Husker Scope – UNL CSE Jeffrey Falkinburg

Project Overview

For this project we would like to have the team work with us to build an app for IOS and Android that implements a Dual Channel Function Generator and Oscilloscope functionality for use within the CSCE 436 - Advanced Embedded Systems and other Engineering courses. The Dual Channel Function Generator will be able to output waveforms (sine, square, triangle, and sawtooth, etc.) via the left and right headphone channels. They will be able to adjust output Amplitude, Frequency, and Phase of the two channels. The Oscilloscope functionality will be able to function like a standard two-channel oscilloscope to analyze audio range (20Hz to 20,000Hz) signals or learning oscilloscope measurement basics. The interface will include many of the standard oscilloscope control features like triggering, time and volts per division, cursors for signal measurement, pause for screen capture, etc. Perhaps in the future it may even incorporate Spectrum Analyzer Functionality as well. The app would input and output through the standard left and right channels of the phone's stereo output (i.e. 3.5mm headphone jack). The app will still work for phones that don't have a physical headphone jack by connecting an adapter to the USB-C or Lightning charging port. This application will be used by engineering students and faculty throughout UNL and other Colleges/Universities.

Sponsor Background

I am a Lecturer in the Computer Science and Engineering Department at the University of Nebraska-Lincoln, a Computer Engineer, and recently retired U.S Air Force Major. My research interests include robotics, embedded systems, 3D modeling, and simulation design. My areas of specialization include VLSI Systems, Computer Architecture, Embedded Systems, Advanced Digital Design. I have been teaching in the CSCE department for three years and have taught the Advanced Embedded Systems Course for two years. Additionally, I taught a similar course at the Air Force Academy for two years prior to that. This course teaches engineering students how to develop the hardware and software interfaces of an Oscilloscope and Function Generator using a Nexys Video FPGA. Having an all-in-one cross platform (IOS and Android) app for students to test out their hardware would be very helpful in the course.

Initially this app will support the CSCE 436 - Advanced Embedded Systems course hopefully starting in the spring 2022 semester. See https://cse.unl.edu/~jfalkinburg/cse_courses/2022/436/index.html for the spring 2022 course website. You can also see links to previous semester versions of my courses at https://cse.unl.edu/~jfalkinburg/.

Project Stakeholders

This application will be used by engineering students and faculty throughout UNL and other Colleges/Universities.
- *Jeffrey Falkinburg, Lecturer, Principle Investigator and Primary Contact*
- *Charles Daniel, Computing Coordinator, CSE Computing Expert*
- *CSCE 436 – Advanced Embedded Systems Students*
- *Other UNL Engineering Students*

Current System Overview

The Advanced Embedded Systems Course I have and currently teach at UNL teaches engineering students how to develop the hardware and software interfaces of an Oscilloscope and Function Generator using a Nexys Video FPGA. Having an all-in-one cross platform (IOS and Android) app for students to test out their hardware would be very helpful in the course. Figure 1 gives you a broad overview of how the application will interface with other systems as a piece of engineering test equipment.
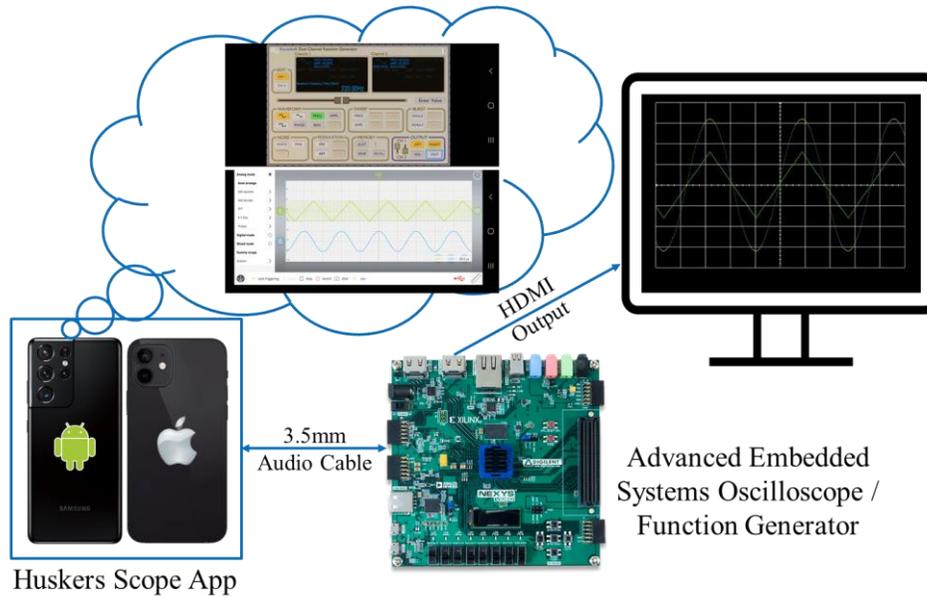
Figure 1: Husker Scope App Interface Overview

