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Integrated smart door system in apartment room based on internet

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Abstract

Internet of Things (IoT) is technology which provides communication between machines without human intervention. There are many applications that implement IoT technology e.g. smart power, smart home, transportation management, and smart city. This paper proposes the usage of IoT to develop electronic key that can help to improve the security in apartment. Electronic key uses Android smart phone to access and control the door. Electronic key uses Raspberry pii, motor DC, webcam, microswitch, and Arduino GSM. Raspberry is used to get command from server and instruct the Arduino GSM to open or close the door and webcam is used to take picture from the environment for documentation. This research uses three steps to verify the user who want to open or close the door i.e. using username and password, bluetooth, and QR code scanner.

Keywords*: arduino GSM, electronic key, internet of things, raspberry pii*

1. Introduction

Internet of Things (IoT) is the interconnection amongst devices via internet, and it is enables those devices to send and receive data. IoT evolves from machine to machine (M2M) communication. The connection between machines is occurred via network without human interaction. M2M uses the network to connect a device to the cloud, manage it, and collect data. Iot may be a sensor network of billions smart devices. IoT consist of web that enables smart devices using embedded processor, sensors, and communication hardware. IoT gateway or other edge device is used to share data amongst IoT devices. Most of IoT devices act without human intervention, although people can interact with the device e.g. to set them up, give them instructions, or may be access the data. The concept of IoT is to provide a new service through real time communication amongst devices [1, 2]. The number of IoT devices increased and became 8.4 billion in 2017. It is estimated that there are going to be 30 billion devices in 2020. From Asia IoT Business Platform survey in ASEAN 2017, more than 83% business in Indonesia is trying to explore and implement IoT technology. Although the growth of IoT technology in Indonesia is slow, it is predicted that Indonesia is ready to implement IoT in many sectors. From Asia IoT Business Platform survey, there are 11.8% business implement the IoT solutions, 5.1% business has implemented IoT, 29% of them is trying to explore the IoT solutions, and the other 37% is doing research to learn about IoT solutions [3].

There are many researches that implement IoT technology. The term "Internet of Things" is known in 1999. The point of IoT technology in that time is refer to the Radio-frequency-identification (RFID), that would allow computers to manage all individually. In 2002, the research article that mentioned the Internet of Things was submitted to the conference for Nordic Researchers in Logistics, Norway [4]. This research implemented smart and connected objects in the information system infrastructure. Cisco System is estimated that IoT was born between 2008 and 2009, that has the growth ration from 0.08 in 2003 to 1.84 in 2010 [5]. Today, there are many developed innovations of IoT. In 2014, Antonio J. Jara [6], proposed an extension of the IoT to wearable computing. This research enables the wearable devices to connect to internet. The extension can be found in the new generation of wearable sensors e.g. cadence, speed sensors, electrocardiograms, and activity monitors such as HOP Extended from HOP Ubiquitous, etc. Jih-Wei Wu, Ding-Wei Chou, and Jehn-Ruey

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Jiang [7] proposed a new paradigm of the Virtual Environment of Things (VEoT). This paradigm is used to integrate real-world smart things ans virtual-world avatars/objects in a computer generated virtual environment, so the entities in either worlds can have interactions real time. This research add VEoT-based NVE (Network Virtual Environments), that is called X-Campus to guide and navigate visitors in National Central University Building. This X-Campus aims to verify the feasibility of VEoT. JSathiskumar and Dhiren R. Patel [8] presents sensor network location privacy in IoT and its related issues. This research discuss and explore solution directives for issue in location privacy that is also associated with sensors in IoT. Jonathan Kua et.al. explore the activity queue management (AQM) that is implemented in home gateways. This provides protection for IoT flows. This research investigates the effect of different algorithms implemented at home gateways. We find that deploying multiqueue FlowQueue Controlled Delay (FQ-CoDel) or the hybrid FlowQueue Proportional Integral Controller Enhanced (FQ-PIE) at the home gateway can provide excellent capacity sharing, flow isolation, and good protection in terms of throughput and queuing delays for IoT flows and other applications, which cannot be achieved with traditional FIFO or other single-queue AQMs such as Proportional Integral Controller Enhanced (PIE). Sachchidanand Singh and Nirmala Singh [9], provide the explantion of IoT concept and its characteristics, the security challenges, technology adoption and its trends, and also suggest a reference architecture for E-Commerce enterprise based on IoT.

