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Human Hardware-Software Interfacing for Audio Control

The goal of this project is to create a device which allows humans to control audio playback through intuitive hand motion control. The device will support several gestures which have the capability to control volume, mute, pause, skip a song, or return to the previous song. Each of these gestures is tied to the downward motion of the finger which triggers a toggle, except for volume control, which is tied to the left or right turning of the entire hand.

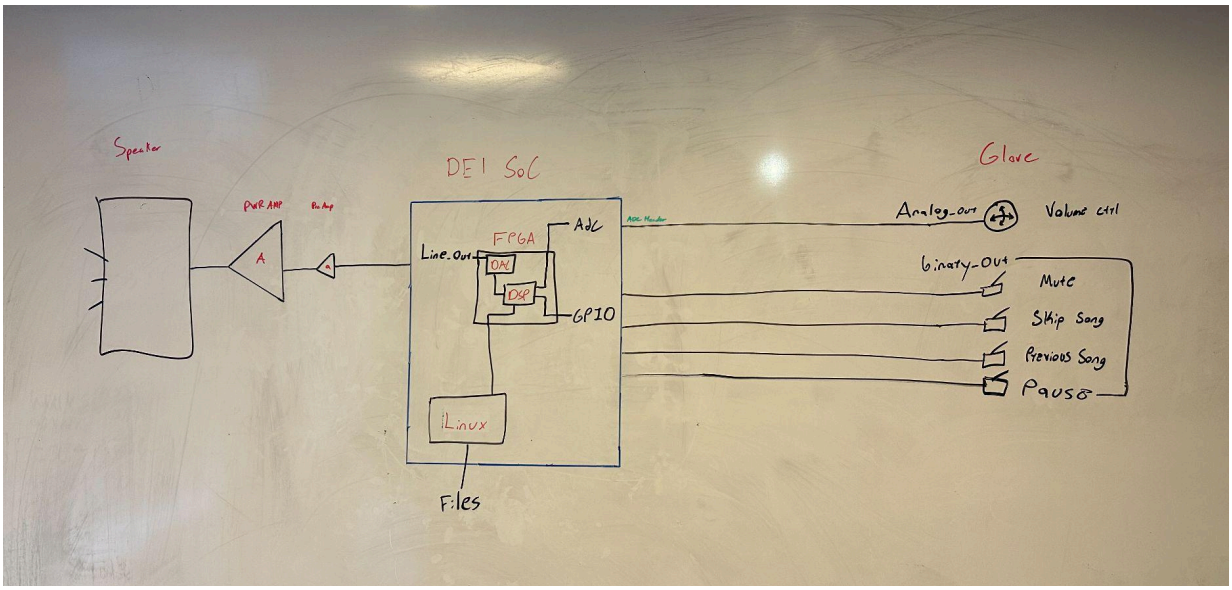

Figure 1. Block Diagram of Connections Between Interfacing Device, DE1-SoC, and Speakers.

Human Interface Component

The human interface point comes in the form of a glove which is responsible for generating four signals (see Figure 1). The 3 single-bit digital signals for mute, pause/play, skip song, and previous song, along with 1 analog signal for volume control. The digital signals are triggered by endstop switches, while volume control is generated by a gyroscope. These signals are fed directly to the signal processing unit.

Hardware - Signal Processing Component

The hardware component of the project comes in the form of the signal processing unit (see Figure 1). This custom hardware on the FPGA takes inputs from the human interface component, as well as the output of the audio playback component and adjusts the audio signal according to the inputs of the human interface. Each of the digital signals will be buffered into pulses through

synchronizers, allowing us to discretely determine the number of events. Additionally, race conditions, such as receiving both the skip song and previous song input simultaneously will result in no action. Meanwhile, the analog signal will be passed through the SoC's ADC header, before being interpreted by the signal processing unit, and similarly being used to adjust the audio playback. The audio itself comes into a FiFo from the software component, and then after being processed is sent through a DAC, once again on the FPGA, to the line out header on the development board.

Software - Audio Playback Component

The software component of the project is responsible for loading audio files from a Linux environment, formatting them to be read by the FPGA, and outputting them by mapping the data into the FPGA's memory to be read by the FiFo. Additionally, the software component will need to be able receive the skip song and previous song signals from the FPGA to change the currently playing audio.

Analog Hardware - Amplification and Speaker Playback

The line level output of the hardware component will be fed through a simple wall outlet fed power amplifier and brought to a speaker level before being inputted to a speaker so that users can hear the currently playing song.

Work Distribution

- Analog Hardware - Derrick
- Human Interface - Carlos
- ADC, DAC and FiFo - Jayden & Derrick
- Signal Processing Core - Jayden & Carlos
- Software Component - Carlos

Material List

- Speaker
- 3-Axis Gyroscope (Acceleromentor are optional)
- 4 (at least) Endstop Switches
    - Will buy a pack of 10 in case they break
- Long wires with dupont female connectors (for GPIO connection)