

A Review of Motion Sensors as a Home Security System and approach to the Internet of Things Project

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Abstract: Home security is an essential factor and must be maintained; currently, the development of technology or security systems continues to be improved, one of which is Eye Retina and Artificial Intelligence. In this research, the use of Motion Sensors in Home Security, performance evaluation, and future development. In this time, more crimes occur in our environment, one of which is theft or breaking into people's homes in various areas; this problem is disturbing to residents in areas where these crimes often occur, even though so far, residents have used many methods to prevent crime, one of which is installing CCTV. However, thieves still have managed to escape the CCTV surveillance. But suppose we use a security system that can make a sound. In that case, the sound can make criminals cancel their intention to steal because the sound disturbs their concentration and can also wake the house owner or tell residents about a crime in the house. And in this article, I will describe a home security system. This system requires several supporting equipment, such as PIR, Arduino, Buzzer, and other tools.

Keywords: Microcontroller Arduino, home security, Motion Sensor, PIR Sensor, IoT



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1. INTRODUCTION

Often the emergence of acts of theft or house burglary is caused by opportunities, and behind that opportunity appears evil intentions within the perpetrators of crime; this is what we need to be aware of regarding home security. The security systems that we usually use, such as CCTV, often don't work when there is theft because thieves now know how CCTV works, so before they launch their action, they always monitor the CCTV first, then then they will damage it so that their action doesn't can be recorded. With the current Science of Technology & and technology also growing, of course, we can develop a home security system that is even better so that criminals do not know where and how it works, so the perpetrator cannot damage the system. This house guard is a motion sensor placed in a particular place so that it can notify the occupants of the house if someone who is not known comes in and wants to do evil. It works because if a movement is detected, the Passive Infra-Red (PIR) sensor [1,2,3,4] will give a certain signal to the Arduino. If Arduino has read it, it will then give commands to the buzzer and the active LED light to make a sound and turn on the LED light. This is a sign or warning of danger to the occupants or people around the house. This article aims to find out the function and how to make a home safe using the PIR and Arduino sensors. The PIR sensor [5,6,7,8,9] is a pyroelectric sensor that can detect infrared energy emissions. It works based on the infrared energy it receives, which has a wavelength of about 8-14 micrometers. As the name implies, Passive Infrared means that PIR [12,13,14] does not emit any energy like active infrared, which consists of a transmitter and receiver

(transmitter & receiver); it only measures the beam. In this study, the propagation [10,11,15,16,17,18,19,20,29] analysis will be tested between the PIR sensor and a human or object, how many meters the sensor can be read by a human or object so as to produce a sensor value of = 1.

2. THEORY

2.1. PIR OR MOTION SENSOR

PIR (Passive Infrared Received) sensor is a sensor to detect infrared rays. PIR (Passive Infrared Received) sensor [21,22,23,24,25] is passive, meaning that this sensor does not emit infrared rays but only captures infrared rays [1]; because all objects emit radiant energy, a motion will be detected when an infrared source with a certain temperature, e.g., humans, passes through another infrared source with a different temperature, e.g., a wall. The sensor will compare the infrared radiation received by each unit. Time, so that if there is movement, there will be a change in the sensor's reading. PIR sensor (passive infrared receiver) consists of several parts, i.e., Fresnel lens, Infrared filter, Pyroelectric sensor, Amplifier, and the direction of the PIR sensor wave range.

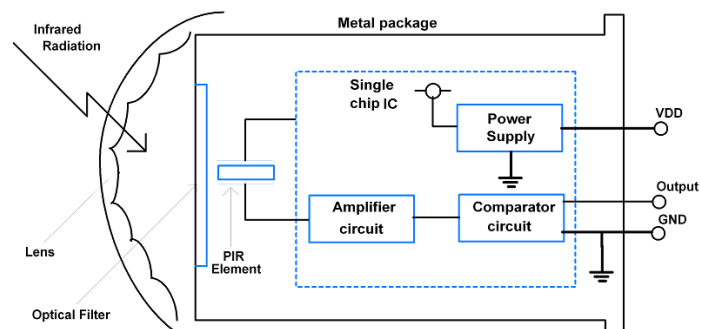


Figure 1. a PIR sensor parts and pins

Figure 1 is an image of the part of the PIR sensor [26,27,28,30]; the curved part is in charge of capturing infrared radiation, which consists of a lens and an Optical Filter. Inside the middle or inside or part of the element, there is a Metal package consisting of a PIR Element, a single chip IC, an amplifier circuit, a power supply, and a comparator circuit.

