IOP Conference Series: Materials Science and Engineering

PAPER • **OPEN ACCESS**

Design and implementation of a smart watch

To cite this article: V Tomoloju *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1036** 012061

Design and implementation of a smart watch

V Tomoloju[1], M R Usikalu[1*], W A Ayara[1*] and L N Obafemi[1]

[1]Department of Physics, Covenant University, Ota, Nigeria

Correspondence email: williams.ayara@covenantuniversity.edu.ng
moji.usikalu@covenantuniversity.edu.ng

Abstract. Human connectivity is one of the major factors for productivity, especially in a school environment. The development of this watch is aimed at enhancing productivity by increasing the communication of both staff and students in the community. The watch is centred at creating a connected school community that will provide real-time communication to enhance the educational experience for students, staff and management regardless of their location within the school premises. This will enable members of the community to share information in real-time. The watch was designed with the Arduino pro-micro as the main processor. The watch leveraged WI-FI technology using the ESP8266-01 WI-FI module for connecting to a network and receiving of messages. The watch was connected to a secured intranet network. The watch has an average response time of approximately twenty-five (25) seconds to filter the data sent by the server and extract the message. Upon testing the design, the overall current draw of the watch was found to be approximately 78 mA. A lithium battery with a current capacity of 750 mAH was used for this project, which means that the battery will last for approximately nine hours. This kind of project is recommended for school communities so as to increase connectivity and enhance productivity.

Keywords: Smartwatch, connected community, Wi-Fi, Arduino

1. Introduction

Human connectivity is one of the major factors of productivity, especially in a school environment. A connected school community leverages on technology to provide real-time communication to enhance the educational experience for students, staff and management regardless of location within the school. This will enable members of the community to share information in real-time. The desire of creating a connected school environment is very much important due to the rapid increase in member population contributing to the increase in the community size. Figure 1 shows the basic block diagram for the design.

A community is a small or large unit in a given society that is governed by the same norms or identity in common. Therefore, a connected community in this context refers to interconnectivity amongst members of a set social unit which is a subset of a "smart city". A smart city is a community that uses various types of sensors for the collection of electronic data to provide information that is used to efficiently manage resources and assets. Smart cities optimize the use of technology in infrastructure and building design and operation in a manner that meets their citizens' current and future needs.

Researchers highlight eight aspects that define a smart city: smart energy, smart governance, smart mobility, smart healthcare, smart infrastructure, smart citizens and intelligent technology, as shown in Figure 2 [1]. Community is defined as a sense of belonging in members, a sense of belonging to each other and to the group and a shared belief that the needs of members will be brought to fulfilment through their commitment of being together [2]. Therefore, from this viewpoint, it is safe to say that for a connected community to be possible, a sense of community has to be established amongst its members. Covenant University, as a community, has excelled in effectively incorporating technology in almost all the activities of the school, for example; as teaching aids, for registration, etc. But we still use printed paper and oral means to pass on some vital information most of the time. As a result, some information gets lost, and students can easily claim they were not aware of such announcements. But when the entire community is connected by using technology, this will not be the case. Therefore, it is necessary to develop a means of passing messages instantly, hence the construction of this smart watch.

Researchers designed a community emergency security alert system integrated into a smart community that detects the current location of a victim when triggered, in terms of latitude and longitude, and sends that information via SMS to a phone number of members in the victim's community and to the local security team [3]. Cloud-based intelligent toll collection system for smart communities was built by [4]. The authors built up an intelligent system to dispense with long vehicular lines, fuel wastage, high mishap dangers, and ecological contamination in a keen network dependent on consistent interconnections of remote sensor systems (RSS), web and portable applications that keep running on an Internet of Things (IoT)-Empowered cloud stage. The framework is comprised of the equipment and programming engineering.

