FRANKFURT
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OF APPLIED SCIENCES

Tracing COVID-19 Infected Persons and alerting other people to keep safe distance

Group "C"

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ABSTRACT:

Coronavirus disease (COVID-19), a contagious disease caused by a newly identified coronavirus.[1] The COVID-19 virus spreads through droplets of saliva or discharge from the nose of an infected person. The best way to prevent this is to keep 1.5 meter distance from another Covid-19 patient. Our web based application gives alert to people if there is any Covid-19 patient nearby you. There has been significant effort to increase the safety of this system through design specifications to foresee potential hazards, mitigate them and then make necessary changes by redesigning to address these issues.

Keywords: COVID-19 track and alert, web application, safety critical system, hazard analysis.

Table of Content

1. INTRODUCTION

The project development is based on safety critical measures to track corona virus infected people within a specific area and alert users to keep a safe distance. Using this system, a user can get accurate results of the healthy status of persons that he/she got in contact with at different times and certain distances since the system monitors users.

The development process passed through hazard analysis, Systems Theoretical Accidents Modeling and Process as well as formal methods and other different techniques to identify different weaknesses or erroneous behavior that could possibly arise and these were handled appropriately.

Corona virus is deadly and dangerous, so the security and availability of the system are another prior factor that are exhibited in the development process. The users will be able to get accurate results from the application based on different people that are nearby and hence the safety of users is not compromised.

2. CONCEPTUAL FRAMEWORK

The Covid-19 application is a web based software application which has a safety functionality of tracing infected people and notifying users to keep a safe distance.

3. TASK DISTRIBUTION

From the beginning, we have divided our tasks among our group members according to feasibility and expertise, collaborating with each other with their knowledge and skills. This distribution helps us to enhance our knowledge and mutual understanding among the group members.

No	Task	Member-in-charge
1	Requirement Analysis	Anik Saha, Sanjeeb Kumar Panjiyar
2	Project Management	Anik Saha, Md Imran Hossain, Md Imtiaz Ahmed
3	Design	Md Imran Hossain, Sserunkuma Ivan, Sanjeeb Kumar Panjiyar
4	Implementation	Anik Saha, Md Imtiaz Ahmed

5	Model Analysis	Anik Saha, Md Imran Hossain, Sanjeeb Kumar Panjiyar
6	Safety plan	Md Imran Hossain, Anik Saha
7	Fault Tree Analysis	Md Imran Hossain, Anik Saha
8	STAMP	Md Imran Hossain, Anik Saha
9	HMI Designing	Md Imtiaz Ahmed, Anik Saha
10	Test Cases	Sanjeeb Kumar Panjiyar, Md Imran Hossain, Sserunkuma Ivan
11	Documentation	Md Imran Hossain, Anik Saha, Md Imtiaz Ahmed, Sanjeeb Kumar Panjiyar, Sserunkuma Ivan

Table 1: Task Distribution.

4. **REQUIREMENT ANALYSIS**

Software requirement is a functional or non-functional feature that should be incorporated within the software. Functional means providing the customer a particular service.

4.1 FUNCTIONAL REQUIREMENT

For tracing COVID-19 infected persons and alerting others to distance, we implemented the following requirements:

The project has two parts. One part is for admin and another part is for general users.

1. **USER PART:**
   i. **Registration:** User should fill up his First name, Last name, Phone Number, Id Number/Passport Number, Email Address, Password for registration.
   ii. **Login:** Users can login by giving Email and Password.
   iii. **Consent:** User should give consent for taking user's current location data.

      iv. **Tracking**: When user logged in, the system will track user data by taking their latitude and longitude after every 5 min. System will get latitude and longitude by using GPS.

      v. **Alert Function**: The application will calculate the data from latitude and longitude, and will give users an alert based on distance calculation to nearby users.

2. **ADMIN PANEL:**

      i. **Mark / unmark:** Admin can mark a user as COVID-19 positive or negative based on the medical report of a registered user.

      ii. **Search:** Admin can search a user by Name, Email or ID.

4.2 NONFUNCTIONAL REQUIREMENT

- **Security:** Only admin can mark/unmark users as COVID-19.
- **Safety:** System can alert users properly nearby COVID patients.
- **Server Strategy:** For stopping accidental hazards, we will use two backend web servers and database servers.

4.3 TECHNICAL REQUIREMENT

Backend Technologies: C#, ASP .NET Core 3.
Frontend Technologies: JavaScript (Vue.js), Bootstrap 4, Datatable.
Frontend Technologies: Microsoft SQL Server
Source Control: Git
Source Repository: https://github.com/saha-anik/Covid19Alert

4.4 USER REQUIREMENT

Browser Support: Chrome, Firefox, Edge, Safari.
**Platform:** Windows, Mac, Linux, IOS, Android

