COVIDEX: TEMPERATURE ASSESSMENT AND IDENTIFICATION TRACKING MACHINE FOR CORONAVIRUS PREVENTION

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***Abstract*— During the Coronavirus pandemic, businesses, public transportation, and social service groups are putting in place strategies to return to the 'old normal' or gradual activity. Returning to the former routine carries a higher danger, as COVID-19 is a highly contagious disease with difficult detection. Vaccination slows the pathogen's replication but does not prevent it. As a result, it is ineffective in preventing minor illnesses. COVIDEX can determine a person's temperature and assess their current condition if the user has symptoms of COVID-19, and it will also automate data logging on large establishments upon entry. It also has features of alcohol dispensing for hand sanitation. The test result of the COVIDEX temperature reading capability has shown an accuracy of 90%, its Barcode reading capability has an accuracy of 85%, and on the user ergonomics, it has 84.29% satisfaction.**

Keywords*— *COVID-19, temperature, barcode, scanning, ID

I. Introduction

Establishments like corporations, public transport, and social organizations implement plans during the Coronavirus (COVID-19) pandemic to return to the 'old normal' or gradual activities. COVID-19 spreads pathogenic substances in an aerosol form and causes infected cases to escalate rapidly [1]. Gnostic's paper on COVID-19 diagnosis can describe how quickly a person who has contact with an infected person progresses to being symptomatic and having serious symptoms [2]. Returning to the old normal posts is a greater risk, for COVID-19 is a highly transmittable disease, and determining an infected person is difficult. With the announcement of the Commission on Higher Education (CHED) Chairman J. Prospero De Vera III, CHED COVID-19 Advisory No. 9 dated January 10, 2022, regarding the opening of different Higher Education institutions (HEIs). Phase 2 of the limited face-to-face classes for all programs, even in areas under Alert Level 3 will begin by the end of January 2022. The order was made with the recommendation of the DOH to CHED in partnership with the Inter-agency Task Force (IATF) for the Management of Emerging Infectious Diseases (IATF-EID). It was found out that the already rolled out vaccines are mRNA (such as Pfizer and Moderna) and vector (AstraZeneca) vaccine structured has high efficacy but are contentious. [3] In addition, despite considerable evidence showing vaccines are safe, there is increasing skepticism toward vaccination. Vaccine hesitancy has led to a decline in vaccine uptake and increased prevalence of vaccine-preventable diseases (VPDs). [4] Viruses are constantly changing, including the virus that causes COVID-19. These changes occur over time and can lead to the emergence of variants that may have new characteristics. Students of these HEIs are now more vulnerable and susceptible to COVID-19 Omicron variant infection, which is more lethal than the Delta Variant. [5]Vaccines reduce a person's risk of contracting the virus that causes COVID-19. Still, the disease can continue to spread across a community, causing sickness in unvaccinated and susceptible people or evolving to elude human immune systems. [6 & 7] Vaccine response and its induced immunity are strongly related to the mitigation prevalence. In addition, the vaccine-induced immunity period remains poorly understood [8]. Data indicate that neutralizing antibodies last several months in patients with covid-19 but gently fall in number over time.[9] Vaccination limits but does not stop the pathogen from replicating. As such, it does not protect against mild diseases.[6]

Community mitigation measures are important even if vaccines are widely available, even in the advent of the different available vaccines against COVID-19 infection. Emerging technologies are now rapidly increasing, which plays an important role in mitigating COVID-19 cases. In combating COVID-19, tracking its propagation, and forecasting its trajectory, a multidisciplinary approach was proposed to combine machine learning applications, computational models, and digital surveillance. Early symptom detection and personal identification could help prevent further virus transmission. A non-contact temperature assessment machine combined with an identification system could be used as part of an integrated/ enhanced passive search at entry points of establishments to determine and screen persons who may have early symptoms such as high temperatures. Since the pandemic's beginning, there are only a few technologies related to temperature assessment machines with an identification system. Infrared thermography (IRTs) and Non-contact Infrared thermometers (NCITs) have been commonly used for fever screening at entry and exit points of airports, which are crowded public areas. IR thermography, also known as thermal imaging, is non-contact and non-invasive imaging. On the other hand, NCITs are used to measure a person's surface temperature. Multiple studies were developed to effectively screen and detect travelers [2], [10-13].

