
AC 2012-5201: WORK-IN-PROGRESS: USING MODERN MOBILE TECHNOLOGIES IN STEM EDUCATION

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WORK IN PROGRESS: USING MODERN MOBILE TECHNOLOGIES IN STEM EDUCATION

Abstract

With advances in modern mobile devices and the increasing use of smart phones and tablets by students, there is an opportunity to provide enhanced and personalized educational experiences and convenient remote access to course material. This paper describes an education research endeavor aimed at developing, packaging and assessing course content, interactive learning modules, educational simulations, and visualization examples for smart phones and tablets. Our efforts focus on integrating existing and new tools, optimized for smart phones and tablets, in undergraduate Science, Technology, Engineering and Mathematics (STEM) courses. The project brings together several technologies including a Java simulation environment, an Android operating system with several dedicated apps, Blackboard Mobile™ Learn, Sprint ID and others. The hypothesis here is that the creation of a “central” education site with maximum mobility will be compelling to undergraduate students that seem fascinated by the exciting multi-tasking possibilities that smart phones and tablets bring these days. In this paper, we will work on the development and assessment of a portal for mobile devices that will enable students to operate several state of the art education mobile applications (apps) seamlessly. These apps include visualization modules, mobile labs, lecture video viewing, quiz taking, homework/lab submission applets, and customized educational web site access. An assessment task will be a senior level signal processing class to examine several aspects of the mobile student learning experience.

Index Terms—smart phones, tablets, Android, STEM, central education, University ID.

Introduction

The continuous development of new mobile technologies and the associated portable smart phone and tablet software applications (apps) is generating interest in several areas including education. An increasing number of students and faculty are using smart phones and tablets to obtain content, books and other tools for their classes. To that end there have been reports that smart phones and tablets are being used more than computers by college students¹. Although some apps have been ported to mobile platforms including the mobile blackboard (mobile BB), the iOS Java-DSP⁸ (i-JDSP) mathematical simulations, and YouTubeTM education channels¹², there are both technical deficiencies and lack of assessment. Technical issues include the inability of these apps to operate in a collaborative and seamless manner with regard to accessibility, sharing of data, and multitasking which we take for granted in a desktop/laptop environment. In addition, there has not been adequate assessment, to our knowledge, to demonstrate that mobile education apps are beneficial as learning tools or whether they contribute to increased enrollment and retention in STEM areas. This paper describes our attempt to address both of these issues. To address the technical aspects of this study we worked with the assistance of Sprint Communications, on a new and customized “one stop” mobile portal that houses several education apps and other associated content and software that students find compelling on college campuses and classes. This cluster of apps that are housed in a smart phone portal called “University ID” (in the case of our university “ASU ID”) is customizable and includes apps that we developed at our university from the ground up for STEM education. We note that previous attempts to create customized portals for universities have also been attempted by mobile communications service providers to expand their student customer base on college campuses (example shown in Figure 1).

The difference in our effort is that we include and customize not only the usual sports/entertainment and university service/access apps but we focus specifically on including STEM oriented apps (see Figure 2), some of which were created as part of an NSF project. For example we created an Android app for performing mathematical and signal analysis simulations on Android smart phones and tablets. We included customized YouTubeTM channels that contain educational visualization examples and portions of or entire video-streamed classes. In addition,

we added interactive quiz apps with feedback. Internet II social networks apps have been harnessed specifically for education and class use. For example, Facebook™ pages¹⁰ are being used to post class content, improvised solutions to problems and what if sessions. A Twitter™ site¹¹ is used by the instructor for short announcements and other notes that engage constantly, the students in the class (see for example, Figure 4).

