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| Smart Home Automation System (SHAS) |
| **System Requirements Specification** |
| **CS/SE 6387 Advanced Software Engineering Project**  **R.Z. Wenkstern**  **F. Araujo, M. Al-Zinati**  **Date : 02/20/2013** |

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| Group #2 |
| Govindarajan Panneerselvam |
| Vignesh Swaminathan |
| Jayan Karthik Pari |
| Udaya Kumar Krishnaswamy Rajendran |

# Revision History

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| **Version** | **Date** | **Comment** |
| 1.0 | 2/7/2013 | * Used Professor’s template to adhere to UTD’s branding. * Added Section 1 and Section 2 – VS and UR * Added Section 3 – JKP * Added Section 4.1-4.5 – GP * Added Section 5.1, 5.2 – VS * Added Section 4.6-4.13 – GP * Added Appendix |
| 2.0 | 2/20/2013 | * Made revisions to section 2, 3, 4, 5 * Added Appendix E – Traceability matrix. |

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# 1. Introduction

## 1.1 Purpose

SHAS (Smart Home Automation System) is an intelligent monitoring and control system that monitors and controls various “smart” appliances and devices throughout an enabled house. The system supports the communication and integration of heterogeneous devices and services. While SHAS’s role is to intelligently monitor and control a house, the controls and metrics are focused on maximizing energy efficiency.

## 1.2 Scope of Project

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| Project Includes |
| **Monitoring and Controlling Devices** – By providing a unified point of access to the user to monitor and control his devices through the means of a web interface or a mobile application. |
| **Optimizing Energy Usage** – By controlling devices automatically based on their needs and requirements tailor made to the usage patterns of the user. |
| **Ensure safety of homeowner** – By intimating possible hazards of appliances that have been turned on for a while and intimate emergency response teams in the event of fire hazards, burglar alarms, and intimate natural calamities to the user by gathering data from national emergency information sources. |
| **Suggest Usage Patterns** – For the user based on his usage styles. |

## 1.2.1 Stakeholders

The customers for the SHAS system are R.Z. Wenkstern, F. Araujo, M. Al-Zinati for the organization UT Dallas. The other stakeholders include the project development team consisting of Govindarajan Panneerselvam, Uday, Vignesh Swaminathan, Jayan Karthik Pari.

## 1.3 Overview

### Objective:

The objectives of SHAS include, but are not limited to the following:

1. Provide monitoring and controlling ability to various appliances and devices in the SHAS enabled house.
2. Optimize appliances and devices energy consumption
3. Provide an environment to ensure that the home is constantly monitored and the homeowner remains safe.
4. Suggest usage patterns in order to increase energy efficiency.
5. Provide a unified point of access to allow the homeowner to monitor and interact with the various appliances, devices and sensors throughout the house.

#### Customer’s specific requirement objectives:

|  |  |
| --- | --- |
| CR 1 | Turn air condition or heater on, off, or to some preset temperature when nobody is home or based on the outside temperature. This saves energy by alleviating strain on the air conditioning system. |
| CR 2 | Adjust lighting whenever someone enters or exits a room, saving energy through minimal light usage. |
| CR 3 | Monitor doors and windows to make sure that they are completely shut, so that no air escapes unknowingly. |
| CR 4 | Monitor daily power and water usage in order to give reports to the homeowners while suggesting ways to better conserve their personal usages. |
| CR 5 | Turn water heater on only during peak hours when it is likely to be used so that it is not constantly running. |
| CR 6 | Monitor recent precipitation levels to determine if lawn sprinklers should run or not. If it has rained recently, there is no reason to sprinkle the lawn. |
| CR 7 | Monitor each power outlet’s energy consumption and disconnect them if it has gone beyond a preset threshold. This prevents situations when devices are accidentally left on while unused. |
| CR 8 | Adjust lighting based on current sunlight levels. Less lighting is required when natural sunlight is available. |
| CR 9 | Control of the house through a web interface or a smart phone, This allows the homeowners to easily have complete control of their home. |
| CR 10 | Automatically contact police when a security alarm has been breached. |
| CR 11 | Inform the fire department when smoke is detected. |
| CR 12 | Remote web view of cameras located in the house, allowing the homeowners an increased sense of security. |
| CR 13 | Check if appliances remain on after an unusual amount of time and prompt the owners to shut them off, if they wish. This allows the homeowners to not be concerned in case an appliance is left on accidentally. |

### Specification:

Energy Conservation; Convenience; Desired behavior for HVAC – Safety – Water related – Electricity related devices.

### Project Start and End Dates:

01/23/2013 – 08/05/2013

### Funding Limits:

Not Applicable, since the deliverables are towards securing grades for the “Advanced software engineering project” course, enabling the project’s team members to advance towards their graduation.

### Resources

People – Govindarajan Panneerselvam, Udaya Kumar Krishnaswamy Rajendran, Vignesh Swaminathan, Jayan Karthik Pari.

Money – Not Applicable. Since this being a term project.

Time – Man hours to be put in by everyone.

# 2. Overall Description

## 2.1 Product Perspective

The SHAS system will control, integrate, monitor and communicate with all the devices and appliances chosen by the user to be part of this intelligent system. The heart of SHAS is the communication hub SHAS Controller which controls all the sensors attached to the appliances. The communication between these sensors is achieved through the centralized SHAS Controller platform.