When an object passes through the sensor, passive infrared radiation emits the sensor will detect the result. The heat energy carried by this passive infrared ray causes the active pyroelectric material in the sensor, which then generates an electric current. A passive Infrared Receiver is an infrared-based sensor. However, unlike infrared sensors, most consist of an IR LED and a phototransistor.

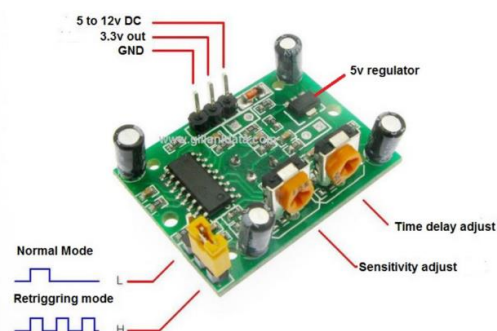


Figure 2. a PIR sensor parts and pins

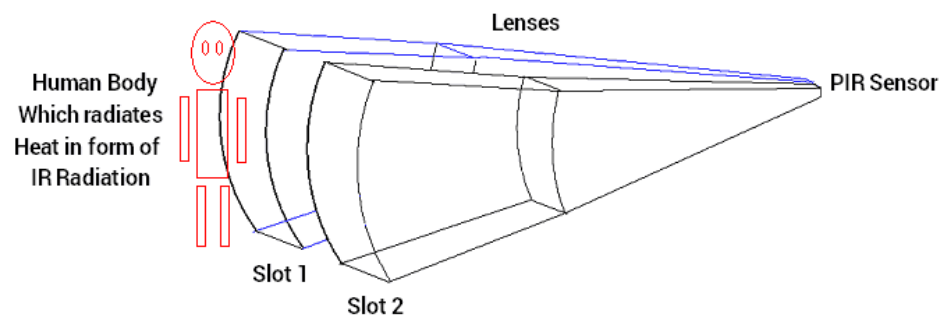


Figure 3 a PIR Sensor radiates

The PIR doesn't emit anything like an IR LED. As the name implies, "Passive", this sensor only responds to the energy from the passive infrared beam owned by every moving object detected by it. The definition of Infra Red or Infrared is an electromagnetic wave that cannot be caught by the eye, with a wavelength between 0.78 m to 1mm. Moreover, the dimensions, function pins, and other parts can be seen in figure 2. Figure 3 shows the radiation from the PIR Sensor, which is identified based on the distance and sensitivity level of the PIR sensor when it encounters a moving object such as a human.

2.1. PIR SENSOR & MCU CONNECTIVITY

Furthermore, Another essential Device is Mini Buzzer; a buzzer is a device that can convert electrical signals into sound signals. Usually, the buzzer is used for alarms because it is quite easy to use; only by providing the input voltage will the buzzer produce a sound [figure 4]. The sound frequency that is issued is between 1-5 kHz. Here the function of the buzzer is to bring out the roots in the form of a strong sound to inform others that theft is happening.

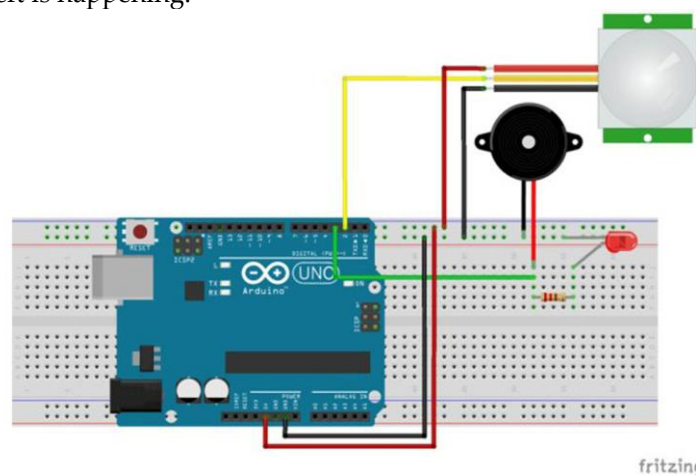


Figure 4. a PIR sensor, LED, and Buzzer connectivity on MCU Arduino

2.2. PIR SENSOR AND IOT CONNECTIVITY

The Internet of Things (IoT) function is to throw data onto the Internet and display it in real-time. The MCU Node type used is NodeMCU 1.0 ESP - 12E Module, and the PIR Sensor used is the HCSR05 type [figure 5]. Specifically, the connection pins are shown in table 1.