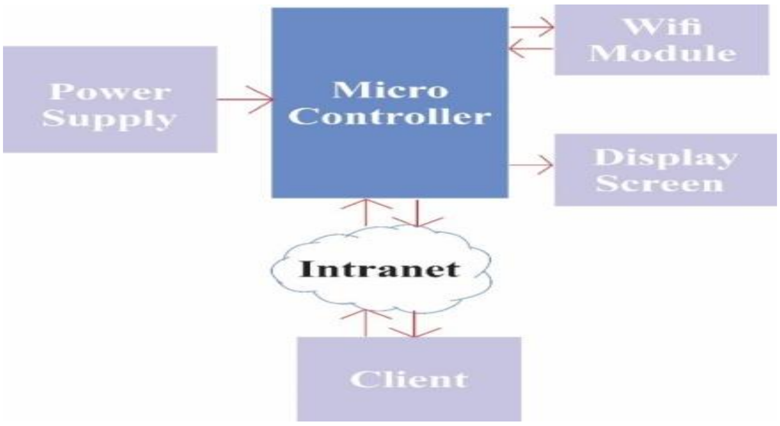

Figure 1. Basic block diagram of the Covenant University (CU) watch

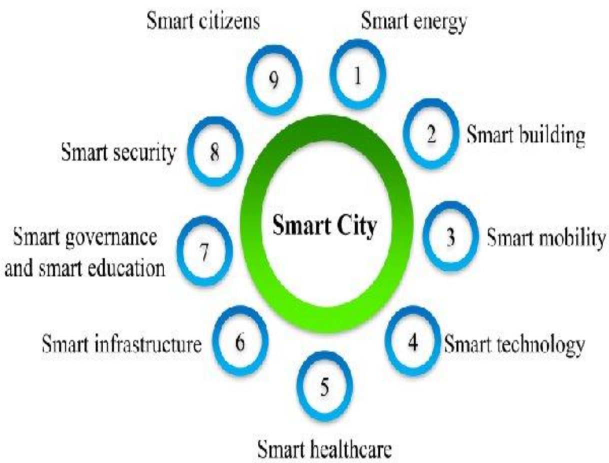

Figure 2. Various aspects of a smart city

2. Methodology

This project has hardware and software architecture. The hardware architecture consists of: Esp8266-01, Arduino Pro Micro, Nokia 5110 LCD screen, resistors, push buttons, switch, lithium battery, multimeter, proteus design suite, fritzing application, bitmap encoder application, access point, web server, 2N222a transistor, diode, Ams117(Voltage Regulator) and mini vibration motor [5 - 6]. The microcontroller (Arduino Pro Micro) was programmed with C/C++ using the Arduino Integrated Development Environment [7]. The software architecture is made up of the network interface which hosted the website to aid in communication between users. The technologies used with the website are Hypertext Mark-up Language (HTML), Cascading Style Sheets (CSS), JavaScript for the front-end side of the website, Hypertext Pre-processor (PHP) for the Structured Query Language (SQL) to implement data storage and access. As illustrated by Figure 3, the individual watch was designed to receive messages sent by other members (clients) in the community on the same network (intranet).

