Smart Hear - Intelligent Hearing for Android

Project Second Iteration Report

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Group 1:

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I. Introduction

This document intends to provide an overall description of the project named "Smart Hear" in detail. The project schedule and the plan of action is also discussed. The proposal document submitted would give an insight about what the project is about. The main outcome of the Second increment was the high and low level design of the application. As of current state we have not deviated from our initial proposal that we submitted earlier.

II. Project goal and objectives

Overall goal

The overall goal is to provide a hearing aid through the use of the smart phone that is accessible to every person today. The smart phone can be utilized in a way that it can act similar to the hearing dog that is what motivated us to take up this idea and try to implement using the smart phone.

This application can be used to provide benefits to the special abled people who face challenges in listening to sound. All the features come at the cost of installing an application that is freely provided to the user. No costs attached.

Objectives

- To provide a smart hearing aid to the user.
- To implement features to provide the user flexibility in varying certain key features of sound like frequency, tempo etc.
- To provide notifications to the user when there are important events like a door bell ring or an alarm that goes off.
- To develop a user friendly application.
- To ensure that we have a light weight application on the client end.
- To make sure that the context is recognized and the user settings are changed accordingly.
- Implement knowledge discovery to provide a summary of a topic that the user is listening or recording.
- Provide user customizable settings that the user can adjust to suit his or her needs.
- Ensure that the application can deliver its functionality at minimal cost of operation.
- Provide a user guide to understand and use the application.

III. Project background and related work

The app is not a new invention or a brand new concept. But the implementation aspect of it is what makes it unique from the others. The following are the projects that are similar to what our idea is.

- Resound LiNX: It is a smart hearing aid kit that can integrate with Apple Iphone and other android devices. The device does noise cancellation and also amplifies the sound that the user is listening to. The device can also integrate with smart watches and provide very handy functionality. But the downfall is that it is an additional device that has to be purchased and is does not have notification features to the user.
- Siemens Hearing Aids: These were introduced at the International CES 2015. They are pretty close to what an interactive hearing aid can deliver and seamlessly work hand in hand with smart devices. They require a specific app to connect the device with the hand held devices and only then can they provide the functionality. On the flipside the product is priced high and is not for everyone to afford it.

Significance

The major significance of the application lies in the fact that the all the useful services are provided under one system. There is no need of another device for the hearing enhancements. The user can access all the features through his smart phone. Even form the implementation aspect the usage of big data framework would ensure that the application can process the data at high performance rates. This would also reduce the cost of the creating and operating the application. User customizable settings is one of the major significance of the project.

IV. Proposed system

Requirements specifications

- The application will provide users facility to login with their Google plus account.
- User should have the flexibility to login with his Facebook account.
- The system will display the user his information along with his profile picture.

- An Android application that serves as the smart hearing aid and also provides a user friendly model for the feature extraction.
- A machine learning framework that can provide a model based on the features received from the client end.
- Analysis of audio files to observe their characteristics.
- Collection of features present in an audio file and weighing the features to select the vital features dynamically.
- To send text notifications on various events based on the pattern of previous audios.
- To be able to detect and send alarms on to the device in potential hazardous situations.

- Integration of the client and the processing framework for a complete application that can perform as a smart hearing device.

Workflow analysis

The first and the most fundamental workflow of the application is that of the designing the UI for the system. This involves selecting the proper HTML elements and arranging the elements in an appropriate manner. It includes making use of the CSS attributes to style the UI of the application. Each page of the application is to be custom designed for suiting the needs of the service or feature being provided over that page. This would also include capturing the sound from the device and storing it in the device storage.

Second task would be do perform basic filtering and other alterations to the sound using libraries such as high pass, band pass etc. The frequency, tempo, pitch and other features of the sound can be altered and extracted individually.

The third workflow deals with the performing model discovery or applying the best fit model over the features extracted. This would involve applying machine learning algorithms like Decision tree etc. to classify the source of the sound.

Technological and architectural requirements

On the technological aspect the project is pretty much dependent on the native Android libraries for implementing the client functionality. This would also include some external Java or Android based libraries or plugins for managing the operations on the sound recorder. The primary development language for the client would Java and XML for the UI part.

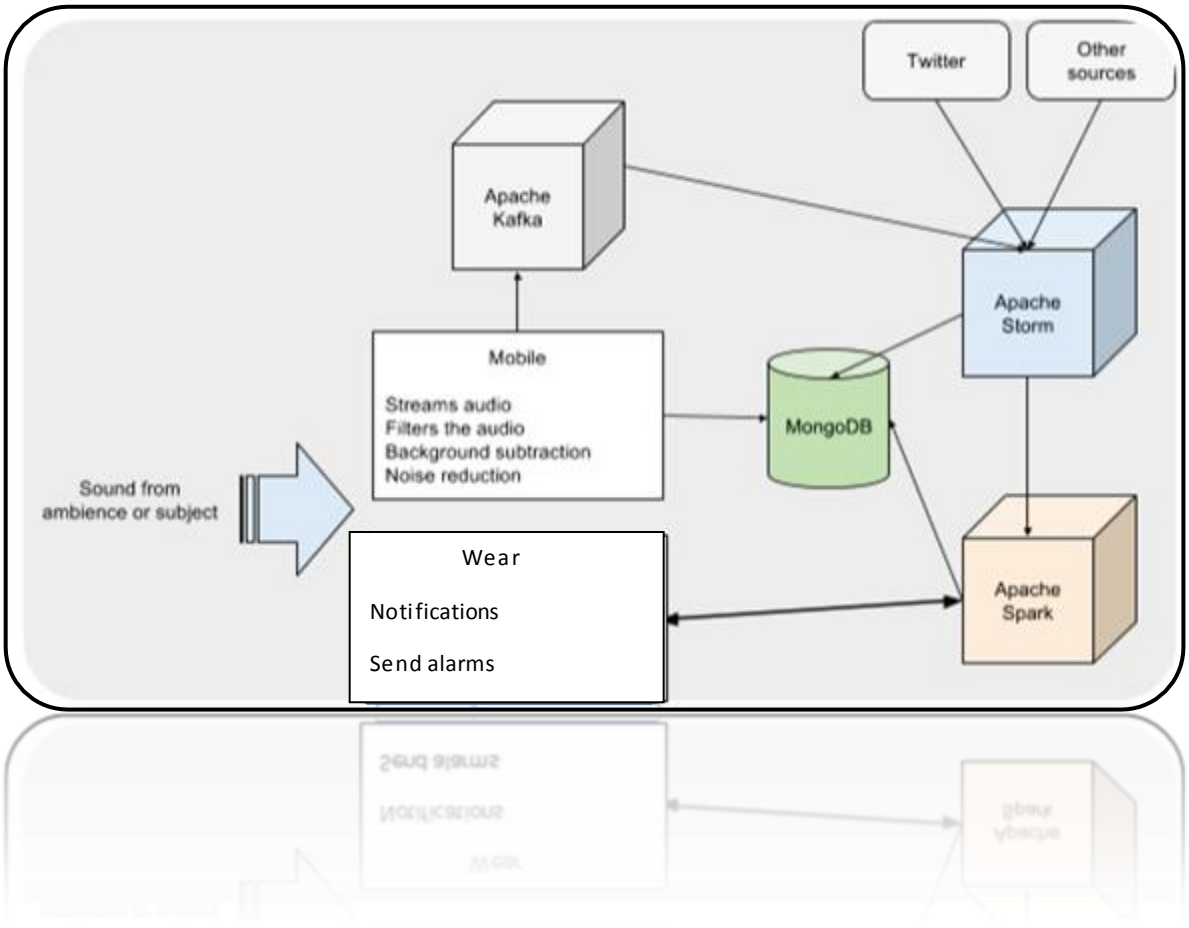
On the server end it would be mostly Scala that would be running on Spark to integrate with the client to perform the machine learning aspect of the application. At the current stage the database that would be in use would MongoDB.