IR thermography, also known as thermal imaging, is a non-contact and non-invasive imaging approach that has been exploited for a wide range of biomedical and non-biomedical applications but is too expensive. NCITs have been used to reduce cross-contamination risk and minimize the risk of spreading disease. Also, NCITs are a more popular and better choice for fever screening. All IRTs cleared by the U.S. Food and Drug Administration (FDA) have been limited to use in an adjunctive capacity and/or as a relative measurement. The Centers for Disease Control and Prevention document indicates that IRTs are not as accurate as NCITs and may be more difficult to use effectively. In studies that were developed, to effectively screen and detect travelers, only major international airports use these kinds of technologies, which are costly and impracticable [2], [10-13]. Mitigation strategies must be feasible, achievable, and acceptable. They must address the needs of each community and implement them in a manner that minimizes both morbidity and mortality from COVID-19 and does not create or exacerbate any health disparities. The temperature assessment machine alone is not enough, thus integrating the idea of implementing Republic Act No. 11055, otherwise known as the Philippine National ID [14]. As an enhanced passive community mitigation strategy, this temperature assessment machine can yield a more successful result. The country is trying its best to return to the 'old normal' of business and commerce. It is unavoidable for large establishments like schools, HEIs, malls, hospitals, government, and non-government offices, and other large establishments to close because many workers will be unemployed. It is also unavoidable in a large establishment to be a less crowded area because these are the center of commerce. When the establishment is under contact tracing, manual identification of the person who contacted the infected person or the person under investigation can be time-consuming. Instead of immediately stopping the transmission of the virus by tracking the person who had contacted an infected person or person under investigation manual contact tracing might do the opposite.

For this reason, this project proposal was initiated to develop this kind of feasible technology that will help mitigate a wide outbreak of this virus while focusing on the opening of Higher Education Institutions. This can also help in early symptom detection, contact tracing, and maybe a countermeasure to spread a new virus that has pandemic potential, which decreases its morbidity and mortality rate. It can easily create a log for every individual entering the HEIs. It also has a sanitizing feature. In today's protocol, when entering an establishment, it is required to check the temperature, log on to a logbook provided using a pen that is also provided, which creates a contact from the previous user, and wait for the security or the personnel in charge to dispense or give you alcohol to sanitize your hand. Our machine creates a contact-free transaction and automates these processes from temperature scanning to logging, and hand-sanitizing.

II. Related Works

The K3F/S Wall-mounted Thermometer Voice Prompt Automatic Infrared Thermometer is commonly used in different establishments. This device is mounted either on a wall or on a stand. It also comes with a feature of alcohol dispensing but it is bought separately from the main device. The K3F/S device is battery-powered. It is commonly sold in different shops online namely Shopee and Lazada.

SMS-CQ: A Quality and Safety Traceability System for Aquatic Products in Cold-Chain Integrated WSN and QR Code [15] and "A QR code-based tracing method for fresh pork quality in the cold chain" [16] focuses on livestock. The SMS-QC scans temperature changes of aquatic items in cold-chain logistics were investigated and assessed in a real-world cold chain through the use of a wireless sensor network (WSN), a quick response (QR) code, and (SMS-CQ) for aquatic products. WSN technology enables SMS-CQ to automatically achieve and capture the real-time temperature, wireless distant transmission, and monitoring; QR code enables QR code production, error correction, and static and sensed dynamic information inquiry. On the other hand, the QR code-based tracking method for a quality assurance system is just the same as the SMS-CQ machine where they both use QR codes the same as Barcode to store information and uses an infrared thermometer to detect temperatures. They both use identification and temperature system but it only focuses on life stocks. The use of WSN to achieve continuous real-time temperature detection that is wireless is not that feasible in applications on HEIs. Even though they can scan these temperatures, they do not store the information gathered by their machine.

Improving HealthCare using Smart Medical Refrigerator Barcode [17], To keep pharmaceuticals, vaccinations, and blood donations useful and safe, a medical refrigerator can monitor storage temperature, expiration dates, and amount. The study developed and improved a new adaptable and rapid "Medical Refrigerator" system to assist pharmacists in safely storing medications without the need for frequent inventory to verify expiration and amount, which costs effort, time, and money. While the drugs are in the refrigerator, the proposed smart fridge employs a barcode scanner to scan goods with expiration dates. This keeps the drugs on track so that the personnel in charge might conduct the necessary action they must do.

