether these devices exist in the commercial market. The document has a holistic approach, intermingling the demand for devices with the functions of the system. The first step in continuing with this project would be to decide on feasibility and do some cost analysis for some of the requirements contained herein.

This document seeks to lay out areas where all interfaces are abstracted. There are areas where there would clearly need to be communication between the various interfaces, but because there is no targeted device, there is no known protocol for speaking with that device.

2.2 Product Functions

The functions of this product are divided into six categories. Accessibility is the first and most highly desired by the customer. This functional category seeks to improve the user experience of the system by providing various benchmarks for deciding on usability. The second major functional area is environmental considerations. The aim for this area is to ensure the inhabitants have a safe

environment in which to live, and the SH system enhances this environment instead of adding risks or hazards to the environment. The most important aspects for this category within this document will be monitoring and helping quality of air and water. The third category is energy efficiency. It is desired by the system and the customers not only to enhance their lives while living in this SH, but also to live in an efficient way. This system will not only monitor the occupants' energy usage, but it will also seek to improve the occupants' abilities to save on energy costs. Fourth we have security. Security is important to the customers as they want their home to be safe. The security system in the SH will provide added layers of protection from various crimes as they are happening, but also add layers to help prevent crimes from happening in the first place. The security will also give the occupants more peace of mind as they will have far greater control and oversight should they ever need to go for some extended trip away from their SH. The fifth section deals with media and entertainment. The goal for this section of the system is to decentralize home entertainment and make it available to the occupants wherever they desire. Finally, there will be automation. This is the section that gets into the guts of what is meant by taking as much of the human element out of routine tasks as possible. The summation and harmonization of all six categories of the SH will provide for a truly rewarding living experience for the occupants of the SH.

2.3 User Characteristics

The primary users of this system will be two older adults entering retirement. One of the adults spent his work life doing IT support and has a mild degree of electronic and computer expertise. The other was a schoolteacher and is not very familiar or comfortable with electronic and computing devices. These individuals are both of sound physical abilities, although one is a little shorter and suffers from sporadic hip pains. See Table A.1.

2.4 Constraints

IEC 61508: Providing for functional safety.

None others at this time, as feasibility and cost estimation activities are out of scope.

2.5 Assumptions and Dependencies

All hardware is available.

All devices will present the data listed below.

Occupants will provide feed elements for the devices that require them.

Table A.1 User/Stakeholder Profiles

Stakeholder	Interests	Constraints
Local building codes	Ensuring the safety for the building for the inhabitants.	Multiple business codes, especially around electrical interfaces.
Robert and Elizabeth Smith	Inhabitants interested in easing their lives.	None.
Interior designer	Ensuring the functionality of the system does not deter from the aesthetic.	None.
Building architect	Ensuring the existing structure can support the improvements.	None.
Construction workers	Making sure the construction details are clearly identified.	None
Developers	Making sure interfaces are defined.	None.
Tim Smith [son]	Ease of use for occasional user.	None.
Cats	Safety.	None.
Relatives	Ease of use and comfort.	One relative in wheel chair.
House sitters	Easily understanding limited sets of functionality.	None.
Guests	Ease of use and comfort.	None.
Maid service	Minimal functional understanding.	None.
Utility company	Negative for alternative energy, sharing alternate use policies.	None.
Internet services provider	Making sure bandwidth and services are available.	None.
TiVo	Negative, will lose business.	None.

3 Core System Requirements

This section lists all of the core functional requirements for the SH system.

3.1 Central Processing Requirements

- 3.1.1 System shall operate on a system capable of multiprocessing.
- 3.1.2 System shall operate on a system capable of near real-time execution of instructions.
 - 3.1.2.1 System shall service triggers or stimuli in no more than 500 milliseconds.
- 3.1.3 System shall operate in a highly available and fault-tolerant manner.
 - 3.1.3.1 System shall have a reported uptime of 99.9% (4 NINES).
 - 3.1.3.2 System shall recover from locked state in less than one (1) second.
- 3.1.4 System shall have a database associated with it that can handle transaction processing at a rate of 1,000 transactions per minute.
- 3.1.5 System shall have redundant databases for fail-over purposes.
- 3.1.6 System shall perform periodical offsite and onsite backups of all configuration and reporting data.
- 3.1.7 System shall support wireless encryption protocols WPA [1–2] and WEP.
- 3.1.8 System shall support wired Ethernet for 1 gigabit per second, and contain cat 6e cabling.
- 3.1.9 System may contain separate SAN device for storage flexibility.
- 3.1.10 System may contain separate video recorder/processor for process distribution.
- 3.1.11 If system supports recording more than three (3) television shows simultaneously, then system shall have separate video recorder.

4 Accessibility

Accessibility is defined as the need of the SH system to be usable by all persons, including those with any physical impairments or those with difficulty operating and/or understanding complex electronic systems. Priority = High.

4.1 Use of SH Features

- 4.1.1 SH System shall be usable by those with slight vision loss.
 - 4.1.1.1 System shall not have any buttons smaller than one (1) inch square.
 - 4.1.1.2 System shall have all consoles and controlling devices between four (4) and five (5) feet from ground level.
 - 4.1.1.3 System shall have backlighting on all buttons for nighttime ease of use.