In terms of the architectural framework we are using a traditional 3 layer architecture but the interaction between the layers may vary depending on the situation. In terms of the traditional scenario the recording is present in the database and then the spark engine processes the data to categorize the audio data. In the real time recording scenario the UI layer directly interacts with the spark engine to process the data as it records. The framework would ensure this flexibility is provided to the user.

Framework specifications

The system would be a flexible framework that can incorporate the services that are customized to suit the user and application needs. The system architecture would comprise of a client server architecture in which our application would be a client accessing service hosted or offered through different servers. Internet would be the medium of communication between the application and the services hosted in the web. One of the service that the application offers requires the traditional 3 tier architecture where in the data is stored through the UI layer into the business layer and ends up in the database. The system architecture is represented in the diagram below.

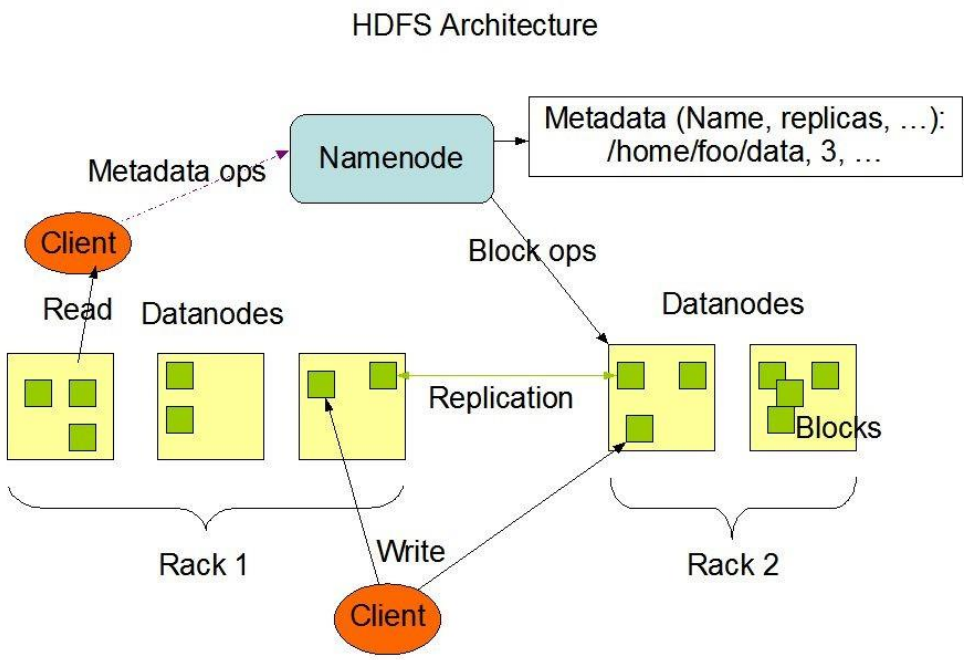
Architecture Diagram:



System specification

Apache Hadoop

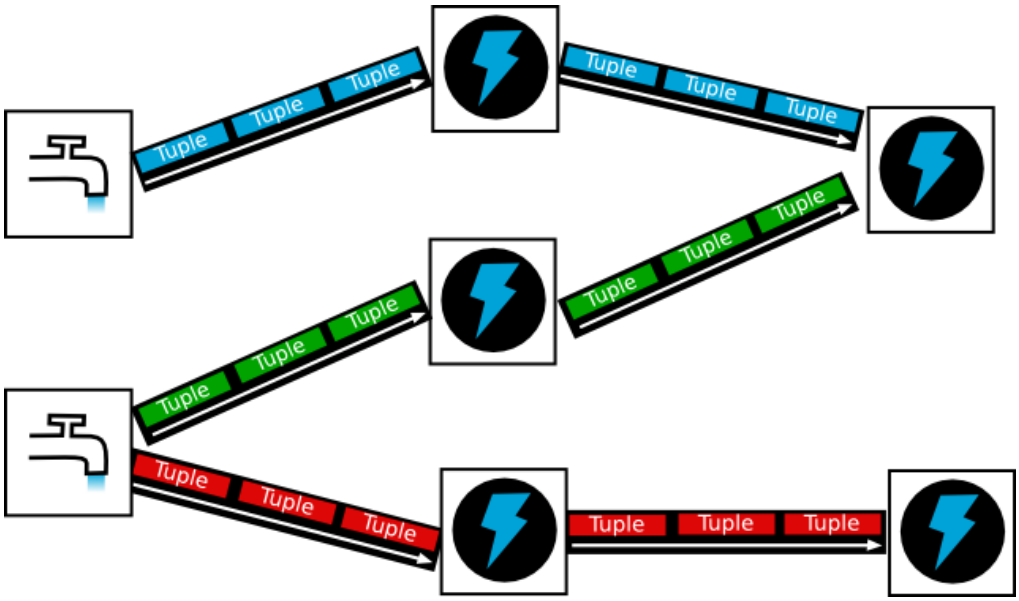
Apache Hadoop is open source framework that processes large amount of distributed data sets among the cluster of nodes using the programming models. Hadoop is developed to be scalable, reliable and distributed computing. It is designed to scale from single server to a cluster of nodes where each node offers local computations and storage. It has two parts namely HDFS and MapReduce. It uses HDFS to store the data where it breaks the input data and distributes to nodes, this enables the parallel processing of data. The MapReduce distributes the programs across the nodes where they performs operations on the data stored in HDFS. Hadoop has YARN which helps in cluster resource management and job scheduling.



3.3.2. Apache Storm

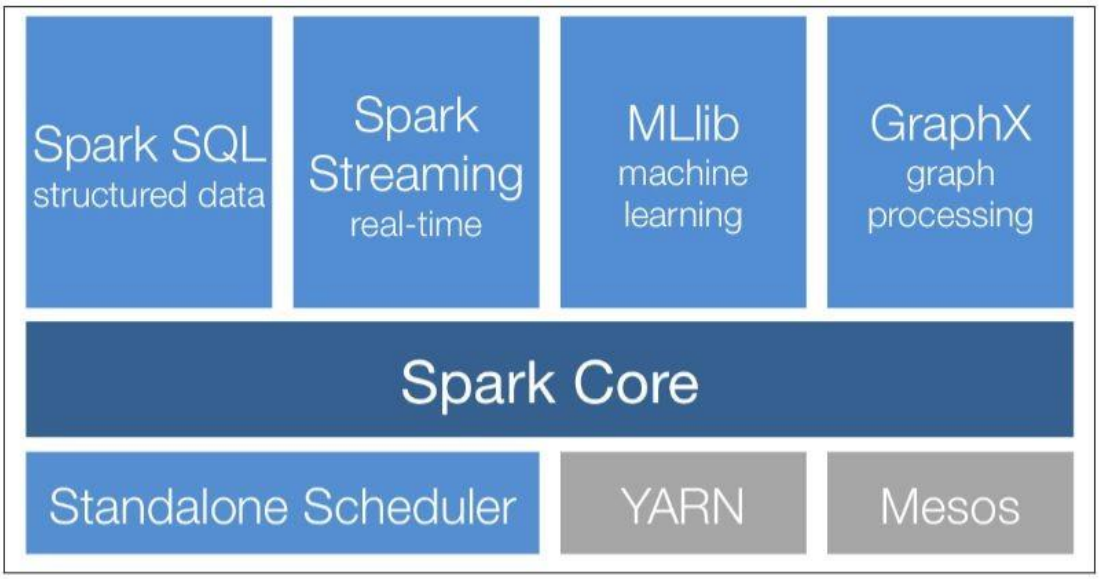
Apache Storm is a distributed computational framework which process high volume of real-time data. It is extremely fast and process millions of records on each node of a cluster at a time. It supports any programming language. Apache storm has three abstractions named spout, bolt and topology. Spout is the source of data, It receives data from kafka or from twitter API or from any other source of information. Bolt processes the input streams of data and can has the ability to produce many output data streams. It works with all the logical computations like functions, filter etc., The topology is the network of spouts and bolts where the edges are connected to bolts which are output streams of spouts.