There are many applications for IoT devices e.g. smart home [10], smart care, smart health [11], smart city, smart appliance [12], smart farming, smart TV, and so on. This paper explores the IoT technology in smart home applications. Life safety and convenience becomes the important thing today. The smart home application provides devices that can be used to increase the security e.g. digital door locks application. This research implements IoT technology in digital door locks applications. The contribution of this research is to improve the security in the smart door lock system. Our research uses three method in the authentication process i.e. Bluetooth technology, login username and password, and also QR code scanner. This aims to increase the security in the system. The devices used are Android smart phone, Raspberry Pi, Webcam, Microswitch, and Arduino GSM. User uses the Android smart phone to control the automatic door locks. User will login to the system by insert the username and password in their Android device. Smart Door System will send code to the Android device after the validation process success. Android device send the code to Raspberry Pi using the Bluetooth technology. Raspberry Pi execute program to validate data and make decision based on the input data. If the code is valid, Raspberry Pi will open the locked door by giving an order to Arduino GSM to open the Microswitch, and camera will take a picture for documentation. This paper is organized as follow: first section is the motivation of the paper and literature study, second section contains research methodology, third section is the experiment result and analysis, last section is the conclusion of the paper.

2. Research Method

This research uses some devices such as: Raspberry Pi, Webcam, Microswitch, and Arduino GSM. The Android device provide interaction between user (owners) and smart door lock system. Raspberry Pi is small single-board computer that can be used to execute simple computer program [13]. According to Raspberry Foundation, there are more than 5 million Raspberry Pi were sold in February 2015. This causes Raspberry became the best-selling in British Computer [14]. In July 2017, it reached 15 million selling [15]. And in March 2018, the Raspberry selling reached 19 million [16]. In this research, the Raspberry Pi is used as processor that can execute program to validate data and make decision based on the input data. Webcam is a video camera that provides streaming to the image captured in real time to or through a computer to a computer network [17]. The image captured may be saved, viewed, or sent on to other networks travelling through systems such as: internet or e-mailed as attachment file. This webcam is used to capture image in the environment for smart door system documentations.

Microswitch or it is also known as miniature snap action switch is an electric switch actuated by very little physical force through the use of tipping point mechanism or sometimes called an "over center" mechanism. This mechanism allows Microswitch to move from left to right to normally open or closed. This Microswitch is used to lock the smart door system. And Arduino GSM is used to move this Microswitch based on the Raspberry Pi instructions. Arduino

GSM is kind of Arduino that enables an Arduino board to do most of its operation which is similar with GSM phone e.g. place and receive voice call, send and receive SMS, and connect to the internet over a GPRS network [18]. Arduino itself is single-board micro controllers kits to build digital devices and interactive objects that have an ability to sense and control objects in the physical and digital world [18].

The mechanism of proposed application in this research can be described in Figure 1. User will use Android smartphone to login to the system. The webservice provides username and password validation. If the validation is success, webservice will send success code that will be sent to Raspberry Pi using Bluetooth connection. If the code is right, Raspberry Pi will give instruction to Arduino GSM to move Microswitch. Microswicth will lock or un-lock the door. The architecture of system proposed in this research is shown in Figure 2. The services in the integrated smart door system are developed in PHP [19] programming language using Laravel framework [20]. The application that is installed in Android device is developed native using Java programming language.

