Prototype of smart office system using based security system

T F Prasetyo*, D Zaliluddin and M Iqbal
Informatic Engineering Study Program, Majalengka University, Majalengka, Indonesia

*Corresponding author’s e-mail: triferga.prasetyo@gmail.com

Abstract. Creating a new technology in the modern era gives a positive impact on business and industry. Internet of Things (IoT) as a new communication technology is very useful in realizing smart systems such as: smart home, smart office, smart parking and smart city. This study presents a prototype of the smart office system which was designed as a security system based on IoT. Smart office system development method used waterfall model. IoT-based smart office system used platform (project builder) cayenne so that. The data can be accessed and controlled through internet network from long distance. Smart office system used arduino mega 2560 microcontroller as a controller component. In this study, Smart office system is able to detect threats of dangerous objects made from metals, earthquakes, fires, intruders or theft and perform security monitoring outside the building by using raspberry pi cameras on autonomous robots in real time to the security guard.

1. Introduction
Creating a new technology in the modern era gives a positive impact on business and industry. Many people are competing to innovate in creating new technologies that can be useful to help every activity of human life. Humans try to improve their quality and effectiveness in life. The advance of civilization is incompatible with the resources availability. Humans’ need and lifestyle become more vary. The competition in human life demands them to strengthen their potential. This situation affects to the business and company’s condition. In order to survive, humans need to utilize the technology, one of them is Internet of Things (IoT). In Nasher and Lestariningatii’s research (2016), Piyare says that the Internet of Things (IoT) can be described as a daily-use of things such as smart phones, Internet TVs, sensors and actuators to the Internet where smart devices are linked together and forming a new form of communication.[1]

IoT technology can and forming a new form of communication. Be applied in creating new concepts and wide development spaces that are implemented not only in homes to provide comfort, security, and improve quality of life but it can also be implemented in an office or company. The existence of IoT technology makes the implementation of smart office can be realized. A great company has employees in a synergy to achieve its maximum target. Then, it is reasonable for a company to improve its performance and productivity by supporting and providing the employees’ needs in work. Feasible and representative office is one of the things that company can provide to encourage its employees to feel comfortable and motivated in giving their best performance in work. In a study conducted by Pancorowati (2015) [2], Strek found that 83% of employees expected proper lighting, appropriate work areas, and comfortable air temperature. They also expected a convenient
archive room, personal office with a neat arrangement of cables. The expected work environment can be seen in the table below [2].

![Figure 1. Expected work environment](image)

Office with high technology is not yet fully secure. There are other problems may occur, such as inefficient use of electricity, poor air circulation, poor security system, natural disaster, fire, and other external threats. In terms of environment comfortability, some companies are not equipped by a well-maintained garden and a comfortable parking lot. Those problems can be solved by creating a security system to monitor the situation in and outside the building. There are some security systems that can be used inside the building. They are metal detector, fire detector, earthquake detector, PIR (passive infrared), RFID, and magnetic switch and keypad sensor. Security system inside the building can be accessed and controlled by internet transmission media. Besides that, these security systems can also be applied outside the building by an autonomous robot. This robot will monitor the security outside the building by using raspberry pi camera in real time to the security guard. The purpose of this research is to create a prototype of the smart office system for IOT-based security system and to realize the representative office to improve the productivity and effectiveness of employees.

There are some relevant studies to this present study. They are: 1) Research conducted by Prof. Dr. Khana Samrat Vivekanand Omprakash in 2011 entitled Wireless Home Security System with Mobile [3]; 2) The Network Architecture Design for an Adaptable IoT-based Smart Office Solution by Karol Furdik, Gabriel Lukac, Tomas Sabol, and Peter Kostelnik in 2013 [4]; 3) Research by Muhammad Priyono Tri Sulistiyono, Danang Aditya Nugraha, Nurfatika Sari, Novita Karima, and Wahid Asrori in 2015 entitled Implementation of IoT (Internet of Things, a research in the University of Kanjuruhan Malang [5]; 4) Research conducted by Renuka Bhuyar and Saniya Ansari under the title Smart Office Automation System [6], and; 5) a research by Saurabh Kul, Amey Mundle, Vaibhav jivark, Vidya in 2016 with the title Survey on Arduino based Security System[7]. Research conducted by Karol Furdik, Gabriel Lukac, Tomas Sabol, and Peter Kostelnik in 2013 carried out research with the title of research The Network Architecture Design for an Adaptable IoT-based Smart Office Solution [4]. Research conducted by Muhammad Priyono Tri Sulistiyono, Danang Aditya Nugraha, Nurfatika Sari, Novita Karima, and Wahid Asrori in 2015 conducted research with the title Implementation of IoT (Internet of Things) research in the University of Kanjuruhan Malang [6]. Research conducted by Renuka Bhuyar and Saniya Ansari in 2016 conducted research under the title Smart Office Automation System [7]. Research conducted by Saurabh Kul, Amey Mundle, Vaibhav jivark, Vidya in 2016 conducted a research titled Survey on Arduino based Security System [5]. Referring to those relevant studies, this recent study uses Arduino controller. Arduino is an open source electronic board.
with an input and output and there is a major component as a program controller that can be written and removed in a specific way that is an ATmega328-based microcontroller chip. Microcontroller itself is a chip or IC (Integrated circuit) that can be programmed using computer. The recorded program aims to enable electronic circuits to read inputs, process and produce desirable outputs. The result can be a signal, voltage, light, sound, vibration and so on [8].