5. PROJECT MANAGEMENT

Task	Planned Start	Planned End	Planned Duration	Actual Start	Actual End	Actual Duration	Status	May 17-23 May	May 24-30 May	June 31 May-6 June	June 7-13 June	June 14-20 June	June 21-27 June	July 28 June-4 July	July 5-11 July	July 12-17 July
Project planning	17 May	23 May	7	17 May	30 May	14	Done	▓	▓							
Requirement anaysis	24 May	30 May	7	24 May	30 May	7	Done		▓							
Risk Analysis	31 May	6 June	7	31 May	6 June	7	Done			▓						
Hazard Analysis	7 June	13 June	7	7 June	20 June	14	Done				▓	▓				
UML Design HMI DESIGN	14 June	20 June	7	14 June	27 June	14	Done					▓	▓			
Mathematical Model & Estimation	21 June	27 June	7	21 June	27 June	7	Done						▓			
Coding	31 May	28 June	28	31 May	4 July	35	Done			▓	▓	▓	▓	▓		
Development	28 June	4 July	7	7June	4 July	7	Done							▓		
Testing	5 July	11 July	7	28 June	12 July	14	Done							▓	▓	
Documentation	12 July	16 July	7	5 July	16 July	14	Done								▓	▓

Project Management

6. PROCESS MODEL

Agile is a combination of iterative and incremental process models that helps teams deliver software products more quickly with priority of satisfaction.
Scrum is considered one of the popular agile frameworks. We used scrum to implement our project. A scrum project has roles, artifacts, and events.
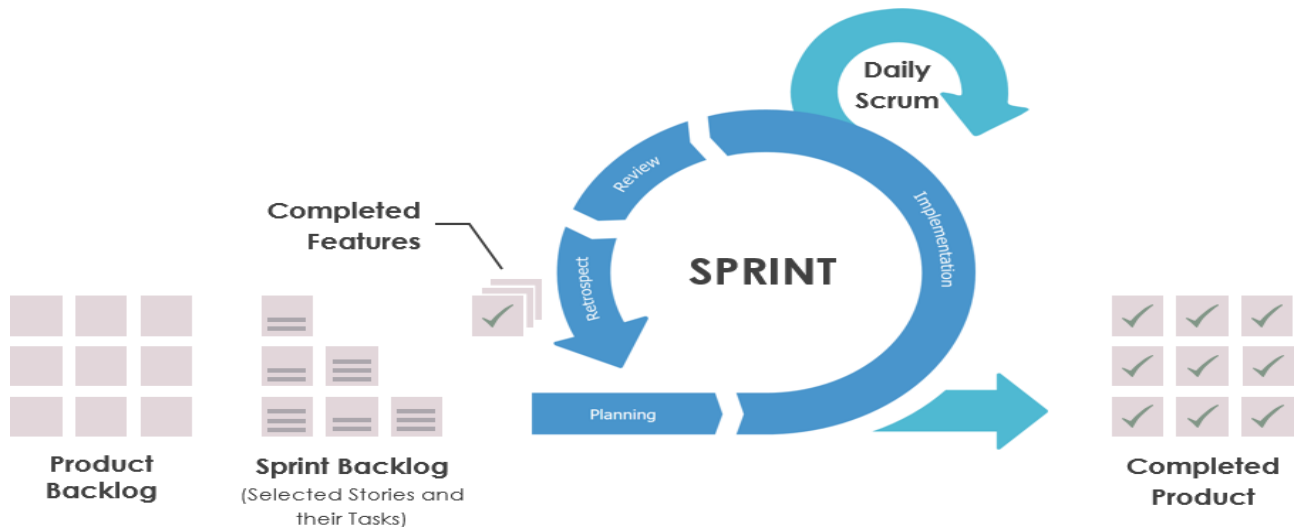
6.1 ADVANTAGE OF FOLLOWING AGILE MODEL

Flexibility: Agile allowed us to adopt changes in our project at every stage, even late changes, and delivered the project on time in a very efficient way.

Speed: It increased speed to complete our tasks frequently like weeks rather than months.

Quality: We constantly tested our software to make sure the right product should be delivered to the customer.

6.2 AGILE METHODS FOR SAFETY-CRITICAL SYSTEMS

Many see formal methods as the holy grail that will eventually allow us to write error-free code that fully meets its requirements, while ensuring that the software is the most reliable component of any system[3].Formal methods have been used in industry over the years [4] , in particular for the implementation of mission-critical systems or safety-critical systems to ensure system correctness and to prove that safety constraints are met.

The consumer is actively involved in the development process, to ensure that the correct functionality is developed. And agile approaches can be interpreted as a way of adjusting the quality of the system to meet user needs while staying within budget and delivering on schedule.

7. **MATHEMATICAL MODEL**

After studying the information published by the World Health Organization [1], we presume that if a COVID-19 negative person is standing within one meter of a person with COVID-19, it can easily be affected by COVID-19. People having COVID-19 release droplets of infected fluid while coughing or exhaling. Most of these droplets land on nearby surfaces and objects. Through touching polluted surfaces or objects, People have a higher chance to have COVID-19. In that way we can say that COVID-19 spreads in a similar way to flu.

For distance calculation we use the STDistance method of Microsoft SQL Server [2]. This method returns the shortest LineString between two geography types. This is a close approximate to the geodesic distance.

Based on the information, we calculate the distance of a person with each person having COVID-19. If the distance is less than 2-meter range, he will get an alert on our website. The person having COVID-19 or not will be marked by Authorizer.

