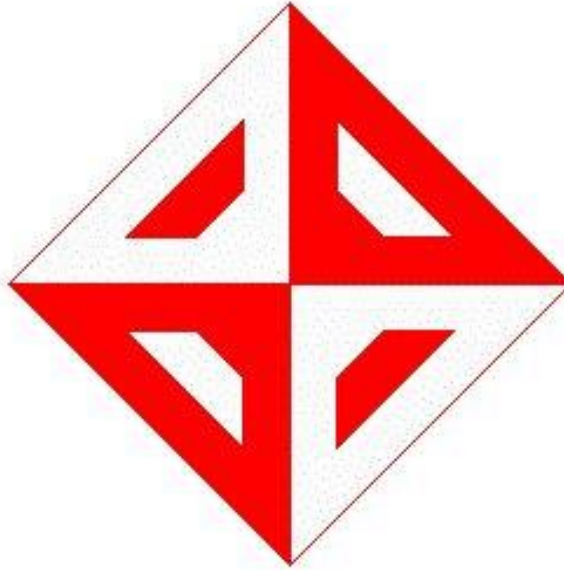


MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING



2011-2012 SENIOR PROJECT PROPOSAL

Project: *DigiMuse*

Group: *Gobit*

M.Burhan Senturk

Ezgi Berberoglu

M.Yigit Yildirim

Kamila Kuchalieva

1. Motivation & Purpose

Technology gets more and more into our lives day by day. If we look back at our high school years, meaning we are speaking about 5 or 6 years back from now, it can be easily seen how far we got on using and developing new technological devices and their features. Back then, we mostly had only computers or laptops that seemed to perform miracles, but nowadays look around and observe what the cell phones are capable of doing. The further the progress of technology goes the more we, the users, seek for novelties. If we should illustrate it through the example, consider the fact that people are quite heavily dependent on the internet services, and they demand to be able to use these services at any instance and place needed. We want to have all kinds of information recourses ready and present by our side for 24 hours a day, 7 days a week.

Some of the most crucial areas where we use technology most widely are public education, self education, and entertainment. There are dozens of technological masterpieces that offer their support in all of these areas. However, there are still gaps to be filled. The goal of our senior project team (Gobit) is to fill one of those gaps by the end of the next semester.

Our purpose is to let the users enjoy self learning support and entertaining capabilities of our final product at the same time. The product to be produced is going to digitalize the notes of sheet music, be able to recognize and process the MIDI formatted music and will transform it to digital sheet music/ tablature and use MIDI for generating realistic sounds. Several musical devices will be supported and depending on which musical device is active the appropriate keyboard will be displayed along with the notes on the same screen. The user will be continuously shown which key he/she should press on to play the musical notes. Meanwhile, each note that is being currently played will be indicated (specified). For more details on product description please refer to Project Description part of this document. Our software will be running on mobile devices.

The users will be offered a self educating facility of our product. New beginners will be able to learn and practice on notes, play their musical compositions right away. They will not be suffering from the inconveniency of tones of papers (sheet music) to be managed and maintained. Digitalization will free them from a lot of work. Users will keep their musical resources in digital libraries and be able to play and try them in different tones.

Important point to be noticed is that there is no such mobile software produced yet. Only some PC versions do exist. By developing this software for mobile devices we will be able to reach a larger range of users, who could practice their musical skills at any time of the day and in any place.

For more details on the project, its features, and background information please do refer to the Marketing Research and Literature Research.

2. Project Description

The main aim of this project is to enable the musicians to create their digital sheet music archive and play it easily with illustrations, tabs and vocalizing abilities with different instruments in a mobile device. The project has three main modules to achieve the goal. First of all, musicians can easily reach traditional printed sheet music in libraries or musical method books. However, they are not portable enough as hundreds of sheet music from different books can be needed at one time. Our project's Optical Music Recognition (OMR) Module simply enables the user to take a photograph of the printed sheet music with his/her mobile device operating on Android and convert it to a digital format i.e MIDI. MIDI (Musical Instrument Digital Interface) is an industry-standard protocol that enables electronic musical instruments (synthesizers, drum machines), computers and other electronic equipment (MIDI controllers, sound cards, and samplers) to communicate and synchronize with each other. Unlike analog devices, MIDI does not transmit an audio signal: it sends event messages about musical notation, pitch and intensity, control signals for parameters such as volume, vibrato and panning, cues, and clock signals to set the tempo. As an electronic protocol, it is notable for its widespread adoption throughout the music industry. MIDI protocol was defined in 1982[1]. Musical note recognition is a highly accurate procedure in theory (around %99) [2], an editing tool is provided just in case an error occurs.

