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# Student Attendance System Prototype with IoT-Based on Fingerprint and Temperature Sensors in New Normal Era of COVID-19 Pandemic

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***ABSTRACT***

*Currently, we are entering the new normal era of the COVID-19 pandemic. Attendance activities can be one of the media for spreading COVID-19. Manual attendance activities make people gather in one place. Manual attendance activities also take a long time. By utilizing internet technology, this research combines body temperature measurement with the internet of things (IoT) based and is equipped with a hand sanitizer. The results of attendance data will be displayed on the web server. This device is made using ESP8266, MLX90164 temperature sensor, fingerprint sensor, IR sensor, pump motor, MB-102 power supply module, and buzzer. The tested device requires only input to activate three sensors (one integrity). As a result, this research succeeded in making the device able to work very well. The device can read body temperature with an average accuracy of 97.55–99.67% with the K3S Infrared Digital Pool Thermometer as a comparison. This device is designed to only take three seconds to clean hands compared to washing hands with soap and running water. The web server design works well too.*

***Keywords:*** *ESP8266; Internet of Things (IoT); LCD; MLX90164 temperature sensor; web server.*

**ABSTRAK**

Saat ini, kita memasuki era normal baru pandemi COVID-19. Kegiatan absensi bisa menjadi salah satu media penyebaran COVID-19. Kegiatan absensi manual membuat orang berkumpul di satu tempat. Kegiatan absensi manual juga memakan waktu lama. Dengan memanfaatkan teknologi internet, penelitian ini menggabungkan pengukuran suhu tubuh yang berbasis *Internet of Things* (IoT) dan dilengkapi dengan *hand sanitizer*. Hasil data absensi akan ditampilkan pada server web. Perangkat ini dibuat menggunakan ESP8266, sensor suhu MLX90164, sensor sidik jari, sensor IR, motor pompa, modul *power supply* MB-102, dan *buzzer*. Pengujian perangkat yang dibuat hanya membutuhkan input untuk mengaktifkan tiga sensor (satu integritas). Hasilnya, penelitian ini berhasil membuat perangkat yang mampu bekerja dengan sangat baik. Perangkat dapat membaca suhu tubuh dengan akurasi rata-rata 97,55–99,67% dengan K3S Infrared Digital Pool Thermometer sebagai pembanding. Perangkat ini dirancang hanya membutuhkan waktu tiga detik untuk membersihkan tangan dibandingkan dengan mencuci tangan menggunakan sabun dan air mengalir. Desain server web juga berfungsi dengan baik.

***Kata kunci:*** *ESP8266; Internet of Things, LCD; sensor suhu MLX90164; server web.*

## INTRODUCTION

It has been more than three years since the pandemic out-broken. The world is still shocked by the pandemic event caused by SARS-CoV-2. This viral infection causes the disease we now call COVID-19. Although several people, countries, and organizations have made various efforts to prevent the spread of this virus, the SARS-CoV-2 virus has spread to various parts of the world until March 2020, the World Health Organization (WHO) stated that the world is currently in a pandemic position [1]. A city in China called Wuhan is where the virus was first discovered. This virus spreads in several ways, namely: droplets (fluids that come out due to respiratory tract secretions, such as sneezing and coughing), physical contact, or contact with something contaminated with the virus, through fecal-oral or human feces (urine) and dirt [2]. The indicator that is most often used to find out someone is infected with this virus is to check body temperature. Body temperature is one indicator of whether a person has been contaminated with the SARS-CoV-2 virus. A body temperature that is more than 38°C is one sign that the person has been infected with COVID-19.

Several countries that have been vaccinated have started their activities as usual while still adhering to health protocols. Activities carried out by the community today are a form of community adaptation to the SARS-CoV-2 virus (new normal era). The new normal is a condition where we must be able to accept an attitude, behavior, and events that are different from the previous period to be accepted and become a new habit [3]. School is one of the institutions opened in this new normal era. And not all schools can be opened in the new normal era, only schools that meet certain requirements may be opened in this new normal era, and the number of students who may enter school is also limited. To be able to implement an offline learning system, the procurement of health protocol facilities is an obstacle. Because the number of schools in Indonesia is very large and also requires no small amount of funds in the process. Health protocol facilities that must be equipped are hand-washing facilities, body temperature checkers, hand sanitizers, and others. Plus teachers have to go the extra mile with class shift arrangements. In addition, the school also conducts attendance activities for its students. Attendance is an activity carried out to collect data about a person's whereabouts in a place [4]. And sometimes during attendance, there are several mistakes, errors, fraud, and falsification of attendance data if done manually and can cause crowds.

