



Prince Mohammad Bin Fahd University  
College of Engineering  
Department of Electrical Engineering

# Monitoring Digital Hearing Devices Using Smartphone Application

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December 21 , 2021

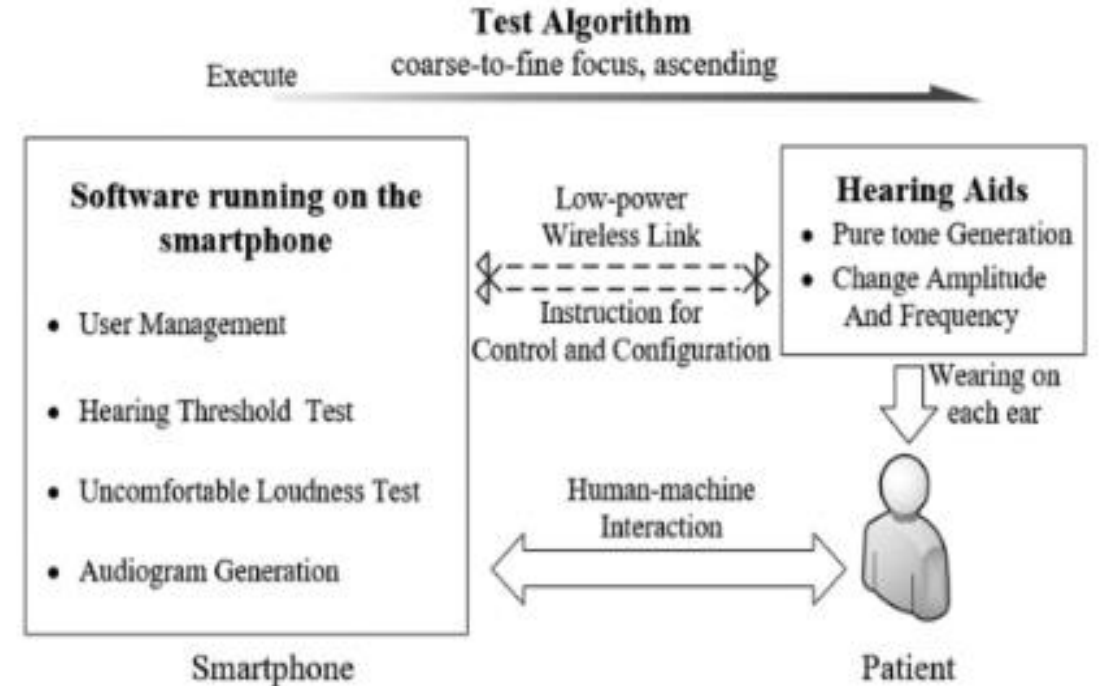
# Outline

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# Project Definition

Design a smartphone application with self-assessment test, communication, and reporting functions.

This system will be using bone conduction headphones with Bluetooth connectivity.



# Project Objectives

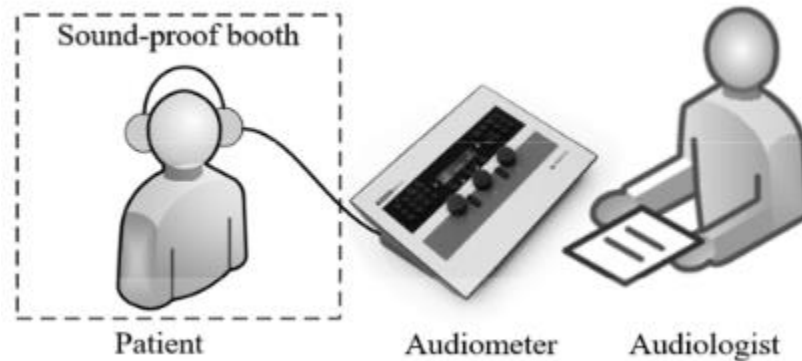
1. **Provide** reliable early diagnosis for patient
2. **Improve** patient's hearing experience
3. **Create** a simple and flexible application
4. **Real time** feedback

# Project Specifications

1. Operates on Bluetooth-based hearing devices
2. Test hearing using set of 8 standard frequencies from 125 Hz to 8000 Hz
3. Communicate test results data at desired times via E-mail
4. Frequency range of headphones: 20-20 kHz
5. Wireless range of headphones: 33 ft (10 m)

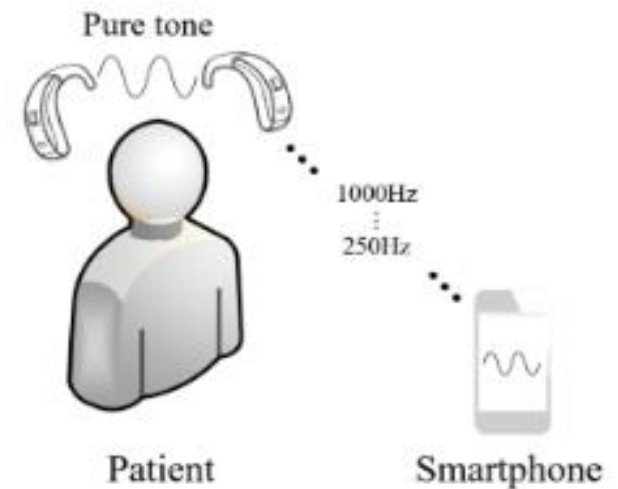
# Background: Problem

- Patients with hearing problems require multiple follow-up appointments for "Tuning and Training" sessions, which can be time consuming and hard during times such as COVID-19.
- Leads to less patients getting correct diagnosis for their case
- Hearing aid devices are not optimized to process many different sounds at once.



# Background: Solutions

The smartphone application is responsible for the needs of the patient in terms of audiometry test, the optimized modes of hearing, and reporting of feedback.



# Solutions

## Why a smartphone application as a solution?

- More convenient for patient
- Easy to use
- Real time feedback

# Solutions

**Which features do you need in the application?**

- Simplicity
- Flexibility
- Security
- User feedback

# Background: Solutions

## 1. Digital Hearing Aid (DHA)

- Recent innovations including DSP, directional microphone technology and fitting have resulted in improved satisfaction with current hearing aids.
  - Less distortion
  - Less buzzing
  - Better noise recognition/understanding
  - Sufficient volume

## 1. Self-assessment hearing test

- Patients can benefit from early diagnosis for hearing impairment by using modern day technology.

# Previous Projects Summary

Projects	1	2	3	4	Our Project
Smartphone Application	√	√	√	√	√
Communication	Low-power wireless link	Bluetooth	Bluetooth	Bluetooth	Wi-Fi + Bluetooth
Online mail webspace			√		√
Self Assessment Hearing Test	√	√	√		√

# Project Plan

## ❖ Phase I: Spring 2021

### ➤ Order components for Subsystems I and II

#### ■ Design Subsystem 1

##### ● Build and Test Subsystem 1

- ◆ Building the circuit with the bone-conduction headphones connected to measure the range, frequency, gain, signal to noise ratio of the device.
- ◆ Collect and analyze readings gathered from the microphone , speaker , and amplifier parts of the bone-conduction headphones

