

Home security monitoring system with IoT-based Raspberry Pi

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Article Info

Article history:

Received Feb 20, 2020

Revised Dec 4, 2020

Accepted Jan 11, 2021

Keywords:

IoT

Monitoring

Raspberry Pi

Sensor

Telegram

ABSTRACT

Home security monitoring system is a system that is able to monitor the house from unwanted events such as theft. Home monitoring systems can monitor and send users notices about the condition of their homes at the same time. Notifications sent in the form of pictures of the state of the room in the house, temperature conditions and gas density conditions. The home security monitoring system was created using Raspberry Pi as the control center of the system. It was connected with several sensors namely PIR sensor is used to detect objects that enter the room, raspicam is used to take pictures when the PIR sensor detects objects, temperature sensors and gas sensors are used to detect the state of temperature and gas concentration, and telegram is used as a liaison application to send notifications from Raspberry Pi to tool users. The final result of this research is to build a home security monitoring system with Raspberry Pi based on telegraph messenger. This system is able to monitor the security of the house from burglars or intruders, notify the temperature of the house and detect smoke or gas.

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1. INTRODUCTION

According to the national statistics agency in 2018 the level of crime from 2015 to 2017 especially those affecting households such as theft and robbery still often occur despite fluctuations. Recorded in 2015 the number of theft and robbery with violence against households was at 1,628,634. Out of 100,000 people, 140 of them are at risk of crime [1]. Many thefts occur when homeowners are traveling and the house is left for a long time. In addition to the risk of theft, the house whose owner is traveling also risks fire due to various factors. Such as electrical zippers, and gas leaks [2].

In some housing environments, security are already available, but they are less efficient when there are security or fire disturbances [3]. This is because the information received is not real-time. Information that is not real-time results in slow handling in case of security and fire disturbances [4], [5]. In addition to security officers, closed-circuit television (CCTV) has also been installed to monitor the condition of the house. However, CCTV does not give notice in real-time when recording interference [6], [7]. If the owner does not see the installed CCTV display, then the homeowner will not know the condition of the house [8]. For that, we need a tool that can monitor the state of the house and notify you directly when someone has been unnoticed or there are other unexpected events [9], [10]. This tool uses the internet of things technology, which can be controlled from anywhere with the help of an internet connection [11], [12].

Some related research that has been developed such as the home security system using a mini personal computer (PC) Raspberry Pi, In this study using a CCTV camera as a means of monitoring the state

of the house that is connected to the Raspberry Pi [13], [14]. The tool can be accessed using Telegram messenger [15]. In addition, there is also a Raspberry Pi-based Home Security System, Raspicam and passive infrared receiver (PIR) sensors to detect human presence in the home [16]-[18]. When the sensor detects the human presence, the camera will take a picture and send a notification to the user using telegraph [19]-[21].

This research will use Raspberry Pi, Raspberry Pi is an inexpensive, small and portable computer board. The Raspberry Pi board only costs \$ 35 and works from a computer for hundreds of dollars. Even though its purpose is not to replace computers, and laptops. but to work in supplements with them. Raspberry Pi boards can be used to plug into computer monitors or televisions, keyboards, mice, and pen-drives [22], [23]. Raspberry Pi easy to use but powerful, affordable and apart from being hard to break, Raspberry Pi is the perfect device for aspiring computer scientists [24].

In the market there are several types of home security systems, but some examples of products offered are less than provide more flexibility in their use. Provision of type and number of devices in the form of limited sensors and prices offered are relatively expensive. An example of implementing an internet protocol (IP) camera-based home security system with an alarm detector or sampling through active infrared technology has a deficiency, one of which is not providing flexibility for users when travelling.

