

Design and Development of Key Management System (KeMas) using RFID based on Arduino Mega 2560 Pro and NodeMCU

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Abstract:

Key Management System (KeMas) is successfully designed to overcome lecture room/lab key lost problem and unidentified key user in Electrical Engineering Department, Politeknik Sultan Haji Ahmad Shah (POLISAS), Pahang, Malaysia. This project has been developed in line with industry 4.0 (IR 4.0) revolution by using internet of thing (IoT) technology. The design of KeMas is done using Arduino Mega 2560 Pro as microcontroller and ESP8266 NodeMCU Wi-Fi module which sends data over the cloud. KeMas also utilizes the Telegram chat application bot as notification and monitoring the retrieval and return of the keys. KeMas is equipped with an RFID reader as a sensor. Once the user swipes his or her identification card, the key is allowed to be taken and a signal will be sent to the Telegram application through mobile phone to notify the name of the person who takes the key and the name of the room/lab key that he or she took. Subsequently, when the key is returned, notification will also be sent via the Telegram application. Hence, users will always get the latest information on the availability of the keys. KeMas is proven to be effective in solving the key lost problem in Electrical Engineering Department, Politeknik Sultan Haji Ahmad Shah (POLISAS).

Keywords: IoT, RFID, ARDUINO, NodeMCU, BOT, Telegram

1. Introduction

Security has become the primary concerned to most of educational institution nowadays. In addition to providing knowledge and skills to students, the educational institution is also responsible for managing high-value assets located in its workshops as well as in lecture rooms.

To ensure the teaching and learning activities can be performed according to the timetable and the safety of high values assets, the Electrical Engineering Department, POLISAS stores all the keys in a special room. Only authoritative staff are given access to use those keys. One of the problems that occur is the missing or untraceable key due to human attitude. Keeping track of the missing keys manually has become a real challenge.

In line with the industry 4.0 revolution, a system named Kemas is developed by Electrical Engineering Department's staff based on Internet of Things (IoT) because IoT technology enables the Internet to reach out into the real world of physical objects (Sadique, K.M. et al, 2018). KeMas is developed with the objective of providing an effective method of retrieval and return of the keys and to identify the key user on real time.

Previously, the process of retrieving and returning of keys in Electrical Engineering Department, POLISAS are done by using manual method. The first method is by using a key register book. The user who retrieves and returns the key should be recorded in the key register book.

Then the key register book is replaced by name tag. In this method, the user named tag is placed on the key holder when the key is taken. This method will tell the other user who is using the key at that time.

However, neither of these manual methods can effectively solve the problem of detecting the absent of the keys. Problem occurs when users forget to write their name in the key register book or do not put the named tag on the key holder.

To solve the problem, a technology needs to be used for the purpose of identifying and tracking the user and the key. Radio frequency identification (RFID) is a matured technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal, or person (Chiagozie, O.G. et al, 2012).

2. Literature Review

This project is developed based on the previous research on smartphone and IoT. The researches prove that the application of smartphone has been able to monitor the condition of any situation in real time anywhere and anytime. Smartphones have significant storage and computing capability. This feature makes them ideal candidates to carry out the delicate task of linking the world of the Internet and the world of “things” (Aloi, G. et al,2016).

Previous researchers have developed a door microcontroller that is controlled using the Android App. Android App is interfaced with door microcontroller through Bluetooth. The Bluetooth technology operates over unlicensed 2.4GHz frequency, it can link digital devices within a range of 10m to 100m at the speed of up to 3Mbps but it depending on the Bluetooth device class (Kumar, M. et al, 2016).

Another previous project was an attendance system with an automatic door unit using radio frequency identification (RFID). In this project the attendance of the employees is recorded automatically when the employee ID card that is embedded with RFID is read by a reader. The method is more effective to prevent problems encountered when getting the attendance manually (Chiagozie, O.G. et al, 2012).

KeMas utilizes the Telegram chat application bot as notification and monitoring the retrieval and return of the keys. Bot telegram chat application as a media access smartphone application has advantages compared to using android applications or using web pages because it can be accessed with multi-platforms both Android, iOS, Windows, and Linux (Findawati, Y. et al,2020). Also, this Telegram chat application bot can send notifications via smartphone directly when the sensor in the monitoring system detects keys taken and return.

3. Methodology

KeMas was developed based on PDCA (Plan–Do–Check–Adjust) methodology. PDCA is an iterative four-step management method for the control and continuous improvement of processes and products.

Figure 1 shows the block diagram of KeMas which consists of the input, controller and output.

