Received: 25 February 2022 | *Revised: 22 April 2022* | *Accepted: 28 April 2022*
DOI: 10.37917/ijeee.18.2.3 *Vol. 18| Issue 2| December 2022*

Open Access

Iraqi Journal for Electrical and Electronic Engineering
Original Article

Design and Implementation of an Injury Detection System for Corona Tracker

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Abstract
Today, the trends are the robotics field since it is used in too many environments that are very important in human life. Covid 19 disease is now the deadliest disease in the world, and most studies are being conducted to find solutions and avoid contracting it. The proposed system senses the presence according to a specific injury to warn of it and transfer it to the specialist doctor. This system is designed to work in service departments such as universities, institutes, and all state departments serving citizens. This system consists of two parts: the first is fixed and placed on the desk and the other is mobile within a special robot that moves to perform the required task. This system was tested at the University of Basrah within the college of engineering, department of electrical Engineering, on teaching staff, students, and staff during the period of final academic exams. The presence of such a device is considered a warning according to a specific condition and isn't a treatment for it, as the treatment is prescribed by the specialist doctor. It is found that the average number of infected cases is about 3% of the total number of students and the teaching staff and the working staff. The results were documented in special tables that go to the dean of the college with the attendance tables to know the daily health status of the students.
KEYWORDS: Covid 19, MAX30100 Sensor, MLX90614 GY-906 Sensor, Robot.

I. INTRODUCTION

Nowadays, there are no effective anti-viral drugs for Coronavirus disease 2019 (SARS-CoV-2) [1][2], so the major attention is going to detect infected cases as fast as possible. The very fast nonspecific symptoms and the high rate of contagion for (Covid-19) disease result in too many symptoms like the cough, respiratory symptoms that required the fast diagnostic and urgent establishment of precise [3][4]. Coronavirus is a difficult disease [5][6], where the progress of infection of this virus can result in respiratory problems and probability of death, there is an imperative requirement to offer different diagnostic strategies for primary recognition of the SARS-CoV-2 [7][8]. Now, with the rapid increase in Coronavirus infections, the researchers thinking how to reduce the spread of this disease. Several systems have been proposed that help in detecting the disease to reduce its spread. One of the ways that is used to avoid the gathering between people is to use the robot in dangerous locations where the human is difficult to reach [9][10]. The objective of the proposed system is to reduce infection of infections between the students and teachers in the university and when the system recognized any infected person, the person is prevented from coming to the university. This system is consisting of two parts: the first one is used to detect the infections between the teachers and university staff and the second is the same as the first one and carries on a robot to move between the students to avoid the gathering between them. As soon as the person stands in front of the fixed device, the sensor inside the device takes the person's temperature, readings of the number of heartbeats, and the percentage of oxygen in the blood. The result is compared with a threshold and when there is an expected infection, the result is sent by mobile via Bluetooth to the nearest health center within the university. While in the second part (mobile robot), the same operations are repeated for the students. Unfortunately, the infections with Covid-19 are increased every day and the person that is expected to be sick is prevented from the exam to avoid the gathering and transmission of infection and if we did not use this system, the infections will be expected to be increased.

II. THE CONSTRUCTION THE SYSTEM

This system was designed and implemented to work within the official departments, which require mixing between people to avoid the risk of spreading infection among the flu in the absence of suspicion of an injury so that the person is prevented from entering the place in case the device readings exceed the threshold of disease. The hardware components of the system are consisted of:

A. Contactless Temperature Sensor Module GY-906

A heat infrared thermometer sensor (Fig. 1. MLX90614 GY-906) is used without a contact condition. It uses the infrared feature to measure heat with high accuracy of 0.02 degrees Celsius. Too many applications are used within this sensor like the human body temperature or any other body. The interfacing between this type of sensor and the microcontroller (Arduino or respray pi) is done through the Standard IIC communication protocol. This non-contact infrared thermometer [11] sensor comes with a breakout board with all of the components needed for operation depending on the required applications. Many applications used this sensor such as Healthcare, Temperature regulators in printers and copiers, Movement detection, Thermal relay/alert, Automotive blind angle detection, Industrial temperature control of moving parts, Livestock monitoring, and body temperature measurement.

