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Design of BTS Shelter Security System Based on Raspberry Pi Computer with Telegram Messenger Application

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ABSTRACT: To reduce the operating cost, some telecommunication providers reduce their headcount by not allocating security officers for each rural Base Transceiver Station (BTS). However, it causes some devices of BTS lost and difficult to find the thief. To solve the problem, the research proposes security system of BTS shelter based on Raspberry Pi 3 computer with Telegram Messenger application via internet.

By design, Raspberry monitors surveillance area by using the infrared beam sensor installed at the main gate of BTS area and the Passive Infrared (PIR) sensor installed inside of BTS shelter. If somebody (thief) enters the BTS area through the main gate, then Raspberry activates alarm siren unit for 5 minutes and send a message to the predefined smartphone of chief security officer via internet by using Telegram Messenger application. Furthermore, if the thief enters into the BTS shelter, then Raspberry activates IP camera to take photograph of the thief and send it to the predefined smartphone, then activates alarm siren unit continuously until the chief security officer arrives and resets it. The test result proves that the system can work properly. Processing time to send the message and photograph is 2 seconds and 8 seconds, respectively.

KEYWORDS: BTS security, IP camera, Infrared beam sensor, PIR sensor, Raspberry Pi, Telegram Messenger

I. INTRODUCTION

Base Transceiver Station (BTS) shelter as shown in Fig. 1 has dimension of 3m(W)x3m(D)x3m(H). It contains the devices of cellular telecommunications system [1]. Generally, BTS shelter is located not far from the tower. Most of BTS shelters are spread over wide area with the long distance apart from each other.

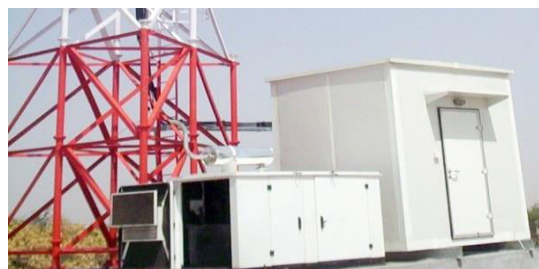


Fig.1. BTS shelter

To reduce the operating cost, some telecommunication operator companies reduce their headcount [2], among other thing, reducing the total number of security officers by not providing security officers for each rural BTS. However, the absence of BTS security officer can lead to the theft of BTS devices. On the other hand, scheduled visit to monitor situation of each rural BTS spread in wide area is ineffective in terms of time, cost, and security effect.

To solve the problem, the research proposes security system of BTS shelter based on Raspberry Pi 3 computer with Telegram Messenger application via internet. The system will monitor and report the BTS situation by real time so the chief security officer can make proper action soon when the system detects thief entering the BTS.

II. RELATED WORK

Previous research [3][4] designed the security system of BTS shelter based on ATmega16 microcontroller via GSM cellular communication. If unexpected condition occurs in BTS shelter, the microcontroller sends a certain

message by using Short Message Service (SMS) to the predefined cellphone. However, message sent by SMS will be delayed due to some reasons, such as high network traffic, full message inbox of the receiving cellphone, different networks between sender and receiver [5]. This system does not utilize IP camera, so it can not provide the security officer with picture of the thief entering BTS. It makes security officer difficult to recognize who the thief is.

Some research designed the cost-effective security system using Raspberry Pi 3 computer and IP camera [6][7][8] so the user can monitor situation of their area visually via internet. Raspberry Pi 3 computer has interface to access IP camera and router-modem. Meanwhile, the other research also completed the security system with Passive Infrared (PIR) sensor to detect the intruder [9][10]. The PIR sensor can detect 10 μm - 14 μm infrared wavelength emitted by human body [11]. Besides the sensor, some security systems utilize Telegram Messenger application to send message and images via internet to the predefined smartphone [12][13].

III. MATERIAL AND METHODOLOGY

To achieve the purpose of research, step of research is arranged to consist of system design, implementation, and testing. Moreover, troubleshooting and improvement are conducted if improper function of the system occurs. The following Fig. 2 shows block diagram of the proposed security system of BTS shelter based on Raspberry Pi 3 computer with Telegram Messenger application via internet. Meanwhile, the placement of BTS security devices is shown in Fig. 3.