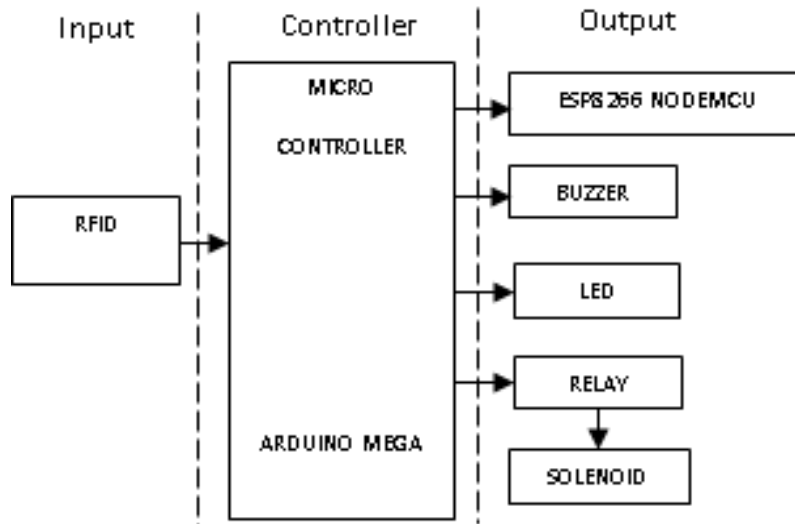


Figure 1. Block Diagram KeMas

The controller will be programmed using Arduino IDE to process the input signal to trigger the output. The function of each block diagram is shown in Table 1.

Table 1. The function of the KeMas components

No	Components	Function
1	Arduino Mega	To process the input and gives a command to the outputs.
2	ESP8266 NodeMCU	Is a microcontroller with Wi-Fi capability. It communicates with the smartphone, sending and receiving text in both directions.
3	RFID Reader	To read the information on the tag and send the information to Arduino to be processed.
4	Buzzer	To give an alarm sound if the key is taken without authority.
5	LED	To indicate that the system is functioning properly.
6	Relay	To control the on/off path of the solenoid.
7	Solenoid	To open the lock latch when relay is on.

The dimension of KeMas is 610mm x 457mm x 203mm. Figure 2 and Figure 3 show the front view and side view of KeMas, with the parts of KeMas are listed in table 2.

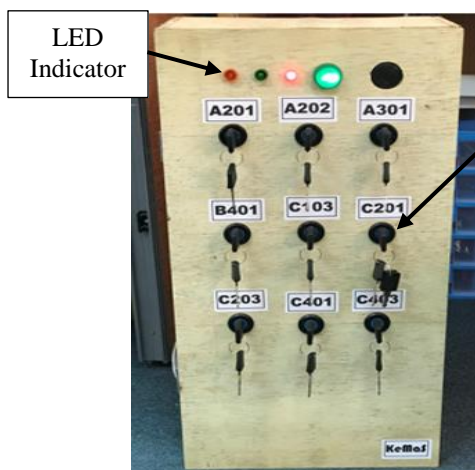


Figure 2. Front View

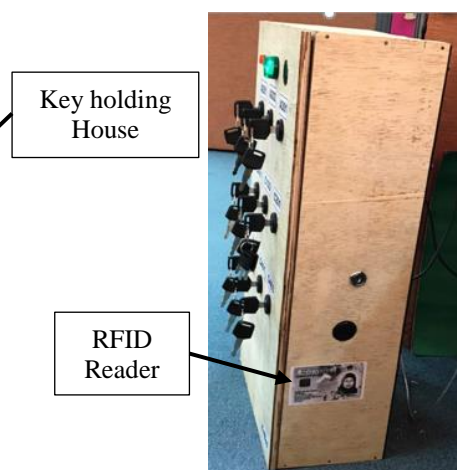


Figure 3. Side View

A flowchart in Figure 4 represents a workflow or process of KeMas.