## 2.2 Product Functions

The main functionality of SHAS is conservation of energy thereby reducing the overall cost incurred to the user. The overall success of SHAS depends on the performance of individual sensors and how they interact with the appliances with which they are connected. The SHAS Controller will respond to the request sent by each sensor and also provide communication between sensors.

## 2.3 User Characteristics

Customer Support User: They will be able to monitor and control the SHAS Controller system. The entire system can be configured by this user. The user with this access belongs to the provider of SHAS.

Administrators: They are the core users and are able to add new users to the system and permit them to individual devices. They can also view the performance of the entire system. These users can get report on the system and also make changes to the device settings.

General Users: They are users with limited privilege with access to some devices.

## 2.4 Constraints

The following are the constraints in SHAS:

* Communication protocols namely RS 232 and ZigBee shall be used.
* The usage history is recorded on NAS for pattern generation and the size of it is 3 TB
* Smart phone applications are for Apple and Android
* SHAS Controller should be functioning with no interruption.
* Cannot have conflicting sensors on the same area of operation because there might be signal interference.

## 2.5 Assumptions and Dependencies:

The SHAS implementation that we propose is to be called as Simple home network coined as SHAS Controller.

This section describes the assumptions made by the project team upon receiving the problem statement to clear the air on some ambiguous requirement specifications.

* Lights, AC units, fans, switches are already present in the house.
* There is only one Master user and others are normal users.
* The house in discussion is assumed to be at Plano, TX

# 3. External Interface Requirements

## 3.1 User Interface

Login Screen: This is for the user to get into the software. It requires a user name and password.

User Account: This enables the user to view the account status of other users.

Reports: This is used to generate report on the SHAS devices.

Settings: The devices can be configured in this section.

## 3.2 Hardware Interfaces

The SHAS Controller is connected to all the devices through the centralized platform. The usage details of each device are stored in the SHAS Controller which can be accessed by the user.

There are control panels that the user can interact with. And apart from that the user also has many override switches that they can use to override the SHAS Controller.

* RJ45 for internet connectivity to Router
* RS 232 Serial Port
* Insteon – Wireless Sensor Networks - For Insteon Devices
* Monnit ZigBee Controller – For ZigBee Devices
* Power controllers for power line devices

## 3.3 Software Interfaces

The user is given both web interface and mobile application interfaces to control and monitor individual sensor and also generate reports on these devices. The web interface will have a bigger screen hence the user will be provided with all monitoring and controlling options. The applications that run on the smart phones for Apple and Android are applications that have limited options than the web interface. Critical ones shall be on the landing page of the application. Critical ones include controls to power outlets and open/close status of windows and doors.

The software interface also includes the SOAP and REST end points. These are the web services that are used for getting weather information for the current day at the current place.

## 3.4 Communication and Protocol Interfaces

The communication between the sensors and SHAS Controller is achieved through Zigbee, IR, RS232 and Wireless Sensor Networks standard. This would also have power line.

# 4. System Features

This is what the entire project is about, this is what the project aims to provide the customer which he/she can use to improve their quality of living and also achieve all the desired effects that were provided along with the problem statement.

The central network and the Automation Center (or otherwise the brains) of our SHAS implementation shall here on be known as SHAS Controller.

## 4.1 SHAS Controller:

#### Description:

The “SHAS Controller” is the centralized home network that controls, communicates, integrates and monitors the devices and appliances in the home.

The SHAS Controller is not a single system, it has lots of subsystems in it, which control and govern the different types of devices and sensors. The zigbee subsystem controls the devices and sensors that communicate through the zigbee protocol. Likewise the IR and WSN Network subsystems control their respective devices and sensors.

The SHAS Controller consists of the intelligent agent “Wiz”. Wiz is the intelligent subsystem that controls and monitors the devices autonomously. The SHAS Controller collects the data from the devices and sensors and stores it. The “Wiz” interprets the usage according to user profiles and mines the long data

SHAS Controller provides the user means to control it through control panels strategically placed in the house and through interfaces either web or smartphone interface. The user has means to override “Wiz” through override switches (or buttons) places strategically in the house.

#### Action/Effect:

We design and deploy the SHAS Controller using various hardware and software components. The SHAS Controller integrates the devices and this allows the user to have a single point of device management. The user has single sign on authentication, which is the primary requirement in any secure environment. Access to usage reports is provided to the user alone only upon proper authentication. Resetting of passwords are part of the system but primarily a software component.

