The Home Safety System Based on Competing Functions

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Abstract

This paper presents a home safety system assured the safety of home appliances that can be integrated with the existing home automation. This system consists of generic rules, a fuzzy set of rules and inferences the home safety services according to the sensor input values. This system has some filters, that judge is the appropriateness of sensor values. This system will use the competing home appliances which are automatically controls near boundary on/off. So, this system has the special database system for competing appliances. This database system will link to the fuzzy logic decision making system. The Geo Fencing system will also be applied to watch the movement of object. IFTTT (If This Then That) service will provide the automotive function as a remote control. The Remote UI will be applied to monitor the condition of the home status.

Keywords- Home safety, Generic Rules, Database, Geo Fence, IFTTT, The Remote UI

1. Introduction

Intelligent home is an integrated system in a home that integrates multiple home services, where the technology and process used to create a building that can act intelligently so that a home becomes safer and more productive for users and more efficient for its owners. The proposed system realizes by the sensors value rules. This system needs to define the set of fuzzy rules. People are always worried about what would be the condition of their homes and offices when they are not there.

Therefore, this proposed system is trying to make a system which would automatically provide the user to save and control the home appliances [1].

There are many types of safety problems that may arise within a home environment. These safety problems can be classified into three big categories: safety of home appliances, safety of indoor environment and safety of interaction between home users and home appliances. The occurrence of home safety problem always have three bad consequences: cause casualty or cause home property loss or both [2].

This system will define the generic rules based on the sensor values. The generic rule is the representation of common senses in terms using the syntax of the fuzzy decision support system. The system will use some filters to judgment between sensors and embedded appliances, because they might be malfunctioned. This system will use the fuzzy inference system to inference the home safety. Intelligent home is an integrated system in a home that integrates multiple home services, where the technology and process used to create a building that can act intelligently so that a home becomes safer and more productive for users and more efficient for its owners. The Geo Fencing system will watch and act as a sentinel system, how the user is moving which way the user moves to the Geo Fence (from inside, outside, inside/outside cross direction). These three conditions will include for the Geo Fencing system. The Remote UI will also provide the functions to monitor and to control the status of home appliances.

2. Related Works

The architecture of home safety system includes the Geo Fencing rules for intelligence fence, IFTTT acts like as remote control, sensor value rules for controlling the home appliances and the remote UI for monitoring the status of home. This proposed system used the fuzzy expert system. This system defined a set of fuzzy rules according to the input sensor values which can be obtained by the sensors. This proposed system acted as a sentinel, which knows everything at home situations. It can provide home safety functions and can also save the electricity usage. On the weekdays and weekends, the system automatically works based on the rules to save the electricity usage. In this proposed system is a new technique of implementing home safety system that will give more safety for smart home appliances and electrical usage based on the rules [1].

Intelligent home management system has been developed which has the ability to turn on and turn off the room lights automatically, record the controlled electronic devices usage status, switching on and off air condition regulating device automatically, showing temperature room in the house, detect fire signs in the house and turned on the sprinklers in the home in case of fire, supervising the home through surveillance cameras, storing photos and surveillance records on home, detecting people movement in home, and providing notification when someone entered home. System is implemented in prototype. The results show that the system can detect light intensity, flame, room temperature, movement of people, and home state and then the information is successfully sent to the server over the WiFi. The result can be read from server by using browser and there is a data logger in the server. Intelligent home management system prototype development covers hardware and software implementations [3].

Expert systems are normally used in various problem solving and decision-making activities such as monitoring, diagnosing and various training related activities. Yashwant Singh Patel proposed a framework that is based on wireless sensors and expert system to solve day to day problem

occurring in home appliances. Whenever problem occurs in any part of home appliance, the sensor detects that problem automatically and sends it for solution to the expert system, Various noise removal algorithms for removing noise from the received data can be applied for getting noise free data. The expert system finds the solution based on the type of problem and sends the solutions with various images through SMS or e-mail to user's mobile or mail-id [4].

The author proposed the intelligent control in smart home based on adaptive Neuro Fuzzy Inference System (ANFIS). This research proposed the use of K-means clustering algorithm in the division of the input space. Every cluster generates a membership function by approximation, the type of membership function is the bell, and then the optimization of the premise and consequent parameters in ANFIS model are realized through the combination of improved adaptive particle swarm algorithm and the least squares method. When the number of iterations that users set is reached, the satisfactory ANFIS model is obtained. The model also went through the simulation of controlling the electric curtains of the smart house in the Matlab platform. Theoretical analysis and simulation experiments show that this model can improve the learning ability of home control system [5].

