

Arduino based outing and attendance system for boarding school students

Matthew Khoo Kah Wen, Nabihah binti Ahmad, Siti Hawa binti Ruslan

Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Malaysia

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ABSTRACT

The continuous flourishing of boarding schools in Malaysia have prompted a need for the development of outing systems that can manage the outing activities of students whilst ensuring their safety and security. In this project, a smart outing and attendance system that accurately records the details of all students and their respective outing activities is proposed. The development of this system via the XAMPP platform allows the information regarding students' outing activities to be saved in an online database, whereby it is closely monitored and managed by the school authorities. Students who attend authorized outing activities have to scan their student ID card at an RFID reader which is installed at the main entrance of the school compound, where the information regarding their departure and arrival time at the school will be transmitted via an Arduino controller to the database. At the same time, this system sends a notification in the form of a WhatsApp message to the phone number of all the students' parents. The system is a well-rounded approach to adequately manage the outing activities of students as each activity has to be registered beforehand with its implementation undergoing strict monitoring by the school authorities.

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Corresponding Author:

Matthew Khoo Kah Wen,
Department of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
86400 Parit Raja, Johor, Malaysia.
Email: matthewkhoo950318@gmail.com

1. INTRODUCTION

Nowadays, the issue of the safety and security of students residing in boarding schools has become a major concern, particularly to their parents who are unable to meet or communicate with them face-to-face on a daily basis. Parties such as the Ministry of Human Resources, the Department of Occupational Safety and Health (DOSH) have urged for schools all around the nation to provide a safe place for students to learn and study, more prominently through its implemented "OSH in School Programme" in its efforts to raise safety and health awareness among all the schools [1]. In addition to this, the main problem of low attendance levels due to frequent truancy among school students have also become a major talking point in the media, with certain schools involving police liaison officers to help diffuse the problematic situation of truancy among these school students, particularly exhibited by the schools in the Serdang district [2].

Moreover, the major trend of outing activities among boarding school students has led to the innovation of various state-of-the-art outing systems within boarding schools in Malaysia that incorporate the use of the Internet of Things (IoT). These automated outing systems are capable of establishing a more effective platform for students to register their outing activities with the school authorities, whilst providing an online database for their activities to be managed [3]. In addition, these systems are able to record the attendance of students and notify the parents of their children's movements through an IoT-based application in their phones.

The development of the smart outing and attendance system in this project as a proposed solution to the referred problems are expected to contribute to the enhancement of the safety and security of boarding school students. The systematic registration of outing activities and daily attendance ensures that the students' movements around the school compound are closely monitored and any truancy attempt by students are immediately captured by the school management. In addition, parents can keep up to date with their children's whereabouts through the notifications sent to their phones, which allows them to virtually monitor their children without the need of physical contact.

The proposed system is generally reflective of a number of related projects that employ the same web-based system designs that produce similar novel contributions, including the projects developed in [4-7] where the application of outing activities for boarding school students is also carried out via an online platform that allows the school authorities to manage and view each activity. However, an added novelty of the proposed system is its open accessibility to the students' parents which allows them to monitor their children's activities on a regular basis, which is a feature that is absent in other relevant projects developed in [8-10].

2. RESEARCH METHOD

This proposed outing and attendance system is designed in regards to the safety and security of boarding school students. All things considered, the complete system that consists of all the hardware and software used as well as the interaction between them are illustrated in the following sections.

2.1. Workflow diagram

First and foremost, the Liquid Crystal Display (LCD), Real Time Clock (RTC) and RC-522 RFID reader are installed as one entity at the school entrance and students are provided with a personal RFID tag or cards that contain a unique serial identification number (ID). When students apply for outing activities, the school management registers their ID in the database through an online webpage in the XAMPP database and forwards a WhatsApp message to the phone number of their parents. Students are then permitted to attend these activities and are required to scan their ID on the reader as they leave the school compound, where the LCD is programmed to display an 'Approved Outing' message and the RTC records down the checkout time of students. This information is transmitted via the Wi-Fi module and updated in the database for the students' activities to be monitored by the school management. The process is repeated when the student checks in after returning from his outing activity, whereby the check-in time is updated in the database and the LCD displays 'Approved Entry'. The workflow diagram of the outing and attendance system is shown in Figure 1.

