PROPOSAL OF SMART HOME SECURITY SYSTEM USING RASPBERRY PI 4

Lee Seungjik
TUIT, Professor of Artificial intelligence
Zaynidinov Hakimjon
TUIT, Head of the Department of Artificial Intelligence
tet2001@rambler.ru
Yusupov Ibrohimbek
TUIT, Head of Department for the international Relations, International Rankings and Strategic development
Mamirov Xudoyberdi.
Ph.D. student in TUIT
mamirov.0710@gmail.com
https://doi.org/10.5281/zenodo.8041126

ABSTRACT: IoT (Internet of Things) technology, the core technology of the 4th industrial revolution, is currently being applied to various fields. Among them, the most basic application is the security system. The security system automatically detects a moving object or person approaching a restricted area, and if the object or person moves, it can immediately take a picture and store it. By taking a picture and storing it, you can recognize what the moving object is and who it is if it is a person. You can open the door by checking who it is, and you can also find out what time someone came. In this paper, we propose a smart home security system based on Raspberry Pi 4. The proposed smart home security system uses a Raspberry Pi 4, a relatively easy-to-handle main processor, and a human body sensor (PIR sensor) to configure smart home security to determine intrusion. In addition, a web camera was connected to the Raspberry Pi 4 to record the intruder's video. As a result of verifying the efficiency by actually implementing the smart home security system proposed in this paper, it was possible for individuals to configure it more easily than the existing home security system. All sensors used in this study were inexpensive and easily available on the market. The computer was configured using Raspberry Pi 4 so that developing countries could have a lot of interest in Raspberry Pi. The PIR sensor detects if there is an object moving within the measuring range, and the detected data is transmitted back to the camera system to operate camera and take a picture. The captured images are immediately displayed on the monitor and stored in the database. The computer program was written in Python language, and it was found that the implementation worked well.

KEYWORDS: IoT, Raspberry pi 4, camera, PIR sensor, smart home, security

1. Introduction

Recently, the world is undergoing technological development in many fields under the influence of the 4th industrial revolution. The characteristics of the 4th Industrial Revolution technology are changing to make people's lives more effective and convenient, and for this purpose, the Internet of Things connected as one based on the Internet forms the core. Also, in the 4th industry, cloud computing that can be connected to one computer around the world, artificial intelligence with self-determination, and virtual reality suitable for simulation are key technologies. Among these core technologies, IoT and artificial intelligence (AI) fields are particularly interested in many countries around the world, so universities and global companies are mainly researching them. These research results are also developing day by

day. In addition, artificial intelligence and the Internet of Things are organically cooperating with each other to create new synergies. IoT technology, represented by smart cities, smart factories, smart farms, smart buildings, and security systems, is of great interest in cities and local governments in each country.

In particular, Korea's competitiveness in the field of IoT-based method systems, smart cities, smart factories, smart farms, and smart buildings has reached the world's highest level. There are many research presentations on the current system and many prototype presentations. [1] to [16]. The theoretical background is sufficient, and based on this technical background, each company makes prototypes and announces and sells them. However, developing countries still imports and uses foreign technology because the competitiveness of IoT is still weak. In order to activate technology in the field of IoT in developing countries, first, each university should pay attention to fostering experts in the field of IoT and produce them, and the discharged manpower should work professionally in this field. In addition, it is important for the government to spread awareness and R&D in the field of IoT.

This study aims to implement a basic Smart Home Security system as a basic step study to activate IoT technologies. In order to induce interest in the IoT of students and related persons, a basic and easy system was created using the most general-purpose sensor and camera. A PIR sensor is used to detect motion in a designated area, and the detected data is transmitted to a computer, which activates another image sensor, the camera, to take pictures of moving objects. It is displayed directly on the monitor system and stored in the computer's database. If necessary, you can take a video and archive it. These digital technologies require skills to understand and use sensors. In order to operate the camera, you need to understand the basics of the camera and have the skills to connect the camera to a computer. The program that directly controls these technologies was written as a Python program, and the necessary software libraries were written by directly downloading them from the outside. Raspberry Pi's RPi.GPIO, time, and Opencv libraries were installed and used on the Raspberry Pi 4 computer.

