FALLARM PROJECT REPORT

Capstone Project Report

In partial fulfillment for the degree of

Master of Science in Computer Science

By

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Acknowledgments

Abstract

Between 2012 and 2050, the United States will experience considerable growth in its older population. In 2050, the population aged 65 and over is projected to be 83.7 million, almost double its estimated population of 43.1 million in 2012. This ageing population has brought about multiple challenges and opportunities to the healthcare industry. One of these challenges is fall and injury prevention of the aged in hospitals, care facilities, as well as home settings.

According to the health report published by Centers for Disease Control and Prevention (CSC, 2009), nearly one-third of people over age of 65 suffer from severe falling injuries. Therefore, a remote monitoring system, which detects patient activities and sends alert directly to caregivers' receiver upon detection of an adverse event is essential.

 The project, "Fall-Arm", is a full and complete application that covers information collection, network communication, and data analysis. The application is compatible with a number of device sensors such as Gyro Sensor and Accelerator Sensor to provide location information. The device application enables the sensors to transfer measurement data automatically to server via network. Server tables the collected data and would send alert to emergency health-care immediately in case of a falling accident happens.

CONTENTS

1.0 INTRODUCTION

1.1 The Concept

Fall-Arm is a remote patient monitoring strategy that enables care providers for remote management of patient's risk of falling 24 hours a day, 7 days a week. Device continuously sense acceleration and orientation patterns and send this data to server that analyze it and classify risk. This risk class is conveyed back to patient as a feedback. Also the system reports any adverse events and alert is send directly to caretaker. Staff can login to website to get full details about the incident or simply to analyze patient data. This closed loop of information exchange increases patient awareness of risk and provides measures to prevent adverse events (QIRIS: Quality Innovation Research Instruction Safety). Also, internationalization has been implemented to support wide variety of users.

This project focuses on the software part, which in turn can be broadly categorized into below areas:

A) Internet programming – to develop a client-server model where the sensor will directly communicate with the server to provide the device data and the client interface will be used by the hospital staff to view, track patient's information, and process the data.

B) Network programming – socket programming to enable communication between the client and the server.

C) Database – to hold the data. This will include information about the patients, doctors, the information received from the device, etc.

C) Web Front-End – to enhance the look and feel of the website.

D) QA – Testing the whole project with Junit and Selenium.

1.2 Background

Fall-Arm is a project originated by QIRIS (Quality Innovation Research Instruction Safety), a non-profit association whose objective is to foster scientific research and technological innovation for person-centered health-care. QIRIS has developed Fall-Arm, a technological solution for fall prevention. Fall-Arm is based on a wearable device that informs the patient in situations where the risk is higher, promoting users' awareness on their responsible mobility (QIRIS: Quality Innovation Research Instruction Safety).

Fall-Arm is approved as capstone project and is customized by using Android as sensor device. This project will be researched, designed and developed to be submitted towards fulfillment of the degree requirements.

1.3 Objectives

To design and develop Fall-Arm patient monitoring system including programming on device side to record activity pattern and supporting software on server side to process data.

1.4 Environment

1. Host operating system platform: Server:

    Windows 7/8, Mac OS 64-bit Client: Android OS

2. Database:

    MySql 5.6.24

3. Programing Languages:

    Java, HTML 5, CSS 3, and Java Script

4. Design Pattern:

    MVC Approach

5. Environment:

   Selenium IDE 2.8.0, Eclipse 4.4.1, NetBeans 8.0, Android Studio (beta)

2.0 Design

2.1 Introduction

Unified Modeling Language (UML) is modeling framework used in object-oriented software engineering. Class Diagram is a Structure diagram, which describes structure of a system. Behavior diagrams include Use Case Diagram, which describes the functionality provided by a system in terms of actors and Activity diagram, which describes the operational step-by-step work-flows in a system. Sequence diagram is an Interaction diagram, which shows how objects communicate with each other

2.2 Use Case Diagram

To achieve a goal there must be some level of interaction between role and system and these interactions are represented in the form of use case diagram. The role can be an external actor or a computer system, which is capable of making decisions. Also a person can be represented as different actors based on the role he plays.

2.2.1 Use Case Diagram of Networking

NETWORKSYSTEM
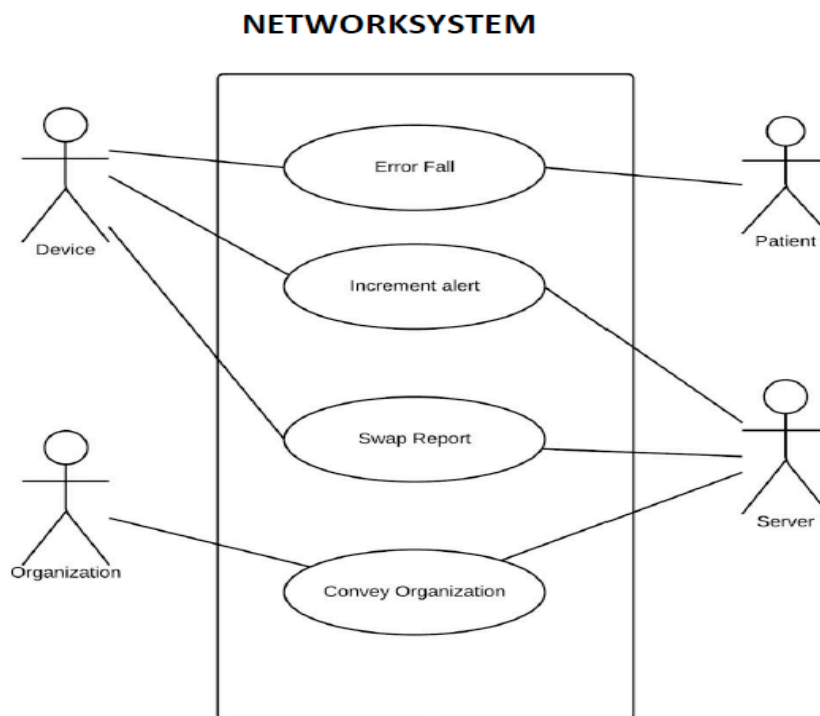
2.2.2 Use Case Diagram of Internet