The app would input and output through the standard left and right channels of the phone's stereo jack (i.e. 3.5mm headphone jack). The app will still work for phones that don't have a physical headphone jack by connecting an adapter to the USB-C or Lightning charging port. A typical stereo jack output is show in Figure 2.

Figure 2: Typical Stereo Jack pinout

Proposed System/Scope

In the following four subsections, we will provide the project vision.

1. Business Justification

This all-in-one cross platform (IOS and Android) app will provide a cheap and easy way for engineering students to have ready access to test equipment like a two-channel Function Generator and Oscilloscope. Perhaps in the future it may even incorporate Spectrum Analyzer Functionality as well.

2. Proposed System Overview and Strategy

Husker Scope would resemble several apps that are available on Andriod and IOS and combine them to create an all-in-one cross platform (IOS and Android) app that would contain functionality of both a Function Generator and Oscilloscope in one app. In the future we would expand the apps' functionality to include a spectrum analyzer capability as well. There are several apps that implement portions of the proposed app, but they are typically not multi-function and are not available on both app stores. Figure 3 shows the Keuwlsoft Function Generator app available on the Google Play store and Figure 4 shows the Lab Nation SmartScope Oscilloscope also available on the Google Play store. These are decent apps available to Android users, but are not available in a single app that also works on IOS devices. The Apple Store has some Function Generator and Oscilloscope apps as well, but often you have to purchase them. I want engineering students to have a one stop for test equipment apps with a common interface that all students can use regardless of what phone platform they are using.

Figure 3: Keuwlsoft Function Generator
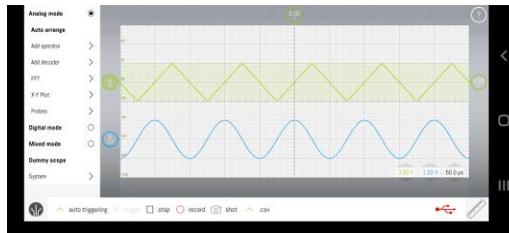

Figure 4: LabNation SmartScope Oscilloscope

Figure 5 shows a digital version of the typical display on an old electron beam 640x480 two-channel Oscilloscope that Advanced Embedded Systems course students learn how to implement on the Nexys Video FPGA.
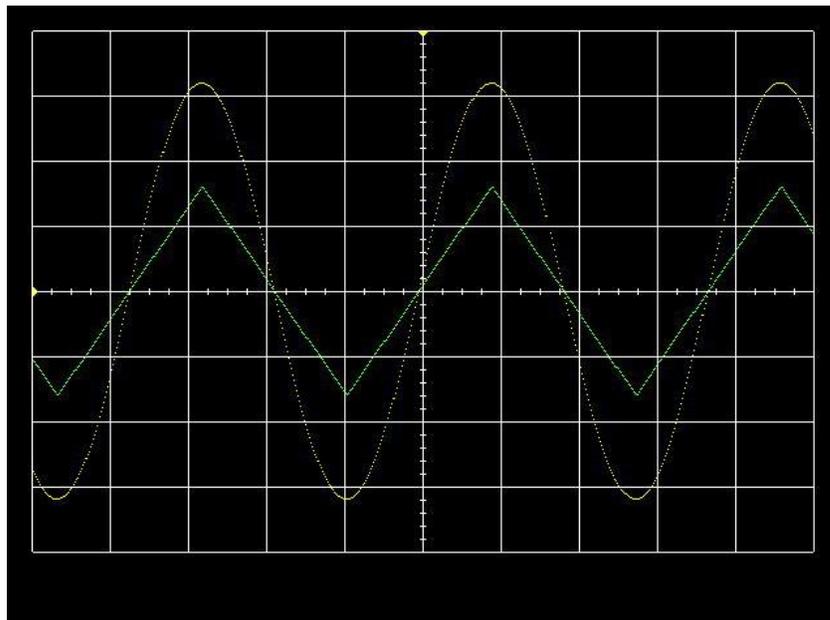