This research will also add several sensors namely PIR sensor, DHT22 temperature sensor and MQ2 smoke sensor. Sending information in real-time using the Telegram Messenger application that has an automatic answering account. Telegrams can respond to certain texts according to the commands we give. The camera used for monitoring is a Raspicam camera. If one of the sensors is active, it will trigger the camera connected to the Raspberry Pi to take photos and send notifications via the Telegram messenger application. After that, the bot on Telegram Messenger offers what we want to do next, there two possibilities can be done by this bot, which is to take a photo or video of the situation at home at that time and send it back to the user. This tool is expected to be able to monitor the state of the house and send notifications to the homeowner if there is interference with the house.

2. RESEARCH METHOD

In this paper we use the system development life cycle (SDLC) method shown in Figure 1, with the following stages:

- Planning

From the results of identification, problems that often occur include; 1) free room access, 2) free access without knowledge, 3) lack of security, 4) room temperature information, and 5) room air condition information, whether it is good for the body. From these problems will be designed a system that can provide information to the user.

- Analysis

After knowing the problem and make a general description of the system. This stage analyzes the needs in designing and building systems. Equipment and material requirements include; 1) Raspberry Pi 3 B, 2) buzzer module, 3) light emitting diode (LED), 4) message queue (MQ) module, 5) temperature and humidity sensor (DHT) module, 6) pear module, and 7) camera module.

- Design

The stages of design are as follows; 1) Preparing the system design, 2) system configuration, 3) system configuration validation, 4) choosing the best system configuration.

- Implementation

The next step is to implement the design, namely; 1) prepare tools and materials, 2) Install the controller, 3) Setup all component modules, 4) Install the entire component library, 5) Setup Supporting software, 6) system coding, 7) system configuration, and 8) system testing.

- Testing

Furthermore, the process of testing and integration, this process will be tested to find out how resistant the system is in processing information data. The following are the testing stages; 1) the system will be tested whether it can overcome the problem according to the planning stage, 2) after the system works well, the system will be implemented reviewed, and 3) modification of the system after several people use this system the data will be accommodated and done according to the shape and system upgrade.

- Maintenance

After the process of testing and integrating the system will be updated or maintained if the user wants to add new features or modules that may be developed again for the previous system. So that the previous system will continue to complement each other and close the shortcomings of the previous system be it physical, software, or component modifiers.

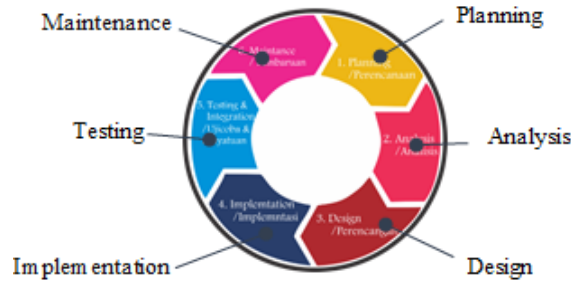


Figure 1. Research method [25]

2.1. Home security monitoring system

In this paper, we have designed an IoT-based home security monitoring system can monitor the safety of homes from burglars or intruders, notify the temperature of the house and detect smoke or gas. expected to be able to monitor the state of the house and send a notification to the homeowner if there is interference with the house. The architecture of IoT-based home security monitoring systems as shown in Figure 2. Our goal is to design a device that can monitor the condition of the house and is easily designed. We use the following components that are easily available: Raspberry Pi, PIR sensor, smoke sensors and temperature sensor.

