Passenger Vessel Safety Measuring Model

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This project is partialFulfillment of the requirements for the degree of Bachelor in Software
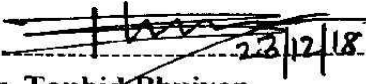
Engineering

Department of Software Engineering
DAFFODIL INTERNATIONAL UNIVERSITY

Fall - 2018

APPROVAL

This **Project** titled "**Passenger Vessel Safety Measuring Model**", submitted by **Dip Chowdhury, 143-35-824** and **Naimul Islam Nobel, 143-35-775** to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc in Software Engineering and approved as to its style and contents.
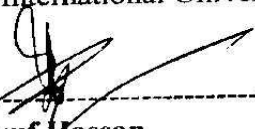
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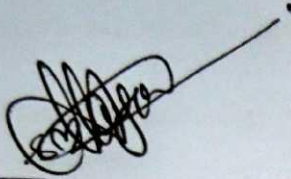
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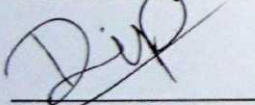
External Examiner

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **DR. Shaikh Muhammad Allayear, Associate Professor and Head, Department of MCT** at Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree.

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Acknowledgement

At first we are very grateful to Almighty that he have given us a chance to walk through final year. In our previous year of university life we have learnt politeness, morality and etc. For this we are thankful to all of our teachers.

I am very grateful to my supervisor, **Dr. Shaikh Muhammad Allayear**for giving a chance to work with this project. In the time of working with this project sometimes I got some obstacles. For overcoming from this obstacles, some of my friends are always there besides us.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

Contents

Chapter 1: Introduction

1.1 Project Overview

The water transport can move people or things by sea from one location to another location on by water transport. Maritime transport in the world is the most used mode of international trading. It is supporting the greater movement of goods, by cargo or ships. We all know that our planet Earth is covered by water. The area is two third of it. People prefer water transport for longer trips. Thus we have got a route of globe as the water transports sail through them. Reason of efficiency air vehicles now a days people is trying to have their goods faster through air way. Though water transportation in our country it is one of the most used way of transporting people for people. But it is not so easy for passengers or even for the owners of passenger vessels to keep look on the safety of passengers. At the meantime, very few on board people are expert with vessel safety procedures rules and procedures. Our plan is to offer a model, which will assure safety of vessel by sending it crucial data to experts so they can analyze, even if anything goes wrong, the software can take some emergency decision so we can stop an accident or a major loss of health or wealth of nation.

1.2 Project Purpose

1.2.1 Background

As we discussed about the problems of water transports, our work and dedication will be dedicated to solve or minimize the problem of sinking a water vessel to save human life. In order to do that we need a working model which can be placed in any vessel and we can have life data to see what is happening. Currently we are focusing on using sensors which's are available in market and we are assembling them and developing our own algorithm which will solve the problem sinking.

1.2.2 Benefits and Beneficiaries

Using our model we will be able to provide remote security system for water vessel owners. The manual system of tracking down vessels will be ended. Just like modern apps and software, our model will assure a live interface by which we will be able to track down all the vessels we want and also we will be able to control their movement. Passengers will feel much more safe and they will show much eagerness to water transportation if we can deploy this model over all the passenger vessel.

As well, at time of rush there will be way for Naval department to see what is happening at field and they will be able to take step hardly in order to secure travel of passengers. And as well passengers will feel more secure to use water transport for there long distance travel. In the meantime, we know it's a common fact of generation, very of people now know how to swim, so if we can deploy this feature in water transports, then water transport will get some positive feedback, as well it will earn it's lost popularity again.

1.2.3 Goal

We are developing this model to ensure safety for passengers of passenger vessel, and our primary goal is to establish this model as a safety standard for all passenger vessels in Bangladesh so we can have constant information about a vessel, and also we can track down all the needed information. Naval department can have a ready module for their inspection, and for more, if anything goes wrong, they would be able to provide us a proper investigation report where they will be able to clarify the exact location and reason for that. Though currently we are working with only weight, as well in future with other feature, this module will help us to provide much more features for automated route selection or more. Currently we have a web interface which can give Naval department a scope to see what is happening.

1.3 Stakeholder

Stakeholder	Level of Auth	Key Interest and Issue	Frequency
Driver	App level interface Data	Sinking or not	Regular
Vessel Owner	App level interface Data	Sinking or not, where the vessel is.	Regular
BWTC	All data if they want.	All necessary steps they need to take against safety measurement.	Often
Developer	All Data	Development Purpose	Often
App Admin	All Data	According to term and condition, he or she will access required data.	Regular
Project Supervisor	All Data	According to term and condition, he or she will access required data.	Regular