#### ■ Design Subsystem 2

##### ● Build and Test Subsystem 2

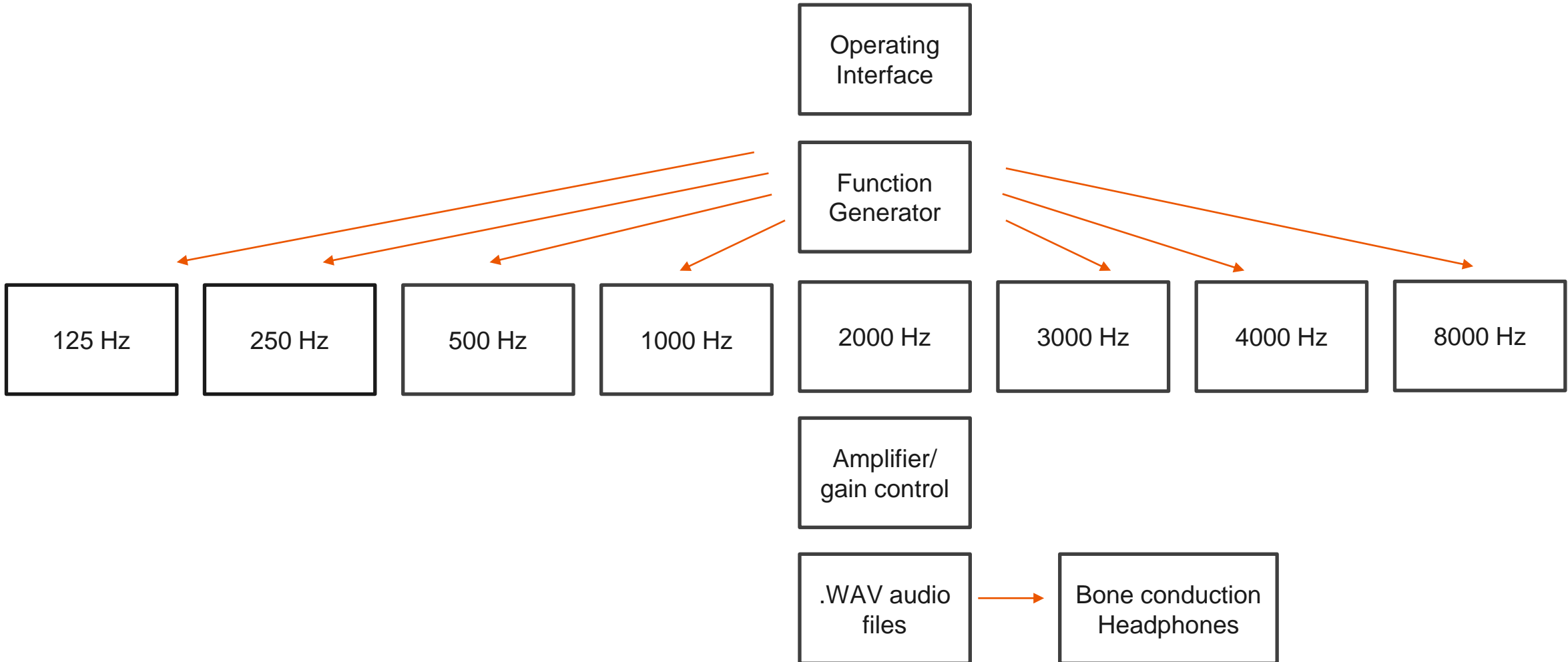
- ◆ Acquire online web server and adding the SMTP to the server to set up an online mail transfer space
- ◆ Collect feedback and troubleshoot any mishaps occurring during the process in order to fix them

# Project Plan

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- ❖ Phase II: Fall 2021
  - Order components for Subsystems III and VI
    - Design Subsystem III:
      - Build and Test Subsystem III
        - ◆ Hearing/Evaluation Test
        - ◆ User interface
        - ◆ Emailing section