As a result, this study implemented a basic IoT system for the security system, and measured and analyzed moving people or objects, which are the most basic data in the Smart Home Security System. A commonly used PIR sensor was used as the sensor, and a Logitech webcam 270 model, a universal web camera, was used as the camera. All of them are universally used and inexpensive, so students can easily purchase and use them. Although this study is still insufficient to induce interest in the new IoT field in it will show a lot of interest from students and professors by developing the most basic IoT system.

2. Smart Home security system (theoretical background)

2.1 Internet of Things (IoT)

The Internet of Things (IoT) is all network technology of things (Things) embedded with sensors, software, and other technologies for the purpose of connecting all computers and things through the Internet, transmitting data with other devices and systems, and improving efficiency. It is a wide range of technologies, including Such things range from ordinary household electronics to sophisticated industrial tools. Currently, more than 7 billion IoT devices are connected to the network worldwide, but experts predict that more than 20 billion things will be connected to the Internet by 2025. Most of these connections are connected to the servers of IoT specialist companies. There is, and it is expected that more servers will be connected in the future. Currently, many companies, led by Amazon, a

representative IoT company, operate cloud computers and are connected to things around the world through the Internet. Cloud computer companies specializing in IoT are expected to appear in developing countries in the future, and I think that developing countries will show a lot of interest in IoT soon.

In the future living environment, the safety of people living in offices or homes becomes important. If an unauthorized person appears in a specific area, a big problem can occur, and when this situation occurs, information to effectively deal with it is very necessary. In addition, if a large computer is used to create such a system, efficiency may be a problem, and the size of the system will become very large. For this system, the size can be configured very small by implementing the system using Raspberry Pi 4, which is exclusively used in the Internet of Things.

2.2 Basic configuration of Smart Home Security System

The basic configuration of the Smart Home Security System requires a system that measures environmental data in a specific area. The changing information of a specific area is very important environmental data. A sensor is required to measure and analyze it, and a transmission system to transmit data is also required. In special cases, you need a camera to take pictures, and the program that drives it is also important. This study can be divided into a sensor part that monitors a specific area, a camera that takes pictures, and a computer part that controls them all. A PIR sensor was used for the sensor, a logitech webcam 270 model was used for the camera, and a Raspberry Pi 4 was used for the computer to implement the system. Based on the basic theory of Smart Home Security System and each sensor, the basic Smart Home Security System was developed.

3. Proposed Smart Home Security system function and operation algorithm

3.1 Implemented system block diagram

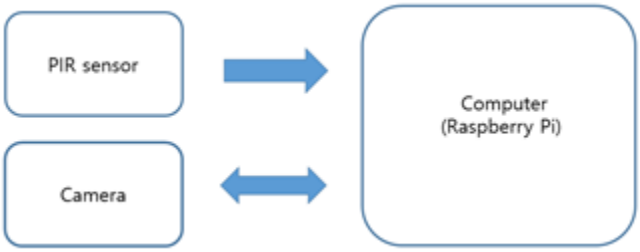

Figure 1. System block diagram

The block diagram of the implemented system is shown in Figure 1. The implemented system is largely divided into three divisions. It can be divided into PIR sensor part, camera part, and computer Raspberry Pi part. The computer part can create a database part inside and store the images taken from the camera in the database. A PIR sensor is connected to the Raspberry Pi 4, so when a person enters the limited range, the PIR sensor detects the person

and informs the Raspberry Pi 4 that a person has entered the restricted area. The Raspberry Pi 4 sends a separate warning message to the monitor and activates another image sensor connected to the Raspberry Pi 4. Since the camera is used as an image sensor, the camera is operated to take pictures of moving objects. The captured data is stored in a database. Since the stored data uses the saved time as a name, it is possible to check when a person was there.