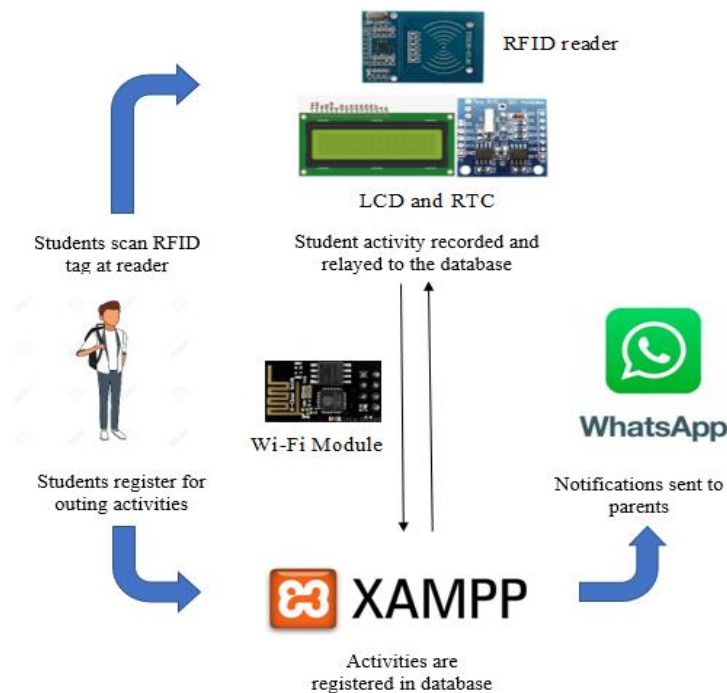


Figure 1. Workflow diagram of the smart outing and attendance system

2.3. Implementation of the outing and attendance system

This section reviews all the important elements involved in the implementation of the proposed smart outing and attendance system. The overall architecture of the system as well as the interaction between the hardware and software components are illustrated in the block diagram shown in Figure 2. This block diagram is indicative of the general functions of the system that were previously highlighted in the workflow diagram.



Figure 2. Block diagram of the smart outing and attendance system

Based on the block diagram illustrated in Figure 4, the Arduino Mega 2560 is used to interconnect all the hardware components into a single entity due to the presence many digital input and output pins on this board. Prior research to this project showed that other boards such as the ARM Mbed LPC 1768 Microcontroller is also applicable but the Arduino Mega 2560 was ultimately chosen due to the ease of operation of the board via an open-source IDE that can be readily downloaded into a computer, where it is free of charge [11].

Meanwhile, the RFID RC-522 reader and tag are collectively used together with the Arduino board. The small size RFID chip contained in the tag makes it applicable as a hand-held device for students to carry it around easily [12], while the Serial Peripheral Interface (SPI) protocol connection of the reader allows it to communicate easily with the Arduino board, making the transmission of information from the RFID tag and reader to the board more seamless [13]. Also, the tag itself is able to identify strong signals from the reader – allowing it to be automatically recognizable and traceable anywhere [14-16]. This will enable the RFID tag (or card) held by students to be easily scanned by the reader when the student leaves or enters the school compound.

Furthermore, the LCD uses an Arduino I²C Serial 16x2 display to print the prescribed messages on its screen when a student scans his card on the RFID reader. This type of LCD module is widely used in circuit implementations due to its inexpensive nature and simplicity of programming, as well as being able to display different types of special, tailored characters and animations [17]. At the same time, the exact checkout and check-in time of the student is recorded by the Real-Time Clock (RTC) which runs on a DS1307 module. The main reason for the selection of the DS 1307 is the capability of this module to keep track of the current date and exact time, as well as the long battery life of the lithium coil cell within the RTC [18].

Moreover, the ESP 8266 Wi-Fi module acts as a central point of communication between the components on the Arduino board and the online XAMPP database, due to the small-sized nature of its chip and its ability to provide an all-round solution for the purpose of Wi-Fi networking and access to the board [19]. It can also host an application and offload all functions provided by Wi-Fi networking from an application processor that is separately located [20]. This trait allows it to seamlessly upload all the data obtained from the hardware components on the Arduino board to the XAMPP database, which include the student ID information and the checkout or check-in time as scanned by the RFID reader and RTC respectively.

