USER GUIDE FOR SMARTPHONE BASED REAL-TIME ACOUSTIC FEEDBACK CANCELLATION SYSTEM

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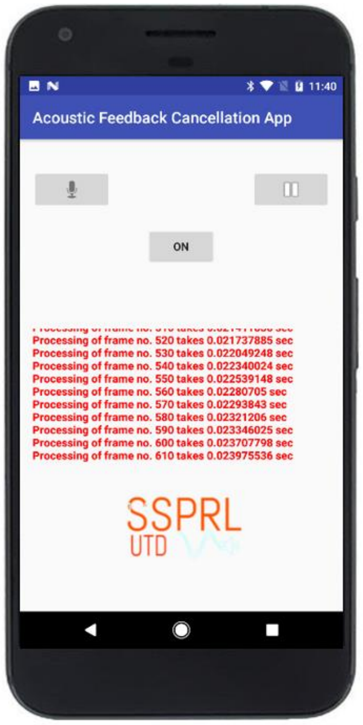
INTRODUCTION

The ‘Acoustic Feedback Cancellation (AFC)’ app is designed to cancel the acoustic feedback arising due to the acoustic coupling between the speaker and microphone in real time on smartphone. The application is trained to perform in noisy conditions as well. The contents of this user guide gives you the steps to implement the ‘Acoustic Feedback Cancellation’ algorithm on Android devices and the steps to be followed after installing the app on the smartphone. This app will be an open source and portable research platform for hearing improvement studies.

This user guide covers the software tools required for implementing the algorithm, how to run C codes on Android devices and usage of other tools that are quite helpful in creating audio apps for audio playback in real time. The MATLAB and C codes used for the ‘Acoustic Feedback Cancellation’ algorithm are made available publicly on the following website: http://www.utdallas.edu/ssprl/hearing-aid-project/. The codes can be accessed and used with proper consent of the author for further improvements in research activities related to hearing aids. The screenshot of the first look of our app is as shown in Figure 1.



```
Processing of frame no. 520 takes 0.021737885 sec
Processing of frame no. 530 takes 0.022049248 sec
Processing of frame no. 540 takes 0.022340024 sec
Processing of frame no. 550 takes 0.022539148 sec
Processing of frame no. 560 takes 0.02280705 sec
Processing of frame no. 570 takes 0.02293843 sec
Processing of frame no. 580 takes 0.02321206 sec
Processing of frame no. 590 takes 0.023346025 sec
Processing of frame no. 600 takes 0.023707798 sec
Processing of frame no. 610 takes 0.023975536 sec
```