- 4.1.1.4 System shall have options to increase and decrease font sizes on web interfaces and all console and controlling devices.
- 4.1.1.5 System shall have liquid layouts for all graphical interfaces for display on many different types of display devices.
- 4.1.2 System shall be easy to use.
 - 4.1.2.1 System shall be understood by users at all levels of understanding with no more than four (4) hours of training.
 - 4.1.2.2 System shall have a help function associated with all user entry possibilities.
 - 4.1.2.3 System shall have text-to-speech capabilities to allow the user to receive vocal instructions for help and how-to menu items.

5 Environment

Environment encompasses air quality controls, but also includes other environmental elements such as lighting levels, water purification, and so on. Priority = High.

5.1 Water, Air Purification

Water purification and air quality are key factors to a good environment within the SH. This system seeks to improve by monitoring both air quality and water purification. Priority = High.

- 5.1.1 SH shall have a reverse osmosis water purification system.
- 5.1.2 SH shall have a nonfiltered water system.
- 5.1.3 System shall store data on how much water passes through the filtration unit each day.
- 5.1.4 System may send notifications to users about how much water passes through the filtration system.
- 5.1.5 System shall have the option to send notifications to users when water filtration unit needs cleaning.
- 5.1.6 System shall incorporate water softener system into water system.
- 5.1.7 System shall monitor the salt in the water softener.
- 5.1.8 System shall accept user input for desirable levels of salt in the water softener device.
- 5.1.9 System shall send notifications to users when salt in softener gets below user-defined levels.
- 5.1.10 System shall monitor air filter.
- 5.1.11 System shall send notification to users when air filter needs to be cleaned or changed.
- 5.1.12 System shall provide monitors for measuring air quality.

- 5.1.13 System shall accept user input for air quality thresholds.
- 5.1.14 System shall notify users when air quality reaches levels outside the user-defined thresholds.

5.2 Health and Safety Detectors

This section describes the role and interfaces for various common household detectors. The detectors carry out their common functionality, but reactions are automated, and historical data are logged. Priority = High.

- 5.2.1 SH shall have at least one (1) multipurpose detector for detecting smoke and carbon monoxide on each floor.
- 5.2.2 System shall not interfere in any way with detector manufacturer's operating procedures.
- 5.2.3 System shall accept user input for dangerous levels of smoke and carbon dioxide.
- 5.2.4 System shall trigger warning and require additional confirmation when users select levels outside the manufacturer's settings for dangerous levels of smoke and carbon dioxide.
- 5.2.5 System shall notify proper authorities when levels above user-defined thresholds of smoke or carbon monoxide are detected.
- 5.2.6 System shall tie into detectors to send remote alert messages to users when elevated levels of smoke or carbon monoxide are detected.
- 5.2.7 System shall utilize radon detector in the basement.
- 5.2.8 System shall allow users to set defined ceiling for radon levels.
- 5.2.9 System shall accept input from users for notification events for radon level detections.
- 5.2.10 System shall send notifications based on user-defined notification events to interested parties when radon levels are more than the user-defined ceiling.
- 5.2.11 System shall activate basement fan system when radon levels report above defined ceiling.
- 5.2.12 System shall record radon levels routinely.
- 5.2.13 System shall allow users to view reports on radon levels.
- 5.2.14 System shall persist radon level data for no less than ninety (90) days.

6 Energy Efficiency

Energy efficiency covers the extent to which the SH system enables the users to monitor and enhance energy efficiency of the house through "smart" and adaptive controls and interfaces. Priority = High.

6.1 Air Conditioner/Heating

Controlling and adapting the air conditioning and heating are important aspects of using energy efficiently. Not only does the SH seek to improve the ease of use of traditional thermostats, but also to provide intelligence in order to optimize the use of the system. Priority = High.

- 6.1.1 SH shall be divided into zones for heating and cooling.
- 6.1.2 System shall accept desired temperature settings for each zone, for no less than four (4) periods in the day.
- 6.1.3 System shall accept input for desired room temperature when room is unoccupied.
- 6.1.4 System shall detect motion to determine if a room is occupied, and make proper adjustments to the temperature.
- 6.1.5 System shall differentiate between pets and occupants for motion detection and temperature adjustment.
- 6.1.6 System shall monitor outdoor temperature and humidity.
- 6.1.7 System shall shut down air conditioning and open windows if temperature outside is cooler than the inside temperature.
- 6.1.8 System shall not open or close any windows if there is something in the desired path of the window (see Figure A.1).
- 6.1.9 System shall reverse directions of windows if they encounter any resistance.
- 6.1.10 System shall send notifications to users if windows need to reverse path or windows cannot complete desired action (open or close).

6.2 Time-of-Day Usage

Time-of-day usage refers to common utility programs that provide reduced rates for utilities used during off-peak time periods.

- 6.2.1 Appliances shall be configured if they need to be used as time-of-day devices.
- 6.2.2 System shall accept definitions for the range for time-of-day savings.
- 6.2.3 System shall queue up appliance(s) to run when time-of-day period starts if it (they) is (are) a time-of-day device.
- 6.2.4 System shall allow user to override the time-of-day setting to run the device/appliance immediately.
- 6.2.5 System may send notification when device has completed its work.

6.3 Water Recovery

Promote reusable resources by capturing rainwater to use for irrigation. Priority = Medium.

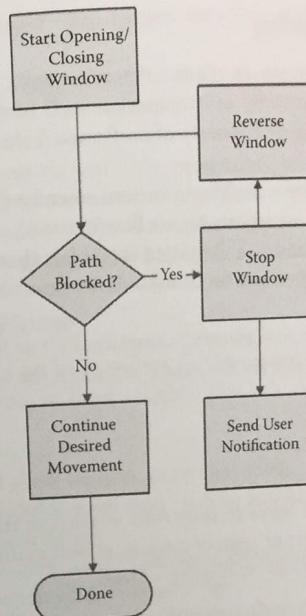


Figure A.1 Window movement flowchart.