B. MAX30100 Sensor

The oximeter sensor that is used to measure oxygen in the blood through the finger and to measure heart rate also called the SpO2 sensor, sensor (see Fig. 2) is used in various medical applications. The energy consumption of this sensor is very low, so it can be used with the simplest batteries and for long periods, such as portable monitoring devices. The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies [12] and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

C. Liquid Crystal Display (LCD)[13]

This is an electronic device that is used to show the internal reading of the components and is connected with the Arduino nano board through the IIC module using the analog pins A4 and A5 also it is connected directly with pin 2 and pin 3 to the GND. Fig. 3 shows our reading through the test using the Liquid Crystal Display (LCD 16X4).

D. IIC Module

The information that is collected through the Arduino nano microcontroller is translated using this chip (see Fig. 4) to display them in the Liquid Crystal Display (LCD 16X4). A tiny trim pot is also included on the board for fine-tuning the display's contrast. Furthermore, there is a jumper on the PCB that powers the backlight [14].

Fig. 1. MLX90614 GY-906 Sensor.

Fig. 2. MAX30100 Sensor (Pulse Oximeter).

Fig. 3. Liquid Crystal Display (LCD 16X4).

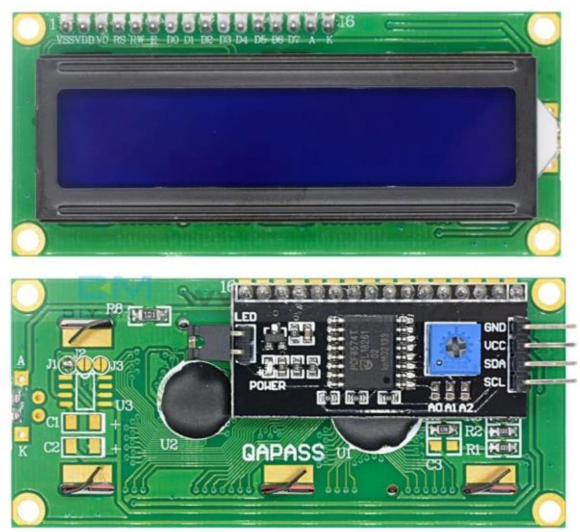

Fig. 4. IIC Module Display Blue/Yellow).

This device (see Fig. 5) was designed using the AutoCAD program and was printed using a 3D printer in proportion to the size of the sensors used within this system. This system was tested at the University of Basrah within the college of engineering, department of electrical engineering, on teaching staff, during the period of final academic exams. Where the fixed part is placed next to the daily attendance fingerprint device for employees and teachers, and the head of the department supervises this process. As soon as the person stands in front of the fixed device, the MLX90614 GY-906 sensor inside the device takes the person's temperature, while the other sensor (MAX30100) takes readings of the number of heartbeats and the percentage of oxygen in the blood. The result is compared with a threshold (more than 38.5 temperature, the oxygen percentage is less than 90%, and the heart rate ranges between (70-85)) and when the result is more than the proposed threshold this mean that there is an infection and the result send by mobile phone application to the nearest health center within the university. The presence of such a device is considered as a warning according to a specific condition and isn't a treatment for it, as the treatment is prescribed by the specialist doctor. The results were documented in special tables that go to the dean of the college with the attendance tables to know the daily health status of the students.

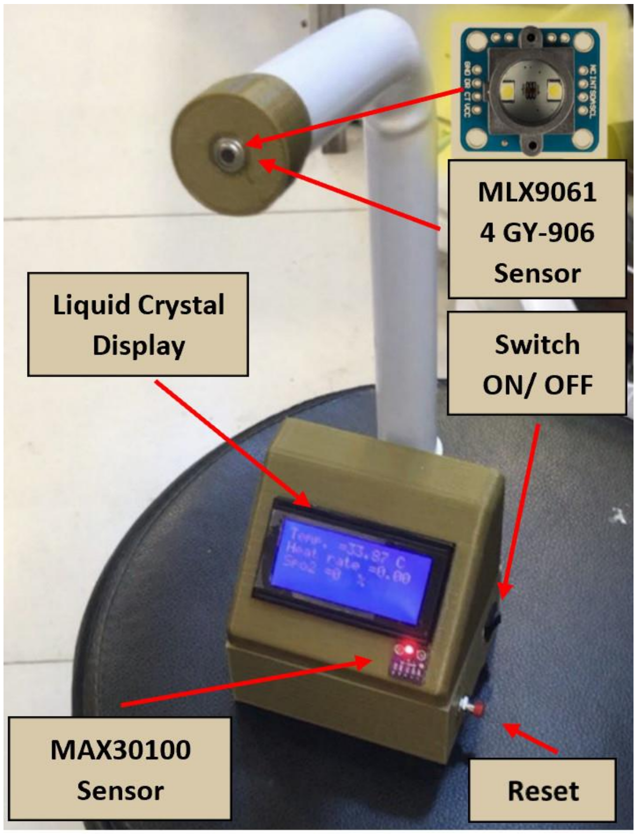

Fig. 5. Static Part of the Proposed System.