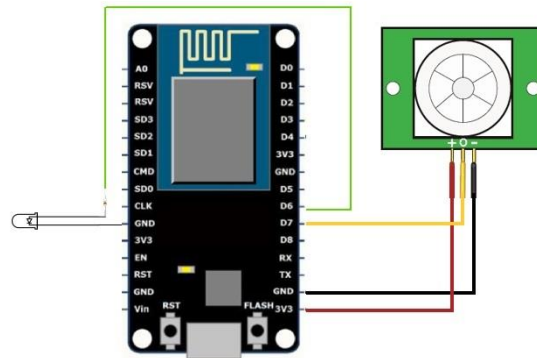


Figure 5. a PIR sensor and LED connectivity on Node MCU

Table 1 .HC-SR501 and NodeMCU Connectivity

Pin Connectivity	HC-SR501	NodeMCU
1	VCC	+3 volt DC
2	Output	D7
3	GND	GND

3. METHOD

3.1. SYSTEM DESIGN

Furthermore, there are several points for placing the PIR sensor in the house; in Figure 6, there are 6 points where the PIR sensor is established, i.e., on bed 1, living room, bed 2, family room, toilet, and house terrace. The security system is the PIR located on the house's balcony, while the other 5 PIR sensors are used for automation systems in the house. This is one of the designs from Smart Home. Where the house can turn on and off the lights in each room automatically if the room is being used; when in use, the light will turn on, and when not in use, the light will turn off automatically. In detail, the working system of this IoT-based PIR Sensor will be shown in the flowchart in figure 7.

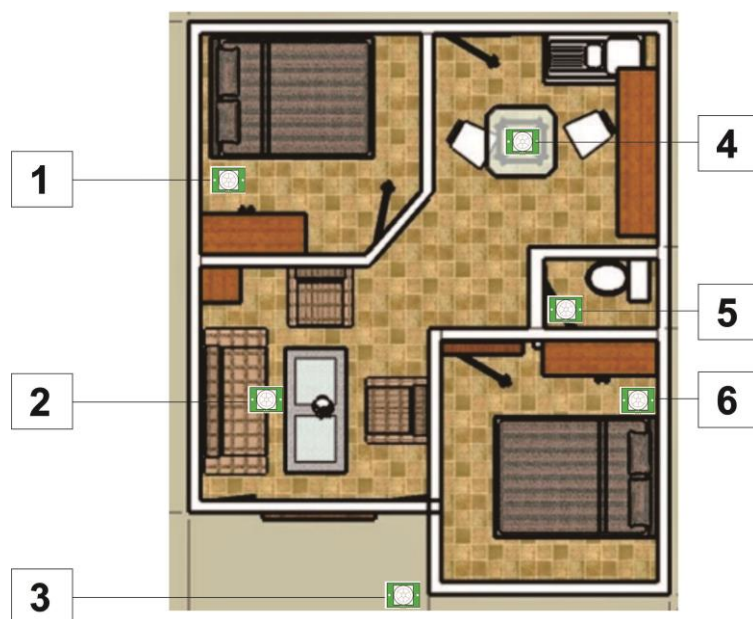


Figure 6. a PIR sensor position on the house

These six sensor positions are samples of PIR position sensors on the house, and these sensors are located in parts of the house that have their respective functions according to the role of the room. e.g., PIR sensor no.3 for security functions, sensor 2 for movement in the living room, 1 and 6 for the bedroom, sensor no.5 for the toilet, and sensor no.4 for the family room. These PIR sensors can be analyzed by grouping sensor data on the server using the MCU Node and analyzing the throughput.