- 6.3.1 System shall have water recovery system for rainwater.
- 6.3.2 System shall use water recovered from rain for lawn irrigation.
- 6.3.3 System shall record amounts of rainwater recovered on a monthly basis.
- 6.3.4 System shall allow user to view reports for rainwater recovery.
- 6.3.5 System shall maintain rainwater recovery data for no less than twenty-four (24) months.

6.4 Alternative Energy

Interface to allow for future expansion and addition of alternative energy sources. Priority = Low.

- 6.4.1 System shall provide interface into central electrical supply for alternative energy to supply power to the house (i.e., solar or wind).
- 6.4.2 System shall monitor the generation of alternative energy.
- 6.4.3 System shall present reports to users of the amounts of alternative energy generated during some user-defined time period.
- 6.4.4 System shall maintain alternative energy generation data for no less than two (2) years.

6.5 Air Flow Monitoring

The air flow monitoring system serves as a detection agent for wasted energy. The monitoring of air flow, especially in conjunction with running central air conditioning or heating, will lead to discovery of drafts and leaks. Priority = Medium.

- 6.5.1 System shall monitor air flow in various rooms within the SH.
- 6.5.2 System shall present reports for air flow to users.
- 6.5.3 System shall maintain air flow data for no less than three (3) years.
- 6.5.4 System shall accept input for thresholds for detecting drafts or leaks of air within the house.
- 6.5.5 Assuming the house is running centralized air or heat, system shall send notifications if drafts are detected that exceed the user-defined threshold.

7 Security

Security includes aspects of home security such as alerts in the event of a break-in, video monitoring of premises or areas of interest, as well as unattended monitoring while the occupant(s) is (are) away. Priority = High.

7.1 Home Security

Home security centers around controlling the access points to the SH as well as providing many cameras to provide views into areas of the SH. The SH will provide automated and human commanded responses to various security situations. Priority = High.

- 7.1.1 System shall have biometric and keypad door locks for all points of entry into the house.
- 7.1.2 System shall allow users to encode a one-time use door code for expected visitors.
- 7.1.2.1 System shall allow users to remotely code a one-time use code for visitors (i.e., over the phone, Internet, or some other mobile device). System shall record all entries based on code entered or biometrics presented.
- 7.1.3 System shall present report to users for all entries.
- 7.1.4 System shall maintain home entry data for no less than ten (10) years.
- 7.1.5 System shall allow for RFID tags to open garage doors.
- 7.1.6 System shall allow for biometric and key pad entry to open garage doors.
- 7.1.7 System shall allow user to configure maximum duration for garage door to remain open.

- 7.1.9 System shall shut open garage door if it is open past the user-defined maximum.
- 7.1.10 System shall allow user to override automatically shutting the garage door (i.e., "Hold Open option").
- 7.1.11 Garage door shall reverse course if something is blocking its path.
- 7.1.12 System shall notify user if the garage door is unable to safely close.
- 7.1.13 System shall allow users to configure entry routine for all RFID, biometric, and key codes (i.e., upon entry for user X through the garage door, turn on garage light, hall light, and kitchen light).

7.2 Unattended Home

Unattended Home is a set of responses to various triggers throughout the home and immediate responses to those triggers. This will aid in security of the home. Priority = High.

- 7.2.1 System shall allow users to set an away mode.
- 7.2.2 System shall define away mode as time and date range when users will be away from their house.
- 7.2.3 System shall allow users to configure lights in any room to go on for some defined duration while they are away.
- 7.2.4 System shall deploy motion detectors always to be on for the duration while the user is away.
- 7.2.5 System shall differentiate between motion detected for pets and humans.
- 7.2.6 System shall send notification to users if any motion detectors are triggered while the user is away.
- 7.2.7 User shall be presented options to view various cameras via the web or some other mobile device when motion detectors are triggered.
- 7.2.8 User shall be given the option to alert the authorities when motion detectors are triggered.
- 7.2.9 System shall turn on user-defined lights inside and outside the house when motion detectors are triggered.

7.3 Monitoring Anywhere

Occupants and users of the SH's system should be able to monitor the home from anywhere they wish. This includes many different cameras within the SH as well as at various points of entry and other triggers placed throughout the home. This will give the occupants more freedom to travel while feeling their home is secured and well cared for. Priority = Medium.

- 7.3.1 System shall show camera data streams to any television in the house.
- 7.3.2 System shall incorporate cameras at points of entry with doorbells to allow users to view visitor.

- 7.3.3 System shall allow user to remotely unlock the door to permit entry to the visitors.
- 7.3.4 System shall allow users to notify emergency personnel of possible intruder.
- 7.3.5 System shall permit users to view security cameras from a secure website or mobile device for remote viewing of property.

8 Media/Entertainment

Media and entertainment include the ability to create, store, and access multiple forms of media and entertainment such as audio, video, and the like anywhere in the house. Priority = Medium.

8.1 Recording Television Shows

Recording television shows allows the users to throw out the VCR and gives them a more automated and intelligent solution for recording all their favorite shows or movies that play through the television. Priority = Medium.