Strom has a Nimbus node which uploads computations, distributes code across the nodes, and monitors the computations and instantiates the workers. The zoo-keeper coordinates the cluster and the nimbus node. The supervisor nodes are the worker nodes of storm which works based on the commands of nimbus node. Some of the storm use cases are real-time analytics, distributed RPC and more. Storm is fault tolerant and is scalable and is easy to setup and operate.



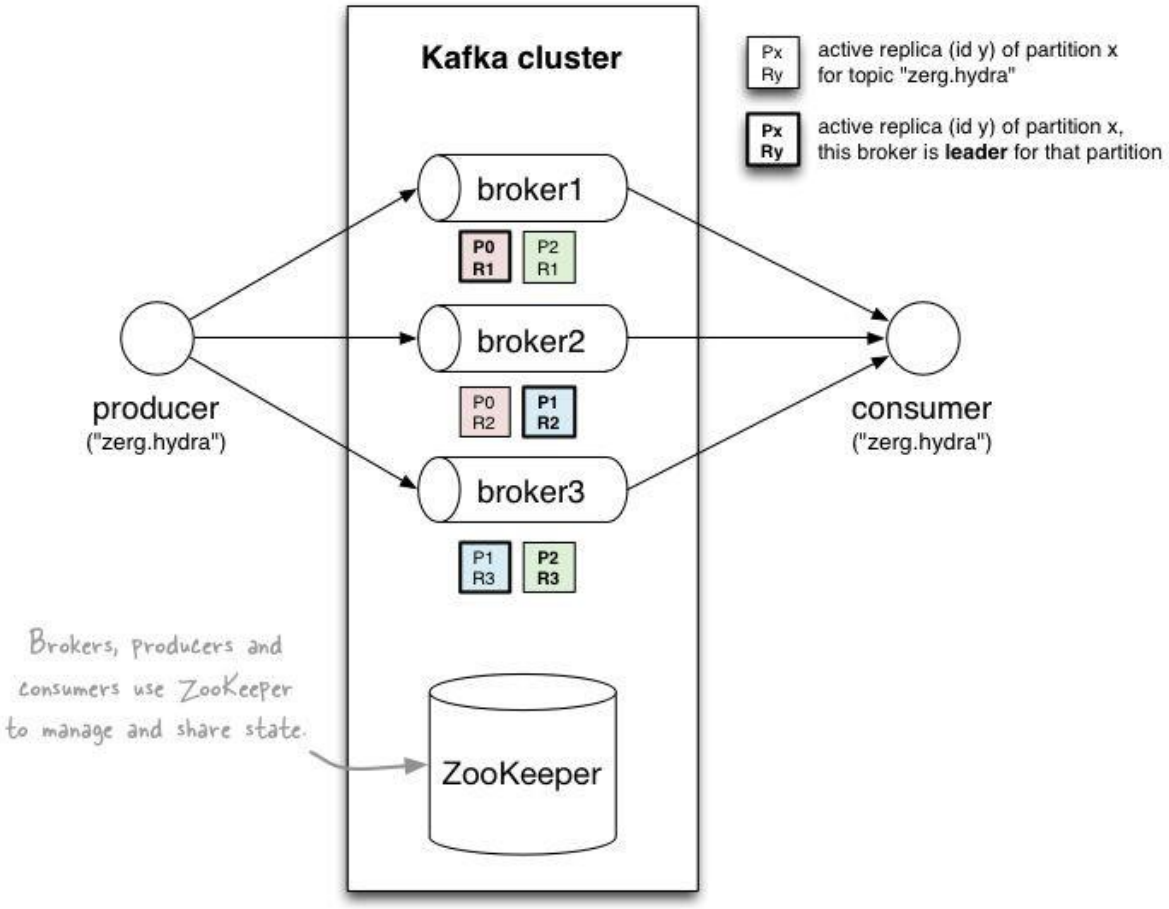
3.3.3. Apache Spark

Apache Spark is a cluster computing platform which has been designed to be fast. Spark extends MapReduce to support more types of computations, Interactive queries and stream data processing. It provides high level APIs in Java, Scala, Python and R, and an optimized engine that supports general execution graphs. It also supports a rich set of higher-level tools including Spark SQL for structured data processing and using SQL and Apache Hive.



3.3.4. Apache Kafka

Apache Kafka is a high distributed messaging system with replicated, partitioned commit log services. It was originated at LinkedIn. Implemented in scala and java. Kafka supports high throughput to support huge volume of data, Supports real-time processing of these feeds to create new desired feeds, Supports large data backlogs to handle any system faults, Guarantees fault tolerance in case of machine failure. Supports low latency delivery. Kafka has high reads and high writes. Kafka has main 3 core concepts Producer, Brokers, Consumers.



3.3.5. MongoDB

MongoDB is an open source document based database which stores the data in JSON format. MongoDB is classified as a NOSQL database. It can be used as a file system by using the concept of load balancing and replications.

After processing the audio signal the classification of the signal which obtained is stored in the MongoDB. We store the classification in three collections named

1. Users
2. Locations and
3. Settings

It stores the audio files, users, user ids, tags, latitude, longitude, time in the collections.

3.3.6. R (RStudio)

R is one of the famous data analytics tool available and being used by researchers from many decades. R is well known as a Software environment as well as a programming language for graphics and statistical computing used majorly for data mining by data miners and statisticians.

Statistical and Graphical techniques such as Linear and Nonlinear modeling, clustering, classification and others are implemented using R and its libraries. When compared to most of the statistical computing languages, R has much stronger Object Oriented Programming facilities. Static graphs is the other major strength of R.

RStudio is the open source IDE which supports R programming language and it is available for free in two editions. One is the RStudio Desktop edition which is used to run desktop applications locally. The other is the RStudio Server which uses web browsers to access RStudio running on a remote linux server.

V. Project plan

The proposed project plan is outlined the by the screen shot from the Kanban tool. The project is divided into four phases each of which is guide lined by a test driven approach. Each iteration has four tasks categorized by stories of designing phase, building the service through implementation and testing. The final task is to store the completed tasks for future integration.

Phase 2:
This phase mainly deals with the designing the system for the implementation phase. The tasks of this phase mainly focuses on the UML diagram and collecting the necessary information for the realization and the implementation of the system. The end result of the phase 1 are initial screens of the application. These are just the rudimentary level implementation screens and these may change during application development process.

Timelines of the project

The timelines of the project schedule are in coherence with the timelines of submission for each of the phase. As of the current state there are no deviations from the project schedule.

