ELECTRICAL AND COMPUTER ENGINEERING
UNIVERSITY of MICHIGAN

EECS 452
DSP Design Laboratory

Motion Controlled DJ

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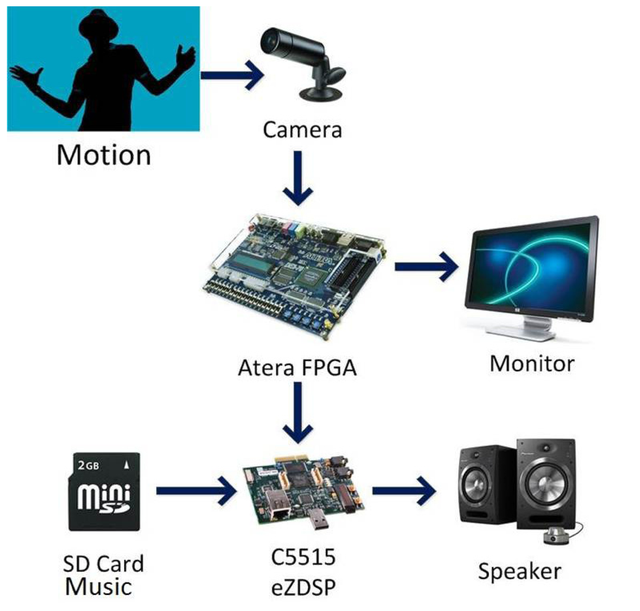
UNIVERSITY OF MICHIGAN

INTRODUCTION

The goal of the project is to create a device which uses hand movements to perform audio processing effects analogous to a DJ performance i.e, volume control, filtering effects, reverberation, etc. DJ equipment is generally large, cumbersome, and expensive. The proposed device would remove the need for this bulky equipment.

The device will use digital signal processing principles to capture and process image signals, and more relevantly to add effects to audio signals. The algorithms used to create these capabilities will be implemented on the C5515 eZDSP Stick and the Altera DE2-70 FPGA Board. A digital camera will be used to capture images, with the aid of colored gloves.

SYSTEM OVERVIEW

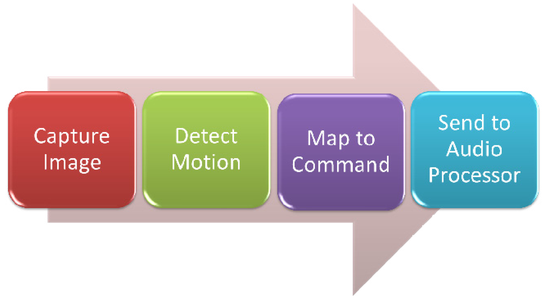


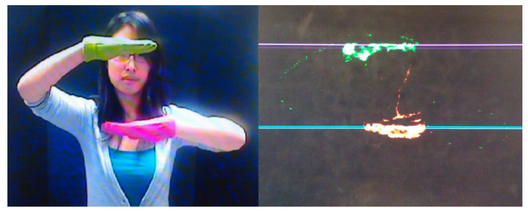
Preload and store a few samples of music onto the C5515 through the use of an SD card. The digital camera will be used to capture the user's hand motions and this image data will then be stored on the FPGA. The FPGA will then output this image – along with calibration/guide lines - onto an attached monitor. The monitor will be used to make sure that we are successfully tracking the hand motion. The FPGA will then compress the image data, translate it into commands that will be used on the C5515, and send the data to C5515 The C5515 will then handle the bulk of our digital signal processing. It will take in the commands generated by the FPGA and apply them to the sampled song. Finally, this altered data will be outputted to a set of speakers.