III. The Mobile Part Of The System

The mobile part of the proposed system consists of a mobile robot (see Fig. 6) that consists of several components such as Arduino nano, H-Bridge, DC-Motor, GY-sensor, MAX30100 sensor, I2C Module, Alarm unit, Switch and Liquid Crystal Display (LCD). The movement of the robot is done according to the differential drive mobile robot kinematics that is illustrated in (1) through (13) (see Fig. 7) [15][16]. The robot consists of two wheels connected through one axis coordinate where the (x, y) represented the center global position of the robot in a fixed reference frame and the orientation reference is represented by the line going through the (x, y) and perpendicular to the wheel axis. The robot line speed is represented by v and the angular velocity of the robot is w. The robot navigates in a circular arc by increasing the speed of the inner wheel while slowing the outer wheel as shown in Fig. 7. using (1) to (3).

$$s_L = r\,\theta \tag{1}$$

$$s_R = (r + L)\,\theta \tag{2}$$

$$s_M = (r + L/2)\,\theta \tag{3}$$

where S_L and S_R represent the left wheel and right wheel displacement respectively, (θ) is the angle of the turn in radians r is the (inner) left wheel radius turn, L is the displacement between two wheels and SM is the displacement at the center point. The velocity (v) components of the point (x, y) are explained in (4) to (6).

$$d(x)/dt=v\cos(\theta) \tag{4}$$

$$d(y)/dt=v\sin(\theta) \tag{5}$$

$$d(\theta)/dt=(v_R - v_L)/L \tag{6}$$

By integrating the Equations (1) to (6) keeping into account the initial position (x_0, y_0) of the robot, we can get:

$$x(t)=x_0+L(v_R+v_L)/2(v_R-v_L)[\sin((v_R-v_L)t/L+\theta_0)-\sin(\theta_0)] \tag{7}$$

$$y(t)=y_0+L(v_R+v_L)/2(v_R-v_L)[\cos((v_R-v_L)t/L+\theta_0)-\cos(\theta_0)] \tag{8}$$

where the initial position of the robot is defined by the point (x_0, y_0), the left and right velocity of the wheel are, v_L ,v_R *and* the robot turn radius of circular trajectory is $(L(v_R+v_L)/2(v_R-v_L))$. So, the new position and orientation of the robot are defined by (9) to (12).

$$s=(S_R+S_L)/2 \tag{9}$$

$$\theta=(S_R-S_L)/L + \theta_0 \tag{10}$$

$$x=S\cos(\theta)+x_0 \tag{11}$$

$$y=S\sin(\theta)+y_0 \tag{12}$$

As soon as the person stands in front of the robot, the MLX90614 GY-906 sensor inside the device takes the person's temperature, while the other sensor (MAX30100) takes readings of the number of heartbeats and the percentage of oxygen in the blood. The result is compared with a threshold (more than 38.5 temperature, the oxygen percentage is less than 90%, and the heart rate ranges between (70-85)) and when the result is more than the proposed threshold this means that there is an expected infection and the result send through the mobile application to the nearest health center within the university.

The result obtained by the robot sensors is displayed in the mobile connected via Bluetooth and programmed using the App Inventory application. The presence of such a robot is considered as a warning according to a specific condition and isn't a treatment for it, as the treatment is prescribed by the specialist doctor. When there is a specific injury is detected, the robot sprays a special dusting solution to the person suspected of being injured from the pump connected with the fogging tank. The results were documented in special tables that go to the dean of the college with the attendance tables to know the daily health status of the students.