OMR feature will also bring a great easiness for music libraries and publishers which want to carry their printed sheet music to the digital world since MIDI format is easily convertible to digital sheet music or tablature. In addition to those, our project will solve any musician's issue by simply digitalizing a musician's sheet music library and lets him/her to carry them with a simple mobile device.

Second, our project's MIDI Reader Module provides MIDI reading facilities in order to enable MIDI to digital sheet music conversion. Since MIDI is a very common format in music world, musicians can easily reach the MIDI file of a song they want to work on, so thanks to our project's MIDI Reader Module, the user can visualize a MIDI file in digital sheet music format or tablature format. This feature is very useful especially for gig musicians who need a quick transcription of a song they must learn in a limited time interval. Also, a collection of sheet music/tablatore can be used by musicians performing on stage. Combining this with the project's OMR Module the user will have the opportunity to make use of his/her sheet music/tablatore library anywhere, anytime with a mobile device.

Last but not least, MIDI Player Module is an essential part of the project. It is not just a simple MIDI Player but also a visual illustrator of the music played with its sheet music/tablatore. This module simply works as following:

- First, the user provides a MIDI file as an input to MIDI Reader Module
- After that, MIDI Reader Module generates the sheet music/tablatore of the input file and opens a new window with it
- Then, desired instrument sound(s) instead of default options can be selected for illustration.
- Finally, the user will have an illustration of how the sheet music sounds, how it is

played in the keyboard of the desired instrument and how it looks in the sheet music/tablature simultaneously.

The software allows the user to set the tempo and tonality as it can be used for self-education purposes. A beginner musician can easily learn positions, scales and bars from the combined information of sheet music, sound and keyboard positions. Hence, the project lets the user to explore different tones and observe what is being played, allows him/her to work on the music in appropriate speed.

The project offers many different realistic instrument sounds and three instrument keyboards for illustration i.e. the Guitar, the Bass Guitar and the Keyboard/Piano. In addition, it enables to choose the octave of the instrument.

Since studying with a metronome is very important to a musician, metronome is added to the project as an important part which can be both used with the MIDI file or without it. Moreover, a tuner will be provided which will take a real instrument sound of the musician and guide him/her to tune his stringed instrument using the software's presets.

If we put that all together the usual pattern is briefly: First, It converts a printed sheet music into a MIDI file using Image Processing and Pattern Recognition techniques. It takes the MIDI file as an input and generates digital sheet music/tablature. After that, the software provides real time simulation of playing the sheet music with sound of desired instrument(s), digital musical notes and keyboard of the instrument. The digitalized music will be stored locally on mobile devices memory. In addition to that it can be e-mailed to the user or someone else if desired.

All in all, our project focuses on digitalizing sheet music and uses it or other MIDI sources for self-learning purposes of a musician. It converts printed music to digital, play MIDI with desired instruments and combine them with visual elements i.e. keyboard of the instrument and sheet music/tablature. The software will also provide a toolbox facility since it has key components for a musician such as tuner and metronome.

3. Literature Research

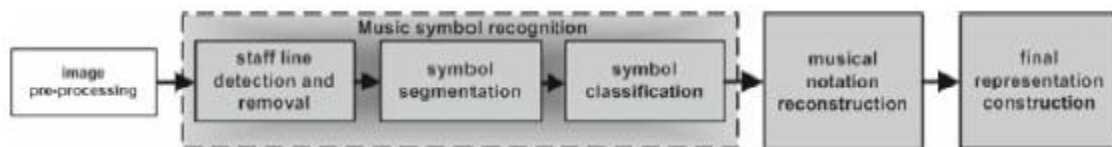
Studies about printed sheet music recognition have been conducted for almost fifty years. The first research to recognize the musical characters was conducted at a graduate level in 1960s. These were performed in several institutions one of which is MIT. Moreover, there are lots of thesis works about music recognition techniques.