3. Background Theory

3.1 Fuzzy Inference System

The primary objective of fuzzy logic is to map an input space to an output space. The way of controlling this mapping is to use IF-THEN statements known as rules. The order in which these rules are carried out is insignificant, since all rules run concurrently. Fuzzy logic is a powerful problem-solving methodology with a myriad of applications in embedded control and information processing. It provides a remarkably simple way to draw definite conclusions from vague, ambiguous, or imprecise information. In a sense, it resembles human decision making with its ability to work with approximate data yet finds precise solution [6]. Fuzzy logic provides an approach to data fusion and reasoning for uncertain data by using the human expert knowledge. The Fuzzy Inference System (FIS) is as shown in figure 1. It is divided into three mains components: the fuzzifier, the knowledge management and the defuzzifier [1].

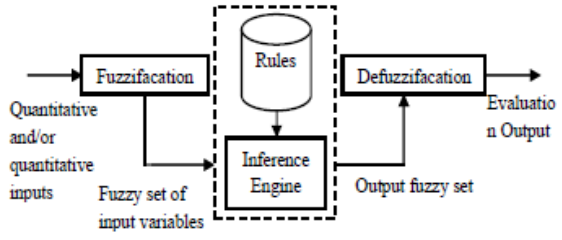

Figure 1. The Fuzzy Inference System

3.2. Geo fencing

Geo fencing is a technology used to monitor mobile objects (vehicles, persons, container, etc.,), located by GPS. The geographic coordinates of the tracked object are automatically and regularly sent to a control center, via mobile phone networks. The set of geographic coordinates is used to constitute a virtual boundary (Geo Fence) around a geographic area. The system can determine whether the tracked object is located inside or outside the Geo Fenced area. This technology can also allow the detection of spatial proximity between the tracked mobiles and a specific Geo Fenced area [7].

3.3 IFTTT

IFTTT is a web based service that allows Internet users to create a chain-reaction from one web service application to another. Based on a user-defined conditional statement, called a recipe, the trigger of one web service application activates an action of another web service application. The IFTTT model can be applied to home automation devices where one device can trigger the action of another device. The IFTTT technology is described as shown in Figure 1. The Figure 2 describes how home automation devices would react on the user-define recipes. Two recipes are shown in Figure 3. First recipe is "If motion is detected in a room, then turn on the lights". When the motion sensor in the room detects a movement, it sends a trigger to the central node. Based on the recipe and the trigger, the central node sends an action to the room lights to turn on. Second recipe is "If temperature and humidity changes in the garden, the turn on the irrigation system". When the temperature and humidity sensor senses change, it sends the trigger to the central node. Then, the trigger is Quantitative and/or quantitative inputs Fuzzy set of input variables Output fuzzy set Evaluatio n Output Rules Inference Engine Fuzzifacation Defuzzifacation interpreted by the central node that sends an action to the irrigation system. These recipes can be generated by remotely accessing the central node of the home automation system, or it can also be accessed within the home network. The central node acts as a router for the home devices to access the Internet and integrates all different types of data communication mediums. Therefore, the central node offers a web interface to allow users to configure the different recipes, which can be accessed from computers, smartphones or tables [8].