# Design: Subsystem 1 Block Diagram



# Headphone Options



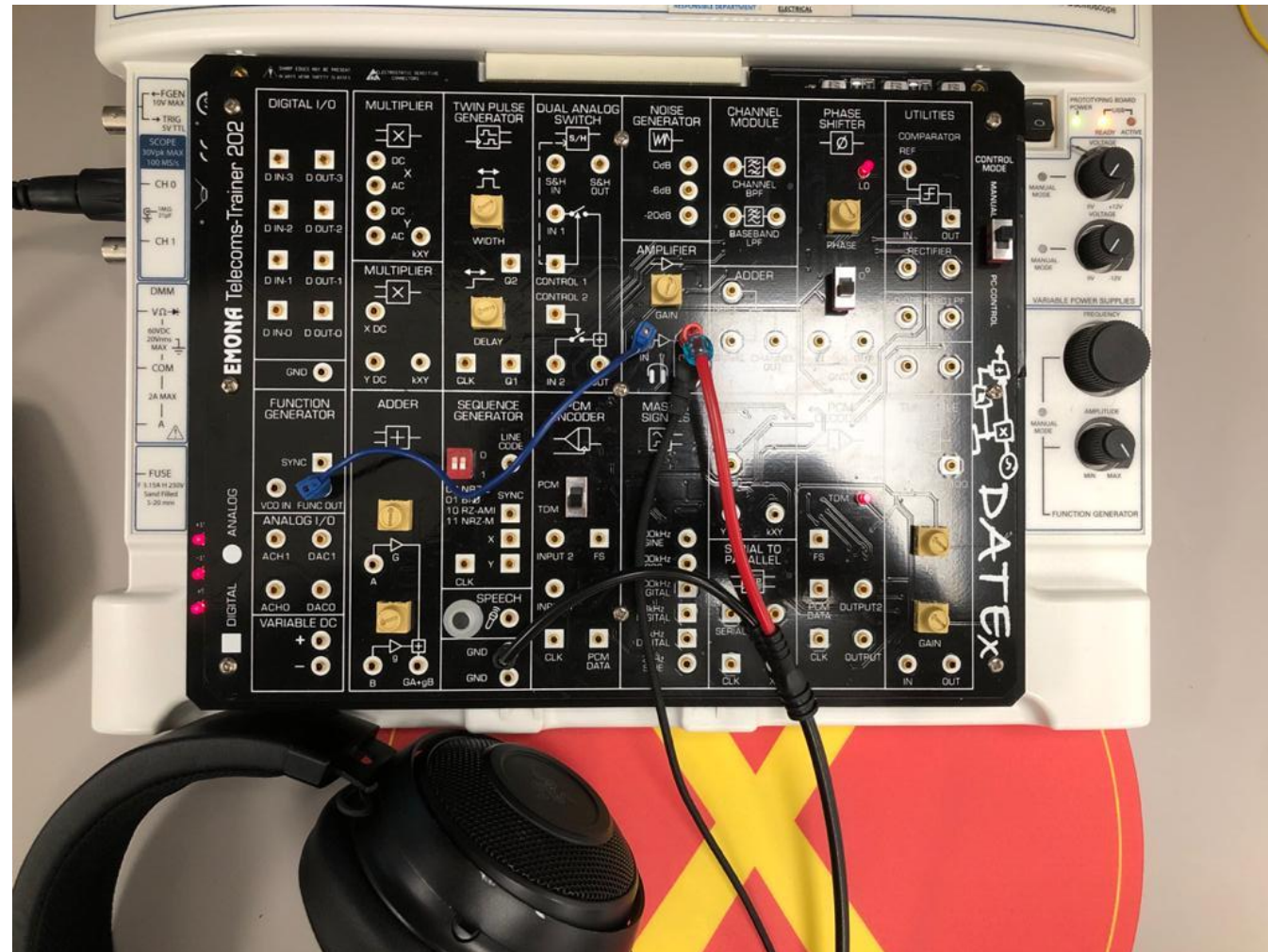
Wired Headphones



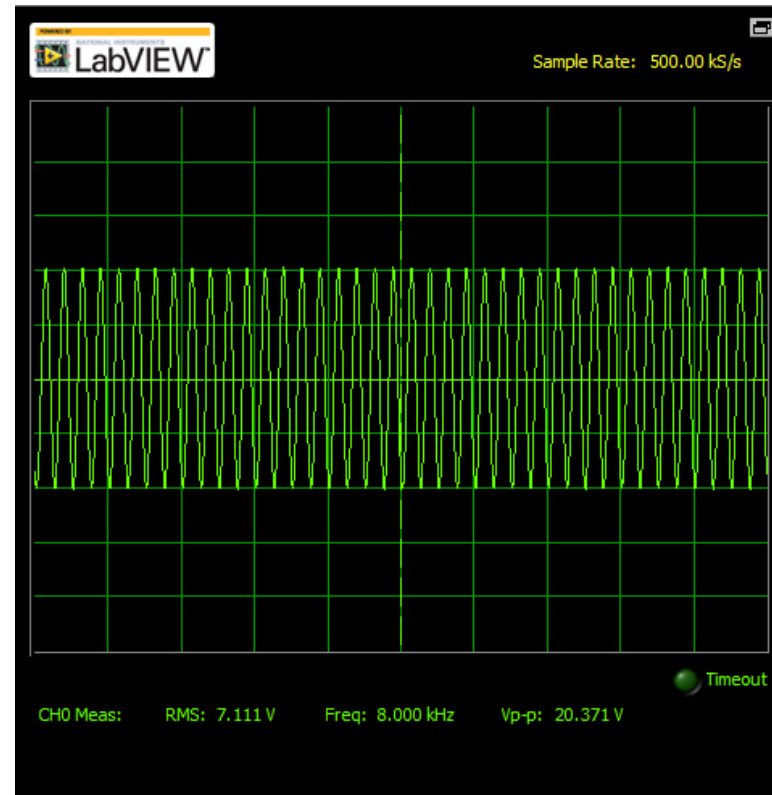
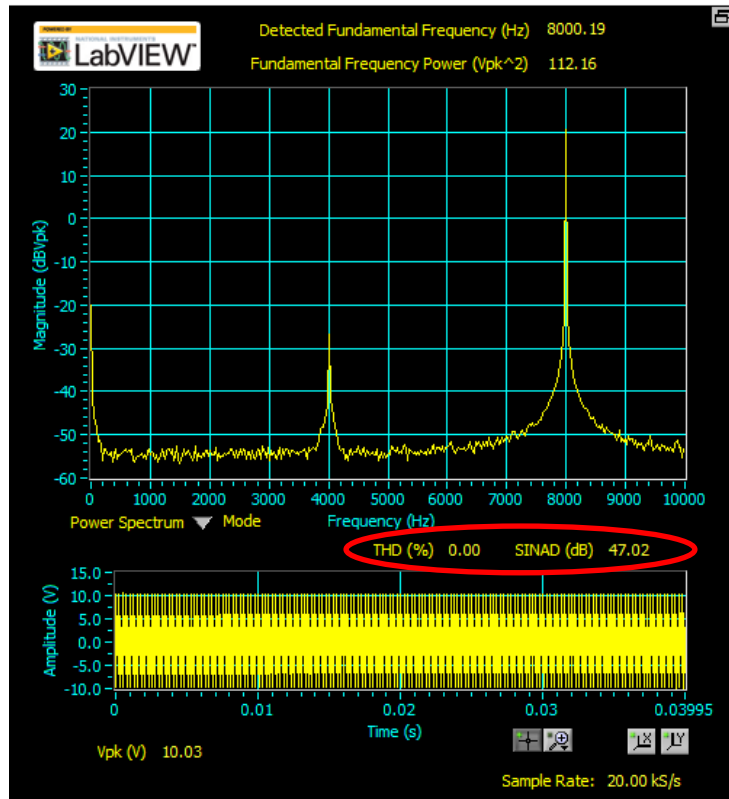
AfterShokz Aeropex Open-Ear Wireless Bone Conduction Headphones, IP67 Rated, Blue Eclipse