2. Methods
Waterfall method was used as a system development methodology. This study used IoT project builder cayenne-based Arduino Mega 2560 and Raspberry Pi as the Waterfall model to create a prototype of smart office system. Waterfall model has several mechanical process

Figure 2. System development methodology part 1
2.1. Requirements analysis and definition
In this process, the designed system is defined and analyzed in detail. The analysis process consists of analyzing the concept of the prototype, the sub-system division in the smart office, how the system works, obstacles may occur during the designing process, advantages of the system, the function and specification of the system especially in the case study of security system.

2.2. System and software design
This second process explains specifically the analysis of the software, started from device design analysis, user specification, software requirement specification, and others. In this study, the platform cayenne was used as an inside sensor configuration to connect to the internet. Apart from software analysis, this process also analyzed the hardware, started from prototype design analysis, hardware requirements, prototype architecture system and so on.
2.3. Implementation and unit system
This process is the designing process of each sub-system based on analysis result in previous process. In this process, the designing of software and hardware was also conducted.

2.4. Integrated and system testing
This is the continuation process of implementation and unit system process. Here, the software system was created to control the autonomous robot and the hardware system which is prototype of smart office system was also created based on designing results of previous process. Then, the application from the software and the hardware were completely integrated.

2.5. Operation and maintenance
The final process is the operation and maintenance process. In this process, the smart office system was run completely by the rules. The maintenance process was also conducted in order to optimize the system performance.

3. Results and Discussion
The prototype of smart office system scheme can be seen below.

![Figure 4. The prototype of smart office system scheme](image)

The designed system is the prototype of smart office system for IoT project builder cayenne-based security system. (case study of security system). This system has two functions to make the concept of smart office. The first function as a security system inside the office, can be controlled and monitored through the internet either from dangerous objects made of metal, fire, earthquake, theft and other dangerous possibilities. If the security system is categorized based on the sensor, there are several detectors of it: metal detector to detect the dangerous objects made of metal, fire detector to detect fire, vibration detector to detect the earthquake, RFID and keypad sensor works for office door security meanwhile PIR sensor and magnetic switch sensor detects thieves. The second function of the system as a security system outside the building. The system uses a camera that is integrated with Raspberry Pi on autonomous robot. Autonomous robot which was built is Robot Line Follower which will run automatically followed a predetermined line to control the security of the office during the night.

3.1. Software requirements analysis
Overall, the system uses microcontroller Arduino Mega 2560, Arduino Uno R3 and Raspberry Pi which has been embedded the C programming language. The software which is needed in the prototype of the smart office system: Arduino IDE 1.6.5., Fritzing and Cayenne.
3.2. Hardware requirement analysis
Apart from the software, the hardware is also needed in designing this prototype of smart office system for IoT project builder cayenne-based security system. The hardware are: Arduino Mega 2560.

Arduino Mega 2560 was used inside the building by utilizing ATmega 2560 because of greater storage capacity. Arduino mega was used to control the existing sensors inside the office such as metal sensors, fire sensors, vibrating sensors, RFID sensors, PIR sensors and magnetic switch sensors and others. Arduino mega also integrated with ethernet shield to be connected to the internet.

3.2.1. Raspberry Pi. Raspberry Pi was applied on the autonomous robots. Raspberry Pi was integrated with Arduino Uno R3. Arduino Uno served as a control to its line follower robot. While the raspberry was used to monitor its safety, by installing the raspian as the operating system used in the raspberries. In addition, the raspberries was integrated with a 5 MP resolution camera that was used to monitor the security outside the office.

