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Miniature Circuit Breaker (MCB) Current Detector by using Microcontroller and Global System of Mobile (GSM)

Noor Farhana Md Husin[1], Nor Akmal Mohd Jamail[1]*

[1]Faculty of Electrical and Electronic Engineering,
University Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

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Abstract: Rising electricity consumption has important implications for economic growth and trade. Although the increased electrical energy consumption is necessary to develop income, pollution, uncertainties, and environmental issues have the potential to become major national challenges. The main problem that had been solved is that electrical hazards in residential areas are frequently linked with malfunctioning home appliances and surging appliance demand, which occurred in overloading. The prevailing electrical distribution system is insufficiently protected and does not provide sufficient warning to the household. The focus of the project is on how to overcome the conventional operation of a Miniature Circuit Breaker (MCB) and improve the system by continuously monitoring electricity usage to optimise system management and minimise hazards caused by electrical faults. MCB Current Detector has been developed by using a microcontroller which is Arduino MEGA and GSM SIM900A Module. This system detects a current reading in the protective region of the MCB, directly logged to MicroSD Card and sent an alert signal to the household in the form of a light indicator, an alarm, and an SMS message. As a result, the homeowner can take precautions as needed and assist the wireman with maintenance. In the meantime, this system can assist in the reduction of electricity bills. The prototype has been created and been tested on four (4) types of a load of home electrical appliances, the load was a 5W smartphone charger, 2200W electrical kettle, 45W table fan, and 750W bread toaster. The results of the test show the prototype had sent a notification to the user based on the current reading flow.

Keywords: Miniature Circuit Breaker, Current Detector, Global System of Mobile

1. Introduction

The supply of electricity from the utility is required for the operation of residential and commercial buildings. The consumer entity that connects the customer to the service is the Distribution Board (DB) [1]. The fault current is determined by the short circuit power sources. When compared to a small Distribution generator connected to the distribution system, the transmission grid has a higher short

*Corresponding author: akmal@uthm.edu.my

circuit power. The fault current seen by protection relays when a distribution system is landed is lower than the fault current seen when the distribution system is connected to the transmission grid [2].

Rising electricity consumption has important implications for economic growth and trade. Although the increased electrical energy consumption is necessary to develop income, pollution, uncertainties, and environmental issues have the potential to become major national challenges [3]. Residential buildings have the highest number of fire cases (2093) among all other types of buildings [4]. The structures were destroyed due to an electrical fault caused by short circuits, overloading, or lightning. The threat grows as more electrical equipment are utilised in each household unit.

Usually, the old building is not maintained well, so most of the electrical protection system is not upgraded. The inefficient or old MCB can cause burning, continuous tripping, melting wires, flickering or dimming lights. This project proposed using a microcontroller to build a Smart Overload Detector by using a Microcontroller and GSM to notify the user before the MCB tripping to overcome the improvise of conventional distribution boards.

2. Methodology

The contribution of the national sustainable development of households today varies with the argumentation of demand response. As demand for load increases, the tendency for failure increases. The fact to the study, in Malaysia, users are not understanding the technical aspects of home distribution boards. The project is assisted users in notifying them of usage and alternatives before an overcurrent occurs. Therefore, the exact root cause of the overload is undefined. The household will require the assistance of a wireman to maintain for them. The point of the project is to assist wiremen in detecting the source of a fault by referring to the display, alarm, indicator, notification, and tracking the records in a data log to speed up the energy recovery time.

2.1 Software Development and Components

The Arduino IDE had use for programming the microcontroller. The circuit design using Fritzing for Breadboard Circuit View. And Microsoft Excel for analysing the data logger. The diagram for the prototype. From supply 230V connected to MCB 6A and socket. The current sensor clamped between MCB and socket. The list of components had been used:

- Arduino MEGA
- SCT013-000 (100A)
- ADS1115 as ADC converter
- Tiny Real-Time Clock (RTC) Module
- Micro SD Card Module and Micro SD Card
- I2C Arduino OLED (1.3inch)
- RGB LED
- Piezo Buzzer
- Resistor
- GSM SIM900A Module

2.2 Circuit Design

Figure 1 shows the complete circuit of this project.