3.2 Sensors and computers

3.2.1 PIR sensor

Figure 2. PIR sensor

Figure 2 is a picture of the PIR sensor. The PIR sensor weighs about 7g and is small, and the size is about 3.2cm x 2.4cm x 2.8cm. The range of operating voltage is about DC 4.5V ~ 20V, and the sensing distance is about 3 ~ 7m, which can be adjusted by volume within the sensor. The delay time can also be adjusted from 5 to 200 seconds. Since the most important working environment temperature is around -20 ~ +80 ℃, everything operates normally within the normal range. These sensors are small in size, inexpensive, use low power, and are easy to use and connect.

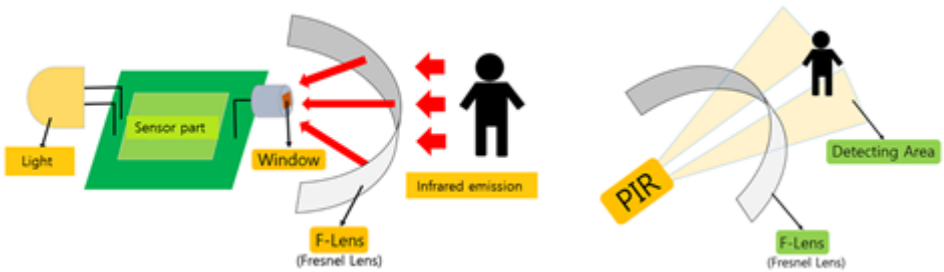

Figure 3. PIR sensor operating principle

Figure 3 shows the operating principle of the PIR sensor. When a person emitting infrared rays comes within the detection distance, the sensor passes the infrared rays of the person through the condensing lens, F-Lenz (Fresnel Lenz), and reaches the window located on the sensor surface. The window passes only infrared rays of a certain frequency band. The infrared signal passing through the window is converted into voltage through the sensor unit and amplified by the amplifier built into the sensor unit itself.

3.2.2 Camera

Figure 4. Camera

Figure 4 is the camera used in this study. The model name is Logitech webcam 270. This camera is a web camera and can be used by connecting to the USB connector of Raspberry Pi 4 in general, so it can be used very conveniently. It has a resolution of 1280 x 720 pixels, uses Logitech RightLight technology, and is available with Logitech Vid HD software. In this study, programming was done using the opencv library, which is a commonly used library.

3.2.3 Computer (Raspberry Pi 4)

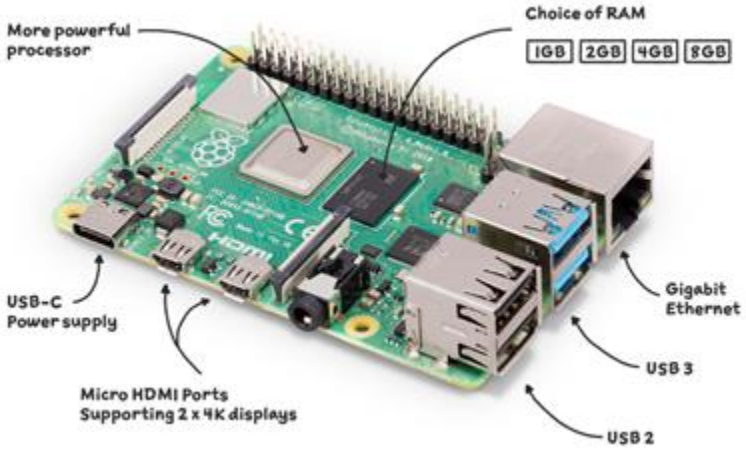

Figure 5. Computer (Raspberry Pi 4)

Figure 5 is Raspberry Pi 4 used in this study. The Raspberry Pi 4 is a single board, capable of interfacing with a screen, keyboard and mouse. The computer used in this study has 8 MB of RAM. The operating system uses the Raspberry Pi OS, and the computer language mainly used in this computer is the Python language. There are two Micro HDMI ports that can connect a monitor to the outside, two USB 2.0 ports for general use, and two high-speed USB 3.0 ports. In addition, there is a jack that outputs an audio signal to the outside, a connector that can connect a dedicated display device, and a camera port that can connect a dedicated Raspberry Pi camera. Since Bluetooth and Wi-Fi are built-in, it is possible to transmit data through wireless communication with the outside without connecting a separate device. The operating system used can be downloaded and installed from the

Raspberry Pi website, and the Micro SD card used at this time can be used farther than 16GB. When installing the operating system, if you use the Raspberry PI Imager provided on the website, you can easily install the operating system on the Micro SD card.