Figure 1. Screenshot of the AFC Application

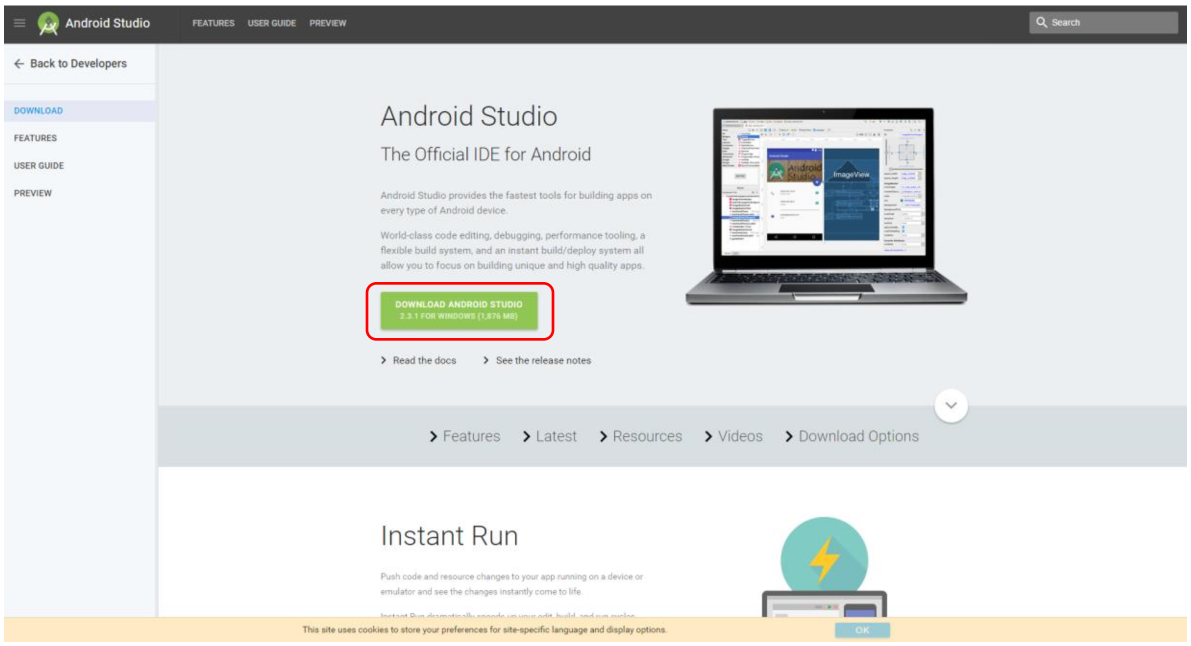
1. SOFTWARE TOOLS

Android is an open-source operating system developed by Google for mobile phones and tablets. The Android apps are usually coded in Java. In this section, it is shown how to set up the Android Studio IDE (Integrated Development Environment) for developing Android apps.

Android Studio IDE requires either Windows Operating System or Apple Operating System. Android Studio IDE can directly build and upload source codes into Android smartphone or generate a APK file which can be downloaded and installed on the Android smartphone.

To download the latest version of Android Studio

1. Open the Android Studio website to download. (https://developer.android.com/studio/index.html)
2. Click Download Android Studio Button (Figure 2).
3. Install the execution file after download.



Android Studio

The Official IDE for Android

Android Studio provides the fastest tools for building apps on every type of Android device.

World-class code editing, debugging, performance tooling, a flexible build system, and an instant build/deploy system all allow you to focus on building unique and high quality apps.

Instant Run

Push code and resource changes to your app running on a device or emulator and see the changes instantly come to life.

This site uses cookies to store your preferences for site-specific language and display options.

Figure 2

2. BUILD AN ANDROID APP

2.1 Programming Language

For creating Android apps, Java is used to create the required shell. The Java Development Kit (JDK) needs to be firstly installed on your computer. This link contains the latest version of JDK: http://www.oracle.com/technetwork/java/javase/downloads/index.html

2.2 Creating Android Apps

After installations of Android Studio and JDK completed, android apps can be created using Android Studio.

1. Open Android Studio.
2. Under the "Quick Start" menu, select "Start a new Android Studio project." (Figure 3)
3. On the "Create New Project" window that opens, name your project "HelloWorld".(Figure 4)
4. If you choose to, set the company name as desired*.
5. Note where the project file location is and change it if desired.
6. Click "Next."
7. Make sure on that "Phone and Tablet" is the only box that is checked. (Figure 4)
8. If you are planning to test the app on your phone, make sure the minimum SDK is below your phone's operating system level.
9. Click "Next."
10. Select "Blank Activity." (Figure 4)
11. Click "Next."
12. Leave all of the Activity name fields as they are. (Figure 4)
13. Click "Finish."