Internet System
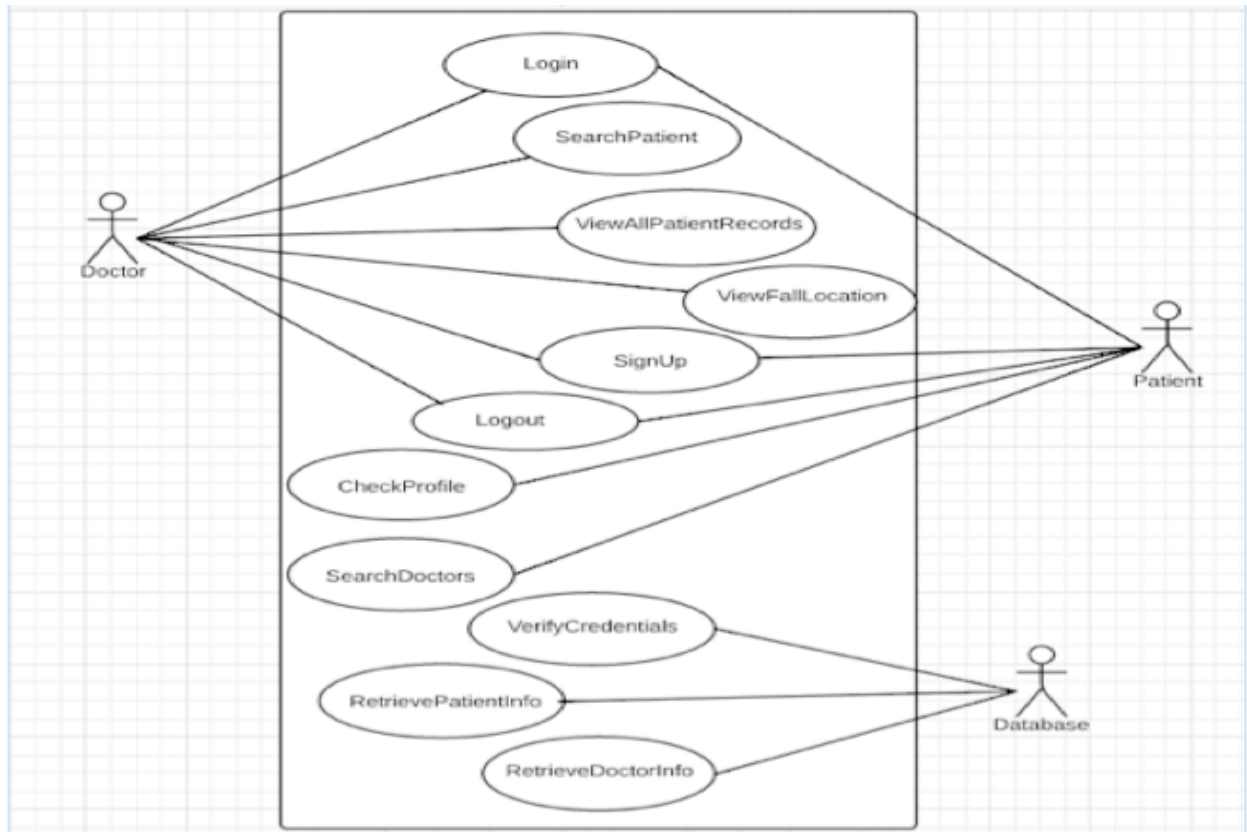
2.2.3 Use Case Diagram of Database
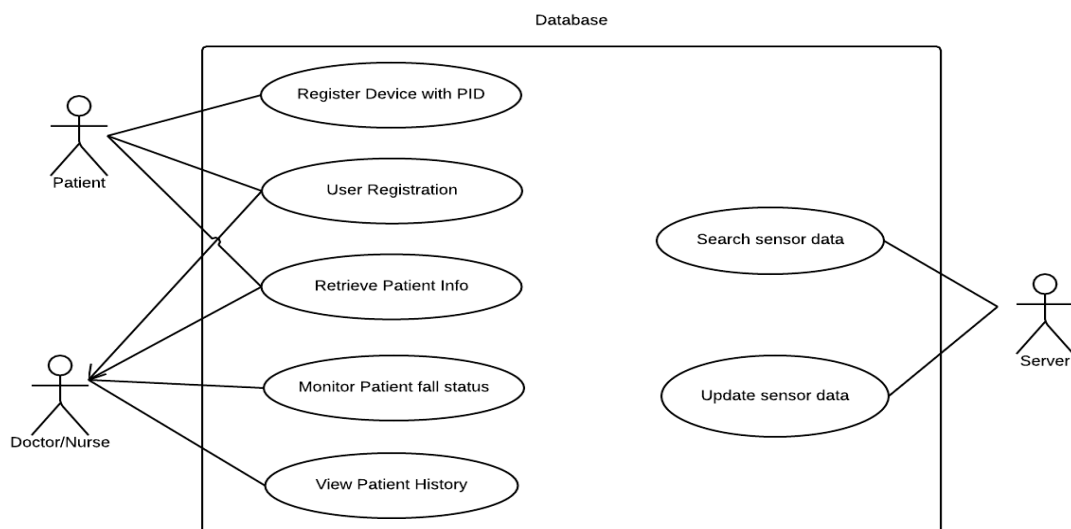
2.2.4 Use Case Diagram of Front End
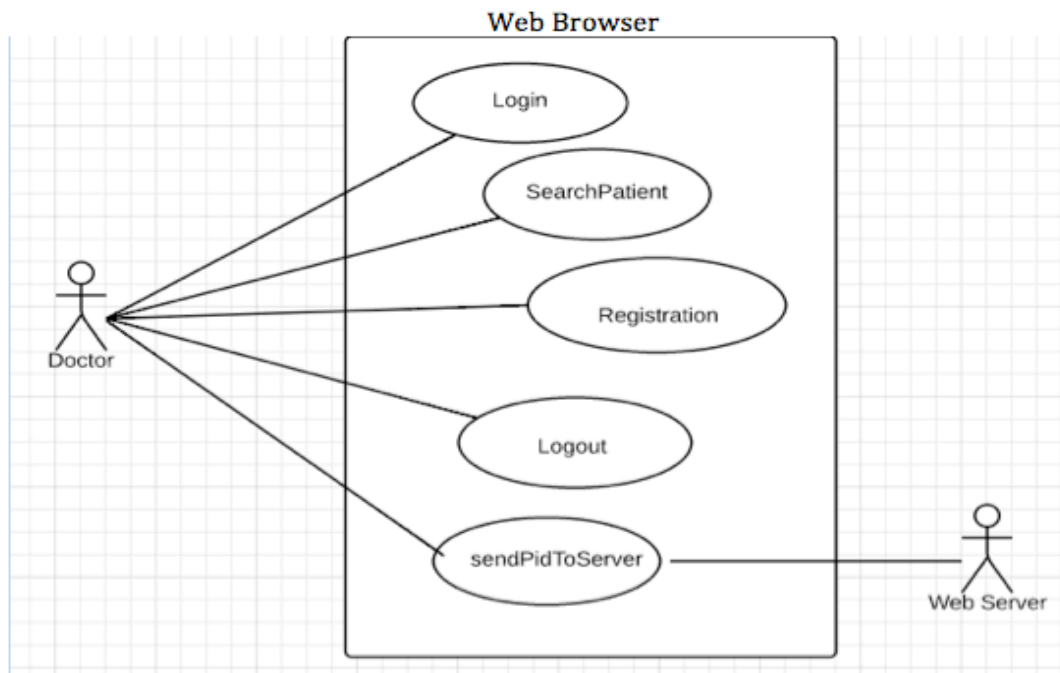
2.3 Class Diagram

Class diagram is a static diagram that shows structure of a system and contains classes, attributes and methods. Additionally it includes relationships between classes. It can also be used for data modeling to define and analyze data needed to support processes.

