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# Designing Device of Touchless Smart Lift using Voice Commands with Method of Speech Recognition based on the Internet of Things to Prevent the Spread of COVID-19

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**Abstract** – *In Indonesia, the number of sufferers who were confirmed positive for COVID-19 as of May 14, 2021 approximately 1,734,285 people. One of the causes of the spread of COVID-19 is indicated by passengers touching the lift push button panels. Based on these problems, a device of touchless Smart Lift was designed using voice commands with the method of speech recognition. This voice command controls hardware using the human voice. Voice commands are part of speech recognition methods. The speech recognition method is very suitable to be applied to controlling a lift, so that lift users can access the intended floor via a smart speaker. From testing the performance of the smart lift, the results obtained were that the infrared temperature sensor distance 5 cm with a temperature of 36.65°C. The fastest response time testing 2.14 seconds. Sensor weight testing 195.5 Kg. Testing the accuracy of voice commands for the first and second floors obtained the best results of 100% and for the third floor 95%. From the results of this research, it is hoped that the smart lift device will be able to reduce the spread of COVID-19 without touching the lift push button panel.*

***Keywords****: smart lift; voice command; speech recognition; internet of things; COVID-19*

## I. Introduction

In December 2019, the city of Wuhan, China was infected with a new virus that attacks humans [1]. This virus is known as 2019-nCoV or called COVID-19. Previously, the type of corona virus that had infected humans in 2002 was SARS-CoV, while in 2012 it was MERS-CoV. These viruses have grown to engulf humans and cause death [2].

COVID-19 in Indonesia was initially confirmed in March 2020. The number of patients confirmed positive for COVID-19 as of May 14, 2021, was 1734.285, the number of patients who recovered was 1.592.886, and the number of patients who died was 47.823 [3].

The lift is a vertical transportation activity that functions to transport people and goods. One of the indications that the spread of COVID-19 occurs during use of the lift, where it spreads through touching the lift buttons, and the large number of passengers in the lift room [4], [5]. The method for reducing COVID-19 is supervised by the lift staff inside [5], [6].

Voice command is a hardware control using voice [7]. The sound spoken by the user must match the statement set in the programming [7]. This speech recognition method is very suitable to be applied in controlling a lift so that lift users can access the desired floor, using voice commands via the smart speaker in the lift [7]–[10].

The research contribution is designing a touchless Smart Lift device [10], [11], which is capable of controlling a lift using voice commands to reach the desired floor access. Before the user enters the lift, the device will first check body temperature through a temperature sensor [12]–[16]. The temperature sensor will detect the body

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temperature of each user who enters the lift [14], in order to prevent the spread of the COVID-19 virus in the lift [5]. If the passenger's body temperature is high, the system will activate the alarm buzzer and display the notification "Do not enter the lift". If the body temperature is normal, passengers are allowed to enter the lift. The smart lift device works using voice commands [7], and a Node MCU ESP8266 [9], [17] microcontroller based on the Internet of Things (IoT) [9], [18] to reach the desired floor. It is hoped that this research will be able to help reduce or prevent the spread of COVID-19 without touching the lift push button panel, so that this can provide a sense of security and comfort to lift passengers.

## II. Research Method

The system of smart lift works depending on an internet connection via Wi-Fi. How does this smart lift system work if the Node MCU ESP8266 is connected to the internet? Before passengers enter an lift, they must check the appropriate temperature. If the passenger's temperature is high, it activates an alarm and displays a notification, "It is forbidden to get into the lift." If the passenger's temperature is appropriate, it is permitted to ride the lift.

Furthermore, the system will check whether the passengers in the lift enter the 50% standard with the COVID-19 pandemic standard; if it does not meet the standard, it activates an alarm and notification in the form of "Passengers exceeding 50%"; if it has entered the lift standard 50% of passengers can access a floor that is desired by saying “OK Google” on the Google Assistant smart speaker system. If the user says something like "OK Google, First Floor," then the lift system will go to the 1st floor of the Smart Lift system, which can only be accessed up to 3 floors. When the pronunciation of the command does not match what was said, the system will not work and repeat the command.