Wireless Headphones

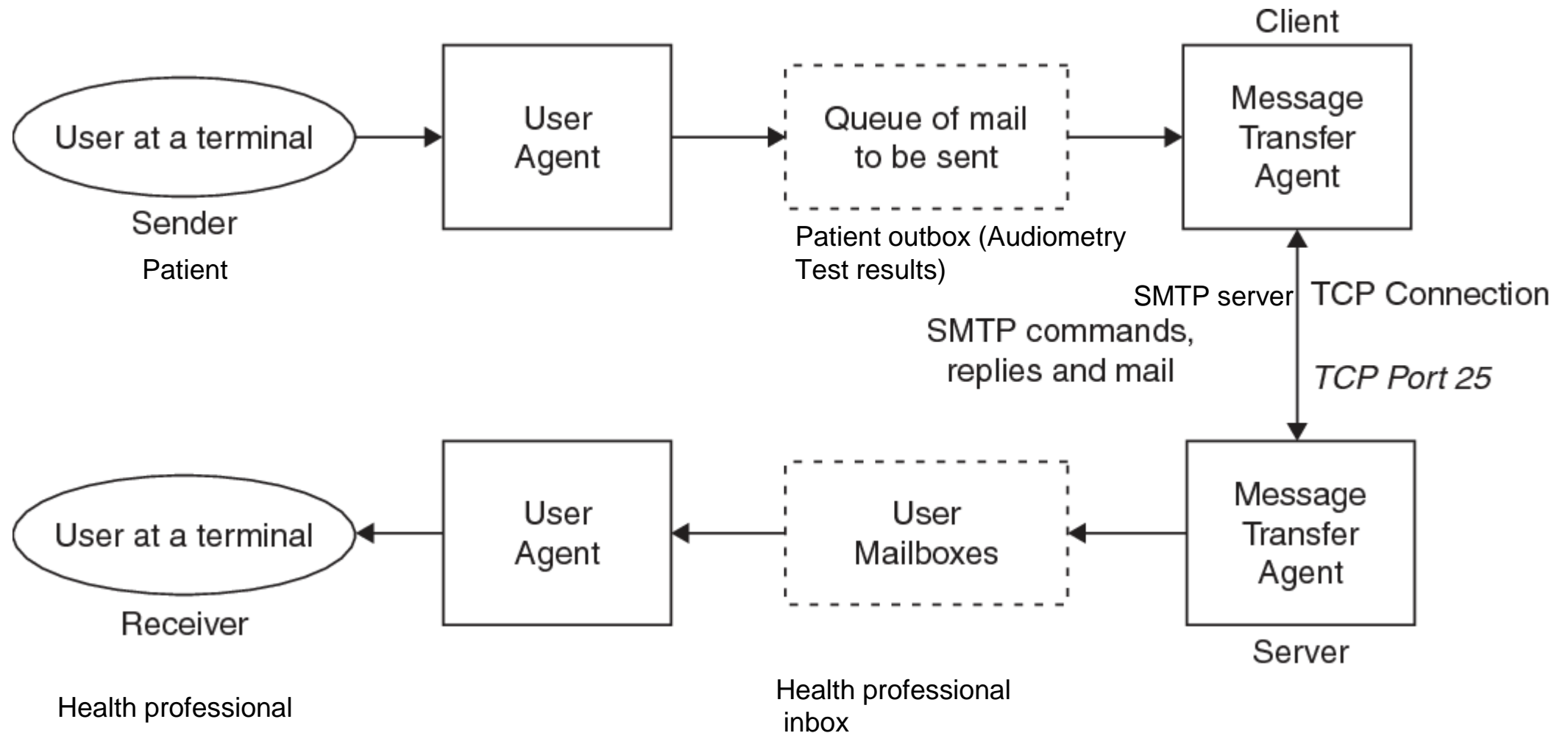
# Build: Subsystem 1



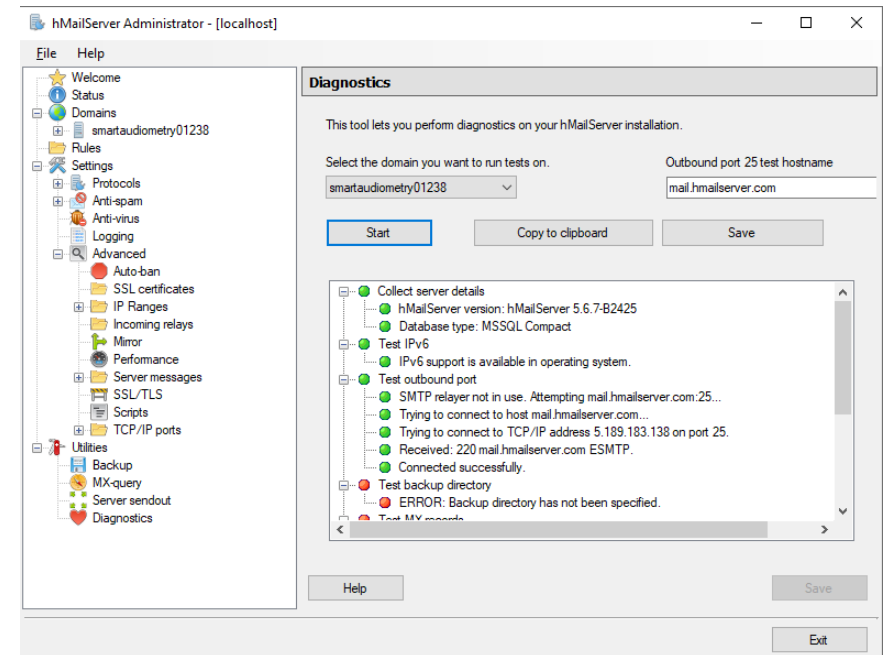
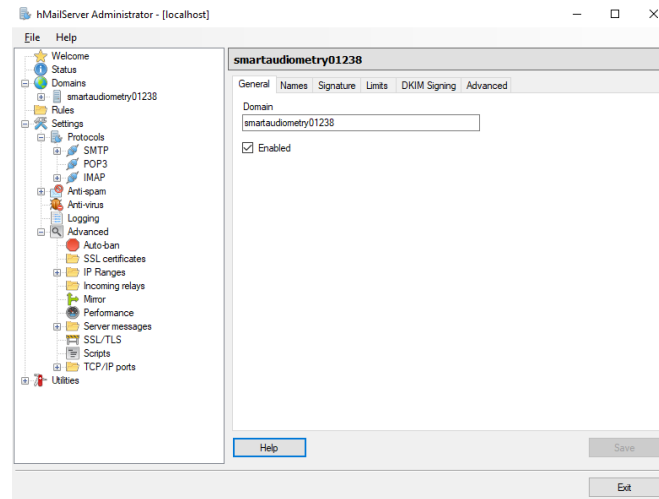
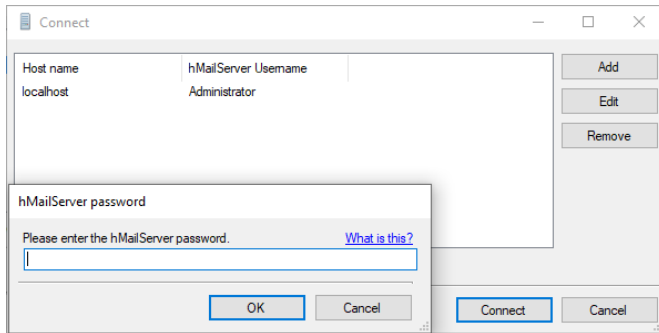
# Test: Subsystem 1



# Design: Subsystem 2 Block Diagram



# Build: Subsystem 2



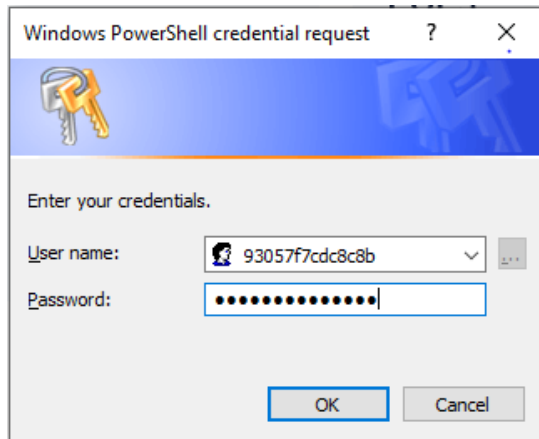
# Test: Subsystem 2

```
Windows PowerShell
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\zayer> Send-MailMessage -To "practionerem@gmail.com" -From "zayer.em@gmail.com" -Subject "Test Results" -Body "Results for tests from Smart Audiometry!" -Credential (Get-Credential) -SmtpServer "smtp.mailtrap.io" -Port 587

cmdlet Get-Credential at command pipeline position 1
Supply values for the following parameters:
Credential
PS C:\Users\zayer>
```



Inboxes > Smart Audiometry Inbox > Test Results

Start with...

**Test Results**  
to: <practionerem@gmail.com> 2 minutes ago

Test Results  
to: <practionerem@gmail.com> 5 days ago

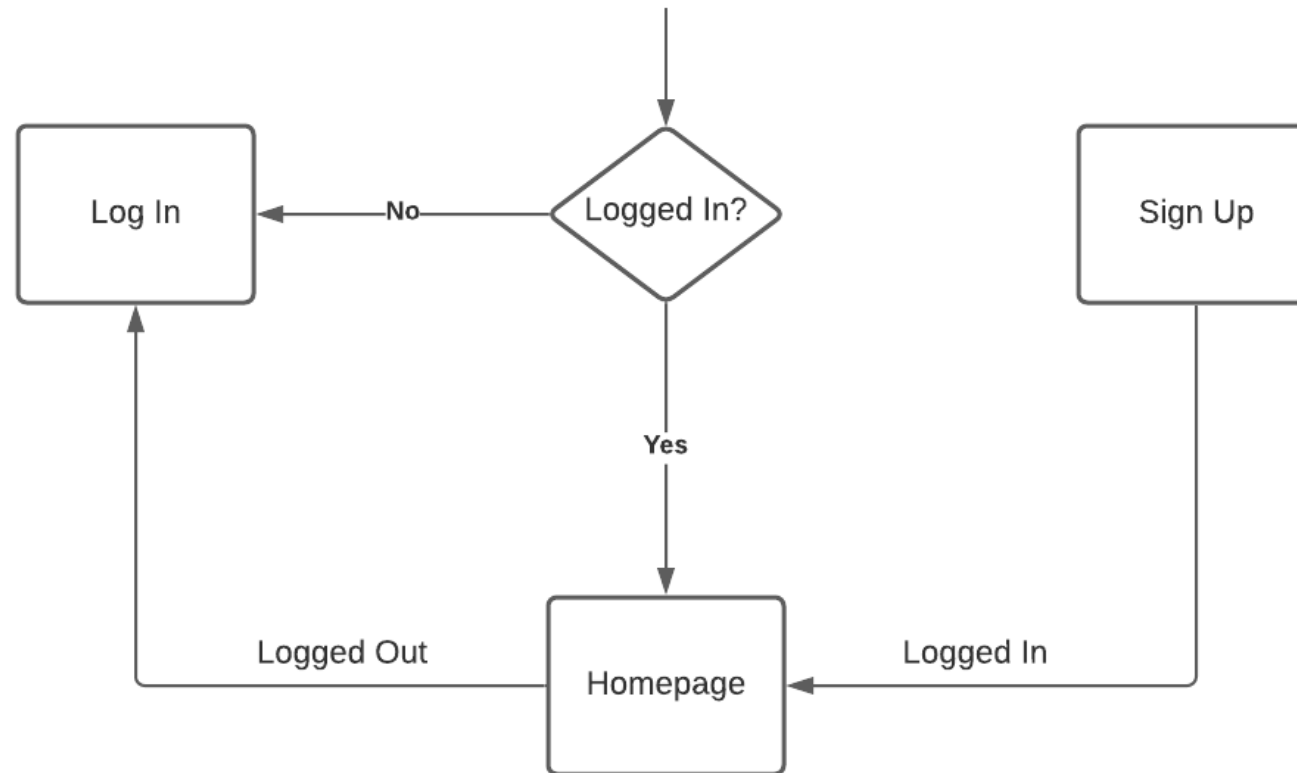
Test Results

From: <zayer.em@gmail.com>  
To: <practionerem@gmail.com>  
[Show Headers](#)

HTML HTML Source **Text** Raw Spam Analysis Tech Info

Results for tests from Smart Audiometry!

