Automatic Accident Detection and Rescue System

Software Project-1

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30th December, 2020

Declaration

We declare that this thesis is our original work and has not been submitted in any form for another degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

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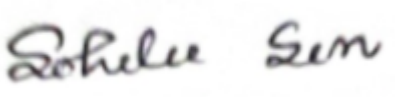

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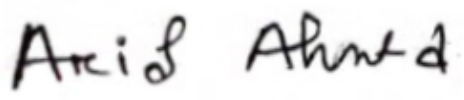

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Approval

The thesis titled "Automatic Accident Detection and Rescue System" has been submitted to the following respected members of the board of examiners of the department of computer science in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science on (30th December,2020) and has been accepted as satisfactory.

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Software Project 1 Project

Report (Fall 2020-2021)

Section: G2

Project Title: Automatic Accident Detection and Rescue System

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1. Introduction

1.1 Purpose

In recent times, road accidents have been a major problem in urban and metropolitan areas of Bangladesh. While the overall trend of fatal accidents is down (Ahmed, 2013), Research also shows that there are major issues with reporting accidents (Ahmed, 2013). It is not too far of a reach to suggest that the number of road accidents will continue to increase as metropolitan areas like Dhaka get more and more congested (Khan et al., 2018, 116-127). However, there are ways to increase the aforementioned rate at which fatal accidents are occurring. More importantly, there are ways to reduce the harm caused by accidents as well as increase the reporting of accidents. This project, titled Automatic Accident Detection and Rescue System, could be one of the ways to address reporting and prevention of road accidents. The abstract idea of this project is to use tools and sensors used in everyday smartphones to Detect, Report, and Provide Help for roadside accidents. The idea is to use a combination of Global Positioning System (GPS), Accelerometer, Gyroscope and other sensor data to detect an accident and then report said accident through Short Messaging Service (SMS) and Global System for Mobile (GSM). Once an accident is detected, the software aims to inform local law enforcement (Police), Fire Service about the location of the accident, as well as provide Hospital and Other information to the victim(s). If an accident is failed to be detected, the software aims to provide a simple and convenient manual way to report the accident and seek help. There exist hardware systems that are available that provide similar functionality but the usage of these devices is not prevalent in developing nations such as Bangladesh. In contrast, smartphone usage is very much prevalent in countries such as Bangladesh, especially in metro areas such as Dhaka. The monetization aspect of this software can be handled through a subscription model where a user pays a very small fee periodically for the service.

1.2 Project Scope

This project aims to save lives from potential death caused by vehicular accidents by providing an easy and effective rescue system to victims. The Automatic Accident Detection and Rescue System will be designed to detect and report accidents to concerned Emergency Response entities such as the local Police Station, Hospitals etc. Due to time and resource limitations, this project will be limited in terms of functionality by means of only informing the Police; in addition, it will be limited in its geographic scope as this version of the software will be limited to work in Dhaka. However, this model will be scalable to a national level and can support

multiple emergency response entities.

2. Overall Description

2.1 Productive perspective

Objectives: The purpose of this project is to implement such an automatic system that uses smartphones to detect vehicle accidents and report it to the closest available responders to assist in reducing the number of deaths in victims of vehicular accidents. The detection system would help reduce fatalities because of vehicle accidents by decreasing the inevitable delay between an occurrence of an accident and the emergency responders being informed. The system also will provide victim information to emergency services like the Local Police department as well as Medical emergency services. In this project, we are utilizing the several sensor functionalities built into most common android smartphones to detect accidents and report it to the closest available emergency responders with the location of victims. On an emergency responder side, the system will inform responders about the incidents that occur close to them and provide them with real time tracking of emergency victims on a map. This can help emergency responders keep track of the victim's location and rescue them as soon as possible.

2.2 User classes and characteristics

User Class	Characteristics
Victim	To ensure the device works properly before going to a drive. And when in danger press the panic button.
Trusted contacts	To get information about accidents and inform family members.
Police officer	To get notification about an accident on the road, send appropriate responders, and/or file a case where a legal matter arises.
Hospital coordinator	To receive an alarm and dispatch an ambulance to the accident spot.
Fire service helpline	To send a rescue team as soon as they receive an alert.

2.3 Operating Environment

This is going to be a “Progressive-Web Application” but the primary target audience is people using Android based systems as the system will behave very close to a native Android application.

2.4 Design and implementation constraints

This system will be implemented using JavaScript, HTML, CSS, React.js and Web APIs. This will allow the application to easily work across multiple device vendors including Android devices that do not support Google services.