3.3. The designing of smart office system hardware
The designing process of smart office system hardware consists of 2 (two) designs:

3.3.1. Security system inside the office

![Figure 5. Hardware circuit design inside the office](image)

**Table 1. Pin I / O security system on Arduino**

| No | Hardware Name                   | Pin On Arduino                      |
|----|--------------------------------|------------------------------------|
| 1  | Metal Sensor                   | Digital 2, VCC, GND                |
| 2  | Fire Sensor                    | Digital 7, VCC, GND                |
| 3  | Vibrator Sensor                | Digital 5, VCC, GND                |
| 4  | RFID sensor                    | SDA, SCK, MOSI, GND, 3,3 Volt, Digital 21 |
| 5  | Keypad                         | GND, VCC, Digital 37,38,39,40,41,42,43 |
| 6  | PIR Sensor                     | Digital 6, VCC, GND                |
| 7  | Magnetic switch sensor         | GND, Digital 4                     |
| 8  | LED                            | Digital 3, GND                     |
| 9  | Buzzer                         | Digital 8, GND                     |
| 10 | Servo                          | GND, VCC, Digital 15               |
| 11 | Relay 5 Volt                   | GND, VCC, Digital 10               |
| 12 | LCD                            | GND, VCC, Digital 27, Digital 29, Digital 31 |
| 13 | Fan DC                         | IN 1, IN 2 (relay 5 volt)          |
3.3.2. Security system design on Robot Autonomous

![Design of autonomous robot block diagram](image)

**Figure 6.** Design of autonomous robot block diagram

| No | Hardware Name          | Raspberry Pi                 |
|----|------------------------|------------------------------|
| 1  | Arduino Uno            | Line USB 1                   |
| 2  | Usb wireless TP-link   | Line USB 2                   |
| 3  | Module Camera          | Slot camera                  |
| 4  | Batere 9 volt          | Slot power                   |

**Table 2.** Pin I / O security system on autonomous robot

3.4. The Making of Smart Office System Prototype

Figure 7 describes the prototype of a smart office equipped with multiple sensors that support security in an office like activities such as PIR, Flame, RFID, Metal detector and Earthquake sensors.

![Security system on smart office](image)

**Figure 7.** Security system on smart office.

![Security System on autonomous robot](image)

**Figure 8.** Security System on autonomous robot.

Figure 8 describes the autonomous robot system in keeping the security of the office from the outside by moving for a specified time and detecting movement or humans passing through this system. Other capabilities not only detect but capture images or videos they see and in control by internet based phone devices of things.
4. Conclusion

Based on the results of the discussion and testing that have been done, then the conclusions of this study are:

- The Prototype the smart office system in the security system consists of security system inside the building and the autonomous robot was designed by using Arduino Mega 2560 and it was integrated with Raspberry Pi using Internet of Thing (IoT) transmission media with platform Cayenne and stages of system development using the waterfall method.
- The security system in the prototype of smart office system was designed using several sensors i.e. metal sensor, fire sensor, vibrator sensor (SW-420 sensor), RFID sensor, passive infrared, keypad and Magnet switch sensor.
- The security system of the autonomous robot uses the raspberry Pi microprocessor and it was integrated with the arduino uno R3 microcontroller.

5. References

[1] Nasher G A, Ningati L and Indriani S 2016 *Smart House Scheduling and Controlling System Using Android* (Bandung: Informatics Engineering Program Faculty of Engineering and Computer Science University Computer Indonesia)
[2] Pancorowati M H 2015 *Effect of Office Spatial Against Employee Productivity* (UNESA: Journal of UNESA)
[3] Omprakash P K S 2011 *Wireless Home Security System With Mobile* International Journal of Advanced Engineering Technology
[4] Furdi K, Lukac G, Sabol T and Kostelnik P 2013 The network architecture designed for an adaptable IoT-based smart office solution International Journal of Computer Networks and Communications Security 1 6 216-224
[5] Kul S, Mundle A, jivark V and Vidya 2016 Survey on Arduino based Security System International Journal of Computer Applications
[6] Sulistyanto M P T, Nugraha D A, Sari N, Karima N and Asrori W 2015 Implementasi IoT (Internet of Things) dalam pembelajaran di Universitas Kanjuruhan Malang SMARTICS Journal 11 20-23
[7] Bhuyar R N and Ansari S M Smart Automation System for Office Environment
[8] Saptaji 2014.5 5 menit handling rtc ds3231 ds3232 dengan Arduino http://saptaji.com

Acknowledgments

We have thank to Universitas Majalengka for giving chance and facilities to do this research.