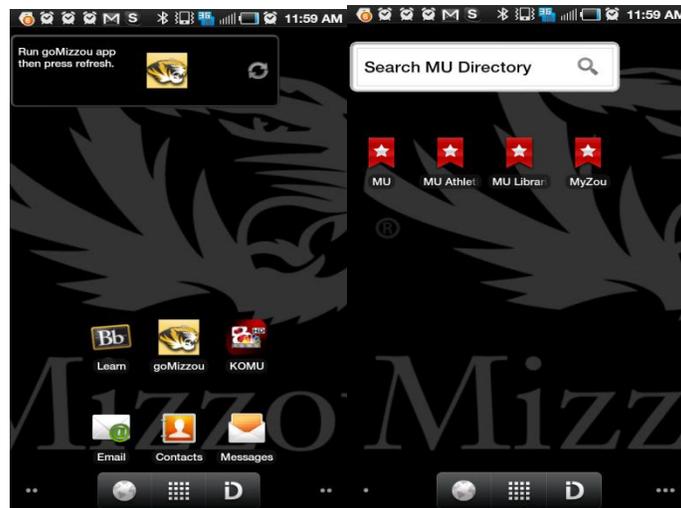


Figure 1. An example of an educational Sprint ID package⁵.

Popular platforms available for developing mobile applications include the iOS, Android, Windows Mobile, Symbian and Blackberry². We choose the open source Android platform for this study, since it has a rapidly-growing user base³. An iOS version is also being developed.

The rest of the paper will be organized as follows. First, we will give a brief introduction to Sprint ID, Mobile Learn and other software that we will need to create our “central” (“one stop”) education platform. Second, we will discuss the details of the portals and applications used in building the ASU ID package. Third, we will develop assessment instruments and present preliminary assessment results. Finally, concluding remarks are presented.



Figure 2. The customized University ID package that can be used to access portals and applications such as (a) Mobile Blackboard, (b) MATLAB, (c) YouTube, and (d) Android-based Java-DSP.

The University Portal and its Associated Apps

Figure 2 shows a preliminary realization of the University ID smart phone portal. It contains several STEM related applications including Blackboard Mobile™ Learn, MATLAB®, IEEE™ Xplore, the J-DSP environment⁹, YouTube™ and Facebook™. In Figure 2, we also illustrate the Mobile Blackboard content access environment, the MATLAB® environment, the use of YouTube™ to access an educational video showing a DSP simulation/visualization, and the Android-based J-DSP simulation app. Additional apps shown in the portal include access to an app for LabVIEW® educational content, an app for access to IEEE™ Xplore for research paper downloads, customized email shells for instructors and TAs, quiz apps, etc.

The mobile lab is based on the newly developed A-JDSP, which is an Android based software app that was created from the previous award winning J-DSP¹⁴ (Figure 3 and Figure 4). This provides an interactive signal processing simulation environment on an Android smart phone or tablet. Blackboard Mobile™ Learn is a commercial education environment that allows students to view grades, access documents in multiple formats, view and post in discussion forums etc. Sprint ID allows students to download different applications and widgets (such as calendar and weather display at one location).