On the other hand, the XAMPP development tool is used for the storage of the student outing information after it is uploaded from the Arduino board to the XAMPP database. It is also used to send an auto-generated WhatsApp message to the parents' mobile phones after an outing activity has been approved and registered by the school authorities. The online webpages used for the registration and monitoring of

these outing activities by the school authorities and parents are developed via a Notepad ++ source code editor, where the Hypertext Preprocessor (PHP) programming language is used to construct and link the coding to the XAMPP database. The main advantage of XAMPP is the ability for interfaces and programming languages written using this development tool to be tested using a regular computer without the need for internet access [21], whilst the PHP server-side scripting language enables the online webpages to be developed easily [22].

3. RESULTS AND ANALYSIS

The testing and analysis of results attained from the hardware design and software systems as well as the integration of both these features is made in a complete and concise manner in order to ensure that each stage of the research is of relevance to the problems stated at the beginning of the paper. Further discussion on the effectiveness of each of the developed features as a solution to the hard problems faced as well as its comparisons to previous projects are also made. This ensures that the novel aspects of the results and their significance in terms of new knowledge or improvements gained are fully addressed in this paper.

3.1. Software – database and webpage design

The database is initially developed through the ‘phpMyAdmin’ administration tool written in PHP language [23], as shown in Figure 3. This database is a platform that stores and organizes the information of parents, teachers and students into columns that correlate to the functions of the outing and attendance system.

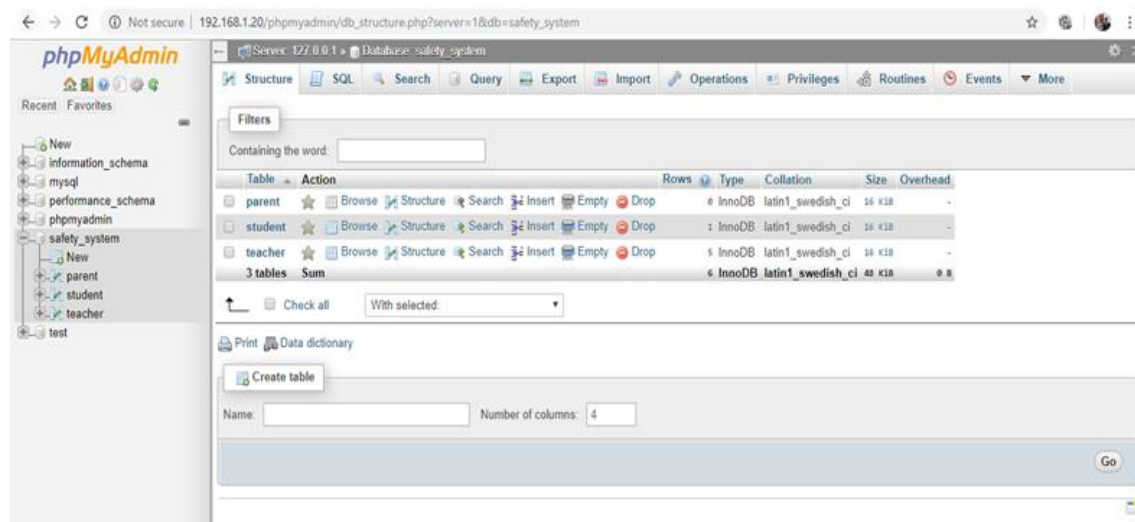


Figure 3. Homepage of the smart outing and attendance system in the database

When a student registers for a new outing activity, the school authorities have to log in to a specific ‘outing approval’ webpage to officially key in the outing information of the student activity for it to be approved as shown in Figure 4. These details are then transferred and displayed on the Students’ Details page (shown in Figure 6) which enables the ease of monitoring of the students’ activities by the school authorities. In addition, an auto generated WhatsApp message is sent to the phone number of the parents containing the name, ID and outing purpose their children after their details have been officially registered. This is done via the ‘click to chat’ feature shown in Figure 5. This feature is advantageous as it allows the teacher to begin a chat with a parent without requiring their phone number to be initially saved in the phone address book [24], thus saving time.

