Proceedings of Symposium on Electrical, Mechatronics and Applied Science 2018 (SEMA'18), pp. 65-66, 8 November 2018

Development of a iot based digital ammeter with bluetooth in half-duplex communication

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Keywords: Internet of things, half-duplex, android app, bluetooth

ABSTRACT – IOT is receiving great attention from the industries to improve the efficiency of systems and operations. The implementation of IOT in measurement instruments such as an ammeter is still lacking. Ammeter is an instrument commonly used in the light emitting diode (LED) industry for measurement of current supply to a LED module within a certain allowable limit. In this paper, the development of a digital ammeter using Bluetooth module for wireless data acquisition and remote setting for pass and fail current rating of a LED module was presented. A digital current acquisition system with a half-duplex Bluetooth system has been successfully developed to obtain current data of LED luminaires.

1. INTRODUCTION

IOT devices are capable to handle remote tasks such as system health monitoring, environment monitoring, remote control, service and big data accessing, where all the tasks could be done on internet based on the wireless technologies [1].

Currently, NexusLED Green Technology Sdn. Bhd. is a Light Emitting Diode (LED) module manufacturer and supplier in Malaysia. In this industry, operator utilizes a power supply with ammeter to test the reliability of their products. The current supplies to different models of LED modules are required to meet certain standards of current limit. The existing measurement of the current is laborious and without data acquisition system that can acquire current consumption of the product. Conventional benchtop ammeter displays the current and voltage measured on a Liquid Crystal Display (LCD). Most of the ammeters are without output data and wireless connectivity. To increase the efficiency in the measurement test, the measurement of the current supplying to a LED module can be digitized and recorded with the aid of Bluetooth technology [2]. The significance of integrating IOT into an ammeter improves the connectivity of instrumentations and ready for data acquisition that can be used for big data analysis.

In this project, a digital ammeter was designed and developed using a microcontroller interfaced with a hall-effect current sensor for sensing current in a range of 0.01A – 20A. In half-duplex manner, the ammeter can be set with a pass-current range for each single product's models and determine whether the current flows in the LED module is within the pass or fail limit according to the current ratings of different models of LED modules. The setting of the current ratings should be immediate without the need of a USB cable in re-programming a microcontroller. That would be expected to increase the efficiency in the reliability test.

2. METHODOLOGY

2.1 The conceptual design

Figure 1 shows a block diagram of the entire IOT system included in a digital ammeter and the android phone system. The main controller in sensing the current (Amperes) from a LED module is an Arduino Atmega 2560 microcontroller. The whole system was programmed using C++ High Level Language supported by Arduino IDE compiler. Once started up, the microcontroller receives the current time and date from a RTC module. Subsequently, the microcontroller reads the current from a ACS 712 hall-effect sensor and digitized via a 10-bit ADC in the microcontroller. The microcontroller compares the amount of current from the hall effect current sensor with a minimum (min) and maximum (max) current-pass range and indicates whether the current flows are within or out of the range. Subsequently, data are simultaneously sent to the smartphone via Bluetooth (HC-05) module installed in the digital ammeter. Moreover, the microcontroller is always ready to receive the current-pass range (minimum and maximum) setting values from an android phone.

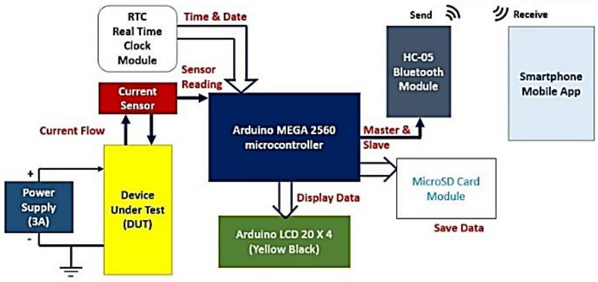

Figure 1 Digital Ammeter System Block Diagram with Bluetooth Communication.

2.2 The Android App Design

The android app was designed using MIT App Inventor 2 online software. The Android app was used as a remote controller via Bluetooth link which possess two main functions: acquires data from an ammeter and send the current-pass range to the ammeter. To achieve both functions, the app was designed with an app user interface for data reception and transmission (Figure 2).

2.3 Signal Strength Measurement at Different Angles and Distance

The Bluetooth signal strength between the android app and the digital ammeter has been tested in an open area. The signal strength measurement was carried out at difference angles $(+45^{o})$ by moving the smartphone away from the digital ammeter placing at the centre of measurement area. The data received was monitored when the data is continuously sending from the digital ammeter to the smartphone app.

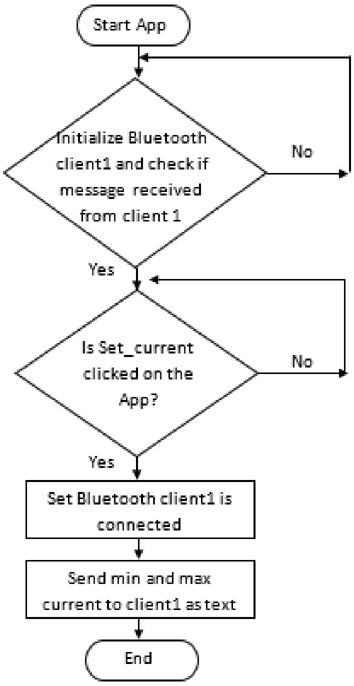

Figure 2 The flow diagram for the App design.

3. RESULTS AND DISCUSSION

The current output from the current sensor is linearly proportional to the digitized value converted from the ADC of the microcontroller. The current values were sent through the Bluetooth module connected to the microcontroller to the android app. The Android app consists of two screens; first screen is for setting Bluetooth connection between Android app to HC-05. There are two buttons, one is for enabling connection to Bluetooth and another one is for disconnecting from Bluetooth. A user must connect the Bluetooth before proceeded to the next screen. The android app calls the Bluetooth to connect with the selected address once selection was made. Then, the second screen will appear as shown in Figure 3. In this app interface, the data receiving section is on top of the screen, current-pass range setting section is in the middle, and data saving section at the bottom. Data receiving section will receive data from digital ammeter in every second once Bluetooth was connected. Current-pass range setting section allows the user to insert the minimum and maximum value in the two text boxes and send these two values via Bluetooth link to the digital ammeter when setting button is clicked. Data saving section allows user to save the data received from ammeter into CSV file in smartphone storage.

The maximum distance for the Bluetooth to transmit and receive data is approximately 7 m at all angles. The signal was most stable within this distance. However, it was noticed that the signal strength in barricaded area is similar to the open area.

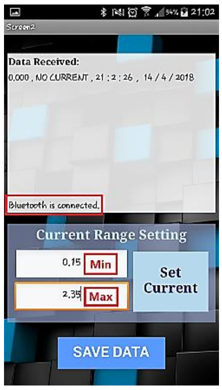

Figure 3 Android App for communication with the digital ammeter

4. CONCLUSION

This work has successfully implemented IOT in a digital ammeter and an android app integrated with Bluetooth module as half-duplex communication protocol. This design has cut down the use of wires to program the microcontroller. Hence, no computer or cables are needed for current setting, and data can be directly saved to phone storage for easy to transfer and managed within 7 meters of distance. The data acquired for different LED modules can be save and further analyzed for product reliability.

ACKNOWLEDGEMENT

The author is grateful to the financial support under the GPPS Grant Vot No. U707 and IGSP Grant Vot. No. U679 from Universiti Tun Hussein Onn Malaysia.

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