3.2. PSEUDOCODE

Pseudocode is a sequence of code used to run the system; figure 3 is an example of running a simple system on a PIR Sensor, followed by the MCU Node as End Devices that will send data to the Internet. The application used is Blynk. Blynk is a ready-made program that can be downloaded via Playstore; Blynk is a Graphical User Interface (GUI) specially made for IoT devices interface using MCU Node or ESP32 or ESP 8266.

```
1. Start
2. Insert the BLYNK Library
3. Insert the ESP8266 Library
4. Define BLYNK_PRINT Serial
5. Define the Library ESP8266WIFI <ESP8266WiFi.h>
6. Define the Library BlynkSimpleEsp8266
   <BlynkSimpleEsp8266.h>
7. Define the Blynk application auth token
8. Define the char SSID (WiFi name)
9. Define the char Password (WiFi Password)
10. Define the BlynkTimer
11. Define the data type of Pinvalue (pinValue=0)
12. Start the void setup
13. Define the Boudrate (9600 bps)
14. Initialize of PinMode Digital (D1,D2,D3,D5) as a LED
    output
15. Initialize of Authorized, SSID, & PASSWORD
16. Start the BLYNK_WRITE (BLYNK_WRITE(V0))
17. Initialize of pinValue as param.asInt()
18. Start the void notification
19. Initialize of bool_sensor as digitalRead(D5)
20. Start the Serial.println(sensor)
21. If pinValue == 1 then "System is ON"
22. If sensor==1, Blynk.notify("WARNING! Please check your
    security system");
23. If digitalWrite D1,D2, High, then LED RED, Buzzer ON
24. If digitalWrite D3,Low, then LED Green OFF
```

```

25. vice versa Step number 22 and 23
26. else if (pinValue == 0) then Serial.println("System is
    OFF")and digitalWrite(D3, LOW); // LED GREEN OFF
27. Start void loop()
28. Blynk run code ==Blynk.run();
29. Timer run code ==timer.run();
30. Finish