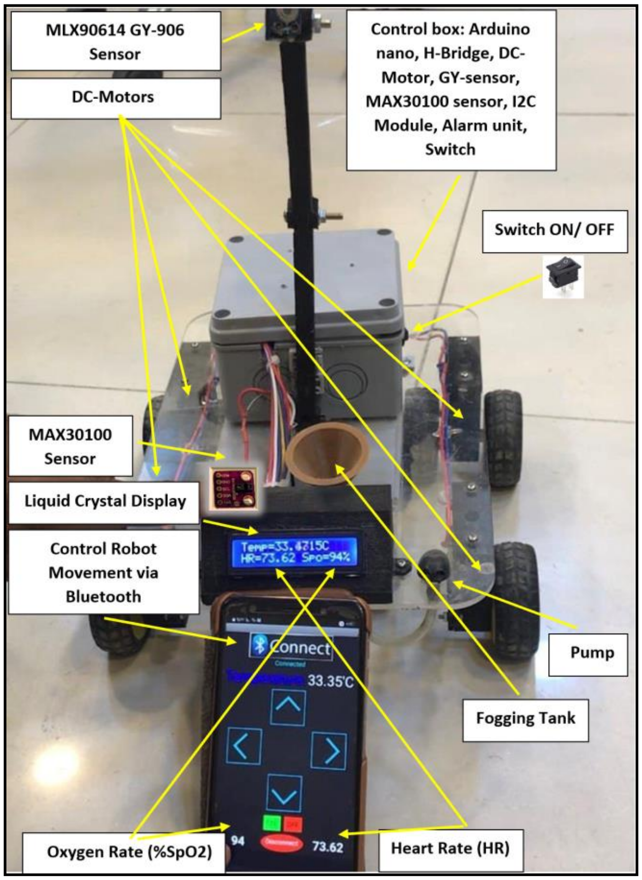

Fig. 6. The mobile part of the system (Robot).

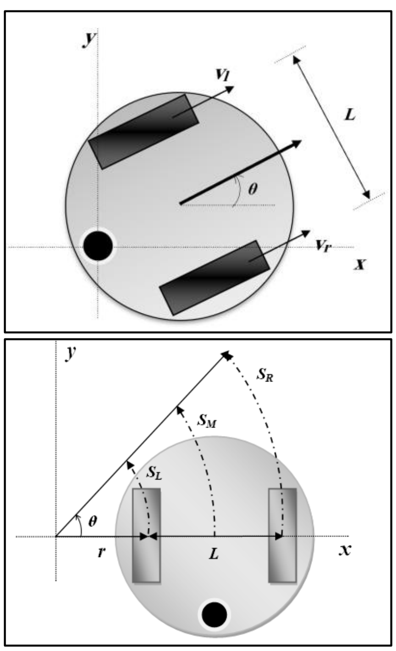

Fig. 7. Mobile Robot Kinematics (differential-drive robot).

IV. Result And Discussion

The proposed system senses the presence according to a specific injury to warn of it and transfer it to the specialist doctor. This system is designed to work in service departments such as universities, institutes, and all state departments serving citizens. This system consists of two parts: the first is fixed and placed on the desk and the other is mobile within a special robot that moves to perform the required task. This system was tested at the University of Basrah within the collage of engineering, department of electrical engineering, on teaching staff, students, and staff during the period of final academic exams. Where the fixed part is placed next to the daily attendance fingerprint device for employees and teachers, and the head of the department supervises this process. As soon as the person stands in front of the fixed device, the MLX90614 GY-906 sensor inside the device takes the person's temperature, while the other sensor (MAX30100) takes readings of the number of heartbeats and the percentage of oxygen in the blood. The result is compared with a threshold (more than 38.5 temperature, the oxygen percentage is less than 90%, and the heart rate ranges between (70-85)) and when the result is more than the proposed threshold, this means that there is an infection and the result send by mobile phone to the nearest health center within the university. The average daily health status for teaching staff and worker staff in one-week during the mid-term exam is shown in Fig. 8. Unfortunately, the infections are increased every day and the person that is expected to be sick is prevented from the work to avoid the gathering and transmission of infection and if we did not use this system, the infections will expect to be increased.

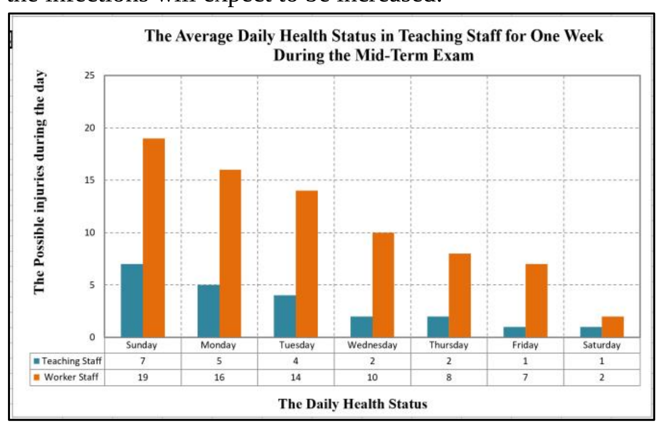

Fig. 8. The Average Daily Health Status for Teachers and Staff for One Week During the Mid-Term Exam.