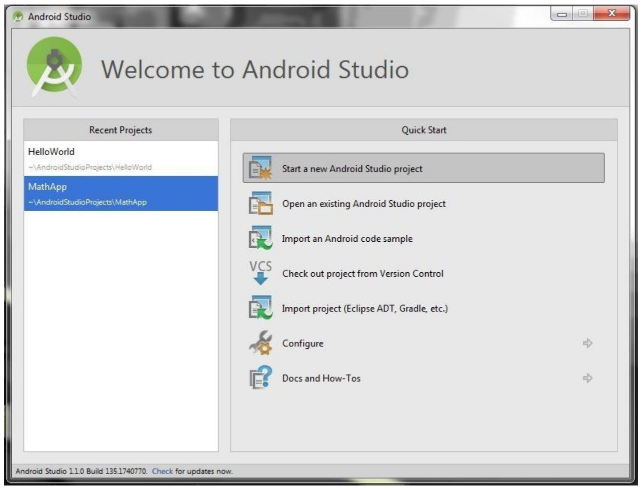
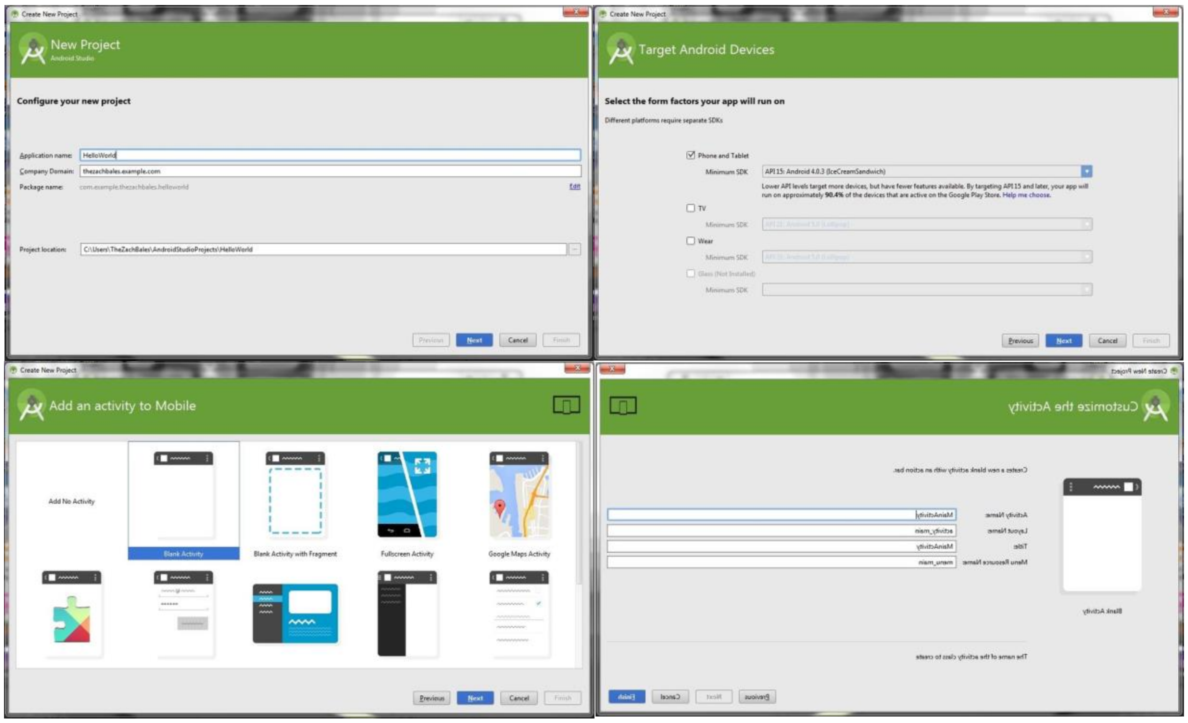

Android Studio
Welcome to Android Studio
Recent Projects
HelloWorld
~\AndroidStudioProjects\HelloWorld
MathApp
~\AndroidStudioProjects\MathApp
Quick Start
Start a new Android Studio project
Open an existing Android Studio project
Import an Android code sample
Check out project from Version Control
Import project (Eclipse ADT, Gradle, etc.)
Configure
Docs and How-Tos
Android Studio 1.1.0 Build 135.1740770. Check for updates now.

Figure 3



Configure your new project

Application name: HelloWorld
Company Domain: thezachbales.example.com
Package name: com.example.thezachbales.helloworld
Project location: C:\Users\TheZachBales\AndroidStudioProjects\HelloWorld

Select the form factors your app will run on

Different platforms require separate SDKs

Phone and Tablet ✓
Minimum SDK: API 15: Android 4.0.3 (IceCreamSandwich)

Lower API levels target more devices, but have fewer features available. By targeting API 15 and later, your app will run on approximately **90.4%** of the devices that are active on the Google Play Store. Help me choose.

TV
Wear
Glass (Not Installed)

Creates a new blank activity with an action bar.

