Digital Audio Synthesis on iOS Devices

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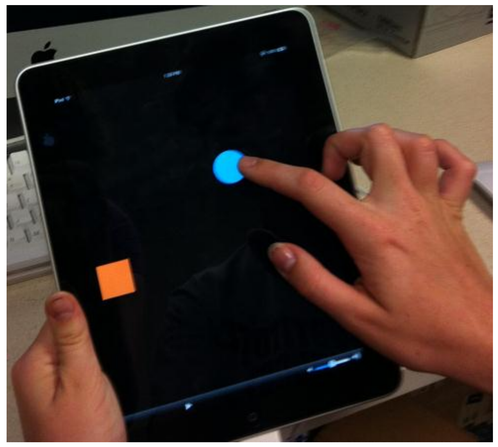
Abstract

As technology advances so does the ability to create new tools for composing and performing music. Electronic tools allow for musicians to think about sound in an entirely different way.

The goal of this project is to develop iOS applications that will support digital audio synthesis and real-time sound processing on mobile devices. The iOS platform was chosen for many reasons, including its widespread use in everyday life by both musicians and those with no musical background, its computational power, and the support it provides for low latency audio processing which is not present on other platforms.

Developing iOS applications for digital audio synthesis requires the combination of three components: iOS 5 Objective-C code, Pure Data patches to manipulate sound, and user interfaces to mediate interaction.



Audio synthesis application running on an iPad

Objective-C

Objective-C is a high-level, object-oriented programming language that is used to write iOS applications within Xcode, the development environment provided by Apple Inc. as part of the iOS software development kit (SDK). The iOS SDK provides several frameworks for dealing with audio, but these tools are limited when it comes to synthesizing or modifying sound.

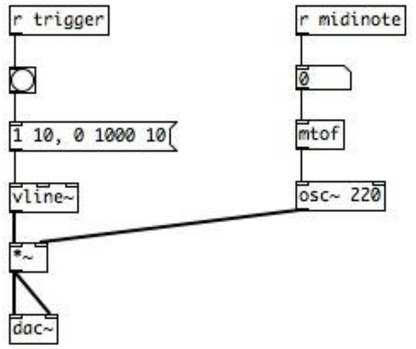
```
- (void)pitchShift:(float)n
{
    [PdBase sendFloat:n toReceiver:@"transpose"];
}

- (IBAction)playButtonPressed:(id)sender
{
    [self pitchShift:((circle.center.x-384)/50)];
    [PdBase sendBangToReceiver:@"play"];
}
```

Objective-C code used to pass information to Pd

Pure Data

In order to avoid the limitations set by the audio frameworks in the iOS SDK, Pure Data (Pd) is used as the primary tool for synthesizing and manipulating audio. Pd is a real-time graphical programming environment designed for audio processing. Pd was chosen because it is a powerful, open-source tool that eases the creation of sophisticated audio signal processing and synthesis.

Objects, represented by rectangles, are placed and connected to each other, and triggers are activated to signal events or messages. The final audio signal processing code is referred to as a "patch" and can be used on its own or incorporated in to another program that acts as the view and controller code.

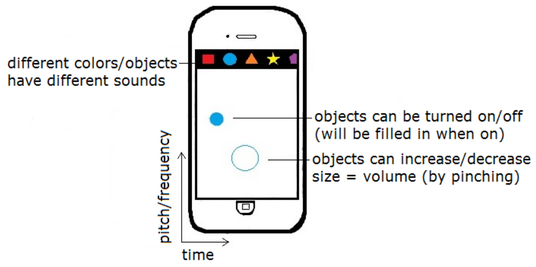


Pd patch used to synthesize different midi notes

User Interface

An iOS user interface is based around the concept of direct manipulation using gestures recognized on a touch screen or through signals recognized by the device's accelerometer or microphone. This offers numerous possibilities for digital audio applications due to providing the user with a more intuitive, "realistic" way of interacting with the program.

Different design concepts for this project included sounds being represented and manipulated as objects on a grid, using free-style drawing as the basis for musical composition, and thinking about the manipulation and representation of time in a unique fashion, such as depicting it as a spiral rather than a line.

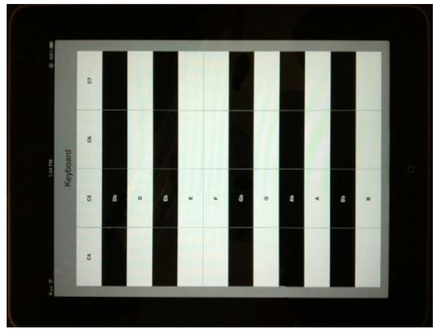


Initial design for an audio synthesis application on an iPhone

Conclusion

Several problems were overcome throughout the duration of this project. The most difficult obstacle was discovering the best way to combine audio signal processing with controller code in a way that would allow for the program to send signals between the two in response to the user interface.

All of the applications developed throughout the duration of this project can be used to create music. While traditional instruments would take a significant amount of time to learn, these programs can be operated by any type of user, from those with no musical background to professional composers.



Piano keyboard application running on an iPad

Future Work

Further modifications and additions will be made in the coming months. These will include increasing the variety of pre-sampled sounds as well as employing different signal processing techniques to synthesize and manipulate audio in real-time.

Multi-touch gestures will be added to the interface to assist with collaborative situations involving multiple users on one device. The possibility of setting up a network between devices running the program so that multiple users in different locations can interact with each other in a creative performance setting will also be explored.

These applications will ultimately be able to be used for a variety of purposes, including personal entertainment, education, and live performances in mobile ensembles.

Acknowledgements

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