1.4 Proposed Model Block Diagram
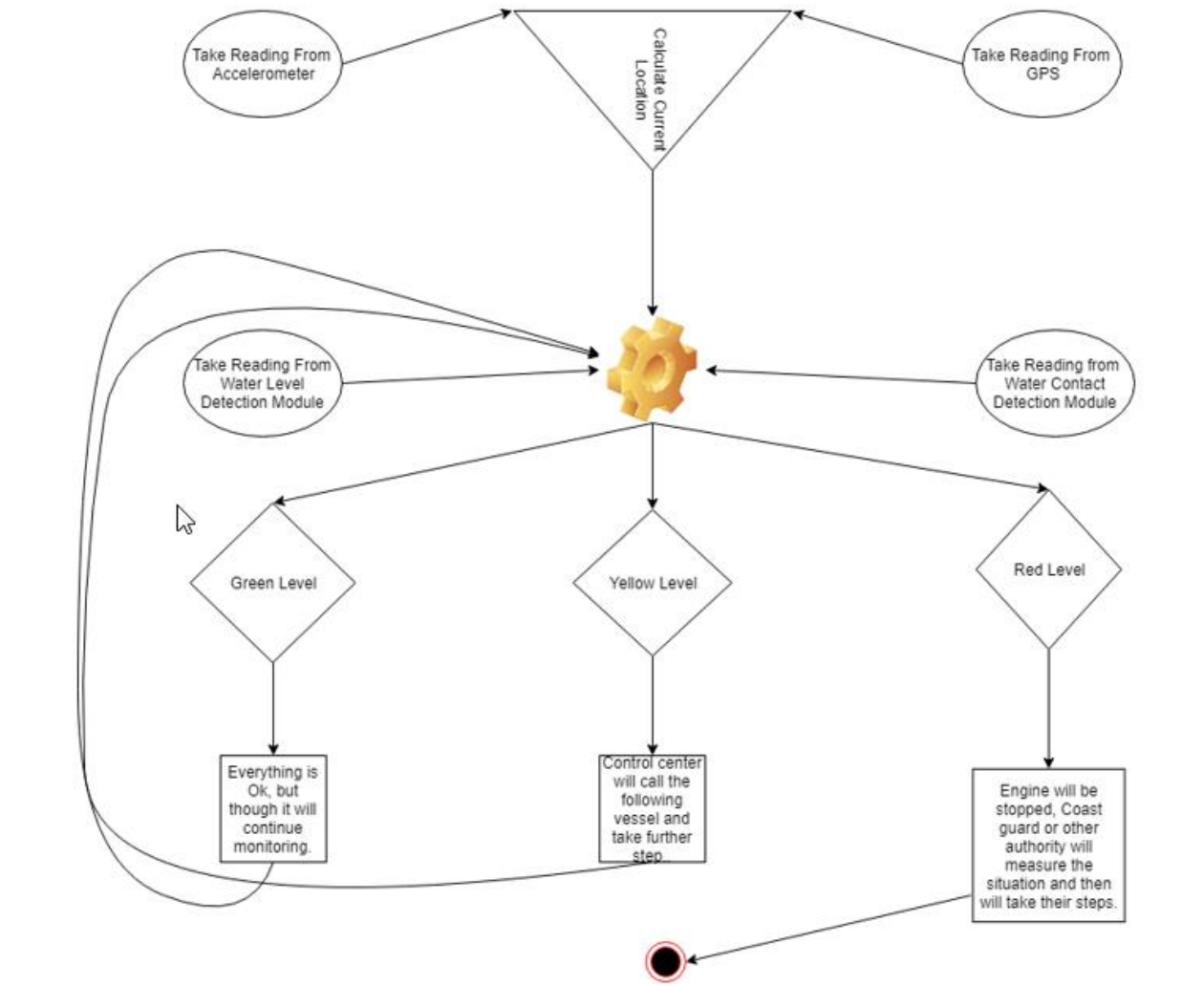
1.5 Gantt Chart

ID	Task Name	Start	Finish	Duration
1	Collecting Information	8/14/2018	9/11/2018	21d
2	Model Analysis	9/12/2018	9/28/2018	13d
3	Data sampling	10/1/2018	10/25/2018	19d
4	System implemention	11/1/2018	11/16/2018	12d
5	testing	11/20/2018	12/12/2018	17d

Fig 1.1 **Part one of gantt chart**
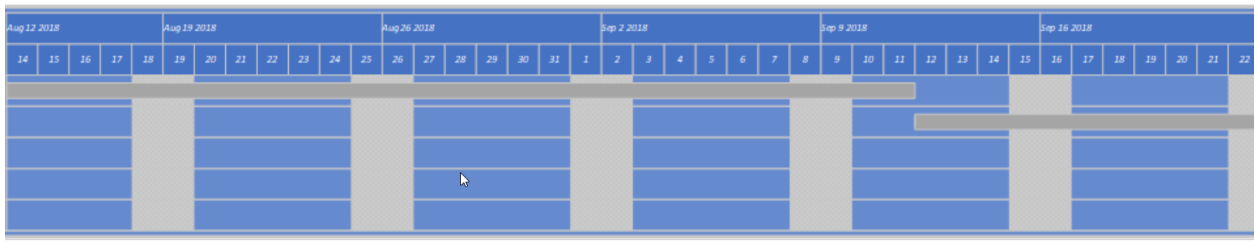
Fig 1.2 **Part two of gantt chart**
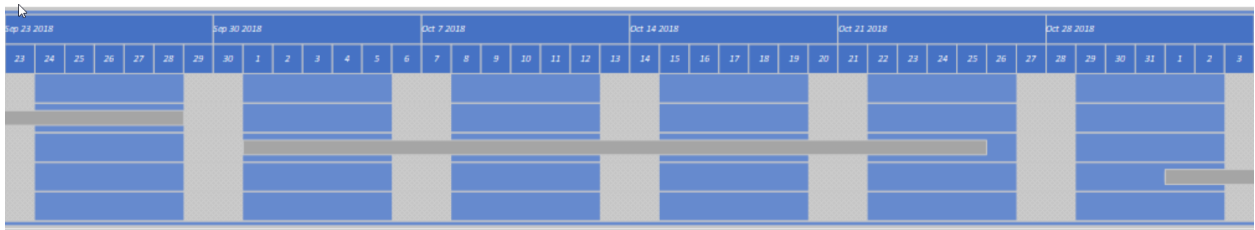
Fig 1.3 **Part three of gantt chart**
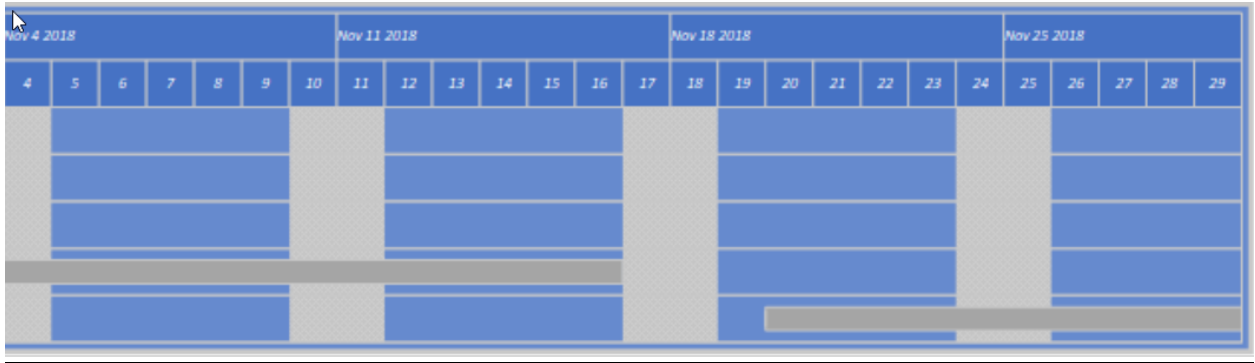
Fig 1.4 part four of gantt chart

As the Gantt chart was too long in width, so we have to divide it in several figures so we can present in a way that anyone can see what this chart is saying.

1.6 Project Scheduling

1.6.1 Release Plan / Milestone

We are developing a working model against the proposal. So our current target is making a 95% accurate working model of a safety measuring procedures where we can assure safety for passengers. In order to provide this type of model we need good amount of time and wealth, as we are currently going to different people in order to raise our fund. As all, we are hoping after collecting our fund we will start working in real time scenario where we can deploy our module and system and can have feedbacks so we can improve it more.

1.7 Acronyms, Definitions and abbreviations

Table 1 - Definitions

Word and Terms	Definition
User	Who will interact with the system
Admin/Administrator	Access to system with full control.
Vehicle Owner	Who has a vehicle want his vehicle in this system.
Web-Portal	Interface of our system in a web page or application for users to access over system.
GPS	Short for of Global Positioning System
GPS-Navigator	An interface of system where you can see where you have to go where other vessel or vehicles are.
Application Store	An online store where we will store this system for users to have a copy in there system so that they can have this to access over our system.
Stakeholder	Anyone who is related to our project.
DESC	Short form of Description.
RAT	Short form of Rational
DEP	Short form of Dependency
WISH	It's a term by which we express a feature of outcome for a system by programming language.
DEFINED	A state of system where we explain a or many feature in established way.

1.8 Overview

We explained our project in several parts so anyone with this document can easily understand what is needed and what we are trying to do. And for future development we have cleared our goal in order to have a proper system. To develop this system we used several equipment which we have listed in end of document with web references. And also for this project we used real life experiments to have a solution for real life problems. Like, if we think of other issues as a problem as speed it will be not considered as the major problem. According to our study it's been like 78% of the time the real cause for a water vehicle accident we can say overweight is the issue. And as we think of other issue like weather and condition water in river and sea, we can say they can't be prevented as we need to have accurate news over them so we can take proper steps to make a safe journey.