Activity Name: MainActivity
Layout Name: activity_main
Title: MainActivity
Menu Resource Name: menu_main

The name of the activity class to create

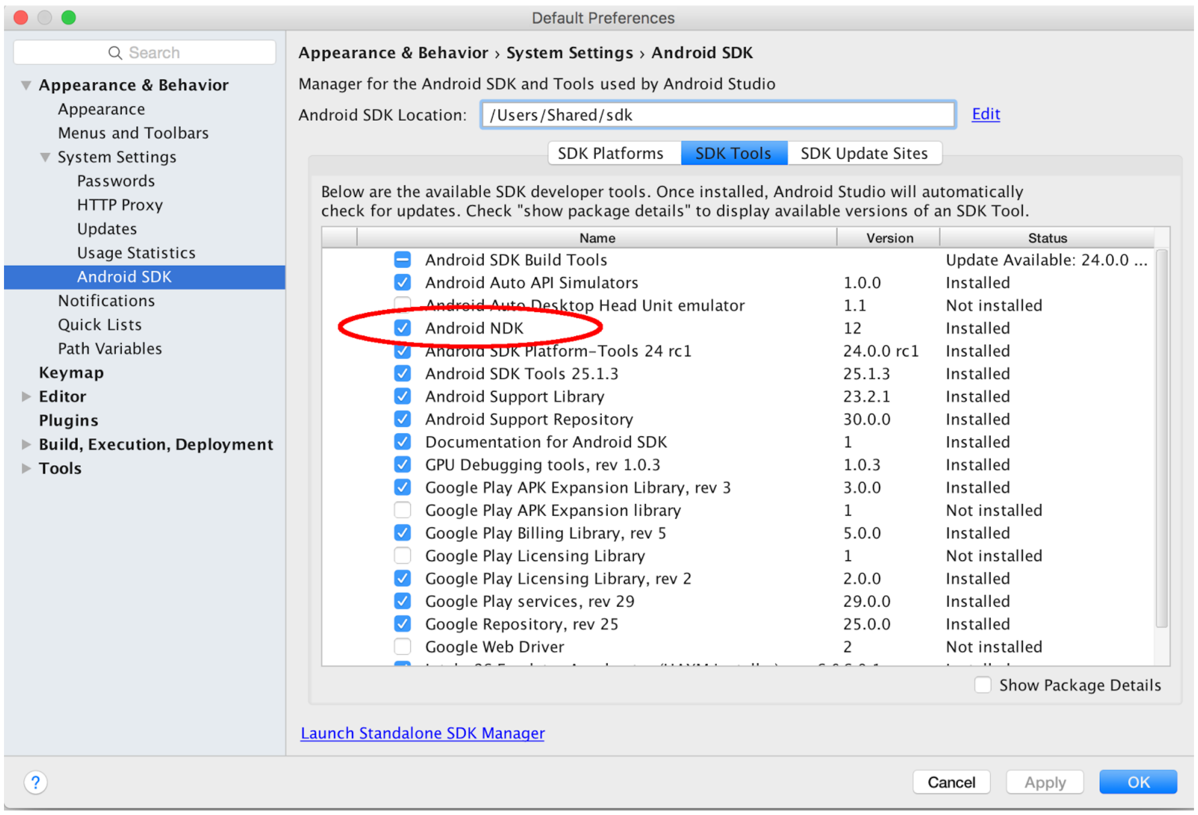
Figure 4

2.3 Adding C File

Android apps are typically written in Java, with its elegant object-oriented design. However, at times, you need to overcome the limitations of Java, such as memory management and performance, by programming directly into Android native interface. Android provides Native Development Kit (NDK) to support native development in C/C++, besides the Android Software Development Kit (Android SDK) which supports Java.

2.3.1 Installing the Native Development Kit (NDK)

1. Menu "Tools" > "Android" > "SDK Manager" (Figure 5)
2. Select tab "SDK Tools"
3. Check "Android NDK"[or "NDK"] if it is not checked
4. Sync and re-build the project.



Appearance & Behavior › System Settings › Android SDK

Manager for the Android SDK and Tools used by Android Studio

Android SDK Location: /Users/Shared/sdk

Below are the available SDK developer tools. Once installed, Android Studio will automatically check for updates. Check "show package details" to display available versions of an SDK Tool.