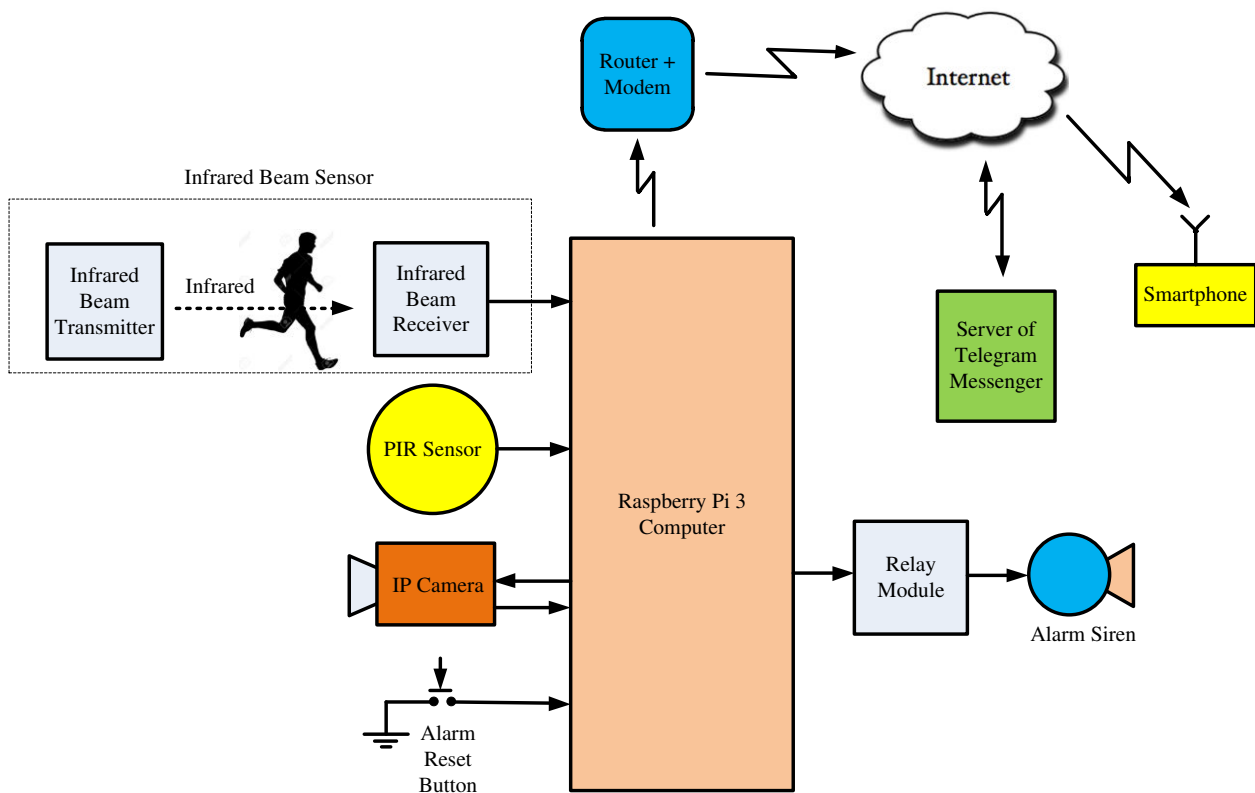


Fig. 2. Block diagram of the proposed security system of BTS shelter

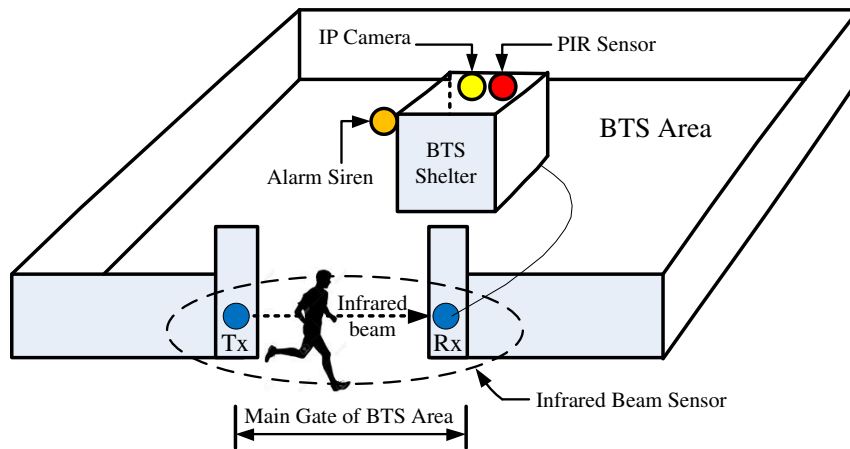


Fig. 3. Placement of BTS security devices

By design, Raspberry Pi 3 computer monitors surveillance area by using the infrared beam sensor installed at the main gate of BTS area and the Passive Infrared (PIR) sensor installed inside of BTS shelter. If somebody (thief) enters the BTS area, then Raspberry Pi 3 computer activates alarm siren unit for 5 minutes and sends a message to the predefined smartphone of the chief security officer via internet by using Telegram Messenger application. Furthermore, if the thief enters into the BTS shelter, then Raspberry Pi 3 computer activates IP camera to take photograph of the thief and sends the photograph and message to the predefined smartphone, then activates alarm siren continuously until the chief security officer arrives and resets the alarm siren unit by pressing the button.