#### Functional Requirements:

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| FR 4.1.1 | The SHAS Controller shall be the central network that integrates and control the devices. |
| FR 4.1.2 | The SHAS Controller shall be the central network that monitors and communicates with the devices. |
| FR 4.1.3 | By Control, SHAS Controller shall allow either the User or “Wiz” to control the system through its network. |
| FR 4.1.4 | By Integration, SHAS Controller shall integrate the heterogeneous devices and sensors through its various h/w and s/w interfaces into its platform. |
| FR 4.1.5 | SHAS Controller shall serve as a platform for further development and refinement of “Wiz”. |
| FR 4.1.6 | “Wiz” shall be the intelligent agent that controls the SHAS Controller in the absence of user supervision. |
| FR 4.1.7 | “Wiz” shall operate within the boundaries of SHAS Controller, and operate with the long data obtained from the user’s usage pattern. |
| FR 4.1.8 | SHAS Controller shall authenticate users who access the system. |
| FR 4.1.9 | Authentication would be a username, password for the web, smartphone interfaces. The control panels have no form of authentication. |
| FR 4.1.10 | SHAS Controller shall maintain a database of all the device and sensor usages. |
| FR 4.1.11 | SHAS Controller shall monitor all the devices and sensors part of the system. |
| FR 4.1.12 | By Monitoring, SHAS Controller would look out for special indicators with which it would raise an alarm, and also SHAS Controller would intimate the user about this. |
| FR 4.1.13 | Alarms would be simple notifications in the smartphone and pop ups in the case of web interface. |
| FR 4.1.14 | SHAS Controller communicates with all the devices through their native commands and languages. |
| FR 4.1.15 | By Communication, SHAS Controller communicates with zigbee through its zigbee access point, and SHAS Controller communicates with the zigbee access point through IR commands. Likewise for all the other controllers SHAS Controller communicates natively. |
| FR 4.1.16 | Also by communication, we mean that customer can instruct a device to perform to their preference through SHAS Controller. |
| FR 4.1.17 | SHAS Controller shall comprise of subsystems for every type of network thereby enabling the device communication much simpler. |
| FR 4.1.18 | Authentication of users is done against a locally residing database, does not authenticate against external authentication methods such as Facebook, Google, Yahoo etc. |
| FR 4.1.19 | User shall have override mechanisms in place to override the “Wiz” in case of any special event or emergency. |
| FR 4.1.20 | Override mechanisms shall be control panels placed strategically across the house. |

## 4.2 Light Control

#### Description:

The “Light Control” feature is one of the standout features of this project. This incorporates the use of “Motion Sensors” as well as “Light Sensors” for implementing this feature. By this feature the customer can expect the lights to turn on or off based on room occupancy.

So we can expect the light to turn on when somebody is about to enter the room, and turn off when somebody is about to leave the room. For some added convenience and ergonomics, we can have the light dim all the way to full power and dim all the way until it powers off completely, in order to avoid startling users. This is a Non Functional Requirement, and can also be considered as scope creep.

Such features require the coordination of both the sensors mentioned above, and there would be certain preset rules set in order to have this feature’s intent intact. Both the sensors work in tandem to achieve this, and they also gather certain inputs such as room occupancy patterns over a period of time.

It can interface with the user’s calendar events for achieving the ultimate intelligent light control. Of course, this would require the user to maintain his/her calendar for the system to be intelligent, for the not so wary/tech savvy users, we can use the long data to capture usage patterns and arrive at some pattern to adhere to.

This feature is intended to conserve electricity, save on power bills, reduce hassle of turning off lights for the user, and also increase the life of the lights.

From here on the Light Control feature shall be denoted by LC.

#### Action/Effect:

We propose to use the Wireless Motion Sensor. This sensor is activated upon movement and can trigger nearby light bulbs, Remote Controlled Switches and Remote controlled dimmer.

We can expect low Power Bills, unattended light control, Autonomous function, less human intervention, Simple override mechanism, increased life of the lights and Satisfaction of being environment friendly by conserving electricity.

#### Functional Requirement:

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| --- | --- |
| FR 4.2.1 | LC shall control all the lights chosen by the user to function intelligently. |
| FR 4.2.2 | By control, LC shall turn off, turn on and operate the dimmer attached to the lights. |
| FR 4.2.3 | LC shall make use of sensors required for the desired operation of it. |
| FR 4.2.4 | The sensors shall include IR Motion sensor, Light Sensor, Lux (Luminescence) Sensor. |
| FR 4.2.5 | The IR Motion Sensor shall sense the motion of humans in the area of operation. |
| FR 4.2.6 | The Light sensor shall sense if there is light or no light in the area of operation. |
| FR 4.2.7 | The Lux sensor shall sense the amount of light luminescence in the units of candela in the area of operation. |
| FR 4.2.8 | The area of operation shall include the functional areas surrounding the lights chosen for LC. |
| FR 4.2.9 | The area of operation shall be limited to the range and dimensions of the sensors required for LC. |
| FR 4.2.10 | The user shall control and monitor the light through the interfaces to SHAS Controller. |
| FR 4.2.11 | The interfaces to SHAS Controller shall include web interface and the smartphone mobile interface. |
| FR 4.2.12 | The user shall override LC through the control panels provided in the area of operation under consideration at user’s will. |
| FR 4.2.13 | The web and smartphone mobile interface shall provide the user the provision of remote access, control and monitor of lights part of the LC. |
| FR 4.2.14 | The LC shall control the settings and behavior of the lights in the area of operation under consideration based on long data and user specifications. |
| FR 4.2.15 | The long data shall include the user’s usage patterns, the hours of operations and user preferences. |
| FR 4.2.16 | The LC shall turn off the lights upon inactivity in the area of operation, and also based on the lux(luminescence) levels. |
| FR 4.2.17 | The LC shall dim the lights based on the lux level in the area of operation |
| FR 4.2.18 | The LC shall turn on the lights upon a sudden activity in the area of operation, based on the luminescence levels in the area of operation. |
| FR 4.2.19 | The LC shall provide user with preset profiles for ease of use. |
| FR 4.2.20 | The preset profiles shall control the lights In the area of operation. |
| FR 4.2.21 | The user shall tweak the preset profiles based on their personal preferences. |

## 4.3 Automatic Temperature Control

#### Description:

The “Automatic Temperature Control” feature is a very good feature that is supposed to increase the quality of living by autonomously controlling the temperature according to the user’s preferences and based on climatic conditions, and based on user’s usage patterns.