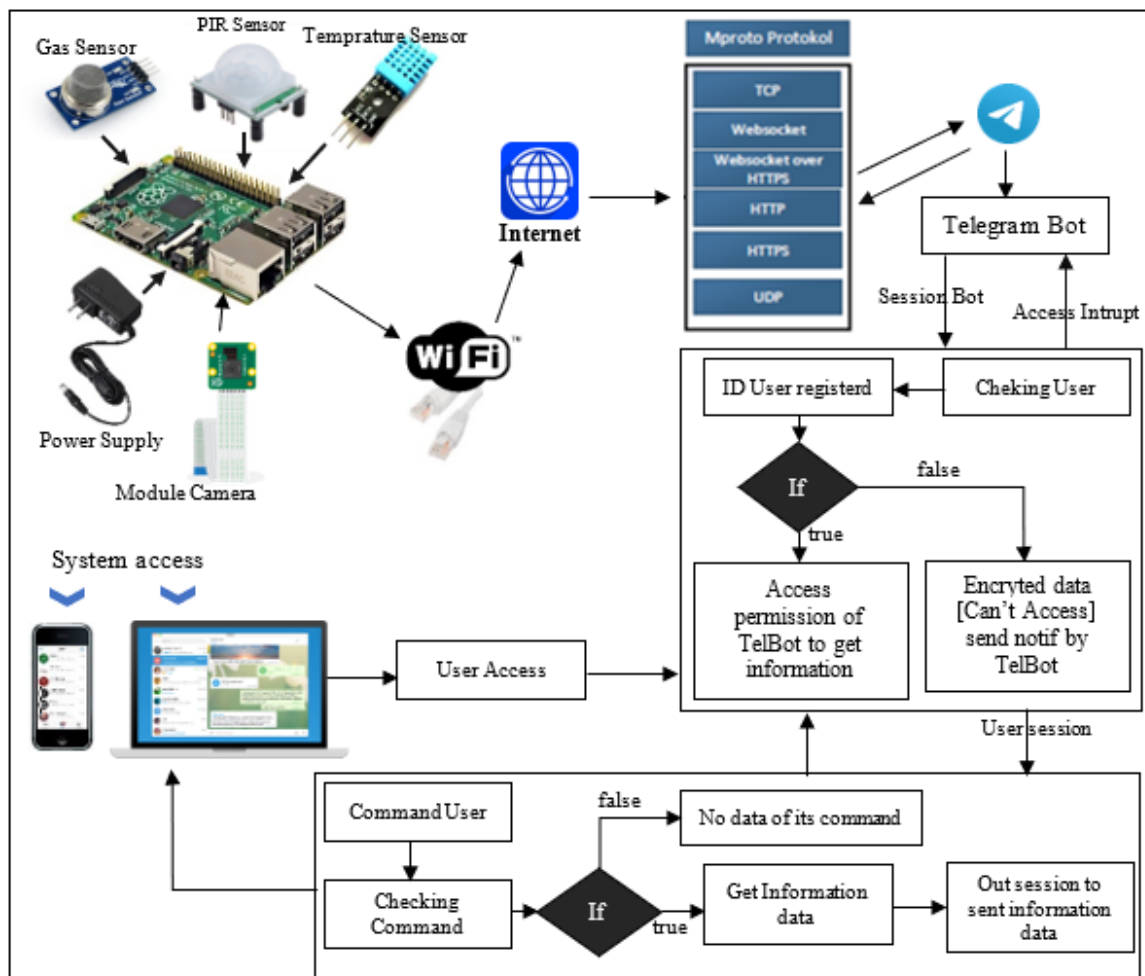


Figure 2. Home security monitoring system

The security monitoring system hardware consists of several component modules, namely Gas sensor, PIR sensor, temperature sensor and camera module. The section will become a single system that can be controlled through the telegram system. So the system will work for security, monitoring and environmental conditions and more specifically such as gas density, temperature and movement of objects to be recorded/captured. These things will be available information on the system. Hardware is connected through two events namely via wifi and Ethernet which already has internet access. Protocol for communication between telegram and system via the mproto protocol. Where mproto protocol consists of several types of protocols among other things namely transmission control protocol (TCP), websocket, websocket over hypertext transfer protocol (HTTP), HTTP secure (HTTPS), user datagram protocol (UDP). Overall, this protocol will allow the security monitoring system hardware to communicate with telegrams. On systems that have synchronized with existing protocols. Where there is a BOT in charge of managing the data received. And provide output according to user demand. The teleport system that has been built has security, that is, the system can distinguish between users who are already registered with the system and illegal users who access the system. Where checking is carried out at the BOT session in distinguishing users who have access and illegal users. In the user session, the system checks the commands sent by the user and the system will validate whether the data is available and can be processed by the system. If the command does not match the system will notify the user, that the command is invalid. And conversely if the command is valid then the system will output information that matches the given user command. And the system will send the information to the telegram. So, when a user accesses the system, the user will be checked by the system first, before accessing the system. After obtaining access permissions from the system the user can give commands to the system for information available on the system.