Figure 5: Typical Oscilloscope Display

3. Scope of Work

The team is tasked to create an all-in-one cross platform (IOS and Android) app with the following prioritized test equipment capabilities:

1. *The Dual Channel Function Generator functionality:*
   o *App will be able to output waveforms (sine, square, triangle, and sawtooth, etc.) via the left and right headphone channels.*
   o *App will be able to adjust output Amplitude, Frequency, and Phase of the two channels.*
2. *The Oscilloscope functionality:*
   o *App will be able to function like a standard two-channel oscilloscope to analyze audio range (20Hz to 20,000Hz) signals or learning oscilloscope measurement basics.*
   o *The interface will include many of the standard oscilloscope control features like triggering, time and volts per division, cursors for signal measurement, pause for screen capture, etc.*
3. *The Spectrum Analyzer functionality (nice to have functionality…if time):*
   o *App will be able to show the frequency components of ambient sound, music, or your voice within the audio range (20Hz to 20,000Hz).*

4. High Level Architecture Requirements (Technical Specifications)

This app will be developed to be deployed on Android and IOS devices with the following Technical Specifications:

- *This app will only operate on low power signals within the audio range (20Hz to 20,000Hz) since it will be utilizing the onboard audio interface to output via the native stereo input/output.*
- *Stereo input/output will interface with a 3.5mm headphone jack (left and right stereo) when the device has one native. Since newer devices don't have a physical heaphone jack on the device the app will need to be tested by connecting a headphone jack adapter via the USB-C or Lightning charging port.*
- *The Oscilloscope (and eventually the Spectrum Analalyzer) will have a selectable input interface using the two-channel audio jack input and the microphone input.*
- *Storage will only be on the device.*

Expected Deliverables from Project Team (Senior Design Provides)

The expectation is a fully functional mobile application that is deployed to both the Google Play Store and the Apple Store by the end of this effort. The app should be able to input and output two-channels (left and right stereo) with at least the Function Generator and Oscilloscope capablilities listed in the scope of work. Additionally, we expect that you plan ahead to have a developmental version being deployed as an APK for Android and via TestFlight for IOS devices starting no later than Release 3. I would like my spring 2022 Advanced Embedded Systems Students to be Beta testers if possible. Earlier apps via distributed APKs for Release 2 is highly encouraged for early deployment testing.

Supporting Materials (Sponsor Responsibilities and Provisions)

You will likely be using similar single function apps on the Google Play and Apple Stores and test equipment available in the labs as a guide for your development of our multi-function app. Some of the similar apps are listed above in the overview. The Husker Scope app will be tested with the audio test equipment used in the labs and will eventually be used and tested by students in the Advanced Embedded Systems course in the spring. See the spring 2022 CSCE 436 course website for more information on how a Oscilloscope (Lab 1-3) and Function Generator (Lab 4) function.
https://cse.unl.edu/~jfalkinburg/cse_courses/2022/436/index.html.

Communication Plan

The communication will be mainly via Slack (text, audio, or Zoom calls). Meetings will be held via Zoom for weekly meetings and in-person for major milestone meetings if possible. The primary contact is available weekly to answer any questions during his office hours or at scheduled office/Zoom visits. Email for an appointment. Otherwise, send a message via Slack and I will get back to you asap.

Sponsor Contact Information

Below is a list of the stakeholders on this project.

Name	Primary Contact (Y/N)	Email Address	Title	Address	Phone Number
Jeffrey Falkinburg	Y	jfalkinburg2@unl.edu	Lecturer – Computer Engineering	368 Avery Hall	402-312-8078
Charles Daniel	N	cdaniel@cse.unl.edu	Computing Coordinator	27D Avery Hall	402-472-7577