From here on the “Automatic Climate Control” shall be denoted by ATC, and the Air Condition/Heating Unit shall be denoted by ACH Unit.

#### Action/Effect:

We recommend the use of air flow sensors that would detect the amount of air flowing from the ACH Unit. We also have air vents that are controlled by motors that open and close the vents that go to each room so we don’t have air flow to rooms that don’t have anyone. The room occupancy would be checked by the existing Motion Sensors part of the implementation of “Light Control” feature. We also control the temperature of the room by using temperature sensors both outside and inside and set the temperature of the ACH Unit accordingly.

The user can expect reduced power bills, the right temperature, unattended autonomous temperature control, reduce air flow wastage with the “Monitoring Doors and Windows” feature, where we don’t waste the climate control air to air seepage from outside, and more importantly reduced hassle of fiddling with the thermostat, from here on known as HVAC.

#### Functional Requirements:

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| --- | --- |
| FR 4.3.1 | The ATC shall control the ACH Unit. |
| FR 4.3.2 | By control, the ATC shall increase and decrease the temperature input for the ACH unit. |
| FR 4.3.3 | By control, the ATC shall control the flow of air that comes out of the vent. |
| FR 4.3.4 | The ATC shall make use of sensors for its desired operation. |
| FR 4.3.5 | The sensors comprise of Air flow sensors placed in the vents, and temperature sensors placed inside various rooms and outside the house. |
| FR 4.3.6 | The Airflow sensors shall detect the amount of air flowing through each vent and control the amount of air flowing into the system. This is purely for the comfort of the homeowner. |
| FR 4.3.7 | The temperature sensors are used to find the inside temperature and the outside temperature. |
| FR 4.3.8 | The HVAC shall display the temperature of the room. |
| FR 4.3.9 | The interface shall display more detailed information on the ATC. |
| FR 4.3.10 | ATC shall arrive at the optimum temperature for the rooms based upon long data on user’s preferences, user profiles and ACH Usage. |
| FR 4.3.11 | ATC shall obtain long data on all aspects of the ACH Operations, user’s interactions with it and their preferences. |
| FR 4.3.12 | The ATC shall be overridden by the user on his will. |
| FR 4.3.13 | By override, the user shall use hardware panels places strategically across the house to override the system, and also through interface for remote access. |
| FR 4.3.14 | The ATC shall have access to user’s calendars for optimized performance, provided the user maintains one on a day to day basis. |

## 4.4 Monitoring Doors and Windows

#### Description:

The “Monitoring Doors and Windows” feature of the system is aimed at monitoring the house and ensuring safety and also in aiding the “ATC” to conserve energy by eradicating air seepage.

This feature would monitor if the doors and windows are opened or closed based on the sensor’s inputs. This data would be relayed to the user in a user friendly format with just either open/close output. With this output the user will know if any door or window is open or close through the user friendly interface part of the system.

This “Monitoring Doors and Windows” shall here on be known as “MDW”. The MDW can be extended to include the refrigerator doors.

#### Action/Effect:

We propose to use the open/close sensor that would be fitted to every door and window in the house. We do not want to make a tradeoff by giving the user the option of choosing which door and window to monitor, since we are also relying on the “MDW” feature to prevent air seepage increasing ATC’s effectiveness.

The user can expect, remote monitoring of doors and windows, increased effectiveness of the ATC.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.4.1 | The MDW shall know if a door is open or closed. |
| FR 4.4.2 | The MDW shall offer user access to this data that it gets, with the data being that if a door is open or closed. |
| FR 4.4.3 | The MDW shall offer a drill down menu of all the doors and windows in the house so that the user shall get much more detail and a broader perspective of safety. |
| FR 4.4.4 | The MDW shall ensure safety of the house only through the means of relaying the open/close information to the user. |
| FR 4.4.5 | The devices and sensors part of the MDW feature shall be connected to SHAS Controller. |
| FR 4.4.6 | SHAS Controller shall provide web/mobile interface to user for ease of access. |
| FR 4.4.7 | SHAS Controller shall obtain long data on the MDW feature with several weeks of usage. |
| FR 4.4.8 | The MDW shall intimate user based on the user’s calendar events, if the user maintains one, and MDW has access to it. |
| FR 4.4.9 | The MDW shall intimate user of a change in the open/close status of a door or window based on the usage pattern. |

## 4.5 Water Heater Control

#### Description:

The “Water Heater Control” is aimed at autonomously controlling the water heater that consumes a lot of energy when it’s constantly running, even when it is not used. So in order to reduce the energy consumption it should be controlled to operate only at a given period of time during the day, when it is most likely to be used. This feature from here on will be known as WHC.

