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HOME ELECTRICITY AUTOMATION VIA IoT: SMART MOBILE PHONE AND BEACON SUPPORTED PROGRAMMABLE HOME TYPE FUSE

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Abstract: In condition of fuse-blowing due to an undesired event (i.e lightning) resulting to short circuit or leakage current on the electrical network system which electrical home appliances are connected to, check of the wiring and re-set of fuse become necessary. Otherwise, refrigerator, deep freezer and security alert devices will not work. Foods like meat, yoghurt etc. which are high in protein will spoil and putrefy. Due to failure of security alert systems, any alert or alarm cannot be activated and any record cannot be done during an attack or burglary. Therefore, these types of devices should not be on failure state for a long time. In addition, another undesired condition about leaving homes for a long time is to be in undesired-working state of the devices. The devices like iron, electrical teapot, water heater and electric heater should not be forgotten on working state. Through a smart fuse, a device can be put to open or closed state. Moreover, these smart fuses can be controlled from the internet via connecting them to a network system. Under favor of the system, all the electrical wiring at home can be controlled and monitored from anywhere.

Keywords: Smart fuse, programmable fuse, iot, house automation, android controlled-home automation

Introduction

Remote control systems have acquired a different dimension and has become part of essentials together with the developing communication technologies. Remote control systems are widely used as technologies that facilitate life in areas such as military, industry, office, and home. Remote control systems related to our houses have been turned into commercial kits with the name of smart home systems. Electronically controlled heating-cooling systems, windows opening-closing systems, combi boiler controlling, burglar and fire alarms are among them (Izomaris, 2017). The basic feature of a smart home system is the remote control via the internet and mobile phones. However, this system is not usable for low income groups and elders. Electronic and mobile phone-based intelligent home fuse has been developed that will facilitate low income and disadvantaged groups in their working lives. The proposed system is modular and offers various preferences for various user profiles. As a standard property, safety switch kit was added to the product. Through this kit, the switches that are connected to the smart fuses are closed when elders leave home. Smart fuses also provide self-setting control. Commercial tools which provide these features are frequently used in the market. In leakage current or short circuit cases, the fuses are opened (i.e. lightning). In such cases, the electricity network is checked, and fuses are re-set. The commercial product does this job automatically. These are called automatic re-set tools (Voltimum, 2017). The proposed system, besides the similar ones on the market, is equipped with the help of a mobile phone to detect short or long term departures from the house.

Many studies are seen about smart breakers in the literature. Makanawala (2015) used the name “smart breaker” in his patent. When he explains the related features, he mentioned that the power of the breaker can be controlled via wireless tools like Bluetooth, zigbee, z-wave, wifi, and wired tools like CAN, I2C and USB. Hyde et al. (2015) mentioned about a microcontroller system which provides the integration between load and power unit

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together with breaker in their patent numbered US90933863 B2. The system controls suitability of power unit and load. The load is not tested in the proposed system. The current is measured, and the breaker opens depending on the current value. Many products with patent are seen in the literature. Generally, the aims that cutting the circuit in excessive currents, and providing load-power balance are pursued (Kim, 2000; Mrenna, 1996. Ramlee et al. (2012) have studied about electrical switches which are controlled through mobile devices and Bluetooth to ease lives of disabled people. Williams et al. (2011) proposed a system which transmits temperature of breaker and power parameters in their study.

Wijetunge et al. (2008) achieved a sensor measurement and a device control through Bluetooth network with an automation program. Five devices were controlled through this way. Chapel et al. (2013) stated two structures, local and remote controller, and mentioned that they can communicate through WAN. Keichi, Mineno and Mizuno (2011), in their study, mentioned about managing spent energy in houses. In their study, they mentioned a wireless network which was composed via ZigBee modules for transmitting data. Fadlullah et al. (2011) mentioned about machine-to-machine communication in smart networks. They proposed ZigBee for locals, and 3G/4.5G for remote connections in the communication network.