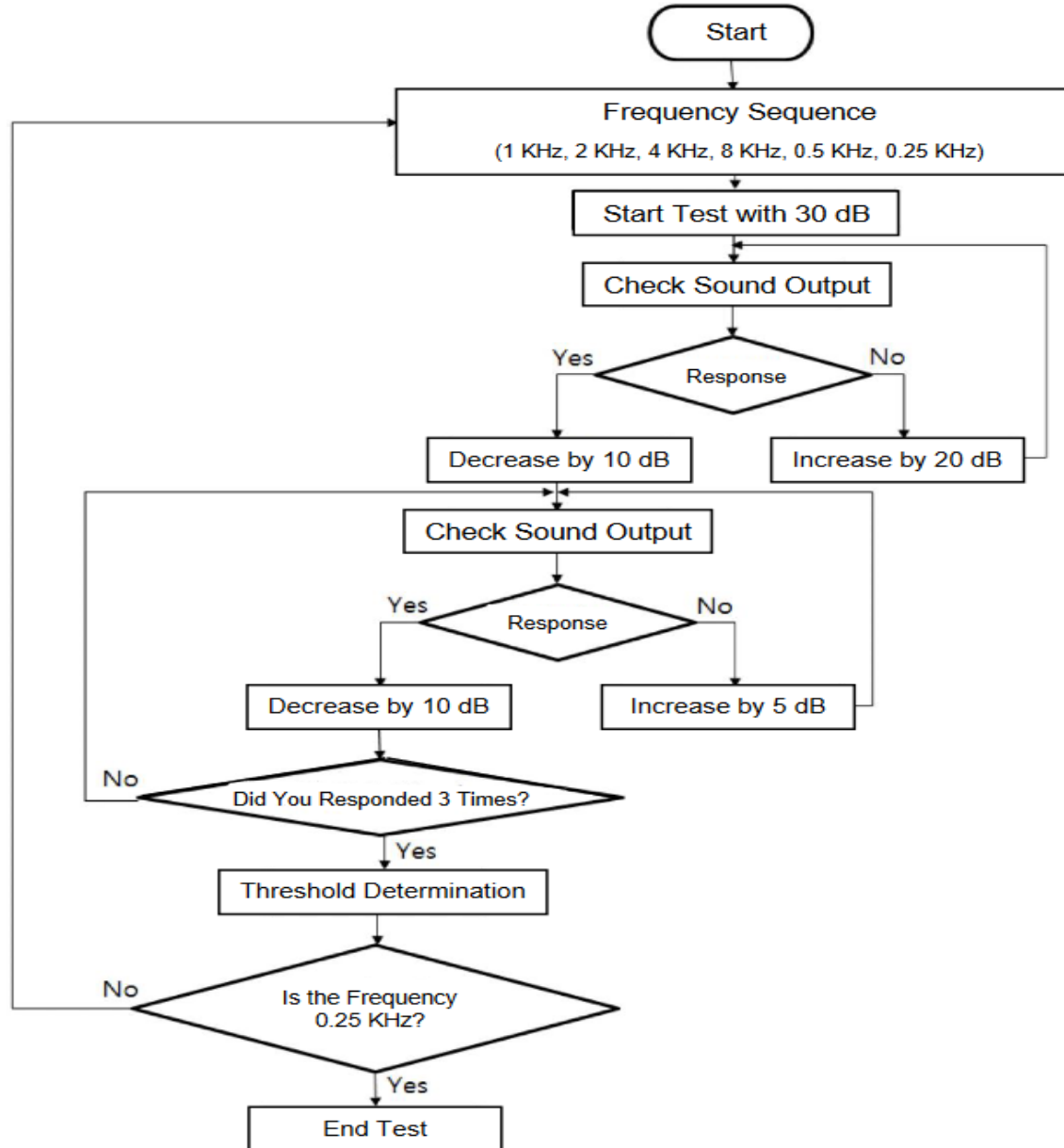
# Design: Sign-in, Sign-Up, and Sign-Out Activities



Designing Sign-in, Sign-Up, and Sign-Out Activities

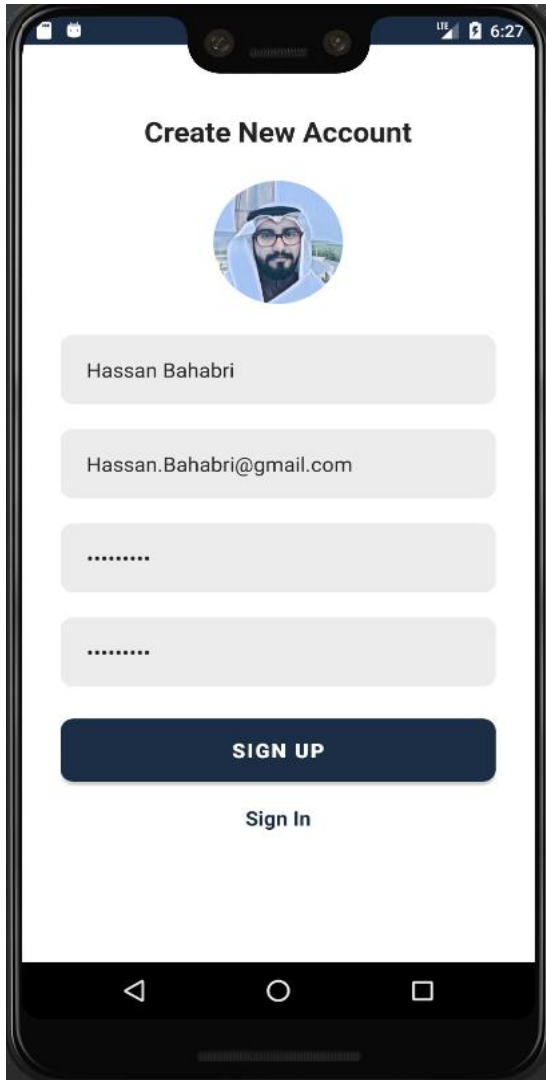
# Design: Audiometry Hearing Test

- Designing Manual Hearing Test





# Test: Firebase Database

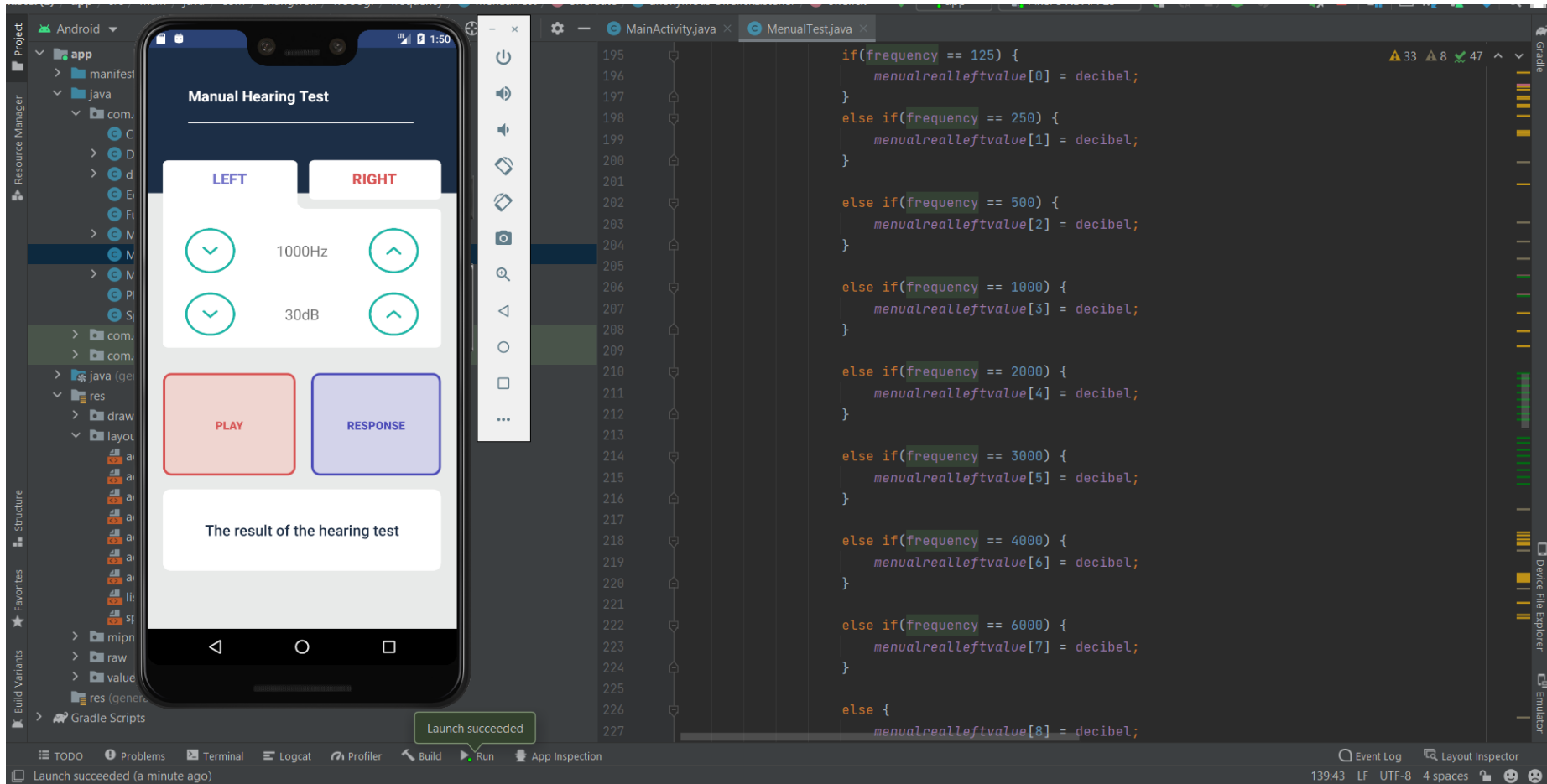


Testing Sign-up Activity

The screenshot displays the Firebase console interface. On the left, the 'Build' section has 'Firestore Database' highlighted. The main area shows the 'users' collection in the 'Test2' project. A document with ID 'd28xYZey7DDJs3nNiCkW' is selected, and its 'fcmToken' field is highlighted, showing the value 'cTtLs1UQ-erl3UvtzHi2P:APA91d7wwaEExIbdNbGZK'. A notification on the right phone screen says 'Token updated successfully'.