While in the second part of the system (mobile robot) which is used for the students, the same operation is repeated as for the fixed part of the system, it is placed within a special robot, and by using the same sensors found in the stator, it is the sense the specific injury, and when the case is detected, the robot sprays a special dusting solution to the person suspected of being injured using a pump connected with the tank**.** The average daily health status for students that is obtained using the mobile part in all the department stages for one week during the mid-term exam is shown in Fig. 9. The infections are more increased every day in the student because they are more than the teachers and staff and the student that is expected to be sick is prevented from the exam and if we did not use this system, the infections will expect to be increased. The results were documented in special tables that go to the Dean of the College with the attendance tables to know the daily health status of the students as shown in Table I. By repeating the test for many weeks in the same term, we can find that the average number of infected cases is about 3% from the total number of the students and the teaching staff and the working staff as shown in Fig.10.

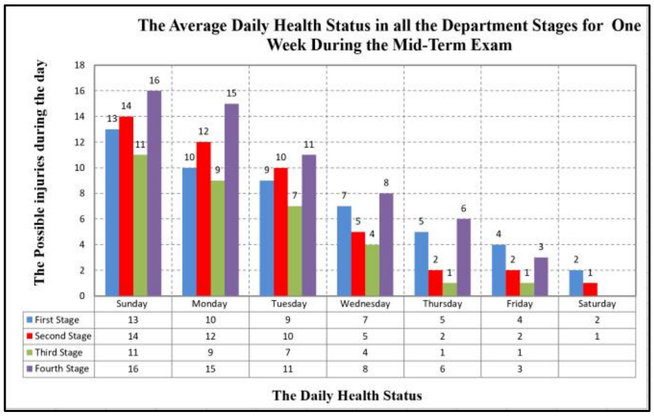

Fig. 9. The Average Daily Health Status for students in all the Department Stages for One Week During the Mid-Term Exam.

TABLE I

SAMPLE OF STUDENT DAILY HEALTH STATUS

Patient Name	**Daily Health Status**		
	Temperature (C)	Heart-Rate(bpm)	***%SpO2***
STUDENT 1	36.2	88	99
STUDENT 2	36.7	78	98
STUDENT 3	38.7	73	97
STUDENT 4	33.4	70	96
STUDENT 5	36.6	81	99
STUDENT 6	39.1	83	98
STUDENT 7	37.3	***89***	95
STUDENT 8	36.7	67	91
STUDENT 9	35.9	89	84
STUDENT 10	36.4	78	77
STUDENT 11	36.2	73	99
STUDENT 12	37.4	78	95

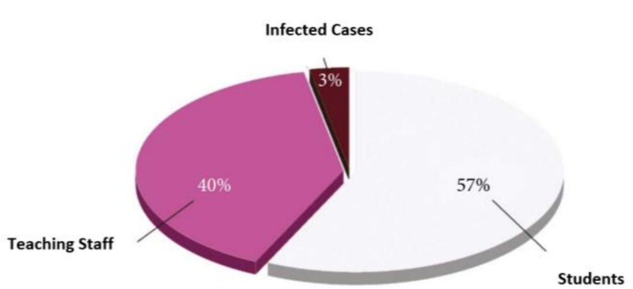

Fig. 10. The Average Detection for the Infected Cases concerning the Whole Number of the Teacher Staff and Student.

V. CONCLUSIONS

In this paper, the suggested system is designed and implemented to work in service departments such as universities, institutes, and all state departments serving citizens to detect the possible infections that could lead to a significant increase in the number of infections among people. This system was tested at the University of Basrah within the college of engineering, department of electrical engineering, on teaching staff, students, and staff during the period of final academic exams. This system consists of two parts: the first (fixed and placed on the desk) for staff and teachers, and the head of the department supervises this process. As soon as the person stands in front of the fixed device, the sensor inside the device takes the person's temperature, readings of the number of heartbeats, and the percentage of oxygen in the blood. The result is compared with a threshold and when there is an expected infection, the result is sent by mobile via Bluetooth to the nearest health center within the university. While in the second part (mobile robot), the same operations are repeated for the students. Unfortunately, the infections with Covid-19 are increased every day and the person that is expected to be sick is prevented from the exam to avoid the gathering and transmission of infection and if we did not use this system, the infections will be expected to be increased. The results were documented in special tables that go to the dean of the college with the attendance tables to know the daily health status of the students. It is found that the average number of infected cases is about 3% from the total number of students and the teaching staff and the working staff.

CONFLICT OF INTEREST

The authors have no conflict of relevant interest to this article.

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