The NodeMCU ESP8266 microcontroller will receive voice commands sent to Google Assistant [7], [8] to go to a floor—system on Smart Lift. The temperature and load cell sensors [12]–[14], [19] will send data to NodeMCU ESP8266 to detect a temperature and lift capacity. Smart Lifts can monitor the temperature history of passengers, detect a passenger, and the history of the last floor using [20] an android application on a smartphone with the aim of lift officers being able to find out the history of using the lift. The following is the Smart Lift system flowchart shown in Figure 1.

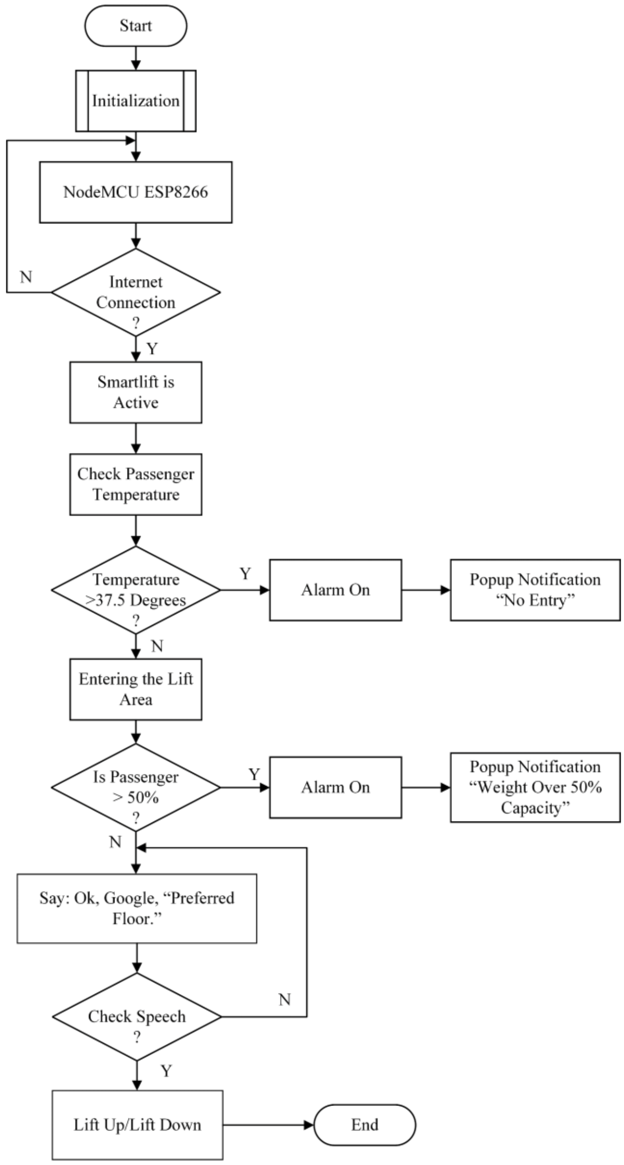


Figure 1. System flowchart of voice recognition

### *II.1. Block Diagram*

**Inputs:**

- The input process consists of a voice command system using a smart speaker with the Google Assistant system, which functions to control an lift with the statement "Ok Google, First Floor"
- The sensor in the smart lift system uses an infrared temperature sensor which functions to read the user's temperature
- Load cell sensor functions to detect the weight capacity of the lift passengers.

- Ultrasonic sensor functions to detect the lift distance so that the floor is precise [20], [21].
- The infrared sensor functions to detect the number of users in the lift to produce 50% capacity with a load cell sensor.
- Buzzer functions as an alarm when capacity exceeds 50% and detects temperature over 37.5ºC.
- Stepper motor functions as a driver to a floor that the user desires

**Process:**

In the process stage, all sensors are sent and received by the NodeMCU ESP8266 microcontroller to process the data obtained by the sensors. This microcontroller uses a system that is connected to the internet. The output will display the results of data processing.

**Output:**

At the output stage, the passenger temperature detection is obtained. If it exceeds capacity, it will activate an alarm. The detection output is 50% to determine the user's total capacity from the infrared sensor, while the scales are to determine the total weight capacity of the lift user. Furthermore, everything generated from the sensor and processed by the NodeMCU ESP8266 can be monitored using the Android Blynk application. This monitoring aims to enable lift staff to discover the history of lift use in the building with Internet connectivity. The following block diagram can be seen in Figure 2.