General Structure of the System

The devices which are left open when leaving houses for long times can cause dangerous results like fire. Smart home systems are suggested in the market to prevent such dangers. On the other hand, these devices are not very economic for low income groups. The proposed system is modular and the smart breaker which can communicate via BLE 4.0 can be offered to the market in an economical way. It transmits network information to mobile units and controlling module via BLE 4.0. Moreover, a communication distance based closing system can be composed by using I/Os on the module. The general structure of the first proposed example is shown in Figure 1. The system consists of three main parts.

Figure 1. General structure of the intelligent fuse system.

- **Smart Circuit Breaker**

The measurements are done and are sent to controlling mechanism. The sending job to controlling is optional. If desired, a cheaper local unit with microcontroller can be built. Communication of this part will be provided through the Bluetooth module.

Design of a microcontroller based electronic card which can communicate with BLE 4.0 module, and is able to broadcast using Bluetooth 4.0 technology may be done. It can be boxed in a way that it suits the rails on distribution switchboards for ease of use and montage. The smart breaker is shown in Figure 2 basically. The circuit board may be designed to fit inside the box.

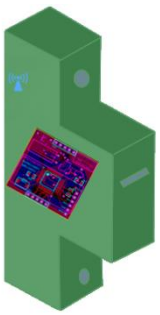

Figure 2. Smart breaker

- **Controlling Unit**

This is the part that smart breaker transmits the measurement results. The communication with smart breaker is provided via Bluetooth 4.0. Controlling module can communicate through wi-fi and ethernet. Therefore, it supports various connection types in remote connections. Also, it can be used through IOS and Android mobile operation system.

Microcontroller based controlling card can work under by 220 V grid voltage and 12 V dry accumulator. It has Bluetooth, wi-fi and Ethernet communication properties. It can send the data that comes from the smart breaker on the internet. In need, energy consumption statistics can be composed in a program. It is suggested to use Mac filtering to prevent data security problems. The unit can show the data it took on 128X64 LCD screen. The first example of the unit is shown in Figure 3.

Figure 3. Controlling unit

- **Mobile Transfer Unit**

The main target of this unit is to determine locations. When the connection distance is excessed (i.e. when a lonely and elder woman goes away), the switches that should be closed are closed.

Mobile transfer unit was designed especially for elder and Alzheimer patients. This module is matched up with the smart breaker, contains BLE 4.0 module and can be reduced to the dimensions of a key. It has low level power consumption like beacons. Its battery can be used for years. The target of this module is to detect when the person leaves home for a long duration. For instance, when an Alzheimer patient leaves home, and a heater is left open, the system detects that and closes the switch that is connected to the heater. The system can also be added with a vibrating and audible alert. The job that this unit does can be done by smart phones and tablets. However, it is evaluated that it may be a more effective solution for the elderly and needy patients. The first example schematic of external mobile transfer unit is shown in Figure 4.

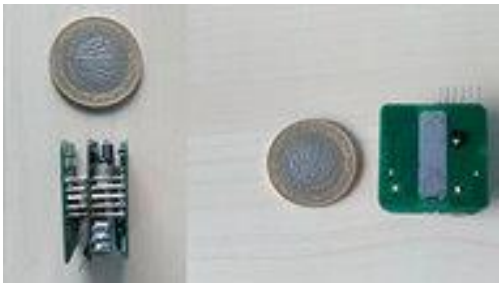

Figure 4. Mobile transfer unit

System Software

The system consists of Microcontroller, Beacon and Android based mobile phone. The tasks of the software partitions are given below.

- **Smart Circuit Breaker Software**

Bluetooth-communicating and low power consuming module program will be loaded into the microcontroller. It may differ depending on microcontroller choice. For example, while Atmel Studio is used for Atmega 328 microcontroller, MicroC can be used for STM microcontrollers. The usable equipment varies. For Bluetooth configuration, AT commands can be sent from microcontroller through serial communication.

- **Controlling Module Software**

The program of controlling module can be also prepared for microcontrollers and can be loaded. The algorithm for the program is shown in Figure 5.
For the communication of the system, Wi-Fi and Bluetooth 4.0 protocols are used. Master/slave relations between the modules should be specified in microcontroller program. Configurations are done with AT commands on Rx/Tx. After matching up, Rx pins are checked for communication. Active cases of Rx pins mean that some information is coming from outside. Activity of Rx pins is checked within some time intervals. Firstly, the data is taken and then it is recorded to memory. Later, the data is read.
Classification and evaluation of the taken data can be done by microcontroller or mobile devices. The criteria and to do list depending on the cases should be specified in the program. For example, maximum and minimum values of the data taken from the sensor, to do list in cases of exceeding maximum value, to do list for under the minimum value, and to do list for normal cases can be specified.
After evaluating the data, the actions done and the condition is sent to the controller module screen and Wi-Fi module.

