COVID-19 SCREENING TECHNIQUE FRAMEWORK FOR UNIVERSITY STUDENTS'ADMISSION

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ABSTRACT

Coronavirus disease 2019 (COVID-19) is a global pandemic. Clinical studies have shown that there was an association between COVID-19 and cardiovascular disease. The virus can directly induce myocardial injury, arrhythmia, acute coronary syndrome, and venous thromboembolism. In Malaysia, students will come back to University soon. The screening techniques framework is required to reduce the pandemic Covid-19 transmission among the students. In this manuscript, we present a new screening technique framework which is consists of temperature and heart rate measurements, movement tracking and risk assessment. Students will be given a questionnaire to stratify their risk into high, medium, and low risk. The temperature will be measured by using an infrared thermometer. The heart rate will be monitored only in those in high and low-risk categories by using a smart bracelet. The students' movement will be tracked by using a Wi-Fi based location technique. To avoid any privacy concerns, the location data will be extracted only if the student shared the location with the confirmed COVID-19 case. Lastly, the risk assessment is required in reporting if the infection occurs among students.

KEYWORDS: COVID-19, Heartbeat, Temperature, Movement, Risk Assessment

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a global pandemic. As of March 21st, 2020 infected patients were present in 167 countries/regions with more than 285,000 cases and nearly 12,000 fatalities worldwide. Clinical studies have shown that there was an association between COVID-19 and cardiovascular disease. The pre-existing cardiovascular disease seems to be linked with an increased risk of death. The virus can directly induce myocardial injury, arrhythmia, acute coronary syndrome and venous thromboembolism (Nishiga et al., 2020). Thus, one of the main presenting symptoms of COVID-19 is fever and increased heart rate. This was reported in patients without a fever or cough (Liu et al., 2020). Hence heart rate measurement could be one of the mass screening methods for the detection of COVID-19 in addition to the questionnaire. In Malaysia, university student admission would prompt a dedicated screening method to reduce the risk of transmission among them. A set of questionnaire will be administered to students for risk assessment and they will be stratified into high, medium and low risk. Bracelet will be given to high risk students for heart rate monitoring and subsequently will be classified using data mining techniques. The location of the students will be tracked by using a Wi-Fi device. The objective of this research is to present a framework in preparing for students registration as the university currently does not have an existing risk assessment strategy. This framework consists of temperature mesurement using infrared thermal sensors, heart rate monitoring using the KNN algorithm, and student movement tracking using Wi-Fi location. This paper is divided into the related study, proposed framework, workflow and conclusion.

2. RELATED STUDY

Most of the countries in the world are using a traditional but effective approach by screening for symptomatic individuals. The first line of detection of possible infection is by measuring the body temperature i.e. fever. A study on health screening framework by Gregoire et al., (2010) showed that health screening is a very important procedure to identify and quarantine a sick individual. Cowling et al., (2010) also suggested that health screening for the pandemic situation should have a proper procedure. Their framework was able to screen 95% of Influenza A cases. The same health screening framework was also used for the entry and exit of airline travellers during the H1N1 pandemic (Khan et al., 2013). Based on their work, data from flight itineraries for travellers who flew from Mexico were used to estimate the number of international airports where health screening measures would have been needed, and the number of travellers who would have had to be screened, to assess all air travellers who could have transported the H1N1 influenza virus out of Mexico during the initial stages of the 2009 A(H1N1) pandemic. They found that screening at just eight airports managed to assess 90% of air travellers who were at risk of transporting A(H1N1) out of Mexico in the early stages of the pandemic. These studies show the importance of a framework for student registration.

3. PROPOSED FRAMEWORK

The university management has to prepare a framework and risk assessment strategy during the student registrations. This is important not only to prepare the medical staff of the University, but also the lecturers and administration staff. The students need to follow the rules as the proposed framework. Figure 1, shows the proposed framework for the students registration.

