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A Covid-19 Symptom Screening and Sanitization Robot Integrated with Automated Sanitizer Dispenser, Contactless Temperature Measuring Device & Pulse-Rate Sensor

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A Covid-19 Symptom Screening and Sanitization Robot Integrated with Automated Sanitizer Dispenser, Contactless Temperature Measuring Device & Heart-rate Sensor

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Abstract-*As of July 20, 2021 about 4 million people have lost their lives due to the Covid-19 global pandemic. According to the World Health Organization, two of the effective ways of preventing this disease are screening out the symptomatic individuals through temperature screening and promoting repeated hand sanitization among the masses. But health screening and proper sanitization is a major challenge in crowded public places with people entering in a short window of time. This study proposes a device that can automatically spray disinfectant on an individual's hands and feet while standing in front of it. This robot can also measure the temperature and heart rate of that individual using sensors and send an email to authority in case there is any abnormality. Results after experiment shows that this robotic solution has produced 98.5% accurate results for temperature and 93% for heart rate. It is 40% faster than manual health screening and disinfection methods. This robot has been manufactured from locally sourced off-the-shelf components. However, with industry-grade instruments and mass production, the cost of solutions can be reduced by 70%. Thus, it is believed to be a low-cost solution helping the world in preventing the spread of Covid-19 viruses.*

Keywords: Automated sanitizer dispenser, Touchless temperature measuring device, Covid-19 precautionary robot, Healthcare assistant.

1. INTRODUCTION

SARS-CoV-2 virus that is responsible for the disease known as Covid-19, transmits through droplets and aerosols. The pandemic has emerged from China with a total of 91,428 confirmed cases around the world [1]. As of July 31, 2021 there's a total of 198,164,741 Covid-19 cases and 4,227,751 deaths in the whole world[2]. Research shows that the virus is highly contagious and the contagious process of this virus is like diffusion from person to person, contamination from surface, spread by sneezing, coughing and shaking hands etc.[3].As the outbreak of the virus has spread around the world, it has become more difficult to manage. So, in order to bring the situation under control, the whole world is in shutdown as of now [4]. The World Health Organization (WHO) has provided some guidelines to reduce its community transmission. There are some major actions that are highly recommended by the WHO. Some key guidelines are- perform hand washes/ rub with soap/ hand sanitizer in a frequent manner, limit social gatherings and time spent in crowded places, avoid close contact with any individual who is sick etc.[5]

But the major concern was to normalize the use of hand sanitizer or soap in common people without increasing the chances of spreading transmission. The global Covid-19 pandemic due to the SARS-CoV-2 has also challenged the regular life of people[4]. Places like offices, schools, factories where a lot of people enter within a short amount of time are the danger arenas for covid pathogens to spread. Because there is a chance of close contact with someone who is suspected to have symptoms of covid-19 [6]. But to undertake face-to-face health screening, health assistants and the people they are screening both are potentially at risk of infection [7]. Therefore, these important places are being closed month after month, just to reduce the spread of this contagious disease [8]. To recover from this situation and go back to the regular world, many researches and studies are proposed. A study on the hospital-based mechanical hand sanitizer dispenser, Erief et al. [9] concluded that the infected person may contaminate the dispenser which may trigger hospital-acquired infection. Consequently, nowadays, automated touchless sanitizers are taking place as this dispenser does not require any human contact to operate. Based on the aforementioned studies it is clear that mechanical and electrical dispensers (having a pushbutton) are vulnerable as these can be contaminated with pathogens and transmit the disease easily. A study conducted by G. M.G. Rojo[10] has developed a non-contact hand sanitizer dispenser based on infrared radiation (IR) sensor. But they show malfunctions especially on sunny days where sunlight intensity varies because of clouds or reflection from the ground. However, until now, there are many instances where students of other countries have implemented this concept in the past. Here, the re-implementation is made for this model by considering all the economic aspects, including its cost,

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reliability, and size, to make this device sustainable in the market. The idea of this study is to prevent the mass transmission of Coronavirus by offering an innovative device. This is an autonomous robot that can disinfect the hand and shoe and measure the heart-rate. Besides, it can also measure body temperature as it is considered to be an initial symptom of Covid-19 and if any deviation in temperature from the accepted threshold is detected, it will automatically send an alert to the authority via mail.