2.3.1 Class Diagram of Device and Networking

5

2.3.2 Class Diagram of Internet

Patient

+patientid : int
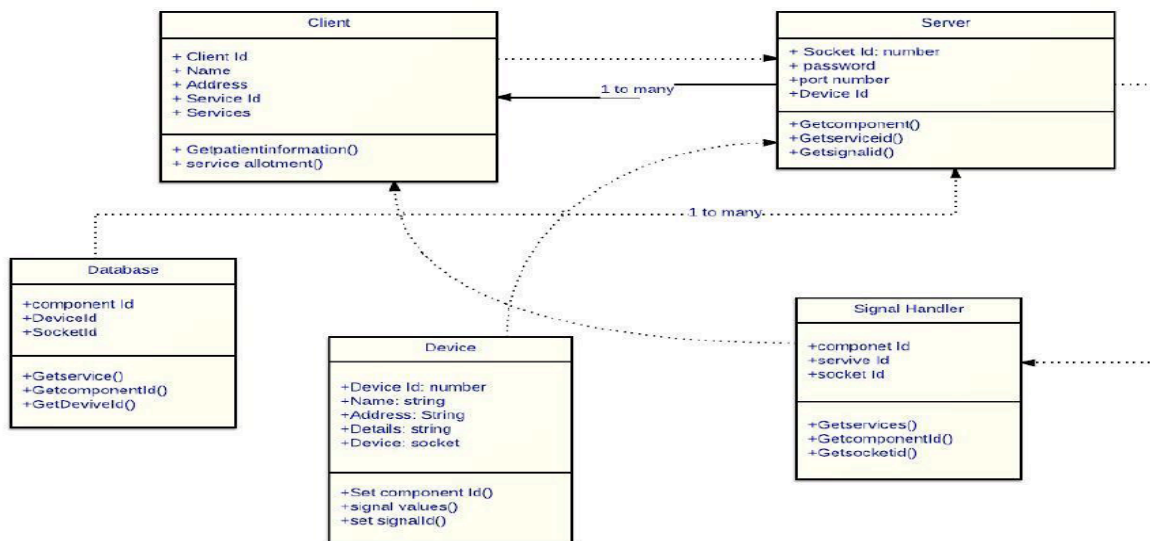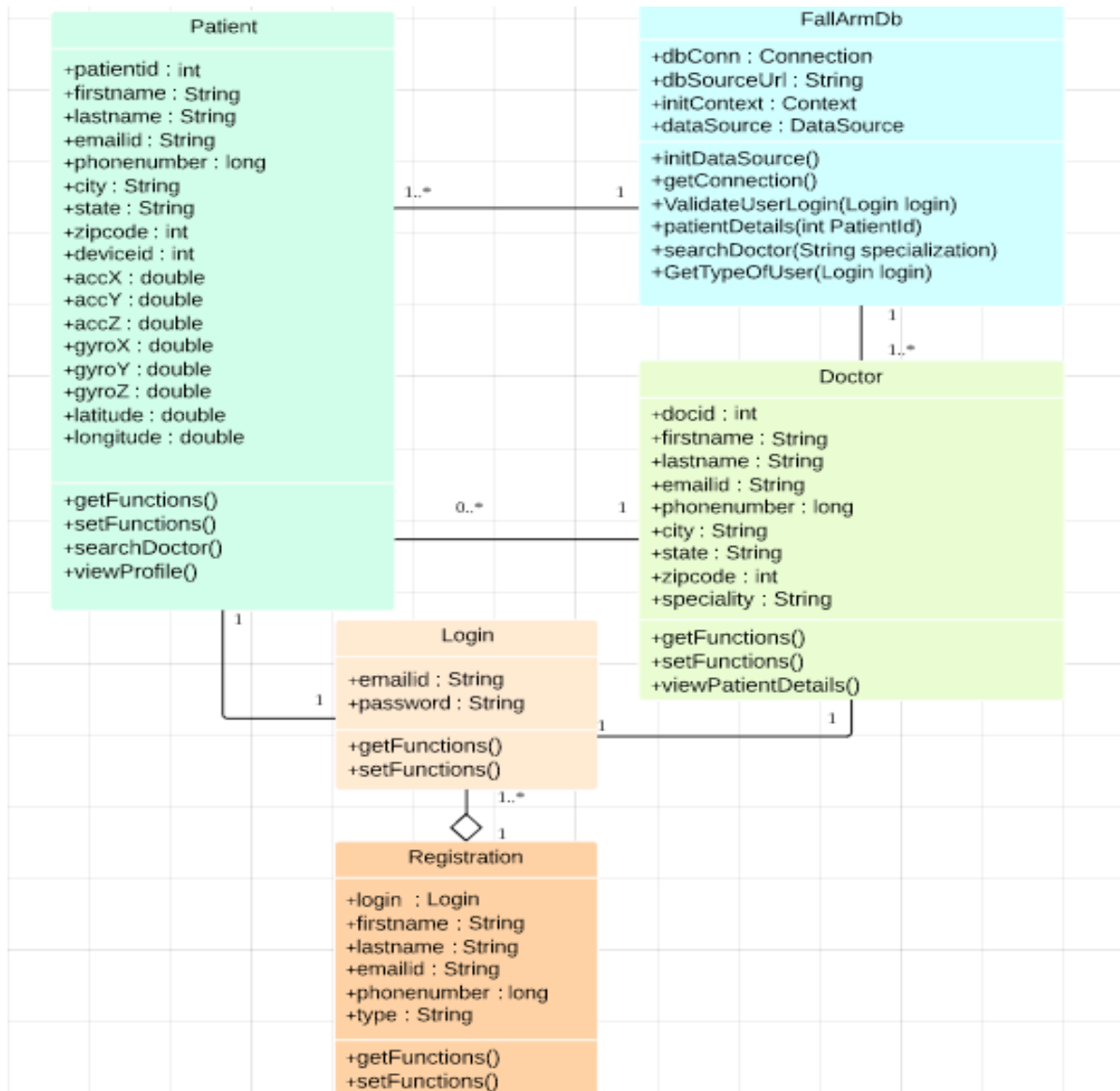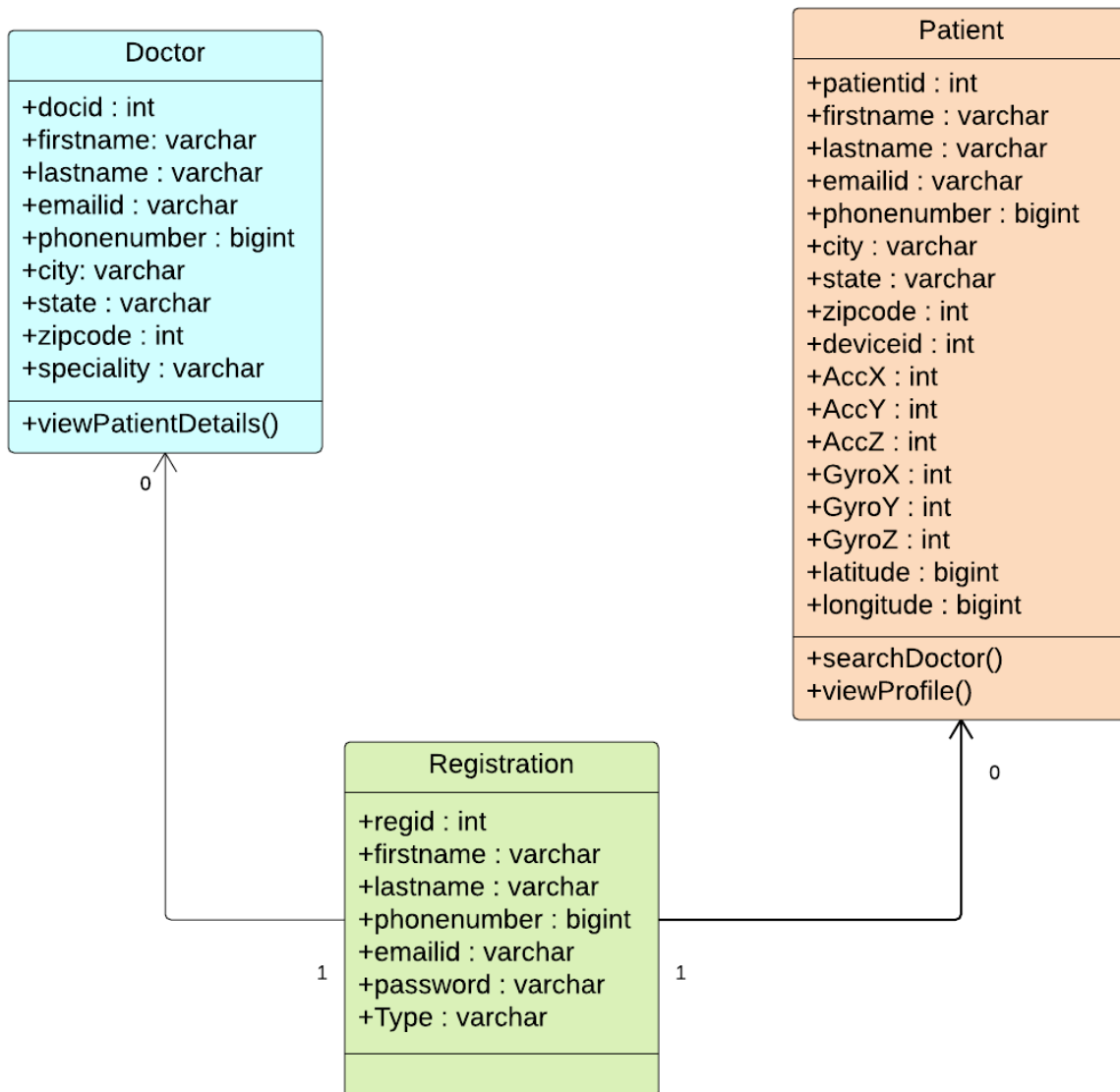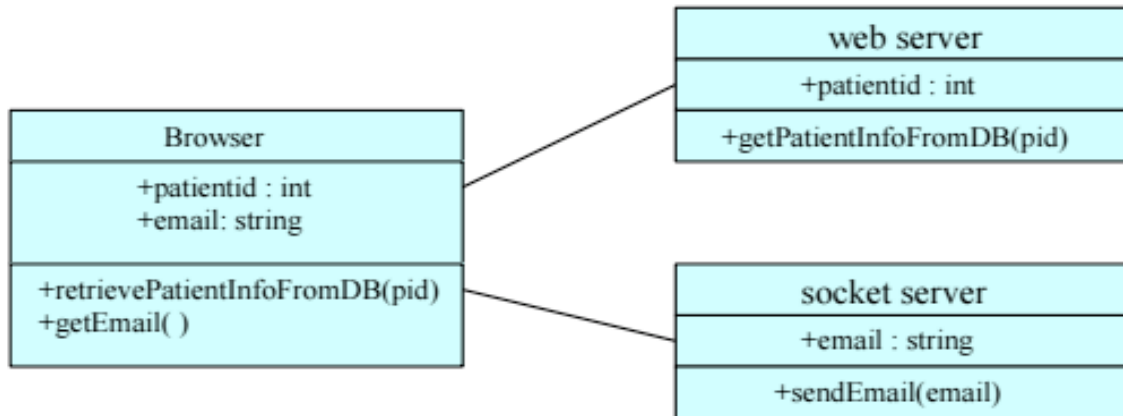+firstname : String
+lastname : String
+emailid : String
+phonenumber : long
+city : String
+state : String
+zipcode : int
+deviceid : int
+accX : double
+accY : double
+accZ : double
+gyroX : double
+gyroY : double
+gyroZ : double
+latitude : double
+longitude : double