2.2. Software

At this step, the Raspberry Pi software is installed. This research uses software, namely the operating system raspbian, python, and telegram messenger. First, install the Raspberry Pi with the Raspbian operating system. Before installing the Raspberry Pi Raspbian application, this Raspbian application can be downloaded via the official website of Raspberry Pi. The initial stage in running a python application is, certainly Raspberry Pi is already alive, then select the home menu of the Raspberry Pi in the top left corner then select the python application.

2.3. Making the project

2.3.1. Design the device

In the first stage, there are a 3-pin PIR sensor, pin for VCC, output, and ground. The VCC pin is connected to the 5v pin on the raspberry pi, the output pin is connected to the GPIO Raspberry Pi pin, here is connected to pin 7 (GPIO4), and the ground pin is connected to the ground pin on the Raspberry Pi. Shown in Figure 3 (a). In the second step, the MQ2 sensor is connected to the Raspberry Pi. On the MQ2 sensor there are 4 pins namely VCC, ground, analog, and digital pins. Because Raspberry Pi 3 cannot read analog pins from the MQ2 sensor, an analog to digital converter is added. Shown in Figure 3 (b). The third stage is connecting the Raspberry Pi DHT22 Sensor which can be seen in Figure 3 (c).

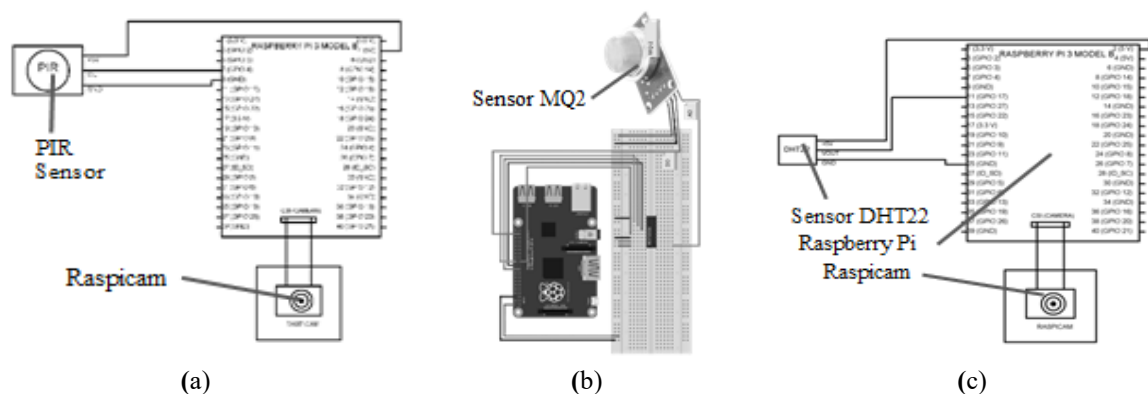


Figure 3. The design of the home security monitoring system; (a) the PIR sensor is connected to the Raspberry Pi, (b) MQ2 sensor is connected with Raspberry Pi, and (c) The DHT22 sensor is connected to a Raspberry Pi

2.3.2. The coding programs

The code generation program begins with creating a bot account on the messenger telegram that is already installed on the smartphone. After that, make a program code for each sensor. The program code is written using a python application that is already installed on Raspberry Pi. In the telegram messenger there is the term BotToken (where BotToken is an identification code of an account that was obtained when registering a Bot telegram account). At this stage, a telegram bot account is created using an Android-based telegram application. To make the program code in the first Raspberry Pi add variables if there are variables that are not known by python, they need to be installed on raspbian. The following is snippet code:

```
import RPi.GPIO as GPIO
import sys
import random
import time
import telepot
import datetime
import Adafruit_DHT as dht
from picamera import PiCamera
from time import sleep
```