Constraints:

Technical Constraints:

Being a web based mobile application, this system will be constrained in the following ways,

- If a mobile phone runs out of battery, the system will not be able to function
- If a device does not contain adequate hardware to allow automatic detection, the system's functionality will be severely crippled.
- Not all areas will have access to Emergency service providers, in such areas the system will have limited functionality
- If the Cell reception is poor in an area, the system will not be able to Properly report an accident

Business Constraints:

The marketability of this product will be limited due to some factors, a primary one being that the general population in Bangladesh may not care much about a system they may never need.

This can be observed by the widespread lack of health, life, and vehicular insurance. However, several products have been able to penetrate the market by changing the business model to where the monthly subscription amount becomes fairly inconsequential to the user.

This, however, means that this project will have to account for low revenues and as such minimize costs in everything including technical abilities of the system.

3. System Features

3.1 Description / Problem Statement

Design and create an automatic accident detection and reporting system. The system should be able to detect an accident automatically, failing that a user should be able to trigger the rescue system manually. Once the rescue system is triggered, it should inform the user's emergency contact of their GPS location and call the local police and medical responders.

3.2 Functional Requirements

- The system should take user information as well as the information of vehicle(s).
- The user should be able to pay monthly for using the system.
- The system should be able detect when an accident happens
    - To a reasonable degree this should be achieved by sensor data
    - A manual override to fix misidentification should be provided
    - A manual way to report an accident, in cases where it is not detected, should be provided
- The system should report accidents to the relevant authorities once detected or manually triggered. The concerning authorities are as follows,
    - Nearest Hospital with an ER (a database of these locations should be maintained)
        - In case a hospital fails to respond, a secondary hospital should be informed after a grace period.
    - Nearest Police station (should be approximated using GPS data)
    - Nearest Fire Service
- The system should inform the user/victim's "trusted contact(s)"

    - User should be given the option to add at least one such contact during the registration process
- The system should be able to detect the speed of a moving vehicle.

3.3 Non-Functional Requirements

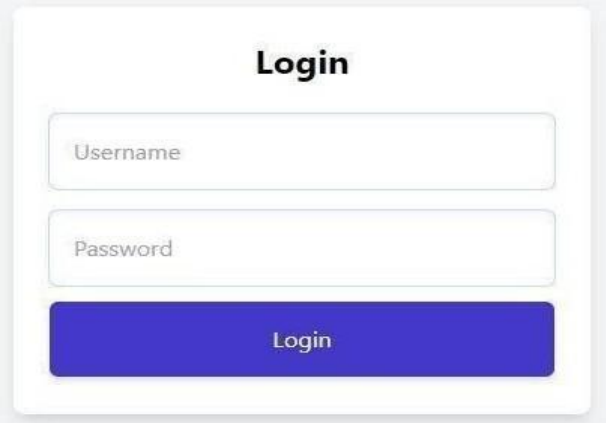
- The registration process should be simple
    - No unnecessary information should be taken from the process
    - A user's authenticity should be verified using a phone number as well as National ID Card number.
    - The user experience should be streamlined (as few steps to register as possible)
- Monthly payments should ideally aim to be automated
    - This can be achieved through tight integration with payment gateways such as bKash
- System should use GPS and Gyroscope data to detect irregular movements and predict to an accurate degree whether an event was an accident
- There should be a clear User Interface shown to the user if an accident occurs so that, in case of false alarms, the user can quickly cancel the emergency response procedure.
- System should integrate with as many emergency care providers through public and private APIs where viable.
- "Trusted Contacts" should be informed when they are being added as a "Trusted Contact"
- If a user's subscription is about to end, they must be informed in advance that their service will be disabled.