Number Of COVID-19 People Around You= NPA2MR ∩ NPHC19

NPA2MR=Number of People Around in 2-meter range

NPHC19= Number of people Having COVID-19

8. **SAFETY PLAN**

Sr no:	Functionality	Failure Mode	Failure Effect	Potential cause	Safety measure
01	User Interface	The required user data will not be displayed	None of the available data is propagated by Machine	Complex design with less testing	All features must be checked with proper Exception handling. And our Testers must be appropriately trained with information about the features of the system.
02	Login	User unable to login our system	Unable to access personal profile	forgot password/username/email address	Users must have the password reset link to their registered email address.
03	Data Update	App feeds of old geographic data.	User is unaware of updated information	Auto Refresh failure	Data update should be conducted on schedule with appropriate time intervals.

| 04	Data access	Unable to access the network by authorized users.	Diminished user experience	DB server down, Web Server down, multiple user requests at a time.	Setup cluster database, Setup second web server, load balance, and established and tested limit values for number of requests
05	Alert	The user did not get alert to the nearby location of the COVID-19 patients.	The reliability of the system should be reduced.	Data format mismatch from that stored in the database to the format used for updating the data.	Mismatch in data format from that contained in the database to the format used to update the data.

9. HAZARD ANALYSIS

In our system, we have found several hazards that may arise from unwanted consequences. Besides, inaccurate updating of the database and downgrading the server may be the potential hazards of our system. For example, it could be difficult to assess nearby patients if an unwanted person updates the details that he / she is a COVID-19 patient or a patient unidentified as a COVID-19 negative. Also a great thread of our system is some database and DB server down issues because it has to accommodate a large amount of people inside the system.

9.1 FAULT TREE ANALYSIS

Some hazardous situations are identified below according to FAULT TREE ANALYSIS [1] by which potential hazards can be classified. FTA method provides a means of eliminating these risks from the system. And by this FTA [5], it offers a graphical representation of potential hazards.