The WHC shall also obtain long data on the user’s usage patterns and work with that data, also the user must give the system some time to do so. The purpose of WHC is to reduce the energy consumption by avoiding unnecessary heating of water thereby reducing the power bill.

#### Action/Effect:

Our solution is to place an electric water heater timer that controls the water heater to function only on specified times i.e., during peak hours of usage. In addition to this, we provide a variable dial switch that would be connected to the SHAS Controller through power line and this would also a control panel with 4 buttons would be provided near the shower. This control panel will have preset temperatures for each person in the household so that the water heater heats the water for that temperature.

This lowers power bill, avoid wastage of heated water, less human intervention.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.5.1 | The WHC shall control the water heater’s temperature. |
| FR 4.5.2 | The WHC shall provide user access to the water heater’s temperature through the control panel. |
| FR 4.5.3 | The WHC shall obtain long data on the user’s usage patterns and autonomously operate. |
| FR 4.5.4 | The WHC shall be connected to SHAS Controller to enable user to control the device from web/mobile interface. |

## 4.6 Lawn Sprinkler Control

#### Description:

The lawn sprinkler control is necessary avoid excess watering of plants. It has to monitor the soil’s moisture level and switches on the lawn sprinkler control based on that. The lawn sprinkler controller is connected to SHAS Controller and can be customized based on weather predictions. If the next day is supposedly going to be a rainy day, it can water the plants just a little less than the optimum requirement and leave the rest to the next day’s rain.

The Lawn sprinklers are fitted with a “Geiser-Miser” device that would stop the flow to a particular sprinkler if the sprinkler’s top is broken, which would allow a lot of water to run on flooding the lawn and also inviting fines from the municipality for wasting water during the event of drought in the municipality.

The “Lawn Sprinkler Control” from here on would be denoted as “LSC” and the lawn sprinkler controller shall be known as “LS Controller”.

The LSC would be connected to SHAS Controller and would subscribe to regional meteorological center’s forecast data to achieve the capability of avoiding or running the lawn sprinklers based on forecast data.

This feature is intended to prevent wastage of water, lower water bill and save plants.

#### Action/Effect:

Our solution provides a lawn sprinkler timer that operates the sprinkler at specified times and a rain sensor that checks the precipitation level. The rain sensor has the functionality to override the sprinkler timer when it is not needed.

We have a data logger that is connected to soil moisture sensors that send the data back to the data logger which is again sent to the SHAS Controller. The lawn sprinkler controller will be controlled by the SHAS Controller instead. “Geiser-Miser” are in between the lawn sprinkler and the water connection, thereby passively prevents the flooding of lawns through broken lawn sprinkler heads.

Lower water bill, avoid wastage of water, prevent flooding, autonomous sprinkler control based on climatic data and soil moisture levels.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.6.1 | The LSC shall control the lawn sprinklers through the LS Controller. |
| FR 4.6.2 | The LS Controller shall be connected to SHAS Controller. |
| FR 4.6.3 | The LS Controller shall autonomously control the lawn sprinklers based on soil moisture and weather data. |
| FR 4.6.4 | The LSC shall obtain weather data from the local MET department. |
| FR 4.6.5 | The LSC shall obtain soil moisture data from the soil moisture sensors. |
| FR 4.6.6 | The LSC shall work with preset user commands and also with long data obtained through user’s preferences. |
| FR 4.6.7 | The LSC shall prevent flooding through the user of “Geiser-miser” devices. |
| FR 4.6.8 | The LSC shall work with drought warnings issued by local MET department. |

## 4.7 Dishwasher Control

#### Description:

The “Dishwasher Control” incorporates ‘timers’ and ‘water level switch’ for automatic turn on/off and also control the water level in the dishwasher based on load size. It should also turn off the dishwasher after a period of inactivity. This feature here on would be known as “DiCon”

The purpose of this feature is to save water from wastage and avoid unwanted power consumption.

#### Action/Effect:

Our solution includes a timer that keeps track of the dishwasher when it is under use. After a period of inactivity the power to the dishwasher is cut off. To avoid excess use of water, the water level switch is placed in the dishwasher that monitors and controls the inflow of water based on the load capacity.

This lowers water bill, lower electricity bill, less human intervention.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.7.1 | The DiCon shall be connected to the SHAS Controller. |
| FR 4.7.2 | The DiCon shall control the water flow of the existing dishwasher unit. |
| FR 4.7.3 | The SHAS Controller shall provide user access to DiCon through existing web/mobile interfaces. |
| FR 4.7.4 | The mobile interface shall include mobile applications specific to Android and Apple mobile OS’. |
| FR 4.7.5 | The user shall have control over the appliance through the “appliance Control” feature. |

## 4.8 Washer/Dryer

#### Description:

The “Washer/Dryer Control” is similar to the “Dishwasher Control” in the way it monitors the washer and dryer. It also incorporates ‘timers’ and ‘water level switch’ for automatic turn on/off of both washer and dryer and also control the water level in the washer based on load size. It should also turn off both the devices after a period of inactivity. This feature here on will be known as W/D Control.

The purposes of this feature are preserve water and avoid excess power consumption

#### Action/Effect:

Our solution includes a timer that keeps track of the washer and dryer when it is under use. After a period of inactivity the power to the devices is cut off. To avoid unwanted wastage of water, the water level switch placed in the washer monitors and controls the inflow of water based on the load size.