- 8.1.1 System shall allow user to record any show on television.
- 8.1.2 System shall present a web interface with a grid listing similar to the *TV Guide* book for users to select shows to record.
- 8.1.3 System shall allow user to record a minimum of two (2) television shows simultaneously.
- 8.1.4 System shall make storage for recorded shows expandable.
- 8.1.5 System shall free storage space as needed by first-in first-out (FIFO) or some other defined priority schedule.
- 8.1.6 System shall provide search feature to search through television shows to select which one to record.
- 8.1.7 System shall provide user the ability to record all occurrences of a specified show.
- 8.1.8 System shall provide user the ability to record only new instances of a specified show.
- 8.1.9 System shall provide telephone menu options for customer to dial in and select channel, time, and duration to record.
- 8.1.10 System shall present users with the option to select quality for recording, recording automatically.
- 8.1.11 System shall give user the option to store only X number of episodes from a certain series at a time.
- 8.1.12 System may skip commercials when system is able to detect the commercial.

- 8.1.14 System shall monitor storage space for future recordings.
- 8.1.15 System shall send notification when resources get low enough where recordings will be overwritten.
- 8.1.16 System shall permit users not to delete a show or a series automatically.
- 8.1.17 System shall not record any new shows if there is space available for recovery.
- 8.1.18 System shall send notifications to users if there is no longer space available to record new shows.

8.2 Video Entry

Video entry is the mechanism by which various formats of video data are able to be loaded into the repository for video playback. Priority = Medium.

- 8.2.1 System shall allow for video input into digital library.
- 8.2.2 System shall allow for storage of video metadata such as category, genre, title, rating, and the like.
- 8.2.3 System shall provide interface to users to edit and update video metadata.
- 8.2.4 System shall accept one-button touch support for incorporating VHS tape into digital library.
- 8.2.5 System shall accept one-button touch support for incorporating DVD videos into digital library, where law and technology provide.

8.3 Video Playback

Video playback allows the users of the SH to be able to enjoy video and both recorded and preloaded content from anywhere within the house. Priority = Medium.

- 8.3.1 System shall allow for recorded video playback at any television in the house.
- 8.3.2 System shall allow for other video media to be available for playback in any room with a television.
- 8.3.3 System shall allow all common features of a VCR or DVD player, such as fast forward, rewind, chapter skip, and so on.
- 8.3.4 System shall allow user to skip commercials where commercials are detected.
- 8.3.5 System shall prevent user from playing back identical media on multiple televisions at the same time.
- 8.3.6 System shall allow user to remove the recording from storage when they are done watching.
- 8.3.7 System shall allow user to remove other video media from the storage.

8.4 Audio Storage and Playback

Audio storage and playback are important features of the smart home. This section describes how the audio is imported into the digital library as well as what capabilities there are for distributing or sharing the audio either to various rooms in the SH or to external media. Priority = Medium.

- 8.4.1 System shall accept input into digital audio library from CD.
 - 8.4.1.1 System shall allow user to enter a CD into a tray and immediately rip the CD.
 - 8.4.1.2 System shall collect all available metadata from the CD from the Internet for categorization.
 - 8.4.1.3 System shall store audio binary in a lossless format.
- 8.4.2 System shall accept input into the digital audio library from a USB device.
- 8.4.3 System shall provide interface for users to place audio file manually into digital audio library.
- 8.4.4 System shall automatically normalize volume of all audio files loaded into the digital audio library.
- 8.4.5 System shall store information about audio files in some searchable entity.
- 8.4.6 System shall provide users the ability to alter metadata for any file in the collection.
- 8.4.7 System shall allow users to remove audio files from the digital audio library.
- 8.4.8 System shall allow for categorization of audio files by important fields such as genre, artist, album, and so on.
- 8.4.9 System shall allow audio playback.
 - 8.4.9.1 System shall allow for wired or wireless connection to any device capable of audio playback.
 - 8.4.9.2 System shall allow centralized panel to play back various audio files in different rooms of the house.
 - 8.4.9.3 System shall provide access point in garage so digital audio can be downloaded to an automobile audio system.
- 8.4.10 System shall allow users to author new CDs.
 - 8.4.10.1 System shall allow users to select tracks for newly authored CD from a playlist or from the complete library.
 - 8.4.10.2 System shall allow user to select which format to use.
 - 8.4.10.3 System shall allow user to select a CD burning drive.
 - 8.4.10.4 System shall provide guidance to users for available space depending on the drive and media selected as well as the format chosen.
 - 8.4.10.5 System shall verify proper media is in the selected drive.

- 8.4.10.6 System shall allow user to select order for the tracks.
- 8.4.10.7 System shall allow user to confirm track information to start authoring the CD.
- 8.4.10.8 System shall perform necessary audio conversion and burn the CD based on the user's authoring details.
- 8.4.10.9 System may notify user when the authoring process is complete.
- 8.4.11 System shall allow users to create, edit, and delete playlists.
 - 8.4.11.1 Playlist shall consist of one to "N" number of tracks selected from the digital library.
 - 8.4.11.2 A single track may reside in any number of playlists.
 - 8.4.11.3 A single track may not reside in an individual playlist more than once.
 - 8.4.11.4 System shall allow users to set a name and description for all playlists created.
- 8.4.12 System shall allow users to transfer music from the digital library to portable music players.
 - 8.4.12.1 System shall allow track transfer according to both complete playlists as well as individual tracks.
 - 8.4.12.2 System shall allow users to format or delete the current selection of tracks on the portable device before transferring.
 - 8.4.12.3 System shall allow users to append additional tracks or playlists to the portable device as space permits.
 - 8.4.12.4 System shall add tracks to the device in the order they were selected by the user until all tracks are transferred or the device is full.