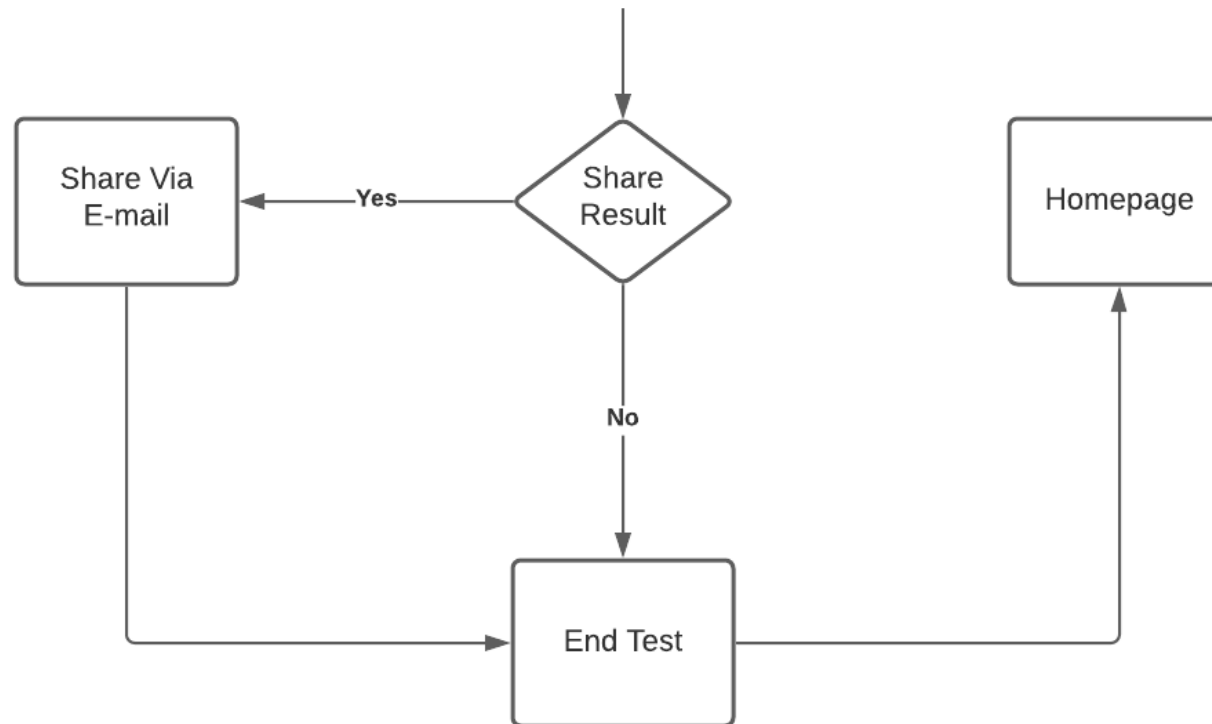
User registered successfully & FCM token generated in our database

# Test: Audiometry Hearing Test



Testing Manual Hearing Test

# Design: The Result Page



Designing The Result Page

# Build: Result Page

The image shows an IDE interface with two main views: the XML editor and the Design view.

**XML Editor:** The file `activity_manual_result.xml` is open, showing the following XML structure:

```
</RelativeLayout>
<TextView
    android:id="@+id/textView1"
    android:layout_width="300dp"
    android:layout_height="50dp"
    android:layout_above="@+id/relativeLayout1"
    android:layout_marginStart="5dp"
    android:layout_marginEnd="8dp"
    android:background="@drawable/borderbottom"
    android:gravity="Left"
    android:text="The Result of The Hearing Test"
    android:textColor="#ffffff"
    android:textSize="20sp"
    android:textStyle="bold"
    app:layout_constraintBottom_toTopOf="@+id/volume_maintext_line_down"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent" />
<RelativeLayout
    android:id="@+id/manual_wrap_char_view"
    android:layout_width="0dp"
    android:layout_height="0dp"
    android:background="@drawable/List_menu_border"
    app:layout_constraintBottom_toTopOf="@+id/guideline8"
    app:layout_constraintEnd_toEndOf="@id/guideline7"
    app:layout_constraintStart_toStartOf="@id/guideline6"
    app:layout_constraintTop_toTopOf="@id/guideline5">
</RelativeLayout>
```

**Design View:** The Design view shows a visual representation of the layout. It features a dark blue header with the text "The Result of The Hearing Test". Below the header is a large white area with a blue border. At the bottom, there are two blue buttons: "End Test" and "Share Test Results". The design view includes a palette, a component tree, and various design tools like a ruler and alignment guides.

Building Result Page

# Test: The Result Page

```

ava - activity_manual_result.xml
ChartView charView = new ChartView( context: this);
charView.outerRectMargin = 80;

charView.innerVerticalTickCount = 9;
charView.topLabels = new ArrayList<String>();
charView.topLabels.add("125");
charView.topLabels.add("250");
charView.topLabels.add("500");
charView.topLabels.add("1000");
charView.topLabels.add("1000");
charView.topLabels.add("2000");
charView.topLabels.add("3000");
charView.topLabels.add("4000");
charView.topLabels.add("6000");
charView.topLabels.add("8000");
charView.strTopUnit = "Hz";

charView.innerHorizontalTickCount = 13;
charView.leftLabels = new ArrayList<String>();
charView.leftLabels.add("-10");
charView.leftLabels.add("0");
charView.leftLabels.add("10");
charView.leftLabels.add("20");
charView.leftLabels.add("30");
charView.leftLabels.add("40");
charView.leftLabels.add("50");
charView.leftLabels.add("60");
charView.leftLabels.add("70");
charView.leftLabels.add("80");
charView.leftLabels.add("90");
charView.leftLabels.add("100");
charView.leftLabels.add("110");
charView.strLeftUnit = "dB";
  