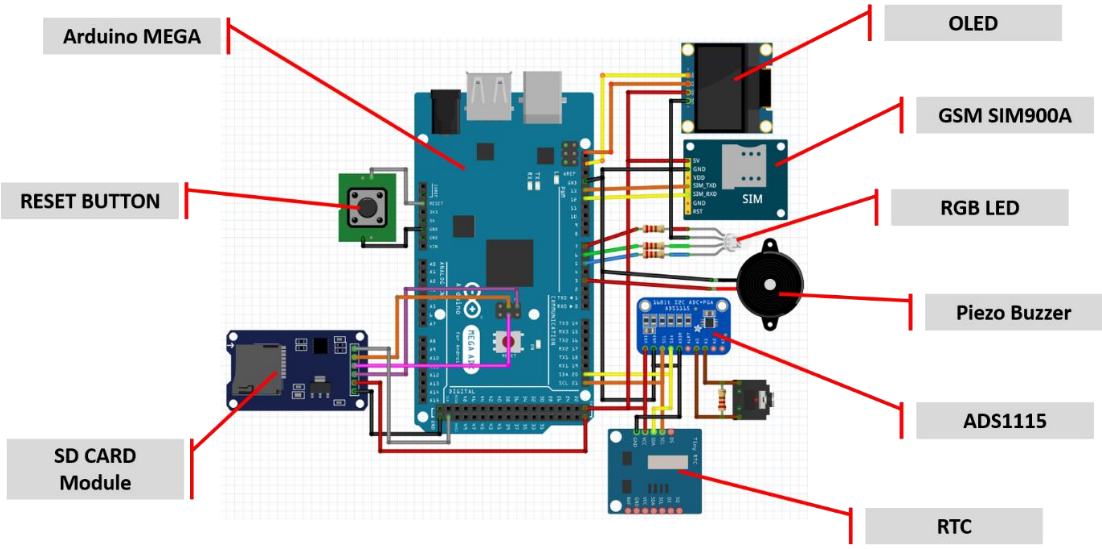

Figure 1: Circuit design

2.3 Hardware Development

From supply 230V connected to MCB 6A and socket. The current sensor clamped between MCB and socket. Figure 2 shows the block diagram of this project and Figure 3 shows the hardware development of the project.