The students’ details page store all the outing information of the registered activities for students in a clear and organized table, as shown in Figure 6. This will allow systematic monitoring of the students’ outing activities and movements by the school authorities. Last but not least, a separate webpage is developed for parents as shown in Figure 7 for them to monitor their children’s outing activity by entering the registered ID number of their children. The respective outing details of their children will be extracted from the database and displayed in an orderly sequence down the page. Thus, this feature gives parents the ease of access to the outing information of their children.

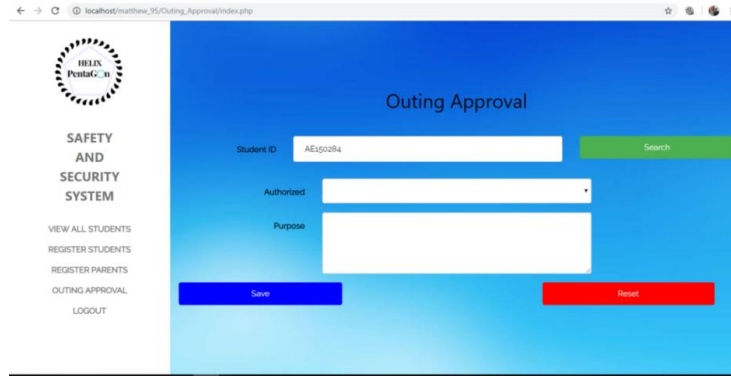


Figure 4. Outing approval page to manage students' activities

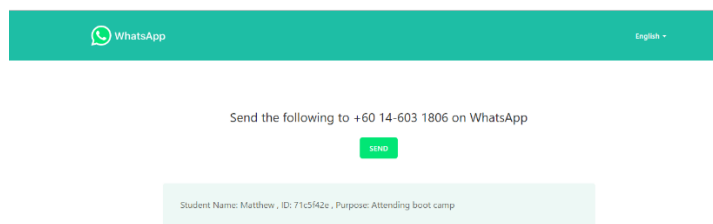


Figure 5. Auto-generated WhatsApp message to notify parents of their children's outing activity

Students' Details					
Name	Student ID	Check Out	Check In	Authorized	Purpose
Helix	96176dc1	10:20		Yes	Camp
Jesse	16186bc1			No	Not approved
Matthew	71c5f42e		10:29	Yes	Camp

Figure 6. Main page for teachers to view student outing activities

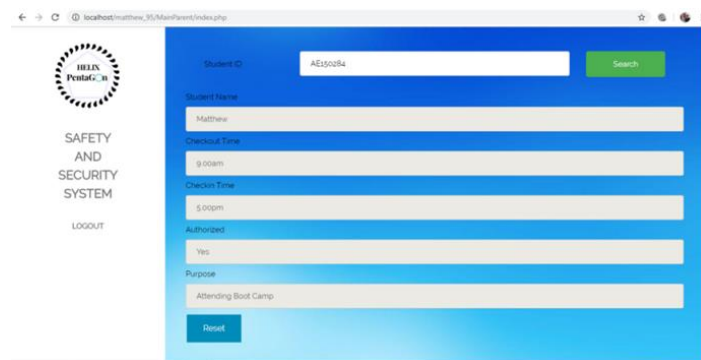


Figure 7. Main page for parents to view their children's outing activities

3.2. Hardware – RFID, LCD and RTC testing

The hardware components are connected to the same Arduino board which is programmed through the Arduino IDE software. The data obtained from the components on the Arduino board is transmitted to the online database via the POST string command followed by the php file location (in the database) that is written in the Arduino IDE, as shown in Figure 8.


```

delay (1000);
Serial1.print("AT+CIPSEND=");
delay (100);
data = "User_ID="+card + "%Checkout_Time="+times; // + String(now.hour(), DEC) + ":" + s
postRequest =String("POST ") + "/outingsystem/addarduinoUPDATE.php" + " HTTP/1.0\r\n" +

```

Figure 8. POST string command to link the Arduino board and online database (red underlined)

The POST method is used in correlation with that used in the php file which receives the details contained within the body of the data sent from the board to determine if these details matches the information saved in the database [25]. Thus, when a student scans his card at the RFID reader, the information from his card is transferred to the database for the system to check if there are any authorized outing activities registered under that ID number. Should this variable return a true value, the term “Checkout” and the exact checkout time of the student (recorded by the RTC) will be displayed on the Arduino IDE serial monitor, which in turn leads to the LCD displaying “Approved Outing”, as shown in Figure 9 (a) and 10 (a) respectively. Thus, the student is permitted to leave the school compound to attend the respective outing activity.