```

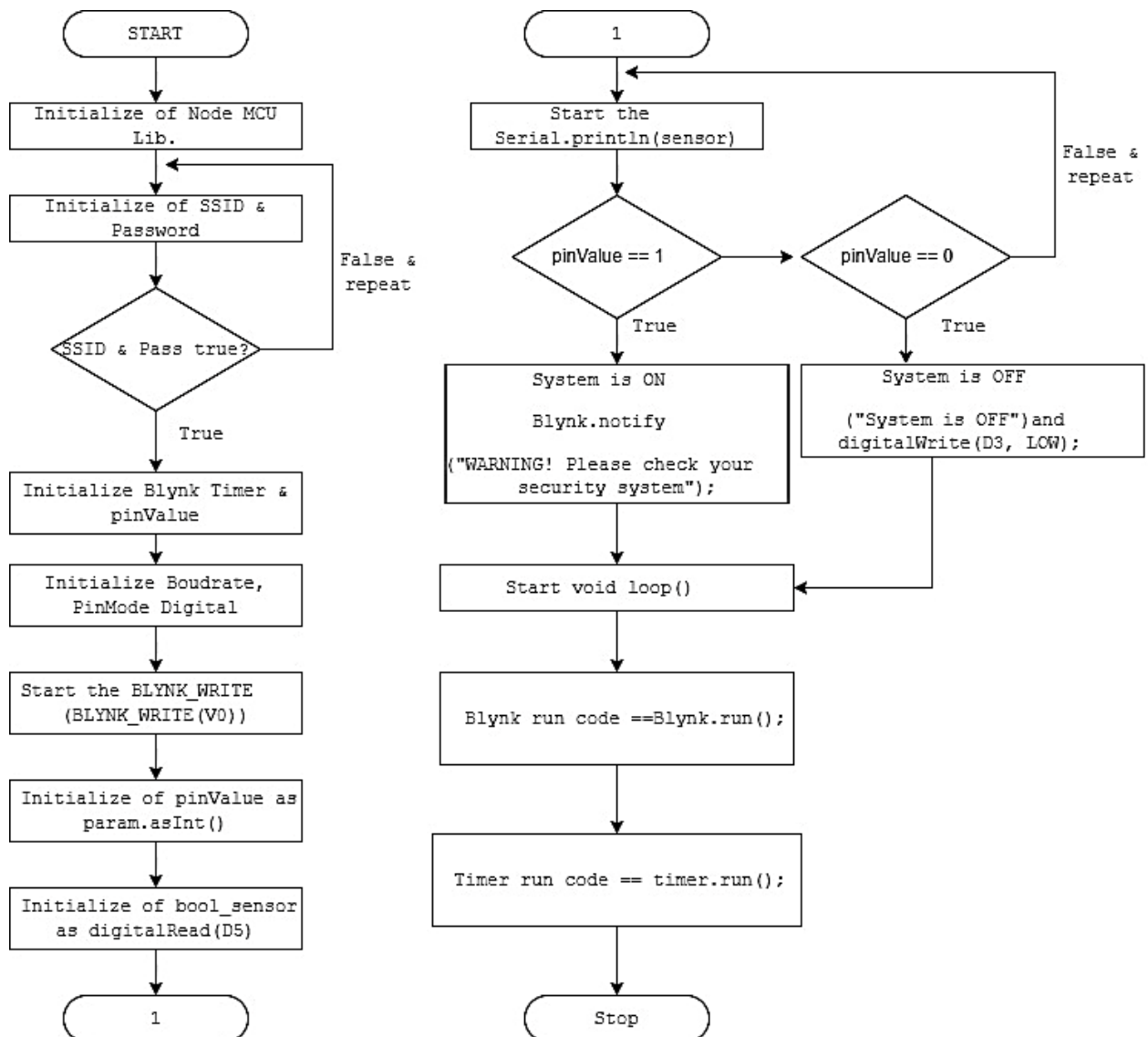


Figure 7. a Flowchart of the systems work

The flowchart shows the simple steps for IoT-based use of PIR sensors and the Blynk IoT project. The LED can be used as an initial indicator for testing, followed by the use of the PIR Sensor. The PIR Sensor is then calibrated using a potentiometer to determine the sensitivity level.

4. RESULT AND DISCUSSION

4.1. PIR SENSOR TEST

Table 2 is the result of the PIR sensor ability experiment based on moving and immovable objects, and the moving objects are Human and immovable objects. Based on the test results, a distance of 5 meters is the maximum distance from which the PIR Sensor can read human objects as well as when compared to PIR and mmWave as in table 3. In table 3, the maximum distance that can be read by mmWave and PIR Sensors is 5.1 meters.