4. External Interface Requirements

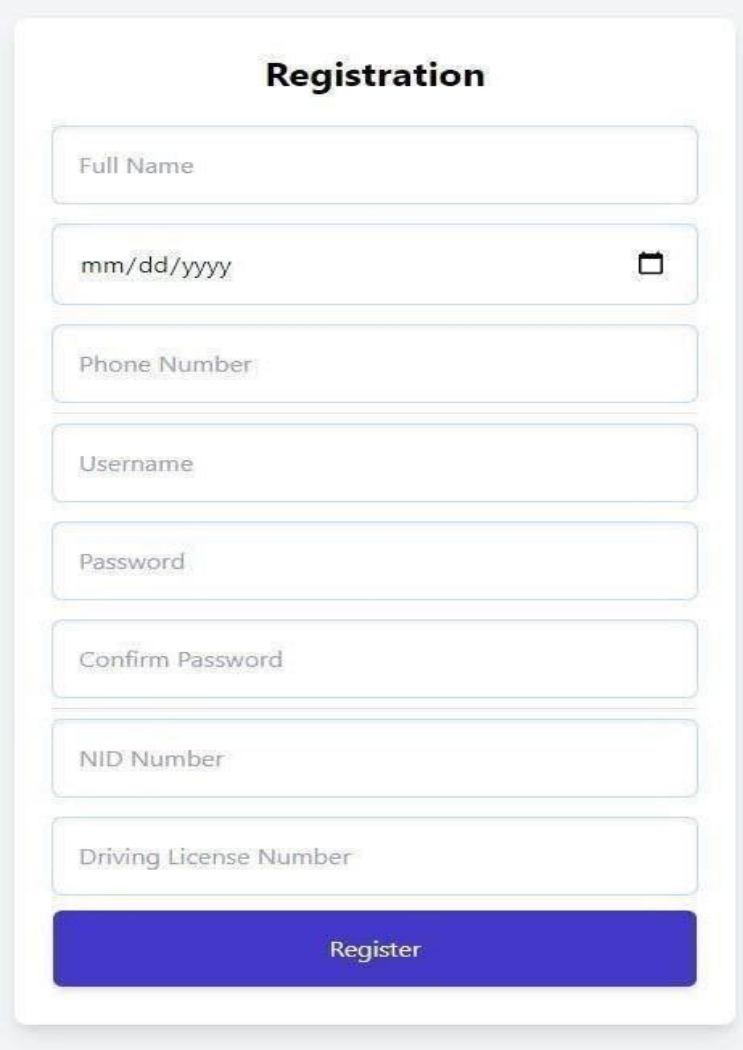
4.1 User Interface

Prototypes:

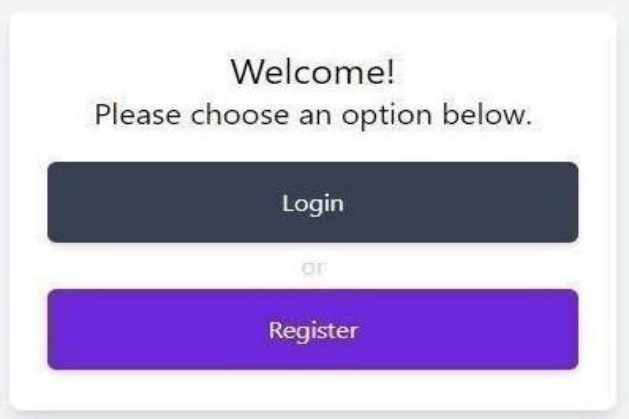
Log in



Registration

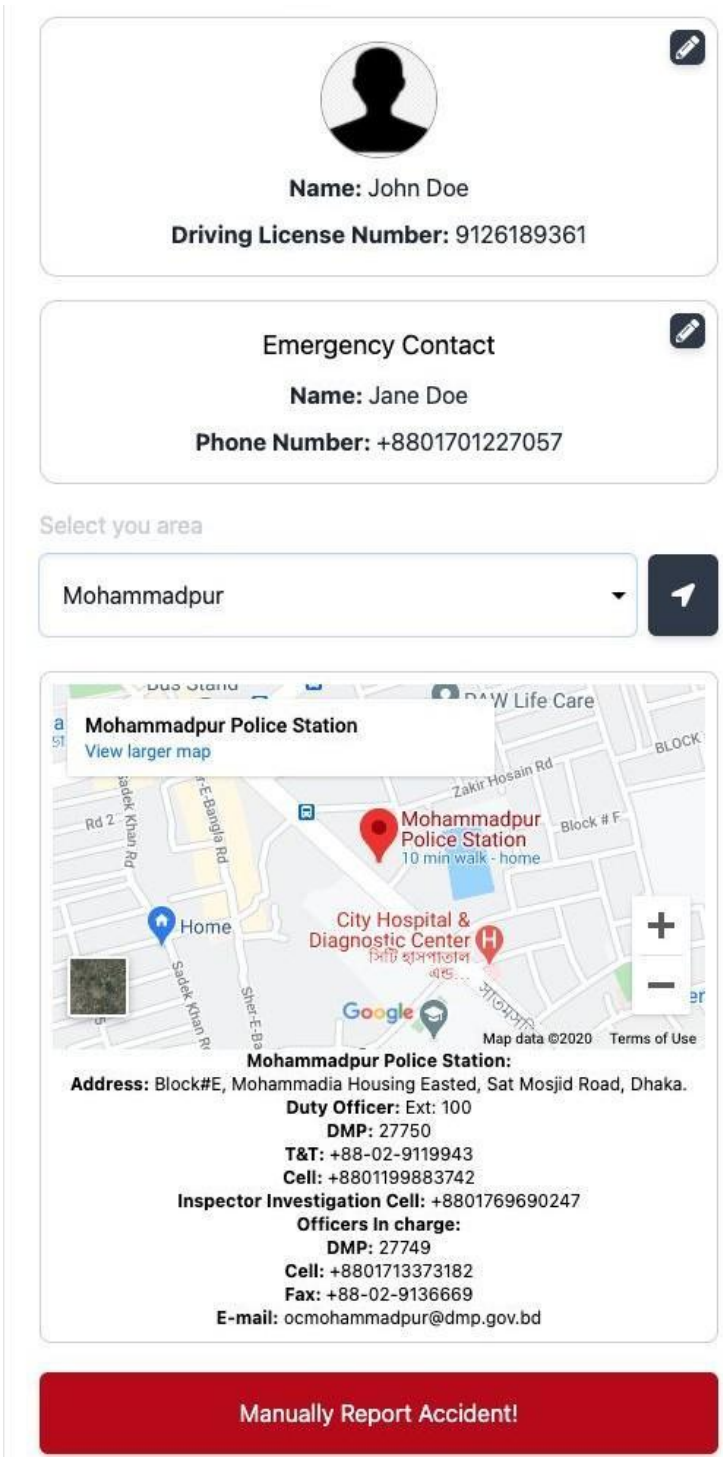


Welcome page:



Accident Detection

Emergency Information:



4.2 Communication interface

Communication interfaces: Phone Call, SMS

4.3 Software interface

Operating System: MacOS, Windows, Android, iOS
Software Used: Visual Studio Code, Node.js, Google Chrome

4.4 Hardware interface

Not a lot of hardware was required for this project. Common hardware like Laptop Computers, Android Mobile Phones were used. These devices were used to develop the software as well as test its working conditions.

A. SMS
   Short Message Service (SMS) is a communications protocol allowing the interchange of short text messages between mobile telephone devices.
B. GSM
   GSM (Global System for Mobile Communications: originally from Group Special Mobile) is the most popular standard for mobile phones in the world
C. Accelerometer
   This sensor reports change in speed of a mobile phone, in our use case we use this acceleration data to detect any sudden changes in acceleration (like those caused by a vehicle collision).
D. Gyroscope
   This sensor reports the orientation of a device in 3D space. We use this in addition to acceleration data to report an accident if a sudden disorientation occurs.
E. GPS
   Global Positioning System: a navigational system involving satellites and computers that can determine the latitude and longitude of a receiver.

5. Quality Attributes

5.1 Usability

Manage your vehicle and check the system: An automatic accident detection and rescue system helps to store important data about the victim and send it to trusted contacts.

Manage accidents & Get situations under control: Get all help from nearby responders We have designed it so that anyone can find help and save his/her precious life.

Get accurate information: This system includes a database of local Police contact numbers that helps you to contact them in case of emergency. One can get this information from the system when an accident is automatically detected or if it was a wrong press you can take

authentic decision by press report accident.

5.2 Performance

- It will give an emergency alert.
- It will give a message to the responders.
- It will find out the nearest police station, fire service, hospital, etc.

- It will ensure best support by contacting family members through trusted contacts. It will inform them about the accident and immediate rescue.
- It will track location coordinates to help ambulances reach the accident spot.
- It will request the police station to respond immediately to an emergency situation.
- It will use built-in sensors to detect an accident in real-time.