Thermal Image Scanning for Influenza Border Screening [18], Although infrared thermal imaging scanners (ITIS) appear to be an appealing choice for mass influenza screening, there is no published evidence of their performance in airports. ITIS was used to assess cutaneous temperature in those who agreed to have their tympanic temperature and respiration rate measured. Thermal scanning of arriving passengers has been used in airports to test for a variety of infectious illnesses. ITIS usage was confirmed during the severe acute respiratory syndrome (SARS) outbreak, however, only the number of passengers who triggered the scanner was reported, with no mention of the fever cut-off level or any following procedure employed to confirm febrile condition.

Contactless Smart Body Temperature Scanner System [19], Fever is the first symptom of an infection. As a result, body temperature screening has traditionally been used to identify people who are suspected of having infectious illnesses. The present temperature scanner is distance-dependent, which causes mistakes when measuring the temperature at different distances. Furthermore, certain contactless temperature sensors can only monitor body temperature from a certain distance. Furthermore, much research is primarily focused on adding new capabilities to the temperature scanner system rather than increasing the temperature sensor's functionality. Furthermore, a common contactless temperature scanner does not provide an automated data logging option for contact tracking.

III. Methods

A. Project Design and Specification

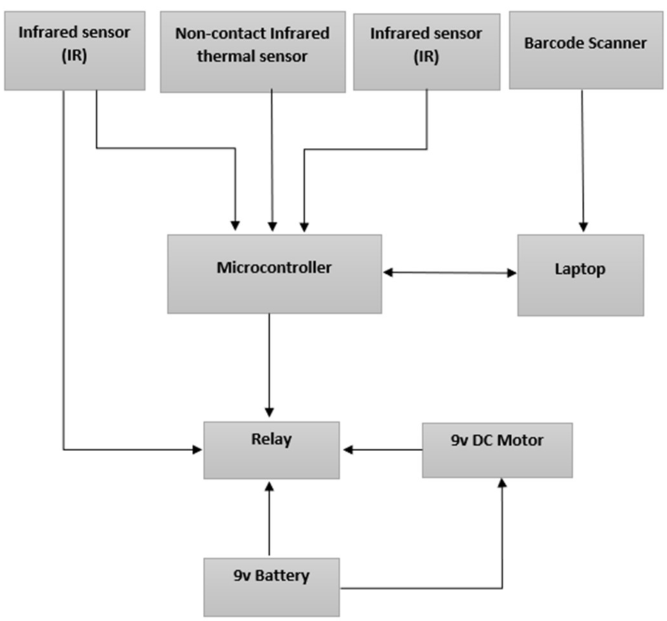

Fig. 1. Block Diagram of the System.

The block diagram in Fig. 1 shows the interconnection of the different components of COVIDEX which includes a Microcontroller, a Non-contact infrared thermal sensor, a Barcode/ QR code scanner, a Laptop, an Infrared sensor (IR), 9 volts DC suction motor, a Relay, and 9 volt Battery. The Arduino microcontroller is a general-purpose microcontroller. It will be responsible for the overall operation of the Thermal scanning capability and Alcohol dispensing capability of COVIDEX. The input devices of the machine comprise the non-contact infrared thermal sensor, two IR sensors, and Barcode/ QR code scanner. The Barcode/ QR code scanner, which is connected to the laptop, will act as the input mechanism for the data pulled from the Laptop. As the machine reads that a user is present and registered, the monitor will output the basic information of the user and will prompt the user to scan the temperature. The non-contact infrared thermal sensor will only start scanning the user's temperature when the IR sensor has detected the user's hand in front of the thermal sensor. After the inputs are processed by the microcontroller connected to the laptop that also processes those inputs, it will be displayed with a user-centered design on the monitor, indicating their temperature and other relevant user information. Then the Laptop will create separate log-in data of the user/s within that period for contact tracing purposes. Then COVIDEX will ask the user to place their hands on the sanitation area where the IR sensor connected to the 9v battery will be triggered. The signal in the 9 volts DC suction motor and the Alcohol will be dispensed, sanitizing their hands.