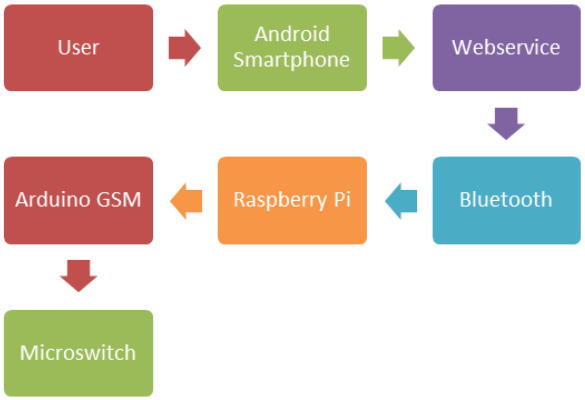


Figure 1. The integrated smart door system process

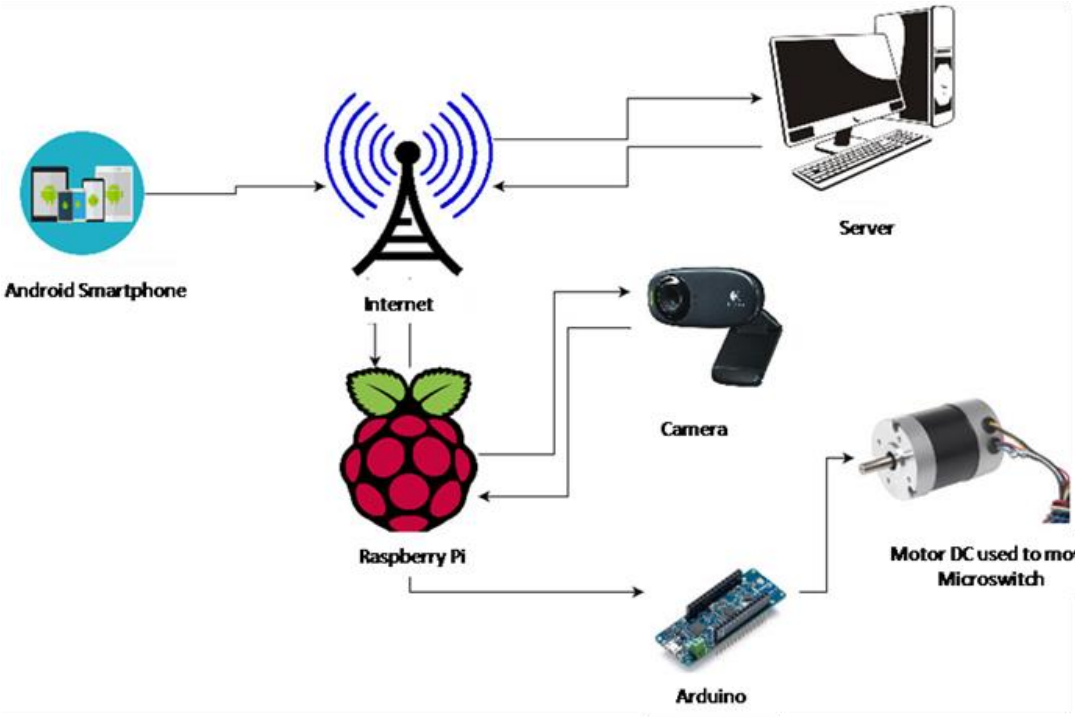
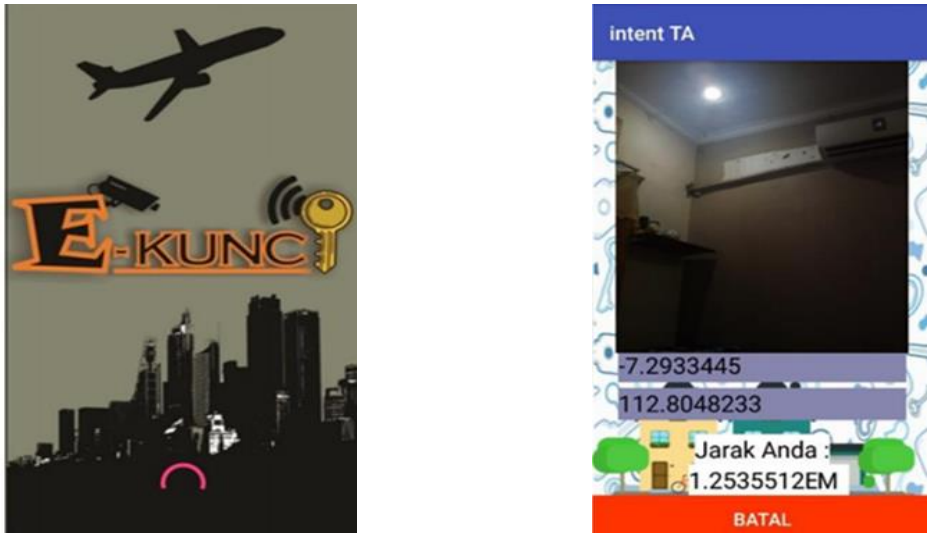


Figure 2. Architecture of smart door system

3. Results and Analysis

The implementation result is shown in Figure 3. Figure 3 (a) is splash screen and Figure 3 (b) is barcode scan interface. In Figure 3 (b), there are latitude and longitude that represent the user position. This uses to validate the position of user is near the door.



(a) (b)

Figure 3. The splash screen and barcode scan interface,
(a) splash screen, (b) barcode scan interface

Figure 4 describes login interface. In login interface, there are input fields for username and password. Figure 5 shows the history of transactions happened. This will help the owner to know the people accessing the integrated smart door system. This history is generated automatically when user interact with the system. Forgot password feature helps user to get their last password. Figure 6 is forgot password interface from web interface and Figure 7 is forgot password interface from mobile interface. User will insert the registered email address, and system will reply the user's last password. Figure 8 describes the email notification which is sent by the integrated smart door system. Figure 9 shows the Smart Door System component.