9 Automation

Automation is the process of making something routine happen automatically, on some set schedule or by some defined trigger such that little or no human intervention is needed. Priority = Medium.

9.1 Pet Care

The pet care system will be added to ensure that proper unattended care of the pets in the household takes place. In this instance cats are the pets within the household, but the system should extend to other future pets as well. The goal is to have a mostly automated system to take care of the pets' primary needs such as food, water, and waste disposal, but the system can also track health care needs such as appointments and vaccinations. The logic flow for the feeding functionality of the pet care function is shown in Figure A.2. Priority = High.

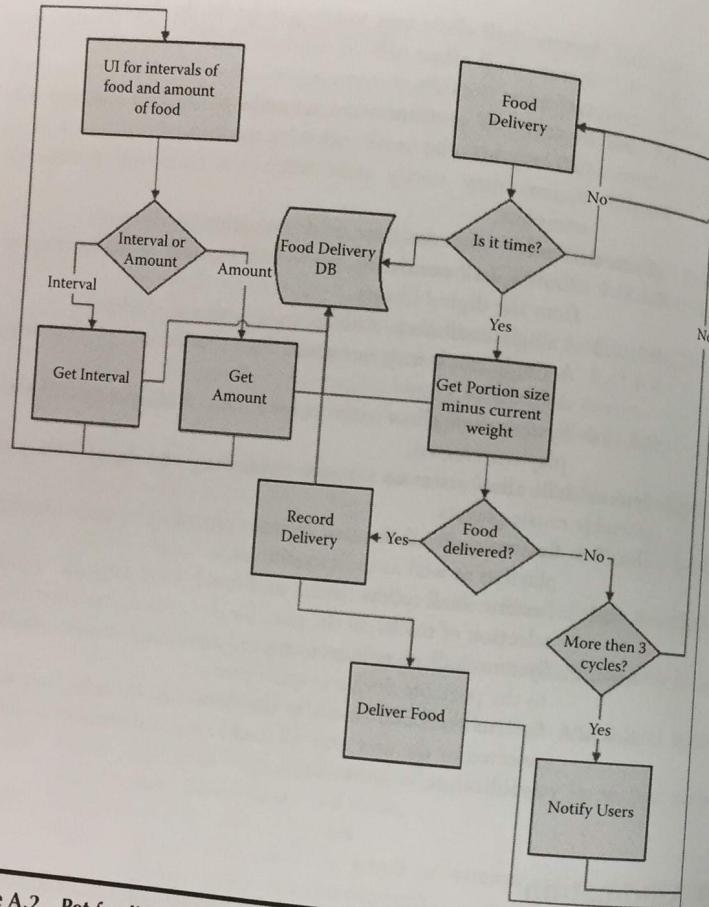


Figure A.2 Pet feeding flowchart.

- 9.1.1 System shall handle providing water for the pets.
 - 9.1.1.1 Pet watering bowls shall be tied into the water filtration system [ref. Requirement 5.1.1].
 - 9.1.1.2 System shall monitor consumption of water on a daily basis for pet bowls.
 - 9.1.1.3 System may send time-defined notifications to users detailing the water consumption by pets.
 - 9.1.1.4 System shall present a report of water consumption by pets.
 - 9.1.1.5 Pet water consumption data shall persist for no less than thirty (30) days.
- 9.1.2 System shall provide food for pets.

- 9.1.2.1 System shall accept user input for intervals to deliver food.
- 9.1.2.2 System shall notify users when food in storage reaches low levels, as users will be required to fill the storage depot.
- 9.1.2.3 Pets' food shall be delivered to their bowls every user-defined interval.
- 9.1.2.4 System shall allow user to set portion weight for every bowl for the system.
- 9.1.2.5 Pet food delivery shall be portioned to user-defined weight.
- 9.1.2.6 Pet food delivery shall not exceed the amount of the portion weight; weight includes food already in bowl.
- 9.1.2.7 Food consumption shall be recorded per pet every feeding cycle.
- 9.1.2.8 Alert messages shall be sent if food delivery system dispenses no food for three (3) consecutive cycles.
- 9.1.2.9 System shall present a report of food consumption per pet.
- 9.1.2.10 Pet food consumption data shall persist no less than thirty (30) days.
- 9.1.2.11 Pets shall wear RFID tags on their collars.
- 9.1.2.12 Pet food bowls shall open only when proper RFID tag is present.
- 9.1.3 System shall monitor and maintain pet litter box(es).
 - 9.1.3.1 Pet litter box shall be cleaned when odor levels reach a user-defined mark, and litter disposal unit is not full.
 - 9.1.3.2 System shall notify users if odor levels are above defined ceiling for more than eight (8) hours.
 - 9.1.3.3 System shall notify users every two (2) hours when litter levels are low and continue to send alerts until the litter levels are within configurable ranges.
 - 9.1.3.4 System shall notify users every four (4) hours when litter disposal container (where dirty litter is stored) is full, and continue to send alerts until the litter disposal unit is not full.
- 9.1.4 System shall monitor pet's health.
 - 9.1.4.1 System may incorporate weight pad to measure weight while pet is feeding (pet based on RFID).
 - 9.1.4.2 System may send user-defined notifications of weight change.
 - 9.1.4.3 System may maintain weight data for no less than thirty (30) days.
 - 9.1.4.4 System shall accept user input for types and intervals for vaccinations.
 - 9.1.4.5 System shall accept input for when vaccinations have been administered.
 - 9.1.4.6 System shall send notifications when vaccinations are more than one (1) week overdue.
 - 9.1.4.7 System shall maintain vaccination records for no less than five (5) years.