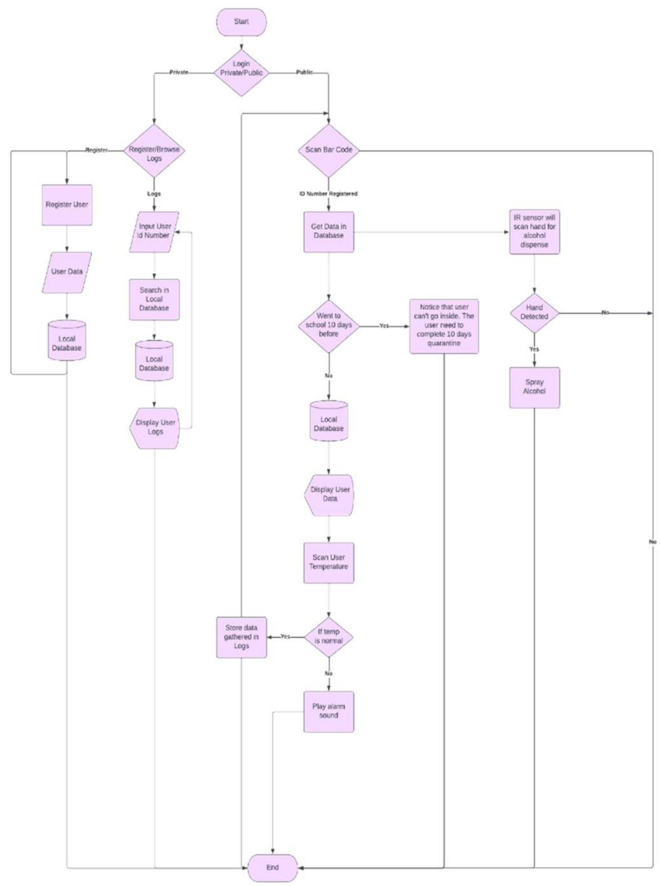

Fig. 2. Flowchart of the System.

Fig. 2 is a graphical representation of the many actions and operations that the device may perform in their proper order. The flowchart shows the input and output, process, and decision-making from beginning to end.

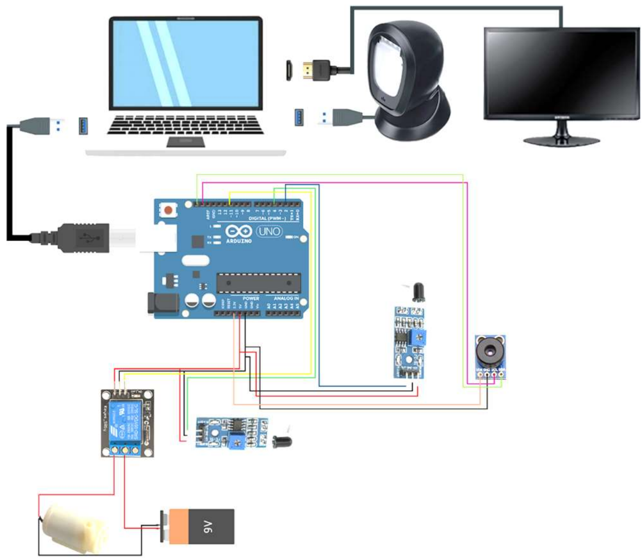

Fig. 3. Schematic Diagram of the System.

COVIDEX comprises three parts, the Main-system, the thermal scanning part, and the alcohol dispensing part. In the Main-system where the Application runs on the Laptop, and the Barcode scanner, Arduino Uno, and Computer Monitor are connected to it. The Barcode scanner and the Arduino Uno are connected to the laptop's Universal Serial Bus (USB) port. In contrast, the Computer Monitor is connected to the Laptop's High Definition Multimedia Interface (HDMI) port using an HDMI cable.

The Thermal Scanning part composes the Thermal Sensor and the IR Sensor, which are connected to the Arduino Uno. The Thermal Sensor's VCC pin is connected to the Arduino Uno's 5 volts supply, its Ground is connected to the Arduino Uno's Ground, and Pins SCL and SDA are connected to the Arduino Uno's SCL and SDA respectively. The IR sensor's (6) VCC pin is connected to the Arduino Uno's 5 volts supply, its Ground pin is connected to the Arduino Uno's Ground, and its output pin is connected to Arduino Uno's Digital I/O Pin Number 2.