Currently, many schools have installed internet access in their environment. This can be utilized in line with current technological advances. Attendance activities can be done by utilizing biometric technology with internet technology. Internet technology is better known as IoT. This technology utilizes the internet as a communication medium for the device system to the sensors used. So that makes our work easier. It can be said that this technology is still part of the wireless sensor networks [5], [6]. By using this technology we can easily implement and repair the device because the device does not require a fixed infrastructure. Biometric technology is a technology that utilizes the characteristics of the human body as an identity, ranging from fingerprints, face recognition [7], voice patterns, and the retina of the eye. One of the biometric technologies that are increasingly popular because of its uniqueness is fingerprint. Every finger on the human body has a different fingerprint pattern and is very difficult to engineer, so the possibility of cheating in attendance activities is very small. Fingerprint biometric technology has some advantages in its use and lowers cost when compared to other biometric technologies [8].

By using this technology, teachers no longer need to perform attendance activities manually, so that teaching and learning activities can be carried out more efficiently. This can also reduce the use of paper and also make the work of teachers and schools easier in this new normal era. Because teachers no longer need to bring attendance papers to class, this technology can reduce errors, mistakes, fraud, and falsification of attendance data. This prototype will be very useful to help the community in the school environment [9].

## LITERATURE REVIEW

### ESP8266 (NodeMCU) Amica Version 1.0

In this research, we use the Arduino ESP8266 Amica board version 1.0 because this board already has a Wi-Fi chip installed directly on the board. Arduino board ESP8266 Amica version 1.0

is often called the second generation NodeMCU (Amica NodeMCU V2). With this Wi-Fi chip, the device made later can be connected to the internet network so that I can apply IoT technology according to the design of the tool that I will make. ESP8266 is an open source-based IoT platform with a low-cost Wi-Fi chip built-in an expressive system using Transmission Control Protocol (TCP)/Internet Protocol (IP) [9]. On the NodeMCU V2 USB to serial converter, the CP2102 type is used. The NodeMCU V2 firmware uses the Lua scripting language [10]. The NodeMCU V2 has 11 Digital I/O pins, an analog pin, and one UART, SPI, and I2C pin each. This board has an RST button that is used to reset the program on the ESP8266, a *flash* button to download a new program, and a blue LED that can be programmed according to the user's wishes.

**Internet of Things (IoT)**

The internet of things which is more familiarly called IoT is a technology that utilizes the internet network to transmit data without the need to interact between users and computers or between users and other users. IoT technology can only be used if the device is connected to the internet. IoT devices are always connected directly to internet cloud services that are used to exchange data or control communications [11]. The IoT is one of the technologies that has changed human life a lot. This technology has been widely applied in various sectors of human life, such as health, industry, infrastructure, military, and so on. The IoT is one of the topics that is very often discussed along with technological advances.

With IoT technology, users can control devices more effectively and efficiently. The tool that will be made in this research project will apply IoT technology. Where fingerprint data, body temperature measurement results, and class schedules for incoming and outgoing students registered on the device will be stored in a MySQL database and will be displayed on a local web server so that the results can be seen by anyone as long as the device is connected to the internet. On IoT devices, it works by translating programs created and uploaded to NodeMCU. So that later these devices can work using IoT technology. IoT technology has changed the internet's motto from computing anywhere, anytime, to anything, anyone, and any service. when the temperature input and attendance input are complete, the microcontroller will send the input results to the database using an internet connection. In the MySQL database, the input will be saved and will be displayed to the web server that has been created through the program code that has been designed. There are four types of communication models in the IoT, namely: device-to-device communications, device cloud communications, a device to gateway communications, and back-end data-sharing model communications [12].

**XAMPP**

XAMPP is a web server that can run on a cross-platform operating system (Windows, Linux, macOS, and Solaris) based on open source [13]. In this research, we use XAMPP version 3.3.0 to create a local web server on our local computer. XAMPP consists of several programs including Apache, an HTTP (Hypertext Transfer Protocol) web server application that serves to create web pages and can also access database systems created by developers; MySQL database (MariaDB), an application that functions to process and edit multiple lists using a database; PHP, a server-side programming language that functions to receive, process, and display data received into the database server which can later be displayed on the web server; Perl, a programming language whose job is to show existence.