2. COMPONENTS AND MEASUREMENTS

This device was fabricated under two key objectives: being user-friendly and cost-effective. Materials to be used in its fabrication have been selected and applied keeping these goals in mind. A brief description of the hardware components mentioned with their key features is presented in Table 1.

Table1: Components list with additional information

No.	Major Component	Brand	Advantages	Price	Quantity
1	R3 Board ATmega328P with USB Cable for Arduino-Compatible	Kuman	1.Inexpensive 2.Cross-platform-runs on Windows, Macintosh OSX, and Linux operating systems while other microcontroller circuits only run on window. 3.User-friendly programming environment	10.69	1
2	Photoresistor Photo Light Sensitive Resistor, Light Dependent Resistor 5 mm	MCIGICM	1.Light resistance (at 10 Lux): 5–10 Kohm which is useful in this study. 2.Perfect dark resistance: 0.5 Mohm. 3.Good response time: 20 ms (Rise), 30ms (Down). 4.Resistance illumination: 4	0.133	1
3	5V 650 nm 5 mW Red Dot Laser Head Red Laser Diode Laser Tube with Leads Head Outer Diameter 6mm	HiLetgo®	1.Optimal temperature tolerance: −36~65 °C operating temperature range 2.Low working voltage: 5 V DC	0.599	1
4	GY-906 MLX90614ESF Non-Contact Infrared Temperature Sensor Module	Jastoo	1.MLX90614 is an infrared thermometer for non-contact temperature measurements. 2.Integrated into the MLX90614 are a low noise amplifier, 17-bit ADC and powerful DSP unit thus achieving high accuracy and resolution of the thermometer. 3.The user can configure the digital output to be Heart width modulation (PWM). As a standard, the 10-bit PWM is configured to continuously transmit the measured temperature in range of -20 to 120°C, with an output resolution of 0.14°C	15.00	1
5	MAX30102 Heart Rate Click Sensor	HiLetgo®	1.Optical Heart-Rate Monitor and Heart Oximetry Solution. 2. Example C Source Code For Arduino And mbed Platforms. 3. 3.3V一5v power supply	1.99	1

6	Ultrasonic Module HC-SR04 Distance Sensor	Smraza	1.The detection zone: 0.78~196 in/ (2cm~500cm); High precision: up to 0.12 in/(0.3 cm) Effectual angle: less than 15° 2.Power supply: 5V DC; Quiescent current: less than 2mA	7.84	1
7	HD44780 1602 LCD Display Module DC 5V 16x2 Character LCM Blue Blacklight	HiLetgo®	1. Using the i2c protocol to reduce the occupation of I/O ports, making it easier to add to the project, and less wiring. 2. With a potentiometer used to adjust backlight (Color: Blue) and contrast.·Power supply: 5v and I2C address is: 0x27 Module dimension: 80mm x 35mm x 11mm	11.00	2
8	RFP30N06LE 30A 60V N-Channel Power Mosfet	Weimeet	1.RFP30N06LE 30A, 60V, ESD rated, avalanche rated, 0.047 Ohm, RDS(ON) = 0.047Ω,2KV ESD protected. 2.Good stability and uniformity with high EAS. 3.Wide Application:power Switching application; hard switched, high frequency circuits and uninterruptible power supply	0.3	1

3. METHODOLOGY

The idea of the robot was to help the world get better from this pandemic situation and how to keep a lot of people sanitized and health screened in a short amount of time effectively. So, the working method of the robot is built implementing this idea. This robot is built with eight key components. This robot becomes a multi-purpose robot by using three different kinds of sensor-temperature, heart-rate and distance sensor. The development of the Robot follows a four-part methodology:

1. Automated Hand Sanitizer Dispenser
2. Automated Shoe Disinfectant Spray
3. Non-Contact Temperature measuring device
4. Heart-rate measuring device

3.1 Working Principle of Hand Sanitizer Dispenser

The main parts of the Hand Sanitizer Dispenser are LM7805, MOSFET, LDR (Light Dependent Resistor), LASER Diode and Pump motor. The MOSFET here acts as a gate which will provide a signal to the pump motor according to the value of the resistor. The resistor is controlled by the LDR. The main function of the LDR is to detect the fluctuation of the laser which eventually results in changing the value of the resistor. Therefore, when the laser is emitted on the LDR, the value of the resistor remains low. On the other hand, when the hand is held on the dispenser box, the laser can't go through the hand and so the LDR is no longer affected by the laser. So, the value of the resistor becomes high, which directs the current through MOSFET. And the MOSFET activates the pump motor. The pump motor will run up to two minutes per signal. So that there is no loss of sanitizer. The circuit diagram of hand sanitizer dispenser is given in fig. 1.

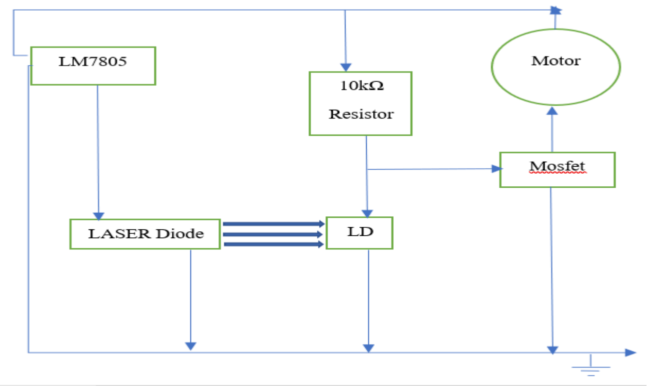

Fig. 1: Circuit of Hand Sanitizer Dispenser

3.2 Working Principle of Shoe Disinfectant Spray Mechanism

The main part of the disinfection spray mechanism is the Sonar sensor, Arduino Uno, Pump motor, Relay module, DC pump motor, and 12V Lipo battery as a power source. The circuit connection diagram is given in fig. 2.

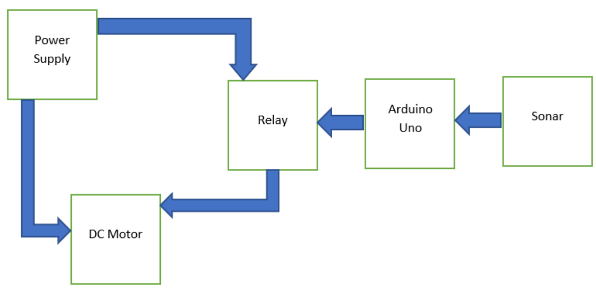

Fig. 2: Circuit of Disinfection Spray Mechanism

The sonar sensor is connected with Arduino and the requirement is pre-programmed in the Arduino that when an object is closer as in 10cm or less than 10cm from the sensor the sonar will give a signal to the Arduino. The Arduino then passes the signal to the relay module to close the circuit as the circuit initially was open while no signal was given. After closing the circuit, the motor will generate power and it will spray the disinfectant.

3.3 Working Principle of Temperature Measuring Process

GY-906 MLX90614ESF Non-Contact Infrared Temperature Sensor Module, LCD Display Module, NodeMCU are the major components used for measuring the surface temperature of any object without any contact. The Temperature Sensor Module consists of four pins from which the clock pin is connected with the NodeMCU D1 pin and the data pin is connected with the NodeMCU D2 pin. The vcc pin of the temperature sensor module is connected with the NodeMCU 3V pin to input 3V in the temperature sensor and the GND pin of both the modules are also been connected. The LCD display used in this project also has a clock pin and a data pin which are connected to the aforementioned NodeMCU D1 and D2 pin.