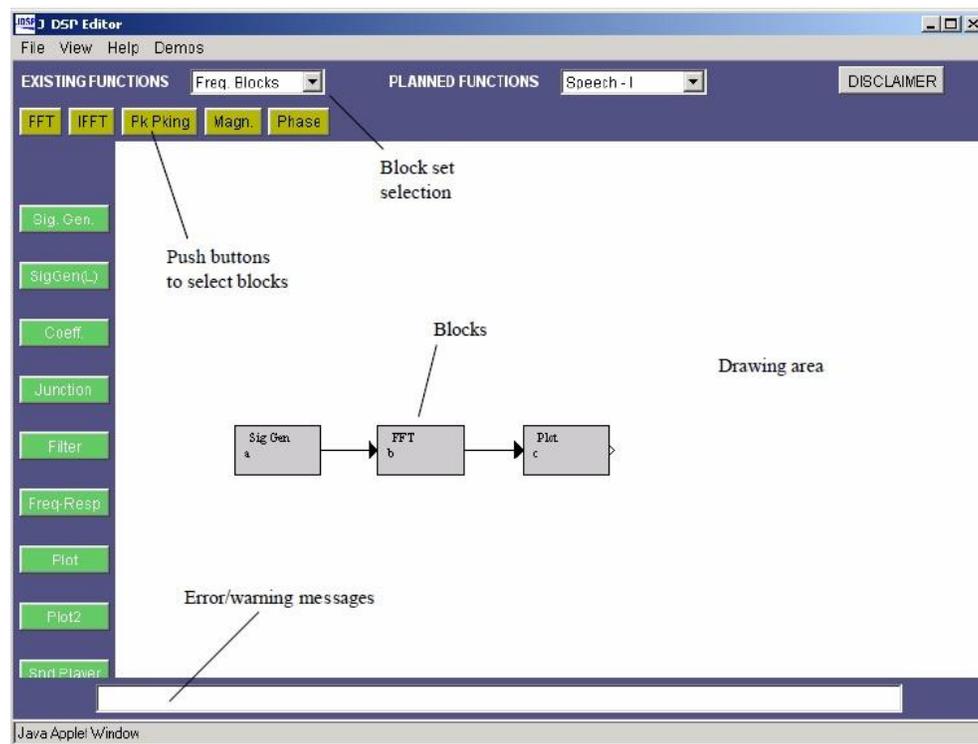


Figure 3. The J-DSP simulation environment⁶.



a) JDSP Facebook site.



b) JDSP Twitter site.

Figure 4. JDSP Facebook™ and Twitter™ sites.



Figure 5. The Mobile Blackboard interface.

In the following we describe how the “central” education platform works. Students can login to the university ID package using their username and password. This central login acts as a

passport to all their applications and enables students to access all apps including the Mobile Blackboard.

The Mobile Blackboard shows all the courses that a student is enrolled in, as shown in Figure 5. By clicking on one of the courses, content and information associated with the selected course can be accessed including course information, homework assigned, and course related video streams.

The University ID will also include the Sprint ID concept, which is developed by a mobile communication provider, and allows students to instantly download, access and personalize programs, apps and widgets in a single environment. Key features are: 1) students can continue to personalize and customize their phone for their campus life; 2) students can install, download or swap commercial apps; 3) access is provided to blend multi-lingual and multi-cultural environments and keyboards.

Specifics for the University ID and the signal processing class

The University ID package will allow signal processing students to check homework, edit and execute MATLAB¹³ code, complete and submit J-DSP lab exercises and view lectures, etc. For example, Figure 6 shows the how a band-pass filter is generated using the “PZ Placement” (pole zero placement) Java function that was customized for the Android. As illustrated in the figure, the students can choose the pole-zero locations using an interactive interface and the magnitude/phase responses of the corresponding filter are plotted dynamically.

Figure 7 shows the MATLAB[®] environment. By tapping the MATLAB[®] icon, students can easily write, revise and perform MATLAB[®] exercises. The figure shows an example project code implemented in the MATLAB[®] environment.

Figure 8 shows the “Course Demo” function. Course demos contain both J-DSP demos and lecture streams. In the figure, the convolution demo will help students to understand the concept of convolution, and it will show the animation of the convolution operation for both discrete time

signals and continuous signals. Additionally, lecture streams enable students to watch the lecture videos. On the left hand of the lecture stream figure, the lecture video is shown, and on the right hand are the lecture notes that are provided by the instructor.