**Related Works**

There are several references were reviewed and compared to our works as follows: I.B. Sulistiawati et al. [14] made an attendance system with NodeMCU ESP8266, fingerprint sensor, and MLX90614 temperature sensor where attendance results will be displayed on a 20x4 LCD and Google Spreadsheet using HTTP communication. The authors of [15] created an attendance system with Arduino Uno R3 and R307 fingerprint sensors. When the user does attendance, the attendance results will be displayed on the LCD then the attendance results will be stored in the database and

then displayed on the web server using HTTP communication. B.R.P. Utami et al. [8] built an attendance system with the WEMOS D1 and the R307 fingerprint sensor. Attendance results will be displayed on a 128x64 OLED screen and on a web server using HTTP communication. C.S. Kishor et al. [9] developed an attendance system using Raspberry Pi 3, NodeMCU ESP8266, Pi camera, RFID-RC522, MLX90614 temperature sensor, and Far-UVC light. Attendance results will be displayed on the web server. P. Thawkar et al. [16] created an attendance system using NodeMCU ESP8266, Arduino Uno, OV7670 camera, MLX90614 temperature sensor, and MAX30100 blood oxygen check sensor. The results will be displayed on the LCD and the web server. A. Nandakumaravarma et al. [17] created an attendance system using Raspberry Pi 3 B+, Pi camera, MLX90614 temperature sensor, and MAX30100. The results will be displayed on OLED 128x64 and Google Firebase and can be viewed on the mobile app. Table 1 summarizes the comparison.

Table 1. Comparison between this research and other previous works

| Research Group | Micro-controller | Temperature Sensor | Sensors | SARS CoV-2 Sterilization | Temperature Display | Data Storage | Work System |
|---|---|---|---|---|---|---|---|
| I.B. Sulistiawati et al. [14] | NodeMCU ESP8266-12E | MLX90614 temperature sensor | Fingerprint Sensor | - | LCD 20x04 | Google Sheets | ** |
| Z.R.S. Elsi and Jimmie [15] | Arduino Uno R3 | - | R307 Fingerprint Sensor | - | LCD + Web Server | MySQL + XAMPP | * |
| B.R.P. Utami et al. [8] | WEMOS D1 | - | R305 Fingerprint Sensor | - | OLED 128x64 | MySQL + XAMPP | * |
| C.S. Kishor et al. [9] | Raspberry Pi 3 + NodeMCU ESP8266 | MLX90614 temperature sensor | Face Recognition + RFID-RC522 | Far-UVC light | Website | MySQL + XAMPP | **** |
| P. Thawkar et al. [16] | NodeMCU ESP8266-12E + Arduino Uno | MLX90614 temperature sensor | Face Recognition | - | LCD + Web Server | Not Notified | *** |
| A. Nandakumaravarma et al. [17] | Raspberry Pi 3 B+ | MLX90614 temperature sensor | Face Recognition | - | OLED 128x64 + mobile app | Google Firebase | *** |
| This research work | NodeMCU ESP8266-12E Amica | MLX90614 temperature sensor | R307 Fingerprint Sensor | Hand sanitizer system using water pump | LCD 20x04 + Web Server | MySQL + XAMPP | *** |

## METHOD

The research begins with the determination and observation of the topic. After that identifying the problem and determining the research objectives. Then, buy some components and start to assemble those components. After those components are assembled, the circuit and control devices will be tested. If the test is successful. The component mechanical design assembly will be carried out. But if it fails, the component will be reassembled. After the mechanical design is assembled, all devices will be tested. If the device successfully passes the various tests carried out, the author will adjust it according to the research objectives. If the device fails to pass the test then the mechanical design of the device will be reassembled. If the test results obtained are for the purpose of the writing, we will collect the results and conduct an analysis, but if it is not appropriate, then we will reassemble the components until they are by the objectives of the research writing. After collecting the results and conducting the analysis, conclusions and suggestions will be obtained and the research is completed. For more details on research procedures, see Figure 1.

