Design Low Cost and Contactless Temperature Measurement Gate Based on the Internet of Things (IoT)

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Abstract. Temperature measurements in preventing the spread of Covid-19 will be carried out automatically using a gate equipped with a temperature sensor. This tool is designed in a portable way, allowing monitoring of body temperature data at certain locations utilizing cloud-based technology provider services Internet of Things (IoT) that is integrated with device medical assistance (the nearest hospital). Hence, it can be followed up to get the first treatment. The hardware design of this device is equipped with an LED running text to display a person's body temperature in real time and also an alarm for the body temperature measured to exceed the threshold. The software design uses the Wi-Fi protocol to process data from sensors for monitoring by end-users in the form of mobile or web app via the server cloud platform by HTTP Post protocol. The results showed that CTM-IoT has a precision of 99.8% and an accuracy of 99.6%. This tool is suitable to be implemented at gate terminals, stations, airports, malls, etc. without being operated directly by officers at close range.

1. Introduction
The majority of temperature measurements in preventing the spread of Covid-19 are using a thermo gun, which is a hand thermometer equipped with an infrared sensor. It still has a weakness that is operated with a short enough distance from visitors / people to be checked. This condition allows transmission to officers who carry out checks. It is also done manually one by one which can inhibit the flow of people. And finally, thermo gun prices are also increasingly rising when there is a considerable market demand. Therefore, we propose a tool with the name Low Cost and Portable Contactless Temperature Measurement Gate based on the Internet of Things (IoT). It is designed to be placed in public places and is designed at a low cost while still paying attention to reliability. The advantage of this tool is the Non-contact Infrared Thermometer / Non-touch Body Thermometer, thus minimizing interaction with the suspect / carrier of the Covid-19 virus. Its use is used to check temperatures, high temperature warnings above the upper limits of normal temperature and recorded. Normal temperatures can be allowed to pass. And an abnormal temperature will cause an alarm to sound at the gate. This tool is suitable for application at gate terminals, stations, airports, malls, etc. Without being operated directly by officers at close range. Research related to contactless temperature measurement systems has also been carried out in [1] [2] [3]. The novelty that is raised in this research is the mechanical system design and web dashboard using the http post protocol in data transmission.

In December 2019, a new coronavirus (COVID-19) epidemic was reported in Wuhan, China, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [4]. COVID-19 has been confirmed...
as having human-to-human transmission [5], which raised high attention not only in China but also internationally. The World Health Organization (WHO) reports that there are 118,326 confirmed cases and 4,292 Pre-proof Journals The global Pre-proof Journal of Death until March 11, 2020 [6], and is evaluated as a global pandemic on the same day [7]. In a retrospective study, an outbreak of severe acute respiratory syndrome (SARS) in Guangdong in 2003 gradually faded with the arrival of heated weather, and basically ended until July [8]. It has been documented that temperature and variations may affect SARS outbreaks [9]. A study in Korea found that the risk of influenza events increased significantly with low daily temperatures and low relative humidity, a significant positive relationship was observed for the Diurnal Temperature Range (DTR) [10]. In addition, temperature and DTR have been linked to deaths from respiratory illnesses. A study showed that absolute humidity has a significant correlation with survival rates and transmission of influenza virus [11]. Some studies report that COVID-19 is associated with meteorological factors, which decrease with increasing temperature [12], but their effects on mortality have not been reported. Therefore, we assume that weather conditions might also contribute to COVID-19 mortality.

As a step to overcome the Covid-19 outbreak, we designed a body temperature detector that is effective and efficient, and without direct contact with others. This tool is designed implementatively using Internet of Things technology as monitoring body temperature data in public places to prevent transmission of the virus. The data will be processed as a report that is integrated with the nearest hospital in order to immediately get first aid for someone who is exposed to the Covid-19 virus with an initial indication of body temperature above 37.5°C. For the next section, this proposed tool is known as Contactless Temperature Measurement based on IoT (CTM-IoT).

2. System Design and Discussion

2.1. System Architecture

The extraordinary occurrence of the Covid-19 spread poses a threat to all humanity. Where this virus can be transmitted through fluids released by sufferers. The initial symptoms of transmission can be known one of them through high body temperature. The majority of temperature measurements in preventing the spread of Covid-19 are using a thermo gun, a thermometer shaped like a shot with infrared. This tool still has a weakness that is operated with a short enough distance from visitors/people to be checked. Conditions allow transmission to the officer who can carry out the checking. It is also done manually one by one which can inhibit the flow of people. And finally, thermo gun prices are also increasingly rising when there is a considerable market demand.

Low Cost and Portable Contactless Temperature Measurement Gate based on the Internet of Things (IoT) was proposed to prevent the spread of viruses by utilizing technology so that its implementation is more effective and efficient. Its monitoring architecture are based on the Internet of Things architecture, which consists of the perception layer, the transport layer, and the application layer [13]. It shows on the figure 1.