Chapter 2: Background and literature reviews

2.1 Previous Research Work

1. Liang-Bi Chen ; Hong-Yuan Li ; Wan-Jung Chang ; Jing-Jou Tang ; Katherine Shu-Min Li," **An intelligent vehicular telematics platform for vehicle driving safety supporting system**," 2015 International Conference on Connected Vehicles and Expo.

2. Jun Han Bae ; Eric T. Matson ; Byung-Cheol Min, " **Towards an autonomous water monitoring system with an unmanned aerial and surface vehicle team** " 2015 IEEE International Symposium on Safety, Security, and Rescue Robotics

2.2 Drawbacks

On the paper noted as number one in Previous Works, The proposed model is too much costly. In that case, we can't afford it for our country as we have to establish a complete new group of people if we want to deploy it in fields. So it is not an proper solution for our country to detect if any other people are riding the vessel at mid of river. So for us, we need a cheap and efficient way to solve this problem.

And on the paper noted as number two in Previous Works, they were trying to develop a unmanned vehicle which will observe the scenario and make travel safe. But for some case, it is also costly and from my perspective, it is not feasible.

Chapter 3: Software requirement specification

3.1 Functional Requirements

<u>Overview of Requirements:</u>

Software and Hardware Requirements:
- Current Model Works with Android, so Accelerometer and GPS is mandatory.
- Android version 4.4 or ant upper version.
- Android need to have more than 4.5 inches long display.
- Android need to be water proofed by conventional way which will be described later in appendix.
- Need Firebase support for current android base App, But for Web based prototype we are using some native DB which will lead us to a scenario where we will be able to have an Idea of what we will do.

Regulatory Requirements:
- A person from passenger vessel need to be trained with proper authority in order to have idea about the app we will provide.
- BWTC authority also need a small workshop with developer guys in order to have an accurate and proper idea about what they need to do with this module and how they will use this module to have safety measurements.

Security Requirements:
-According to term and condition, if anyone tries to di-cipher the code or Authentication keys from our app and server module, they will face legal sue so that we can provide safe experience for any stakeholders. So we will use 128bit encryption over all incoming and outgoing data. in order to provide security and privacy.
- As we will provide our own Authentication key for first time, the prototype will have or own Authentication key, so we will be too much cautious about the prototype that no one else have a single copy of that.

ID of SRS: sFR_1
TITLE of SRS: Downloading the mobile application
DESC of SRS: A user will be able to download the app from a web store which will be and will allow a user to use this app with their own authentication level/
DEP of SRS: None

ID of SRS: sFR_2
TITLE of SRS: Downloading and notifying users for newer updates
DESC of SRS: When it's a newer/updated version or release of app is available at market, The user can check for them manually. Then user will be able to update his app or download the update and will be able to use with their authentications.
RAT: For update and installing newer version of app.
DEP of SRS: sFR_1

ID of SRS: sFR_3
TITLE of SRS: Registration for mobile users
DESC of SRS: After downloading the app user will use this function to register their id as part of system to gain access in system and to register their vehicle for other functions.
RAT: Registration in app to access the system.
DEP for the SRS: sFR_1

ID of SRS: sFR_4
TITLE of SRS: log-in option mobile application users
DESC of SRS: The registered user will be able to log in to system using their email and password. If user want to save their mail and password to avoid repeatedly giving their information to log in they can save it.
RAT: In order for a user to register on the mobile application.
DEP for the SRS: sFR_1, sFR_3

ID of SRS: sFR_5
TITLE of SRS: Regaining access to system.
DESC of SRS: If user forget forgot their password, they can set their password by selecting forgot password. The link will send to their mail address to set new password.
RAT: In order to regaining access to system.
DEP for the SRS: sFR_1

ID of SRS: sFR_6
TITLE of SRS: Search option for mobile application.
DESC of SRS: User can search the passenger vessel and get their current location.
RAT: In order for a user to get location of vessel they searched .
DEP for the SRS: sFR_4

ID of SRS: sFR_7
TITLE of SRS: Search result in a map view
DESC of SRS: User can search the passenger vessel and get their current location in map view. They can also see other vehicle which appear in nearby.
RAT: For displaying vessels current location and status in map.
DEP for the SRS: sFR_6

ID of SRS: eFR_8
TITLE of SRS: Selecting the information link of appearing vessel in map
DESC of SRS: User can select the information link, which is provide all information of vessel including picture, size, capacity, contact number and owner name of vessel.
RAT: In order to show information of passenger vessel .
DE for the SRS: sFR_7

ID of SRS: sFR_9
TITLE of SRS: No match found
DESC of SRS: If user search for a vessel which information not in our database. The search result will be no match found.
RAT: In order to suggest a user to a new search if this result appear .
DEP of SRS: sFR_5

ID of SRS: sFR_10
TITLE of SRs: Profile page
DESC of SRS: Every user will an individual page of profile. They can edit their information, profile picture.
RAT: In order for a user to have a personal profile.
DEP of SRS: sFR_1

ID of SRS: sFR_11
Feature of system: Create an account
In order to create an account owner or user should get registered first then they will be able to logged in.

Scenario: Required information for registration for vessel owner
When the vehicle owner registers on the web-portal by providing username, password, address, email address, phone number
Then the vehicle owner will be able to apply for verification

Scenario: Full information of registration for vessel owner
Given the owner wants to create an account and the vessel owner does not have an account
When the vehicle owner registers on the web-portal by providing username, password, address, e-mail address, phone number, mobile number
Then the vehicle owner will be eligible to apply for verification.

Scenario: Confirmed registration for vessel owner
Given the vehicle owner has applied for verification and has not received a confirmation e-mail after registration. When the vehicle owner receives a confirmation e-mail
Then the vehicle owner should be able to log in.

3.2 Dependability Requirements:

3.2.1 Reliability Requirement

ID of Reliability Requirement: sQR_1
TAG of Reliability Requirement: SystemReliabilityPrimary
GIST of Reliability Requirement: The Primary reliability of this system.
SCALE of Reliability Requirement: System will provide right result upon search,
METER of Reliability Requirement: Accuracy obtained by 50 search as a test drive.
MUST of Reliability Requirement: Must be More than 98% time of the searches.
PLAN of Reliability Requirement: Must be More than 99% time of the searches.
WISH of Reliability Requirement: 100% of the searches have to be.

3.2.2 Availability Requirements:

ID of Availability Requirement: sQR_2
TAG of Availability Requirement: SystemAvailabilityPrimary
GIST of Availability Requirement: System Up time for users.
SCALE of Availability Requirement: Average time of up time of system. Other infrastructural errors might not be considered.
METER of Availability Requirement: 4 days of Test drive.
MUST of Availability Requirement: Must be More than 98% of the time.
PLAN of Availability Requirement: Must be More than 99% of the time.
WISH of Availability Requirement: We wish for 100% of the time.