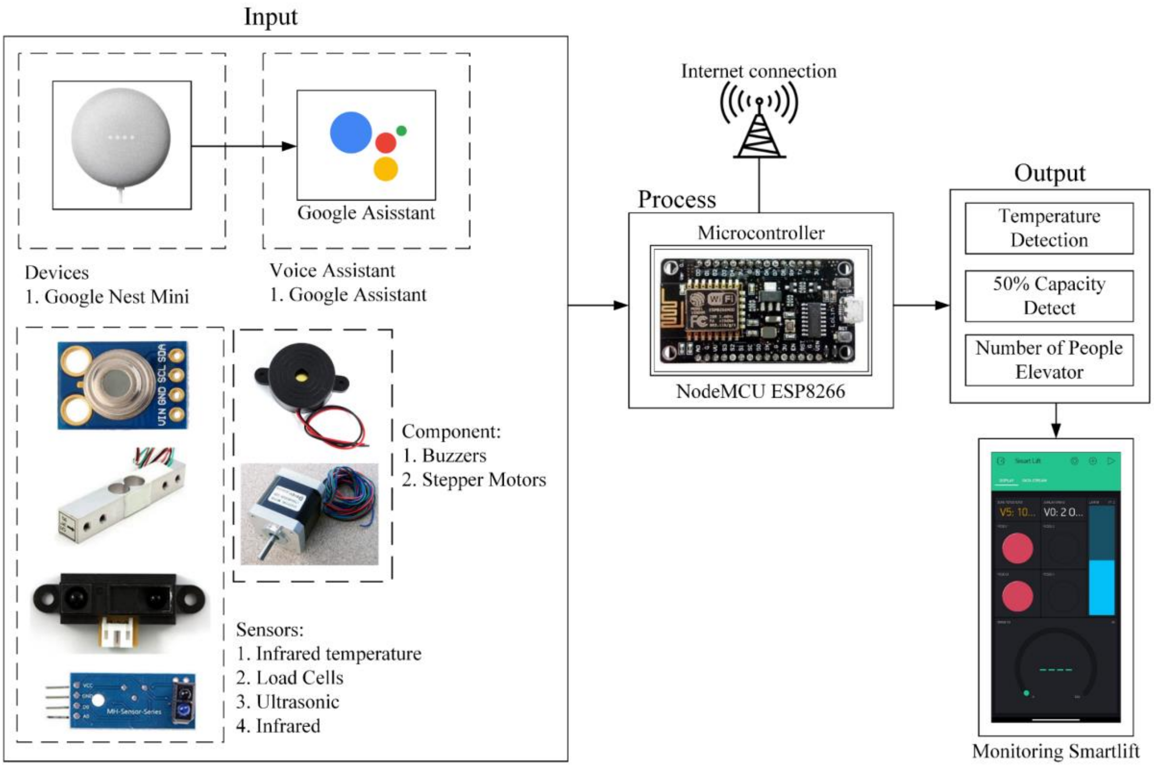


Figure 2. Block Diagram of Smart Lift

*II.2. Smart lift software*

- **Google Assistant**

The Google Assistant architecture uses IFTTT (if this, then that) for communication with smart speakers. When the spoken word has been set via IFTTT, the Adafruit server communicates with the NodeMCU ESP8266 microcontroller to move the lift to a certain floor. The following is the Google Assistant architecture shown in Figure 3.