The data pin of the temperature sensor continuously collects data from the object and transfers them to the NodeMCU module. If the collected data in NodeMCU module doesn't match the required conditions given in the code then it uses the afore generated API in the module to request the IFTTT server. The IFTTT server then sends the authority an email referring to the fluctuation of temperature of that particular person or object. The circuit diagram of the Temperature measuring process made by circuito.io is given in fig. 3.

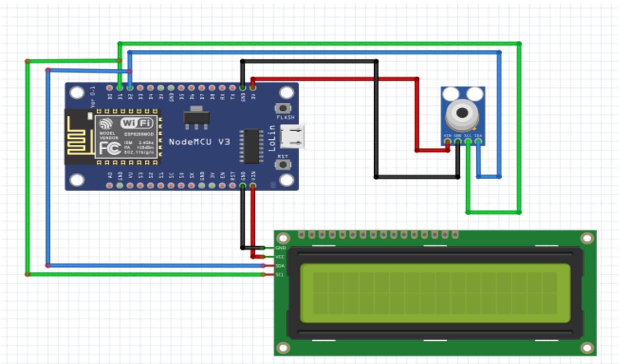

Fig. 3: Circuit of Temperature Measuring Process

3.4 Working Principle of Heart-rate Measuring Process

MAX30102 Low Power Heart-Rate Sensor Module, I2c LCD Display Module, NodeMCU are the major components used for measuring the heart rate of a person. The heart rate sensor consists of four-pin which the clock pin is connected with the NodeMCU D1 pin shorted with the Temperature sensor's clock pin and the data pin is connected with the NodeMCU D2 pin as like D1 pin. The vcc pin of the heart-rate sensor module is sorted with NodeMCU 3V pin to input 3V in heart-rate sensor and GND pin is also shorted with GY 906 sensor. Like before the 12c LCD display is connected to the aforementioned NodeMCU as following. The data pin of the heart-rate sensor continuously collects data of the subject and sends it to NodeMCU. NodeMCU Collects the data and shows the average value of the heart rate and registers it to its own server. If any kind of fluctuations occurs that can't meet the giver requirement the NodeMCU creates an API in the module to request IFTTT server. The IFTTT server then sends the authority an email referring to the id and fluctuations in heart rate besides temperature. The circuit diagram of the Heart measuring process made by circuito.io is given fig. 4.

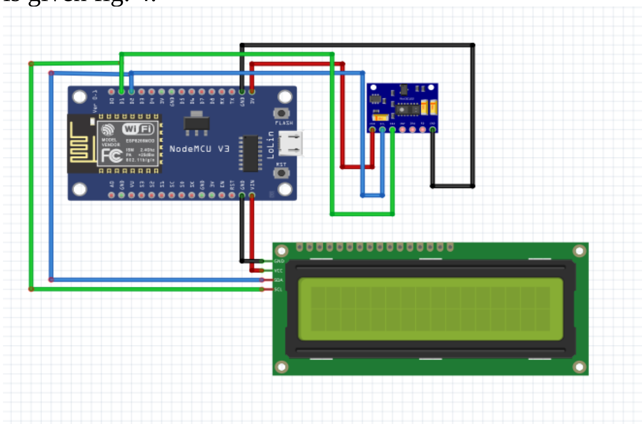

Fig. 4: Circuit of Heart Measuring Process

4 ANALYSES

Measuring the performance of this study has been carried out by assessing the efficacy of the automatic hand sanitizer dispenser, shoe disinfectant spray, temperature sensor and Heart-ate sensor. The test was carried out on three different individuals for the three aforementioned categories. The collected date is shown in Table 2.