Figure 4. Login interface

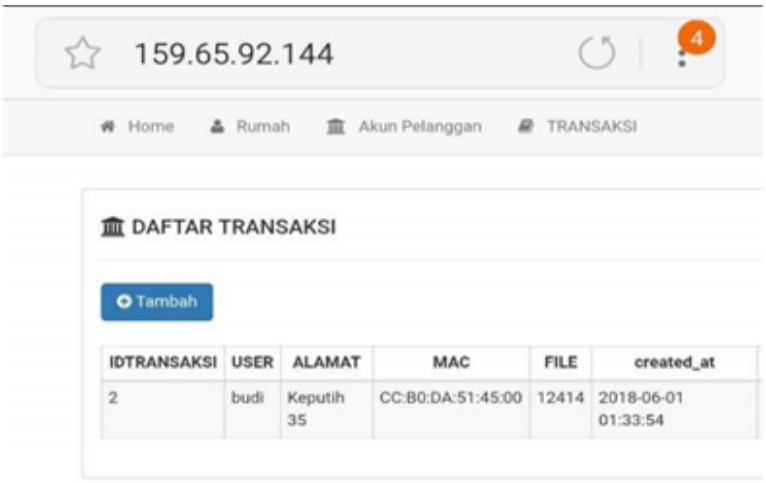


Figure 5. History of transactions happened

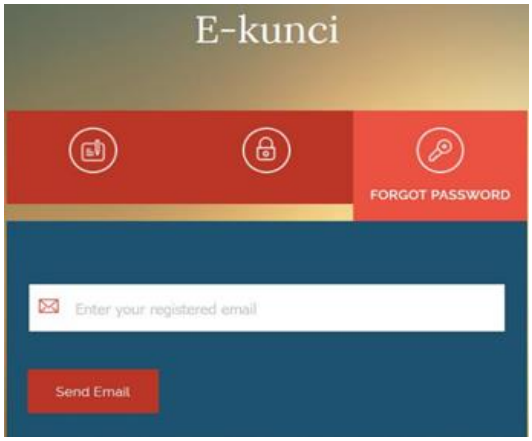
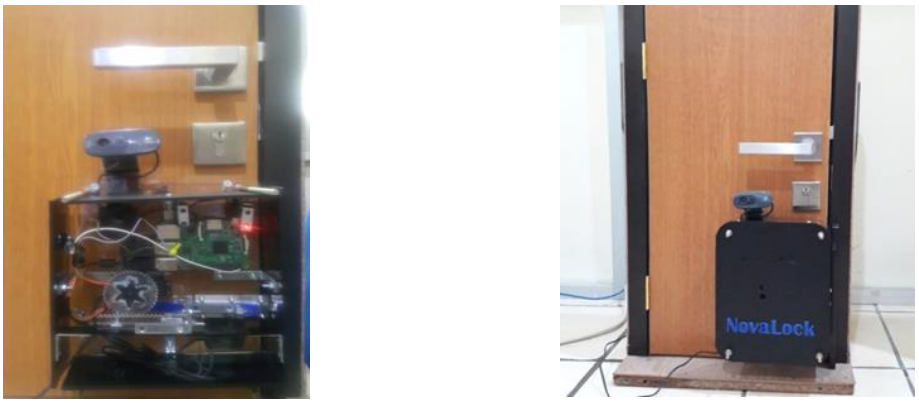


Figure 6. Forgot password interface in web view

Figure 7. Forgot password interface in mobile view

Figure 8. Email notification for forgot password feature



(a) (b)

Figure 9. Smart door system, (a) component inside and (b) front look

To test the system performance, this research proposes four types of test case described in Table 1. This research also uses two different devices and three different places. Evercross smart phone and Samsung Galaxy J5 are used in this research as testing device. The three different places used in this testing are AJK Laboratory, Bumi Marina Surabaya Residence, and Gading Fajar Sidoarjo Residence. This research measures the average of computational time to access the system based on those different devices and places. This test cases also use different internet provider to know the internet connection speed i.e. Telkom WiFi, Firstmedia WiFi, and ITS WiFi.

Table 2 shows the average time to scan QR code using phone's camera and the average time to access the GPS. It results 6.83 seconds. Table 3 shows that the average time to login is 4.75 seconds. The average time to login is less than the average time to scan QR code and access GPS. It is because scan QR code using phone's camera and access the GPS need more computation in device than the login authentication. Table 4 shows the average response time from raspberry to Android device, and Table 5 shows the total average time to show history. From those results, we also know that different device can result different computational time. It is because different device has different specification i.e. RAM, processor, and memory. Since the different internet providers result different internet connection speed, the average computational time between internet providers are also different.