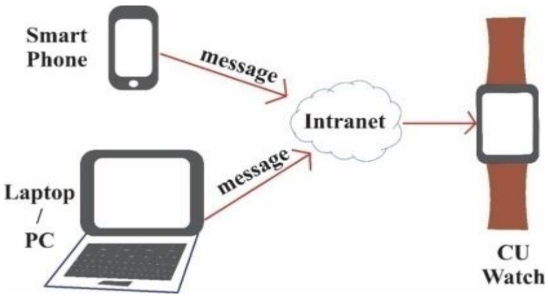

Figure 3. A pictorial representation of the working cycle of the system

According to [8] the Arduino Pro Micro is a board based on the ATmega32U4 microcontroller. It has 18 input/output pins (out of which five can be used as outputs), nine pins can be used as analogue inputs, and twelve (12) digital input/output pins. The Pro Micro has five external interrupt pins that enable initiation of a function instantly when a pin is either high or low (or both). When connecting an interrupt to an interrupt-enabled pin, the specific interrupt triggered by the pin has to be known. The Pro Micro additionally has another serial line for correspondences beside the other line utilized for serial checking of the framework. This feature gives it a user-friendly interface for easy connectivity with other serial devices. According to [9] Nokia 5110, LCD Screen is an 84x48 black and white pixel matric display that runs on the PCD8544. The design is to operate on 3.3 V. By means of a voltage divider, 3.3 V is obtained from the 5 V supply. The current drawn for this display screen is about 40 mA when the backlight is not connected. The backlight consists of four (4) LEDs that draw about 20 mA each. Table 1 shows the various pin configurations for the LCD which was obtained from the official specification guide from spark-fun electronics. Figure 4 is the simulation of the Nokia LCD using proteus design suite in other to ensure that the connections are correct before carrying out physical connections.

Table 1. Pin configurations for the Nokia 5110 LCD screen (obtained from spark-fun electronics graphic LCD hookup guide)

Pin Number	Pin Label	Pin Function	Input/Output	Notes
1	VCC	Positive power supply	Input	Supply range is between 2.7 V and 3.3 V
2	GND	Ground	Input	
3	SCE	Chip select	Input	Active low
4	RST	Reset	Input	Active low

5	D/C	Mode select	Input	Select between command mode (low) and data mode (high)
6	DN (MOSI)	Serial data in	Input	
7	SCLK	Serial clock	Input	
8	LED	LED backlight supply.	Input	Maximum voltage supply is 3.3 V

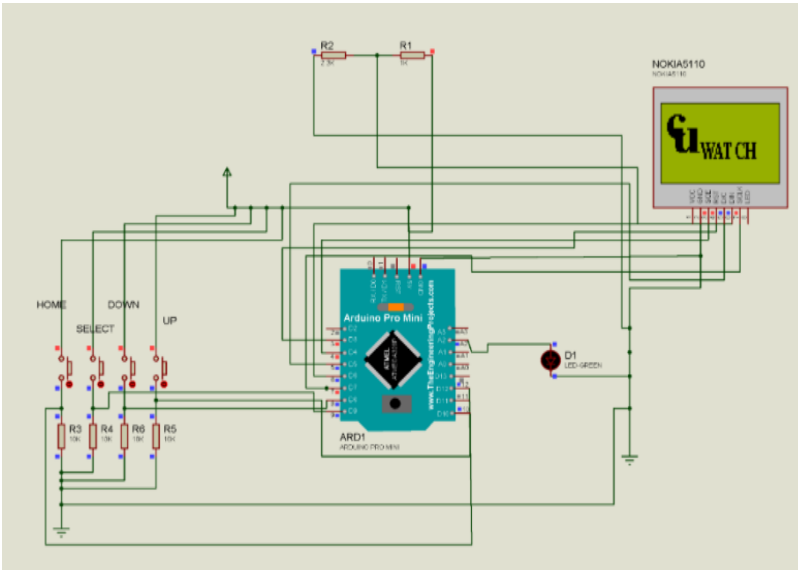

Figure 4. A simulation of the Nokia LCD using Proteus Design Suite

The Wi-Fi module ESP8266-01 is considered for this project. It is the device that will provide CU Watch with wireless connectivity, as shown in Figure 5. The ESP8266-01 is a cheap Wi-Fi microchip module manufactured by Espressif Systems, and it comes with full transmission control protocol/internet protocol (TCP/IP) stack and microcontroller features. This module enables microcontrollers such as the Arduino to connect to a Wi-Fi network, and it uses the Hayes-style commands to make simple TCP/IP connections. This module is a self-contained system on a chip (SoC) that does not require a microcontroller for input and output manipulation. Thus it can be used as a standalone device. For this project, the ESP8266-01 will be controlled by an Arduino. To control the Wi-Fi module with an Arduino, we would have to use the Attention Commands (AT commands) which can be accessed from the [10].