The Alcohol Dispenser part composes of the Relay Module, IR Sensor, 9v DC Suction Motor, and 9v Battery which are connected to the Arduino Uno. The Relay Module's VCC pin is connected to the Arduino Uno's 5 volts power supply, its Ground is connected to the Arduino Uno's Ground and the output signal is connected to the Arduino Uno's Digital I/O PIN 11. The IR sensor's VCC pin is connected to the Arduino Uno's 5 volts supply, its Ground pin is connected to the Arduino Uno's Ground, and its output pin is connected to Arduino Uno's Digital I/O Pin Number 4. The 9v Dc Suction Motor's positive wire is connected to the relay's Normally Open (NO) socket and the negative wire is connected to the battery's negative wire. The battery's positive wire is connected to the relay's Common pin (COM) socket.

B. Testing and Evaluation

The infrared target probe absorbs thermal radiation to provide a substantially consistent source of infrared radiation and an aperture for avoiding penetration of the infrared target while allowing thermal radiation to be transmitted to the target. To detect infrared radiation from the infrared object, the infrared sensor is calibrated. The infrared target is located inside the probe so that it receives thermal radiation from the aperture and then releases thermal radiation to the infrared sensor.

The temperature reading can be easily measured and displayed by these non-contact instruments so that a large number of individuals can be independently tested at entry points. Non-contact infrared thermometers need minimal inter-use cleaning. It can help reduce the risk of transmitting COVID-19 infections by using non-contact temperature measuring instruments. In measuring the temperature of a user, certain aspects can affect the result of the measurements. The followings are the stability and drift, uniformity of the workable target plane, and Temperature differential. This is the following that has affected the thermal scanning capability of COVIDEX, which are unavoidable. NCITs have been used to lower the risk of cross-contamination and mitigate the possibility of disease transmission. While typically 98.6°F (37.0°C) is considered a "normal" temperature, some studies have shown that "normal" body temperature can be within a wide range, from 97°F (36.1°C) to 99°F (37.2°C). [2, 10, 11, 12, 13]. The computation Solution that was used in this Thermal Capability Testing is:

$$Error\ Rate = \frac{|COVIDEX\ reading - Thermal\ Gun\ reading|}{Therm\quad Gun\ Reading} \times 100 \quad (1)$$

$$Accuracy\ Rate = 100\% - Error\ Rate \quad (2)$$

Drift and stability are unavoidable for electrical components, such as the sensor, to malfunction or measure incorrectly—the practical target plane's uniformity. Because NCITs have a minimum temperature detection range, this is one factor that might influence the measurement's outcome. The test region of the forehead or wrist is smooth, dry, and not obstructed during computation. Wearing superfluous garments or head covers (e.g. headbands, bandanas) or using face cleaning goods did not raise or reduce the body temperature or the temperature of the individual in the forehead test location (for example, cosmetic wipes). The test result of COVIDEX might be affected by the environment/environmental temperature in this section. Use direct sunlight or near radiant heat sources in a draft-free environment and outdoors, for example. Examine the environment to see if it's safe to utilize. The temperature should be between 60.8 and 104 degrees Fahrenheit (16 and 40 degrees Celsius) with a relative humidity of less than 85 percent [2, 10, 11, 12, 13]. Position the NCIT in the testing environment or place for 10-30 minutes before usage to encourage it to adapt to the environment.

There are things to consider in COVIDEX's Barcode Reading capability, such as the Identification Card must be visible. Any sticker or dirt attached to the ID can lead the ID unreadable. In addition, if the ID casing already has multiple scratches, it can also cause the ID to be unreadable. The Barcode scanner cannot read the ID in the landscape orientation. Thus ID must be portrait-oriented so that it can be easily read. The barcode calibration was already set and the ID must be either 1 to 3 inches away from the Barcode scanner to be read. The computation used was getting the probability of the successful and unsuccessful reading. By dividing the probability of each outcome by the total number of respondents multiplied by 100%, we can get the Percentage of each outcome.

$$P|N = 20\ Respondents$$
$$P|Successful = x \qquad P|Unsuccessful = y$$
$$P|Successful = \frac{x}{P|N} \times 100\% = P|x\%$$
$$P|Unsuccessful = \frac{y}{P|N} \times 100\% = P|y\%$$