3.2.4 Raspberry pi GPIO pins

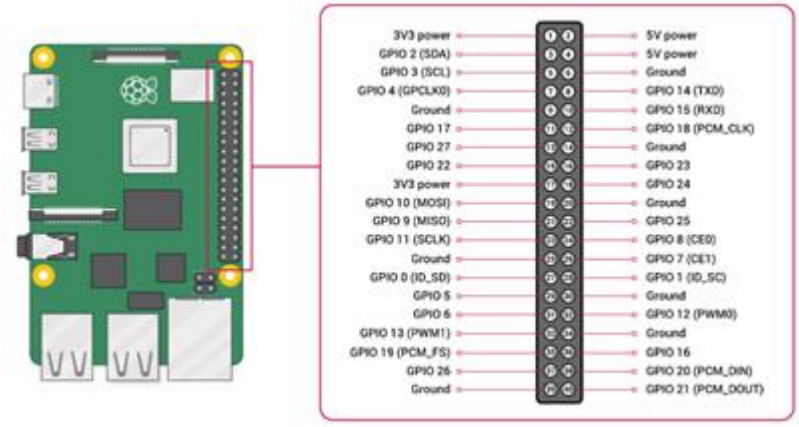

Figure 6. Raspberry Pi 4 GPIO and 40 Pins

Figure 6 shows the PGIO and 40 pins of Raspberry Pi 4. Since it has 40 pins, it can send or receive data to the outside. A number is attached to each pin, and the user can connect them to the outside. It contains power, ground, and pins with special functions. In Raspberry Pi 4, all pins use +3.3V, so you should always be careful when connecting to other computers or connecting external circuits. In this study, the PIR sensor was connected to GPIO pin 7. Python and C languages are mainly used to control externally connected circuits, but in this study, the Python language was used for programming. The editor used the “Thonny” editor built into the Raspberry Pi OS.

4. Proposed Smart Home Security System Diagram and Implementation

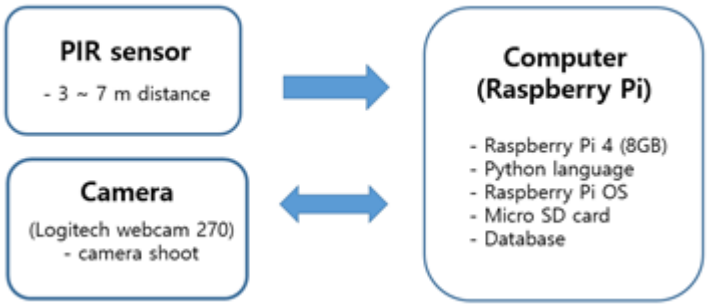

Figure 7. The configuration diagram of the Smart Home Security System

Figure 7 shows the configuration of the proposed system. The PIR sensor can measure a range between 3 and 7m, and the camera takes a picture when a person enters within the limited range. At this time, a warning message indicating an emergency is displayed on the monitor. Overall control for them is done by Raspberry Pi 4, and the main program is written in Python language. The captured image data is stored in the database set in the Raspberry Pi 4.

As a result of completing and implementing this system, the following results were confirmed.

1) Confirmation of basic Smart Home Security System configurability using Raspberry Pi
2) Check the possibility of measuring motion within a limited distance using a PIR sensor
3) Install OpenCV library to use camera and check operation
4) Automatically check camera shooting and saving

Figure 8. Shooting and warning message when a person enters the limited range

Figure 8 shows the case where a person appears in a limited range, that is, in case of an emergency, the camera shoots and displays the “Motion detected” warning on the monitor. Depending on the camera installation location, you can take pictures from different angles, and if you use multiple cameras, you can take pictures from multiple angles.