There are two connectives used in this method, one is AND connective which is used to combine all the factors affecting the failures. Whereas *OR* connective uses at least one hazard to influence the failures [6].
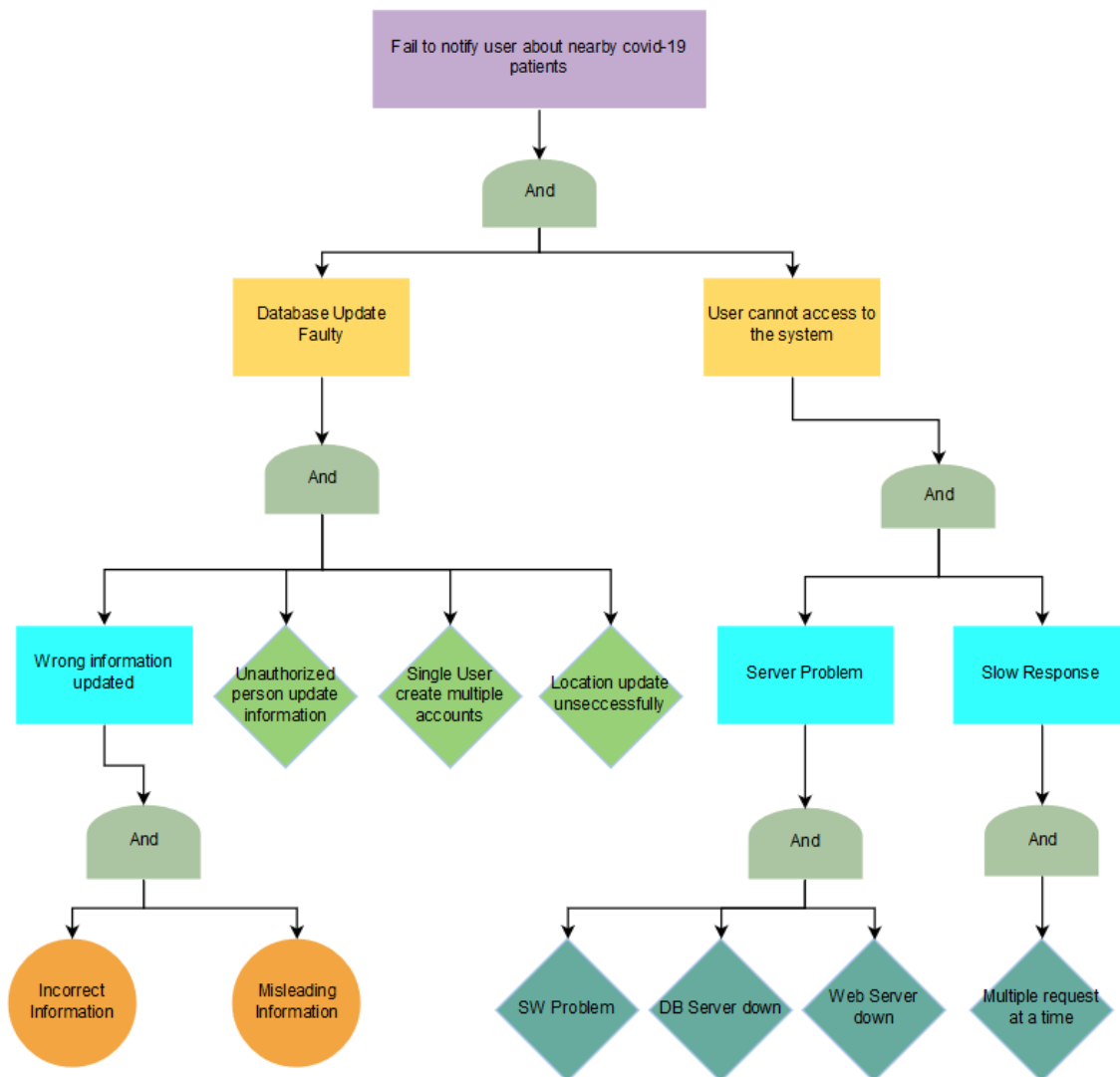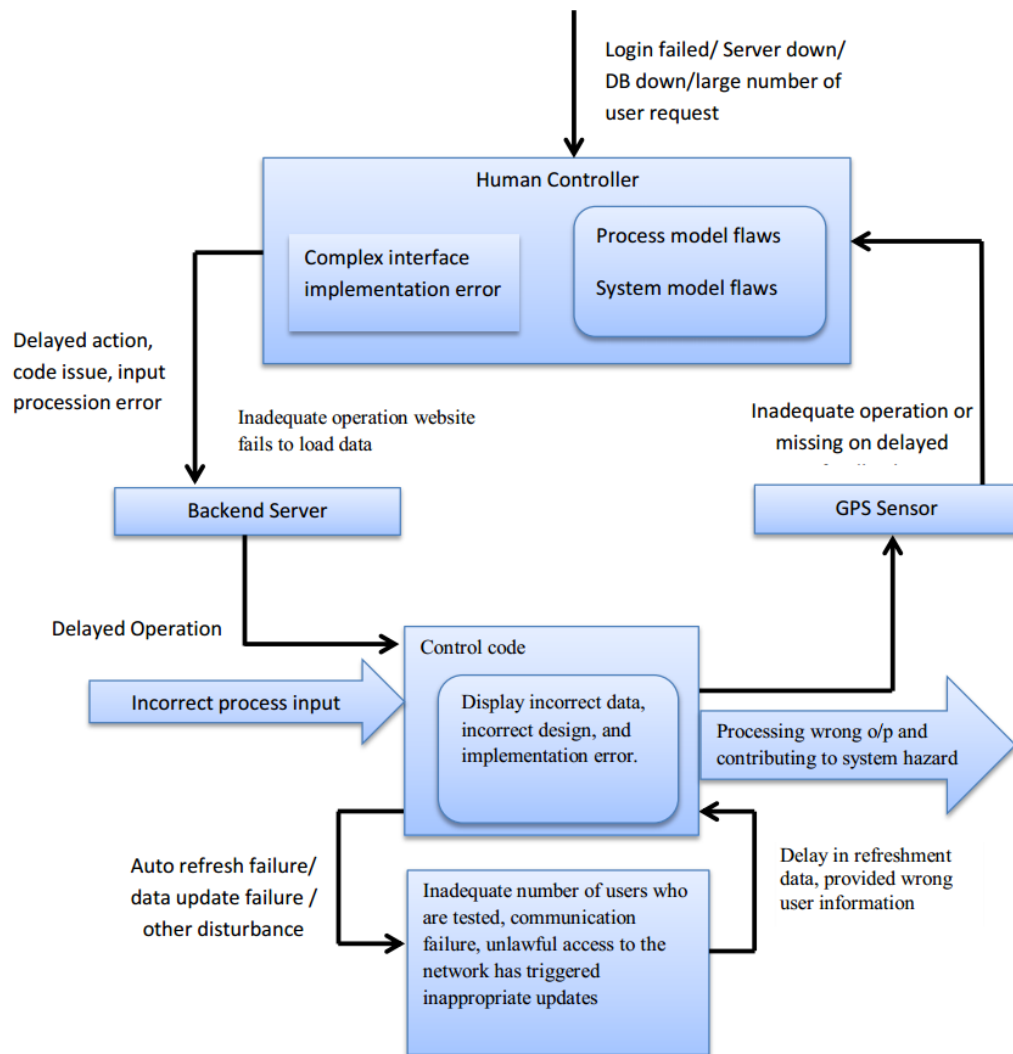
Fault Tree Analysis

9.2 SYSTEMS-THEORETIC ACCIDENT MODELING AND PROCESSES (STAMP)

 STAMP is a modern method of finding system hazards. STAMP may be used to evaluate accidents and recommend observations which may be necessary to reflect and convey the mechanism leading to the accident [2].

In STAMP, accidents are conceived not as a result of component failures but as a result of inadequate control or compliance of security-related constraints on system development, design and operation [2]. Safety can be seen as a control problem, and incidents arise when device failures, external disturbances and/or unstable interactions between components of the system are not treated properly.

Process model: Process model is one of the basic concepts of STAMP. The figure below shows a typical control loop of our system.

STAMP (Control Structure Diagram)

Login failed/ Server down/ DB down/large number of user request

Human Controller

Complex interface implementation error

Process model flaws

System model flaws

Delayed action, code issue, input procession error

Inadequate operation website fails to load data

Inadequate operation or missing on delayed

Backend Server

GPS Sensor

Delayed Operation

Incorrect process input

Control code

Display incorrect data, incorrect design, and implementation error.