CONTACT

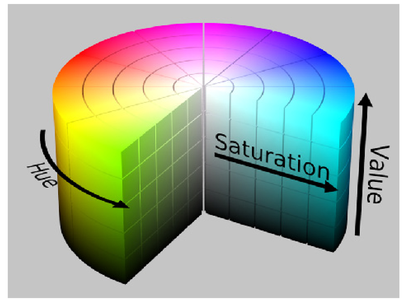
Group may be reached at eecs452-DJ@googlegroups.com

PROJECT DETAILS: MOTION DETECTION

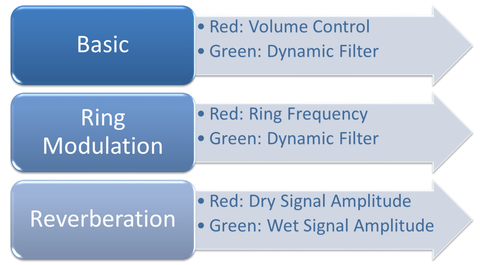




For color detection we changed the captured image frame from RGB to HSV color space; we proceeded to use both RGB and HSV values to set the threshold for each pixel in order to filter the image. The Hue value of HSV color space would detect the target red or green color in addition to the conditions of relations among R, G and B. This would eliminate the negative effects of shadow and reflection.

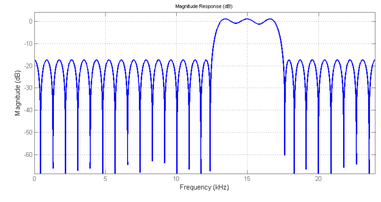


For motion detection we count the number of data points in each row, and set the row with the maximum count to the vertical location of the glove. In order to achieve more stable location information, we convert the vertical position into 8 different indexes to avoid the effects of shaking.



PROJECT DETAILS: AUDIO PROCESSING

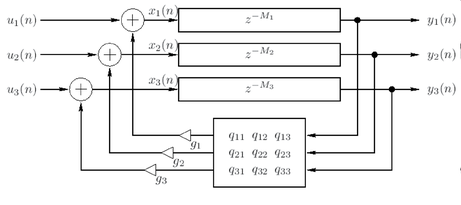
- Volume Control: The input signal is simply multiplied by a scale factor that is determined by the user's vertical hand placement.
- Dynamic Filtering: The user's hand position determines cutoff frequencies for a bandpass filter that is applied to the input signal.
- Ring Modulation: The user's hand position changes the frequency tuning value (FTV) to be used in a direct digital synthesizer (DDS). The DDS is used to generate waveforms of different frequencies from a single, fixed-frequency waveform. This new signal is overlaid onto our original input signal to create a vibrato-like effect.
- Reverberation: Large number of echoes arriving in quick succession, decaying slowly over time.
  - -Implemented digitally using feedback delay networks.
  - -The user's hand positions determine the level of the 'wet signal' (signal with reverb effect applied to it) and 'dry signal'(signal with no reverb applied).
- Reverberation time: The amount of time required for reflections of the sound to decay to 60dB below the level of the original sound.
  - -It often varies with frequency.
  - -There are three different reverberation modes, each having a different reverberation times for the low frequency and high frequency parts of the signal.

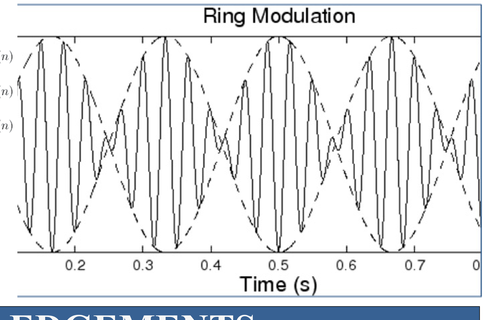


FUTURE WORK

Potential features that may be implemented in the future include:

- Phase Vocoder: This would give the user the ability to modify the tempo of the music without changing the pitch and vice versa.
- Flanging: this would create a distortion effect by mixing a signal with a delayed version of its self.
- Wider range of gestures: More complex gestures to give more parameters of audio control.
- Object recognition: Instead of needing to track colors, the camera will be able to track the movement of a specific object (such as the user's hand).





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