The following Fig. 4 shows schematic diagram of the proposed security system of BTS shelter.

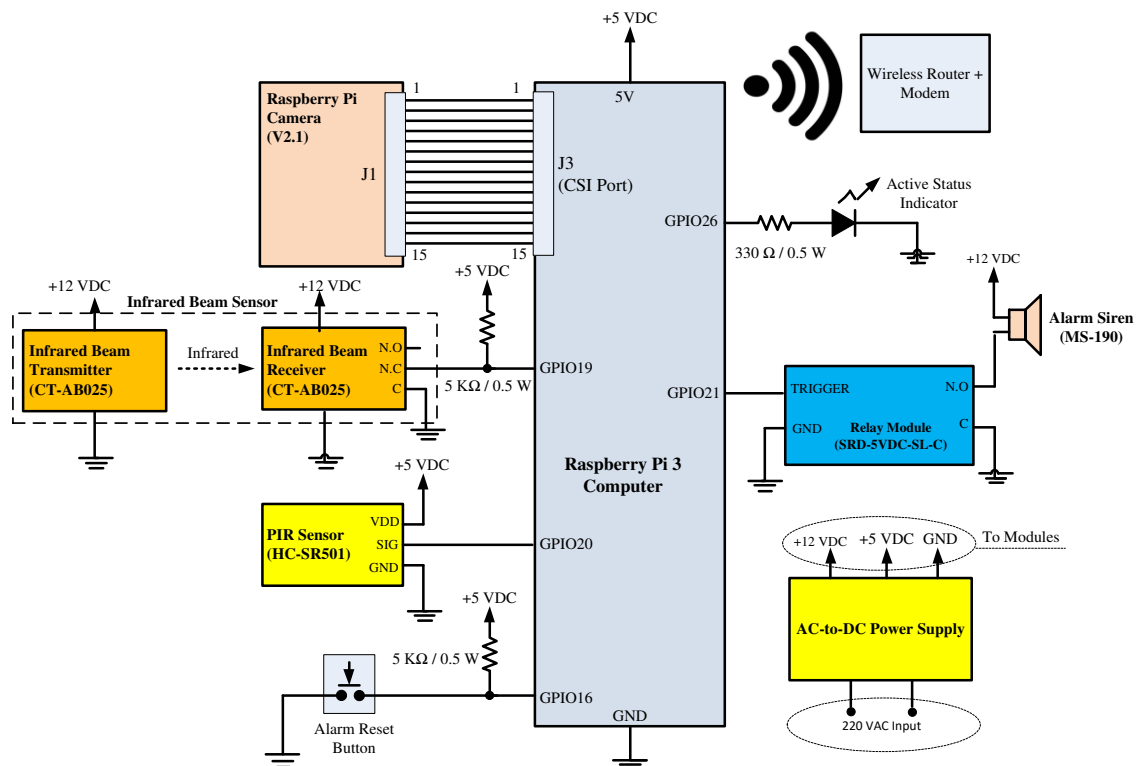


Fig.4. Schematic diagram of the proposed security system of BTS shelter

The system is equipped with “Active Status” LED indicator which lights if system is active. As shown in Fig. 4, the system utilizes the infrared beam sensor (Cardteck, CT-AB025) consisting of a pair of infrared beam transmitter and receiver. The output of infrared beam receiver will be “0” logic if somebody (thief) enters the main gate of BTS area and obstructs the infrared beam coming from the transmitter toward the receiver. Referring to its technical specification, the receiver can detect the infrared beam sent by transmitter which is 20 meters or less away. The infrared beam sensor operates with +12 Volt DC supply. The following Fig. 5 shows the infrared beam sensor (Cardteck, CT-AB025).