9.2 Making Coffee

The coffee-making system will provide an automated process to make coffee for users (see Figure A.3). The system will not be completely autonomous as it does have external dependencies such as power, water supplies, and the users maintaining proper levels of coffee beans in the repository. The system will, however, expose many configuration options to begin the process as part of a timed sequence or through some other stimulus. Priority = Medium.

- 9.2.1 Coffee maker shall be tied into the water purification system.
- 9.2.2 System shall start coffee maker at any user-defined time as long as water is present, coffee bean levels are sufficient, and unit is powered.

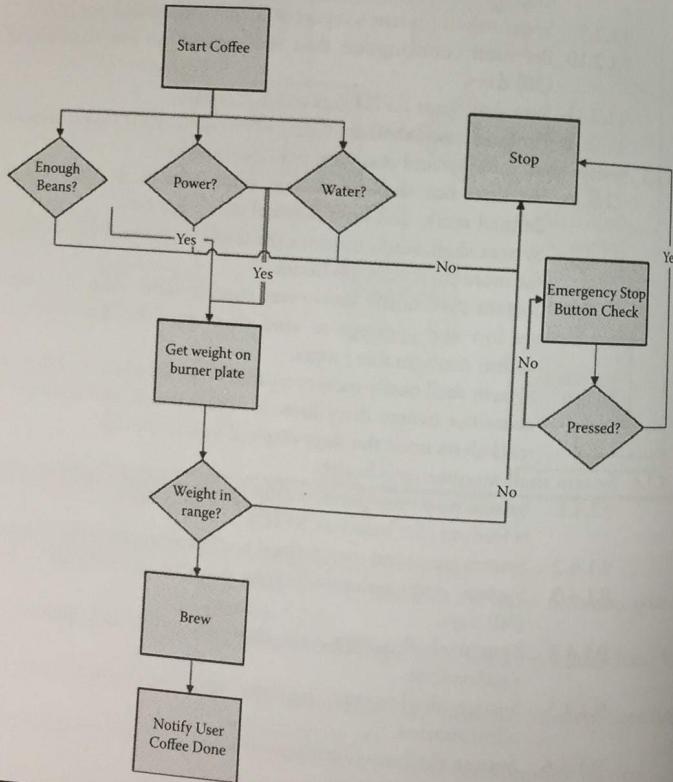


Figure A.3 Coffee-making flowchart.

- 9.2.3 System shall send a notification when bean levels are low.
- 9.2.4 When bean levels are too low to make coffee, system shall send an alert and coffee maker shall blink a warning indicator.
- 9.2.5 Coffee maker shall use a reusable filter.
- 9.2.6 System shall send notification when filter should be cleaned or changed.
- 9.2.7 Coffee maker shall shut off if weight measured by burner plate is less than the weight of the carafe or more than the weight of a full carafe.
- 9.2.8 Coffee maker shall have an emergency stop button clearly visible and accessible.
- 9.2.9 Coffee maker shall stop within one (1) microsecond when button is pressed.
- 9.2.10 Coffee maker shall turn off if carafe is not removed from burner plate for thirty (30) consecutive minutes.

9.3 Hot Tub Maintenance

Hot tub maintenance is important to the users as this process will enable them to have little interaction in the daily needs of maintaining the hot tub. The process once again is not completely autonomous as it has external dependencies such as available water, power, and the users maintaining proper levels of chemicals needed for maintaining the hot tub. Priority = Medium.

- 9.3.1 System shall monitor temperature of hot tub water at all times.
- 9.3.2 Hot tub cover shall open with proper biometric credentials or proper entry of code on numeric key pad.
- 9.3.3 Hot tub cover shall not open if water temperature is not within a user-defined safe range.
- 9.3.4 System shall monitor pH and bacterial levels of hot tub water.
- 9.3.5 Hot tub cover shall not open if pH and bacterial levels are outside user-defined norms.
- 9.3.6 System shall administer chemicals to the hot tub water to maintain proper pH and bacterial levels.
- 9.3.7 System shall notify users when chemical levels are low.
- 9.3.8 System may send notifications of chemical administration information.
- 9.3.9 Hot tub shall be tied into central water system.
- 9.3.10 System shall monitor water levels of hot tub.
- 9.3.11 System shall replenish water to maintain proper water level.
- 9.3.12 System may send notifications of water level replenishment.
- 9.3.13 Hot tub cover shall not open if water level is outside user-defined norms.
- 9.3.14 Hot tub cover shall close with button press or if no activity/motion is detected for some time range, and water displacement levels are normal (no one in the tub).

- 9.3.15 Hot tub shall sound alarm if no activity or motion is detected for some defined time range and water displacement indicates there is someone in the tub.

9.4 Home Indoor Irrigation

The home irrigation system aims to provide care for household plants in an unattended fashion. A source of water will be an external dependency for this system. Priority = Low.