4. PROPOSED WORKFLOW

4.1 Consent Form

The incubation period of COVID-19, which is the time between the exposure to the virus and the development of symptoms is on average five (5) to six (6) days. But it can also be as long as fourteen (14) days. Thus, quarantine should be mandated for fourteen (14) days from the last exposure to a confirmed case.

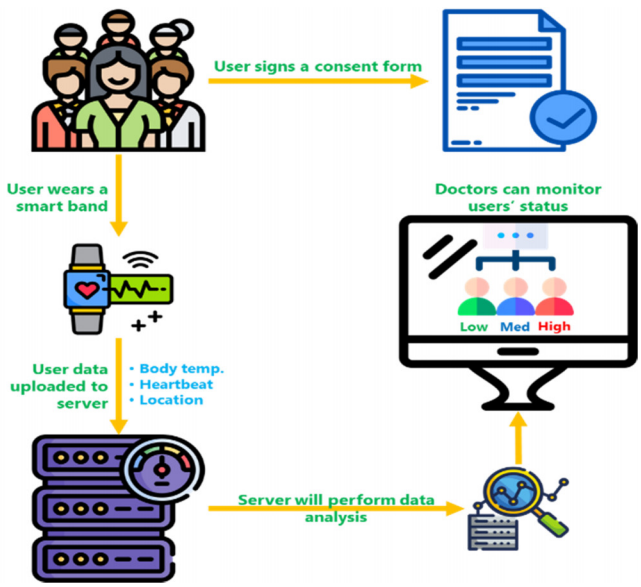

Figure 1: Proposed Framework

Table 1: Description of Figure 1

Items	Description
Users	Students
Consent Form	The form required will be explained in the next section
Smart band	Data from heart rate students
Temperature	The temperature will be measured in the classroom
Movement	The data movement will be captured
Server	All the data will be kept on the server and the analyst of the data will be done and presented to a medical doctor.

Students will fill in a consent form fourteen (14) days before they come to the university. The questionnaire consists of three (3) sections of questions.

Section A is for demographic data. The students are required to fill in their name, faculty, home address, rental address, age, user id and password. All demographic data will be kept in the database and need to be cross referenced with the student database at the university. Then, the students will log in the user id and password from section A. Section B is to assess the students' current health status i.e. the presence of fever, sore throat, cough, or flu. Section C is to assess the students' underlying medical conditions such as hypertension, asthma, diabetes mellitus, heart disease, and pregnancy. Each question from the questionnaire carries a different weightage scoring and the cumulative marks will stratify the students in four risk categories (Figure 2a-b). They are high, medium and low as shown in Table 2. For example, if the student's home address is in the red zone and he has cough and underlying diabetes mellitus, he will be classified as High Risk.

Table 2: Description of risk categories

Risk Category	Description	Marks
High	Red zone area and pre-existing illness	80 and above
Medium	Red zone area and none pre-existing illness	40 and below 80
Low	Non-red-zone and none pre-existing illness	Below 40

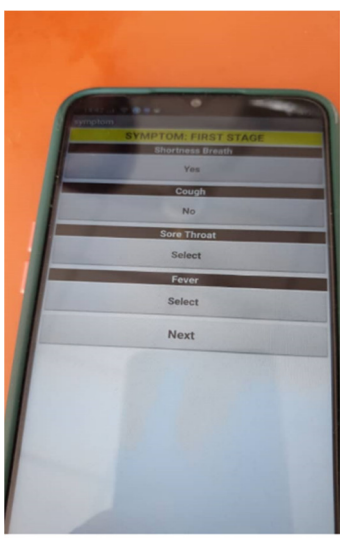

Figure 2a: section b (status of the students)