+getFunctions()
+setFunctions()
+searchDoctor()
+viewProfile()

FallArmDb

+dbConn : Connection
+dbSourceUrl : String
+initContext : Context
+dataSource : DataSource

+initDataSource()
+getConnection()
+ValidateUserLogin(Login login)
+patientDetails(int PatientId)
+searchDoctor(String specialization)
+GetTypeOfUser(Login login)

Doctor

+docid : int
+firstname : String
+lastname : String
+emailid : String
+phonenumber : long
+city : String
+state : String
+zipcode : int
+speciality : String

+getFunctions()
+setFunctions()
+viewPatientDetails()

Login

+emailid : String
+password : String

+getFunctions()
+setFunctions()

Registration

+login : Login
+firstname : String
+lastname : String
+emailid : String
+phonenumber : long
+type : String

+getFunctions()
+setFunctions()

1..*   1

0..*   1

1   1

1..*

1

1..*

1

1   1

2.3.3 Class Diagram of Database

Doctor

+docid : int
+firstname: varchar
+lastname : varchar
+emailid : varchar
+phonenumber : bigint
+city: varchar
+state : varchar
+zipcode : int
+speciality : varchar

+viewPatientDetails()

Patient

+patientid : int
+firstname : varchar
+lastname : varchar
+emailid : varchar
+phonenumber : bigint
+city : varchar
+state : varchar
+zipcode : int
+deviceid : int
+AccX : int
+AccY : int
+AccZ : int
+GyroX : int
+GyroY : int
+GyroZ : int
+latitude : bigint
+longitude : bigint

+searchDoctor()
+viewProfile()

Registration

+regid : int
+firstname : varchar
+lastname : varchar
+phonenumber : bigint
+emailid : varchar
+password : varchar
+Type : varchar