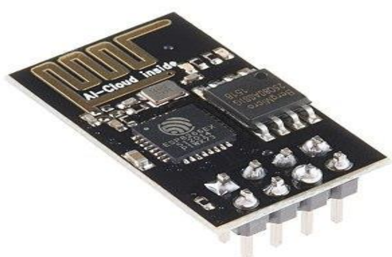

Figure 5. ESP8266-01 Wi-Fi Module

For this project, XAMMP was used to host the website locally. XAMMP comes installed with Apache, MySQL, PHP and Perl. This makes it easier to get a local web server operational rather than installing these packages separately. The XAMMP control panel is where changes to the server can be made. The website is meant to register users of the watch and enable sending of messages to other users. The registration and login page of the website is shown in Figure 6.

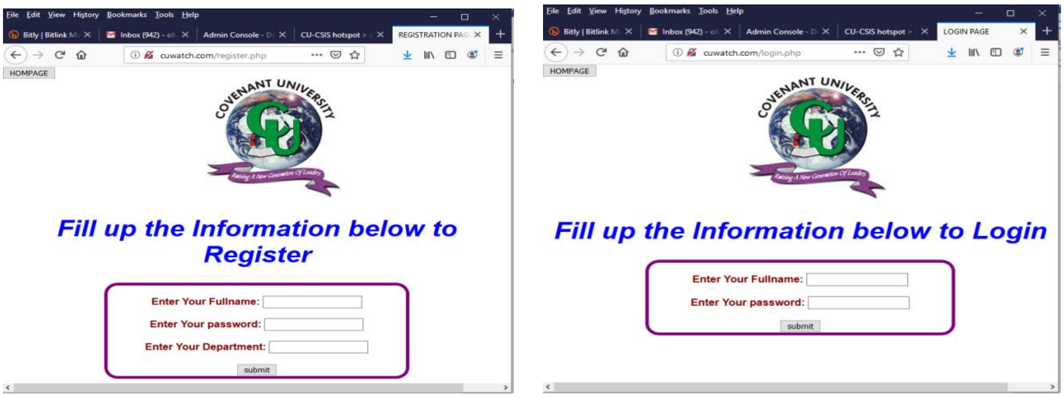

Figure 6. A test run of the registration page and login page of the website

The initial test of this project was carried out on a breadboard. The schematic diagram for this project is shown in Figure 7. Figure 8 is the assembly of the components on the breadboard showing the start-up page and the main menu page of the watch. Figure 9 displays a list of available networks found by the watch and the watch attempting to connect to a network.