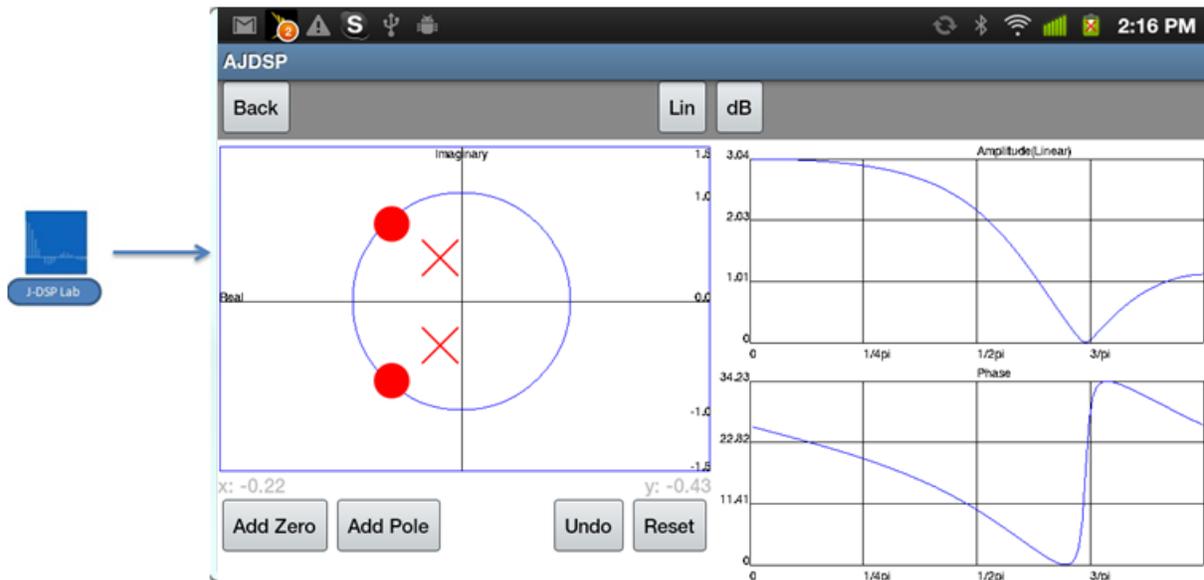


Figure 6. J-DSP simulation of pole-zero placement filter design experiment available on Android phone/tablet.

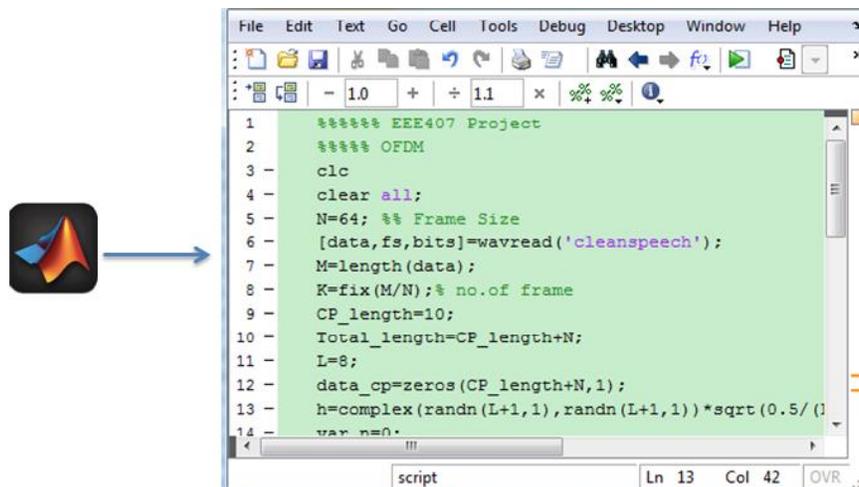


Figure 7. An example of the MATLAB coding environment that can be accessed via ASU ID.

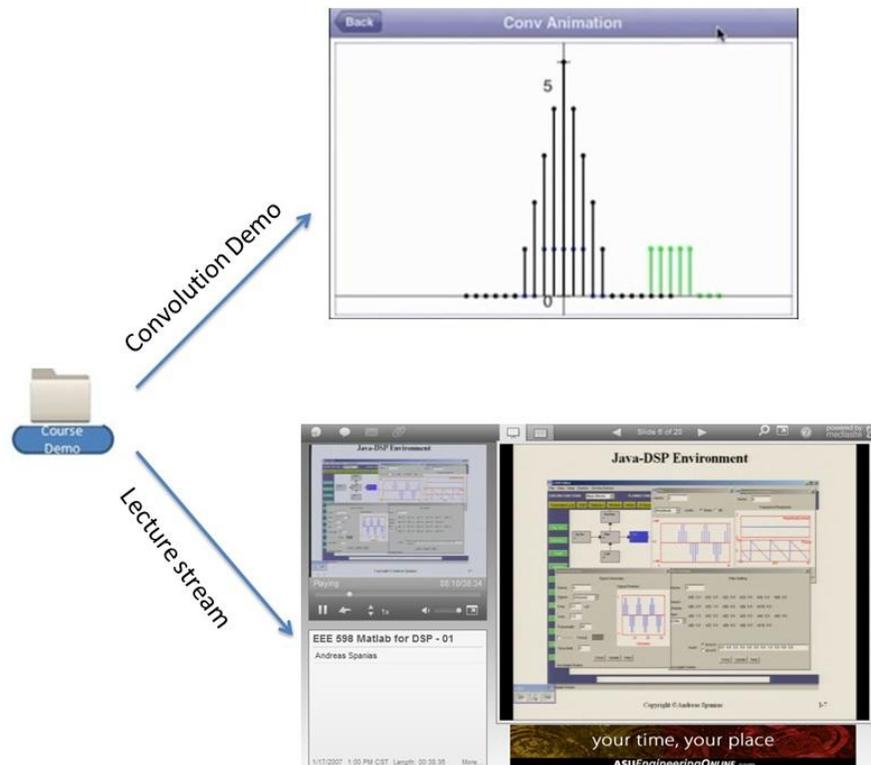


Figure 8. JDSP convolution demo and lecture stream.