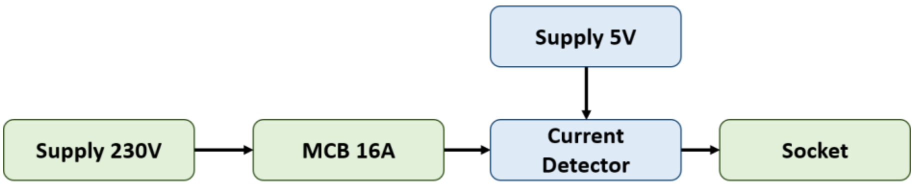

Figure 2: Process of the hardware diagram

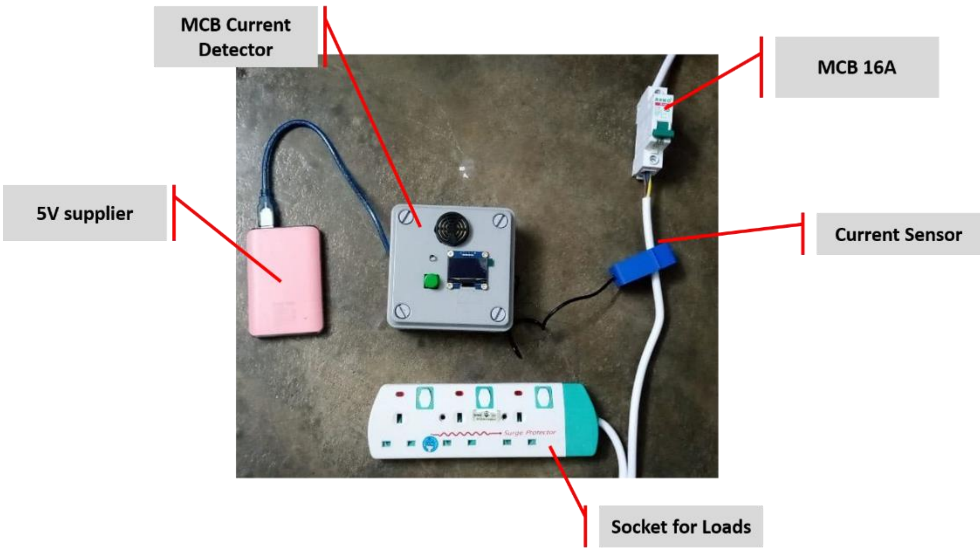

Figure 3: Hardware the project

2.3 Operation System

Figure 4 shows the flow chart of the project.