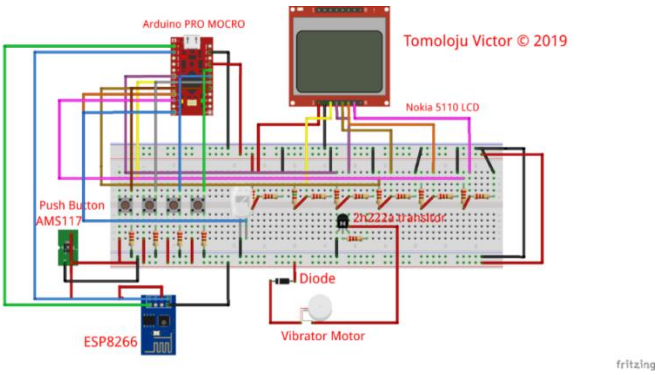

Figure 7. Schematic diagram of the CU watch

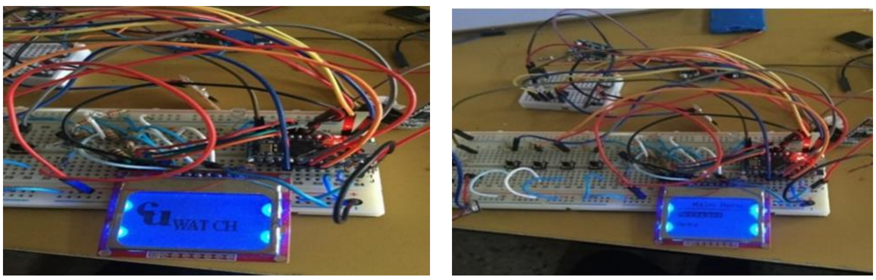

Figure 8. Start-up page and the main menu page of the watch

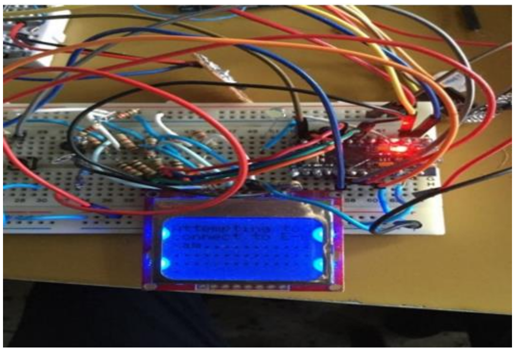

Figure 9. Representation of the watch attempting to connect to a wireless network

3. Results and Analysis

Figure 10 shows the user page, which provides a platform where messages are sent to other registered users. The platform has a check availability feature used to verify if a user is online for the message to be sent. Figure 11 is the database presentation of all users registered on the website. Upon initial registration, every user column for internet protocol (IP) address will be set to "NULL" by default. When a user of the watch connects to the network, it automatically updates the database with the current IP address indicating that the user is online and other users will be able to send messages through the website. Figure 12 illustrates an attempt to check the availability of a user that's offline. When the user connects to the network, the IP address will be updated automatically. Figure 13 illustrates this point for the user "Victor Tomoloju". As a result, the users messaging page will be active. Figure 14 proves this with an attempt to send a message to the user "Victor Tomoloju" through the updated IP address. The CU Watch has a WI-FI connection page where a user can navigate to search for available networks or check the connectivity of the CU watch to ascertain that it is still connected to a network. Networks with "O" in front signifies that the network is open while networks with 'C' in front signifies that the network is closed. Figure 15 shows the received message on the watch.

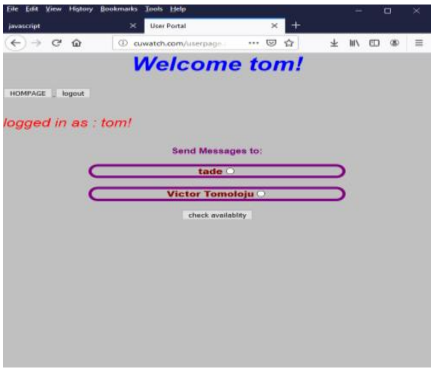

Figure 10. The user portal of a registered user

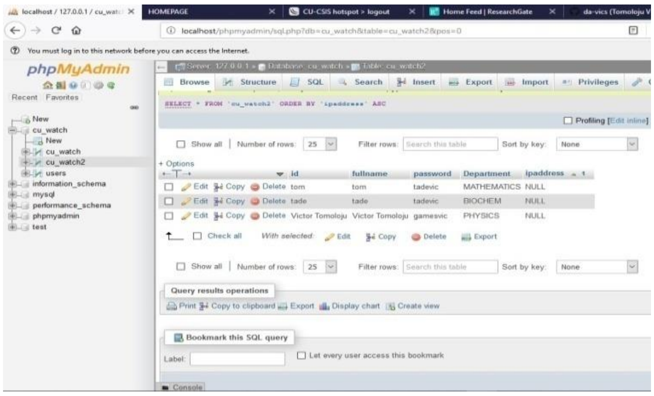

Figure 11. The database interface of the registered users on the website with the IP address of the users set to NULL