Similarly, when the student scans his card on the RFID reader upon returning from his outing activity, the term “Checkin” and the exact checkin time of the student will be displayed on the serial monitor, which in turn leads to the LCD displaying “Approved Entry” as shown in Figure 9 (b) and 11 (b) respectively. While this happens, the checkout and check-in time of the student are simultaneously transmitted from the Arduino IDE to the database where the exact time (in 24 hours format) is updated in the students’ details webpage, as shown in Figure 6.

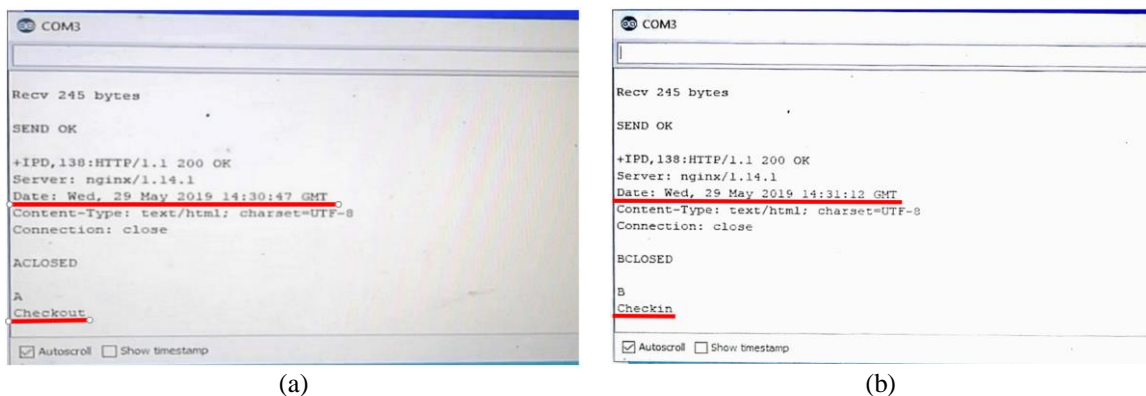


Figure 9. Display of (a) checkout status and checkout time and (b) check-in status and check-in time at Arduino IDE serial monitor

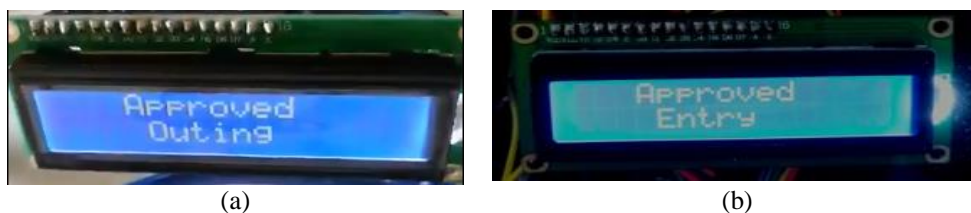


Figure 10. Display of (a) approved outing and (b) approved entry message by the LCD

3.3. Overall results and discussion

The novel aspects of the results obtained from the outing and attendance system as well as their comparisons to other projects are comprehensively described in this section. First and foremost, the school management has the authority to approve or disapprove outing activities of the students via the ‘authorization’ field in the outing approval page shown in Figure 4. This implementation ensures that each registered activity is scrutinized by the school authorities before the students are given the green light to participate in them, thus preventing students from engaging in dangerous or harmful activities.