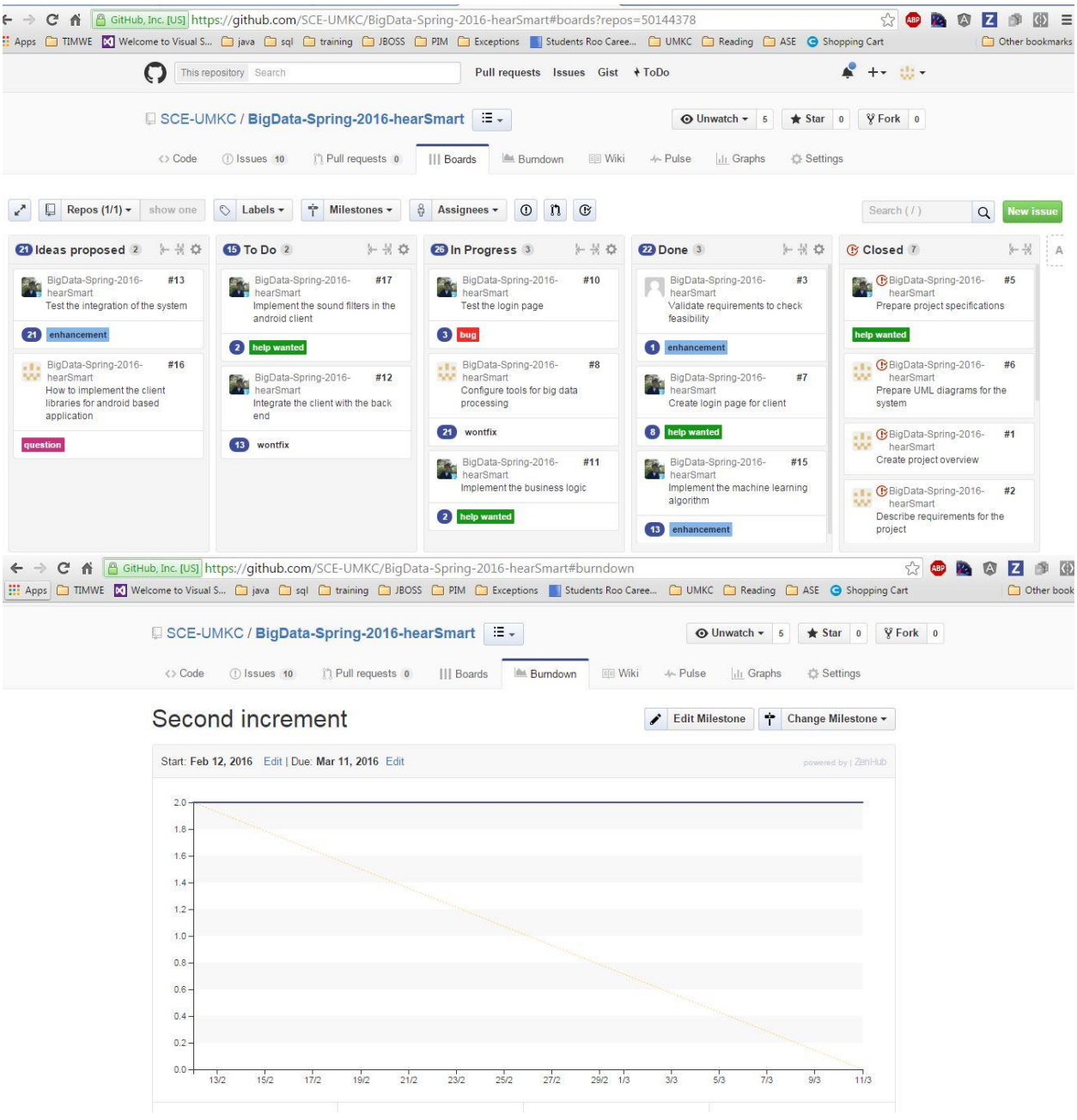


Figure 2: Timelines and commits incurred during second Increment.

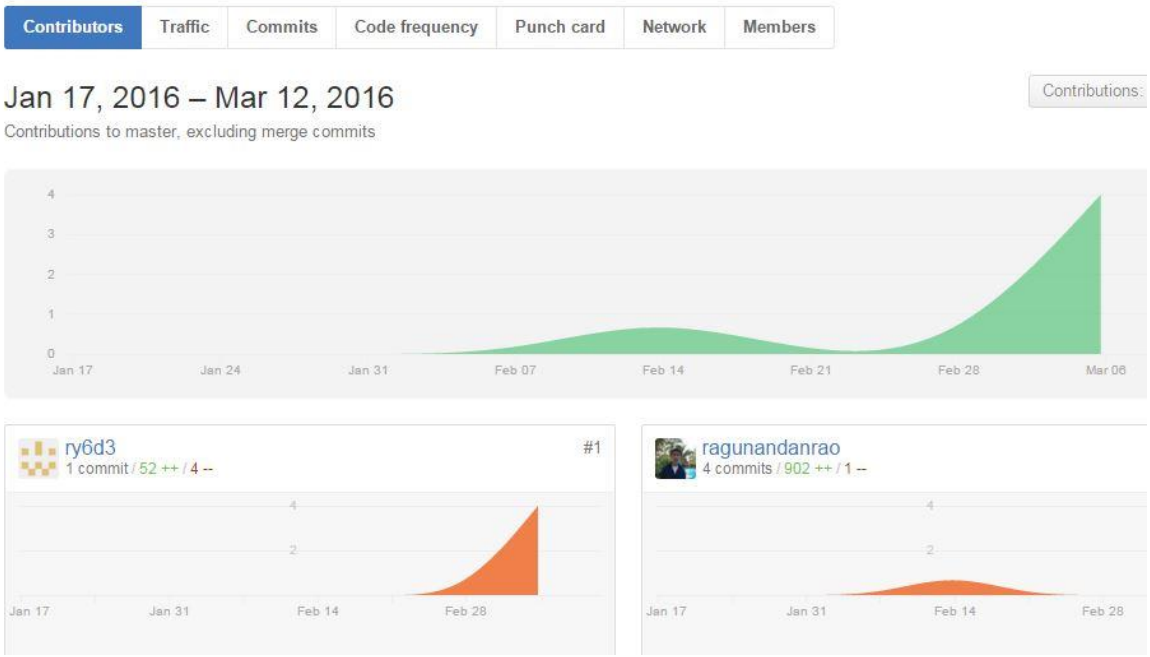


Figure 3: Depicting the contribution of each person to the repository Figure 2: Depicting the schedule and plan for phase 2 of the project.

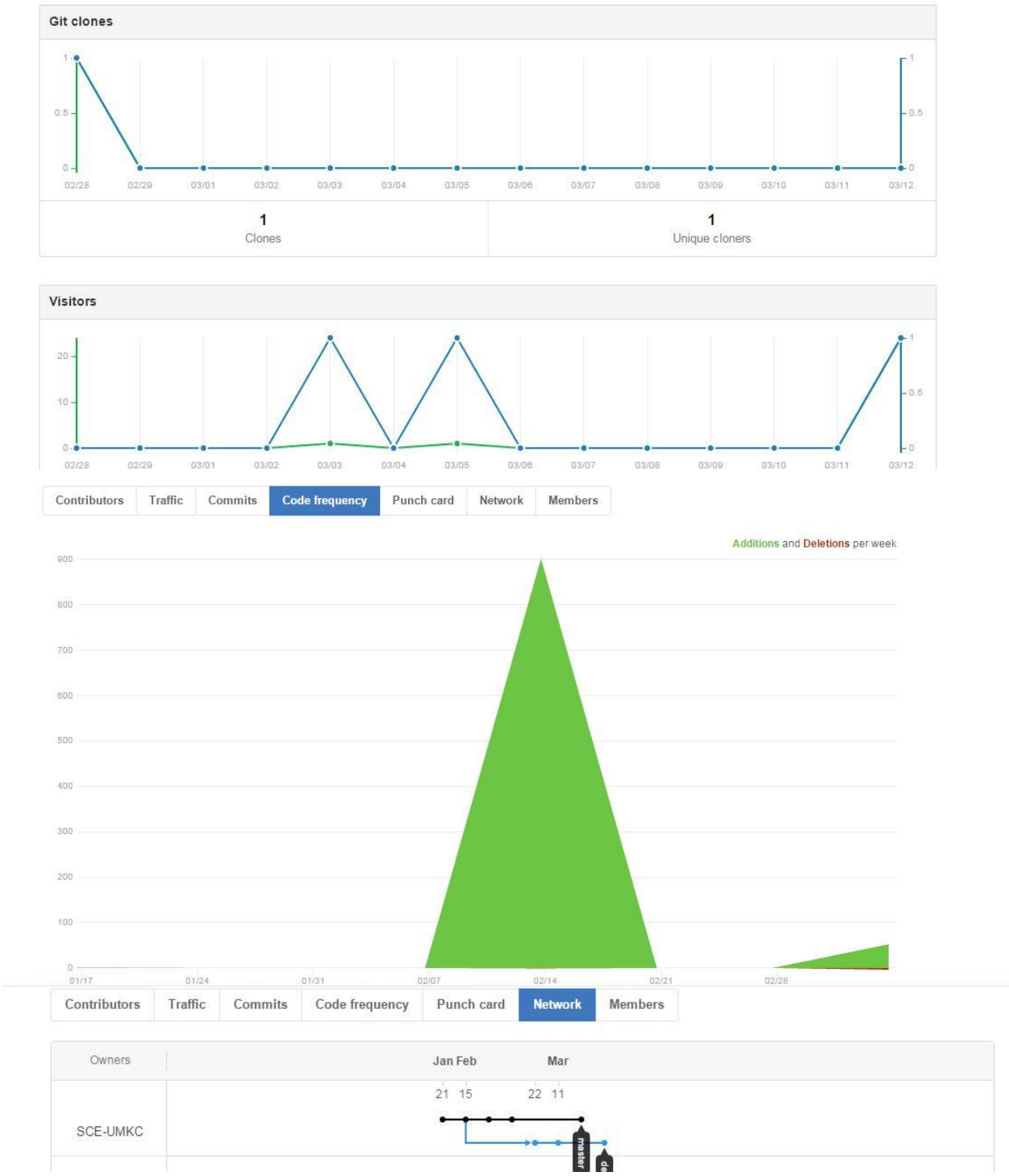


Figure 4: Depicting the analytical graph for the milestone of second increment.