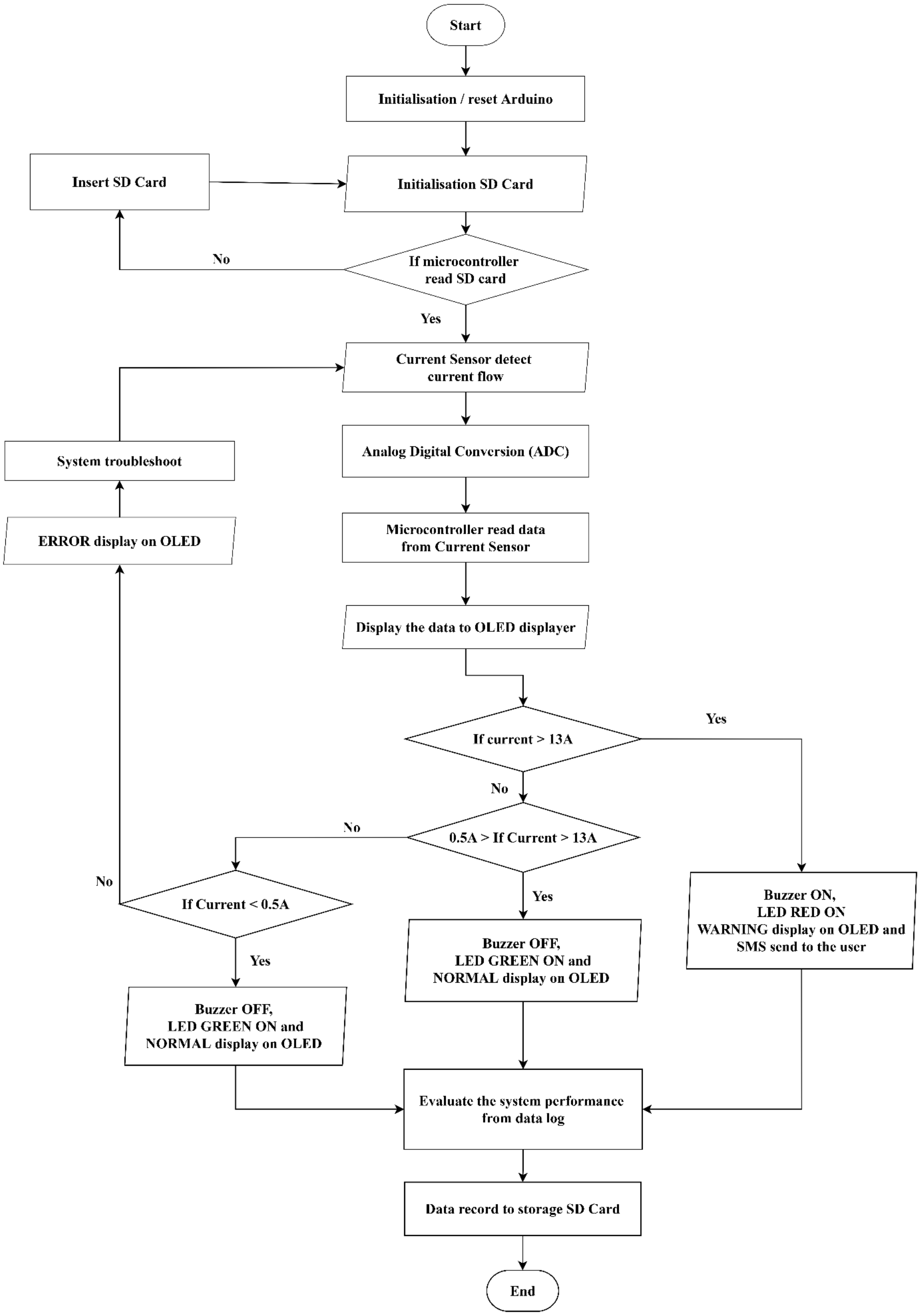

Figure 4: the operation system

The system operates started with initialised by resetting the Arduino. The system initialises the SD Card for logging data. If MicroSD Card is not present, the user had been notifying an error of SD Card processes. If the MicroSD Card is present, Arduino started to read input from the Current Sensor, after been converted at Analogue Digital Converter (ADC). Next, every second reading of current and power is displayed to the displayer and the LED would ON. These are three conditions on the range or current reading from the current sensor. If the value current is more than 13A, the LED RED and Buzzer is ON, while "WARNING" is displayed on OLED and GSM SIM900A module is triggered for sent a warning message to the user. The second condition, the current between 13A to 0.5A, which is a NORMAL condition with LED GREEN is ON. The third condition, the LED is on BLUE for the condition is LOW, which current is less than 0.5A. Every data from the current sensor is always displayed to OLED and logged in SD Card Module.

3. Results and Discussion

The project is tested using SCT 013-000 current sensor connected life wire after the MCB and communicated through Arduino MEGA. The Miniature Circuit Breaker (MCB) Current Detector consists of five parts that are Sensors, Display Status, Alarm System, Light Indicator and SMS text as shown in Table 1. The Sensors part had clamped to connection from source after MCB. The Display Status will display the current reading, power consumption and overload status corresponding to the real-time value. The Alarm System part will change in five (5) conditions, either due to the current reading reaching the threshold value of the MCB protection region or due to no presence of an SD Card for the data log and Clock system (RTC). The light indicator will change accordingly with different conditions as stated in Table 1. The SD Card module will read all of the output current readings and automatically save the data into the MicroSD Card.

Table 1: Notification system

Conditions	Light (LED)	Alarm (Buzzer)	Notification SMS (GSM SIM900A)	Display (OLED)
I(A) < 0.5A	Blue	OFF	-	LOW
0.5A > I(A) > 13A	Green	OFF	-	NORMAL
I(A) >13A	Red	ON	SMS OVERLOAD	WARNING
Clock (RTC) denied	Yellow	ON	-	ERROR
SD Card denied	Purple	ON	-	Check SD Card and RTC

3.1 Results

There are four (4) different loads of electrical appliances, which is a 5W smartphone charger, 2200W electrical kettle, 45W table fan, and 750W bread toaster. The notification system only changes from BLUE to GREEN light of indicator, which is a LOW and NORMAL condition. The displayer displayed the value of current around 0.5A to less than 13A. Other than that, an alarm had not triggered and tripped the MCB. The process repeated with multiple loads in one time with around three-minute running loads is being increased from time to time. There are six (6) experiments had been logged on the utilisation of current on the different types of loads and combined the loaded with 5W smartphone charger, 2200W electrical kettle, 45W table fan, and 750W bread toaster. Also, the data of multiple loads in one time running had been tested. Figure 5 shows the analysis of current reading on utilisation of 5W smartphone charge for around four minutes had been used. The maximum current is 0.02A at first minutes used for 6 seconds. The average minimum current reading is 0.01A.