Although, lots of packages appeared in the market, none of them was proven to have enough performance due to the complexity of the musical characters when the precision is considered. The recognition systems, Notescan in Nigthingale, Midiscan in Finale, Photoscore in Sibelius, SmartScore and Sharpeye, which are considered to be the most advanced packages, are not even successful enough at recognizing all the musical symbols.

After all the research, the first music scanning product was released with the name MIDISCAN in 1991 by Musitek Corporation.

Lots of people have been studying on that area and there are many articles. In the article, “Optical Recognition of music symbols”, published by A. Rebelo, G. Capela, and Jaime S. Cardoso, the aim of the project is stated as conserving the printed sheet music as in our project. Therefore, the first tried to do is to put them into machine-readable form and used different algorithms for music symbols detection and they stated that the recognition of the hand-written music documents is not as successful as desired.

Following schema is used to represent the symbol detection:



The method for recognition involved to parse the notes after the removal of the musical lines. Then, the characters left were easier to be recognized. After the removal of the lines, musical characters are in the same form with the right one:



While the image processing techniques involves several steps such as binarization, noise removal, blurring, deskewing, different approaches for musical symbol classification in the work stated in the journal is given follow:

- Hidden Markov models
- K-nearest neighbor
- Neural Networks
- Support vector machines

In another article written by Andrew H. Bullen with the title “Bringing Sheet Music to Life: My Experiences with OMR”, the writer gives information about the difficulties in digitalizing the sheet music. Because he aimed to use this technique mostly to read the historic music, the quality of the paper and colors used gain a big importance in the recognition of the symbols. He also adds the property of saving the file in different formats including MIDI.

In this article, following musical characters are aimed to be recognized:

menu, the notes can be changed. When SmartScore X Pro and SharpEye OMR is compared, it can easily be understood that SmartScore has a better playback capability and a simple editor. Additionally, it has a capability of reading TIFF images with LZW compression. However, it is very expensive when compared with other packages with a difference of \$200.

A screenshot from another package Harmony Assistant is given below. Although the identification of symbols of the printed musical sheet is good enough, the edit menu is said not to be user-friendly in the article.



In addition to the articles written, there is an interest in music recognition among academics' projects. Some of the academic music OCR projects are Levy Project (Baltimore, USA), Research aimed at recognizing handwritten music (Leeds University, UK) and CANTOR Project (Waikato University, New Zealand). The last one is a reverse way of music writing. The software Works by first breaking the complicated features into lower-graphical-level before recognition. Also, this Project is supported by the Humanities Research of the British Academy in the form of an Institutional Fellowship.

Most of the studies were successful when the parallelism in the music notation was satisfied. That's to say, there are lots of expression marks, articulations and other musical symbols in addition to the notes. Therefore, when playing the printed sheet music, it is not enough to change only the notes into the corresponding voices. They should be considered with the symbols around them which were explained in the previous sentence.

The success of all the work was also dependent on the scanning technique. Because of the variety in the notation, and the importance of even the smallest dots in playing the music made the work difficult to be accurate. However, modern music OCR packages could get an accuracy of more than 99% in interpreting the printed sheet music.

4. Market Research

Our product mainly targets to self-educated musician, music learners in fact all instrument players. In today's world, technology plays an important role on the process of learning to play an instrument. There are a lot of software products trying to help this process.

Our main purpose is to convert printed sheet music to a digital format. This will give us many advantages which are explained earlier in this document. This will be the first component of our product. During our market research we came across many products that are targeting the same audience, however there is not any product that does exactly what we are trying to achieve.

There are products that can convert sheet music to digital formats but they can only convert scanned documents. Some of them are; SmartScore, Capella-Scan and SharpEye. These programs are called Music OCR programs and they all have same technique behind their technology. You need a scanner to scan the sheet music and they use optical character recognition to interpret sheet music or printed scores into editable and, often, playable form. This process is not very practical and also these products are, in general, quite expensive.

Moreover, there is not any mobile version of these programs. We intend to bring this technology into mobile platforms by using image processing techniques. In our approach user will not need any other extra device or hardware, only the built in camera of the mobile device will be enough.