VI. Second Increment Report

This document is a report of second iteration of work performed on the Smart Hear Mobile App. This App proposes to implement various web services into single App. The document emphasizes on the pictorial representation of the application using different implementations which gives an insight on internal system. This document intends to provide an overall description of the project named “Smart Hear”.

The main outcome of the Second increment is the high and low level designs of the App. As of current state we have not deviated from our initial proposal that we submitted earlier. We have taken care of the implementation of Class Diagrams and Sequence Diagrams which showcase the flow of our application. The blueprint of the application is generated using the Wireframes and are available in this document.

During the course of the Second increment our main focus was on the idea and to get to know the feasibility of the various use cases provided in the proposal. We mainly concentrated on the finding the resources for the project in terms of papers on the topic and also in terms of the work that already done. Currently the implementation is very minimal and we believe that it can be caught up very soon. The team’s immediate goal is to get a basic application that record sounds from the microphone of the smart phone and perform mutations such as frequency, pitch other feature modulations.

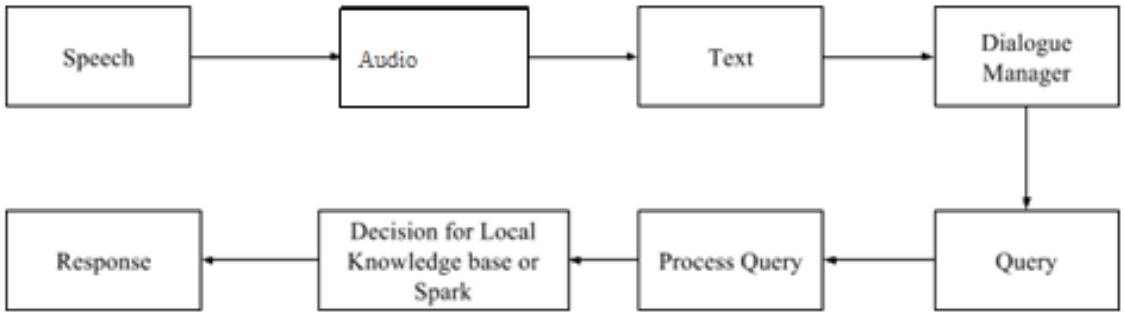


Figure 6

Figure 6 demonstrates a work flow diagram about how a user can generate responses from Speech.