Fig. 5. Infrared beam sensor (Cardteck, CT-AB025)

Figure 4 also shows that the system utilizes the PIR sensor (HC-SR501) to detect the thief in area up to 110° of cone angle, 7 meters of distance to the object [14]. In its operation, the output of PIR sensor will be “1” logic if it detects somebody (thief) entering inside of BTS shelter. PIR sensor operates with +5 Volt DC supply. The following Fig. 6 shows the PIR sensor (HC-SR501).



Fig. 6. PIR sensor (HC-SR501)

Moreover, the system also utilizes the 120 dB alarm siren unit (MS-190) which needs +12 Volt DC to operate. By design, Raspberry Pi 3 computer will command the relay module to provide +12 Volt DC supply to the alarm siren unit when Raspberry Pi 3 computer detects somebody (thief) entering into the BTS. Alarm siren will be stopped if Raspberry Pi 3 computer detects that “Alarm Reset” button is pressed so pin GPIO16 is “0” logic. The following Fig. 7 shows the relay module (SRD-5VDC-SL-C), meanwhile, the Fig. 8 shows alarm siren unit (MS-190).



Fig. 7. Relay Module (SRD-5VDC-SL-C)



Fig. 8. Alarm siren unit (MS-190)

Besides sensors and alarm siren unit, the system also utilizes Raspberry Pi camera (V2.1) to take photograph of the thief entering inside of BTS shelter. The photograph is composed by 8 megapixels in JPEG format [15]. Figure 4 shows that there is the 15 pin ribbon cable connecting J1 port of Camera Serial Interface (CSI) of Raspberry Pi 3 computer to J3 port of Raspberry Pi camera. The 15 pin ribbon cable contains lines for control, clock, camera serial data, 3.8 Volt DC supply, and ground. The following Fig. 9 shows the Raspberry Pi camera (V2.1) connected to the Raspberry Pi 3 computer by 15 pin ribbon cable.

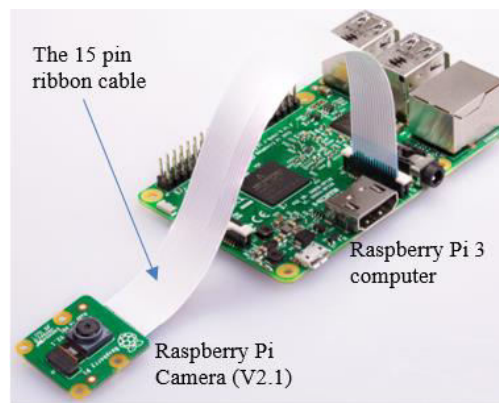


Fig. 9. Raspberry Pi camera (V2.1) connected to Raspberry Pi 3 computer by 15 pin ribbon cable

Raspberry Pi 3 computer is also equipped with 2.4 GHz WiFi 802.11n (150 Mbit/s) [16]. It makes Raspberry Pi 3 computer to have ability to access internet via router-modem. Through internet, all message and photograph of the thief can be sent to the predefined smartphone of chief security officer by using Telegram Messenger application.

The following Fig. 10 shows the flowchart of which the software using python programming language refers. The software is stored in the Raspberry Pi 3 computer. As shown in Fig. 10, the software makes Raspberry Pi 3 computer to start by initializing the system, deactivating the alarm siren unit, and lighting the “Active Status” LED indicator. After that, it checks the output of infrared beam sensor installed at the main gate of BTS area. If the sensor informs that somebody (thief) enters the BTS area, then Raspberry Pi 3 computer activates alarm siren unit for 5 minutes and sends a message “*Somebody enters BTS area*” to the predefined smartphone of the chief security officer via internet by using Telegram Messenger application. Furthermore, Raspberry Pi 3 computer checks the output of PIR sensor installed inside of BTS shelter. If the PIR sensor informs that thief enters into the BTS shelter, then Raspberry Pi 3 computer activates IP camera to take photograph of the thief and sends the photograph and message “*Somebody enters into BTS shelter*” to the predefined smartphone. Moreover, Raspberry Pi 3 computer activates alarm siren unit continuously until the chief security officer arrives and resets the alarm siren unit by pressing the button.

