

# The Home Safety System based on Rule based Approach

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**Abstract**—This paper proposes a home safety system which help us to assure the safety of home appliances and home environment. This system consists of a set of rules, IFTTT model and Remote UI. The system controls the home safety and the home electrical usage. Home safety functions are realized by the geo-fencing rules, when a user exit from geo fence area, the system will automatically lock the home. The size of geo fencing area is the circular geographical area. This system can save the electricity usage on the weekdays, when everybody has gone to his/her work and nobody at home. And it can also provide the safety functions on weekend. This system has two kind of rules; sensor value rules and geo-fencing rules. Sensor value rule uses the appropriate sensor values within the total range (we call them Intelligence values); and the geo-fencing rules uses fuzzy control logic. All of the functions provided our system can be controlled by a smart phone via GPS. Based on the IFTTT (IF-This-Then-That) model, we will define a set of device communication protocols where devices' triggers and actions are combined to manage interactions for safety of the home. Remote UI will also provide the functions to monitor and to control the status of home appliances.

**Keywords**—Home safety; Fuzzy control rule; Geofencing; GPS; IFTTT; Remote UI

## I. INTRODUCTION

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 [1].

This paper proposes a home safety system which helps us to assure the safety of home appliances and home environment. The system consists of the set of rules, IFTTT model and Remote UI. This safety system acts as a sentinel, which knows the status of electrical usage, temperature, human motion and etc., on home situations. It can provide home safety functions, and can also save the electricity usage.

The safety functions are realized by the geo-fencing rules, the sensors value rules of temperature, human motion detector. Firstly we need to define the geo fencing radius (area). If a user entered or exited the geo fencing areas, our system will automatically notify the user and can control the home appliances. The size of geo fencing area uses the circular geographical area. The area describes the circular shape with a single point that represents the center of circle

and radius. The Fig.1 shows the architecture of the rule based home safety system.

This system can also save the electricity usage on the weekdays, when everybody has gone to his/her work and nobody at home. And it can also provide the safety functions on weekend. On the weekdays and weekend, the system automatically work based on the rules to save the electricity.

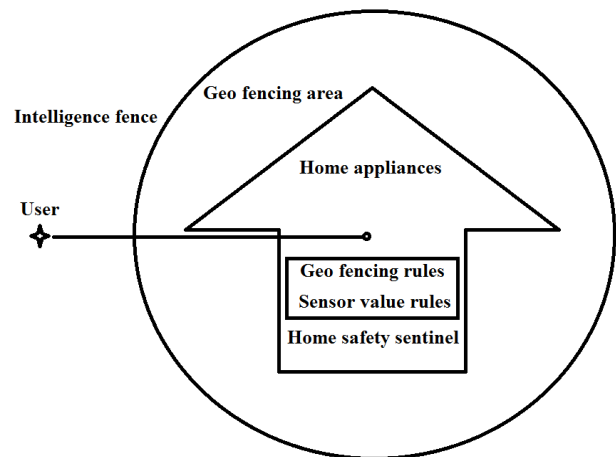


Fig.1. The architecture of home safety system

The home safety system has two kind of rules; sensor value rules and geo-fencing rules. We need to define sensor value rule uses the appropriate sensor values within the total range and the geo-fencing rules used fuzzy control logic. All of the functions provided our system can be controlled by a smart phone via GPS.

IFTTT (IF-This-Then-That) model is a web based service to created individual rule statements. We will define a set of device communication protocols where the home appliance devices' triggers and actions are combined to manage interactions for safety of the home. Remote UI will also provide the functions to monitor and to control the status of home appliances.

## II. RELEATED WORKS

Zhengguo YANG proposed an effective approach for home safety problem detection and reaction is necessary. In order for home safety problem detection, there are three levels of events defined: elementary event that excited by abnormal change of raw data, sematic event that is generated by one or more elementary events and entire event represents the emergency level of a house. For the relationship between these events and raw data, a Finite State Machine (FSM)

based modeling is applied. The raw data taken as input and output to the three levels of FSMs. Two simulation cases are proposed: one is heat stroke and another is carbon monoxide poisoning [1].

The continuous technical progress of the smartphone built-in modules and embedded sensing techniques has created chances for context-aware automation and decision support in home environments. Z. Meng, and J.Lu presented a rule-based service customization strategy which employs a semantic distance-based rule matching method for context-aware service decision making and a Rough Set Theory-based rule generation method to supervise the service customization. The simulation study reveals the trend of the algorithms in time complexity with the number of rules and context items. A prototype smart home system is implemented based on smartphones and commercially available low-cost sensors and embedded electronics. Results demonstrate the feasibility of the proposed strategy in handling the heterogeneous context for decision making and dealing with history context to discover the underlying rules [2].

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 detect 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 [3].

Geo fencing is one the components in the wider spectra of ambient assisted living related applications. Such applications are meant to provide support to persons with disabilities or to those impaired, as well as to their caretakers. Geo fencing targets the same mobility of such persons. As mobility related data can be translated into events with a temporal dimension, Bogdan Tarnauca, Dan Puiu and Septimiu developed a geo fencing service based on the complex event processing paradigm. They present the architecture of a complex event processing based geo fencing service along with the results obtained during the evaluation phase of the first prototype [4].

Various services using the location information are developed with the wide spread of smartphones. Geo-fencing is one of the services. In Geo-fencing services, terminals automatically carry out the some processing associated with the virtual border when they detect that themselves passes the border. However, it is a problem that power saving of Geo-fencing service covering over indoors and outdoors with high accuracy. Yoshitaka Nakamura proposed indoor/outdoor estimation method using various types of sensors with small power consumption [5].