- 9.4.1 System shall control any number of indoor irrigation access points.
- 9.4.2 All access points shall be accompanied with soil moisture detector.
- 9.4.3 System shall allow user to define desired moisture level and watering intervals for each watering access point in the house.
- 9.4.4 System shall control watering units at each access point to keep soil at a steady moisture level.
- 9.4.5 If plants are on an interval, system shall bring the moisture level up to defined range during each watering interval.
- 9.4.6 System shall record water used and average soil moisture levels per access point.
- 9.4.7 System shall maintain indoor watering information for no less than forty-five (45) days.
- 9.4.8 System may accept input for soil moisture warning levels.
- 9.4.9 System shall send notifications if moisture levels drop below user-defined floors for more than four (4) hours.

9.5 Outdoor Irrigation

The outdoor irrigation system will promote a healthy lawn as well as landscaping. The system will depend on water supplies, but will be able to automate the lawn watering process. Priority = Low.

- 9.5.1 Irrigation system shall be plugged into the water system.
- 9.5.2 System shall control any number of yard irrigation devices.
- 9.5.3 System shall allow user to configure any irrigation device.
- 9.5.4 Irrigation devices shall be configurable for type of stream, amounts of water, and turn rotation during cycle.
- 9.5.5 System shall test irrigation devices independently for setting configurations.
- 9.5.6 System shall run a test cycle of all irrigation devices simultaneously to test configuration and coverage.
- 9.5.7 System shall have access to any number of devices reporting soil moisture.

- 9.5.8 System may base water cycles on soil moisture or by a set schedule.
- 9.5.9 System shall allow user to set groups of irrigation devices or individual irrigation devices.
- 9.5.10 System shall not run irrigation devices if rain is detected.
- 9.5.11 System shall be able to retrieve weather forecast from the Internet.
- 9.5.12 System may be configured to skip a user-defined number of watering cycles if rain is in the immediate forecast (i.e., rain is 60% likely over the next two days).
- 9.5.13 System shall record the amount of water deployed through each individual irrigation device.
- 9.5.14 System shall present users with reports for water deployment through the lawn irrigation system.
- 9.5.15 System shall maintain data for lawn irrigation for no less than thirty (30) days.
- 9.5.16 System shall allow for motion detectors to be present in specified areas in lawn (i.e., flowerbeds or flower pots).
- 9.5.17 System shall allow for users to configure settings for when to activate lawn motion detectors.
- 9.5.18 System shall deploy countermeasures (i.e., loud sound, scent repellent) when motion detectors are tripped during user-defined time periods (for scaring off animals trying to eat plants).

9.6 Outside Building Cleaning

The outdoor building cleaning system will allow automatic periodic cleanings of all exterior surfaces of the building to promote better curb appeal. This system will depend on ready water supplies and users maintaining proper levels of chemical or cleaning agents used by the system. The system is made to be abstract enough to enable users to clean virtually any exterior surface. Priority = Medium.

- 9.6.1 SH shall have reservoirs for cleaning different surfaces outside the home (i.e., windows and siding).
- 9.6.2 System shall monitor levels of all materials needed to clean exterior surfaces.
- 9.6.3 System shall send notifications when materials are low.
- 9.6.4 System shall accept any number of cleaning devices to control.
- 9.6.5 System shall allow users to assign category to the type of device under the system's control.
- 9.6.6 System shall accept input on what type of schedule should be used to deploy devices for cleaning various exterior surfaces.
- 9.6.7 System shall deploy cleaning devices according to the user-inputted schedule.

- 9.6.8 System shall store and report information about cleaning material usages on a daily basis.
- 9.6.9 System shall maintain cleaning material usage data for no less than thirty (30) days.

9.7 Ability to Configure Routines

The ability to configure routines will enhance the lives of the occupants, especially those portions of their lives that are routine. Although life is mostly variable, there are some situations where routines are the mode of operation. All systems able to be controlled by the SH shall be presented as options to configure and set new routines within this system. It is adaptable and changeable as the lives and routines of the occupants change over time. Priority = Medium.

- 9.7.1 System shall allow users to configure routines.
- 9.7.2 System shall allow users to set alarm or wake-up calls for various occupants within the house, including visitors.
- 9.7.3 System shall allow users to control certain activities as a result of a trigger. Example trigger-based routines would be alarm at some time, 5 minutes afterward turn on bedroom TV, 10 minutes after the alarm turn on the shower, 15 minutes after the alarm ensure coffee maker is operational or coffee is warm.

9.8 Voice Activation

The voice activation system currently will consist of a finite set of commands to which the SH will programmatically respond. In the future this should be extended such that any commands can be programmed to control any device or system interfaced by the SH. Priority = High.

- 9.8.1 System shall support voice activation in major living areas (i.e., living room, kitchen, etc.).
- 9.8.2 System shall support commands to raise the current target temperature of the thermostat.
- 9.8.3 System shall support commands to lower the current target temperature of the thermostat.
- 9.8.4 System shall support command to draw a bath in the master bathroom.
- 9.8.5 Master bed shall have heating element capable of warming the bed.
- 9.8.6 System shall support command to begin prewarming the bed in the master bedroom.
- 9.8.7 System shall support command to prepare the hot tub for use.
- 9.8.8 System shall support commands to dim or switch off lights in any room in the house.

- 9.8.9 System shall support commands to turn air conditioning or heating on and off.
- 9.8.10 System shall support commands to open windows or blinds on various levels of the house.
- 9.8.11 System shall support command to lock all points of entry.
- 9.8.12 System shall support command to secure the house, which would lock all points of entry and close all windows and blinds.

9.9 Driveway

The system is geared to provide ease and safety in the winter months to attempt to prevent snow accumulation on the driveway surface, and more important, the formation of ice. Priority = Low.