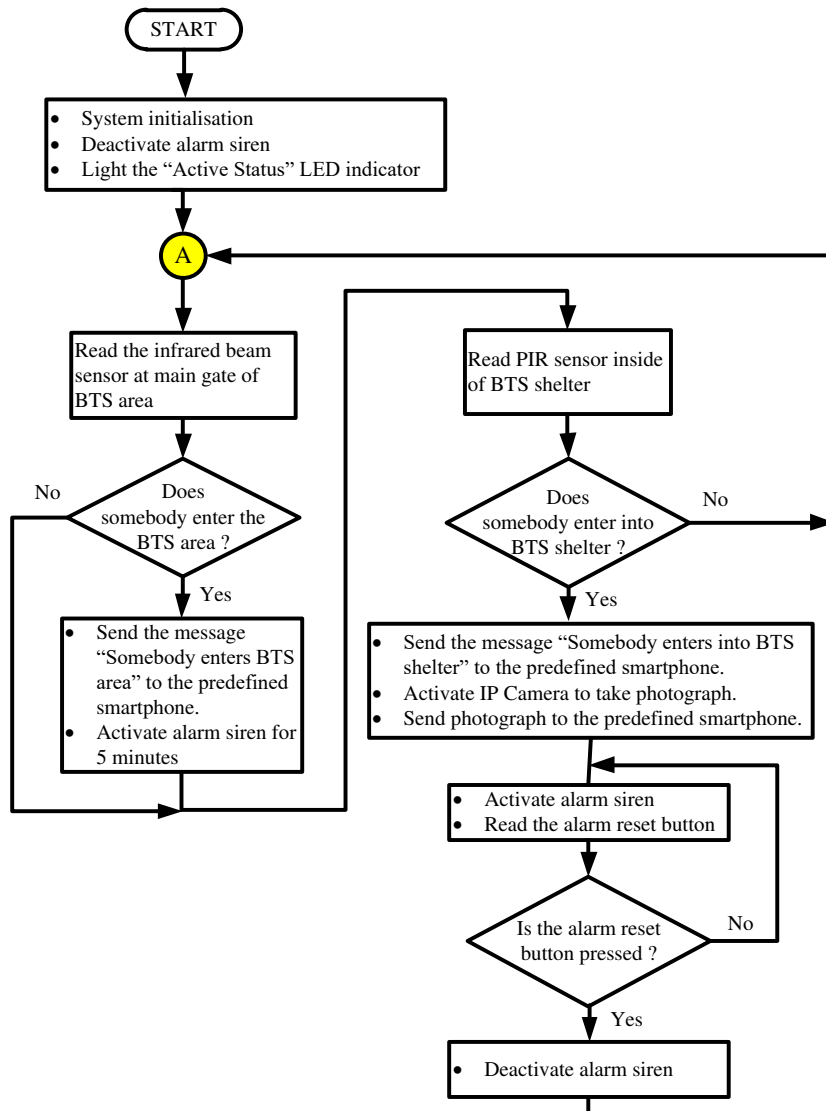


Fig. 10. Software flowchart of the proposed security system of BTS shelter

IV. EXPERIMENTAL RESULTS

The following Fig. 11 shows model implementation of the proposed security system of BTS shelter. It shows that the infrared beam sensor is installed at the main gate of BTS area, meanwhile, the other parts, such as PIR sensor, IP camera, controller including Raspberry Pi 3 computer and router-modem, are installed inside of BTS shelter. Moreover, the alarm siren unit is installed outside of BTS shelter.