5.3 Data Requirements

Logical data model – UML diagrams

Use case Diagram

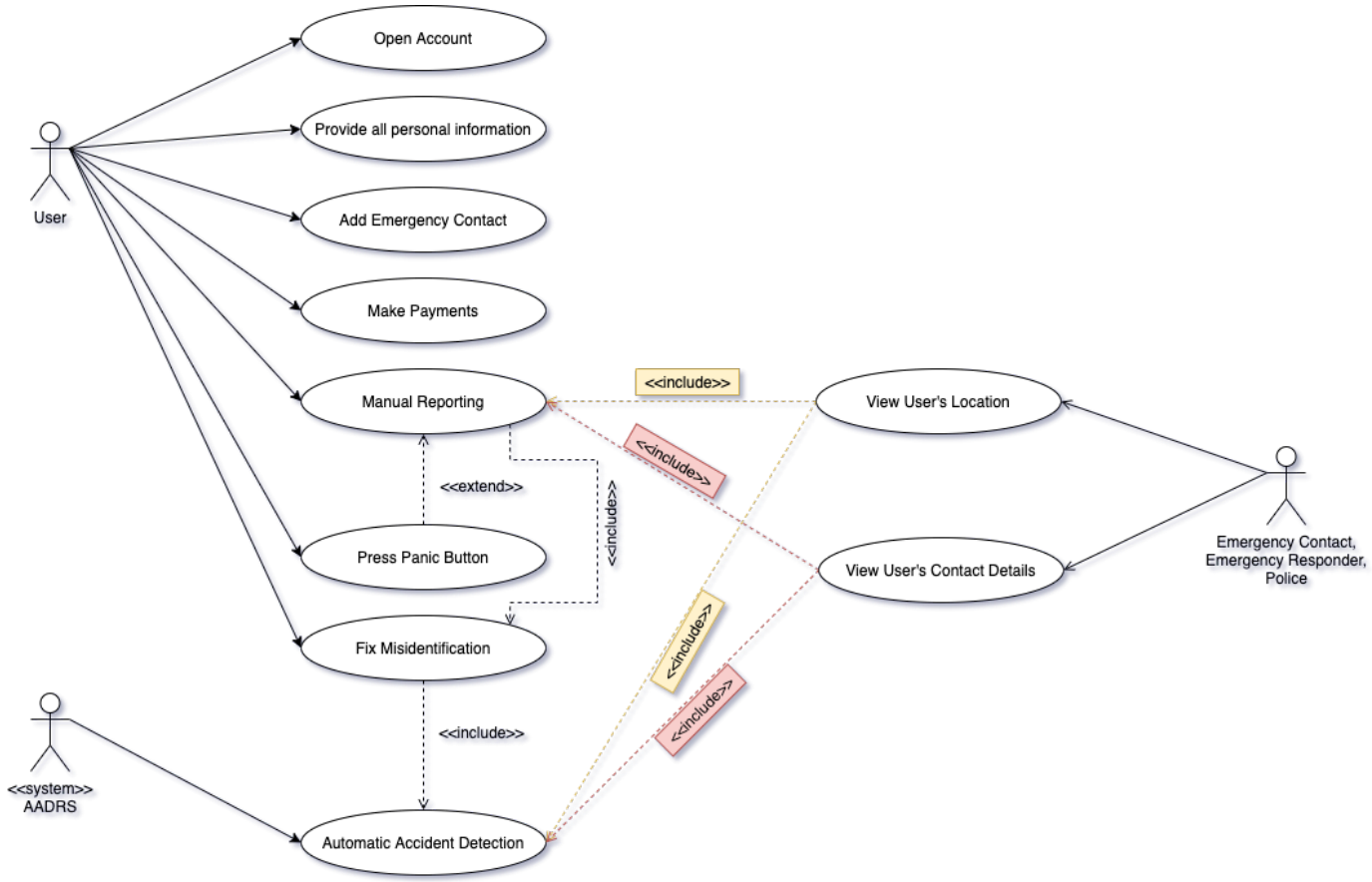


Fig:1 Use Case diagram

Class Diagram

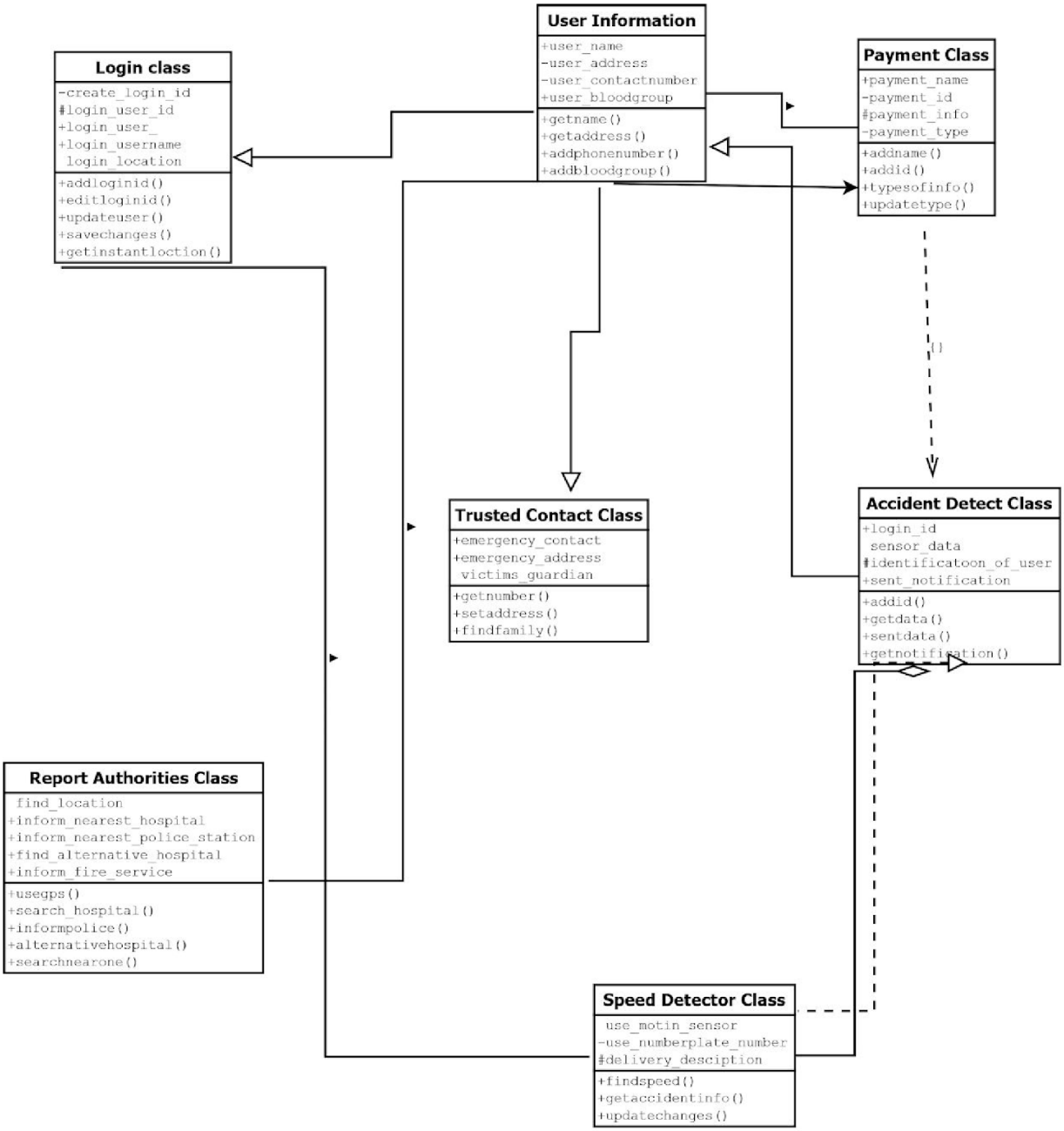


Fig:2 class diagram

Workflow Diagrams

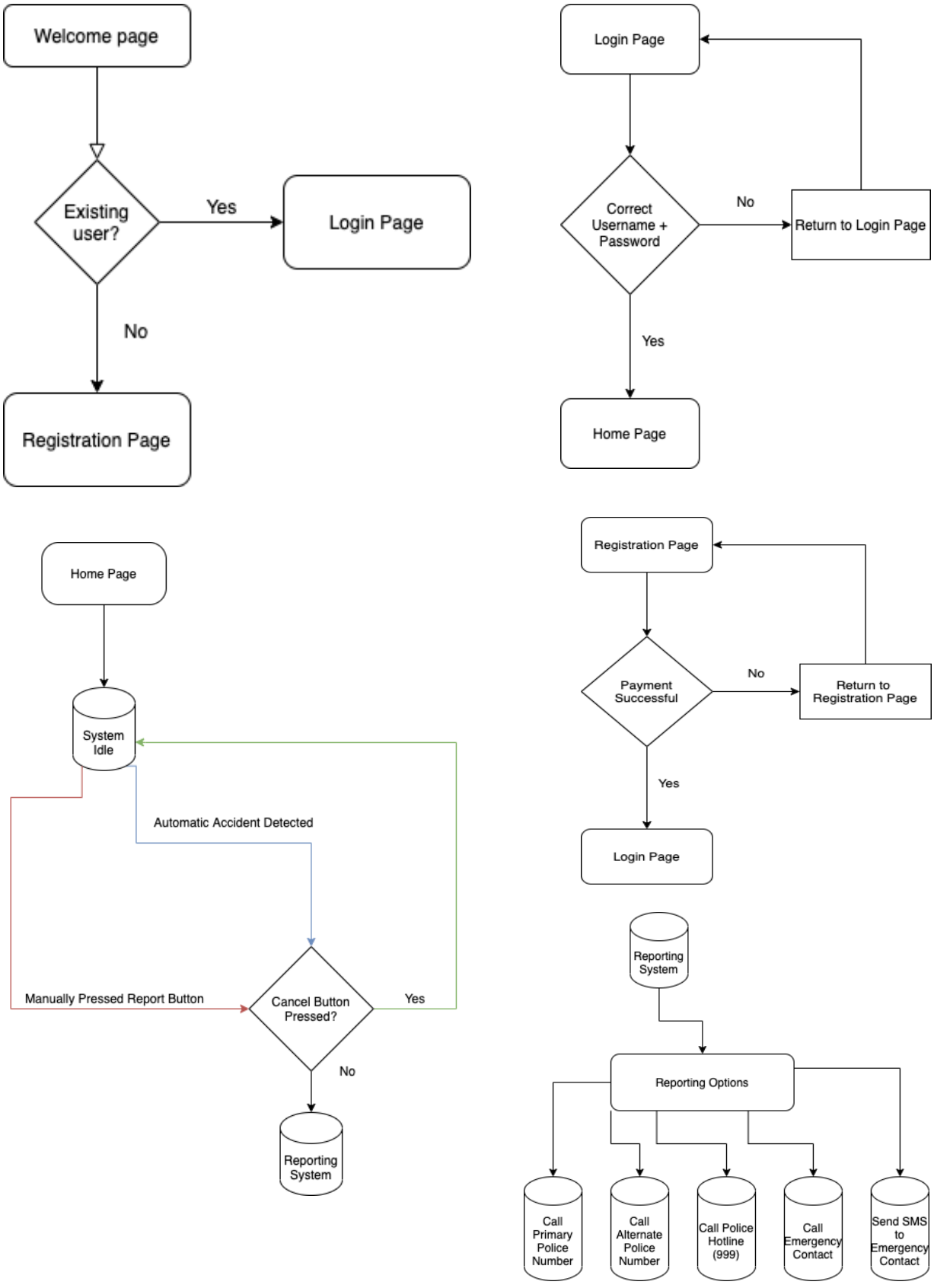


Fig:3 Work flow diagram

Data dictionary

Entity	Attribute	Type/size	Validation	Key
User	username	Number (5)	10000-9999	Primary
User	forename	Text (10)	Required	
User	surname	Text (15)	Required	
User	dob	Date (8)	Valid Date	
Trusted contacts	name	Text (25)	Required	Primary
Trusted contacts	contact number	Text (15)	Required	

Police officer	Officer station ID	Number (6)	9999-1111	Primary
Police officer	Forename	Text (10)	Required	
Police officer	Surname	Text (15)		
Hospital coordinator	Coordinator ID	Number (13)	11110-11111	Primary
Hospital coordinator	Hospital ID	Number (13)	11110-11111	Primary
Hospital coordinator	Ambulance ID	Number (15)	999-100	Primary
Fire service helpline	Helpline ID	Text (12)	Required	
Fire service helpline	Help line contact number	Text (15)	Required	Primary
Fire service helpline	Helpline contact alternative number	Text (15)	Required	

6. Process

6.1 Budget Planning

- Business Owners agree that the requirements meet their needs.
- Developers agree that they understand the requirements and that they are feasible.
- Testers agree that the requirements are verifiable.
- Management agrees that the requirements will achieve their business needs.

6.2 Constructive Cost Model

The project type is semi-detached.