Processing wrong o/p and contributing to system hazard

Auto refresh failure/ data update failure / other disturbance

Inadequate number of users who are tested, communication failure, unlawful access to the network has triggered inappropriate updates

Delay in refreshment data, provided wrong user information

HAZARDS MAPPING AND SAFETY CONSTRAINTS AND REQUIREMENTS

| Hazard	Hazard Mapping	Safety Constraints	Safety Requirements
H1: Incorrect Database Update	1. Unauthorized person update information 2. Single user creates multiple accounts. 3. Update wrong information.	SC1: Database is maintained by an authorized admin. SC2: Every user have to give their unique ID (Passport id or national id)	SR1: Database must be updated by current data

| H2: System doesn't show specific information	1. DB Server Down 2. Web Server Down 3. Implementation error 4. SW problem	SC3: Setup cluster database SC4: Setup second web server SC5: Load balance	SR2: System must have an availability of 99.99%
H3: User doesn't access the system	1. Multiple users request at a time. 2. User forgot password 3. System returns incorrect response	SC6: Apply backend pagination SC7: User can request password through email	SR3: System should be easily accessible

10. DESIGN
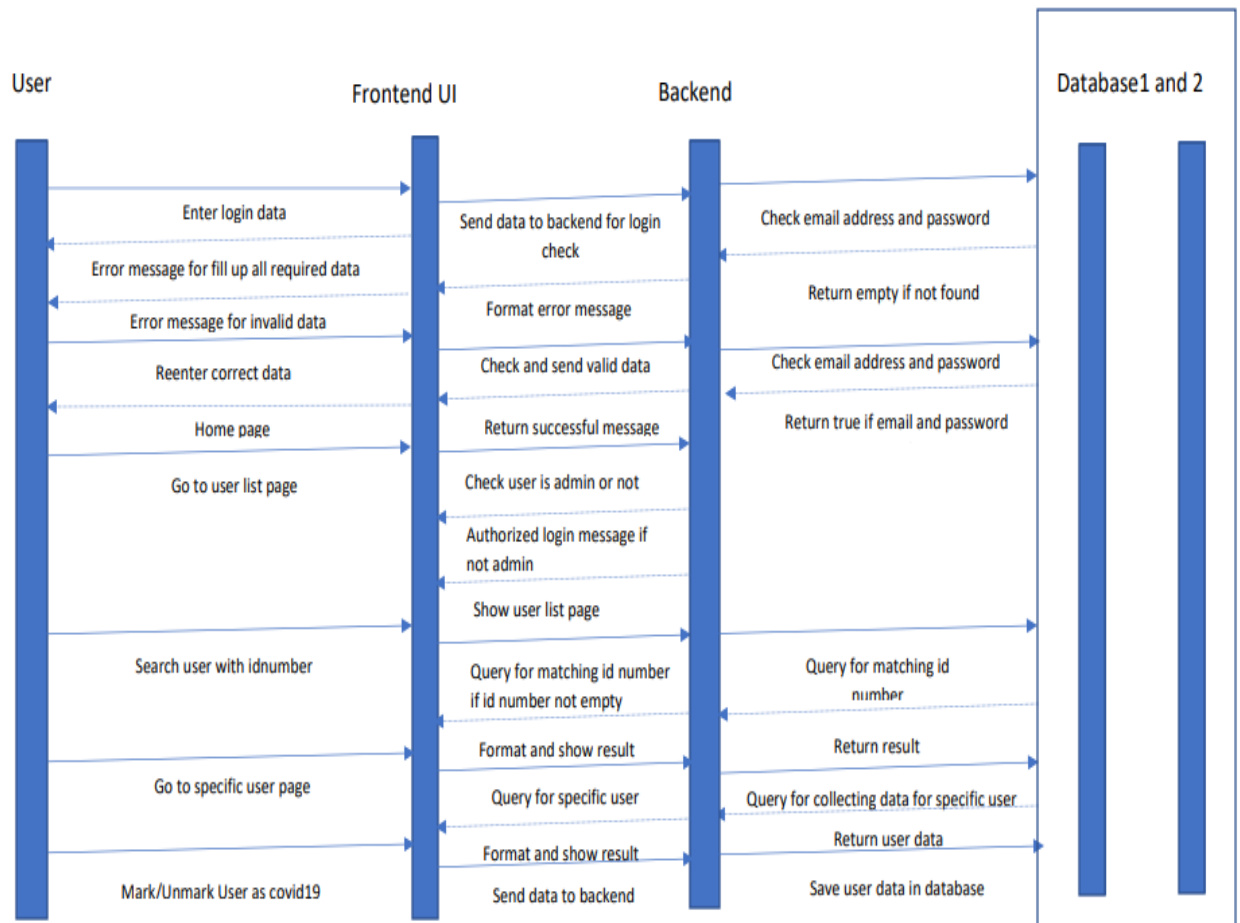
10.1 USE CASE DIAGRAM
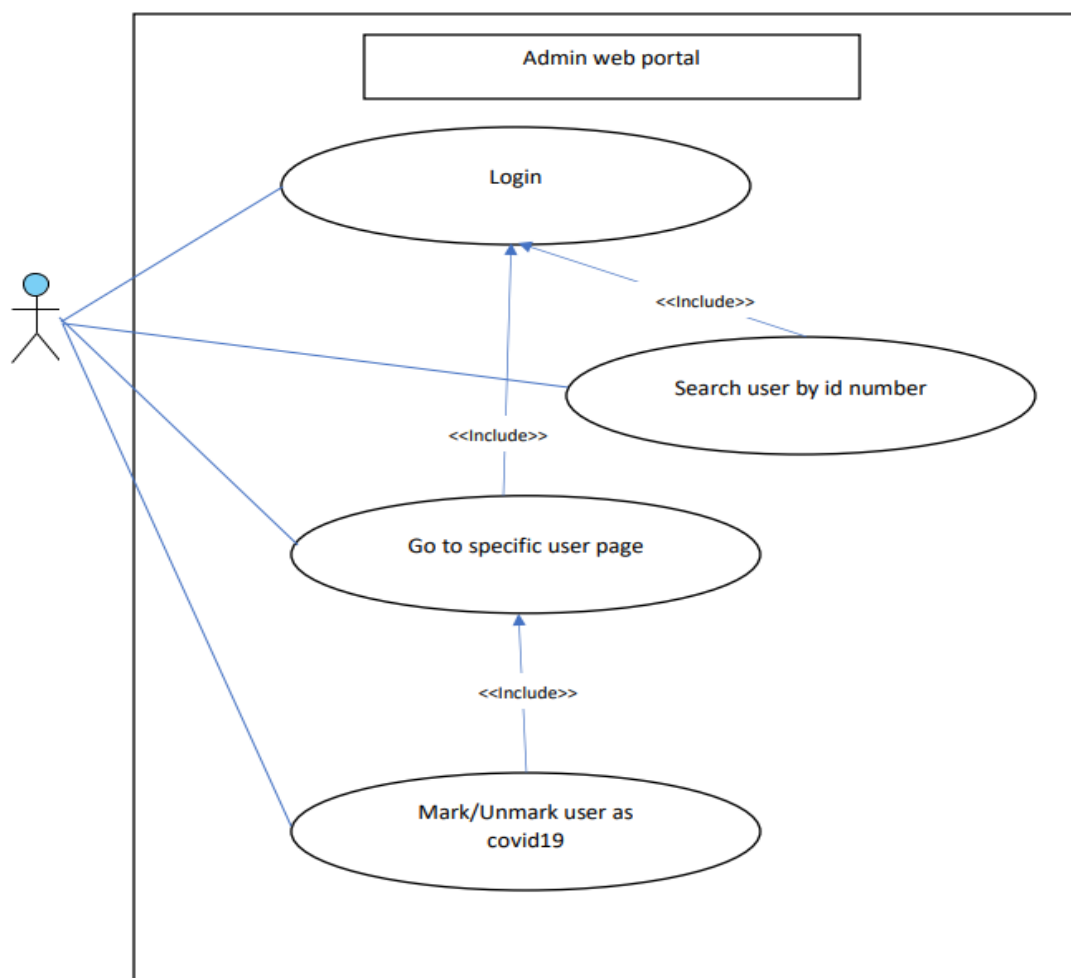
Use case diagram for admin
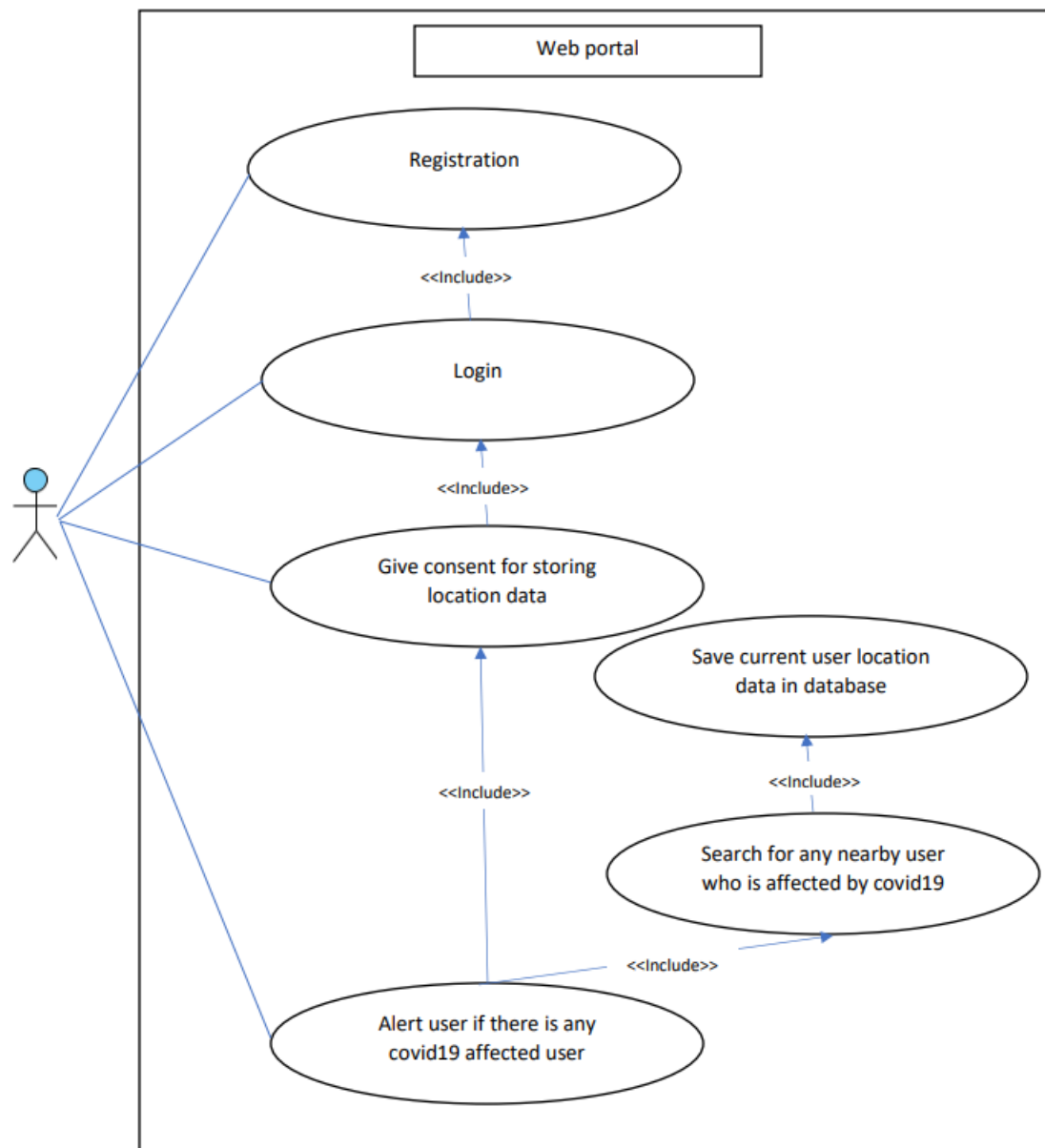
Use case diagram for normal user