In the Alcohol dispensing capability, the primary focus was on the Infrared Sensor integrated into it. The IR Sensor was triggered when it detected an object 1 – 4 inches away from it. Just like the Thermal Sensors capability, unavoidable factors that can lead to it not dispensing are its Drift and Stability, for electrical components, such as the sensor, to malfunction or measure incorrectly. Projection. The capability of the Bar code reader to read the Bar code located in the ID will be tested. It is known that Barcode scanners like QR Code scanners have their scanning range limitation. If the object or hand is too far or not within the range of the IR Sensor it can also lead to the Alcohol dispenser not dispensing. The computation used was the probability of Successful dispensing and Unsuccessful dispensing. By dividing the probability of each outcome by the total number of respondents multiplied by 100%, we can get the Percentage of each outcome.

$$P|N = 20\ Respondents$$
$$P|Successful = x \qquad P|Unsuccessful = y$$
$$P|Successful = \frac{x}{P|N} \times 100\% = P|x\%$$
$$P|Unsuccessful = \frac{y}{P|N} \times 100\% = P|y\%$$

The Philippine National ID was implemented in 2018 but the development and production of the National ID are still ongoing. Moreover, not all of the population has acquired their respective ID. In the testing at University, a database will be created and students will be preregistered which will act as the main database of the University. This will be used during the testing as the users will swipe their ID and the systems data acquisition comes in, checking the ergonomic ability of COVIDEX systems.

A list of questions was also presented to the User/ Respondent to get their feedback on using the machine. Using Single E's Questionnaire (SEQ) was used. The User/ Respondents will answer the questionnaire by rating the questions from 1 to 7. From the range of 1 to 7, 1 being the Lowest or unsatisfied and & being the Highest or Very Satisfied. From the 20 respondents we had, we have given them a Google Form Document so they can evaluate our device. Using the formula (3) to get the average of the evaluated answers in the SEQ. In the solution, x = is the rating of the SEQ, and 7 is the highest rating that can be given.

$$Average = \frac{\sum x}{(highest\ rating\ given \times number\ of\ responsdents)} \times 100 \qquad (3)$$

IV. Results and Discussion

A. System Testing Results

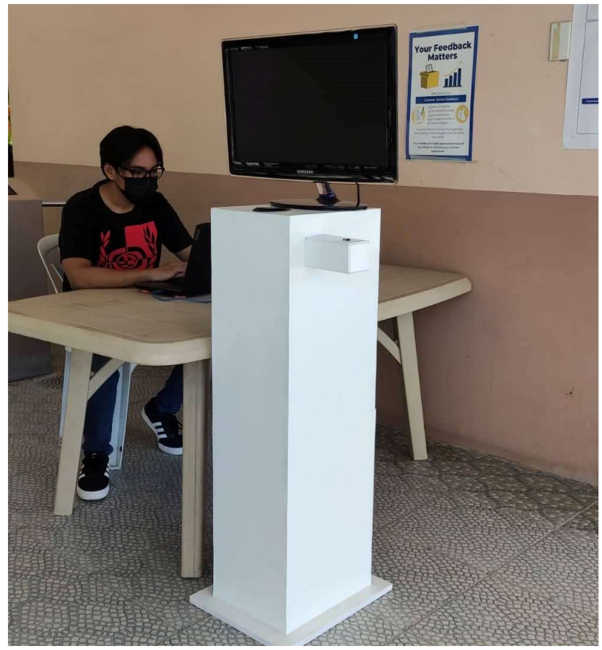

Fig. 4. The AUDI System.

As seen in Table I, from the tested 20 persons or respondents who have used the machine presented in Fig. 4, the Error percentage of COVIDEX ranges from 1.69 as the highest Error Percentage and 0.27 as the lowest Error. Thus, it has a higher Accuracy Percentage which ranges from 98.34 to 99.72.

Data show that the Error difference between the COVIDEX Thermal Reading, which acted as the Measured or Tested Value, and the Thermal Gun Reading, which was set as the Given value, is very low; thus, making the COVIDEX Thermal capability Accuracy High.

In the Barcode reading capability shown in Table II, the records are taken in their first trial of swiping their ID; from the 20 respondents, there are 2 respondents whose ID was not read. It was not read due to the Barcode scanner's projection factors.

The total success rate of the Barcode scanning capability of COVIDEX is 90%, out of the 20 respondents, 18 were read immediately in their first trial of swiping their ID.