- **Mobile Transfer Unit Software**

The program of this unit can be done in two different ways. If the transfer unit is a mobile device which has an Android operating system, an Android application program will be realized. If a device that has dimensions of a key will be used, a program of a microcontroller system can be done, like the other modules.

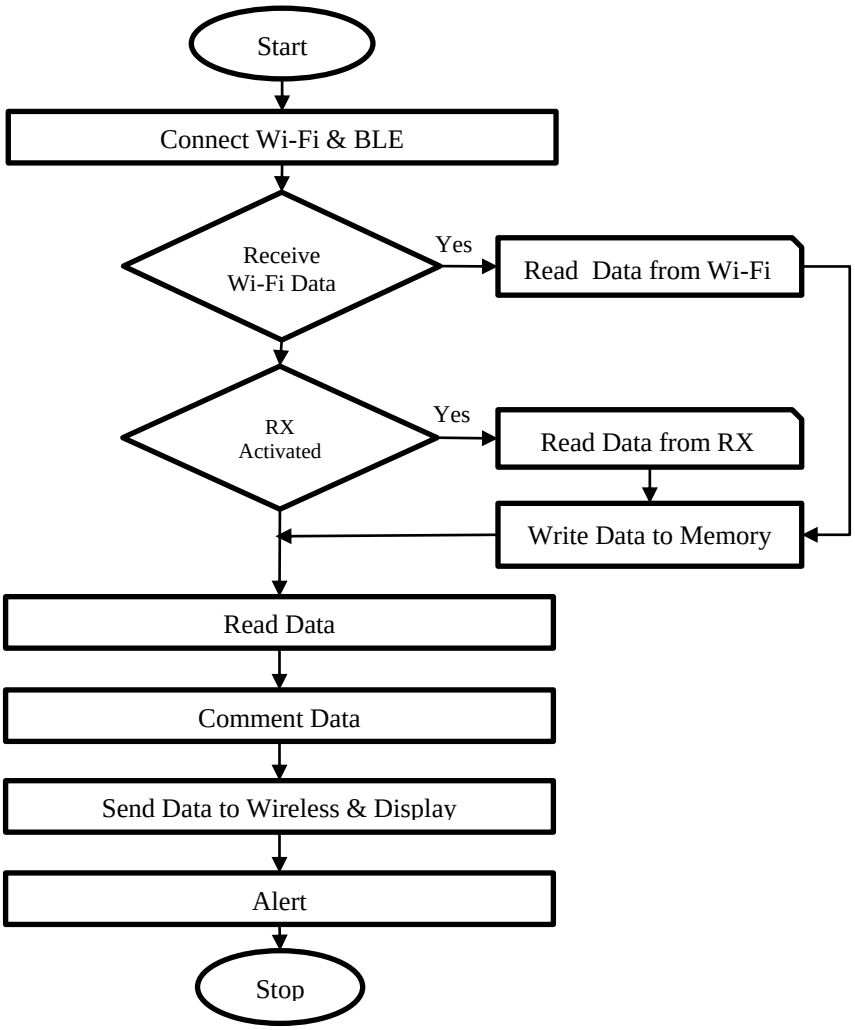

Figure 5. Flow diagram of the system

Result and Conclusion

With the production of the proposed first example:

- It will help prevent damage caused by power cuts caused by fuses in the house
- The accidents which may happen to elders, lonely people and Alzheimer patients can be prevented in some degree.
- Energy waste is prevented.
- Energy consumption can be observed, and some directions can be made for energy conservation.
- Development and serial production of the device will contribute to the national economy.
- Usage and utilization of people, and the public contribution may be a subject to social research studies.
- Through motivating to the usage of wireless technology, it will contribute to the studies on this subject in the country.

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