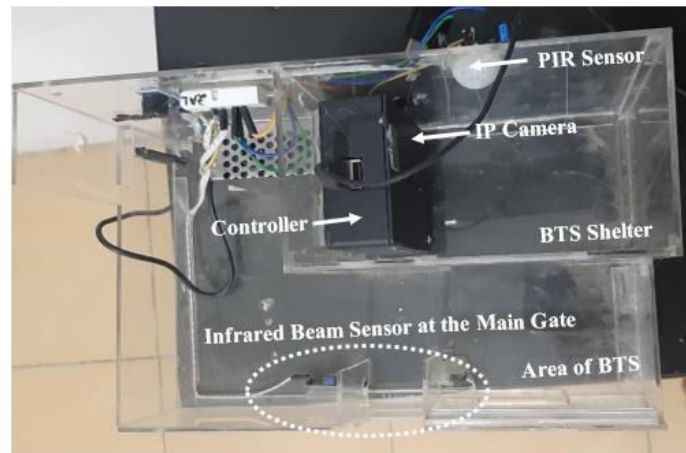


Fig. 11. Model of the proposed security system of BTS shelter

The following Table 1 shows the test result of system response due to intruder detected by the infrared beam sensor and the PIR sensor which is installed at the main gate of BTS area and inside of the BTS shelter, respectively. The test is conducted by obstructing the infrared beam which emits from its transmitter toward receiver. Obstructing the infrared beam simulates the thief entering BTS area through its main gate. Meanwhile, placing somebody into the detecting area of PIR sensor simulates the thief entering into BTS shelter. After that, the response of system is monitored.

Table 1. Test result of system response due to intruder detected by the infrared beam sensor and the PIR sensor

No	Test item	The system response that should be	The actual system response	Remarks
1	Nobody enters either BTS area or BTS shelter.	<ul style="list-style-type: none"> Alarm siren unit is off. IP camera is off. Neither message nor photograph is sent to the predefined smartphone. 	<ul style="list-style-type: none"> Alarm siren unit is off. IP camera is off. Neither message nor photograph is sent to the predefined smartphone. 	The actual system response is proper.
2	Somebody enters BTS area, however, nobody enters into BTS shelter.	<ul style="list-style-type: none"> Alarm siren unit is active for 5 minutes. IP camera is off. Message “Somebody enters BTS area” is sent to the predefined smartphone via Telegram Messenger. The processing time is 2 seconds. The predefined smartphone receives and displays the message sent by the controller. No photograph is sent to the predefined smartphone. 	<ul style="list-style-type: none"> Alarm siren unit is active for 5 minutes. IP camera is off. Message “Somebody enters BTS area” is sent to the predefined smartphone via Telegram Messenger. The processing time is 2 seconds. The predefined smartphone receives and displays the message sent by the controller. No photograph is sent to the predefined smartphone. 	The actual system response is proper.
3	Somebody enters into BTS shelter.	<ul style="list-style-type: none"> Alarm siren unit is active continuously until chief 	<ul style="list-style-type: none"> Alarm siren unit is active continuously until chief 	The actual system

No	Test item	The system response that should be	The actual system response	Remarks
		security officer presses the “Alarm Reset” button. <ul style="list-style-type: none"> • IP camera takes photograph of the thief. • Photograph of the thief and message “Somebody enters into BTS shelter” are sent to the predefined smartphone via Telegram Messenger. Processing time to send the message and photograph is 2 seconds and 8 seconds, respectively. • The predefined smartphone receives and displays the photograph and message sent by the controller. 	security officer presses the “Alarm Reset” button. <ul style="list-style-type: none"> • IP camera takes photograph of the thief. • Photograph of the thief and message “Somebody enters into BTS shelter” are sent to the predefined smartphone via Telegram Messenger. Processing time to send the message and photograph is 2 seconds and 8 seconds, respectively. • The predefined smartphone receives and displays the photograph and message sent by the controller. 	response is proper.

As shown in Table 1, the actual system response due to the infrared beam sensor and PIR sensor is the same with the system response that should be. It means that the system including Raspberry Pi 3 computer, infrared beam sensor, PIR sensor, alarm siren unit, the predefined smartphone, and router-modem for accessing the internet, works properly. It also means that algorithm of which the software using python language refers is correct so the system works properly as designed.

Moreover, processing time for sending the photograph (8 seconds) is longer than the message (2 seconds) because bytes amount of the photograph in JPEG format is bigger than bytes amount of the message.

V. CONCLUSION

Referring to the test result and analysis, it can be concluded as follows:

1. The proposed security system of BTS shelter can work properly as designed. It is indicated by ability of the system to detect somebody (thief) entering either BTS area or BTS shelter, then send properly either message, photograph of the thief, or both of them to the predetermined smartphone via internet by using Telegram Messenger application.
2. Processing time of the system to send photograph and message to the predetermined smartphone by using Telegram Messenger is 8 seconds and 2 seconds, respectively.