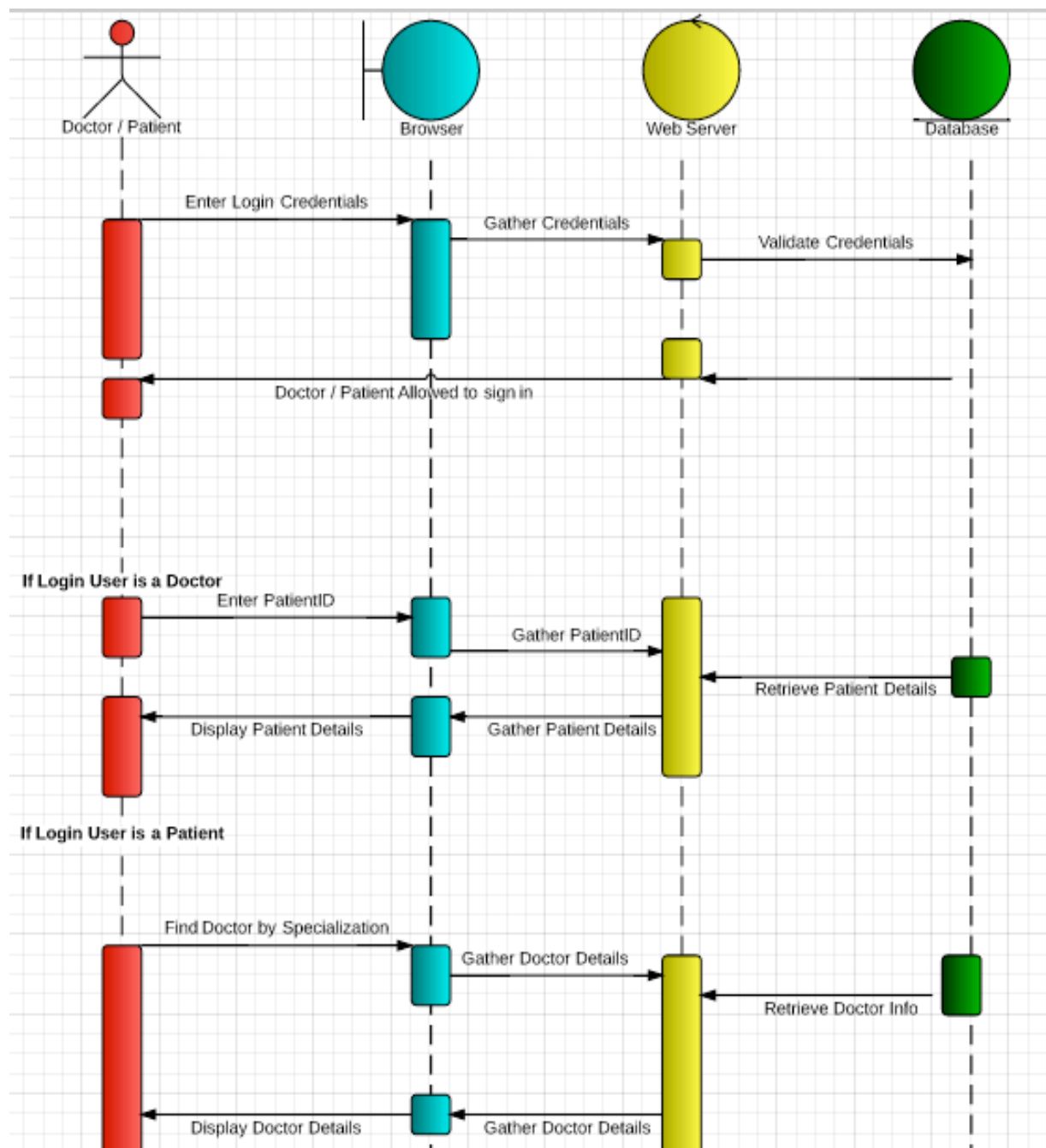**2.3.4 Class Diagram of Front End**

2.4 Sequence Diagram

A sequence diagram, in the context of UML, represents object collaboration and is used to define event sequences between objects for a certain outcome. A sequence diagram is an essential component used in processes related to analysis, design and documentation. A sequence diagram is also known as a timing diagram, event diagram and event scenario
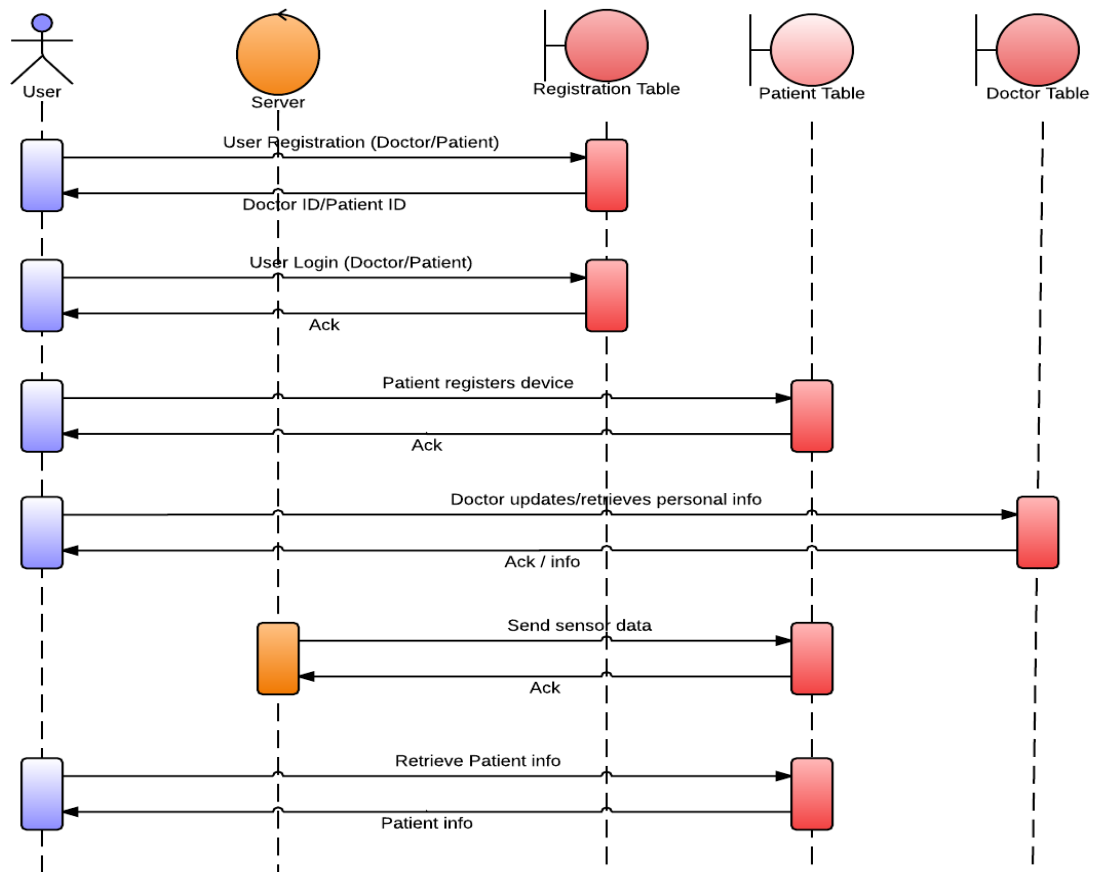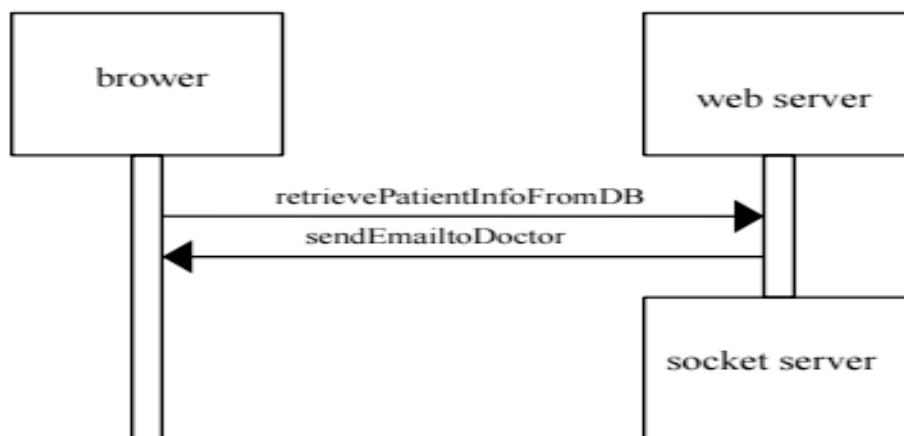
2.4.1 Sequence Diagram of Networking
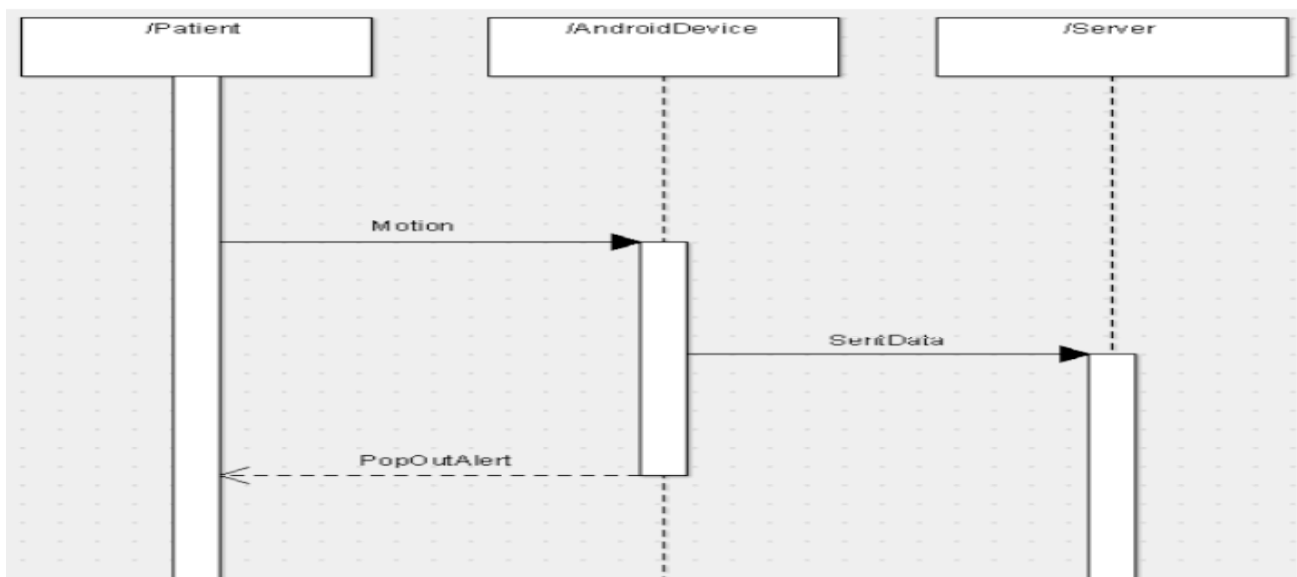
2.4.2 Sequence Diagram of Internet

2.4.3 Sequence Diagram of Database

2.4.4 Sequence Diagram of Front End

3.0 Implementation Details

3.1 Introduction

Software includes an android device to monitor person's activities. Sensor and device is programmed to detect and track acceleration, orientation, longitude and latitude values. Java based Socket Programming is for communication with server- device and server-staff. Java, J2EE Servlets, JDBC, JSP, html and CSS are used to implement the Web UI and Web Server for the Fall-Arm Guardian project. We are developing server side programming that will monitor patient's activities. Patient's risk will be calculated and related information is stored in the database, which can be later used to analyze and display specific patterns. Internet based GUI is provided for staff to access patient details. User Interface should be designed to match the skills, experience and expectations of users and user interface design. In this project, Internet programming mainly includes designing the graphical user interface for the staff at the hospital so that they can view the patient details.