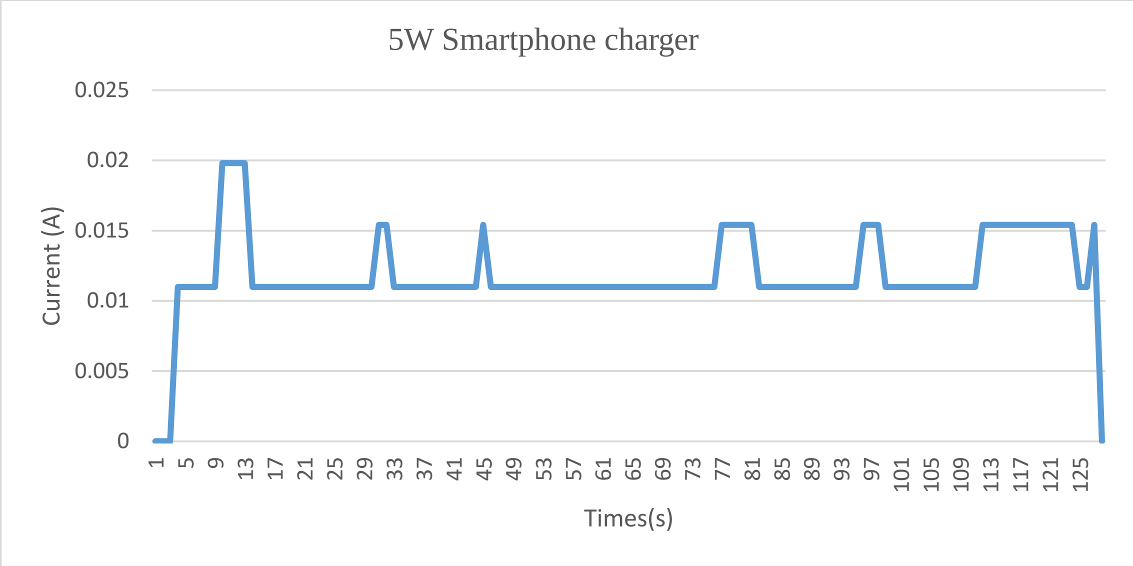

Figure 5: The utilisation of current on 5W smartphone charger

Figure 6 shows the utilisation on current on 2200W electrical kettle for around four minutes. The maximum current was record for 2 seconds is 8.61A and the average minimum current is 4.8A. the experiment take around four minutes to boiled 1.7 litre of water.