Furthermore, the accessibility of this system to the students' parents allows them to keep a close view on their children's outing activities. The WhatsApp message sent to their phones and their access to the online webpage helps to keep in touch with the latest information regarding their children's activities. This feature is analogous to the project proposed in [26], where a safety and security system is developed using RFID and Global System for Mobile communication (GSM) technology to simultaneously record the head count of students boarding the school bus and send a Short Message Service (SMS) notification to inform their parents regarding their whereabouts. Though both prototypes are comparable, the present outing and attendance system is preferred as it encompasses a separate online webpage that allows parents to access the system at any time to check on the latest updates of their children's outing activities.

Despite the numerous advantages offered by RFID such as portability and ease of information transfer, this type of technology still has their own drawbacks that could affect the outcome of the project. According to a similar project developed in [27] on an Activity Attendance Monitoring System (AAMS) for university students using RFID technology, the main limitation of RFID is the occurrence of signal collision and interference if the reader attempts to read multiple tags at one time when they are all held at close proximity to each other. Though this interference could result in data loss, it can be prevented through the application of anti-collision algorithms [19, 28] or simply by maintaining appropriate distances between each of the tags. Once this is accounted for, the RFID reader will be able to perform its primary functions of detecting the RFID tag (implanted in the student ID card) to allow the information stored in the tag to be transmitted to the online database for further processing. This will contribute to the smooth and seamless operation of the entire system. In short, the implementation of required measures enables this project to be used as a definitive approach to resolve the main problems of safety and security currently faced by boarding schools.

4. CONCLUSION

As a conclusion, the IoT-based Smart Outing and Attendance System is able to manage the outing activities of boarding school students in an efficient and organized manner. It is also capable of ensuring a protected environment for students residing in boarding schools as it only allows students to leave the school compound to attend activities authorized by the school management. At the same time, parents are constantly notified of their children's participation in outing activities through a WhatsApp message that is sent to their phones each time their children leave the school compound. Hence, this system allows parents to keep tabs on their children's movements as they are unable to communicate with their children on a face-to-face basis.

The development of this system encompasses both the hardware and software features which are intricately designed to work hand-in-hand to ensure that an ideal system is provided for students to apply for their outing activities and the school authorities are able to monitor these activities through reference to the online XAMPP database. The results obtained from the testing process have shown that the system is capable of managing student activities through the organized storage of outing information in the database and the consistent relay of information between the hardware and software components which ensures that the output of the system is produced in accordance to the input provided. All things considered, this project has established a systematic and comprehensive approach in the management and administration of student outing activities.

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BIOGRAPHIES OF AUTHORS



Matthew Khoo Kah Wen completed his pre-university studies (STPM) at SMJK Nan Hwa, Sitiawan in 2014 before receiving his Bachelor's Degree of Electronic Engineering with Honours at Universiti Tun Hussein Onn Malaysia (UTHM) in 2019. He is currently pursuing his Master's Degree in Electronic Engineering at the same university, whereby he is taking on full time research in the field of Microelectronics. His research project is pertaining to the design of a CMOS 14-bit Successive Approximation Register (SAR) Analog-to-Digital Converter (ADC) using VLSI implementation.



Nornabihah bt Ahmad received her Bachelor's Degree of Electrical and Electronic Systems with Honours at Universiti Kebangsaan Malaysia in 2002 before obtaining her Master's Degree in Electronic Engineering (Microelectronics) at Kolej Universiti Tun Hussein Onn Malaysia in 2005. She then completed her Ph.D in the field of Electronic Engineering at Massey University, New Zealand in 2014. She is currently working as a senior lecturer at the Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM). She has published several research papers in international journals and conferences that cover various research areas such as Digital, Analog Integrated Circuit Design and VLSI Design. Her current fields of research interests are IC design, low power VLSI circuit design, cryptography co-processor, SoC, low power digital system and ASIC/FPGA design. She is also a member of the Board of Engineers Malaysia (BEM), IEEE, IEEE Circuit and IEEE Young Professionals.



Siti Hawa Ruslan is currently an associate professor at the Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM). She received her Bachelor's Degree of Science in Electrical Engineering at the University of Miami, Florida in 1987 before completing her Masters in the field of Electrical Engineering at Universiti Teknologi Malaysia in 1991. She has published several research papers in international journals and conferences that mostly revolve around digital and analog integrated circuit designs. Her current fields of research interests are IC design, low power VLSI circuit design, as well as device modelling and simulation. She is presently a senior member of IEEE.