

Overview

This project is a virtual guitar imitation device, realized by several sensors and an accelerometer attached onto two gloves.

There are 7 tactile sensors corresponding to 7 notes on the left glove. On the right glove, there are 4 tactile sensors to change options, implemented as Reset, Mode Switch, Octave Up, and Octave Down (on the fingertips), in addition to an accelerometer.

To play, the user should touch their left thumb to a note sensor and make a strumming action with their right arm as if playing a guitar in the air.

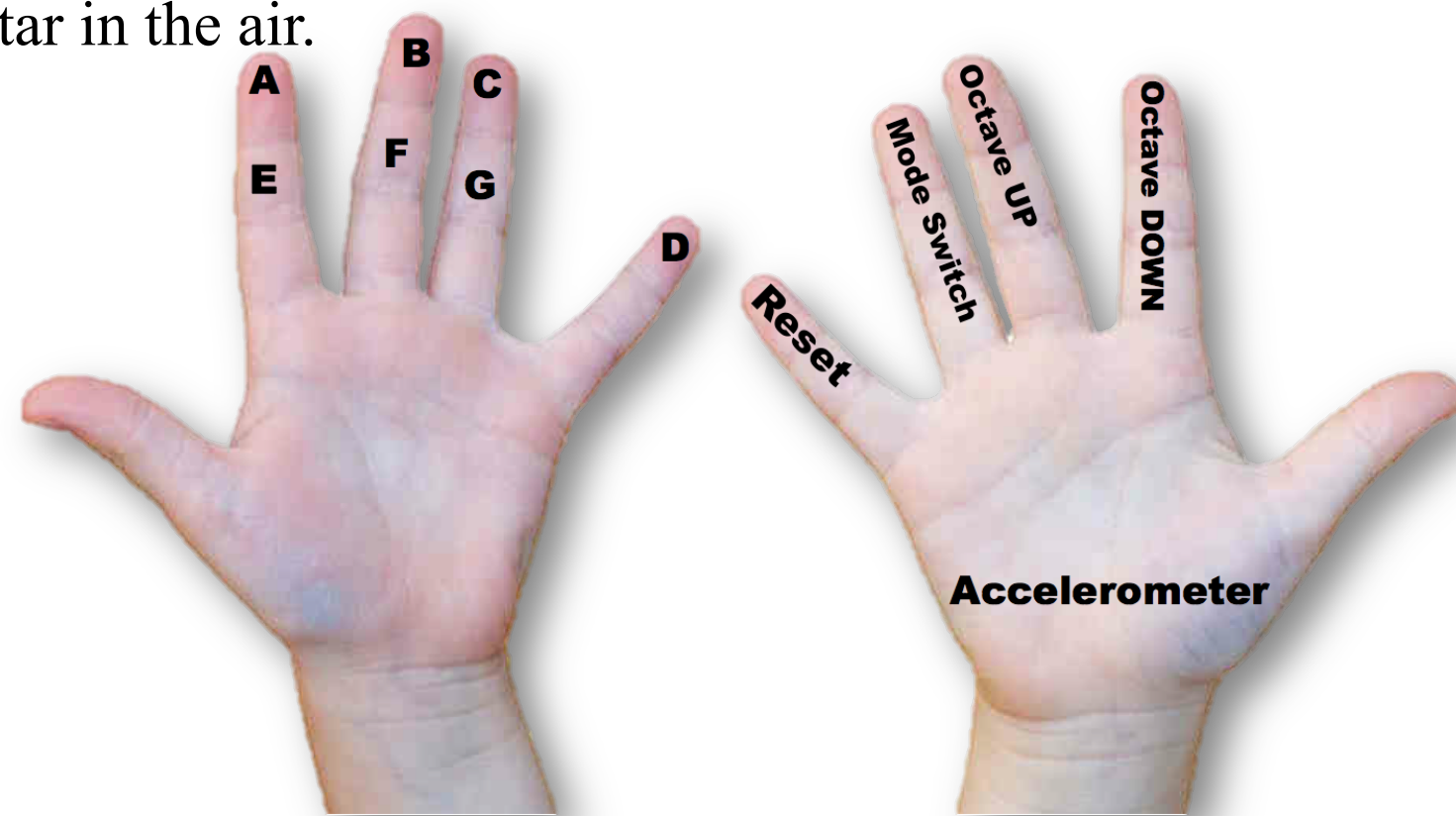


Fig. 1: Sensor and accelerometer assignment

Hardware

This project is based on the Altera DE2 FPGA, and the below circled features were used:

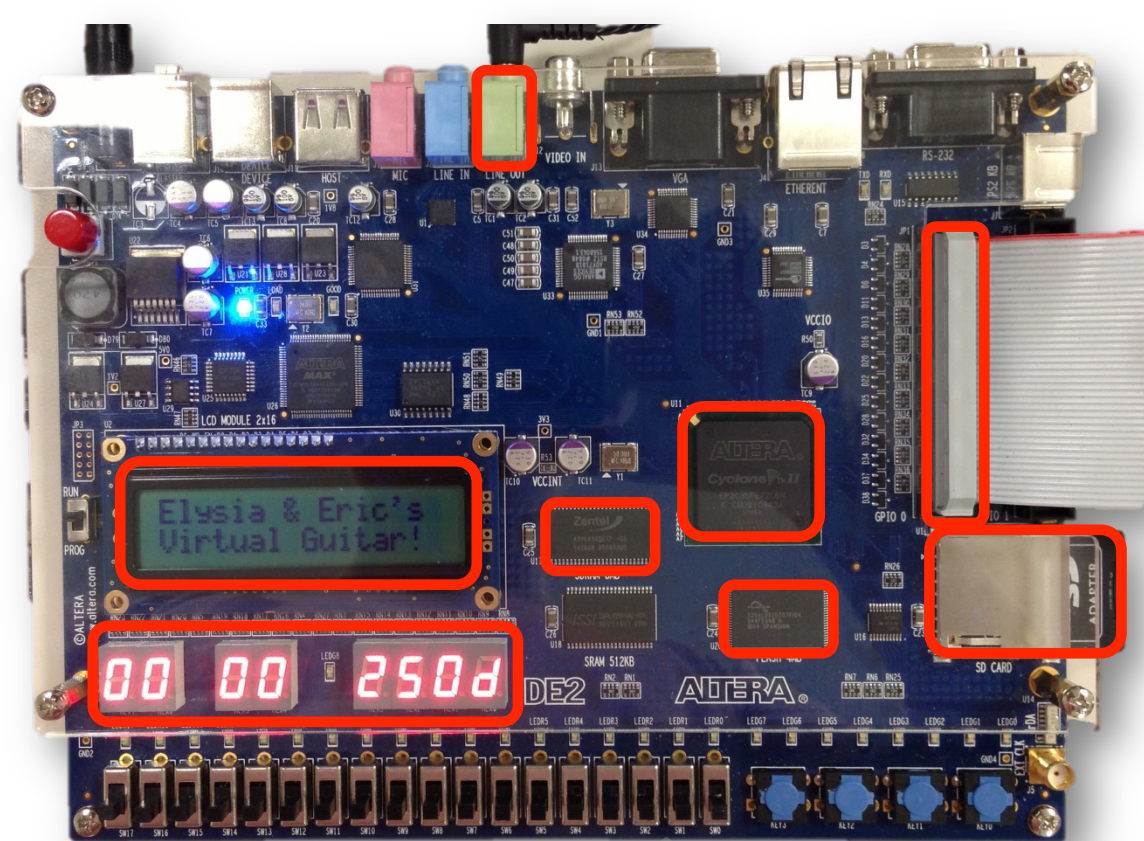


Fig. 2: Altera DE2 (Top View)