Activity diagram of the system

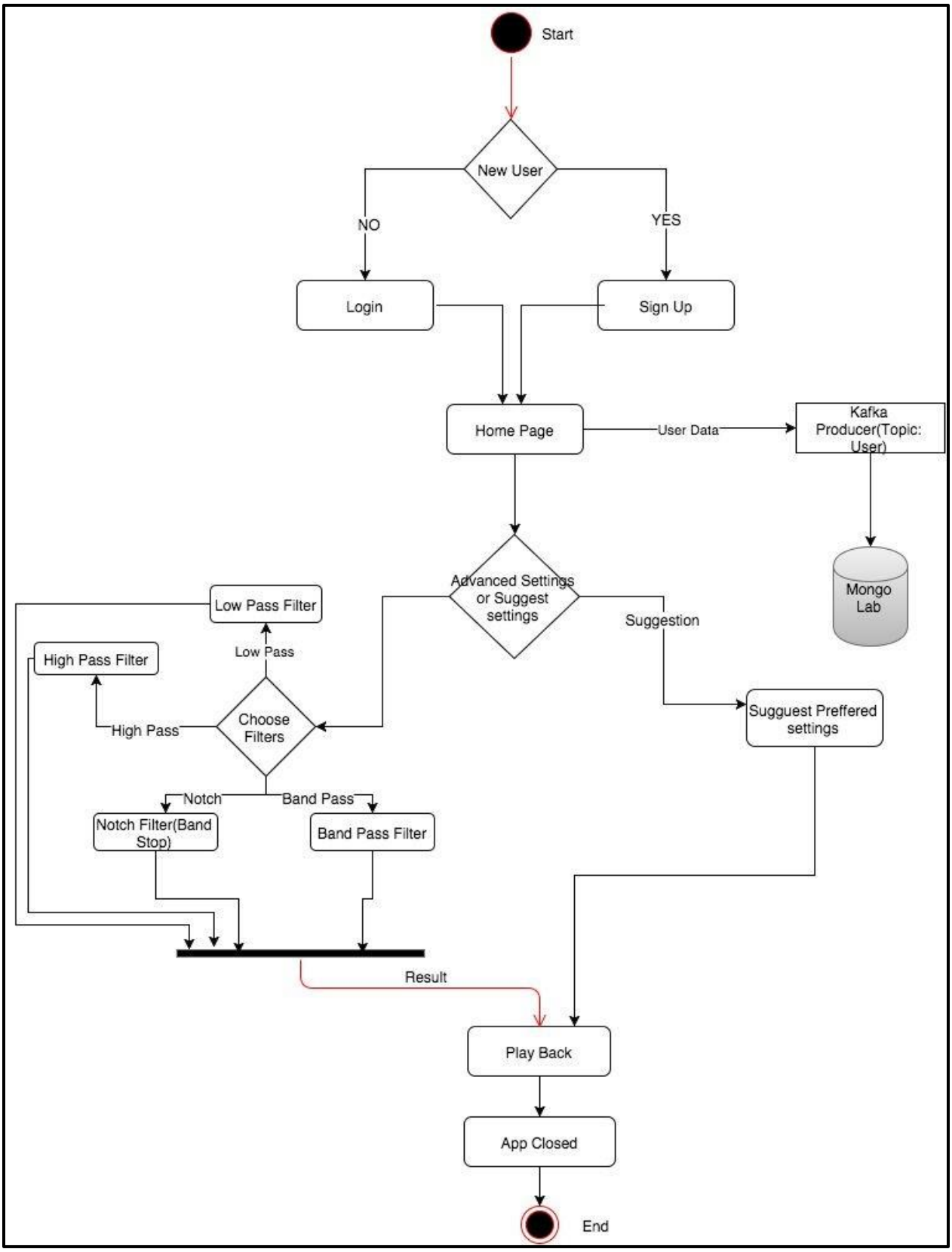
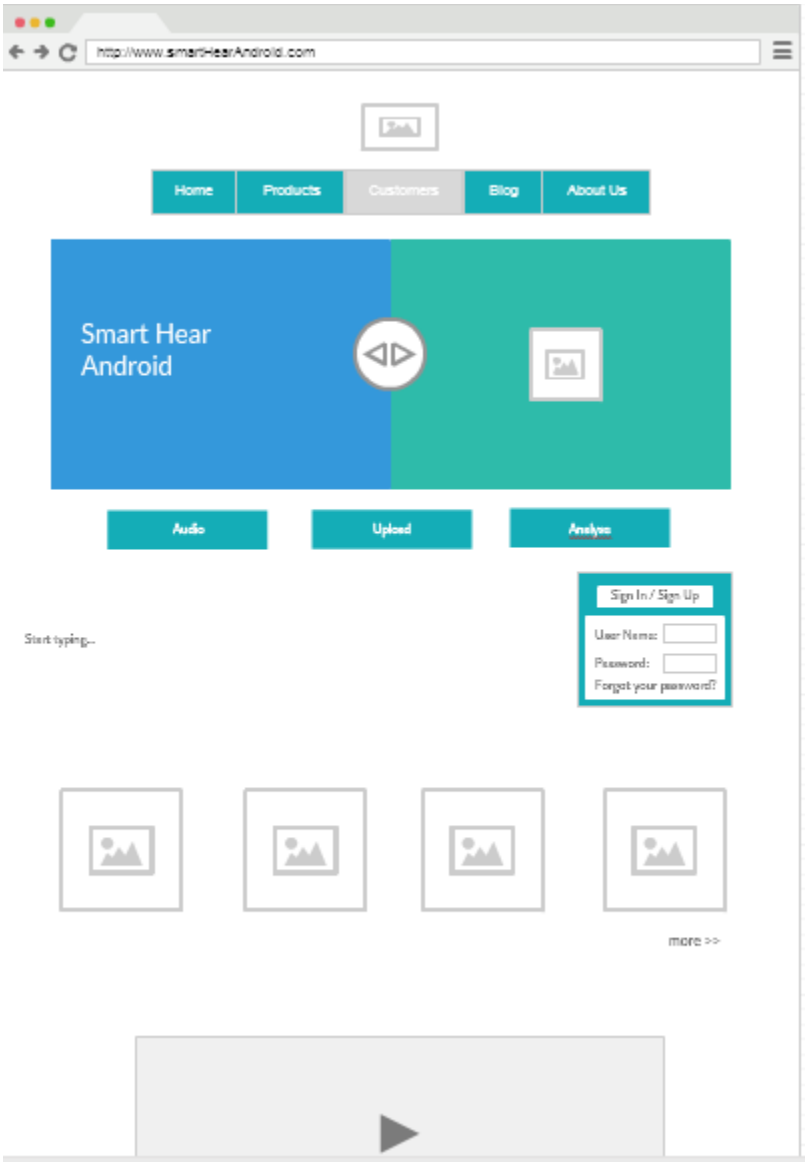
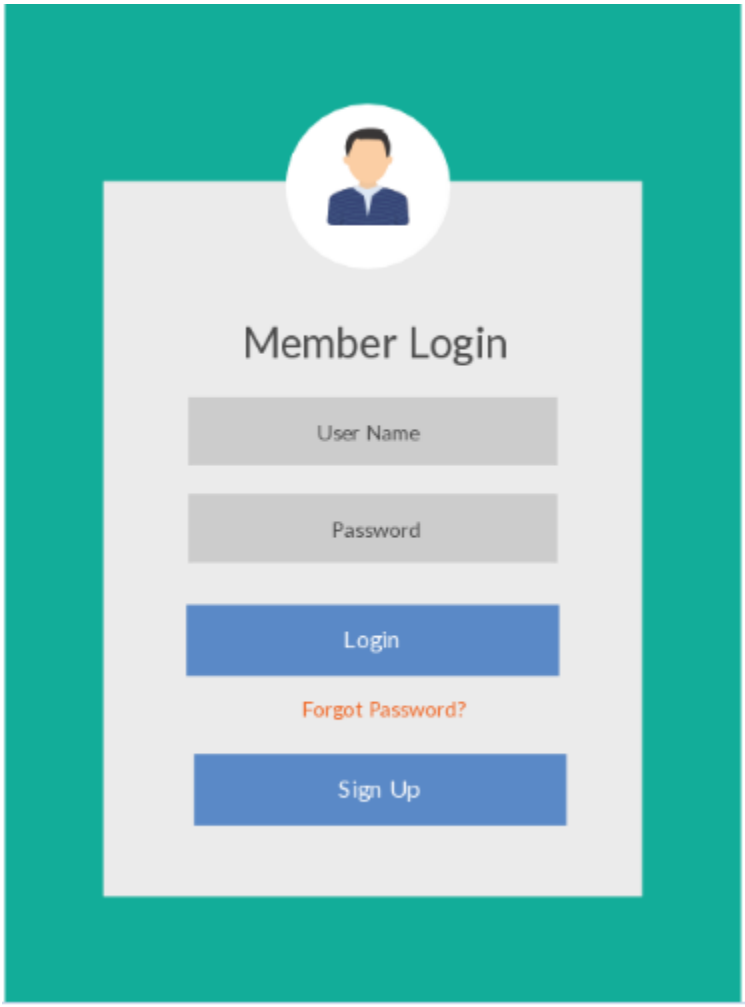


Figure 9

Figure 9 demonstrates a state diagram which explains High Level Design Architecture of the System.