ID of Availability Requirement: sQR_3
TITLE of Availability Requirement: Must have ab Internet Connection
DESC of Availability Requirement: Application need to be connected to internet
RAT of Availability Requirement: To provide service and to communicate with server and database for the application.
DEP of Availability Requirement: none

ID of Availability Requirement: sQR_4
TITLE of Availability Requirement: GPS Connectivity for Application
DESC of Availability Requirement: Application need to be connected with GPS
RAT of Availability Requirement: In order to provide location of users location and to get location of other vehicles in order to see who is where.
DEP of Availability Requirement: none

3.2.3 Safety and Security Requirements:

ID of Safety and Security Requirement: sQR_5
TAG of Safety and Security Requirement: CommunicationSecurityAdvanced
GIST of Safety and Security Requirement: To have a secure communication line with server and database for users
SCALE of Safety and Security Requirement: All data will be encrypted when they will be on network as user name and password will be secured.
and password from those messages.
METER of Safety and Security Requirement: WE tried to break through security to get username and password of other users but there was nothing more than encrypted data.
MUST of Safety and Security Requirement: All the data which will be send and received over network should be encrypted.

ID of Safety and Security Requirement: sQR_6
TAG of Safety and Security Requirement: VehicleOwnerLoginAccountSecurity
GIST of Safety and Security Requirement: To secure the accounts
SCALE of Safety and Security Requirement: Without previous authentication no one will be able to login and will be notified by message if login fails reason of not having proper authentication.
METER of Safety and Security Requirement: 10000 times tried with non-existing user and pass but there was no access to system.
MUST of Safety and Security Requirement: All the time, 100% of the time

ID of Safety and Security Requirement: sQR_7
TAG of Safety and Security Requirement: AdminLoginAccountSecurityPrimary
GIST of Safety and Security Requirement: For Account Security of Admin
SCALE of Safety and Security Requirement: Admin without proper authentications cant login in web portal.
METER of Safety and Security Requirement: Tried to login with non-existing user account for 10000 times but there was no access.
MUST of Safety and Security Requirement: All the time, 100% of the time.

ID of Safety and Security Requirement: sQR_8
TAG of Safety and Security Requirement: VehicleOwnerAccountSecurity
GIST of Safety and Security Requirement: For Account Security of User
SCALE of Safety and Security Requirement: After 5 times of login failure the following IP-address and username will be marked as black listed and can't be logged in until 15 minutes.
METER of Safety and Security Requirement: We tried to log in with several user ID with wrong password but all the time it was a failure and the user name was locked till 15 minutes.
MUST of Safety and Security Requirement: Locking period is 15 minutes and in any case no one can bypass that period till system admin gives user a scope.

ID of Safety and Security Requirement: sQR_9
TAG of Safety and Security Requirement: AdminAccountSecurityAdvanes
GIST of Safety and Security Requirement: For Account Security of Admin

SCALE of Safety and Security Requirement: For an admin After 5 times of login failure the following IP-address and username will be marked as black listed and can't be logged in until 15 minutes.
METER of Safety and Security Requirement: Tried to login with non-existing user account for 10000 times but there was no access.
MUST of Safety and Security Requirement: Locking period is 15 minutes and in any case no one can bypass.

ID of Safety and Security Requirement: sQR_10
TAG of Safety and Security Requirement: UserCreateAccountSecurityPrimary
GIST of Safety and Security Requirement: Primary security for user account creation
SCALE of Safety and Security Requirement: When user will try to create an account, if the username is already taken, then the system will ask for a different username.
METER of Safety and Security Requirement: During testing phase our system was successful for asking a newer username for user which was never been used in our system before.
MUST of Safety and Security Requirement: All the time, 100% of the time.

ID of Safety and Security Requirement: sQR_11
TAG of Safety and Security Requirement: VehicleOwnerCreateAccountSecurity
GIST of Safety and Security Requirement: Primary security for user account creation for vehicle owners.
SCALE of Safety and Security Requirement: When user will try to create an account, if the username is already taken, then the system will ask for a different username.
METER of Safety and Security Requirement: During testing phase our system was successful for asking a newer username for user which was never been used in our system before.
MUST of Safety and Security Requirement: All the time, 100% of the time.

3.3.1 Security requirements

ID of Security Requirements: sSCR_1
TAG of Security Requirements: AdminAccessAdvanced
DESC of Security Requirements: Only Admin can access to all data. Else the other featured will be wrapped under different security credential as only with proper authorization can be accessed.
MUST of Security Requirements: All the time, 100% of the time

ID of Security Requirements: sSCR_2
TAG of Security Requirements: DatabaseAccess
DESC of Security Requirements: The whole control of database can be obtained by only with DBAdmin privilege. Else the security team will have an alarm that someone else is trying ti have access over the database.
MUST of Security Requirements: 100% of the time.

ID of Security Requirements: sSCR_3
TAG of Security Requirements: UserAccessPrimary
DESC of Security Requirements: User can see surrounding vehicls and their types. User can have notification if water is floating over the safe zone.
MUST of Security Requirements: 100% of the time.

3.3.2 Integrity Requirement:

ID: IGR1
DESC: This System will work in any condition until all the parts are having 90% integrity. In case of natural disaster, sensors might give wrong reading but our system will be able to understand that there's something wrong near it's atmosphere.
MUST: 95% integrity assure that standard.

ID: IGR2
DESC: Micro controller and Arduino will provide 99% accuracy until the battery runs out. In order to charge battery, we will try to provide solar panel to charge it's battery.
Must: 97% integrity assured though its casing may be damaged.

ID: IGR3
DESC: All the software and data will be encrypted in 128bit encryption. SO it will be safe and it's near impossible to decode without our personal key.
MUST: 100% of the time.

3.3.3 Privacy Requirements

ID: PR1
DESC: All data will stored under firebase provided by google. And also all communication channeled through HTTPS protocol as it will be hard and near impossible for intruders to snatch data.