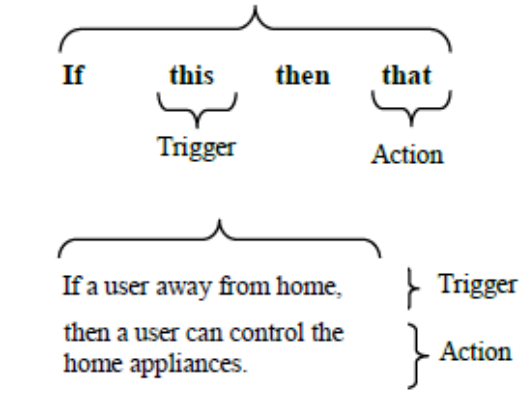

Figure 2. IFTTT Description

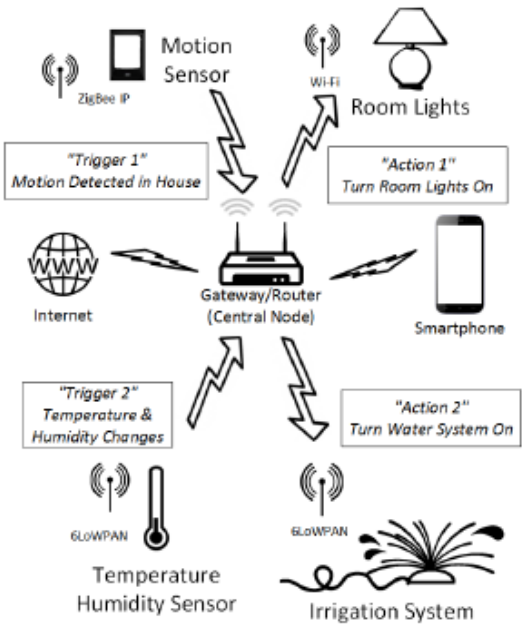

Figure 3. Home Automation Overview

3.4 Remote UI

Remote UI refers to Web 2.0. The user can create new services by combining the object provided services, it is called Web 2.0 or mashup. It can be specialized for the composition of services that enable accessing/controlling smart things [10]. A mashup is a web application or a web page which usually uses application programming interfaces (APIs) in order to blend information from multiple sources to create compelling services. As more and more embedded devices (like smartphones and sensor equipped appliances) will be applied to provide their functions as services online, and an abundance of real objects will essentially become a part of ambient spaces (interoperating and communicating over TCP/IP networks), the need to create value-added services by composing numerous embedded device enable services[9].

4. The Architecture of Home Safety System

The architecture of home safety system is shown in Figure 4. This architecture includes the special database system for the competing home appliances, some filters to judgement for sensors and home appliances to avoid malfunction, the Geo Fencing rules for intelligence fence, IFTTT acts like as remote control, sensor value rules for controlling the home appliances and the remote UI for monitoring the status of home. This system will use generic rules. Firstly, the system needs to define a set of fuzzy rules according to the input sensor values. This system also needs to define competing functions for competing appliances. The input value can be obtained by the sensors. Secondly, it proceeds to perform the fuzzy decision support system. And then this system will be made defuzzification by using the Sugeno fuzzy inference method to get crisp output. The Sugeno fuzzy inference method can be computed by the weighted average method. According the crisp output, finally the system will save the home appliances according to the competing functions which located in the special database.

In this system, the size of Geo Fence size can range from a few tens of meters to several kilometers. The Geo Fencing areas can be defined by geometric shapes. The geographical areas are defined as circular area, rectangular area and ellipsoidal area. This system defines the circular geographical area with a single point that represents the center of the circle and a radius. Coordinates from characteristic points of the shape are necessary to define the Geo Fence perimeter. These coordinates are used in equation (1), along with the inside or outside of the Geo Fence, which enables the computing of alerts. Sensor value rule uses the appropriate sensor values within the total range and the geo-fencing rules use fuzzy control logic, which is the IF THEN statements. The geographical circular area is described as shown in Figure 5. The function of geographical circular area is defined by equation (1).

$$F(x,y) = 1 - \left(\frac{x}{r}\right)^2 - \left(\frac{y}{r}\right)^2 \qquad (1)$$

Where F is the function to determine the spatial characteristics of a point (x,y) relative to a geometric shape, r is the radius of a circle, x is the abscissa of a Cartesian coordination system with the origin in the center of the geographical area, y is the ordinate of a Cartesian coordination system with the origin in the center of the geographical area. The function F defined in equation (1), determines whether a point is located inside, outside, at the center, or at the border of a geographical area. interface and creates new services by combining the object provided services.