Wireframes for the application




Member Login
User Name
Password
Login
Forgot Password?
Sign Up

Initial Screen for Application

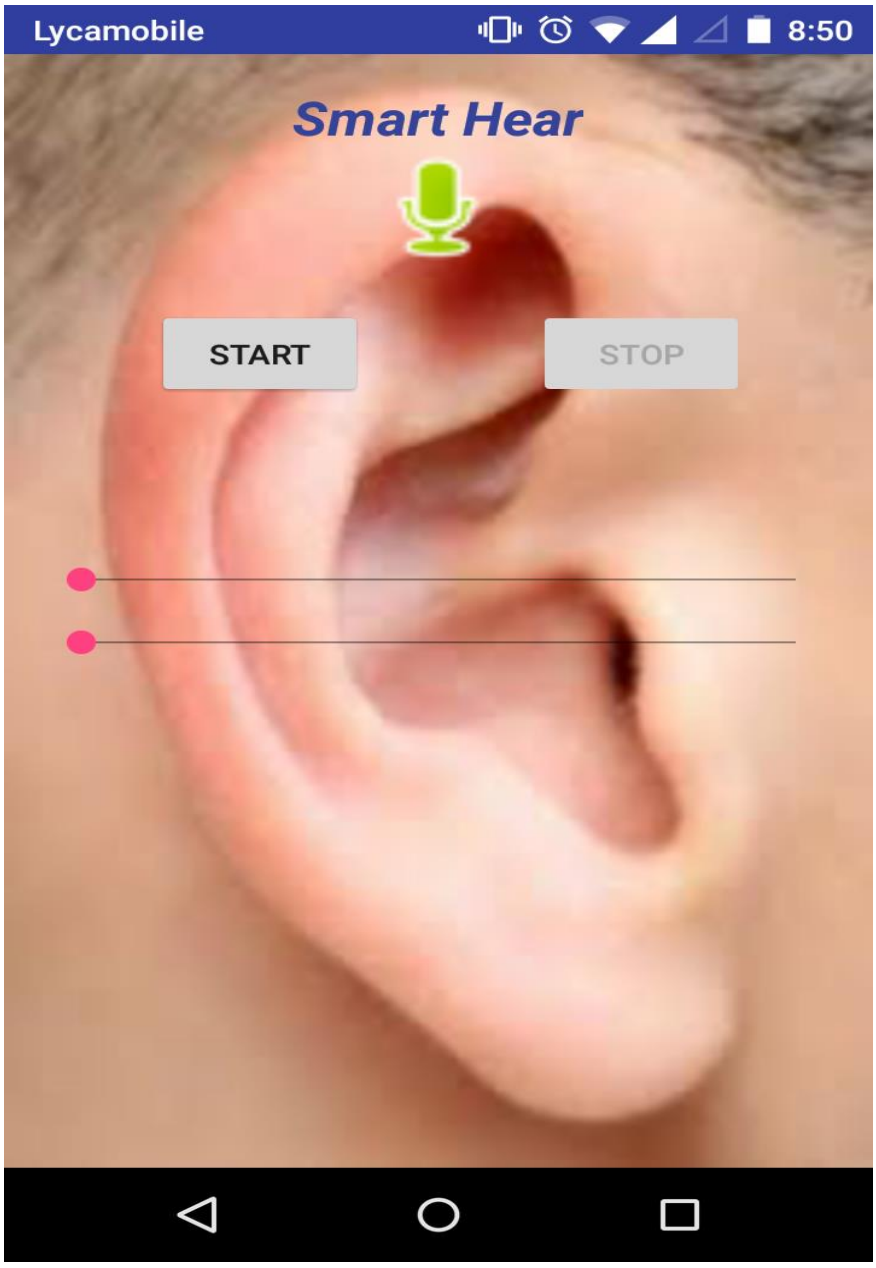


Figure: Home Screen of the application

Low Pass Filter Figure

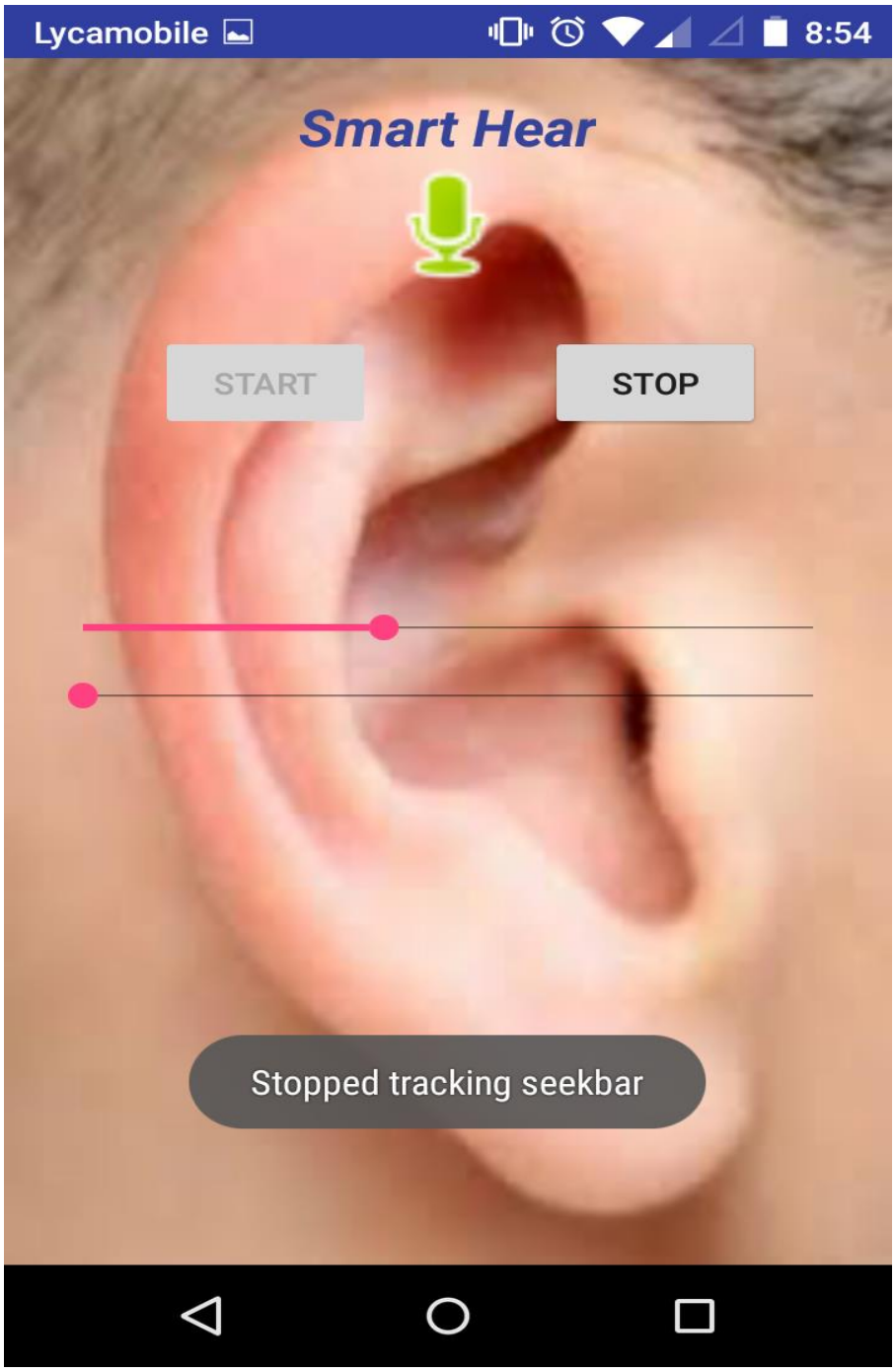


Figure: Low Pass Filter Figure

High Pass Filter Figure

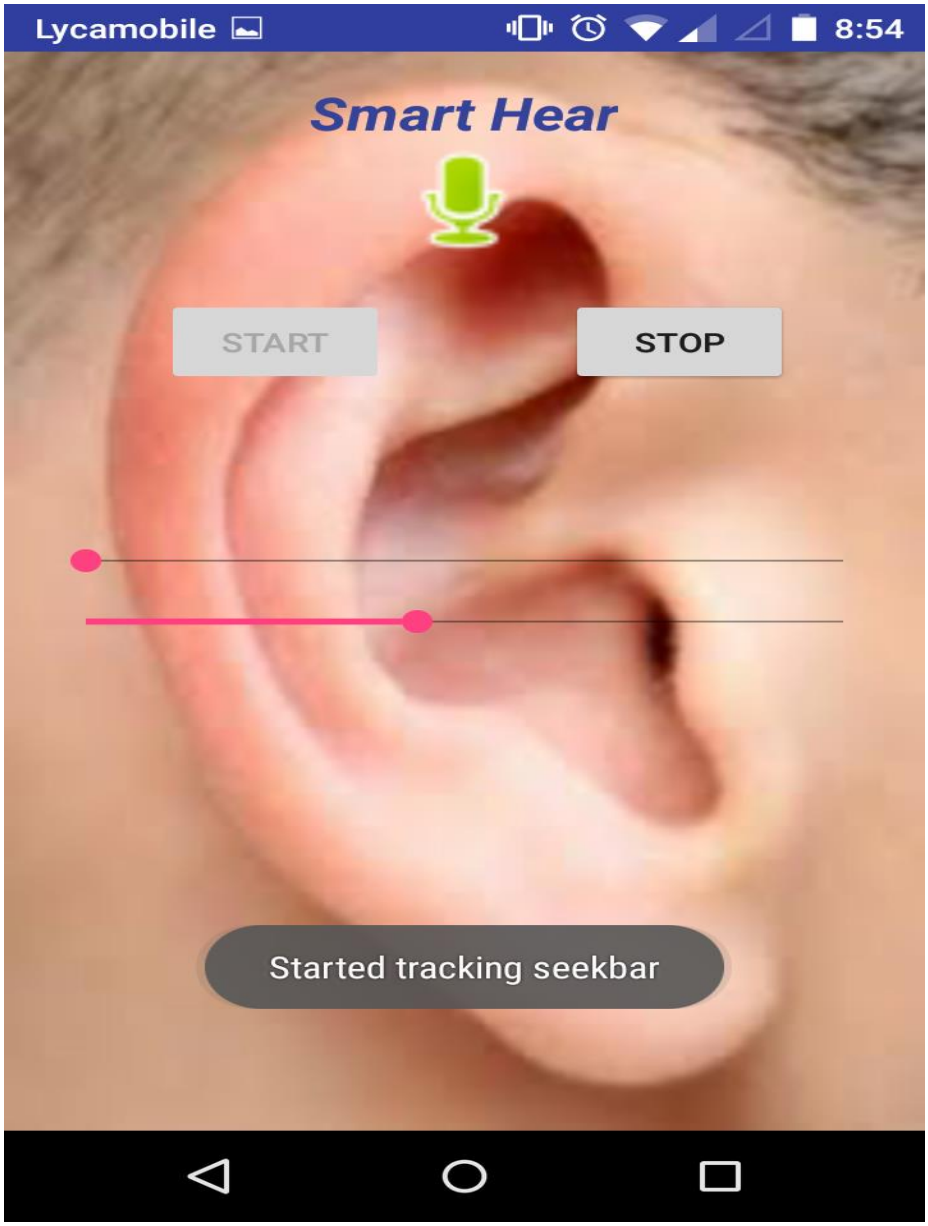