ID: PR2
DESC: Database access will be authorized under several international standard so only a Database admin can access all data and he/she can't see individual data unless there's any catastrophic fault or failure.
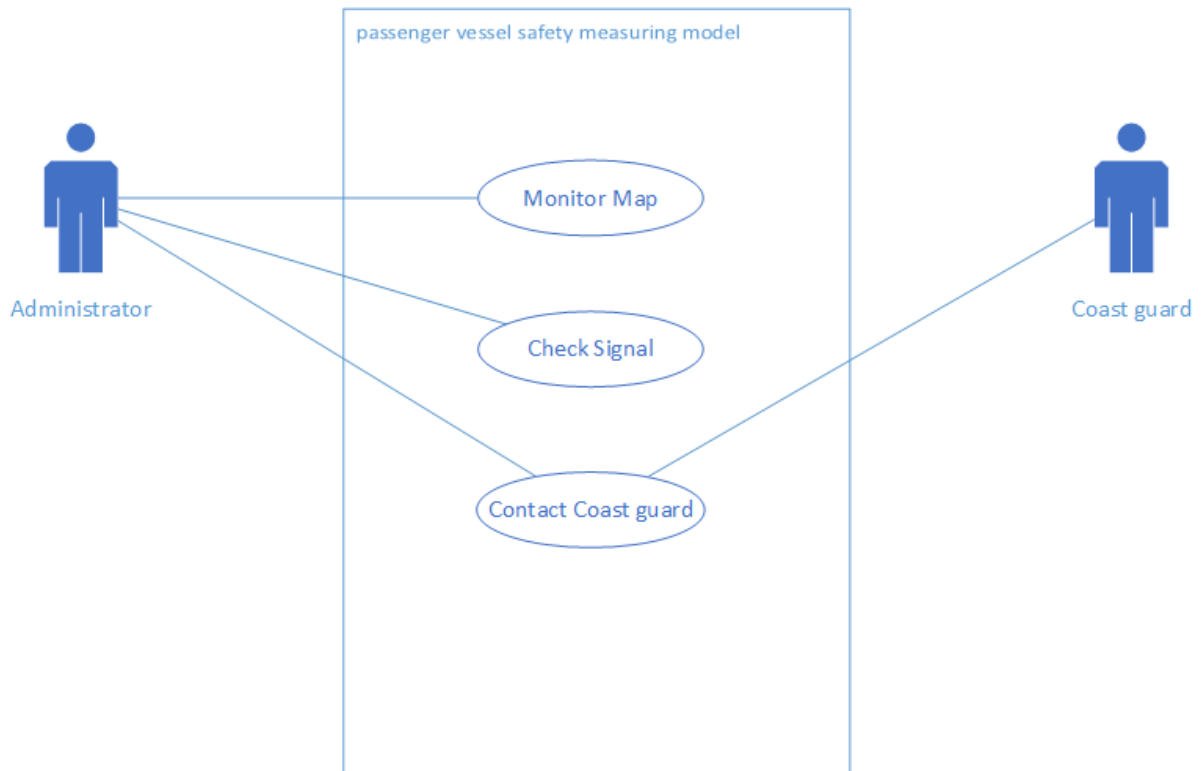
Chapter 4: System Analysis

4.1 Use Case Diagram

Fig.1 Use Case for Whole System
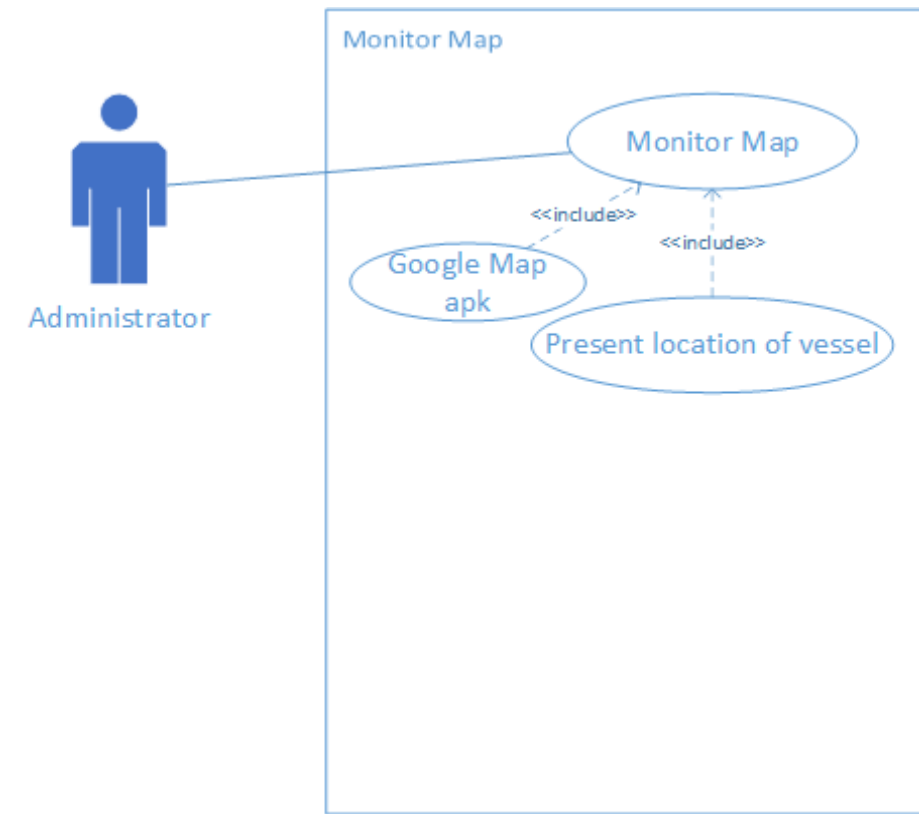
4.1.1 Use Case Diagram for Monitoring Map

Fig.2 Use Case for monitoring Map
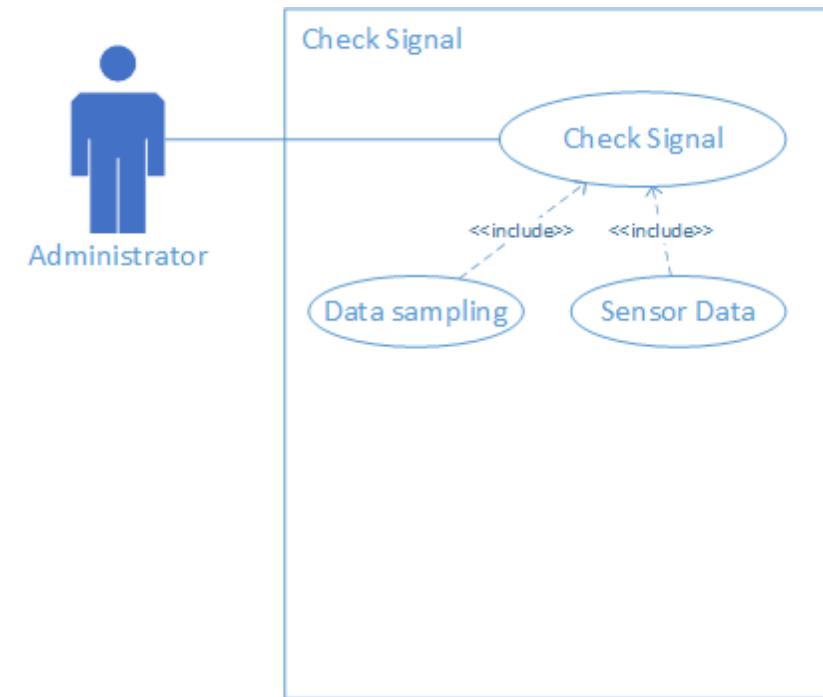
4.1.2 Use Case for Checking Signal