```

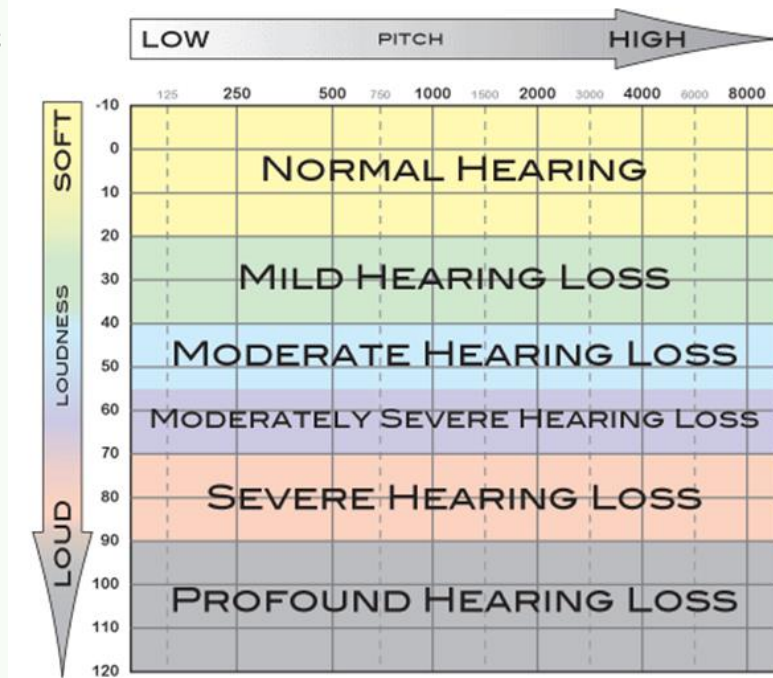
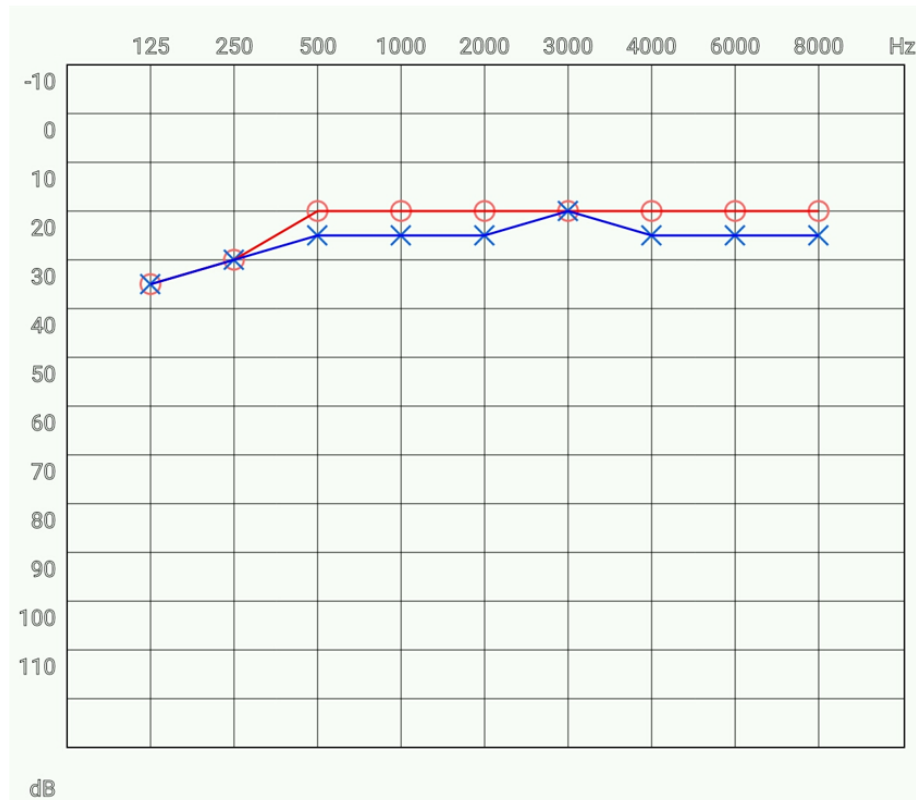
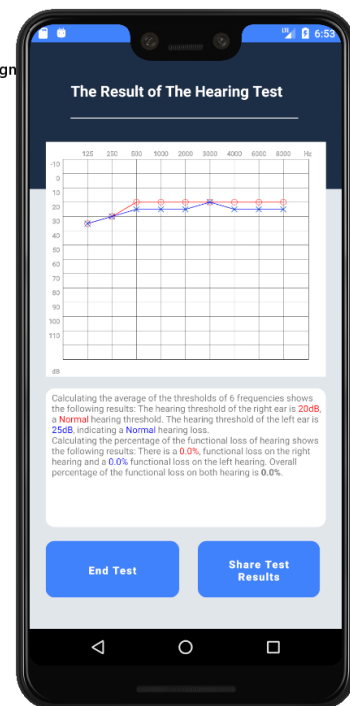
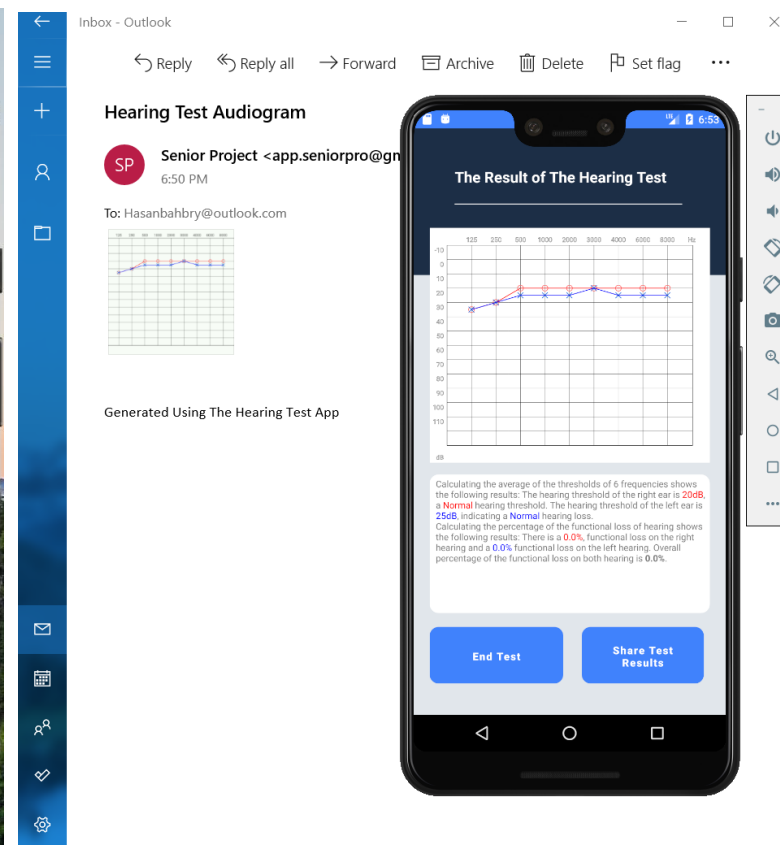
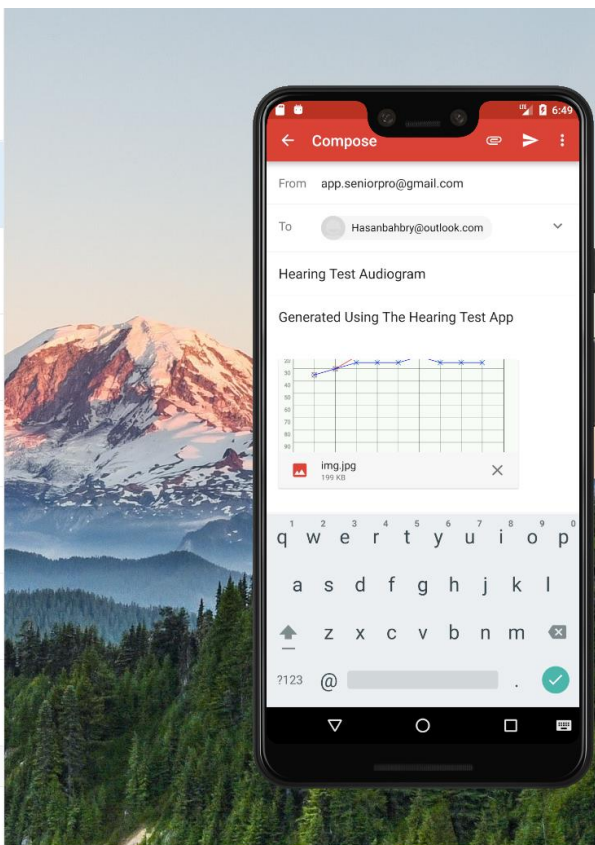
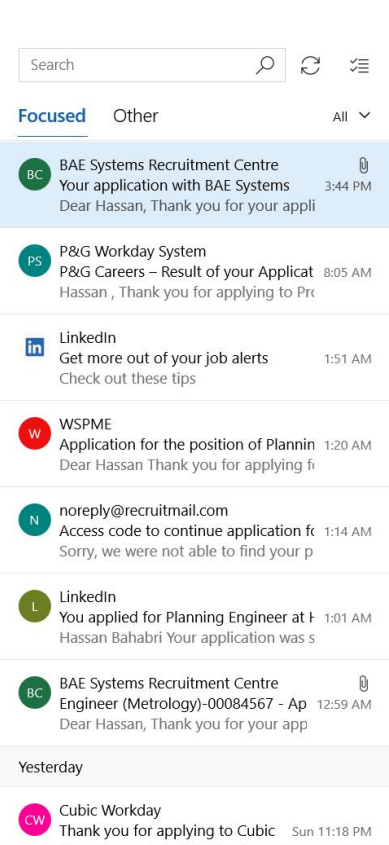