Geo fencing enables remote monitoring of geographic areas surrounded by a virtual fence (geo fence), and automatic detections when tracked mobile objects enter or exit these areas. Fabrice Reclus and Kristen Drouard presented fundamental concepts of geo fencing and some applications based on this technique, in the transport & logistics sector.

Tracking and tracing systems that are based on global navigation satellite services and include a geo fencing feature, could also efficiently contribute to the enforcement of heavy goods vehicles (HGV) regulations: weight and height restrictions on specific routes or tunnels, dangerous goods transports restrictions, restricted access in urban area [6].

The home safety system has many techniques in daily life, the home safety sentinel is necessary for weekdays and weekend to safe home appliances and to save the electricity usage. We proposed the home safety system based on the rule based approach.

### III. BACKGROUND THEORY

#### A. 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 [6].

#### B. Fuzzy logic

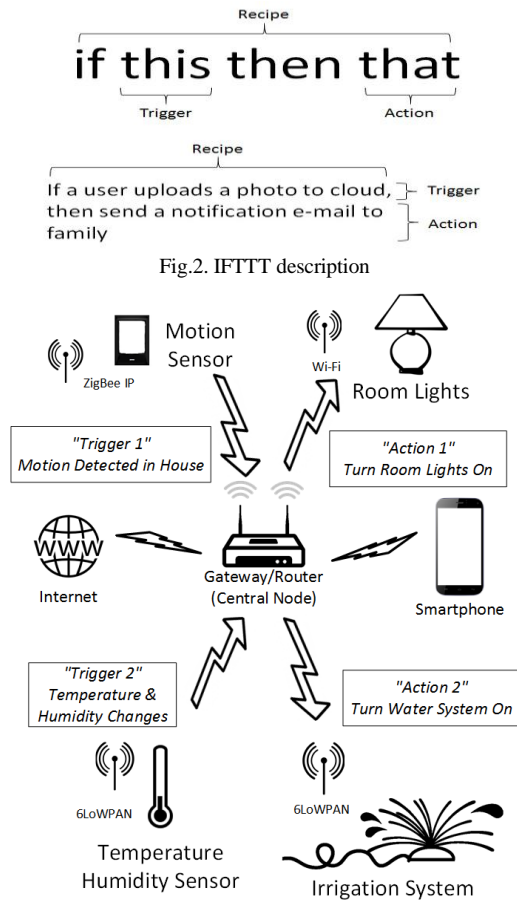
The primary objective of fuzzy logic is to map an input space to an output space. The way of controlling this mapping is to use IF-THEN statements known as rules. The order in which these rules are carried out is insignificant, since all rules run concurrently. Fuzzy logic is a powerful problem-solving 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 find precise solution [7].

#### C. 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 Fig.2.

The Fig.3 describes how home automation devices would react on the user-define recipes. Two recipes are shown in Fig.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 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].



automation devices where one device can trigger the action of another device via the internet. IFTTT can available as a web application as well as on mobile. Users can compose individual rules (or recipes) with a web interface. This system will define a set of rule, when a user exit from the geo fencing area, the system will automatically lock the doors and windows. We will also define a set of rule for weekdays and weekend in order to save the electricity usage. The remote UI can be used to monitor and control the status of home appliances via internet.

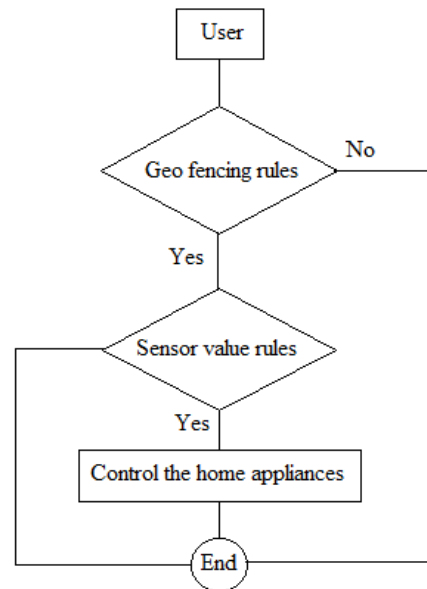


Fig.4. The proposed system design

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 supplied to the calculation algorithm, 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 Fig.5.

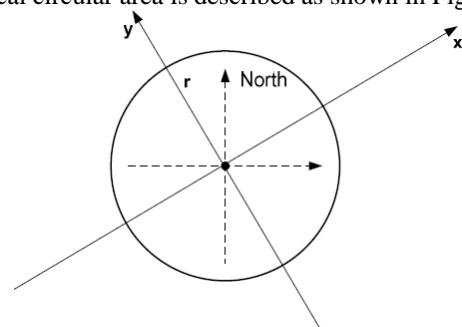


Fig.5. The geographical circular area

#### D. 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 [9]. 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 apply 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 [10].

#### IV. THE PROPOSED SYSTEM

The proposed system design is described as shown in Fig.4. In the home safety sentinel include a set of rules which are the geo fencing rules and sensor value rules. The home safety sentinel is watching the status of home appliances based on the set of rules. IFTTT model can be applied to home

The function of geographical circular area is defined by equation (1).

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

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. This clause defines a function F determines whether a point is located inside, outside, at the center, or at the border of a geographical area. If the value function F is equal to zero, 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 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, we will define a set of device communication protocols where devices' triggers and actions are combined to manage interactions for safety of the home. This system use Web 2.0 for remote user interface and create new services by combining the object provided services.

## V. CONCLUSION

This paper proposes a home safety system which helps us to assure the safety of home appliances and home environment. Our home safety system act as a sentinel, which knows everything on home situations. It can provide home safety functions, and can also save the electricity usage. When a user exit from geo fencing area, the system will automatically lock the home. On the weekdays and weekend, the system automatically work based on the rules to save the electricity. There exist several home safety systems. We are expected our proposed system to be more effectively and safety for home.

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