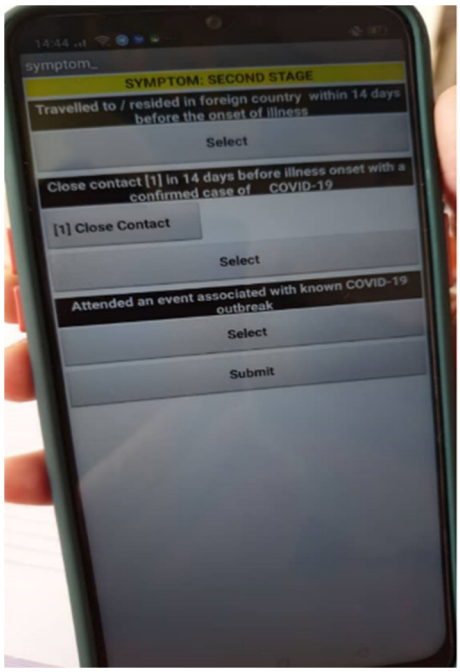

Figure 2b: section c (disease of the students)

4.2 TEMPERATURE

One of the screening techniques for individuals with COVID-19 is by using temperature measurement. In this paper, we are proposing an Artificial Intelligence (AI) algorithm for the temperature screening process using an Infrared Thermal camera device. The development of AI algorithm involves automated multiple measurements of body temperature for rapid and high degree of screening accuracy. An industrial standard thermal camera will be connected to our AI engine to establish an algorithm by implementing a real-time deep learning detection in which the positioning of bare human body can be easily measured. The parameters such as the distance of an individual, human body physical condition, the surrounding temperature will allow a simultaneous processing of a large number of individuals. Any object with a temperature above absolute zero emits a detectable number of radiations. The thermal camera converts IR radiations into grey value and establishes the accurate corresponding relation between grey value and temperature through the temperature measurement algorithm model. The model (Temperature Gray Level Curve) is obtained by black-body calibration. Figure 3 illustrates the thermal detection temperature screening.

Figure 3: Temperature Screening Study

The advantages of these high-speed data processing capabilities are:

- High Efficiency: It takes only one second for the thermal camera to measure the temperature for each person. Thus, no congestion will be made when passing through the temperature screening site.
- Safety: Thermal camera supports non-contact temperature measurement which can accurately measure the temperature from 2.5 meters away. This eliminates the risk of direct contact transmission.

4.3 Heart Rate

A heart rate monitoring by using the bracelet will be added along with temperature measurement in high risk students. We will use KNN algorithm method. The author (Helmi et al., 2020) has developed the heart rate measurement using K-Means for monitoring ISA students in USIM. He classified it and showed the student activities during classes. The *k*-nearest neighbours (KNN) is one of the furthermost simple classification methods especially in analyzing a huge matrix of features or providing recommendation (Tarus et al., 2018). Pseudocode provides the normal stages of applying the KNN.

Input:

$D = \{d1, d2, \ldots., dn\}$ //set of n data items
k //number of desired clusters

Output:

A set of k clusters

Steps:

1. *Arbitrarily choose k data items from D as initial centroids;*
2. *Repeat*
    a. *Allocate each item d1 to the cluster with the nearest centroids (Equation (1));*
    b. *For each cluster, calculate the new mean*
    c. *Calculate the junction among clusters to keep the k number of clusters*

***Until** convergence criteria are met.*

Algorithm1 : KNN Psuedo code.

The KNN equation is as below:

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} |x_i^{(j)} \quad c_j|^2$$

Equation 1

In Figure 4 show the example of the output capturing from MI band 4.