Next, describe the pin that is connected to the sensor, and raspicam on the Raspberry Pi. After that, make the code to connect the Raspberry Pi with the telegram using botToken that has been obtained in making bots on the telegram. The following is code snippet:

```
bot = telepot.Bot('933115180:AAHai0Uo-_umiMXhh-TGK01FJOANPzEyr7c')

def handle(msg):
    global previous_state
    global current_state
```

After that, create a link message that will be used as a chat media between the Raspberry Pi and telegram. Program code to read the analog-to-digital converter ADC installed for the MQ2 sensor, then make a code that works, if the PIR sensor detects an object or is active then Raspicam takes a picture, then it is saved on a Raspberry Pi and sent to the telegraph messenger. Also, if the gas sensor detects excess gas, it will send a notification via a telegram messenger. The following is a piece of program code, The following is a code snippet:

```
def init():
    GPIO.setwarnings(False)
    GPIO.cleanup()
    GPIO.setmode(GPIO.BCM)
    GPIO.setup(SPIMOSI, GPIO.OUT)
    GPIO.setup(SPIMISO, GPIO.IN)
    GPIO.setup(SPICLK, GPIO.OUT)
    GPIO.setup(SPICS, GPIO.OUT)
    GPIO.setup(mq2_dpin, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
    GPIO.setup(pir, GPIO.IN)
    GPIO.setup(led, GPIO.OUT)

def readadc(adcnum, clockpin, mosipin, misopin, cspin):
    if ((adcnum > 7) or (adcnum < 0)):
        return -1
    GPIO.output(cspin, True)
    GPIO.output(clockpin, False)
    GPIO.output(cspin, False)
    commandout = adcnum
    commandout |= 0x18
    commandout <<= 3
    for i in range(5):
        if (commandout & 0x80):
            GPIO.output(mosipin, True)
        else:
            GPIO.output(mosipin, False)
        commandout <<= 1
        GPIO.output(clockpin, True)
        GPIO.output(clockpin, False)

    adcout = 0
    for i in range(12):
        GPIO.output(clockpin, True)
        GPIO.output(clockpin, False)
        adcout <<= 1
        if (GPIO.input(misopin)):
            adcout |= 0x1

    GPIO.output(cspin, True)
    adcout >>= 1
    return adcout
```

To run the program created can use the F5 button on the keyboard and select the run menu on the menu tab. To connect to a Telegram, make sure the Raspberry Pi is connected to the internet. If the tool works then save the program code that has been created with the extension .py. Furthermore, the program created is set so that it can run automatically when the device is turned on. By adding code to the profile of raspbian. By entering the command line then type "sudo nano / etc / profile", then add the code "python / home / op / project.py &". then the tool is ready to use.

3. RESULTS AND ANALYSIS

Implementation is the final stage of making a home security system tool with a telegram-based Raspberry Pi, so it can be tested and used. At this stage several hardware devices are used for the home security system. The components used were the DHT22 temperature sensor, PIR sensor, raspicam, MQ2 sensor, and Raspberry Pi. As shown in Figure 4.

To find out the temperature of the room detected by the device, send the command "/ temp" from the telegram through the bot account. The detected object's movements will be sent automatically every 5 seconds to the bot telegram. The example can be seen in Figure 5 (a). The results of the Gas Test in the room detected by the device, send the command "/ density" from the telegram through the bot account as shown in Figure 5 (b). The coding of the MQ2 sensor program is used to test the series of MQ2 sensors connected to the Raspberry Pi, whether it is functioning properly. So that the MQ2 sensor can detect the presence of flammable gases that can be informed via messenger telegram. In this MQ2 sensor program code the threshold of the detected gas is determined. The gas threshold detected is carbon monoxide gas which refers to air pollution standard index (ISPU) as shown in Table 1 [26].