The second component of our product will be a MIDI editor/player. Printed music will be photographed and converted to MIDI format by our first component and our second component will open the MIDI files. MIDI format is extensively used in the market. On the internet, it is very easy to find and freely download the MIDI format of any song. For instance, findmidis.com and musicrobot.com are good sources for downloading MIDI songs.

For this part of our project, Guitar Pro is the product that inspired us the most. It provides the similar functionality we intend to add to our product. It enables users to open a midi file and see the notes and tabs of the song. It also shows the finger positions on the keyboard as you listen the song. It helps a lot to learning process of playing an instrument. Our product will also provide all this features. Guitar Pro has both mobile and desktop versions. However, mobile version of the Guitar Pro is only available for iOS and it only supports Guitar Pro specific file formats not MIDI. We will build our product for Android OS and we will support the most common format, MIDI. Furthermore, Guitar Pro mobile is quite expensive.

For Android OS there are a few applications such as; GuitarTapp and Ultimate Guitar Tabs but with these applications you can only view tabs online.

There is also an application called Budgerigar - Midi Sequencer which enables users to edit MIDI files. However directly editing MIDI files is quite complicated for an ordinary user. This application does not provide note view.

All in all, there is no application for Android market with which you can convert MIDI files to sheet music format to easily read and edit them. Moreover, there is not any mobile application which one can transfer printed sheet music to digital world. Similar desktop versions of our product have thousands of users. We believe that users will appreciate the mobile version of these applications. It will be easy to use, functional and useful for many purposes.

5. Schedule

First Term:

Current Week														
Weeks	10/10 to 10/17	10/17 to 10/24	10/24 to 10/31	10/31 to 11/06	11/06 to 11/13	11/13 to 11/20	11/20 to 11/27	11/27 to 12/04	12/04 to 12/11	12/11 to 12/18	12/18 to 12/25	12/25 to 01/01	01/01 to 01/08	
Project Selection - PreProposal														
Project Proposal														
Requirement Analysis and SRS Document														
Individual Research														
Initial Design Report														
Preparation of First Basic UI														
Detailed Design Report														
Prototype Demo														
Weeks	10/10 to 10/17	10/17 to 10/24	10/24 to 10/31	10/31 to 11/06	11/06 to 11/13	11/13 to 11/20	11/20 to 11/27	11/27 to 12/04	12/04 to 12/11	12/11 to 12/18	12/18 to 12/25	12/25 to 01/01	01/01 to 01/08	

Second Term:

Current Week														
Weeks	02/06 to 02/13	02/13 to 02/20	02/20 to 02/27	02/27 to 03/05	03/05 to 03/12	03/12 to 03/19	03/19 to 03/26	03/26 to 04/02	04/02 to 04/09	04/09 to 04/16	04/16 to 04/23	04/23 to 04/30	04/30 to 05/07	05/07 to 05/14
Implementing Image Processing Module														
Implementing UI of Mobile App														
Conversion to MIDI Format														
Implementing MIDI Reader Module														
Adding Extra Features to MIDI Player														
Testing the Application														
Weeks	02/06 to 02/13	02/13 to 02/20	02/20 to 02/27	02/27 to 03/05	03/05 to 03/12	03/12 to 03/19	03/19 to 03/26	04/02 to 04/09	04/09 to 04/16	04/16 to 04/23	04/23 to 04/30	04/30 to 05/07	05/07 to 05/14	05/14 to 05/21

REFERENCES

<http://itunes.apple.com/us/app/guitar-pro/id400666114?mt=8>

https://market.android.com/details?id=net.currach.android.budgerigar&feature=more_from_developer

https://market.android.com/details?id=com.by845tools.guitartapp.trial&feature=search_result

https://market.android.com/details?id=com.ultimateguitar.tabs&feature=related_apps

www.visiv.co.uk/

<http://www.musitek.com/>

<http://www.capella-software.com/capella-scan.cfm>

http://www.sibelius.com/products/avid_scorch/index.html?intcmpid=SB-HP-AUMU1

<http://www.inescporto.pt/~jsc/publications/journals/2010ARebeloIJDAR.pdf>

<http://journal.code4lib.org/articles>

<http://www.leeds.ac.uk/music/>