3.2 Web Front-End

HTML: Html is the main markup language used for displaying web pages and any information that can be displayed in a web browser.

CSS: Cascading Style Sheets (CSS) is a style sheet language used for describing the look and formatting of a document written in a markup language.

JavaScript: JavaScript is the programming language of HTML and the Web.

3.3 Internet programming – Java

Servlet: A servlet is a small Java program that runs within a Web server. Servlets receive and respond to requests from Web clients, usually across HTTP, the HyperText Transfer Protocol.

JSP: JavaServer Pages (JSP) is a technology that helps software developers create dynamically generated web pages based on HTML, XML, or other document types. It is used in developing web pages that support dynamic content, which helps developers insert java code in HTML pages by making use of special JSP tags. Using JSP, you can collect input from users through web page forms, present records from a database or another source, and create web pages dynamically. JSP tags can be used for a variety of purposes, such as retrieving information from a database or registering user preferences, accessing JavaBeans components, passing control between pages and sharing information between requests, pages etc. JSTL: JSP Standard Tag Library

3.4 Database – MySQL

Created a Fall-Arm database in MySQL. JDBC is used to connect MYSQL with java program. In the java class we have methods to retrieve data from database and to store data into database. Android device send the signal (6 parameters) to the socket server, then it will insert the signal data to the sensor data table in the database with patient ID.

3.5 Network Programming – Java

For socket programming Java networking API is used. Messages will be sent and received using SMTP (Simple Mail Transfer Protocol).

3.5.1 Data from Android Emulator/device:

The format contains following fields
 • Acceleration: 3 Float values X, Y, Z axis
 • Orientation: 3 Float values for X, Y, Z axis
 • Geo Location: Latitude and Longitude
 • Patient Id: Patient Id is Unique.

3.5.2 Risk Calculation
 Server-side programming includes risk calculation. The risk is measured in a scale of 100, (100 being the highest and 1 being the lowest). The risk is calculated based on the 3 Acceleration parameters. All of these values are stored in the database. The correction for acceleration due to gravity is applied on these measured parameters. The risk algorithm is to use the three coordinates of the accelerometer to find the level of risk, and calculated as (round (POW (x, 2) + POW (y, 2) + POW (z, 2))).

3.5.3 SMTP

JavaxMail API is used to send alert messages to staff and it is sent via Gmail SMTP server using SSL connection. Sender's email, password is authenticated and an email/message is sent to staff. The message includes patient id and risk factor in it, so that staff can login to website.

An alert message sent via mail/SMS to the nurse/staff. The message displays the PID number and the risk factor of the patient who is in risk.
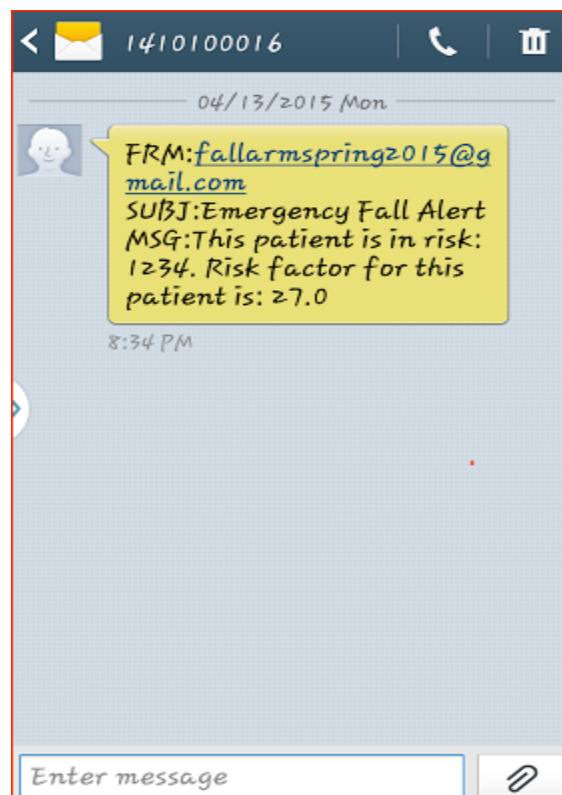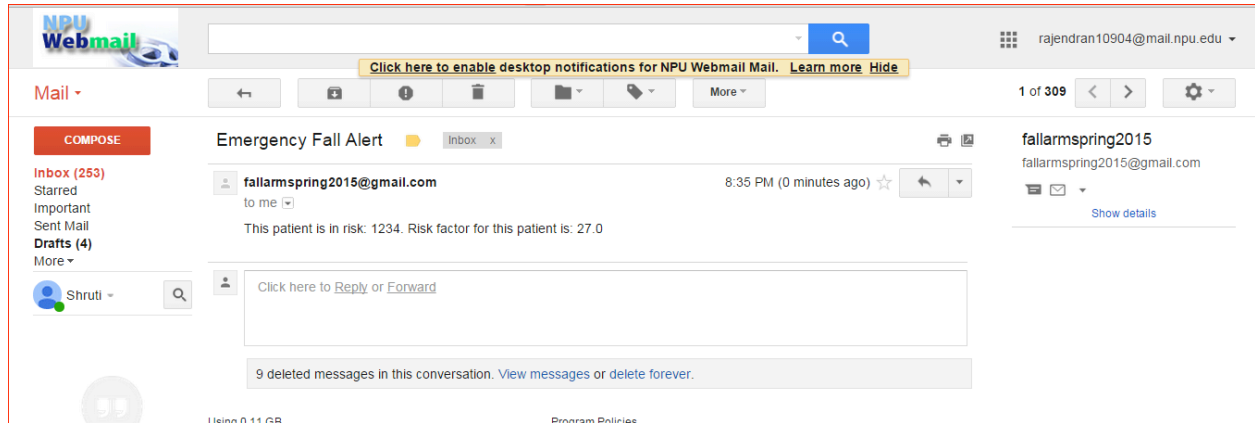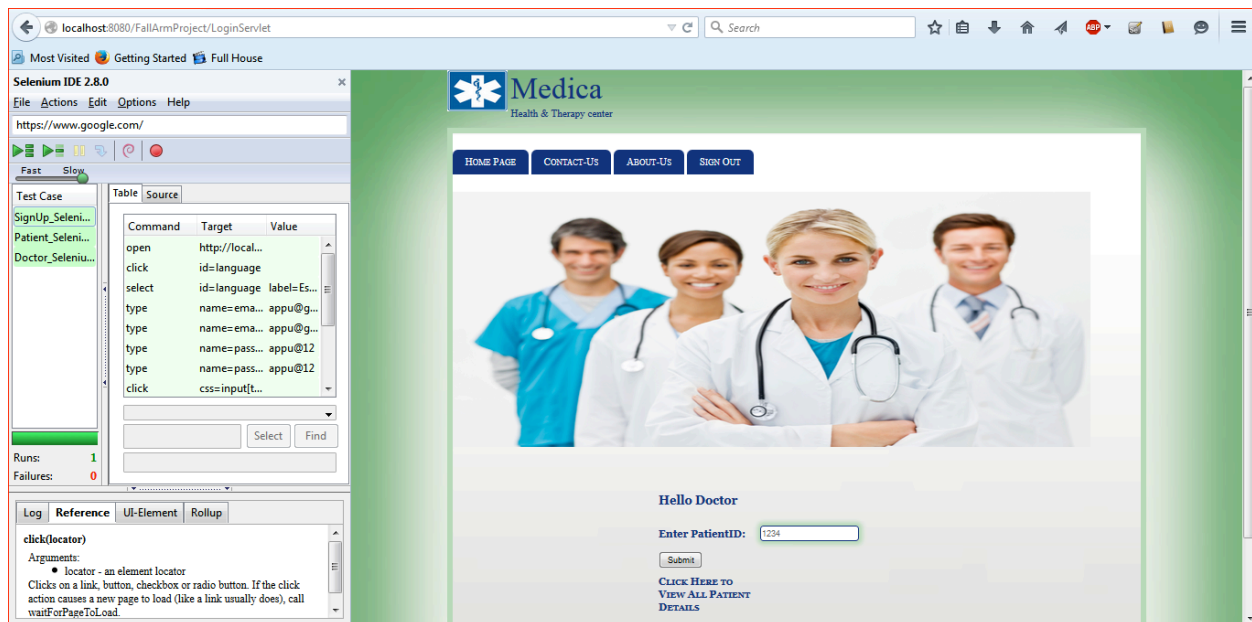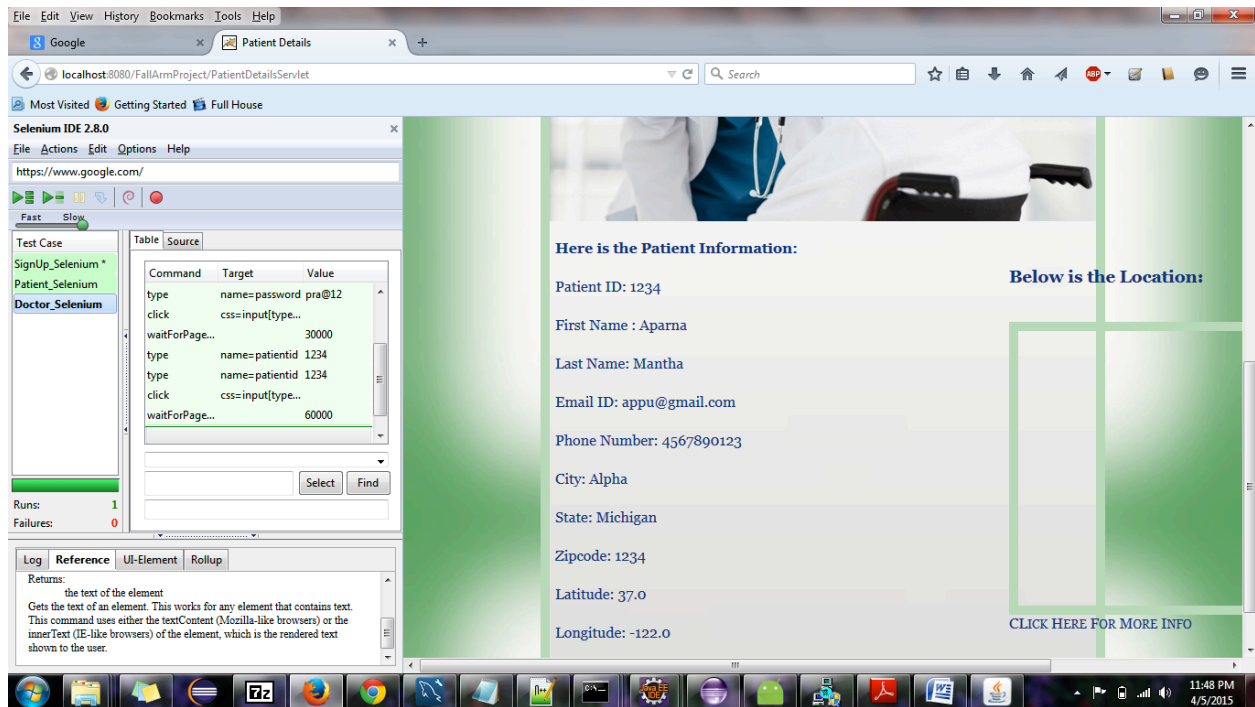
4.0 Test Result