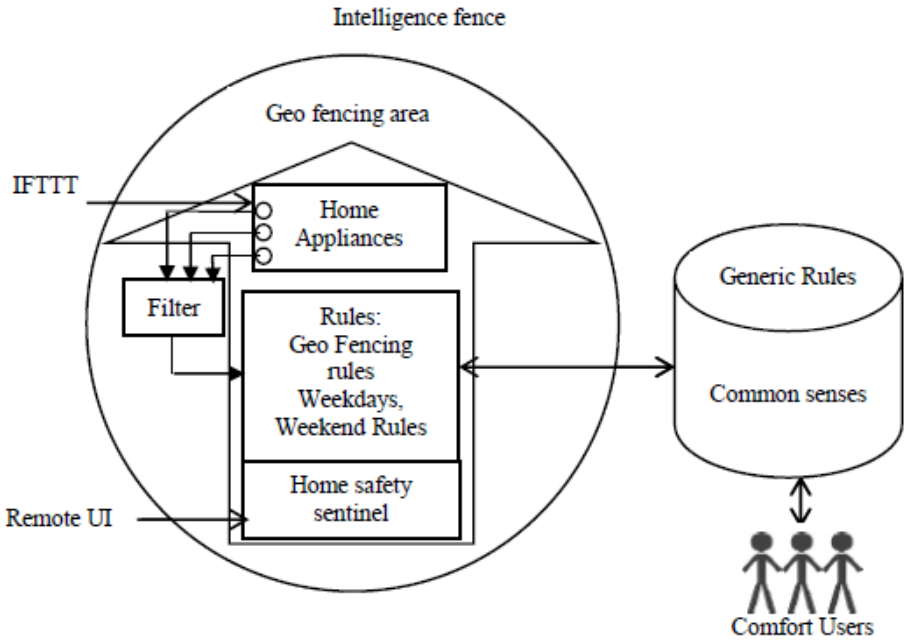

Figure 4. The architecture of home safety system

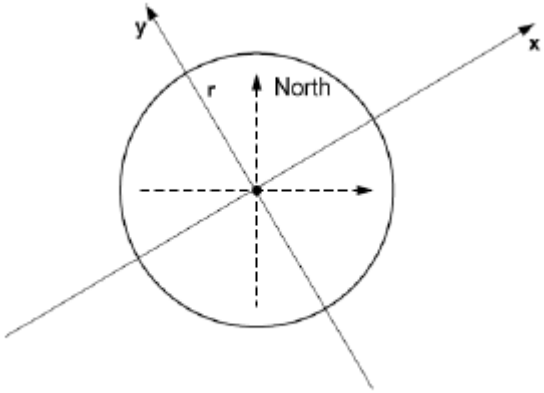

Figure 5. The geographical circular area

If the value of function F is equal to one, the location is at the center point of the geographical area. If the value of function F is greater than zero, the location is inside the geographical area. If the value of function F is equal to zero, the location is at the border of the geographical area. If the value of function F is less than zero, the location is outside the geographical area.

IFTTT is a web-based service that allows Internet users to create a chain-reaction from one web service application to another. Based on the IFTTT (IF-This- Then-That) model, this system will define a set of device communication protocols where devices' triggers and actions are combined to manage interactions for home safety. This system uses Web 2.0 for remote user interface and creates new services by combining the object provided services.

5.Evaluation of Home Safety System

The sensor and embedded appliances might be malfunctioned. So, this system will define the generic rules and must have some filters to avoid the malfunctions. The generic rule is the representative of common sense. The scenario is using the temperature to define the rules. These rules will be putted into the special database. When the people are sleeping sometime, they use the blanket, because the room temperature is a little bit low, i.e., common sense. There has rules based on the common senses, about the temperature, humidity, the electricity usages and more interestingly the home appliances, we can hold the state of appliances then we will be doing some more interesting senses, competing appliances (e.g., the heater and air con).
In this system, we assume that the competing appliances, the air conditioner is set to 25 degree and the heater is also set to 25 degree. When the heater starts to heat, it takes time to give warm. When the room temperature is high, the air conditioner kick the heater, it takes time to low the room temperature. They may over shift belong, and as soon as over shift. But, the temperature was higher than 25 degree, may be outside temperature as like 30 degree, at that time the air conditioner kick the heater, to cool down the temperature, (i.e competing appliances (competing functions)).

The following rules are the generic rules to use the competing functions. These rules are located into the special database.
Rule 1: if the heater is higher than 25 degree, then the air conditioner is cool down the temperature until 25

degree.
Rule 2: if the air conditioner is lower than 25 degree, then the heater is high temperature until 25 degree.
Rule 3: if the outside temperature is higher than 25 degree, then the air conditioner is cool down the temperature until 25 degree and the heater is just warm.
Rule 4: if the outside temperature is lower than 25 degree, then the heater is warm up to 25 degree and the air conditioner is still 25 degree.

This system will also use the rules for the Geo Fencing system. In this system, it uses the linguistic variables of fuzzy set for testing the Geo Fencing system which is shown in table 1.