TABLE I. COVIDEX Thermal Scanning Capability Testing

Person	COVIDEX Reading (in °C)	Thermal Gun Reading (in °C)	Error difference	Error Percentage	Accuracy Percentage
1	36.2	36.5	0.3	0.8287	99.17

2	35.9	36	0.4	0.2786	99.72
3	35	35.2	0.2	0.5714	99.43
4	35.1	35.2	0.1	0.2849	99.72
5	36.5	36.6	0.1	0.2740	99.73
6	36.1	36.7	0.6	1.6620	98.34
7	36.2	36.6	0.4	1.1050	98.90
8	36.7	37.2	0.5	1.3624	98.64
9	36.1	36.7	0.6	1.6620	98.34
10	35.5	35.8	0.3	0.8451	99.15
11	35.5	35.7	0.2	0.5634	99.44
12	36	36.5	0.5	1.3889	98.61
13	35.1	35.3	0.2	0.5698	99.43
14	35.1	35.2	0.1	0.2849	99.72
15	36.7	37	0.4	0.8174	99.18
16	35.5	36.1	0.6	1.6901	98.31
17	36.5	36.9	0.4	1.0959	98.90
18	36.3	36.7	0.7	1.1019	98.90
19	35.2	35.5	0.3	0.8523	99.15
20	37	37.1	0.1	0.2703	99.73

TABLE II. COVIDEX BARCODE SCANNING CAPABILITY TESTING.

Persons	Barcode Reading (Successful / Unsuccessful)
1	Successful
2	Successful
3	Successful
4	Successful
5	Successful
6	Unsuccessful
7	Successful
8	Successful
9	Successful
10	Successful
11	Successful
12	Successful
13	Successful
14	Successful
15	Successful
16	Unsuccessful
17	Successful
18	Successful
19	Successful
20	Successful

In the Alcohol Dispensing capability presented in Table III, the records are also taken in their first trial in placing their Hands below the IR sensor, almost the same as the testing in Barcode reading; from the 20 respondents, there are 3 respondents whose hands were not read by the IR. It was not read due to the Range limitation factors the IR Sensor had.

The total success rate of the Alcohol Dispensing capability of COVIDEX is 85%, out of the 20 respondents, 17 were read immediately in their first trial of placing their hand below the IR sensor.

TABLE III. COVIDEX ALCOHOL DISPENSING CAPABILITY TESTING

Person	Alcohol Dispensing (Successful / Unsuccessful)
1	Successful
2	Successful
3	Unsuccessful
4	Successful
5	Successful
6	Successful
7	Successful
8	Successful
9	Successful
10	Successful
11	Successful
12	Successful
13	Unsuccessful
14	Successful
15	Successful
16	Successful
17	Successful
18	Successful
19	Unsuccessful
20	Successful

B. SEQ Evaluation of the System

Fig. 5. COVIDEX Software Main Form.

The Single Ease Questionnaire (SEQ) was employed for the COVIDEX software shown in Fig. 5. The Users and Respondents will provide their responses to the questionnaire about their 'Overall satisfaction with COVIDEX' by giving each question a value from 1 to 7. Using a scale from one to seven, one representing the least pleased or most dissatisfied and seven representing the most satisfied or very satisfied.

All in all, all the results garnered a high rate of satisfaction. With these data, we can say that our system is very user-friendly, and the ergonomic ability of COVIDEX is high. In addition, COVIDEX is feasible and low-cost, this is the edge that COVIDEX has compared to the Related Studies presented. Most systems introduced in our Related Studies did not have this ergonomic ability. The related studies presented did not have this user-friendly capability.

V. Conclusion

As a result of this research, a device that can automatically collect data and perform temperature checks has been developed and installed at the institution's front door, which was evaluated following its objectives, including its capacity for temperature screening, bar code scanning, alcohol delivery, and the system's ergonomic capabilities. The results of the many tests that were carried out show that COVIDEX has a good grade overall. Both the thermal scanning capability and the barcode scanning capacity of the COVIDEX have a high percentage of accuracy. The thermal scanning capability can detect temperatures with a high degree of precision. Additionally, COVIDEX has a large capacity for dispensing alcoholic beverages. The system has been given a favorable rating due to the excellent quality of its overall design and the ease with which it may be used. Therefore, it has been shown and validated that COVIDEX has accomplished its major goal, and it has a very high overall rating and a very high acceptable rating.

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