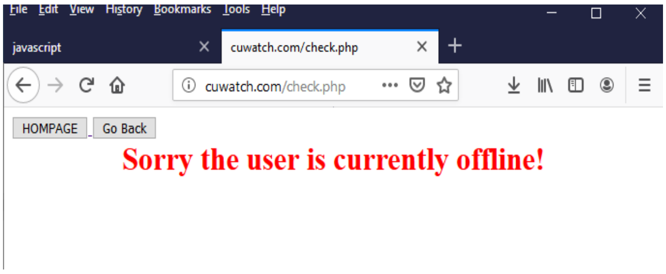

Figure 12. User availability check

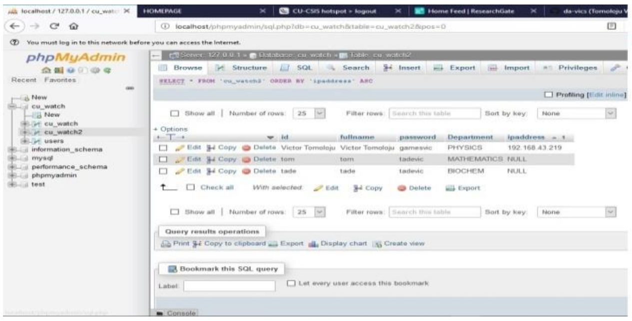

Figure 13. The database interface of the registered users on the website with the IP address of a user updated upon connection

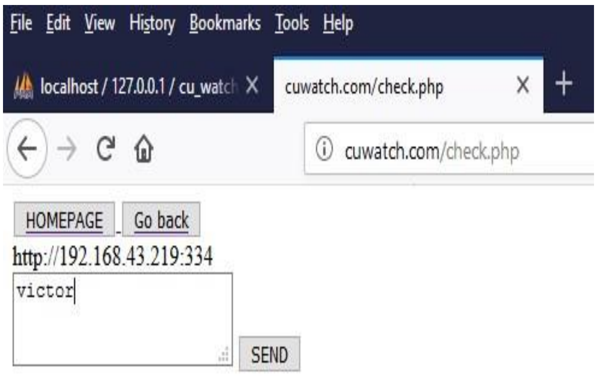

Figure 14. A test of the messaging page for a user upon getting an IP address

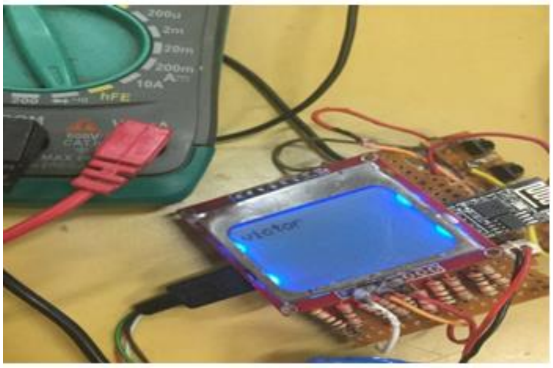

Figure 15. Received message on the CU watch

The watch was tested by sending messages on it and the response time gotten from ten attempts to send messages to the CU watch is displayed in Figure 16. It took approximately twenty-five seconds to send a message to the watch. The result obtained is in consonance with that obtained by [4].