Fig.3 Use Case for Checking Signal

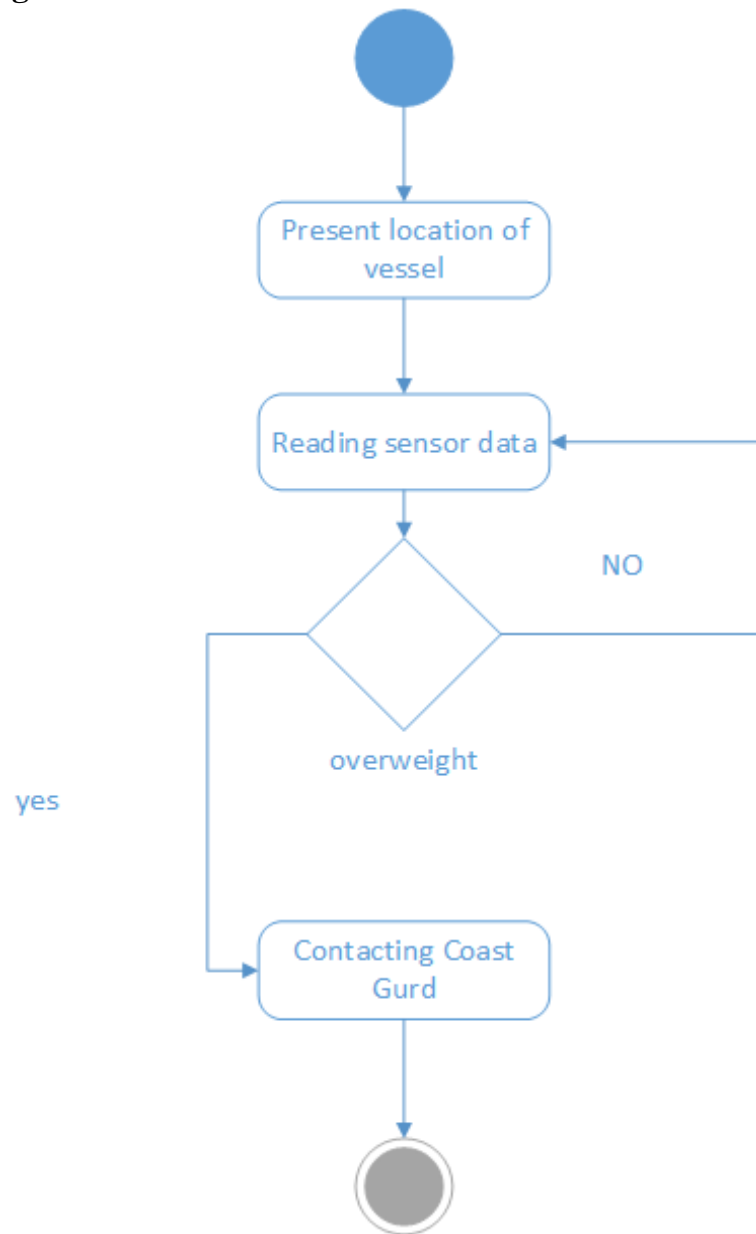## 4.2 Activity Diagram

Fig.1 Activity Diagram for Whole System

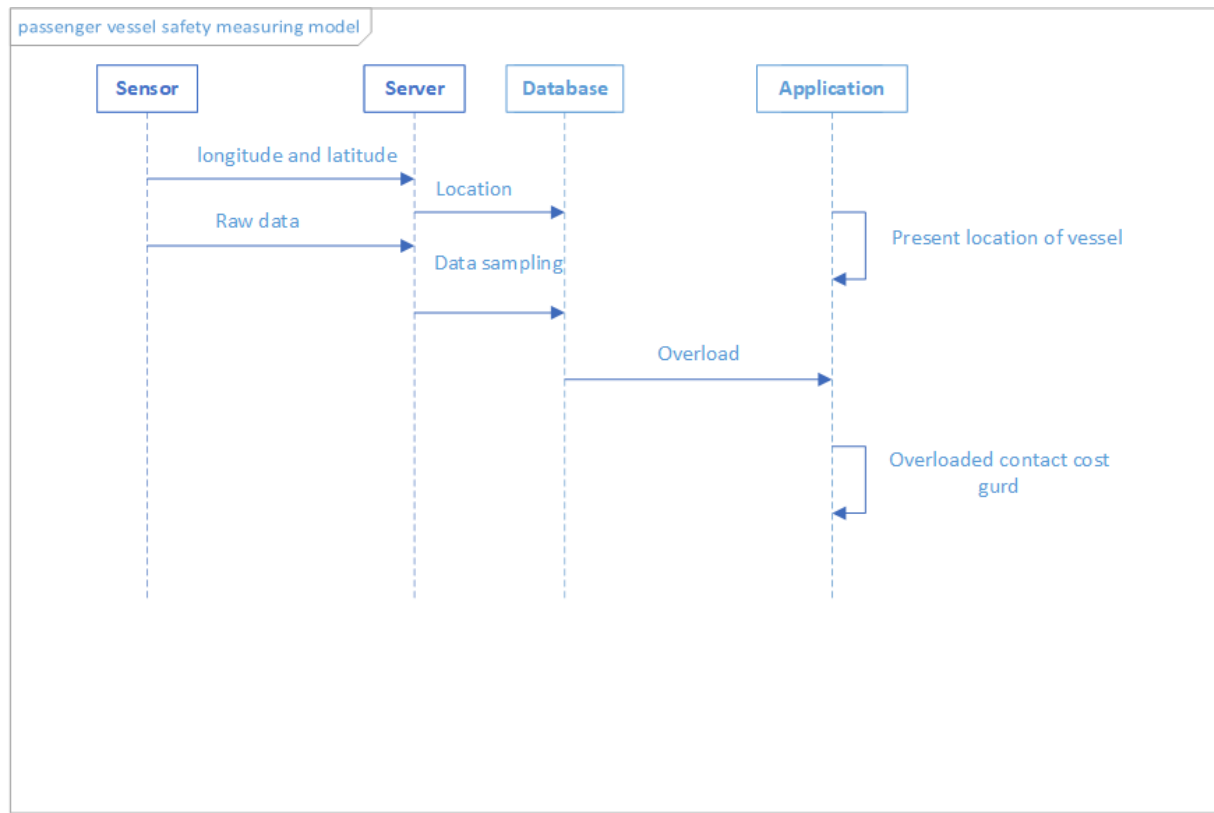## 4.3 System Sequence Diagram

Fig.1 System Sequence Diagram for Whole System
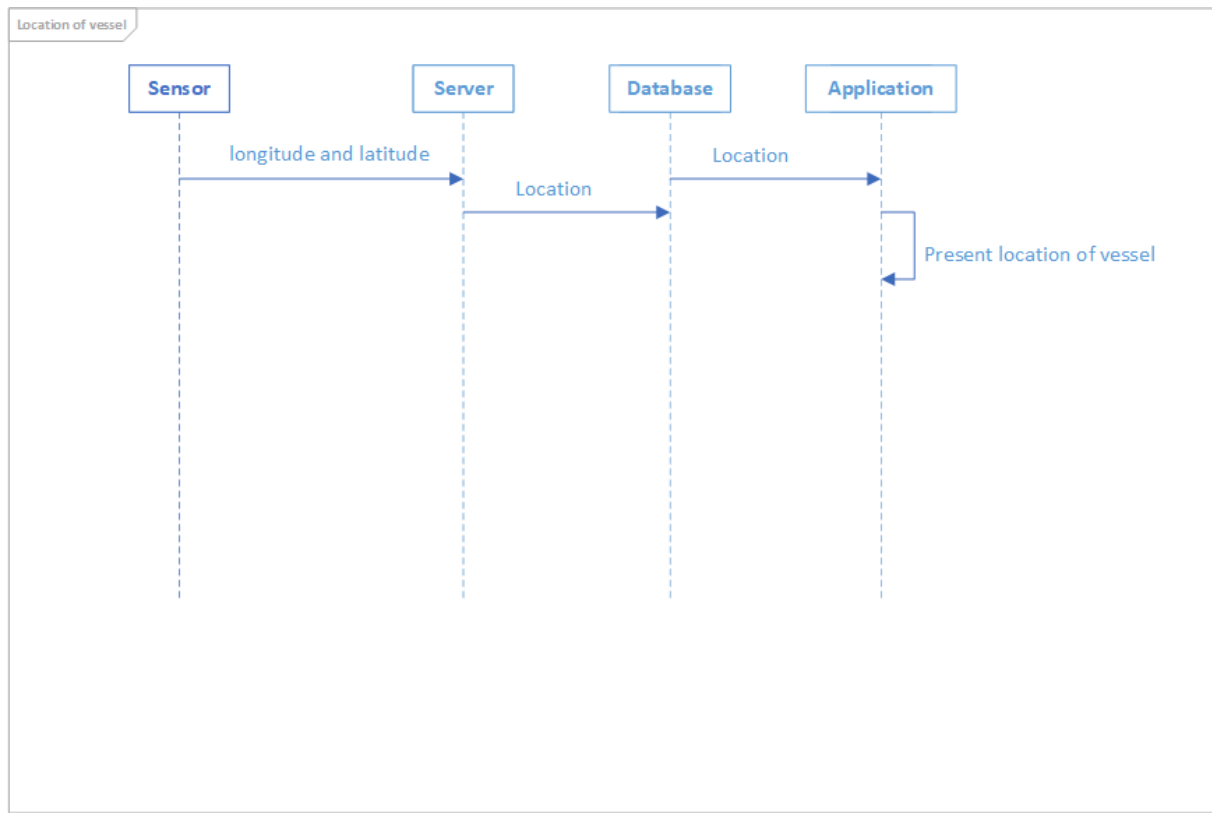
4.3.1 System Sequence Diagram for Location