REFERENCES

- [1] S. U. Rahayu and N. N. Lubis, “Prototype of Temperature Monitoring System for BTS Shelter using Android Smartphone,” *J. Phys. Conf. Ser.*, vol. 1819, no. 1, pp. 1–7, 2021.
- [2] J. Middleton, “Ten ways for operators to cut costs,” 2008. <https://telecoms.com/opinion/ten-ways-for-operators-to-cut-costs-2/> (accessed May 22, 2022).
- [3] Muhammad Siregar, Suwarno, and S. Putri, “Equipment Design Of Electronic Security System In Shelter Real Time Though SMS Based On ATmega16 Microcontroller and GSM Module,” *JESCE (Journal Electr. Syst. Control Eng.*, vol. 2, no. 2, pp. 68–79, 2019.
- [4] B. Choudhury, T. S. Choudhury, A. Pramanik, W. Arif, and J. Mehedi, “Design and implementation of an SMS based home security system,” *Proc. 2015 IEEE International Conference on Electrical . Computer, and. Communication Technologies , ICECCT 2015*, March, 2015.
- [5] Dexatel, “Top 5 Reasons Why Your SMS Delayed or Not Delivered 5 reasons why SMS is delayed,” *Dexatel*,



2018. <https://dexatel.com/blog/text-messages-delayed/> (accessed May 22, 2022).
- [6] R. Namdeo, S. Sharma, V. Anand, and C. Lohi, "Smart Automated Surveillance System using Raspberry Pi," *International Journal of Recent Technology and Engineering*, vol. 9, no. 2, pp. 308–311, 2020.
- [7] Tiamiyu, "Cost-Effective Raspberry Pi Based Surveillance System Using Innovative Technology," *LAUTECH Journal of Engineering and Technology*, vol. 13, no. 2, pp. 1–18, 2019.
- [8] M. Manjunath, Venkatesha, and Dinesh, "Raspberry Pi Based Anti-Theft Security System using Home Automation for Multi-Level Authentication," *Perspectives in Communication, Embedded-Systems and Signal-Processing (PiCES) – An International Journal*, vol. 4, no. 10, pp. 249–253, 2021, [Online]. Available: <http://pices-journal.com/>
- [9] Deepak S Kumbhar, S. M. Taur, H. C. Chaudhari, and S. S. Bhatambrekar, "IoT Based Home Security System Using Raspberry Pi-3," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 6, no. 1, pp. 305–309, 2019, [Online]. Available: www.ijrar.org
- [10] S. K. Panda and Sushanta Kumar, "Design of IoT based Real-Time Security System Using Raspberry Pi," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 7, pp. 1163–1168, 2020, [Online]. Available: www.irjet.net
- [11] P. Chodon, D. M. Adhikari, G. C. Nepal, R. Biswa, S. Gyeltshen, and Chencho, "Passive Infrared (PIR) Sensor Based Security System," *International Journal of Electrical, Electronics and Computer Systems (IJEECS)*, vol. 14, no. 2, pp. 1–5, 2013.
- [12] H. K. Sharma and M. Sharma, "IoT Based Home Security System with Wireless Sensors and Telegram Messenger," in *International Conference on Sustainable Computing in Science, Technology & Management (SUSCOM-2019)*, pp. 583–588, 2019 [Online]. Available: <https://ssrn.com/abstract=3352452>
- [13] A. Kasote, P. Kolage, N. Sadgir, and G. Avhad, "Smart Home Automation via Telegram Chatbot and Android Application," *International Journal of Advance Research and Innovative Ideas in Education (IJARIE)*, vol. 7, no. 3, pp. 572–57, 2021, [Online]. Available: www.ijarjie.com
- [14] www.mpja.com, "HC-SR501 PIR Motion Detector," www.mpja.com, 2011. <https://www.mpja.com/download/31227sc.pdf> (accessed May 23, 2022).
- [15] Raspberry Pi, "Introducing the Raspberry Pi Cameras," *Raspberry Pi*, 2022. <https://www.raspberrypi.com/documentation/accessories/camera.html#introducing-the-raspberry-pi-cameras> (accessed May 23, 2022).
- [16] S. Karthick, S. Krithika, and S. Malligaraj, "Raspberry Pi Based Smart Lock System," *International Journal of Current Research*, vol. 9, no. 5, pp. 51117–51119., 2017, [Online]. Available: www.journalcra.com



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