5. CONCLUSION

The system proposed in this study used commonly and easily available parts. Also, a Raspberry Pi 4 computer was used to promote interest in Raspberry Pi in developing countries. For those who are new to the Internet of Things, it is composed using the most common and low-cost parts, so anyone interested in the Internet of Things or the Smart Home Security System can implement it without spending a large amount of money. This study is a basic study to propose and arouse interest in the Smart Home Security system among the basic systems of the Internet of Things in developing countries, so it can be implemented relatively cheaply. However, in order to implement a more precise and delicate system, more precise sensors and more diverse warning devices should be added. A more precise sensor can identify abnormal situations more quickly, and a better camera can take higher-resolution photos. In this study, two sensors were used, but I am sure that it will become a more effective Smart Home Security system if a system is created using more sensors in the future and connected with communication.

References:

(1). Ye-Jin Jang, Young-Tae Chun, "Technology trend of Smart-home Security System", Korean Security Science Review, no.30, pp.119-138, 2012.

[2] Han-Gook Kim, "Analysis of Entry Strategy and Market Trend of Home Security", Korea Entertainment Industry Association, pp.223-226, 2014.11.
[3] Woo-Sik Lee, Nam-Gi Kim, "Omnidirectional Distance Estimation using ultrasonic in Wireless Sensor Networks", The Journal of The Institute of Webcasting, Internet Television and Telecommunication vol.9, no.5, pp.85-91, 2009.
[4] S.J. Kim, H.S. Oh, "Implementation of Efficient Security System Using WebCAM", Korea Multimedia Society, vol.12, no.1, 2009.
P. Bedi, R. Singh, and TK. Matharu, "Ensuring security in a closed region using robot", ICCIC 2010, pp.1-4, 2010.
[5] B. Nahar, ML. Ali, "Development of mobile phone based sureillance system", ICCIT 2010, pp.506-510, 2010.
[6] Kyu-su Lee, Hyeon Sim, and Jai-Cheol Oh, "The Design and Implementation of Intruder Access Control System by based of Ubiquitous Sensor Network", The Journal of The Korea Institute of Electronic Communication Sciences, Vol.7, No. 5, pp.1165-1171, 2012. https://doi.org/10.13067/JKIECS.2012.7.5.1165
[7] Kim Young Kwan, "Smart Home (Home IOT) ecosystems six components", Digieco, 2014.11
[8] Kim Howon, "IoT technology and security", Information Security Journal, vol.22, no.1, 2012
[9] Park Su Hong, "Mobile IPTV technology and national and international standardization trends", HN Focus Vol20, 2010
[10] Park Jongyoul, Moon Jinyoung, Paik EuiHyun "Module based Security system for a Convergence IPTV Service", Korea Institute of Information Technology, 2010
[11] Kim Moongu, Park Jonghyeon, "Smart TV national and international trends and development directions", TTA Journal, No.131, 2010
[12] Wi Yukyeong, Kwak Jin, "Analysis of Smart TV Trends and Security Vulnerabilities to Use in the Smartwork", Korea Multimedia Society, 2012
[13] Kee-Hyun Choi, Kyung-Soo Jang, Ho-JinShin, "Smart Home Environment for the Protection of Multimedia Digital Contents," The Journal of The Institute of Internet, Broadcasting and Communication (JIIBC), VOL. 11 No. 2, pp. 189-196, 2011.
[14] Minzheong Song, "A Study on Business Types of IoT-based Smarthome: Based on the Theory of PlatformTypology," The Journal of the Institute of Internet, Broadcasting and Communication(JIIBC), VOL. 16 No. 2, pp. 27-40, 2016. https://doi.org/10.7236/JIIBC.2016.16.2.27
[15] Nak-Hyun Kim, Keun-Wang Lee, Mun-Seog Jun, "A Design of Protocol for Protection of Privacy Using Temporary ID in u-health Environment based on ZigBee," Journal of the Korea Academia-Industrial Cooperation Society(JKAIS), Vol. 29, No. 2, pp. 447-480, 2012.
[16] Huda AL-SAFFAR1, Ergun ERÇELEBİ2, "Development of Smart Security System for Remote Control Using Small Computer" Turkish Journal of Science & Technology, Volume 12(2), 107-112, 2017