10.2 SEQUENTIAL DIAGRAM
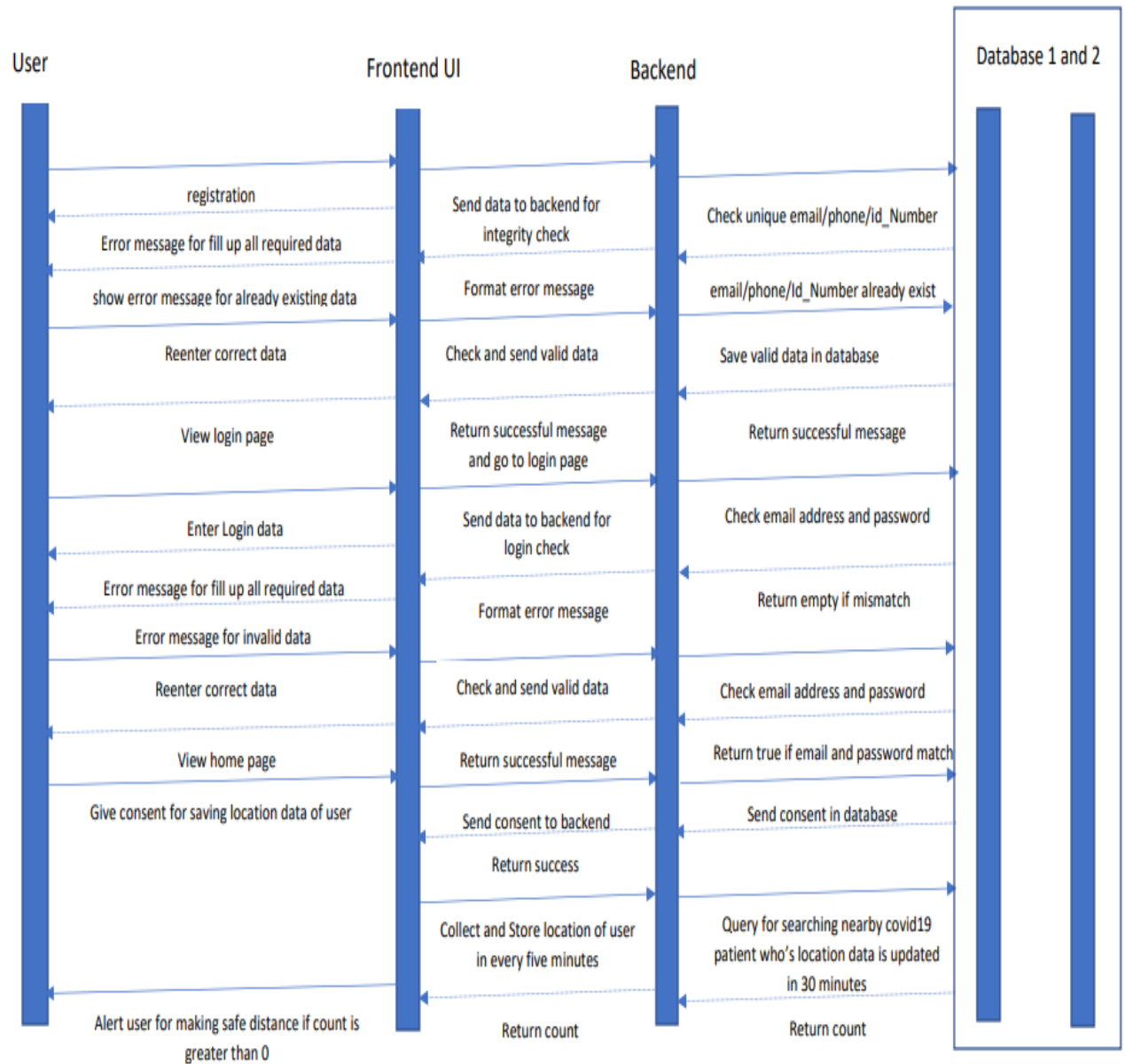
Sequential diagram for user

Sequential diagram for admin user

10.3 HMI

The design presented in this work includes complementary internal and external HMI, where the internal interface manages information about the users COVID status , location and other data, and the external interface will show the information to the user and will give alert .

EXTERNAL INTERFACE

User part:

Following screenshots of users registration, login

Covid19 Alert System
Registation

First Name *

Last Name *

Email *

Phone *

IdNumber *

Password *

Confirm
Password

[Registration]

Covid19 Alert System
Login

Email *

Password *

[Login]

Following screenshots of Consent Given and Notification Part:

Welcome

Please give permission to get your location!

[Give Location Permission]

Welcome

NearBy Covid19 Patient!

Admin part:
Following screenshots of admin login, COVID-19 positive or negative user list.

Show 10 entries   Search: [   ]

ID Number	First Name	Last Name	Phone Number	Email Address	Covid Status	Profile
123456	Sanjeeb	Saha	+4917384423234	sanjeeb@gmail.com	✗	Unmark
12345678	Anik	Saha	+491748482960	shantunusaha@gmail.com	✔	Mark
1234567890	Anik	Saha	+491748482961	aniksaha@gmail.com	✗	Unmark
23456	mou	saha	+490178336362	mousaha@gmail.com	✗	Unmark
234567890	Imran	Haldar	+49174568930	imran@gmail.com	✗	Unmark
23456Y75432	test	test	123456770765	teeteet@tetete.com	✗	Unmark

Showing 1 to 6 of 6 entries   Previous   1   Next

11. SOFTWARE TESTING

11.1 FUNCTIONAL TEST CASES

User Panel	Test	Admin Panel	Test	Status
APP	-verify if the user has installed the app to access the Internet.	**Database**	-Verify the database is working properly.	**Success**
Registration	-Verify if the user has entered the correct First Name and Last Name,Phone Number, Email Address and ID Number. -Verify if the user has entered the Password and Confirm Password is the same or not. -Verify for the both when fields are blank and the "Registration" button is clicked.	**Verify user**	-verify if the user has agreed to the consent to take location data. -Letter to sent and signed by the user is correct	**Success**
Login	-Verify if the user will be able to login with valid email and valid password. -Verify if the user cannot login with valid email and invalid password. -Verify if the user is able to login with a new password only after he/she has changed the password.	**Mark**	-Mark the infected people as COVID-19 after the diagnosis.	**Success**
COVID-19 Tracking	-Check the GPS is enabled in the device of every user. -Detect the infected people within the range of the people to people contact after every 5 minutes. -Fetch the information from the database.	**Unmark**	--Unmark the infected people not as COVID-19 after the diagnosis.	**Success**
COVID-19 Alert message	-Alert messages to the people who came in contact with infected people.	**Search**	-Verify if the provided Name. Email and IN number are correct.	**Success**

11.2 NON-FUNCTIONAL TEST CASES

Requirement	Test Cases	Status
Security	-Verify if the admin can mark/unmark users as COVID-19	**Success**
Safety	-System can alert users properly nearby co COVID-19 patients	**Success**

Technical	-Verify it the app had data economy, unlink ability, communication, traceability and alert functionality.	**Success**
Error Tracking	-Verify if the user has correct COVID-19 Status. -Verify if the user has their own profile saved in the database.	**Success**

12. FUTURE PLANNING

In future we will add another role named approver. So when the admin checks the patient data and marks or unmarks the patient, another person can check validity of the data. Also when we have lots of data of the user's current location, in future we will show the data on map view.

13. CONCLUSION

Since the app gives the idea to trace the infected people and alert other people when they come in contact with infected people. To conclude the report, it is a web application that consists of a user and admin panel along with the database. The user part allows the people to register and login as a logged user to establish a connection with the application. The COVID-19 status is checked by our admin panel and the data of every person is recorded and kept safe. To track the people to people contact we have used GPS technology to check the location of the people and to locate the exact place when infected people come in contact with the infected and after diagnosis, we can alert a message in the user device as a COVID-19 Status either positive or negative. For maintaining the safety-critical aspect of the application, we have designed the model regarding requirement analysis, safety plan, and risk analysis through the UML diagram, use case and sequence diagram. The application used the Fault Tree Analysis and STAMP for the hazard analysis. It used several safety constraints and safety requirements related to hazard analysis and maintain the hierarchy system to develop better and effective safety-critical systems. We developed some mathematical models and Human Machine Interface to cope with the app. Thus, through all the implementation of safety-critical aspects and requirements, we developed the web application for tracing COVID-19 patients.

14. REFERENCES

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