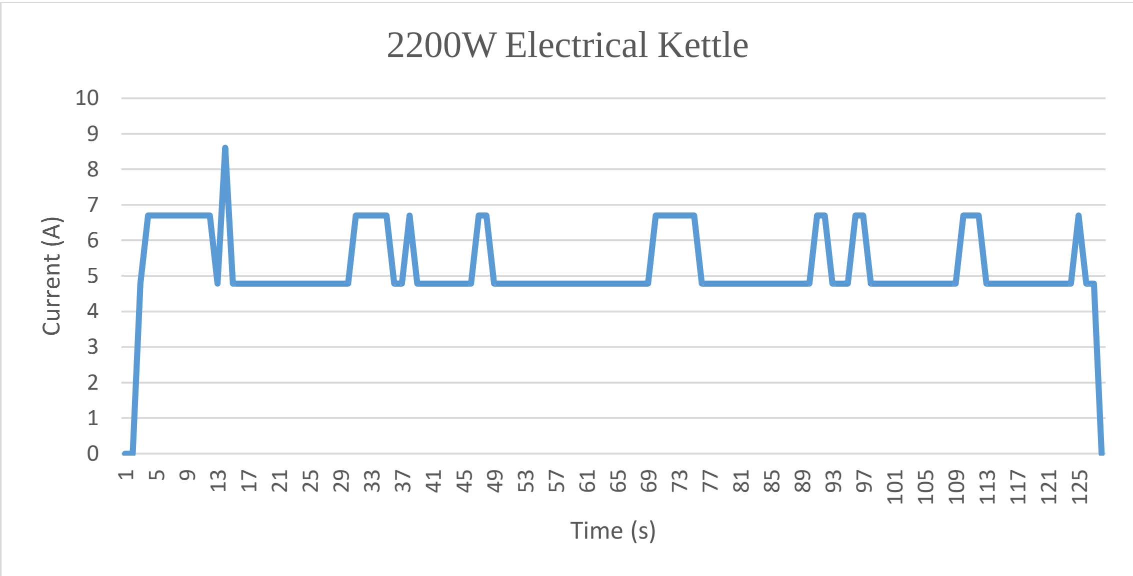

Figure 6: The utilisation of current on 2200W electrical kettle

Figure 7 shows the utilisation of current on a 45W table fan. The average maximum current reading had been logged is 0.14A and the average minimum current reading is 0.1A. the experiment takes around three minutes on the table fan is ON.

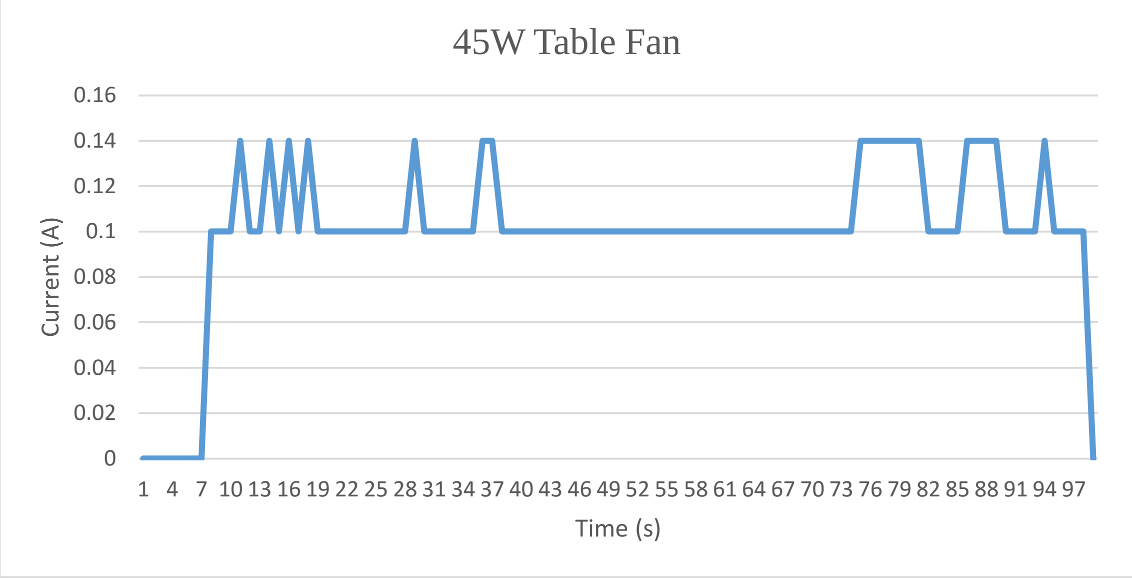

Figure 7: The utilisation of current on 45W table fan

Figure 8 shows the utilisation of current on 750W bread toaster. The average maximum current reading is 2.3A and the minimum average current is 1.6A. this experiment takes around two minutes for toasted bread.