Fig.2 System Sequence Diagram for Location

4.3.2 System Sequence Diagram for Checking Signal
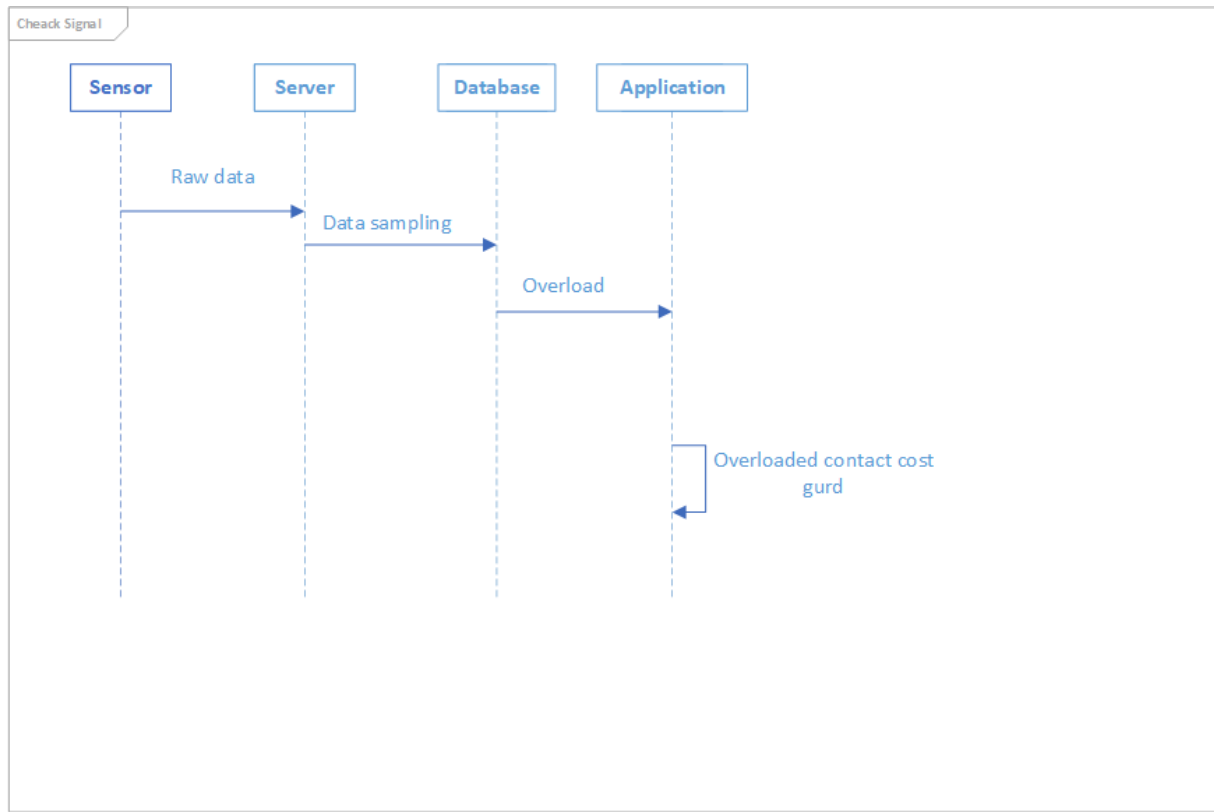

Fig.2 System Sequence Diagram for Checking Signal

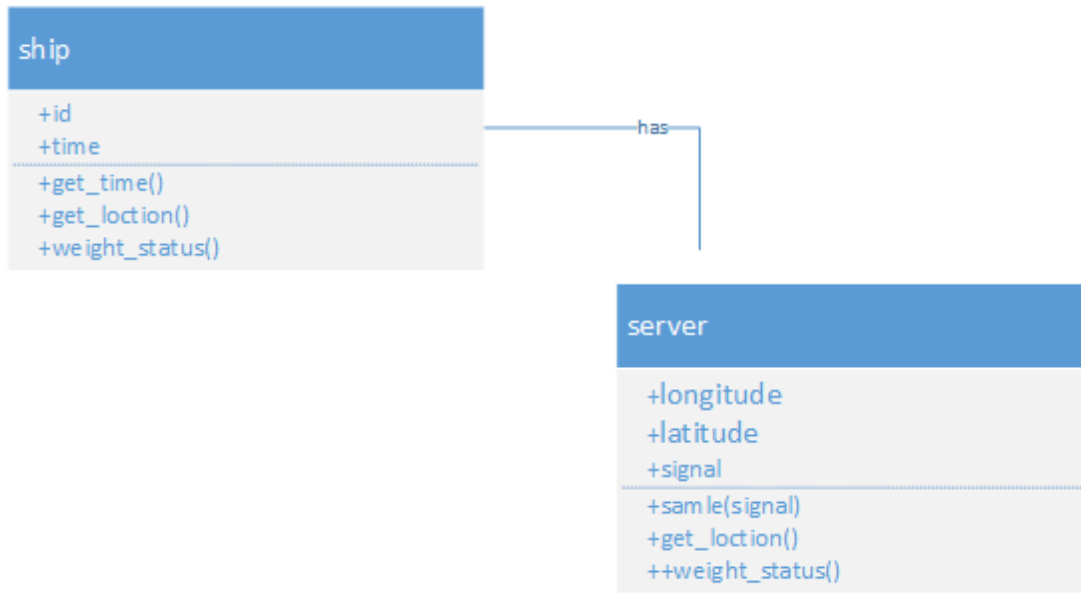# Chapter 5: System Design Specification

5.1 Class Diagram

Fig.1 Class Diagram for Whole System
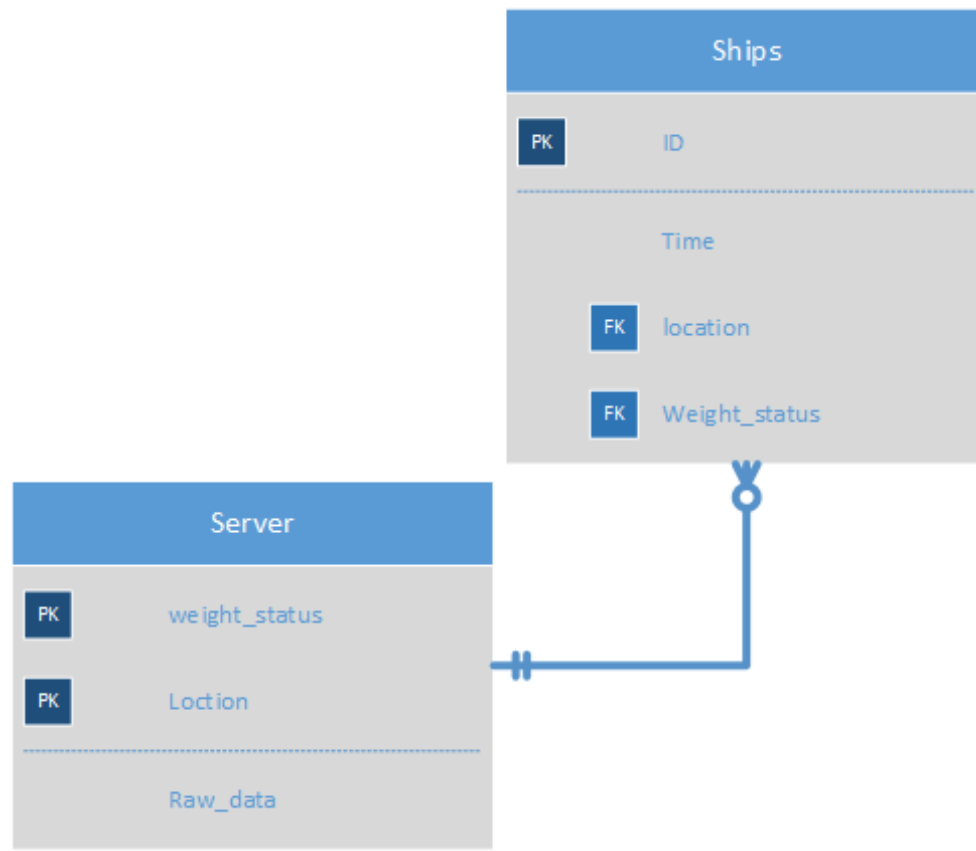
5.2 Database Design Diagram

Fig.1 Database Design Diagram for Whole System (Currently)

5.3 Development Tools & Technologies

5.3.1 User Interface Technology

Currently we are using android and JavaScript and html language to provide an interface for all the viewers. In future, we will provide complete interface with JavaScript and html for web users and Android will be for android users. We are hiring artists for image arts and contents so we can provide a sweet and easy user experience for all.

JavaScript:

JavaScript, in short for which is JS, is a is best known as the scripting language for Web pages which is lightweight, interpreted, object-oriented language with first-class functions. But developers use it in many scenario as in non-web based scenario. With many different features JS is the best option for many IoT based projects to see and work through the project.

JavaScript Generally runs in client side of machine, which assure performance of animation and many things on client then server, So JavaScript supported systems are more handy for users.

For web and Android we are using Times new Roman as default font.

HTML:

Hypertext Markup Language (HTML) is the one and only option to create interface of a web page. Now a days we might have many options but HTML is the only standard option. With other tools like CSS and JavaScript it is the most used language for representing a system or web service to clients.

In web technology user get instructions of interface in HTML and then users machine renders it in a interface which make easy the system by reading and interacting with buttons. To describe the structure of web page we use HTML and other tools and make user experience much easier.

5.3.2 Implementation tools and Platforms

We are using Raspberry Pi 3B for current prototype development, in future we will try something cheap but more efficient for the project.

We will use node red server and node red web for the assembly purpose.

Node Red:

Node-RED is a programming module used for joining together APIs, hardware devices and other online services.

It gives us a scope to use it in a handy was that represent the working modules in a browser as well interact and edit them in there with an easier interface.

The whole project will be mounted on a dummy ship in order to provide a prototype. In future all the equipment will be waterproof and will be mounted in a real vessel.

Chapter 6: Discussion

6.1 Summery