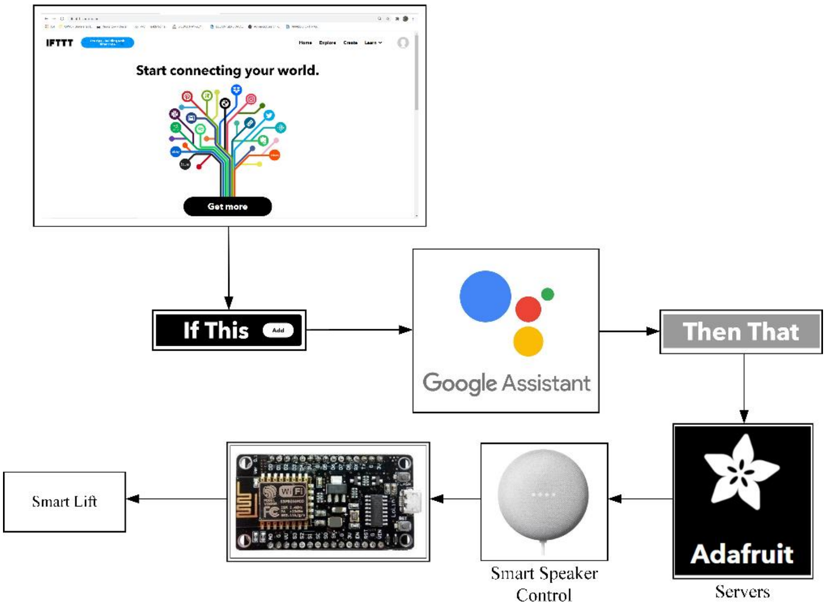


Figure 3. Architecture of Google Assistant

### II.3. Software Design

The application that will be implemented in this smart lift uses the Blynk application, which functions as an infrared temperature sensor monitoring system to detect the temperature of lift passengers, 50% capacity detection functions to detect the number of lift passengers, and the weight capacity of passengers with the COVID-19 pandemic standard is 50%, and the Number of Lift People to determine the number of passengers detected by the infrared sensor. To remotely monitor building staff so that the lift can find out the history of using the lift in the building and find out whether the person is in good health through an infrared temperature sensor.

Additionally, this application can send notifications in the form of popups to smartphones via notifications sent on temperature detection if it exceeds > 37.5°C and capacity detection exceeds 50%. In this application system, hardware and smartphones are connected to the internet network to monitor the smart lift system. The following is an application image of the smart lift system shown in Figure 4.


Figure 4. Software Design Application of Smart Lift

## III. Result and Discussion

This chapter tests the smart lift device to determine whether the designed device works as expected. Tests carried out on hardware include voice assistant testing to determine how responsive it is to control the smart lift, and software testing includes testing temperature sensors, temperature sensor notifications, load cell sensors, notifications of capacity exceeding 50%, and infrared sensors.

The following results of the smart lift device can be shown in the figure 5.


Figure 5. Device of Smart Lift

### *III.1. Testing of Infrared Temperature Sensor*

The infrared temperature sensor test takes temperature measurement data for lift passengers before entering the lift area. If the temperature measurement is ≤37.5°C, passengers can access the desired floor. If the passenger is >37.5°C, it will provide popup notification information to be monitored by the building and activate the buzzer so that passengers are prohibited from entering to ride an lift. An illustration of temperature testing can be seen in Figure 6.

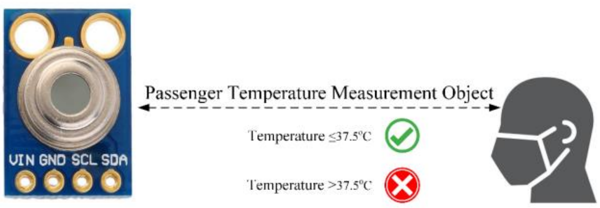


Figure 6. Illustration of Infrared Temperature Sensor Testing

Figure 6. Shows an illustration tested by placing the passenger's forehead close to the infrared temperature sensor. When the forehead is brought closer to the sensor area, it will display the passenger's temperature. The results obtained for measuring the sensor distance to the passenger's forehead to get a temperature value, giving a popup notification in the form of "no entry," and activating if the temperature is > 37.5°C, along with infrared temperature sensor testing data can be seen in table 1.

Table 1. Testing of infrared temperature sensor

| Number of Test | Measuring Distance (cm) | Temp (°C) | Alarm | Status |
|---|---|---|---|---|
| Passanger Without Covid-19 | 1 cm | 36.3 | Off | Allowed |
| | 2 cm | 36.3 | | |
| | 3 cm | 36.2 | | |
| | 4 cm | 36.1 | | |
| | 5 cm | 36.1 | | |
| Average | | 36.2 | | |
| Passanger With Covid-19 | 1 cm | 37.9 | On | Not Allowed (Send Popup Notification) |
| | 2 cm | 37.8 | | |
| | 3 cm | 37.7 | | |
| | 4 cm | 37.6 | | |
| | 5 cm | 37.6 | | |
| **Average** | | **37.72** | | |

Table 1 shows that the distance measurements made on the infrared temperature sensor to the passengers obtained a maximum distance of 5 cm to get the passenger's temperature value. The average temperature measurement for passengers without exposure to COVID-19 was 36.2°C, while passengers exposed to COVID-19 were 37.72°C. The following results of the infrared temperature sensor measurement graph can be seen in Figure 7.