ale

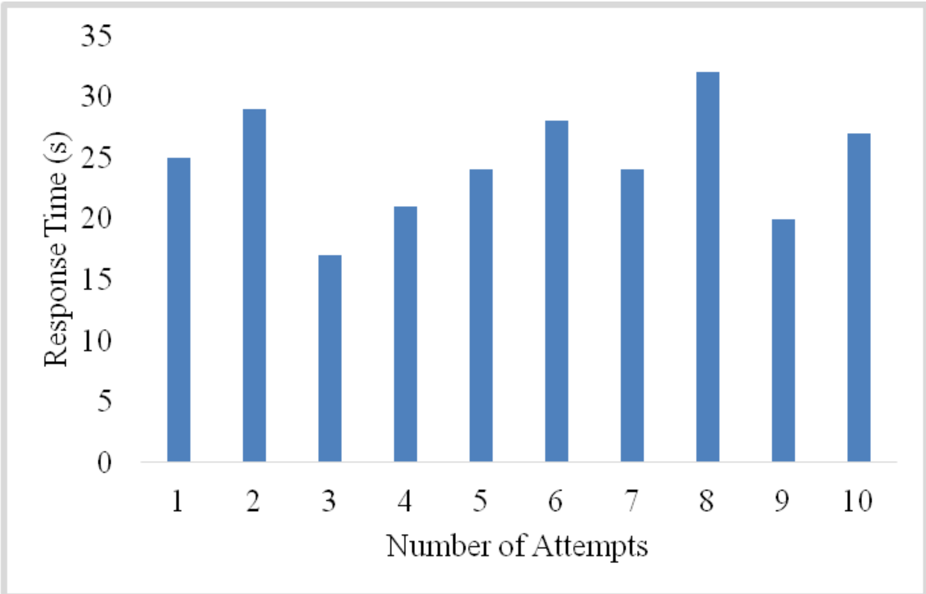

Figure 16. Response time of CU watch

4. Conclusion

A web interface was created to allow for interactions between various users. A smartwatch was developed that is able to instantly receive messages through a wireless network. A website was designed for the users of the watch to be registered and for sending messages to other users. The user data is stored using SQL database. The design of the Covenant University Watch and its components was successfully done; the system can send and receive messages through the platform. We hereby recommend that Covenant University invests into this idea to increase the overall community productivity. For future work, this project can be improved on and further enhanced by including a separate smaller microcontroller for processing of the network data. Also, the size and weight should be further reduced in conformity with standard smart wristwatches.

Acknowledgements
Authors acknowledged the support of Covenant University for the study

References

[1] Frost and Sullivan "*Smart Cities -A $1.5 Trillion Market Opportunity"* Retrieved from https://forbes.com/sites/sarwantsingh/2014/06/19/smart-cities-a-1-5-trillion-market-opportunity/ on (13/12/18).
[2] Chavis D. M and McMillan D. W 1986. Sense of community: A definition and theory, *Journal of Community Psychology*, **14(1):** 6-23,
[3] Matthews, O. V., Osaghe, N. E., Stanley, U., Enefiok, K. M., Ogukah, P. 2018. Implementation of a community emergency security alert system. *International Journal of Innovative Science and Research Technology,* **3**(6):2456-2165.
[4] Popoola, S. I., Popoola, O., Oluwaranti, A. I., Atayero, A. A. A, Badejo, J. A., Misra, S. 2018. A Cloud-Based Intelligent Toll Collection System for Smart Cities, Smart and Innovative Trends in Next Generation Computing Technologies 2017, *Communications in Computer and Information Science.*, **827**:653-663. Doi: 10.1007/978-981-10-8657-1_50.
[5] Ayara W. A, Omotosho T. V, Usikalu M. R, Singh M. S and Suparta W. 2017 Development of a solar charged laboratory bench power supply, *Journal of Physics: Conference Series*, **852(1):** 012044
[6] Nwoye C. D., Usikalu M. R., Babarimisa I. O, Achuka J. A and Ayara W. A. 2017 Construction of An Automatic Power Switch using Infrared Motion Sensor, *Journal of Informatics and Mathematical Sciences,* **9(2):** 331–337
[7] Usikalu M. R, Shittu A. H and Obafemi L. N 2018. Construction of an intelligent and efficient light control system, *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD),* **8(4):** 1057-1066
[8] Usikalu M. R, Adebesin E. and Obafemi L. N 2019. Design and construction of backpack mobile charger, *ARPN Journal of Engineering and Applied Sciences,* **14(21):** 3743 - 3746
[9] Spark-fun electronics. *Graphic LCD Hookup Guide*. Retrieved from https://learn.sparkfun.com/tutorials/graphic-lcd-hookup-guide on (21/12/18).
[10] Philips Semiconductors "PCD8544 48 X 84 pixels matrix LCD controller/driver*" Retrieved from http://pdf.datasheetcatalog.com/datasheet/philips/PCD8544U.pdf on* (21/12/18).
[11] Spark-fun electronics *ESP8266 Module (WRL-13678)*. Retrieved from https://mouser.com/ds/2/813/ ESP8266 ModuleV1-1095236.pdf on (15/12/18).