![Figure 1. System Architecture](attachment:system_architecture.png)
2.2. The Perception Layer

The perception layer collects body temperature data in real time. Data obtained from the GY-906 Infrared Thermometer sensor, which sensor is very accurate, and the price is not too expensive. This sensor is placed approximately as high as 1 meter to be reached by humans to measure their body temperature through the wrist or forehead right in front of the sensor which is on the right side of the device. The measurement results are displayed on the LED Running Text. If the temperature does not match the setpoint (abnormal temperature) then the buzzer alarm will ring. Data is processed through the Arduino Uno microcontroller which is supplied by the adapter. It uses NodeMCU 8266 (Wi-Fi 802.11) for the extension of Wi-Fi module. Flow data at the perception layer is shown in Figure 2.

![Flow Data Perception Layer](image)

Figure 2. Flow Data Perception Layer

2.3. Transport Layer

At the transport layer, the temperature data obtained from the sensor is processed by a microcontroller (Esp8266). Then the data is uploaded via the internet network (Wi-Fi) using the HTTP Post protocol. Data from the sensor that is processed by the microcontroller will be used as a client. The data will then be entered into Cloud using HTTP Post. It very easy to access and suitable for processing temperature data. Security using the HTTP Post protocol needs to be considered in order to ensure encrypted data, avoiding exposure to API tokens and sensor data to third parties. Security that is often used is Transport Layer Security (TLS), a continuation of the cryptographic protocol that provides secure communication on the Internet.
2.4. Application Layer
At the application layer, the body temperature monitoring platform at a particular location is displayed in tabular or graphic form on the mobile app and the web app. This system is integrated with the nearest hospital for further handling of indications of exposure to the Covid-19.

![Cloud-based topology](image1)

![Mesh Topology](image2)

Two types of connections are commonly used to connect IoT devices to the network, as shown in Figure 5 and Figure 6. The first is a cloud-based topology. In this architecture, each device is connected directly to cloud services where it can send sensor readings or get specific instructions for its function. As shown in Figure 5, this is a simple topology where processing power and analytical capabilities are centralized in the cloud so that users will be facilitated to monitor data from various specific locations and users do not need to embed special computing power into their equipment containing analytical descriptions of the data obtained [14]. The main objective of this topology is to bring computing power, storage or analytical services as close as possible to the sensor and thus reduce network traffic to the cloud. Figure 6 shows the mesh network structure. Unlike cloud computing that connects every IoT device to the cloud directly, on a mesh network, every IoT device is connected to a connected router. The router facilitates communication in the network to control network traffic. Then, the router is connected to an interconnected gateway where data is usually processed. Although the mesh network has a more complex structure than a centralized network, in a large deployment environment, the mesh has several advantages, namely: (1) there is no single point of failure, (2) it can be expanded, (3) it is reliable [15].

3. Results

3.1. Hardware Prototyping
At this stage, we assemble the mechanical and electronic system parts. The mechanical part consists of an iron frame, holder and led running text bracket. While for the electronic system, the controller module, sensor, buzzer, and running text are assembled become the embedded system. Figure 5 is the CTM-IoT design, and Figure 6 is the result of making CTM-IoT.
3.2. User Interface

The user interface is used to make it easier for users to monitor the measured temperature. The user interface is designed in the form of a website dashboard. Website development is carried out with the Laravel framework with the Rapid Application Development (RAD) development method. Figure 7 shows the main dashboard display, and Figure 8 shows the admin user display.

3.3. Precision and Accuracy

Precision and accuracy testing is carried out to provide assurance that this tool is suitable for use. Precision is the closeness of the measurement results when done repeatedly. Meanwhile, accuracy shows the closeness of the results to the measurement values that are considered correct. The measuring instrument used for comparison is the thermo gun. Each measurement was carried out 20 times. Figure 9 shows the precision result, and Figure 8 shows the accuracy result.
In the precision test, the standard deviation (SD) is 0.067, and the relative standard deviation (RSD) is 0.2%. In the accuracy test, the average error is 0.4%. Hence, the final test results obtained a precision level of 99.8% and an accuracy rate of 99.6% is obtained.

4. Conclusion
The spread of Covid-19 can be prevented from spreading using the help of tools that implement IoT technology. This system is designed in public places, especially in rooms or buildings. So that the spread of the virus with an initial indication of high body temperature can be controlled and also monitored via the Wi-Fi protocol. The existence of a design system like this, an indication of patients infected with the Covid-19 virus can be treated as soon as possible by the doctor and carried out isolation so as not contagious. Data on human body temperature at certain locations will be stored in the cloud provided by the cloud server via HTTP Post methods. With a simple and portable tool design, it is hoped that this tool can be realized at any point throughout Indonesia. Based on the results of precision and accuracy testing, CTM-IoT is suitable for use.

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