Figure: When High Pass Filter is passed

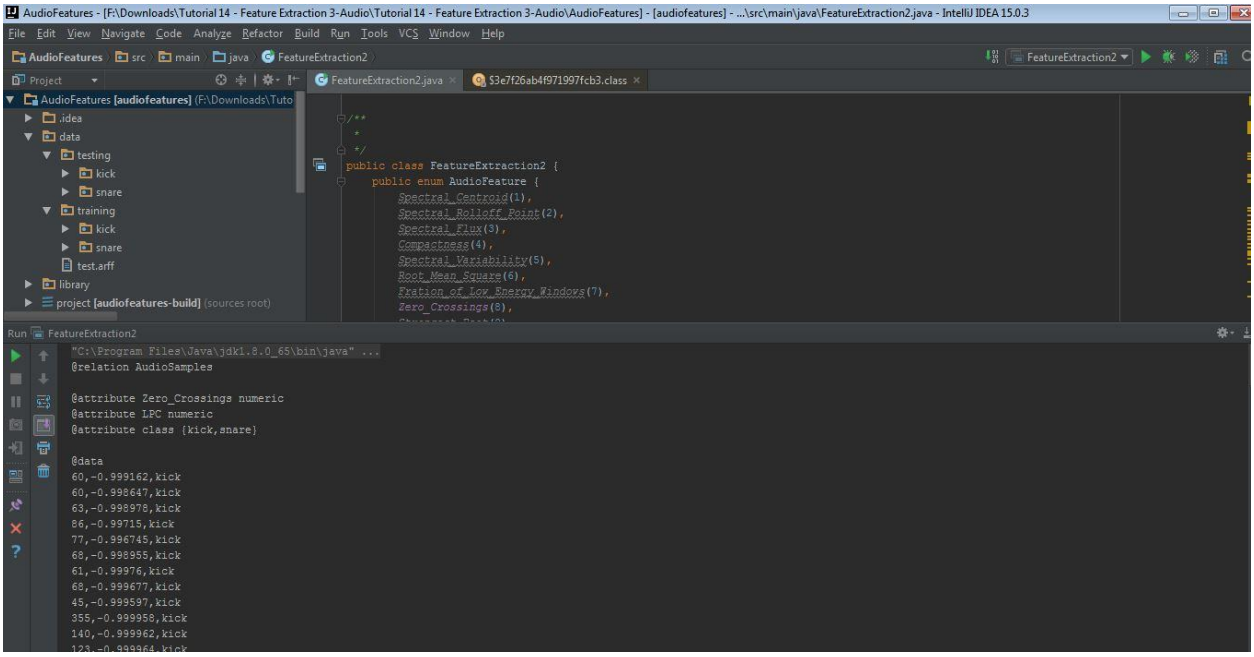


Figure: Results from Audio Filters Applied

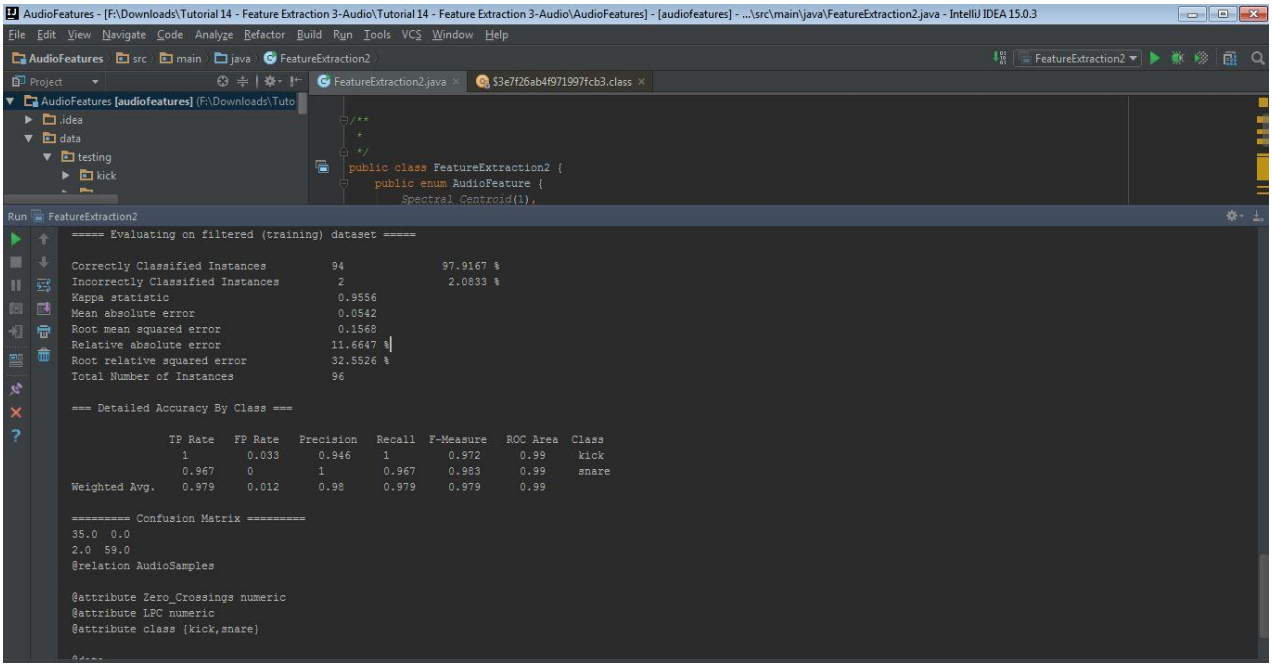


Figure: Using J Audio Feature Extraction

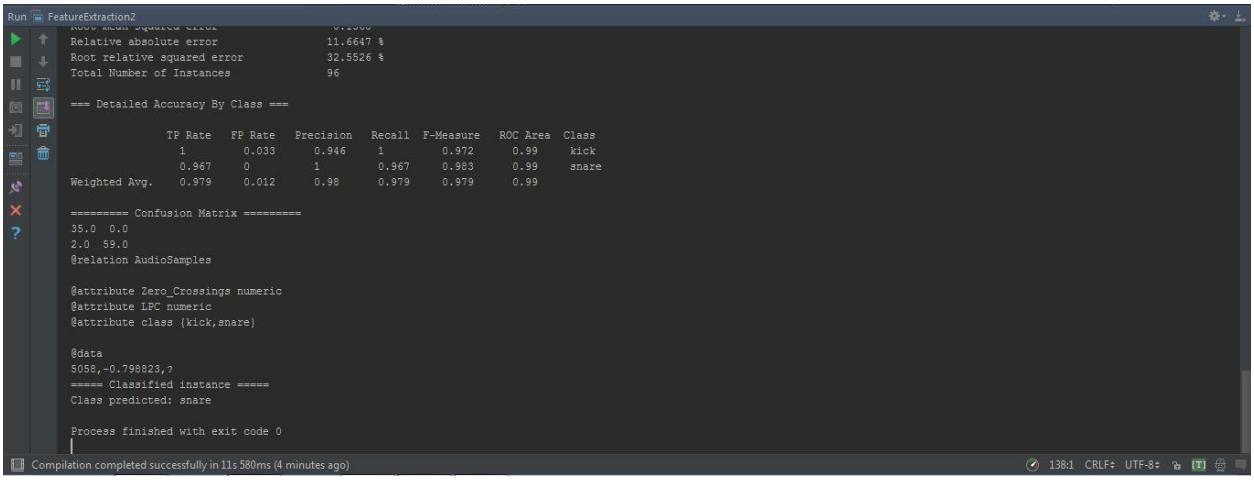


Figure: Outputs showing Confusion matrix

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