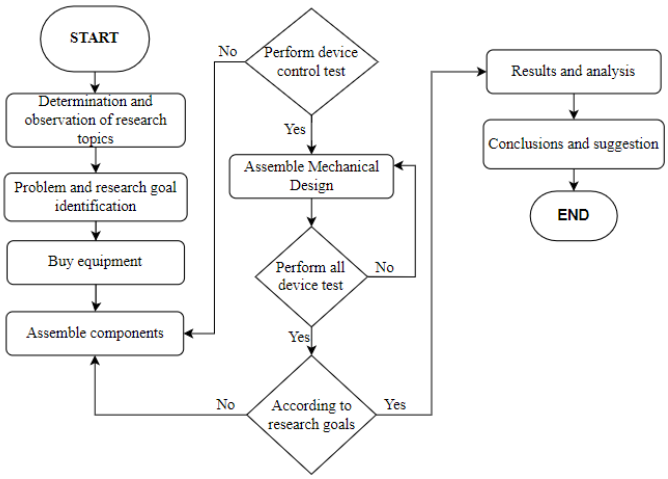


Figure 1. Research procedures flowchart

## RESULT AND DISCUSSION

### Control Workflow Design Result

The device that is made later will work according to the prototype flowchart in Figure 2. When the device is first turned on (starts), it will connect to the Wi-Fi that has been set, so we just have to wait for the device to connect to the Wi-Fi. After the device is connected to Wi-Fi, we need to input our fingerprint into the device. If the fingerprint entered is not registered, the LCD will display that the fingerprint is not registered. And if the inputted fingerprint is a fingerprint that has been registered to the device, then the MLX90614 temperature sensor, fingerprint sensor, and IR sensor will be active simultaneously. After completing inputting and taking attendance, the results of attendance and temperature measurements will be sent to the database, and the relay will turn on and activate the motor pump. If the measurement results show a normal temperature, the LCD will display the temperature measurement results and attendance results, and the attendance activity ends. But if the results of the body temperature measurement are not normal, the buzzer will light up and the LCD will display the results of the body temperature measurement, and the attendance activity ends.

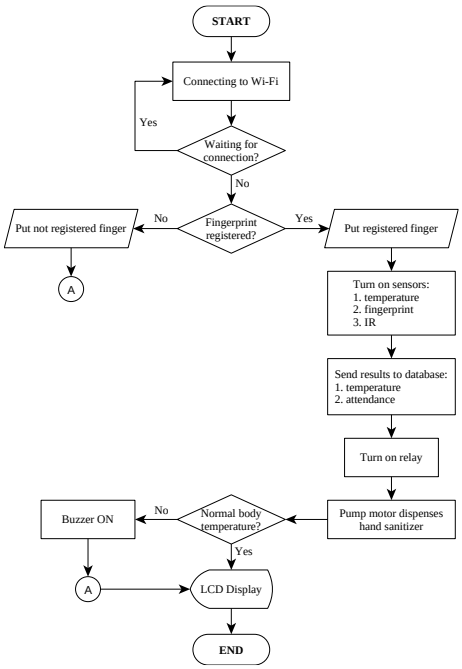


Figure 2. Flowchart of the work system prototype END

## Implementation Results

Figure 3 is an image of the wiring diagram created on the device. The wiring diagram consists of several components such as ESP8266 (NodeMCU) Amica version 1.0, ESP8266 baseboard with relay, fingerprint sensor, IR obstacle sensor, MLX90164 temperature sensor, breadboard module power supply, 5V motor pump, LCD, buzzer, and 1N4007 diode. Those components then are assembled. Then the assembly is carried out on the mechanical design of the device. Figure 4 is the implementation of a mechanical and electrical design made so that the device can work properly. The laying of components is carried out in such a way that the results are needed. Figure 5 is a web dashboard display that was created. Later, to register fingerprints, users only need to enter the registration page, so they don't need to change the code on the microcontroller used. In addition, attendance results will be displayed on the web server dashboard.

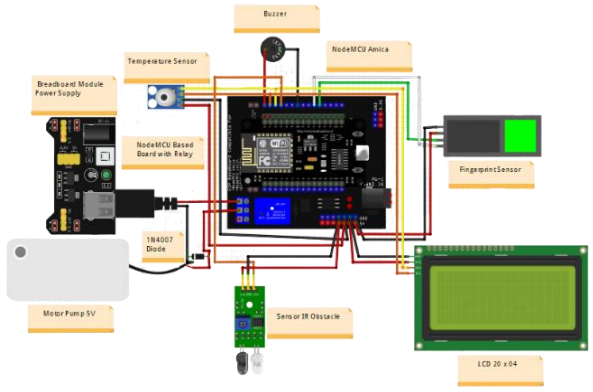


Figure 3. Wiring diagram of the system prototype.