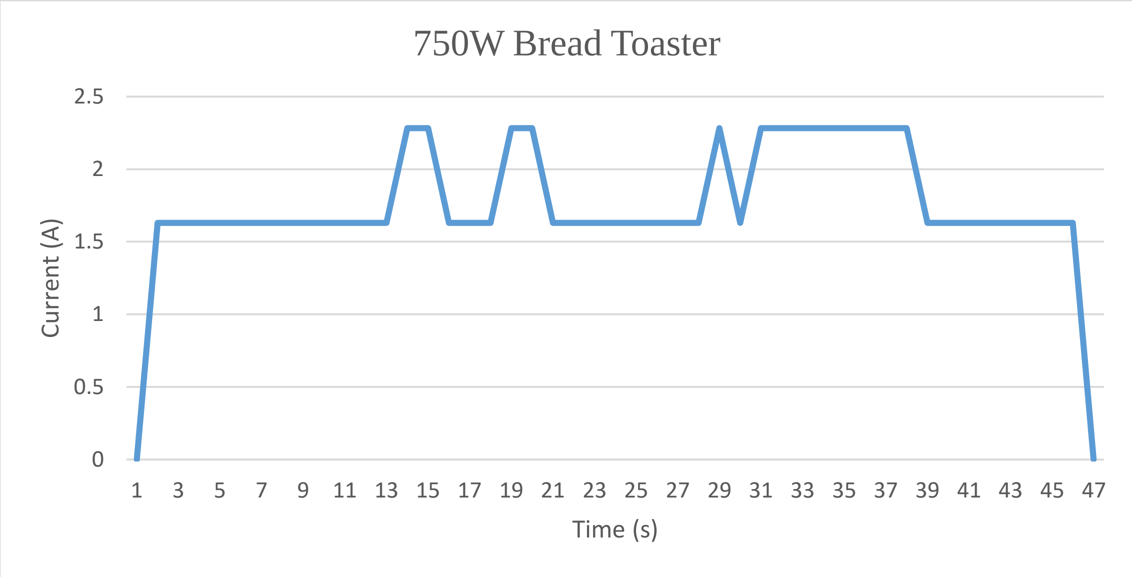

Figure 8: The utilisation of current on 750W bread toaster

Figure 9 shows the utilisation of current on a 45W table fan and 750W bread toaster. The average maximum current reading is 2.42A and the minimum current reading is 1.73A. the experiment takes around two minutes for toasted bread while the table fan is ON.

Figure 10 shows the utilisation of current on 45W table fan, 750W brad toaster and 2200W electrical kettle. The maximum current reading is 9.12A is frequently reached around twenty-second for toasted bread and boiled 1.7-litre water while the table fan is ON.