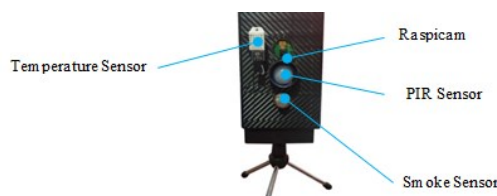


Figure 4. Hardware Home security monitoring system

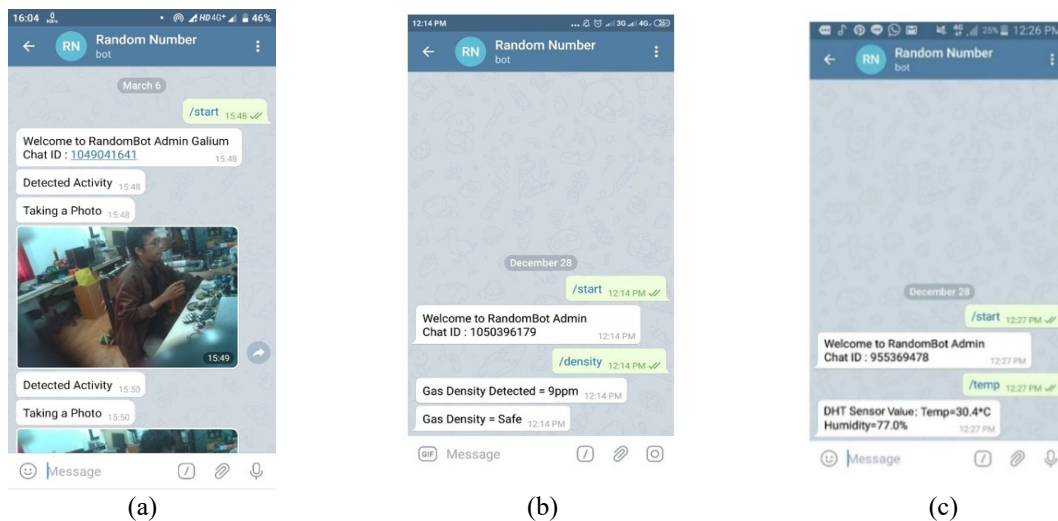


Figure 5. Test Results; (a) photo of activity, (b) gas sent to telegram, and (c) temperature

Table 1. Air pollution standards index

| Category | CO (PPM) |
|------------------|-------------|
| Good | 0-50 ppm |
| Medium | 52-100 ppm |
| Not healthy | 101-199 ppm |
| Very not healthy | 200-299 ppm |
| Dangerous | >300 ppm |

Referring to data from ISPU in this study, the threshold for CO gas detection is made with the provisions that "safe if CO gas is detected below 50ppm, standby if detected above 100-200ppm, and dangerous if above 300ppm". So, if the detected gas exceeds the limit or is in a dangerous condition, the tool will automatically send a notification to the messenger telegram bot account that has been created, that the gas state detected has exceeded the specified threshold. From the test results above, the condition of the room is still good for now because the gas density reaches 9 ppm. In Figure 5 (c) room temperature testing is carried out in a room that does not use air conditioning. The first thing to do to graph the temperature monitoring with the DHT22 sensor on the Raspberry Pi is to create a Thingspeak.com account. Thingspeak is a website that provides a graph for internet of things (IoT) project makers who want the processed data to be displayed in a graph. If all configurations are correct, the DHT22 sensor data will be successfully sent to the Thingspeak web as shown in Figure 6.