This lowers water bill, lower electricity bill and less human intervention.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.8.1 | The W/D Control shall control the water flow of the existing washer/dryer units.  interfaces. |
| FR 4.8.2 | The W/D Control shall be connected to the SHAS Controller. |
| FR 4.8.3 | The SHAS Controller shall provide user access to W/D Control through existing web/mobile |
| FR 4.8.4 | The mobile interface shall include mobile applications specific to Android and iOS mobile OS’. |
| FR 4.8.5 | The user shall have control over the appliance through the “Appliance Control” feature. |

## 4.9 Smart Power Outlet

#### Description:

The Smart power outlet controls the operation of electrical outlets. This uses no sensor s but this could be powered on or off remotely by the home owner. Also, the home owner could remotely monitor the outlets that are in use. The home owner could also set time intervals for outlets to provide electricity. A notification would be sent to the home owner if some outlet is on for a long time.

This feature is intended to monitor and control electric outlets from home. Hence, once the home owner leaves home and doubts if something is switched off, he/she doesn’t have to all the way back to switch the outlet off. The home owner could do it with their smartphones. Even when the home owner has a doubt, he/she could monitor electric outlet from anywhere. In our system every outlet communicates with SHAS Controller and SHAS Controller could be connected with a smart phone to control the outlets.

The “Smart Power Outlet” shall henceforth be known as “SPW”.

#### Action/Effect:

This smart power outlet discussed here would ensure that the home owner could monitor and control the power outlets from anywhere using their smartphones. Additionally they can also time certain outlets and makes sure that no electricity is wasted.

This prevents wastage of electricity and saves the time of the home owner. This could also prevent the house from fire accidents by notifying the home owner if some outlet is giving out power for a long time

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.9.1 | The SPW shall be connected to the SHAS Controller. |
| FR 4.9.2 | SHAS Controller shall provide user access to devices connected through the Smart outlets. |
| FR 4.9.3 | The user access is provided by SHAS Controller through web/mobile interface. |
| FR 4.9.4 | The SPW shall allow user to access the devices. |
| FR 4.9.6 | The SPW shall provide a drill down view of all the devices connected to smart power outlet. |
| FR 4.9.7 | The SPW shall allow user to control the devices connected through the smart power outlets. |
| FR 4.9.8 | The SPW shall obtain long data on every device’s usage, and can offer an intelligent mode to the user upon which, it would autonomously control the outlets. |
| FR 4.9.9 | The user can override the intelligent mode of the SPW through the mobile/web interface and also with the control panel. |

## 4.10 Emergency Call

#### Description:

The “Emergency Call” feature is a very important aspect of the SHAS implementation. This alerts the emergency services in the event of emergencies. The feature shall here on be known as “EC”.

It is considered an emergency if one of the following sensors go off. The sensors that trigger emergencies are burglar alarms, smoke alarms and Carbon Monoxide detectors.

#### Action/Effect:

We connect all the emergency sensors to the SHAS Controller and we write special cases and events which when triggered would not only intimate the user but also the emergency services through the means of an SMS, or a phone call with a prerecorded message.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.10.1 | The EC shall notify emergency services upon triggering of the emergency sensors. |
| FR 4.10.2 | The EC shall notify based on a prerecorded message. |
| FR 4.10.3 | The Prerecorded message shall be recorded for each and every emergency. |
| FR 4.10.4 | The user shall spend time to record these messages in order for the emergency services to verify the authenticity of the emergency call being made. |
| FR 4.10.5 | The user shall input the emergency services details and can also optionally provide personal numbers to get additional notifications and send them out to family members etc. |

## 4.11 Remote Surveillance

#### Description:

The “Remote Surveillance” feature is to ensure safety of the inhabitants and also the safety of the home in itself. This feature here on will be known as “RS”.

The RS would include indoor and outdoor cameras so that the user can monitor the inhabitant’s activities and also the activities outdoors and look out for suspicious elements. This would give the users a sense of security and also for the inhabitants.

#### Action/Effect:

We connect IP enabled cameras to the SHAS Controller both indoors and outdoors. This can be activated based on motion sensors already established through other features. We can use them to record the activity of not an entire day but only for activities that happen within a particular radius, to save on space and eliminate unwanted data.

The user can expect increased sense of security, and also has surveillance feature.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.11.1 | The RS shall be connected to SHAS Controller. |
| FR 4.11.2 | The mobile interface shall provide the user access through mobile applications. |
| FR 4.11.3 | SHAS Controller shall provide access to the RS through web and mobile interface. |
| FR 4.11.4 | The User shall control the devices part of RS through the user interfaces. |
| FR 4.11.5 | The user shall turn on and turn off the devices part of the RS. |
| FR 4.11.6 | The user shall override the RS to help provide user’s control. |
| FR 4.11.7 | The mobile applications shall be available for Apple and Android OS. |

## 4.12 Appliance Control

#### Description:

The “Appliance Control” is the standout feature of the SHAS implementation. You can pretty much control each and every device in the home through the use of remote controlled wall sockets to which the appliances are connected. Already through the implementation of SPW, we already have smart outlets. This feature here on will be known as “AppCon”.