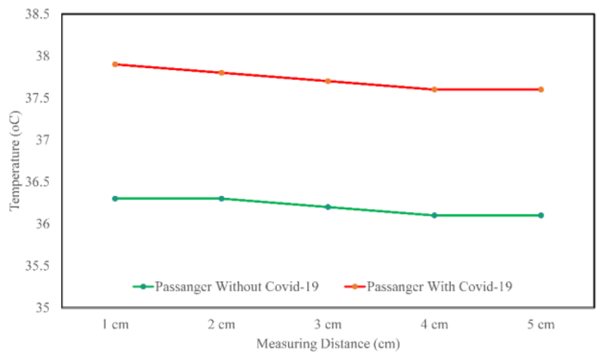


Figure 7. Testing Graph of Infrared Temperature Sensor

When the infrared temperature sensor detects a passenger's temperature >37.5°C, it will give a popup notification and turn on a buzzer for passengers exposed to COVID-19 so they are prohibited from entering the lift area. The following is the result of the popup notification when the temperature exceeds > 37.5ºC, which can be seen in Figure 8.

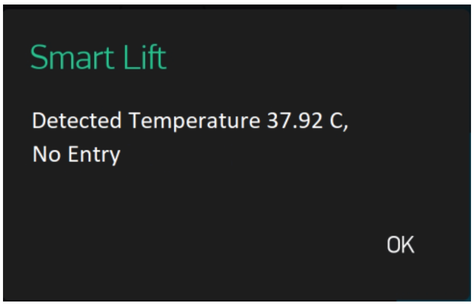


Figure 8. Popup Notification of Temperature Sensor Detection

### *III.2. Testing of load cell sensors*

This test aims to measure the weight of passengers (Kg). The load cell sensor was tested to measure the maximum load capacity of the lift users. Load measurements are simulated for as many as 4 people weighing 300 kg or 50% of the capacity of a maximum weight of 600 kg. When a passenger exceeds >300 Kg, a popup notification will be given to the lift attendant's smartphone: "Weight Exceeds 50% Capacity". Then, if it exceeds this capacity, the number of passengers must be reduced. The following is an illustration of passenger scale measurements shown in Figure 9.

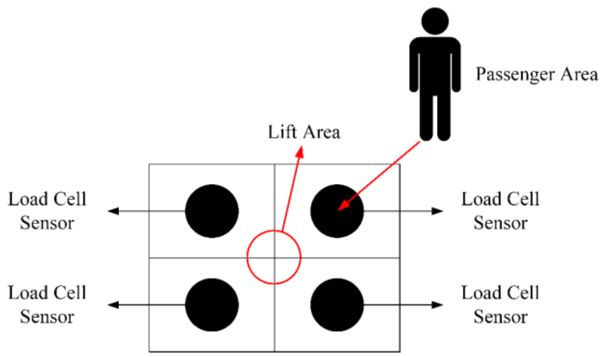


Figure 9. Illustration of Weighing Sensor Testing

Figure 9. Shows an illustration of a load cell sensor test. The test is carried out by placing it in the passenger area. Then, several experiments were carried out to get the value of the passenger weight with a maximum weight of 50% of the lift passengers from the maximum load of 600 Kg. When the weight exceeds > 300 kg, it will give a popup notification through the Blynk application and activate the buzzer alarm. The results obtained are weight, alarm buzzer, and status. The data generated on the load cell sensor can be seen in Table 2.