Concept-specific assessment tools shown in Figure 9 enable the instructor to evaluate whether the lecture and all the tools enabled the students to answer concept-specific questions correctly. Figure 9 shows two sample questions for the convolution demo.

Lab 1 Pre-Assessment Questionnaire

1. The following signal is causal.

A. True B. False

2. Based on J-DSP convolution, any signal convolved with a causal signal result in a causal signal.

A. True B. False

The diagram shows a folder icon labeled 'Assessment Tools' with an arrow pointing to the questionnaire text.

Figure 9. Illustration of assessment tools.

Preliminary Assessment

Some assessment instruments have been developed and were partially disseminated this spring (2012) in the senior-level signal processing class. These instruments assessed the capability of the technology in computer lab sessions. Some preliminary assessment in the fall of 2011 that used the mobile iOS lab has revealed that 88% of students think that using the block diagram approach was easy and intuitive. Additional assessment in the spring 2012 senior-level DSP class revealed similar results. Smart phone access was reported to be convenient in interviews we carried out for students that used the tablet instead of the desktop/laptop PC. The students were intrigued by the availability of DSP simulation software for their labs on the tablet. They found the modern app-oriented environment very convenient for performing labs and exercises. For the smaller devices they expressed satisfaction for the availability of mobile exercises but they also mentioned that it was at times difficult to work with a 3-4 inch screen. Because the software is new and in a beta version, the students also helped identify bugs and glitches. Figure 10 shows students using i-JDSP on the iPhone and iPad for a computer exercise. Figure 11 shows i-JDSP assessment sessions held for both undergraduate and graduate students to collect assessment data. Students suggested modifications for some functions that would make them more ergonomic and user-friendly. A detailed set of questions and responses is given in Table 1. From the table one can see that about 88% students agree or strongly agree that by solving the i-JDSP lab, the concepts are clearer and the lab helps to distinguish between two similar definitions, such as IIR and FIR. In the longer term, assessments will look into enrollment and retention in the signal processing class.

Summary

In this paper, we introduced a comprehensive mobile “central” education environment for undergraduate students in STEM area. “University ID” is a smart phone portal that is used to house a cluster of education apps for STEM education. These apps include visualization modules, mobile labs, lecture video viewing, quizzes, homework/lab submission applets, and customized educational web site access. Moreover, entertainment apps and social networks and are customized to make the course material more appealing to the students. For example, a customized YouTube™ app on the “University ID” allows students to directly access YouTube™

channels that contain educational visualization examples and portions of or entire video-streamed classes. Also, Facebook™ pages and a Twitter™ site are used by the instructor as a bulletin board and communications platform. Some preliminary assessment of the mobile iOS lab has revealed that most students find using tablets or other mobile devices to perform labs is convenient, but they also mentioned it was difficult to work with the 3-4 inch screens of smart phones.



Figure 10. Students perform class experiments on iPhone and iPad (iOS) devices.



Figure 11. Undergraduate and graduate students in i-JDSP assessment sessions with iPad tablets.

Evaluation Questions	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Performing this exercise, you learned the concept of cascaded and parallel configuration of systems	53.3	33.3	13.4	0	0
Do you now understand more clearly the relationship of the frequency response with the poles and zeros?	93.9	6.1	0	0	0
The contents of this exercise helped you understand the concepts of FIR and IIR filter design.	39.4	48.5	12.1	0	0
After the lab, you know which of the IIR filters have ripple characteristic in both stopband and passband.	48.5	39.4	12.1	0	0
The contents of this exercise helped you understand the introductory spectral analysis concepts of the Fast Fourier Transform.	46.7	40.0	13.3	0	0

Table 1. Statistics based on the general assessment. Total number of students = 33.

Acknowledgements

This project is supported in part by NSF award 0817596, the SenSIP center, and Sprint Communications.

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