#### Action/Effect:

We include remote controlled wall sockets that sit atop on the existing sockets. These are connected to SHAS Controller and controlled by them.

The user has extended and detailed access to every device in the house.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.12.1 | The AppCon shall provide detailed drill downs to the user. |
| FR 4.12.2 | The AppCon shall be accessible through the mobile applications provided by SHAS Controller. |
| FR 4.12.3 | The AppCon shall collect Long Data and get the required usage patterns. |
| FR 4.12.4 | The AppCon shall suggest better appliance usage based on the historical data. |
| FR 4.12.5 | The AppCon shall consist of devices that are connected to the SHAS Controller. |

## 4.13 User Interface

#### Description:

The “User Friendly Interface” requirement is paramount to everything. This is because; the user gets to interact with the system only through this. This would be the face of SHAS Controller. Hence the user needs to be able to interact with an easy to use interface that is self-explanatory and also one that does not require training. This feature here on will be known as “UFI”.

The user nowadays has many ways to interact with the device with the advent of smartphones. Hence we also provide smartphone applications for the two most widespread OS, Apple and Android.

#### Action/Effect:

We develop the web interface through the Java SDK, and also create REST Endpoints with which we can develop applications and connect the applications to the SHAS Controller.

We also provide login credentials to the user, so that unauthorized access is not allowed. Also standard logon behaviors are enforced.

#### Functional Requirements:

|  |  |
| --- | --- |
| FR 4.13.1 | UFI shall be user friendly. |
| FR 4.13.2 | UFI shall provide both web interface as well as mobile interface. |
| FR 4.13.3 | UFI shall provide mobile interface through the user of mobile applications. |
| FR 4.13.4 | The mobile applications of the UFI shall be for Apple and Android OS. |
| FR 4.13.5 | The User shall have login credentials to prevent unauthorized access. |
| FR 4.13.6 | The user shall interact with devices through the interfaces. |
| FR 4.13.7 | The user shall interact with the SHAS Controller with limited functionality through the control panels. |

# 5. Non Functional Requirements

## 5.1 Product Non Functional Requirements

The product non-functional requirements cover everything that deal with the qualities and constraints of the Smart Home Automation System. The motive of the system shall be to provide comfort to the home owner in a smart, and energy efficient way.

### 5.1.1 Usability

This product shall be simple to the user to use SHAS. This device shall have an application that runs on the user’s smart phone and has control over the system irrespective of the location of the user. This application on the user’s smartphone shall have an easy to use interface that makes him comfortable with using SHAS.

### 5.1.2 Accessibility

The system shall be active and running every minute. User has several ways to override the system. The most elegant way would be to use the user’s smartphone application that controls the system. This application shall be installed on one or more user’s smartphone or tablet. This system shall not have many special features for visually challenged people or people with other disabilities.

### 5.1.3 Security:

The system shall provide security features. If the water sprinkler is broken it should not ooze out the water in an irregular fashion but rather shall have a mechanism to hold water in such cases. There shall be a security provision that sends a notification to the user if there is an electrical outlet has been switched on for a long period of time. Fire alarms and smoke alarms shall be installed at the designated places and when fire breaks out, the system shall inform the nearest Fire station/ contact 911.

### 5.1.4 Maintainability:

The SHAS shall be maintainable with respect to the individual product that makes the system. Every component in SHAS shall be of plug-and-play type and are self-discoverable. A single “press” of a specific button on SHAS Controller should put the replaced device in action. Also, if there shall be some defect on any one of the devices there shall be a support team for that product and with the help from them that problem could be solved.

## 5.2 Process Non Functional Requirements

### 5.2.1 Design

When designing the SHAS system, the biggest emphasis shall be on security because the smart appliances should not be controlled by an unauthorized user from outside the house. Each device in here shall not violate any rule set by other devices and hierarchy in the design shall be maintained.

### 5.2.2 Documentation

In SHAS documentation, information regarding products and services shall be collected and documented. This helps user to find accessibility privileges, security issues, and other usability related documents. The documentation shall be made in such a way that these would be traceable and straight forward.

### 5.2.3 Case Tool

There shall be several CASE tools used in building SHAS. This includes Microsoft Project for planning and managing the project and developing the project plan, IBM Rational Doors for gathering and documenting requirements using IEEE Std 830, IBM Rhapsody for designing with designing with Architectural layers, and JUnit and Maverix for testing

## 5.3 External Non Functional Requirements

### 5.3.1 Watering Regulations

Every state in USA will have a different set of watering restrictions based on its geographic location, climate and other factors. Hence based on these and the current season, the regulation imposed by the state will change. For example, in the City of Dallas maximum only twice per week watering should only happen. Also, the house number decides when the lawn should be watered.

### 5.3.2 Device Standards

The devices used should follow certain standards that are set such that it doesn’t harm the environment. The wireless sensor network Standard 802.15.4 shall be used by the devices for communication. Also, the products shall follow CE and FCC radio frequency guidelines. FCC is Federal Communication Commission, is a US marking that the electronic item shall be used in the United States of America. CE marking is a European Conformity marking that indicates that the product complies with all relevant European requirements. Similar to this, other standards that shall be met are the amount of lead in the water and the quality of the water that is sprinkled.