Table 2. Testing of load cell sensor

| **Number of Tests** | **Total Passengers** | **Mass of Passengers (Kg)** | **Alarm** | **Status** |
|---|---|---|---|---|
| 1 | | 79 | | |
| 2 | | 80 | | |
| 3 | 1 | 80 | Off | Allowed |
| 4 | | 81 | | |
| 5 | | 80 | | |
| **Average** | | **80** | | |
| 6 | | 156 | | |
| 7 | | 157 | | |
| 8 | 2 | 157 | Off | Allowed |
| 9 | | 158 | | |
| 10 | | 157 | | |
| **Average** | | **157** | | |
| 11 | | 232 | | |
| 12 | | 235 | | |
| 13 | 3 | 235 | Off | Allowed |
| 14 | | 234 | | |
| 15 | | 235 | | |
| **Average** | | **234.2** | | |
| 16 | | 383 | | |
| 17 | | 385 | | |
| 18 | 4 | 385 | On | Not Allowed (Send Popup Notification) |
| 19 | | 384 | | |
| 20 | | 384 | | |
| **Average** | | **384.2** | | |

Table 2 shows that the passenger capacity of the 50% lift was 4 people with an average weight of 384.2 Kg. When the passenger load is > 300 Kg, it will send a popup notification, "Overload 50% Capacity," and activate the buzzer alarm to give a warning to reduce the number of passengers in the lift. The following popup notification results can be seen in Figure 10.

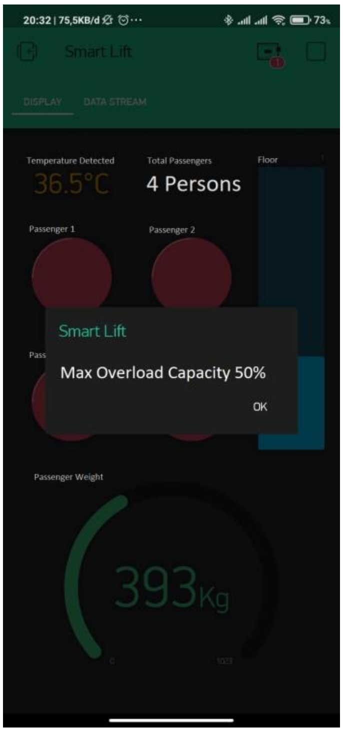


Figure 10. Notification of Weighting Scale Detection

### *III.3. Hardware testing on google assistant smart speakers*

In this test, the aim is to activate the lift on a floor with the commands "first floor," "second floor," and "third floor" to test the overall response time to drive a stepper motor to go from floor 1 to floor 3. Following is the response test time is shown in Table 3.

Table 3. Testing the response time of the Google Assistant Smart Speaker

| Number of Tests | Response Time (seconds) |
|---|---|
| 1 | 2.31 |
| 2 | 2.26 |
| 3 | 2.52 |
| 4 | 2.14 |
| 5 | 2.76 |
| 6 | 2.98 |
| 7 | 3.07 |
| 8 | 2.53 |
| 9 | 2.42 |
| 10 | 2.62 |
| **Average** | **2.561** |

Table 3 shows that the response time test obtained an average of 2.561 seconds. For the fastest response time on the 4th experiment of 2.14 seconds. The response time is measured when the command is pronounced, and the hardware on the stepper motor moves to obtain the response time in testing the response time to determine whether it is fast or not based on the internet network connected to the NodeMCU ESP8266 microcontroller. The following is a time response test graph that can be seen in Figure 11.

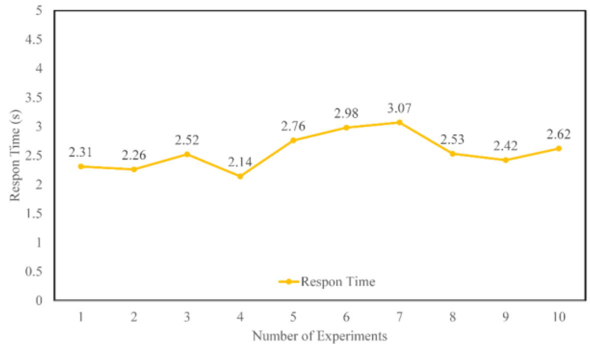


Figure 11. Measurement of the Response Time for Google Assistant Smart Speaker

### *III.4. Comparison of sensor measurements and manual measurements*

This test is to compare sensor measurements and manual measurements using measuring devices. Comparison of tests by comparing infrared sensor temperature and digital thermometer manual measurements. Furthermore, to compare passenger weight with load cell sensor measurements compared to manual measurements of digital scales. The results obtained are in the form of success values and measurement errors against sensors with measuring instruments. The following formula can be used to calculate the success and measurement error.