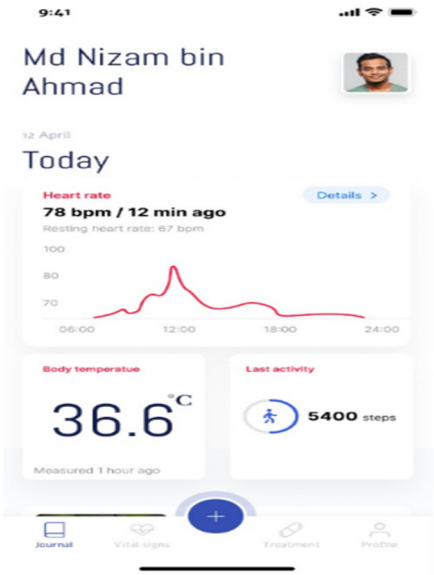

Figure 4: The temperature and heart rate

4.4 Movement

The students movement data and location will be tracked from their smartphone using the university Wi-Fi network (Narzullaev et al., 2020). This information also allows us to identify their daily physical activities in order to exclude the physiological increased of heart rate especially when they are engaged in physical activities such as jogging and playing sports. Figure 5 shows the illustration of the connectivity in the tutorial classroom. For example in tutorial room BR 1019, the red color shows the student with the symptom. The color in blue shows the student that might be infected because of sharing the same Wi-Fi devices. But another color is normal color because it connected to difference Wi-Fi devices. This show the location of the individual students based on the nearest Wi-Fi devices.

4.5 Risk Assessment

In the University, we develop a Covid19 risk assessment and mitigations for students registration. Risk assessment is one of the major developments for Covid-19 to ensure the University health care is prepared to handle the infection. The risk mitigatios requires the usage of four applications. Table 3 presented each application for students to install. Risk mitigations for each risk category when the students are already in campus or in their housing are show in Table 3.

Table 3: Risk Mitigations for Each Risk Category

High
1. Temperature check ASAP at University Health Center.
2. If High temperature. *Mitigation:* • *Quarantine* • *Wear bracelet* • *Download and activate Contact Trace Apps.* • *Check temperature every day*
3. If Normal temperature: *Mitigations:* • *No quarantine* • *Wear bracelet* • *Download and activate Contact Trace Apps.* • *Check temperature every day*

Medium	**Low**
1. Temperature check ASAP at University Health Center	1. No temperature check at University Health Center
2. If High temperature. *Mitigations:* • *Quarantine* • *Wear bracelet* • *Download and activate Contact Trace Apps.* • *Check temperature every day*	*Mitigations:* • *No quarantine* • *Wear bracelet* • *Download and activate Contact Trace Apps* • *Check temperature every week.* • *Educate on emergence of symptoms and the need to get medical treatment ASAP*
3. If Normal temperature: *Mitigations:* • *No quarantine* • *Wear bracelet* • *Download and activate Contact Trace Apps.* • *Check temperature every week*	

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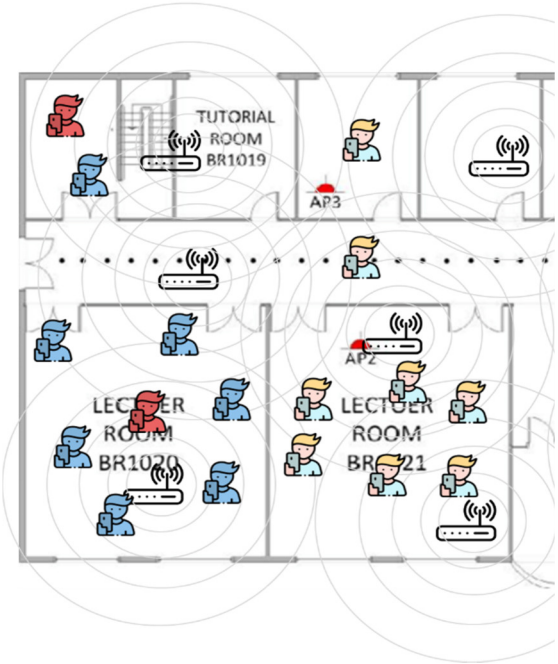

Figure 5: Illustration of the Classroom

5. CONCLUSION

Students are potential carriers of COVID-19 and universities should develop an effective screening framework to minimize the viral transmission. Our framework consists of 4 components i.e. temperature measurement, heart rate monitoring, movement tracking and risk assessment for the mitigation guideline.

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