# Appendix A: Glossary

|  |  |
| --- | --- |
| **Term** | **Definition** |
| **Carbon Monoxide Detector** | A carbon monoxide detector or CO detector is a device that detects the presence of the [carbon monoxide](http://en.wikipedia.org/wiki/Carbon_monoxide) (CO) gas in order to prevent [carbon monoxide poisoning](http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning). |
| **Electric Meter** | An **electric meter** is a device that measures the amount of [electrical](http://en.wikipedia.org/wiki/Electricity) [energy](http://en.wikipedia.org/wiki/Energy) consumed by a [residence](http://en.wikipedia.org/wiki/House), [business](http://en.wikipedia.org/wiki/Business), or an electrically powered device. |
| **Water Meter** | A water meter is a device used to measure the volume of water usage. It is used to measure the volume of water used by residential and commercial buildings that is supplied by the public water system. |
| **Lawn Sprinkler Timer** | Automatic turn on /off of the lawn sprinkler. |
| **Rain Sensor** | Monitor the precipitation level of the soil to control the lawn sprinkler |
| **Water Heater Timer** | Automatic turn on/off of the water heater on specified times. |
| **Electronic Timer** | Control the automatic turn on/off of electrical appliances. |
| **Water Level Switch** | It is a pressure switch that controls inflow of water based on the load size. |
| **Water Heater Timer** | Automatic turn on/off of the water heater on specified times. |
| **Electronic Timer** | Control the automatic turn on/off of electrical appliances. |
| **Water Level Switch** | It is a pressure switch that controls inflow of water based on the load size. |
| **Smart Power Outlets** | It is a power outlet that could be controlled and monitored by the user remotely. |
| **Open/Closed Sensor** | It is used to detect and update the Data logger if a window/ door is open or closed |
| **Smoke Detector** | It is used to detect smoke inside the house |
| **Natural Gas Detector** | This detects any leakage if gasoline from the kitchen. |

# Appendix B: References

1.    Build an IEEE 802.15.4 Wireless Sensor Network for Emergency Response Notification for Indoor Situations.

2.    Smart home energy management system using IEEE 802.15.4 and ZigBee

3.    ZigBee-based Smart Home system design

4.    Research and Design of Smart Home System Based on Zigbee Technology

5.    The Networking Technology within Smart Home System - ZigBee Technology

6.    <http://www.universal-devices.com/developers/>

7.    <http://www.camiresearch.com/Data_Com_Basics/RS232_standard.html>

8.    <http://www.sensor-networks.org/index.php?page=0823123150>

# Appendix C: Open Issues

1.    On Apple and Android market we have several “Ease of Access” options that could be utilized in our system. This shall include the basic ones like giving a notification to the user that the window is open when he/she locks the rooms from outside. Saying the current room temperature aloud when the user opens the door with the key and enters the house. This could be a valuable addition at no cost and will be of little help if any guest with visual disability visits the house.

2.    The data for Watering regulations shall sometimes become outdated and new data could be provided to the devices on SHAS by extracting data from a website using a web crawler. But this could create problems in the future when there is an update on the website’s design. This problem arises because there is no reliable web service providing this data at present. The user shall be able to manually add these data to SHAS whenever there is an update in the watering regulations.

3. The user level permissions needs to be identified, if a complex user access control is needed.

# Appendix D: Abbreviations

ATC- Automatic Temperature Controller

LC- Light Control

MDW- Monitoring Doors and Windows

WHC- Water Heater Control

ACH- Air Condiion/Heating

LSC- Launch Sprinkler Control

FCC- Federal Communication Commission

UFI- User Friendly Interface

EC- Emergency Call

W/D Control- Washer Dryer Control

DiCon - Dishwasher Controller

RS- Remote Surveillance

SMP- Smart Power Outlet

AppCon- Application Controller

# Appendix E: Traceability Matrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **FR 4.2** | **FR 4.3** | **FR 4.4** | **FR 4.5** | **FR 4.6** | **FR 4.7** | **FR 4.8** | **FR 4.9** | **FR 4.10** | **FR 4.11** | **FR 4.12** | **FR 4.13** |
| **CR 1** |  | X |  |  |  |  |  |  |  |  |  |  |
| **CR 2** | X |  |  |  |  |  |  |  |  |  |  |  |
| **CR 3** |  |  | X |  |  |  |  |  |  |  |  |  |
| **CR 4** |  |  |  |  |  | X | X |  |  |  |  |  |
| **CR 5** |  |  |  | X |  |  |  |  |  |  |  |  |
| **CR 6** |  |  |  |  | X |  |  |  |  |  |  |  |
| **CR 7** |  |  |  |  |  |  |  | X |  |  |  |  |
| **CR 8** | X |  |  |  |  |  |  |  |  |  |  |  |
| **CR 9** |  |  |  |  |  |  |  |  |  |  |  | X |
| **CR 10** |  |  |  |  |  |  |  |  | X |  |  |  |
| **CR 11** |  |  |  |  |  |  |  |  | X |  |  |  |
| **CR 12** |  |  |  |  |  |  |  |  |  | X |  |  |
| **CR 13** |  |  |  |  |  |  |  |  |  |  | X |  |