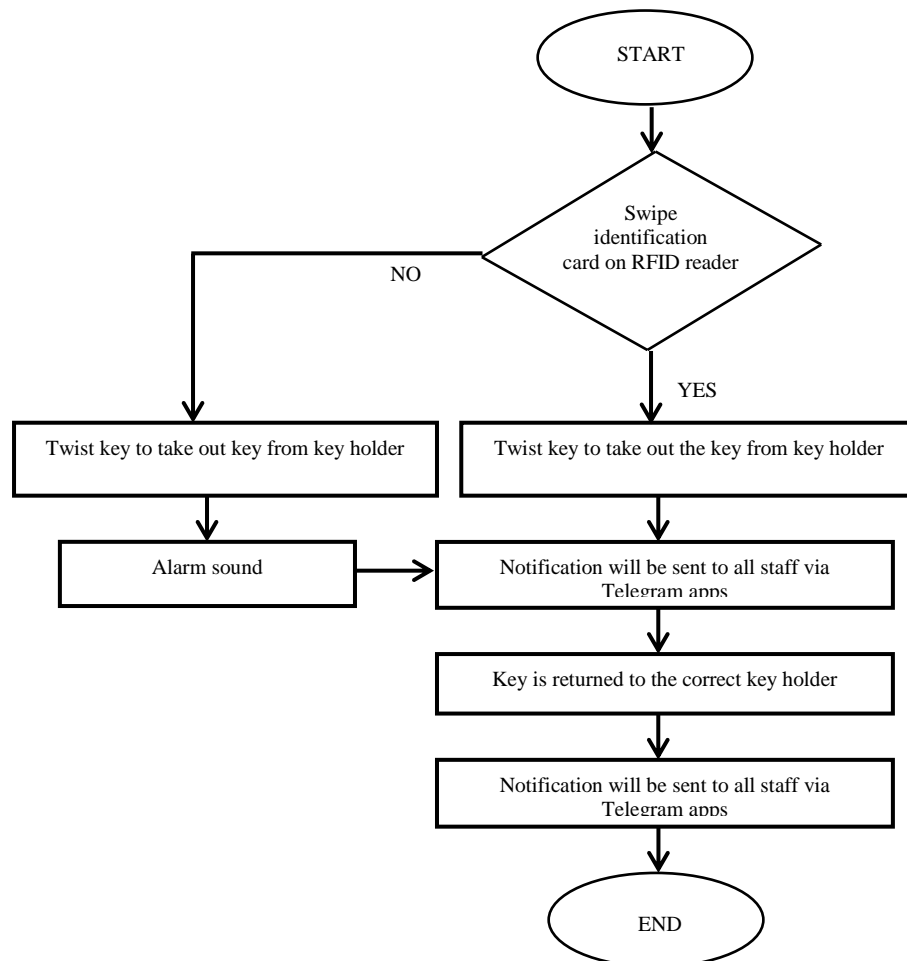


Figure 4. Flowchart of KeMas

KeMas has been undergoing a test run for a month to get feedback from the Electrical Engineering Department staff as well as to monitor the functionality of the KeMas system. Figure 5 shows the test run process of KeMas.



Figure 5. Kemas test run

After the test run, a survey has been conducted on 160 Diploma of Electrical and Electronic Engineering (DEE) students and 50 Electrical Engineering Department staff. The results are shown in Figure 6 and Figure 7. The results show that 95 % of the students and 90% of the staff are satisfied with KeMas performance.

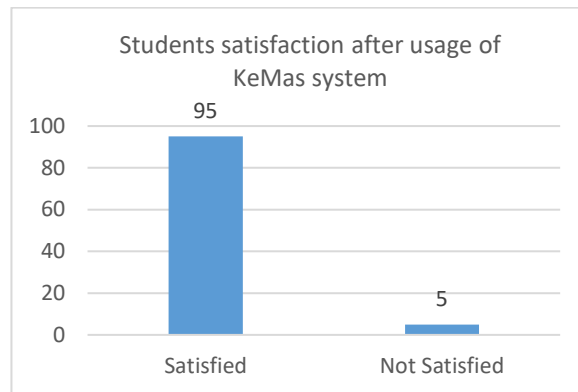


Figure 6. The percentage of satisfaction for DEE students after Kemas is implemented.

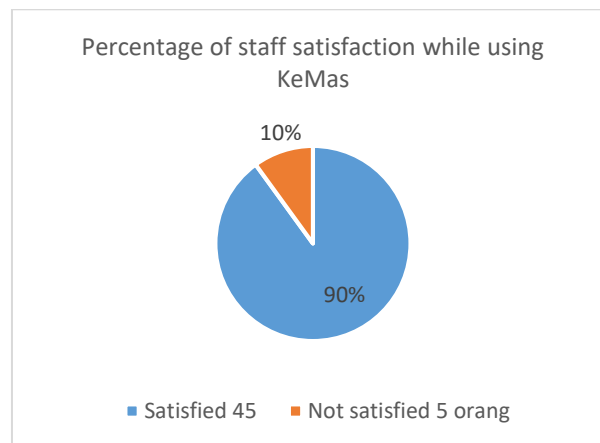


Figure 7. The percentage of satisfaction for Electrical Engineering Department staff after KeMas is implemented.

4. Conclusion

KeMaS was developed to allow the retrieval and return of keys to be implemented systematically. Users need to register and follow a set of procedures. The user scans his or her identification card on the scanner provided. IoT technology is used in the development of KeMaS where users get the latest information about the identity of the person and the key taken and returned through Telegram application.

KeMaS has been proven to solve the room/lab key lost problem and unidentified key user in Electrical Engineering Department, Politeknik Sultan Haji Ahmad Shah (POLISAS), Pahang, Malaysia.

For future development, the team would like to provide second alternative to user by facilitate biometric sensor using fingerprint scanner.

Acknowledgments

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