Table 2: Analysis of Hand Sanitizer Dispenser.

Hand Sanitizer Dispenser Observed on	Estimated Time (S)	Actual Time (S)	ΔTime
Person 1	5	4	1
Person 2	5	7	2
Person 3	5	5	0

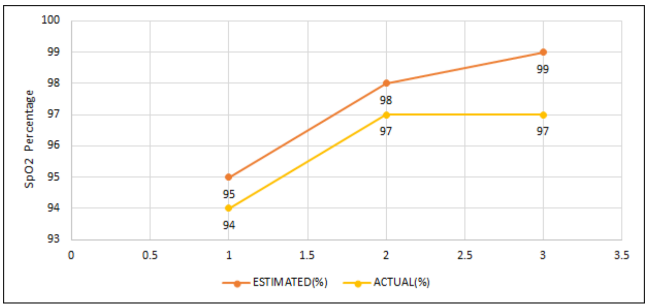

Fig. 5: Hand sanitizer dispenser deviation per Person

The data given in Table 2 has been recorded after performing the hand sanitizer dispenser on three individuals and a graph has been generated that is given in fig. 5. The graph in fig. 5 shows that the estimated results are almost the same as the actual result. So, the success rate in measuring the temperature using this robot is 98.5% which is believed to be very satisfactory.

Table 3: Analysis of the Shoe Sanitizer Dispenser

Shoe Disinfectant Spray Observed on	Estimated Time (s)	Actual Time (s)	ΔTime
Person 1	4.0	5.1	1.1
Person 2	4.0	4.6	0.6
Person 3	4.0	4.9	0.9

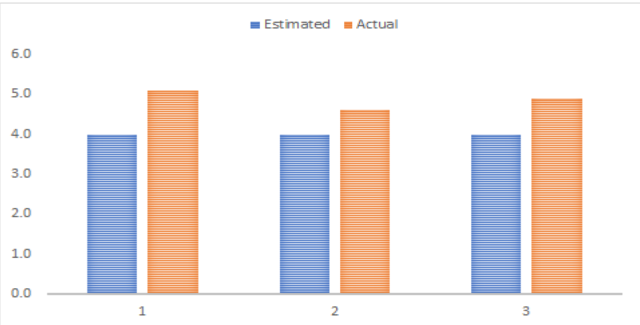

Fig. 6: Shoe disinfectant spray readings deviation per Person

The data given in Table 3 of the shoe sanitizer dispenser has been recorded using the sonar sensor and a graph has been generated that is given in fig. 6. The graph in fig. 6 shows the deviation of the estimated timings and actual timings. As the motors used in this project were cheap and not industry-grade components, the difference of timings is high. So, the success rate in this particular sector was 87% only which is believed to be increased to (98-99) % upon using industry-grade motors.

Table 4: Analysis of temperature measuring Device.

Temperature Observation from	Estimated Temperature (°C)	Actual Temperature (°C)	ΔTemparature
Person 1	36.5	37.2	0.7
Person 2	37.4	38.3	0.9
Person 3	36.2	37.2	1.0

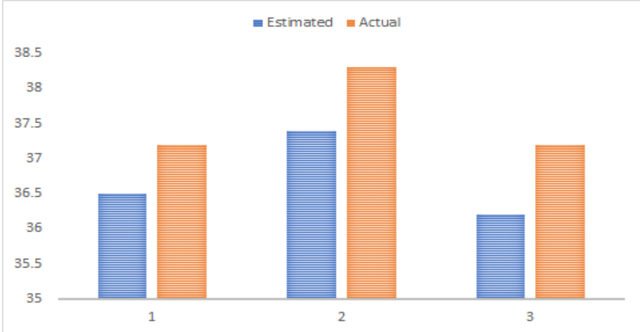

Fig. 7: Temperature deviation per Person

The data given in Table 2 of temperature has been recorded using the Gy-906 temperature module sensor and a graph has been generated that is given in fig. 7. The graph in fig. 7 shows that after doing several attempts, the temperature reading of the GY-906 temperature module sensor is quite close to the actual reading; though there has been observed a slight fluctuation. To reduce this fluctuation, some measures can be taken. One prominent measure would be while checking the temperature the Person has to be approximately within the 5cm boundary of the sensor. The fluctuation rate will increase if the person is away more than 5 cm.