Figure 4. Mechanical and electrical design results

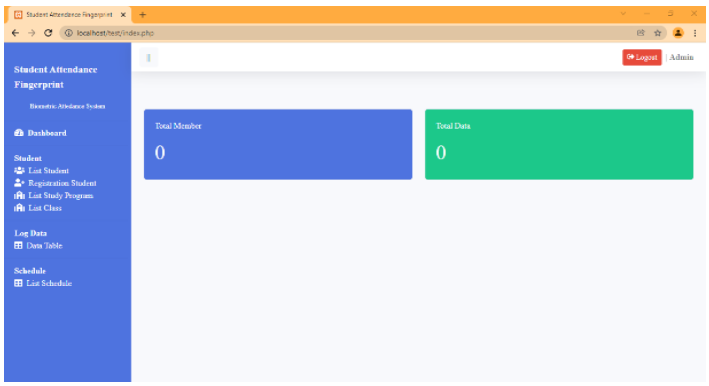


Figure 5. Web dashboard display

## MLX90614 Temperature Sensor Calibration Result

Based on the tests and objectives of the previously disclosed MLX90614 temperature sensor design calibration, we then conducted a test on the digital thermometer and sensor prototype. Sampling was carried out on the head and hands at a distance of 2 cm from the device. Table 2 shows the results of temperature measurements obtained from experiments conducted.

Table 2. Comparison between temperature sensor and digital pole thermometer

| Thermometer Type | Measurement results | | Averaged results | |
|---|---|---|---|---|
| | Head | Hand | Head | Hand |
| MLX90614 Temperature Sensor | 34.03 | 33.91 | | |
| | 33.93 | 33.63 | 33.89 | 33.80 |
| | 33.73 | 33.87 | | |
| K3S Infrared Digital Pole Thermometer | 36.40 | 36.40 | | |
| | 36.40 | 36.40 | 36.40 | 36.40 |
| | 36.40 | 36.40 | | |

Based on the results obtained through calculations, in the application and use of temperature measurements, the MLX90614 temperature sensor will be added a value of ±2.6°C. It is hoped that the application of the calibration formula and the results of calculations and tests carried out can increase the accuracy of temperature measurements using the temperature sensor. The weakness of this comparison is that we did not try with the high temperature, such as 38°C or above.

### Device Test Results

Table 3 is the result of testing the device. Testing was done by triggering the three sensors used. On the other hand, Figure 6 shows the test display of the device mounted on wood attached to a concrete wall, while Figures 7 the result of the attendance display on the web.

Figure 6. Device prototype trial view

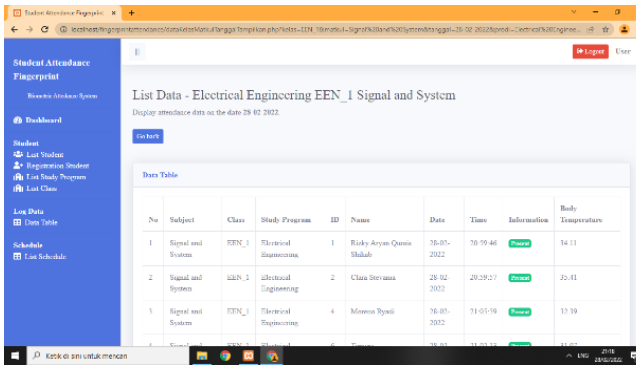


Figure 7. Display attendance results on the web

Tabel 3. Device prototype test results

| Fingerprint sample | Fingerprint Sensor | Time | LCD | Motor Pump | Buzzer | Temperature measurement results | Comparison temperature | Difference (%) |
|---|---|---|---|---|---|---|---|---|
| Student A | Identified | OK | OK | On | On | 34.11 | 36.3 | 2.19 |
| Student B | Identified | OK | OK | On | On | 35.41 | 36.3 | 0.89 |
| Student C | Identified | OK | OK | On | On | 32.39 | 33.3 | 0.91 |
| Student D | Identified | OK | OK | On | On | 31.97 | 32.3 | 0.33 |
| Student E | Identified | OK | OK | On | On | 31.89 | 32.3 | 0.41 |
| Student F | Identified | OK | OK | On | On | 34.05 | 36.3 | 2.25 |
| Student G | Identified | OK | OK | On | On | 35.69 | 36.3 | 0.61 |
| Student H | Identified | OK | OK | On | On | 32.67 | 34.4 | 1.73 |
| Student I | Identified | OK | OK | On | On | 33.85 | 36.3 | 2.45 |
| Student J | Identified | OK | OK | On | On | 33.91 | 36.3 | 2.39 |
| Not User | Not identified | OK | OK | On | On | 34.32 | 36.3 | 1.98 |

## CONCLUSION

After completing component assembly and performing device tests. there are several conclusions from the results and analysis of the research conducted. First, the prototype can check body temperature without making contact and is equipped with automatic hand sanitizer, and can collect attendance data. Second, the prototype can collect attendance data with an IoT-based fingerprint sensor equipped with body temperature measurements and automatic hand sanitizer, so it can be an alternative for schools in managing student attendance in the new normal era of the COVID-19 pandemic.

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