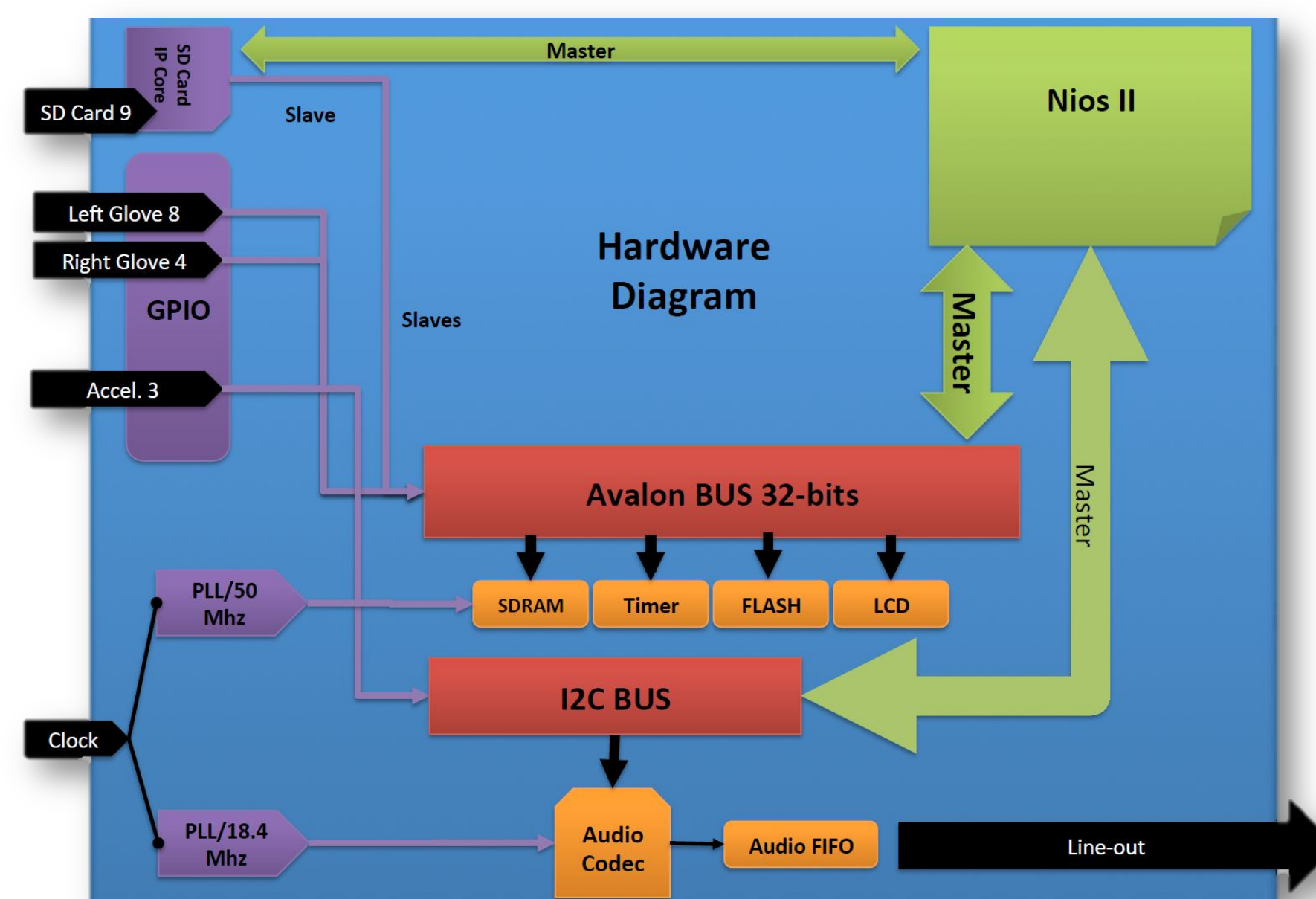


Fig. 3: Hardware Diagram

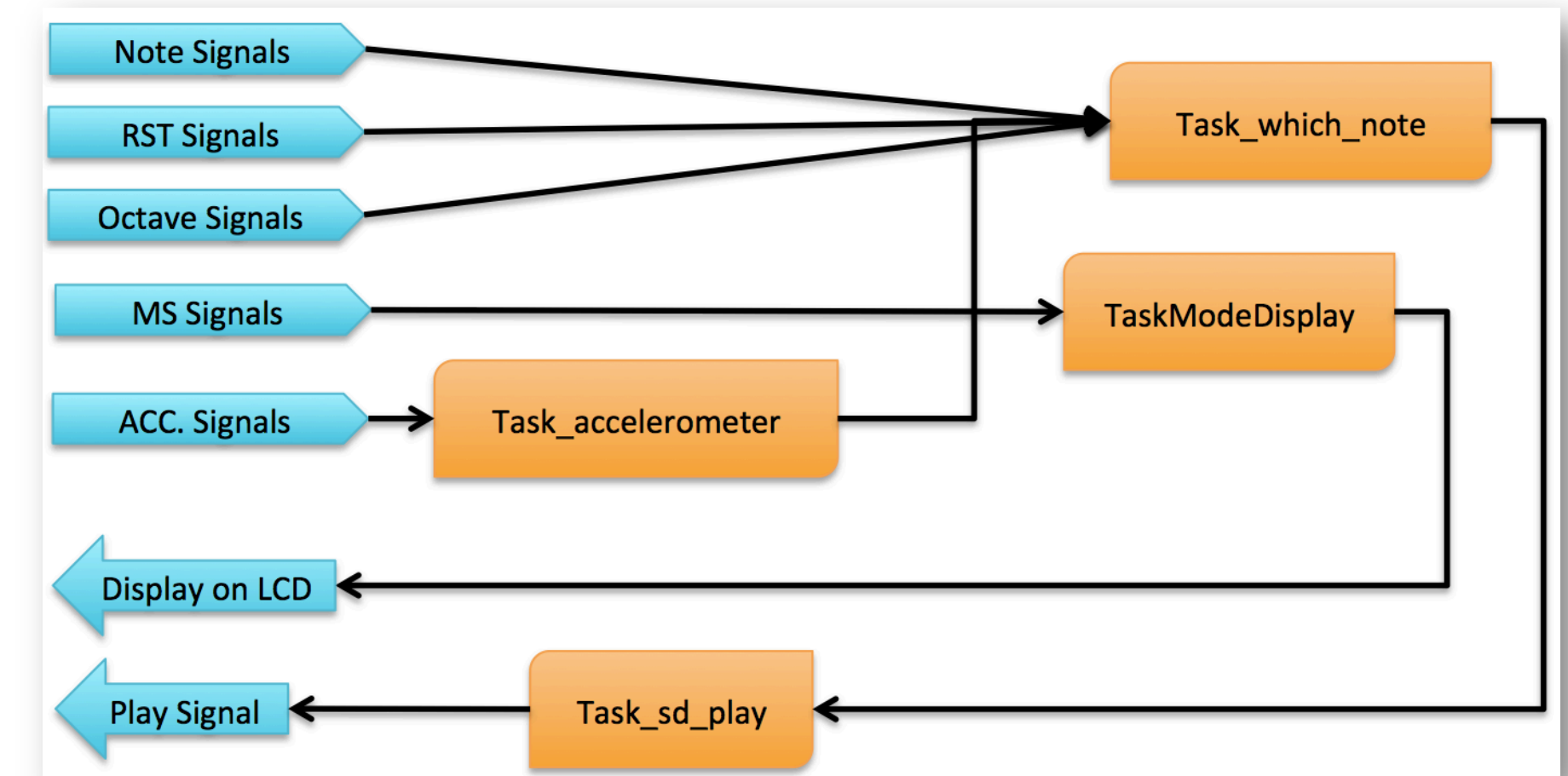
The digital output accelerometer (MMA8452Q) interfaces to an I2C bus and has 3-axis detection with range ± 2 , ± 4 , and $\pm 8g$.

The SD card stores the .wav sound files of notes & chords that can be played by the gloves. The SD card must be 2GB or smaller in size and FAT16 formatted.

The DE2 has an I2C bus and audio CODEC (Wolfson WM8731) onboard that are physically wired together. Two I2C master cores were used separately for the audio and accelerometer in order to ensure no conflicts between components. The I2C buses run at 100 kHz. SDRAM and the CPU clock at 50 MHz.

Software

This project is based on NiosII MicroC/OS-II. The communication between tasks is realized by message queues. The signal capture from the hardware is realized by interrupts.



The audio CODEC setting is shown as follows:

Sample rate: 48 kHz

Associated PLL: 18.432 kHz divided down by a 27 kHz clock

Width: 16 bit

Channels: 2

File format: .wav file

Signal Capture

For the 7 note tactile sensors on the left hand, polling is used to determine which one is pressed. The sensors are simply on/off switches set up to be active-low. There are 4 interrupt-handlers for the right hand Mode Switch, Reset, Octave Up, and Octave Down sensors.

Signal de-bouncing was achieved in hardware by using a RC-delay method. The Altera DE2 also provides an internal weak pull-up resistor feature.

The accelerometer was configured to detect free-fall motion at $\pm 2g$ in 1-axis, as 1D was sufficient for this project's purposes.