Table 5: Analysis of Heart-rate sensor

Heart-rate observation from	Estimated Heart-rate	Actual Heart-rate	ΔHeart-rate
Person 1	65	69	4
Person 2	78	80	2
Person 3	92	94	2

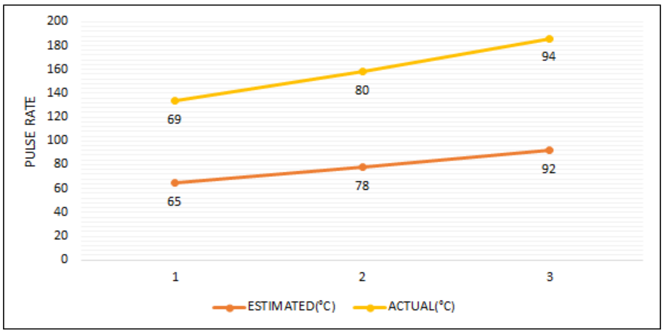

Fig. 8: Heart rate deviation per Person

The data given in Table 3 of Heart rates has been recorded using the Heart-ate sensor. The graph in fig. 8 shows the deviation of estimated and actual reading of Heart rate for three different persons. This deviation was created due to the fluctuation of IR emission. So, the success rate of this particular working process is calculated to be 93%. But with further measures and developed devices being used the success rate can be increased to 99.9%.

Table 6: Regular method vs non-contact robotic method.

Location and Date	Regular Method Timing (s)	If Non-contact Robotic Method is used(s)	ΔTime
Shwapno Super Shop 18-03-2021	19.0	10.8	9.8
Infinity Mega Mall 20-03-2021	21.2	10.0	11.2
Afmi Plaza 25-03-2021	17.6	10.3	7.3

Alongside the individual working ability of This robot, there is another aspect that has been observed. The timing of the traditional method of health screening and hand sanitizing was noted and compared with the timing of This robot. And the findings are shown in Table 5. From the table, it can be easily observed that the traditional method certainly consumes more time than This robot by two-fold. Therefore, using This robot offers time efficiency as well as reduces the spread of coronavirus.

5. RESULT & DISCUSSION

The results from the analysis indicate that This robot can be very effective. A review of relevant literature revealed that numerous dispenser devices of various designs and sensing techniques are available in the market. However, most of these devices are relatively expensive for the general population, especially for the people of the third world countries where a significant portion of the population are living below the poverty line. While performing a cost analysis, this robot shows a maximum cost of only around USD 25. As this device is made of components that are available in almost every country at a very low price. The presented device can be made more cost-effective by alternating some of the components. The Hand Sanitizer used in this device was liquid type with Isopropanol and Chlorhexidine Gluconate (0.3%). Gel-type hand sanitizer can be also.

6. CONCLUSION

In this paper, the Non-Contact Temperature and Sanitizer Dispenser Devices with Heart-ate Sensor is the best way to avoid the use of traditional contact or radiation thermometer and handheld devices for preventing the spread of SARS-Cov-2 infections. The measured temperature and heart-rate is displayed through the LCD and with the help of IFTTT server if there's any fluctuation a mail is sent to the respected authority. The system shows that the temperature reading results are 98.5% accurate based on the data gathered.
The automatic touchless hand sanitizer device demonstrated in this study is expected to play a key role in contactless hand disinfection in public places and reduce the spread of infectious diseases in society.

7. ACKNOWLEDGEMENT

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