Currently we are developing the extended edition and a paper for the system which will extend the scope of security. Weight might not be the only factor but also we need to find more cheap and efficient sensors to implement. Like, if we can have a strip like sensor which can help me to find the water level of the vessel, we can have an approximate idea of how many people are in the deck and also current approximate weight of the vessel.

Even though, we need to use modified micro controller and also modified computing interface to make our project cheap. Like, if we need a strip sensor of 1 meter, and we buy 1.5 meter and then cut it off to use, the cost of 0.5 meter is unnecessary. Also, we want to add more options in web and android interface so that naval department can have a full control over a vessel and they can make passenger travelling safe.

6.2 Conclusion

Now we have a module and a way to make people travelling safe, and well we can use this procedures over other water transports to make their journey safe. Also, if we can merge this technics with other real life lore, we can establish individual system for individual systems. But for now, we have to do more with this project and we need real data sample analyzing to make a proper model.

References:

1. An Intelligent Vehicular Telematics Platform for Vehicle Driving Safety Supporting System: https://www.researchgate.net/publication/283083251_An_Intelligent_Vehicular_Telematics_Platform _for_Vehicle_Driving_Safety_Supporting_System

2. Towards an autonomous water monitoring system with an unmanned aerial and surface vehicle team:
https://www.researchgate.net/publication/304417496_Towards_an_autonomous_water_monitoring_s ystem_with_an_unmanned_aerial_and_surface_vehicle_team

3. Gross tonnage: https://en.wikipedia.org/wiki/Gross_tonnaget

4. File:Ship diagram-numbers.svg: https://commons.wikimedia.org/wiki/File:Ship_diagram-numbers.svg

5. Maritime transport: https://en.wikipedia.org/wiki/Maritime_transport

6. Investigation of the causes of maritime accidents in the inland waterways of Bangladesh: https://www.researchgate.net/publication/274838985_Investigation_of_the_causes_of_maritime_acci dents_in_the_inland_waterways_of_bangladesh

7. Collision of marine vehicles in Bangladesh: A study on accident characteristics: https://www.researchgate.net/publication/235250312_Collision_of_marine_vehicles_in_Bangladesh_ A_study_on_accident_characteristics

8. An Analysis of Accidents in the Inland Waterways of Bangladesh: Lessons from a Decade (2005-2015):
https://www.researchgate.net/publication/319946820_An_Analysis_of_Accidents_in_the_Inland_Wat erways_of_Bangladesh_Lessons_from_a_Decade_2005-2015

9. Waterway accident characteristics assessment and information system development: http://lib.buet.ac.bd:8080/xmlui/handle/123456789/529