4.1 Introduction

Software testing can be stated as the process of validating and verifying that a computer program/application: Testing tools are JUNIT, Selenium. Junit testing was done using Eclipse to investigate and validate the application developed. Selenium integrated JUnit is used to test the Java Servlet Pages. JUnit can also be used to test the database part of the application.

4.1.1 Test Environment

Junit mechanism was used to create unit tests and test suites. We need to add a jar file of Junit to the eclipse to create the Junit test case environment. Selenium was used to test the web interface and web implementation. Selenium IDE is downloaded as a plugin in the Mozilla Firefox. Attaching a JUNIT4 jar file to the eclipse creates Junit test case environment and Selenium is downloaded as a plugin in MOZILLA FIREFOX.
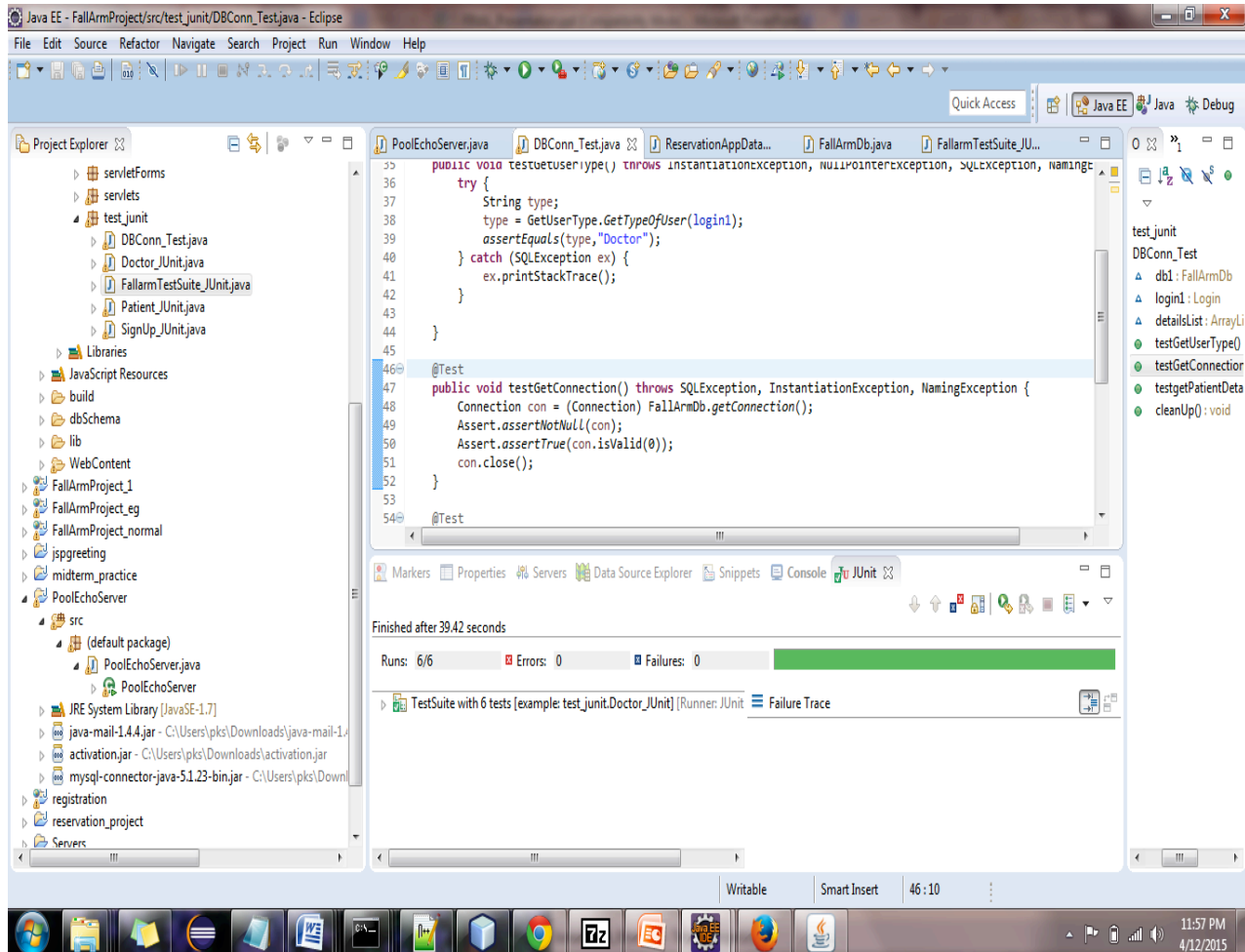
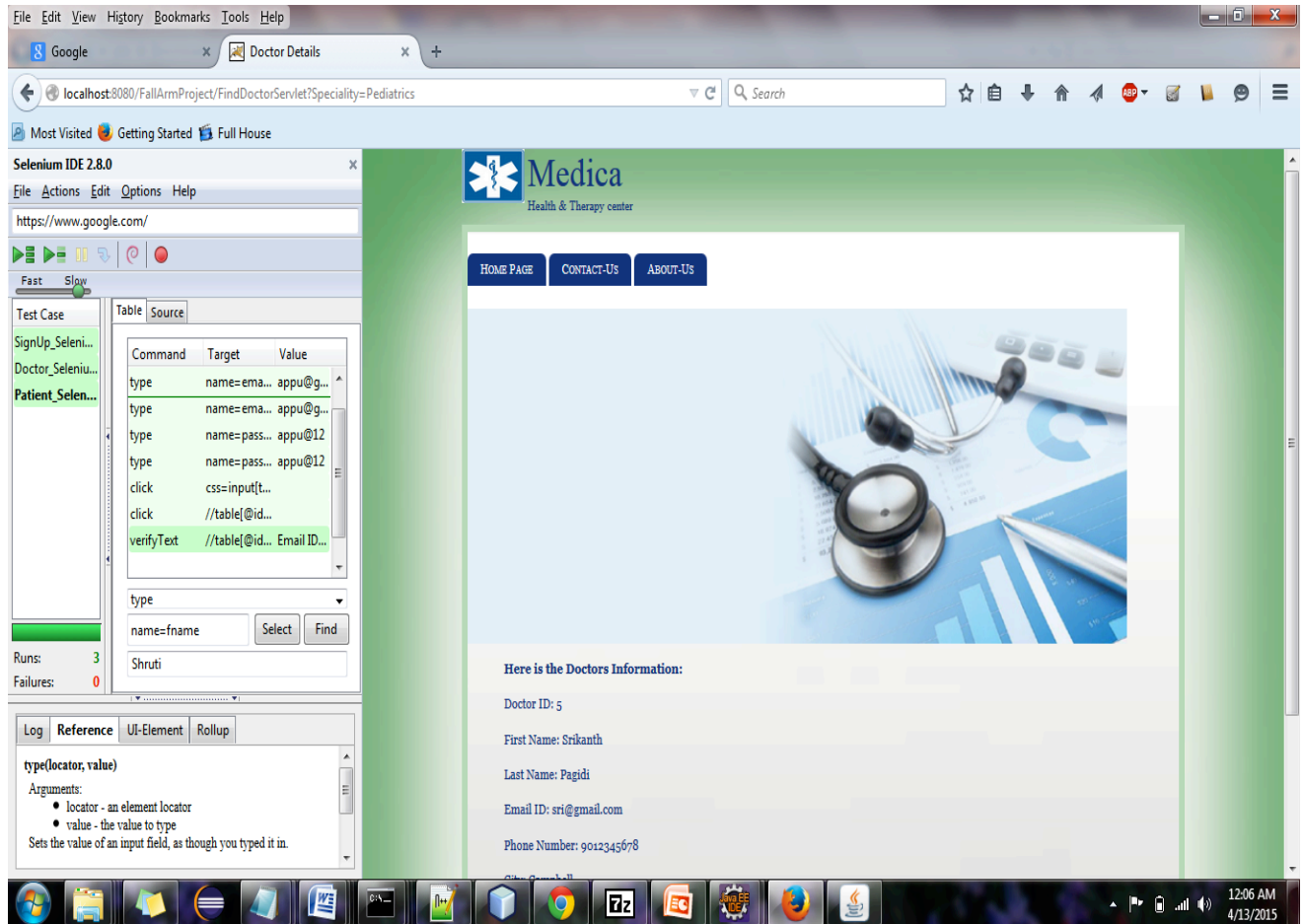## 4.2 Internet Test

4.3 Database Test
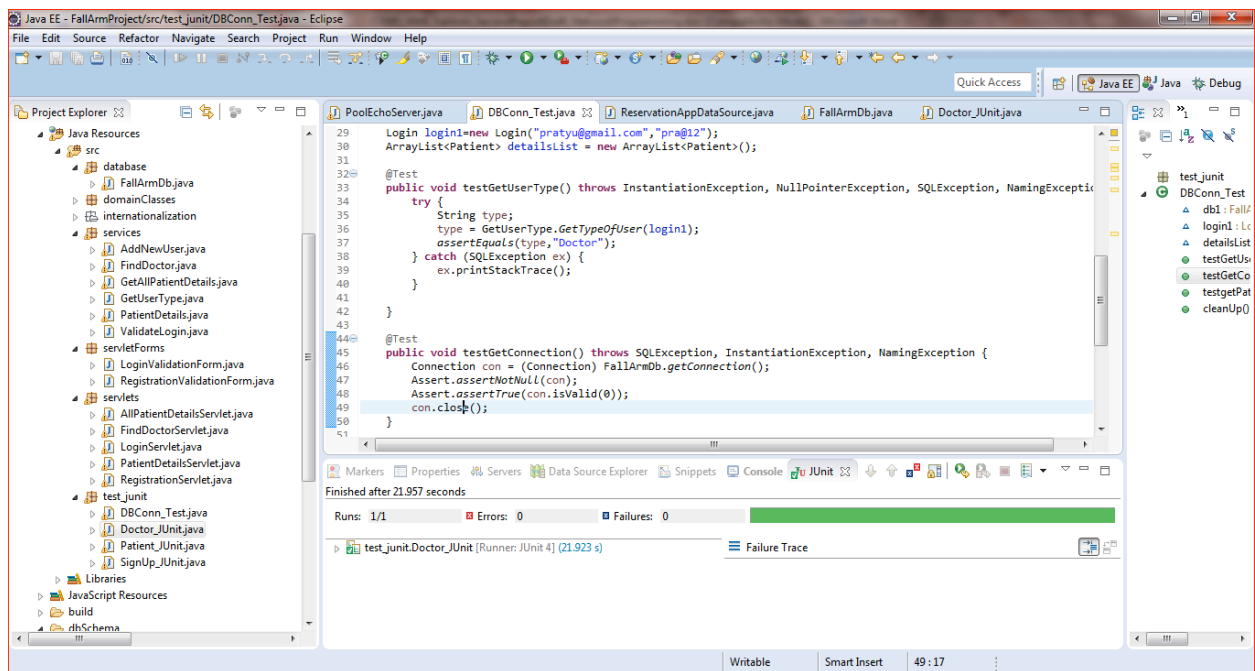
4.3.1 Test Result

JUNIT

Selenium

5.0 Future Enhancements

In this project nurse may send updates or suggestions to the patient as a first aid

6.0 Conclusion

The complete software package is successfully implemented and available for service. From android device sensor data is sent successfully to the server side, on the server side the risk of the patient is calculated. When a fall is detected, email will be sent to the Doctor in the hospital, doctor logs into the system to check patient information. The Fall-Arm software helps patient in getting emergency help in the event of fall.

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