- 9.9.1 Driveway shall have heating element installed underneath it.
- 9.9.2 System shall constantly monitor driveway surface temperature.
- 9.9.3 System will turn on driveway heating if the surface temperature of the driveway is conducive to freezing water.
- 9.9.4 Driveway heating element will shut off or not run if the driveway is above forty (40) degrees Fahrenheit.
- 9.9.5 System will monitor and record when driveway heating element is in use.
- 9.9.6 System may be set to only run heating surface at night, or based on time-of-day settings.

9.10 Kitchen Food Stocking

The kitchen food stocking program will provide a way for the occupants to control and view inventory from anywhere in the world. This will be helpful when shopping for groceries as well as when deciding what options may be available for dinner. Priority = Low.

- 9.10.1 System shall allow users to enter food associated with RFID tag into the kitchen inventory system.
- 9.10.2 System shall present reports to users of food inventory.
- 9.10.3 System shall allow users to call in (i.e., from grocery store) to check on stock of certain items in the kitchen's inventory.
- 9.10.4 System shall monitor and track the usage of certain items.
- 9.10.5 System shall present users with reports on item usage (i.e., for diets, and food spending forecasting).
- 9.10.6 System shall maintain item inventory and usage for no less than eighteen (18) months.
- 9.10.7 System shall provide interface for recipe center [ref. 9.11] to provide feedback on stock of items needed for recipe.

9.10.8 System may provide intelligent interface to create shopping list templates based on average food usage.

9.11 Kitchen Recipe Center

The kitchen recipe center will provide users with an easy way to recall and cook recipes while operating in the kitchen. The system will provide easy access to recipes and provide voice-automated help and limited automation for backing functions. The recipe center also provides some publishing mechanisms to share recipes with family and friends. Priority = Medium.

- 9.11.1 System shall allow users to enter recipes.
- 9.11.2 System shall allow users to define categories for recipes stored within the recipe center (i.e., appetizer, beef main course, dessert, etc.).
- 9.11.3 System shall provide touchpad interface in the kitchen for users to search, recall, and view recipes.
- 9.11.4 System shall provide interface for users to add, modify, and delete recipes from the repository.
- 9.11.5 System shall provide interface to the food stock to create grocery lists of what items may be needed for some arbitrary number of recipes.
- 9.11.6 System shall provide users with recipes in a specified category where all items are currently in stock. (i.e., "What can I make tonight?").
- 9.11.7 System shall provide users the ability to send recipes to friends electronically (i.e., e-mail, micro web pages, etc.).
- 9.11.8 System shall provide users the ability to create/print a categorized cookbook of all recipes currently within the system.
- 9.11.9 System shall allow users to store image file linked to any recipe within the system.
- 9.11.10 System shall allow user to enter assisted baking mode.
 - 9.11.10.1 System shall automatically preheat the oven.
 - 9.11.10.2 System shall verbalize order of ingredients to add.
 - 9.11.10.3 System shall accept verbal confirmation once item is added before instructing to add the next item.

9.12 Phone System

The phone system will be a unified approach to handling voice mail for the occupants of the house. The key functions are allowing for easier retrieval from anywhere as well as extending the system via multiple virtual inboxes. Priority = Medium.

- 9.12.1 System shall serve as answering machine for household.
- 9.12.2 System shall allow users to configure number of rings before answering.

- 9.12.3 System shall allow users to configure any number of phone mail boxes for recipients.
- 9.12.3 System shall allow users to record greeting message that will be played after user-defined number of rings.
- 9.12.4 System shall allow users to configure greeting message to be played for individual mail boxes.
- 9.12.5 System shall record messages for recipients along with date, time stamp, and incoming phone number to nonvolatile memory.
- 9.12.6 System shall send out notification to users when they have a new message in their mailbox (i.e., e-mail, text message, pages, etc.).
- 9.12.7 System shall make messages available via authenticated web interface for user retrieval.
- 9.12.8 System may use voice-to-text engine to send the text representation of the message to user's e-mail account.

9.13 Wall Pictures

The wall pictures allow for occupants of the home to allow for friends and family members to share pictures with them and have those pictures displayed on select wall monitors throughout the house. Priority = Low.

- 9.13.1 System shall provide wireless support for driving any number of wall-mounted monitors for picture display.
- 9.13.2 System shall provide web-based interface for authenticated users to publish new photos for display on wall monitors.
- 9.13.3 System shall allow users to configure which pictures get displayed.
- 9.13.4 System shall allow users to configure which remote users can submit pictures to which wall monitor.
- 9.13.5 System shall support the following playback modes:
 - Random: Display random photos.
 - Slideshow: Display photos in order for some user-defined time.
 - Single: Display only selected or most recently submitted photo.
- 9.13.6 System shall provide remote users with storage for up to 20 pictures in their repository or 100 MB, whichever is greater.

9.14 Mail and Paper Notification

The system will notify occupants of status and delivery events for both mail and newspaper boxes. Priority = Low.

- 9.14.1 System shall monitor any number of mail and newspaper boxes for motion and weight.
- 9.14.2 System shall allow users to set notification events for those boxes.

- 9.14.3 System shall send notifications when motion is detected coupled with a change in static weight of the box.
- 9.14.4 System shall allow user to turn off any notification events for a set period (i.e., when snow or something else may trigger the motion and weight sensors).
- 9.14.5 System shall permit user to query the status of any of the boxes. The status would be empty or occupied.