$$Error\ rate\ (\%) = \frac{Measure\ Manual - Measure\ Sensor}{Measure\ Manual} \text{x}100\%$$

$$Succes\ rate\ (\%) = 100\% - Error\ Rate\ (\%)$$

To calculate the error rate formula, enter the measurement value of the infrared temperature sensor with manual measurement of infrared temperature and the load cell sensor with manual measurement of digital scales. Measurements were made with a maximum of 10 trials. The following results of the success and error testing data for temperature sensor measurements can be seen in table 4.

Table 4. Comparison of infrared sensor temperature and manual temperature measurements

| Number of Tests | Thermometer Digital ($^0$C) | Thermometer Sensor ($^0$C) | Error Rate (%) | Succes Rate (%) |
|---|---|---|---|---|
| 1 | 36.1 | 36.3 | 0.55 | 99.45 |
| 2 | 36.1 | 36.3 | 0.55 | 99.45 |
| 3 | 36.1 | 36.2 | 0.28 | 99.72 |
| 4 | 36.1 | 36.1 | 0.00 | 100 |
| 5 | 36.1 | 36.1 | 0.00 | 100 |
| 6 | 37.7 | 37.9 | 0.53 | 99.47 |
| 7 | 37.7 | 37.8 | 0.27 | 99.73 |
| 8 | 37.6 | 37.7 | 0.27 | 99.73 |
| 9 | 37.6 | 37.6 | 0.00 | 100 |
| 10 | 37.6 | 37.6 | 0.00 | 100 |
| **Average** | **36.87** | **36.96** | **0.24** | **99.76** |

In table 4, it was found that the average error rate in temperature measurement was 0.24%, and the success rate temperature measurement was 99.76%. The following graph of the success of temperature measurement can be seen in Figure 12.

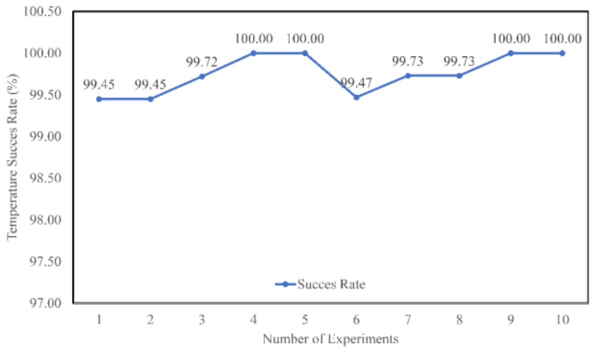


Figure 12. Graph of the success rate of temperature measurement

Furthermore, the measurement results of the load cell sensor with manual measurement of digital scales can be seen in Table 5.

Table 5. Comparison of load cell sensor and manual weighting scale measurements

| Number of Tests | Digital Weighing Scales (Kg) | Load Cell Sensor (Kg) | Error Rate (%) | Succes Rate (%) |
|---|---|---|---|---|
| 1 | 78.8 | 79 | 0.25 | 99.75 |
| 2 | 79.7 | 80 | 0.38 | 99.62 |
| 3 | 79.7 | 80 | 0.38 | 99.62 |
| 4 | 80.6 | 81 | 0.50 | 99.50 |
| 5 | 79.7 | 80 | 0.38 | 99.62 |
| 6 | 78.8 | 79 | 0.25 | 99.75 |
| 7 | 80.6 | 81 | 0.50 | 99.50 |
| 8 | 80.6 | 81 | 0.50 | 99.50 |
| 9 | 79.7 | 80 | 0.38 | 99.62 |
| 10 | 79.7 | 80 | 0.38 | 99.62 |
| **Average** | **79.79** | **80.10** | **0.39** | **99.61** |

In table 5, it was found that the average error rate in measuring passenger weight was 0.39%, and the success in measuring passenger weight was 99.61%. The following results of the success rate measurement of passenger weight graphs can be seen in Figure 13.