This research provides comparison study to compare this research with some similar researches. There are total 5 papers that is compared. These papers are chosen because they have the same topic. Siddhi Kavde et.al. [21] implement IoT to smart door lock system so the owners can control their door using the smart phone. This system uses the Bluetooth technology to authenticate the owners. The smart lock is an electromechanical lock that is used to lock and un-lock the door based on the instruction from the person who has authorization to access it. This system also monitors the critical event that become the main part in the smart home.

Naser Abbas Husein and Inas Al Mansoori [22] provide a smart door system for home security by using Raspberry Pi3. This research use cameras, keypad and pi-lids to provide an alarm system that can notify the owner and also recognize the guest by giving them user id. Faiz Aman and Anitha C [23] implement motion sensing and image capturing to smart door system in Android platform. If a person comes in front of the door, the motion sensor will be triggered, the image will be captured and system will notify the owner. Charoen Vongchumyen et.al. [24] proposes the smart way to solve problem in conventional door-locking system. The system can remotely lock an un-lock the door, check the door state, notify the owner whether there is someone knocking the door, and generate temporary pass code that can be use in specific date and time. Muhammad Sabirin Hadis et.al. [25] designs the smart lock system for doors with special features using Bluetooth technology. This research support feature for people with disabilities.

Table 1. The List of Test Cases

No	Code	Test Case Description
1.	TC-01	Scan QR Code using Camera and access the GPS
2.	TC-02	Login to back-end system
3.	TC-03	Raspberry response after login
4.	TC-04	Show history

Table 2. TC-01 Test Result

No	Place	Device	Network	Success Status	Time
1.	AJK Laboratory	Evercross	GPS	Yes	12.2 s
		Samsung J5	GPS	Yes	10.8 s
2.	Bumi Marina Surabaya	Evercross	Telkom WiFi	Yes	5.3 s
	Resdence	Samsung J5	Telkom WiFi	Yes	2.2 s
3.	Gading Fajar Sidoarjo	Evercross	Firstmedia WiFi	Yes	8.3 s
	Residence	Samsung J5	Firstmedia WiFi	Yes	2.2 s
Average Time					6.83 s

Table 3. TC-02 Test Result

No	Place	Device	Network	Success Status	Time
1.	AJK Laboratory	Evercross	ITS WiFi	Yes	5.4 s
		Samsung J5	ITS WiFi	Yes	3.5 s
2.	Bumi Marina Surabaya	Evercross	Telkom WiFi	Yes	3.6 s
	Resdence	Samsung J5	Telkom WiFi	Yes	5.s
3.	Gading Fajar Sidoarjo	Evercross	Firstmedia WiFi	Yes	5.2 s
	Residence	Samsung J5	Firstmedia WiFi	Yes	5.8 s
Average Time					4.75 s

Table 4. TC-03 Test Result

No	Place	Device	Network	Success Status	Time
1.	AJK Laboratory	Evercross	ITS WiFi	Yes	12.3 s
		Samsung J5	ITS WiFi	Yes	11.1 s
2.	Bumi Marina Surabaya	Evercross	Telkom WiFi	Yes	4.2 s
	Resdence	Samsung J5	Telkom WiFi	Yes	4.5 s
3.	Gading Fajar Sidoarjo	Evercross	Firstmedia WiFi	Yes	8.7 s
	Residence	Samsung J5	Firstmedia WiFi	Yes	4.1 s
Average Time					7.48 s

Table 5. TC-04 Test Result

No	Place	Device	Network	Success Status	Time
1.	AJK Laboratory	Evercross	ITS WiFi	Yes	5.7 s
		Samsung J5	ITS WiFi	Yes	5.2 s
2.	Bumi Marina Surabaya	Evercross	Telkom WiFi	Yes	5.5 s
	Residence	Samsung J5	Telkom WiFi	Yes	5.0 s
3.	Gading Fajar Sidoarjo	Evercross	Firstmedia WiFi	Yes	5.3 s
	Residence	Samsung J5	Firstmedia WiFi	Yes	5.3 s
Average Time					5.3 s

4. Conclusion

The integrated smart door system is proposed to increase the security in apartment room. Life safety and convenience become important. This proposed system is expected to be able to increase the security using the IoT technology. The rapid growth of IoT technology today, results many applications that can be used to help many problems in our life. From the testing result, it can be concluded that this system can provide the safety and convenience for user. It is because this system use only Android device to control the door. The input from user will be sent to the server, and server send the response. This mechanism also minimizes the computation, because our proposed system do the validation process in the online server. Nevertheless, our proposed method depends on the internet connection. When the connection becomes slower, the system will also have the slower response. Besides, the specification of device used also affects to the average computational time from system.

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