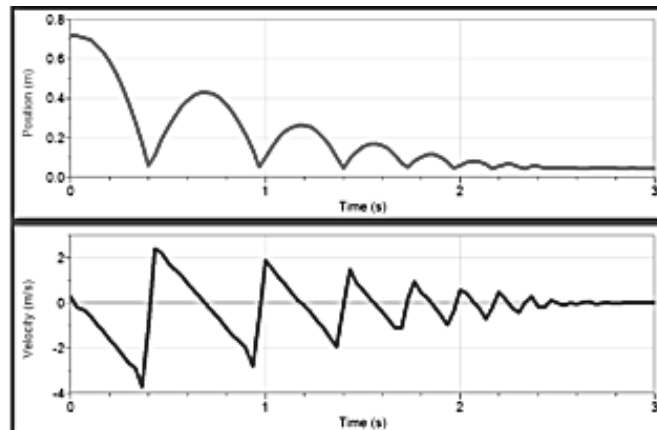


Figure 8. a Position and Velocity of PIR or motion sensor

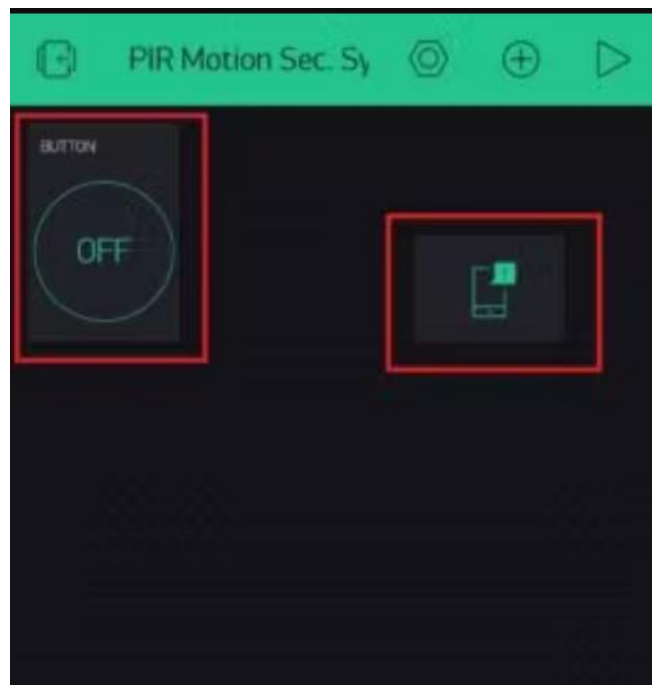


Figure 9. an example of PIR Motion at Blynk IoT

BLYNK App [Figure 9]. It can continue to be developed based on the complexity of the sensor and the type of sensor; the more sensors used, the more components must be

added as well as the number of sensors, e.g., 5 LEDs and 1 Buzzer, then there are 6 Buttons and button text to be able to control the sensor via the IoT server.

Table 2. Experiments on humans and objects

No	Testing	Human	Object	Distance
1	Testing 1	√	√	1 Meter
2	Testing 2	√	√	2 Meter
3	Testing 3	√	√	3 Meter
4	Testing 4	√	X	4 Meter
5	Testing 5	√	X	5 Meter
6	Testing 6	√	X	6 Meter

Table 3. Comparison of mmWave and PIR Sensor Performance on Human activity (Walking, Typing, and Breathing)

Target location	Distance from a sensor (meter)	Major Motion (Walking)		Fine Motion (Typing)		Very Fine Motion (Breathing)	
		mmWave	PIR	mmWave	PIR	mmWave	PIR
1	4.2	√	√	√	X	√	X
2	3.4	√	√	√	X	√	X
3	2.7	√	√	√	X	√	X
4	2.6	√	√	√	X	√	X
5	3.6	√	√	√	X	√	X
6	4.2	√	√	√	X	√	X
7	5.1	√	√	√	X	√	X

Based on test data from dev.ti.com, if mmWave is compared with the PIR sensor, the results will be significant; mmWave clearly has a better performance when detecting human walking, human typing, and breathing up to 5.1 meters, while PIR is only when human walking at a distance of 5.1 meters max [31].

Moreover, Based on data from the motion sensor analysis vernier [32] or PIR Sensor shown in figure 8, the results of the analysis of position (meter) and velocity (m/s) are based on time (s). On the position and velocity graphs for 3 seconds, the resulting graph of position 0.7 meters at start time and velocity of 2 m/s at the start to 3 seconds returns to 0.

5. CONCLUSIONS AND SUGGESTION

This discussion concludes that PIR can detect movement at a considerable distance, and the response from PIR is also excellent here; Arduino, which acts as the MCU system, also works well and can capture signals from the PIR and give commands to the buzzer. From the data transmission experiment, the effective distance or maximum distance is 3 meters, where this distance, humans, and objects can be read correctly. Moreover, a Placement of PIR sensors in homes is one of the keys to building the Internet of Things

for Smart Houses; PIRs can be used for security systems and automation in terms of saving electricity use (kWH).

SUGGESTIONS

This research can be developed by analyzing more deeply the Quality of service of PIR Sensor using many points, e.g., 50 points, and how to analyze performance on the server. Moreover, the analysis can be in the form of a delay (m), velocity (m/s), and missing data, as well as throughput (bytes) on the Internet of things (IoT) network.

AUTHOR CONTRIBUTIONS

Conceptualization; Yandri Lesmana (Y.L), Rahmadani Pane (R.P), Elysa Rohayani Hsb (E.R.H), Lukman Hakim (L.H), Nelly Agusti (N.A), Deci Irmayani (D.I), P.D.P.ADI (P.D.P.A); methodology; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I), (P.D.P.A); validation; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); formal analysis; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); investigation; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I) data curation; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); writing—original draft preparation; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I), (P.D.P.A); writing—review and editing; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I), (P.D.P.A); visualization; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I), (P.D.P.A); supervision; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); project administration (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); funding acquisition; (Y.L),(R.P),(E.R.H),(L.H),(N.A),(D.I); have read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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