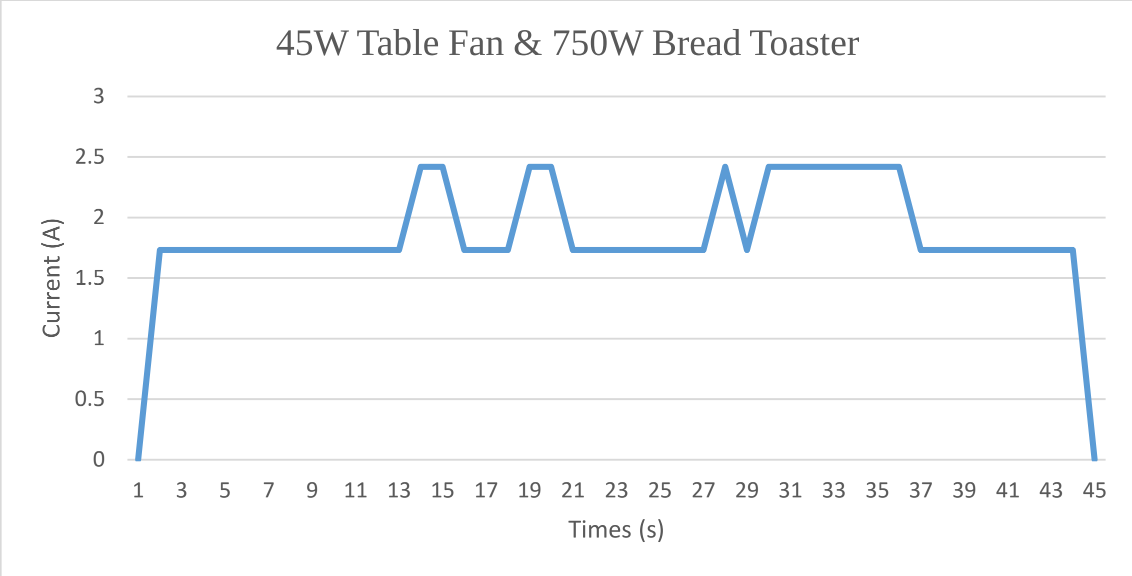

Figure 9: The utilisation of current on 45W table fan and 750W bread toaster

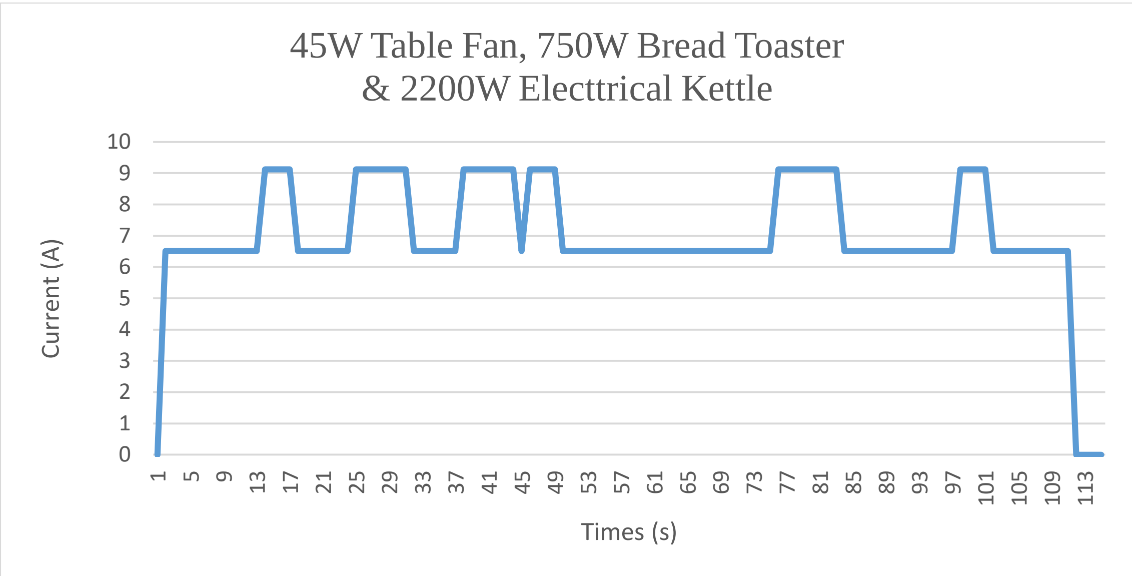

Figure 10: The Utilisation of Current On 45W Table Fan, 750W Brad Toaster and 2200W Electrical Kettle

3.2 Discussions

The data log on the SD Card contains three types of information is the date and time, the current reading, and the power consumption in txt format. the information was acquired hundreds of times per second and saved in Microsoft Excel. As a result, graphs are created with Microsoft Excel tools to show the pattern of current readings. The SMS text was provided with a warning latter which is OVERLOAD, current reading, and power consumption at the same time of overload occurs.

4. Conclusion

The conclusion is the response of the system can have seen by using different loads before the MCB reaches the peak overload current values. Different loads produce different results current values and graph patterns. The proposed prototype had monitored current readings, notified the user, and also assisted the user in order to improve the system. Furthermore, as an initiative to reduce fatal cases involved in electrical in residential areas, this project helped to improve household safety while assisting in the reduction of electricity bills.

Acknowledgement

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