Image credits:

[http://alphaonenow.com/userfiles/image/aud\\_audiogram.gif](http://alphaonenow.com/userfiles/image/aud_audiogram.gif)

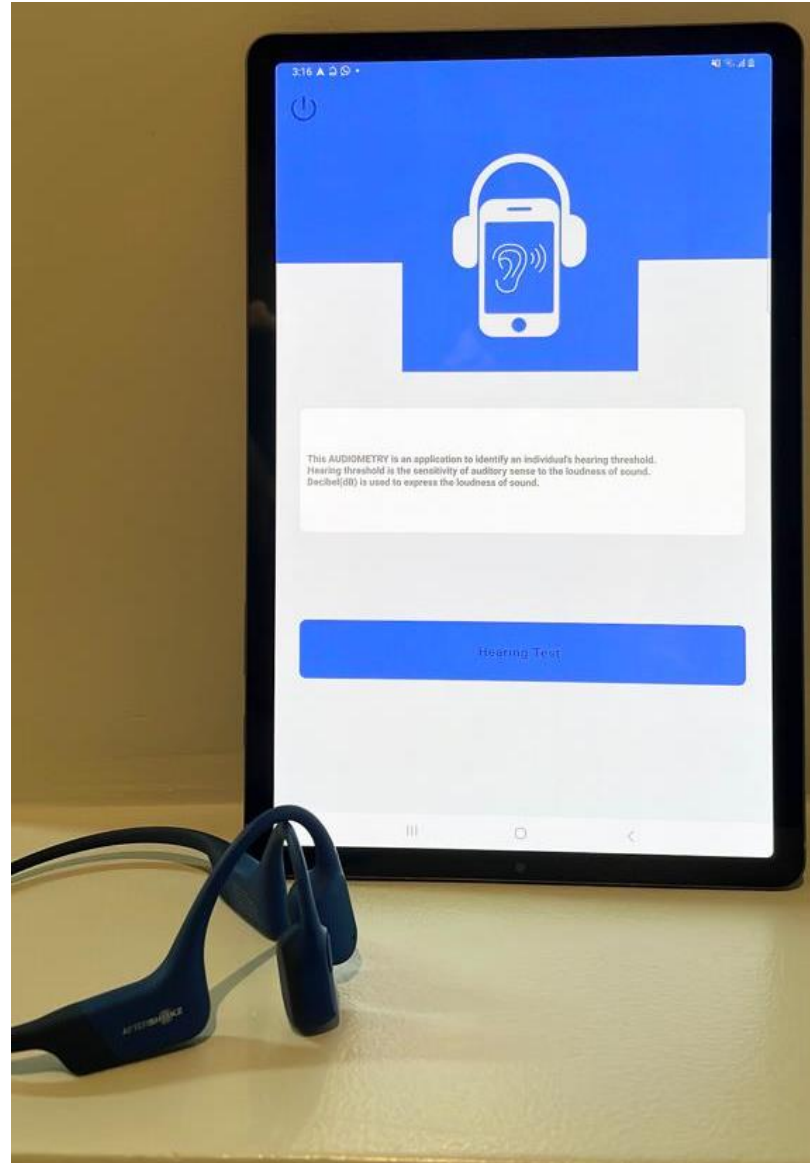
Testing The Result Page

# Test: The Emailing Procedure



Testing The Emailing Procedure

# Final Prototype



# Completed Work

- The project has been completed successfully based on the specifications
- All subsystems correlated to our specifications have been fully designed, built and tested using the necessary components, respectively
- The final prototype has been fully implemented and ready for demonstration

# Project Management Plan

Title: Monitoring Digital Hearing Devices Using a Smartphone Application		Advisor: Dr. Hiren Mewada					Design II (ASSE 3)			Fall 2021										
Ehab Alzayer (EZ) – 201501238							Project PLAN & Progress													
Hasan Bahbry (HB) – 201602622							ProgRpt No. 8													
Mustafa Aljishi (MJ) – 201402984							Plan updated (Date): <b>December 21, 2021</b>													
Sajad Alquriniawi (SQ) – 201502769							Instructor: Dr. Sadiq Alhuwaidi													
							Period Highlight		1	Plan		Actual								
							Actual (beyond plan)			Complete (beyond plan)										
ACTIVITY							PLAN START	PLAN URATIO	Assigned To	ACTUAL START	ACTUAL URATIO	PERCENT COMPLETE	Periods (Weeks 1-15)							
Write a plan	1	1	ALL	2	2	100%														
Ordering Components	2	1	EZ, SQ	2	2	100%														
Design subsystem 3 (determine app software tools)	2	2	ALL	3	2	100%														
Bulid subsystem 3 (using Firebase)	3	2	HB, MJ	3	2	100%														
App authentication method	3	3	EZ	3	4	100%														
App Database	4	3	ALL	4	4	100%														
Integrate app functionalities (Hearing/Evaluation Test, User interface, Hearing Modes, Emailing section)	5	4	EZ, HB	5	4	90%														
Test subsystem 3	6	5	SQ	6	5	100%														
Prepare midterm presentation and video	7	3	ALL	7	3	100%														
Design subsystem 4 (design filters after getting the app design)	8	2	HB, MJ	8	2	100%														
Bulid subsystem 4	9	4	EZ SQ	8	4	55%														
Test subsystem 4	10	2	SQ	10	2	0%														
Implement final design	10	1	ALL	11	2	100%														
Prepapre final report	12	2	HB, MJ	12	2	50%														
Prepapre final presentation	12	2	HB	12	3	100%														
Prepare project demo	13	3	MJ	13	3	100%														
Submit Rpt/PPT/Brochure/Video...etc.	14	2	EZ	14	2	0%														
<b>Progress Details:</b>							<b>Issues (delay, etc.):</b>													

# Teamwork Task Division

Task	Ehab	Mustafa	Hassan	Sajad
Research & Planning	30%	20%	30%	20%
Spring Semester Tasks	30%	20%	10%	40%
Fall Semester Tasks	15%	35%	35%	15%
Write reports & presentations	25%	25%	25%	25%

# Challenges & Decision Making

- Revisiting subsystem 2 because testing results were not convincing, leading to taking a different approach
- Installing the Android Studio software and working with its special files
- Using the Firebase website and registering our App
- Merging our divided codes into one single code in the Android Studio
- Importing subsystem 1 audio files to subsystem 3 app code files
- Generating FCM token between the app and Firebase Database to keep the user logged in and his information secure
- Late delivery of bone-conduction headphones
- Laptop battery swelling (Sent for maintenance)

# Risk Management

	Source	Events	Threats	Response
1	Computer	Could not Install the Android Studio	Cannot proceed with subsystem 3	Upgrading computer hard disk from HDD to SSD
2	Programming	Project mainly software base	Unable to build the smartphone application	Many online resources available for Android Studio using Java language
3	Team member	Positive Covid Test	Test delay	Unpredictable
4	Computer	Maintenance needed	Cannot access documents	Upload documents and data to iCloud
5	Delay in delivery of wireless headphones	4 days delay	Cannot start on subsystem 1	Started with subsystem 2

# Impact of COVID-19 on your Project

- Delay in receiving bone-conduction headphones
- Sudden change in semester schedule to finish before end of Ramadan. Overall, less time to work on the project

# Impact of Project

- This project can have a major impact on society and economy overall
  - Taking an audiometry test directly from smart phone for instant results
  - Less time spent to get results instead of going to the hospital
  - Less money spent to book appointments and follow up appointments

# New Skills Acquired and Applied

- Time management
- Communication skills
- Teamwork
- Research skills
- Acquiring some basic knowledge about programming using the Java language
- Learned to use the Android Studio software
- Learned to build a project in Firebase website

# Budget Estimate

- List Key components and their approximate cost
- Add up total estimate

Item	Quantity	Unit Cost (SR)	Subtotal
Bone Conduction Headphones Bluetooth V5.0	1	740.49 SR	-
Android Tablet	1	1320 SR	-
Computer	1	-	-
Java/C++	-	-	-
			2060.49 SR

**Thank You for Listening**

Any Questions?