Based on SLOC (source lines of code) characteristic, and operates according to the following equations:

- Effort = PM = Coefficient<Effort Factor>*(SLOC/1000) ^P
  =3.0*(8) ^1.12

  = 30.80 Staff months.
- Development Time = DM = 2.50*(PM)^T
  =2.50*(30.80) ^0.35

  =8.29 months.
- Required Number of people = ST = Effort (PM)/Development Time (DM)
  = (30.80/8.291)

  =3.71 number of people

where:

PM: person-months needed for project=30.80staff months.
SLOC: source lines of code=8000kLoc.
P: project complexity (1.04-1.24) =1.12 (semi-detached).
DM: duration time in months for project= 8.29months.
T: SLOC-dependent coefficient (0.32-0.38) = 0.35(semi-detached).
ST: average staffing necessary=3.71 numbers of people.
Productivity:10000 Loc / 30.80 staff months=324.67 / staff months.

Item	Semi-detached
Effort (Staff-months)	30.80
Development Time	8.29 months
Average Staff	3.71
Productivity	324.67

Software Project Type	Coefficient <Effort Factor>	P	T
Organic	2.4	1.05	0.38
Semi Detached	3.0	1.12	0.35
Embedded	3.6	1.20	0.32

Ethical issues: With a system like ours there is always a possibility that a user might make false reports, however making false reports to the police and other emergency services is a crime in Bangladesh. So, the false report concern is not an issue for our system. As is commonplace with false reports, the offending individual has to pay a fine or face legal issues. From the perspective of the app, we have designed some safeguards to prevent accidental misuse, like the option to cancel a report. There will also be a limit on the number of reports that a user can make in a certain period of time. After crossing the limit, he/she can't use the app for a certain period of time. If any of users mistakenly press the button,he/she will have the button to manually cancel this. The other ethical issue comes from tracking one's location. Our system is designed to only report the location once an accident occurs, so there is no tracking unless the user is in danger or they have explicitly pressed a button.

6.3 Methods and Setup

1. First the car owner has to install the app from the play store or visit the web version to install the web app.
2. Then he/she should register himself/herself verifying his/her driving license and NID number
3. Also he/she has to give his/her general information like name, date of birth, passwords etc.
4. After registration he/she can log in to the app
5. If he/she faces any accident he/she can manually select the area and press the red button if he/she is not severely injured.
6. If the accident was successfully detected by the automatic system, the reporting should work without any user interaction

6.4 Stakeholders

1. Vehicle owner and/or driver
2. Other Vehicle drivers on the Road
3. Road transport authorities (BRTA)
4. Private sector collective transport operators
5. Police / enforcement agencies
6. Emergency services

6.5 Methodology (Project Management)

The development of this project will be managed through an agile process. Due to the small size of the team and nature of the project being highly subject to change, we have chosen Scrum as our agile framework.