	Name	Version	Status
−	Android SDK Build Tools		Update Available: 24.0.0 ...
✓	Android Auto API Simulators	1.0.0	Installed
	Android Auto Desktop Head Unit emulator	1.1	Not installed
✓	Android NDK	12	Installed
✓	Android SDK Platform-Tools 24 rc1	24.0.0 rc1	Installed
✓	Android SDK Tools 25.1.3	25.1.3	Installed
✓	Android Support Library	23.2.1	Installed
✓	Android Support Repository	30.0.0	Installed
✓	Documentation for Android SDK	1	Installed
✓	GPU Debugging tools, rev 1.0.3	1.0.3	Installed
✓	Google Play APK Expansion Library, rev 3	3.0.0	Installed
	Google Play APK Expansion library	1	Not installed
✓	Google Play Billing Library, rev 5	5.0.0	Installed
	Google Play Licensing Library	1	Not installed
✓	Google Play Licensing Library, rev 2	2.0.0	Installed
✓	Google Play services, rev 29	29.0.0	Installed
✓	Google Repository, rev 25	25.0.0	Installed
	Google Web Driver	2	Not installed

Show Package Details

Figure 5

2.3.2 Writing a Hello-World Android NDK Program

Creating a new project with support for native code is similar to creating any other Android Studio project, but there are a few additional steps:

1. In the Configure your new project section of the wizard, check the Include C++ Support checkbox.
2. Click Next.
3. Complete all other fields and the next few sections of the wizard as normal.
4. In the Customize C++ Support section of the wizard, you can customize your project with the following options:
    - C++ Standard: use the drop-down list to select which standardization of C++ you want to use. Selecting Toolchain Default uses the default CMake setting.
    - Exceptions Support: check this box if you want to enable support for C++ exception handling. If enabled, Android Studio adds the -fexceptionsflag to cppFlags in your module-level build.gradle file, which Gradle passes to CMake.
    - Runtime Type Information Support: check this box if you want support for RTTI. If enabled, Android Studio adds the -frtti flag to cppFlags in your module-level build.gradle file, which Gradle passes to CMake.
5. Click Finish.

After Android Studio finishes creating your new project, open the Project pane from the left side of the IDE and select the Android view. As shown in figure 6, Android Studio adds the cpp and External Build Files groups:

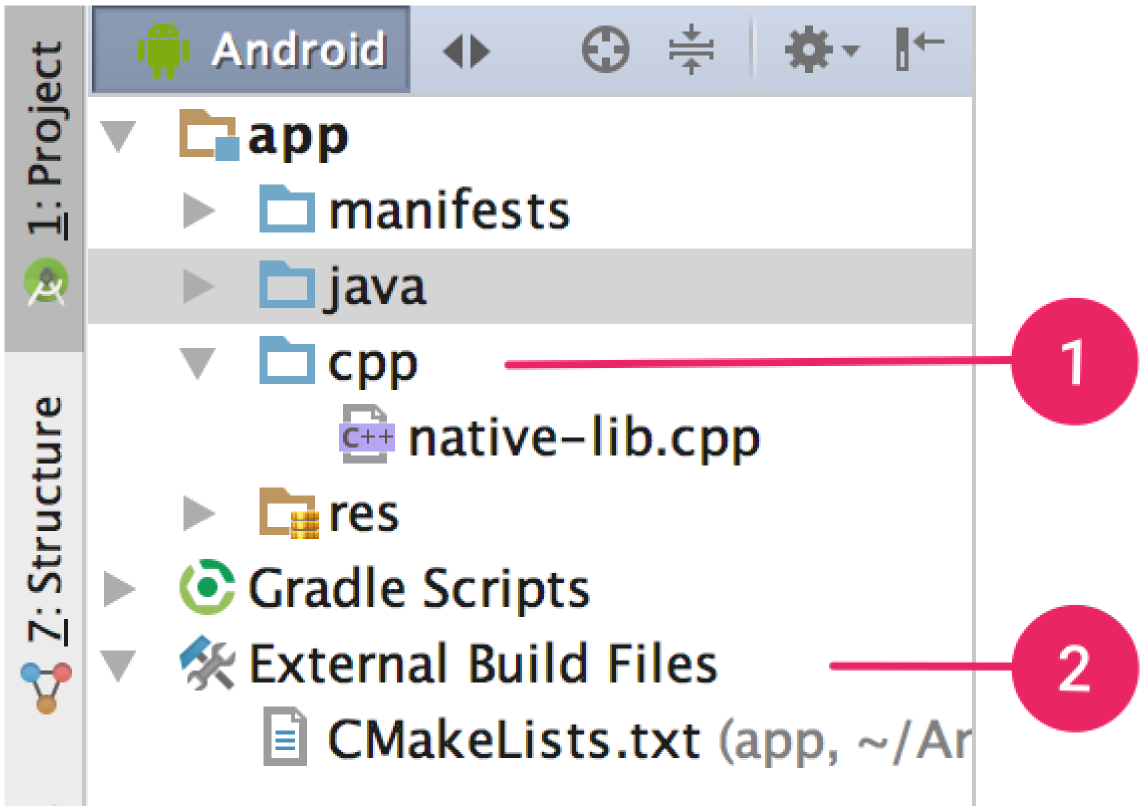


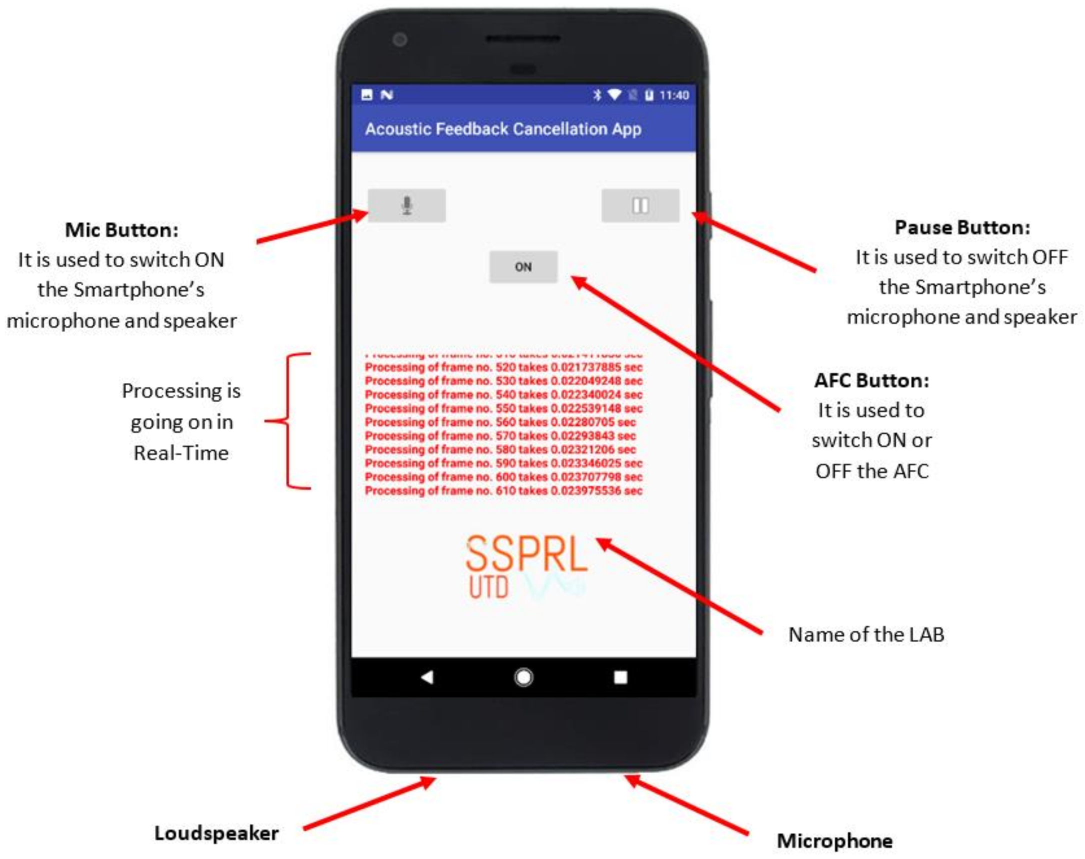
Figure 6

1. The cpp group is where you can find all the native source files, headers, and prebuilt libraries that are a part of your project. For new projects, Android Studio creates a sample C++ source file, native-lib.cpp, and places it in the src/main/cpp/ directory of your app module. This sample code provides a simple C++ function, stringFromJNI(), that returns the string “Hello from C++”.