Table 1. Linguistic Variables of Fuzzy Set

	Light	Air Con	Fan	Doors
Inside	On	On	On	On
Center	On	On	On	On
Border	On	On	On	On
Outside	Off	Off	Off	Off

This system defines the following rules to control the home appliances by using the geographical area.
Rule 1: If F(x,y) = 1 then the location is at the center point of the geographical area (control the home appliances)
Rule 2: If F(x,y) > 0 then the location is inside of the geographical area (control the home appliances)
Rule 3: If F(x,y) = 0 then the location is at the border of the geographical area (control the home appliances)
Rule 4: If F(x,y) < 0 then the location is outside of the geographical area (lock the home)

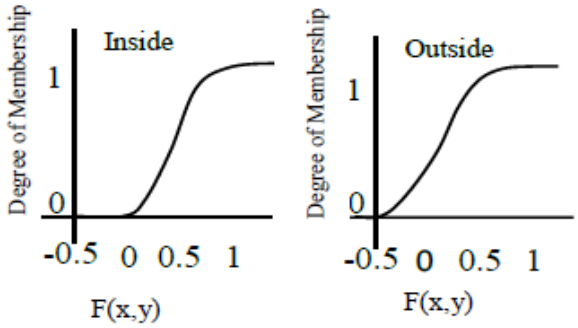

Figure 6. Fuzzy set of inside and outside of geographical area

Each input variable has membership functions as shown in figure 6. The output variable also has membership as on, off in table 1. These rules are applied to input and output of the Sugeno inference system in equation (2), which is weight average method to get crisp output for controlling the home appliances. The crip output of the system is the weighted average of all rule outputs, computed as

$$\text{The crisp output} = \frac{\sum_{i=1}^{N} W_i Z_i}{\sum^{N} W_i} \qquad (2)$$

Where, N is the number of rules, Z_i is the output level of rules and W_i is output degree of rules. According to the crisp output value from this equation (2), it will apply to control the home appliances. The Figure 7 is showing the result of IFTTT service to control the appliances by using IFTTT service. The IFTTT service can create chains of conditional statements, which is called 'applet'. The following conditional statement is tested based on android location, which acts as a remote control for appliances. If (EnteredOrExited) an area (OccuredAT) via Android (LocationMapUrl) then (Notify or Control the appliances)

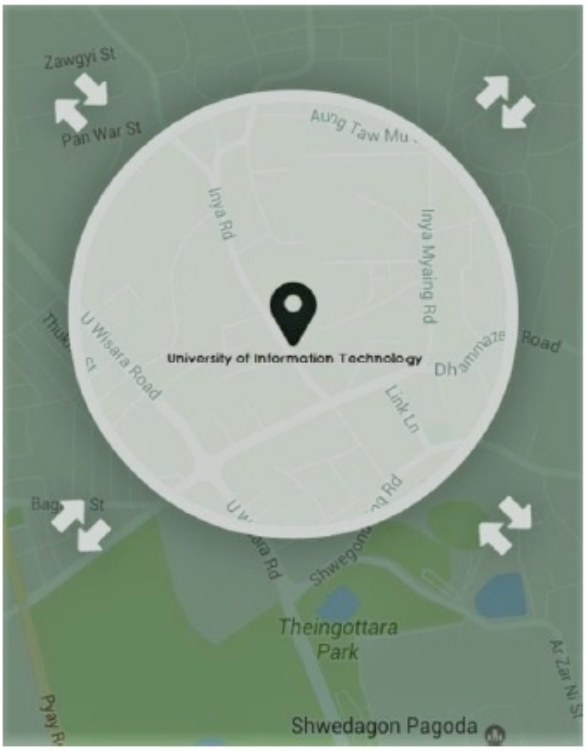

Figure 7. IFTTT service

If the user entered or exited at the specified area then send notification to the user and the user can control appliances which the user wants to switch on/off for electrical appliances.

6. Conclusion

This paper proposes a home safety system which helps us to assure the safety of home appliances and home environment. This system acts as a sentinel, which knows the movement of user to Geo Fence from inside, outside or cross direction. It can provide home safety functions. In this system has a special database for competing appliances. It is a new technique of implementing home safety system that

will give more safety for smart home appliances based on the rules. This system will save cause casualty or cause home property loss or both. There exist several home safety systems. This system to be more effectively and safety for home. This system will be acted intelligently the home safety services as like the human manner. In future work, this research plans to develop the detail of competing functions and movement of user.

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