Scrum is an agile framework for developing, delivering, and sustaining complex products, with an initial emphasis on software development, although it has been used in other fields including research, sales, marketing and advanced technologies. It is designed for teams of ten or fewer members, who break their work into goals that can be completed within time-boxed iterations, called sprints, no longer than one month and most commonly two weeks. The Scrum Team tracks progress in 15-minute time-boxed daily meetings, called daily scrums. At the end of the sprint, the team holds sprint review, to demonstrate the work done, and sprint retrospective to improve continuously.

The scrum process can be quickly summarized using a simple diagram:

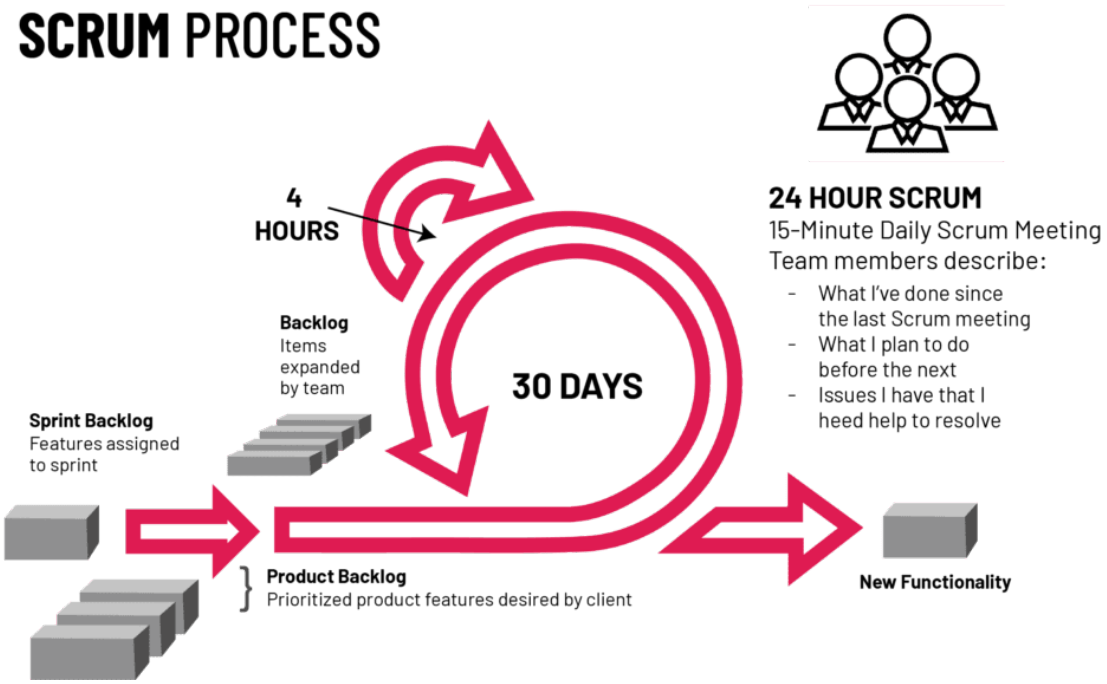


Fig 4: Scrum Process Diagram

7. Testing

- Business Owners agree that the requirements meet their needs.
- Developers agree that they understand the requirements and that they are feasible.
- Testers agree that the requirements are verifiable.
- Management agrees that the requirements will achieve their business needs.
- We can continuously monitor the designs which enable us to satisfy the user requirements at every stage.
- Validating the planning will illustrate the difference between how the functionality works and also the way it's expected to work.
- Any difference between the result and the user requirement documents are captured.
- Initially, the requirements and specifications of the system were examined. We then tested a series of sanity checks to ensure the functional and non-functional requirements are satisfied

7.1 Test items

1. The User must have a valid driving license and NID card.
2. The User shall be able to add other general information specified in the Data Dictionary.
3. The User can manually press the button for help.
4. The User can manually select the area.

8. Conclusion

In this project, we are developing an automatic accident detection and smart rescue system, which uses sensors available on smartphones to detect accidents and generate emergency alerts and send it to the nearest emergency responder and send an SMS/call to emergency contact containing location coordinates of the accident. The system will drastically increase the survival rate of an accident victim by providing emergency aid in time. The system will provide help during other emergencies like during fire, robberies/theft and other medical emergencies. Emergency responders would be able to pinpoint the victim's location on a map in real time. The probability of false positives in an exceedingly smartphone-based accident detection and rescue system is inevitable. We have added some features to cut back these issues.

In the future, this project can be expanded to include hardware sensors that may be more reliable than those available on a smartphone. However, due to limitations of this project this kind of feature set is beyond the scope of this project.

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Appendix A

Glossary:

Definitions:

Victim(s) - This document refers to users of the applications as victims when they are an injured party to a vehicular accident.

The system, The application, The app, et al. - These terms refer to the proposed software (titled Automatic Accident Detection and Rescue System) in the context of this document