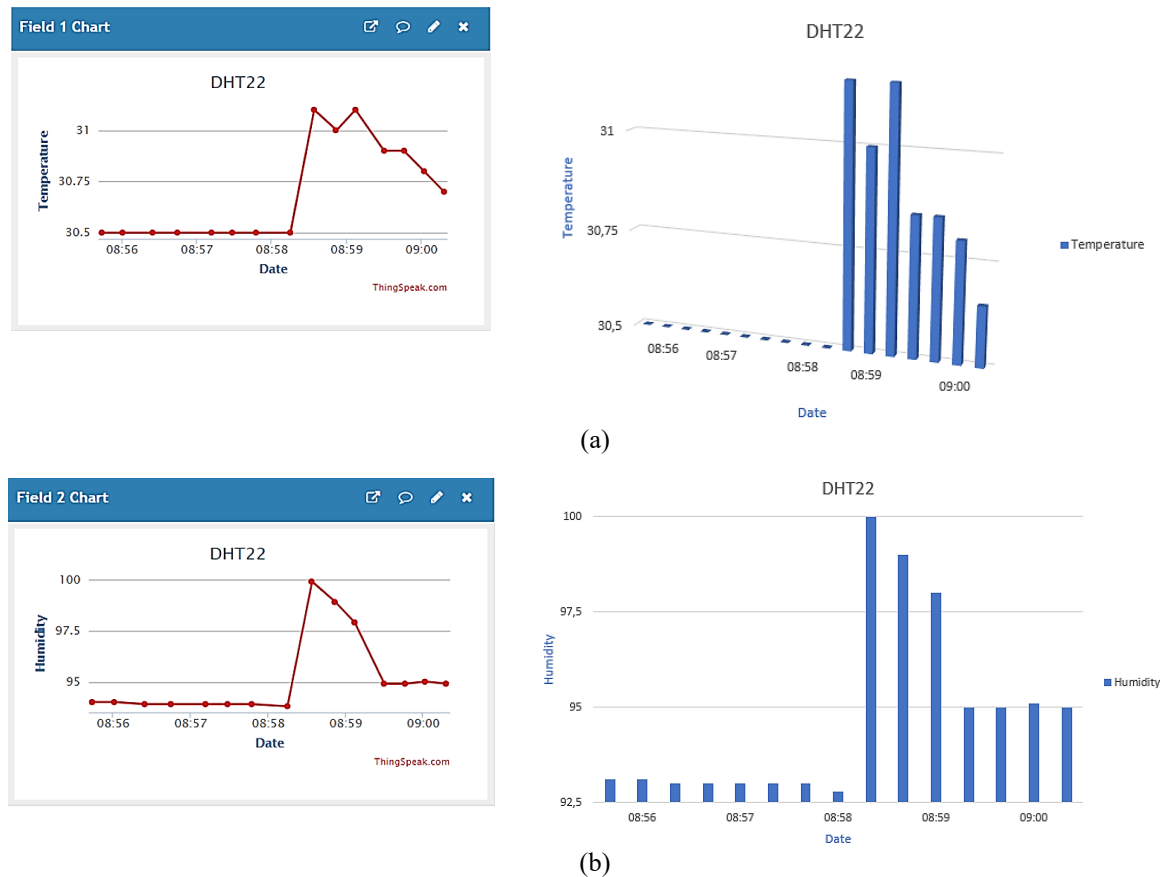


Figure 6. The DHT22 data in the thingspeak application; (a) temperature and (b) humidity

4. CONCLUSION

Based on the results of research that has been done on home security monitoring system tools with Raspberry Pi-based telegraph messenger, it can be concluded that. In designing and building a home security monitoring system tool with Raspberry Pi based on a telegram messenger, there are several stages, namely the design of the tool design, the assembly of the device on the casing, the making of the program code to the testing of the tool. In testing the home security monitoring system tool that has been made with several sensor components mounted on a casing box is running well, both the DHT22 sensor installation with Raspberry Pi, MQ2 sensor with Raspberry Pi and PIR and Raspicam sensors. After testing this home security monitoring tool can be an early warning if there is theft, gas leak, and fire. This tool connected with a telegram messenger with the help of a wifi connection and were able to send a messages in real-time to house owner.

ACKNOWLEDGEMENTS

The authors would like to thank STMIK STIKOM Indonesia for providing financial support. The publication of this paper under the LPPM STIKI Grant. And the control system Laboratory managed by LPIK STIKI.

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