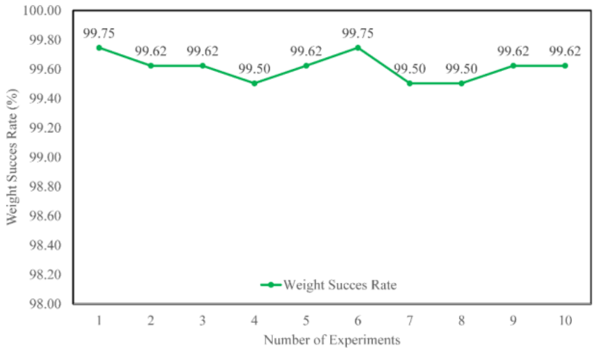


Figure 13. Graph of the success rate of passenger weight measurement

### *III.5. Testing speech recognition on a smart lift device*

Evaluating the efficacy of voice commands through the utilization of speech recognition techniques is intended to assess the performance of the intelligent lift device. In this scenario, testing is conducted by comparing speech recognition or voice command utterances for a match. The voice commands evaluated for matching were "first floor," "second floor," and "third floor."

This assessment employs voice instructions, such as "OK Google," in conjunction with the specific floor to which the lift user intends to travel. The spoken words will be compared to the ones saved in the database.

If the information is accurate, the intelligent lift system will be approved and initiate the movement to the requested floor. The intelligent lift system will, however, reject the statement if it is false. test of the smart lift voice command can be observed in Table 6.

Table 6. Smart lift voice command performance testing

| Number of Tests | Correct Pronunciation Accepted (A) or Rejected (R) | | |
|---|---|---|---|
| | First Floor | Second Floor | Third Floor |
| 1 | A | A | A |
| 2 | A | A | A |
| 3 | A | A | A |
| 4 | A | A | A |
| 5 | A | A | A |
| 6 | A | A | A |
| 7 | A | A | A |
| 8 | A | A | R |
| 9 | A | A | A |
| 10 | A | A | A |
| 11 | A | A | A |
| 12 | A | A | A |
| 13 | A | A | A |
| 14 | A | A | A |
| 15 | A | A | A |
| 16 | A | A | A |
| 17 | A | A | A |
| 18 | A | A | A |
| 19 | A | A | A |
| 20 | A | A | A |
| **Average (%)** | **100** | **100** | **95** |

Table IV demonstrates that the test involved 20 voice commands, specifically "first floor," "second floor," and "third floor," which were tested for compatibility. The test findings indicate that the smart lift voice command achieved a perfect accuracy rate of 100% for the "first floor" and "second floor" orders. During the testing phase, the voice command "third floor" achieved an accuracy rate of 95%. Figure 14 displays the graph depicting the outcomes of voice command performance testing.

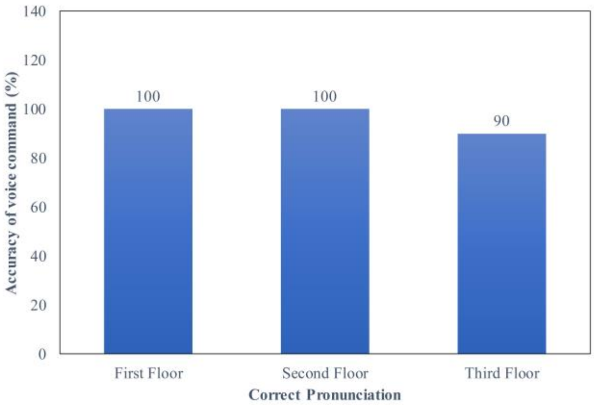


Figure 14. voice command accuracy performance graph

## IV. Conclusion

From the results of testing conducted on smart lift devices, it can be concluded that: (1) Testing the infrared temperature sensor obtained a reading distance of 5 cm. (2) The fastest response time test was 2.14 seconds. (3) Testing the sensor weight scale obtained an average of 195.5 Kg. (4) Testing the infrared temperature sensor obtained an average of 36.65ºC. (5) Testing the accuracy performance of voice commands for the "first floor" and "second floor" on the smart lift device obtained the best results reaching 100%. Meanwhile, the accuracy of the voice command for "third floor" was 95%. (6) The signal strength of the internet network connection greatly influences the device's performance in sending popup notifications and sensor monitoring data.

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