2. The External Build Files group is where you can find build scripts for CMake or ndk-build. Similar to how build.gradle files tell Gradle how to build your app, CMake and ndk-build require a build script to know how to build your native library. For new projects, Android Studio creates a CMake build script, CMakeLists.txt, and places it in your module’s root directory.

3. ACOUSTIC FEEDBACK CANCELLATION APPLICATION

The developed algorithm demonstrates the real-time operation to cancel the negative effects of acoustic feedback arising in the hearing aid devices due to the coupling between the speaker and the microphone. The application is trained to perform in noisy conditions as well. See Figure 7 for a screenshot of the Android application.


11:40
Acoustic Feedback Cancellation App
ON
SSPRL
UTD
Mic Button:
It is used to switch ON the Smartphone's microphone and speaker
Pause Button:
It is used to switch OFF the Smartphone's microphone and speaker
Processing is going on in Real-Time
AFC Button:
It is used to switch ON or OFF the AFC
Name of the LAB
Loudspeaker
Microphone

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Processing of frame no. 520 takes 0.021737885 sec
Processing of frame no. 530 takes 0.022049248 sec
Processing of frame no. 540 takes 0.022340024 sec
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Processing of frame no. 600 takes 0.023707798 sec
Processing of frame no. 610 takes 0.023975536 sec
```

Figure 7 Screenshot of the proposed AFC Application

Following are the key things to keep in mind while using the application:

- When the Mic button is pressed the microphone and the loudspeaker gets switched ON and thus due to the acoustic leakage from the speaker the signal gets picked up by the microphone of the smartphone giving rise to the undesirable irritating "whistling" and "screeching" acoustic feedback sound.

- Pause button is used to switch off the smartphone's microphone and loudspeaker
- When the AFC button is in "OFF" mode, the application merely plays back the audio through the smartphone without processing it.
- On switching "ON" the AFC button, Acoustic feedback cancellation algorithm gets activated and the incoming audio stream degraded by acoustic feedback is processed by applying the noise injection acoustic feedback cancellation procedure.
- As it is computationally efficient, so it consumes very less power of the smartphone while running.

To learn more about the application, please refer to our video demos on http://www.utdallas.edu/ssprl/hearing-aid-project/.

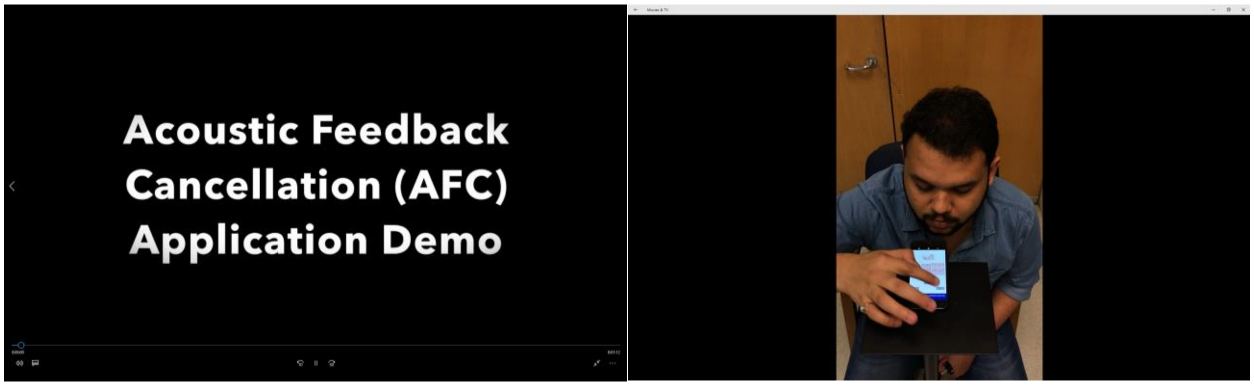

Figure 9 Video screenshots for Demo videos