

Virtual Board Breaking

1. Overview

Virtual Board Breaking provides a way of simulating breaking a wooden board with your fist. The force with which the fist "hits" the virtual board will be determined using a three axis accelerometer mounted onto a glove worn by the user. The video monitor will display a force gauge, the image of a board breaking, as well as instructions for use. The system will also allow the user to choose the orientation of the board to be broken. The system will also generate sound effects to go along with the image of the board breaking. Through testing, we will determine the force threshold necessary for the board to break and use the threshold to determine whether the screen should show a cracked or a full broken board.

2. Hardware

2.1 Three Axis Accelerometer (DE-ACCM3D)

We will be using a three axis accelerometer to determine the acceleration produced by the punch the user throws. The accelerometer will be wired to the analog to digital converter described below and mounted to the glove.

2.2 Analog to Digital Converter (AD7824)

The AD7824 is a four channel analog to digital converter that outputs 8 bits of data per channel. We will be using it to sample and digitize the output of the 3-axis accelerometer. The output of the AD7824 will be directly connected to the labkit with the bits coming in parallel.

2.3 Taekwondo glove

The 3axis accelerometer will be mounted to the back of the glove.

3. Input Modules (Christine)

3.1 Debounce Module

The debounce module code will be taken from the code provided in lab #3. It will be used to debounce the button inputs used in other modules.

3.2 Sensor Modules

The sensor module will receive digital acceleration samples from the ADC through the labkit connections. It will output 8 bits of digitized sample that correspond to the data for one of the axes. It will take a two bit input from the switches on the labkit to determine which axes to look at based on the board orientation that the user selects.

3.3 Signal Processing Module

The purpose of the signal processing module is to detect the magnitude and duration of the acceleration peak generated by the user. This module will take in 8 bits of digitized data from the sensor module and a one bit button input to determine when the system should begin processing data. The module will output the appropriate 8 bit magnitude reading to the force gauge module for display purposes, a three bit value to determine the image to display on the screen, and a pulse signal to indicate when the image and sound should be simultaneously played and displayed.

The module will determine the maximum acceleration value detected so far and save the maximum value and the time at which it was seen. It will determine the duration of the acceleration by detecting the time at which the acceleration falls below some delta below the maximum acceleration value determined.

4. Output Modules (Erika)

4.1 Main Graphics Module

The main graphics module will coordinate the display and sound effects from the board, force gauge, and sound modules for a 1024x768 display.

4.2 Board Image Module

A MATLAB script provided by the staff will be used to convert the .bmp file for RGB format use on the display. This data will be stored in BRAM to be read later when needed. The pixel values will be computed pixel by pixel when the image is needed. We will cycle through six images of 512x512 pixels. This module will take in a two bit axes selection as input to determine which board image should be displayed as well as a three bit input from the signal processing module to determine which board break picture to display.

4.3 Sound Module

A MATLAB script provided by the staff will be used to convert a .wav file of the board being broken into a coe file that can be played back with the AC97, which will down sampled to 6kHz to also save on memory space. The sound module will take the three bit signal and pulse signal from the signal processing unit to determine which sound and when to play the sound.

4.4 Force Gauge Module

The force gauge module will receive the 8 bit magnitude output from the signal processing module. It will output a three bit color value per pixel as done in lab 5. The length of the bar is proportional to the magnitude of the signal to provide feedback to the user as to the size of the force of the punch.

5. System Diagram

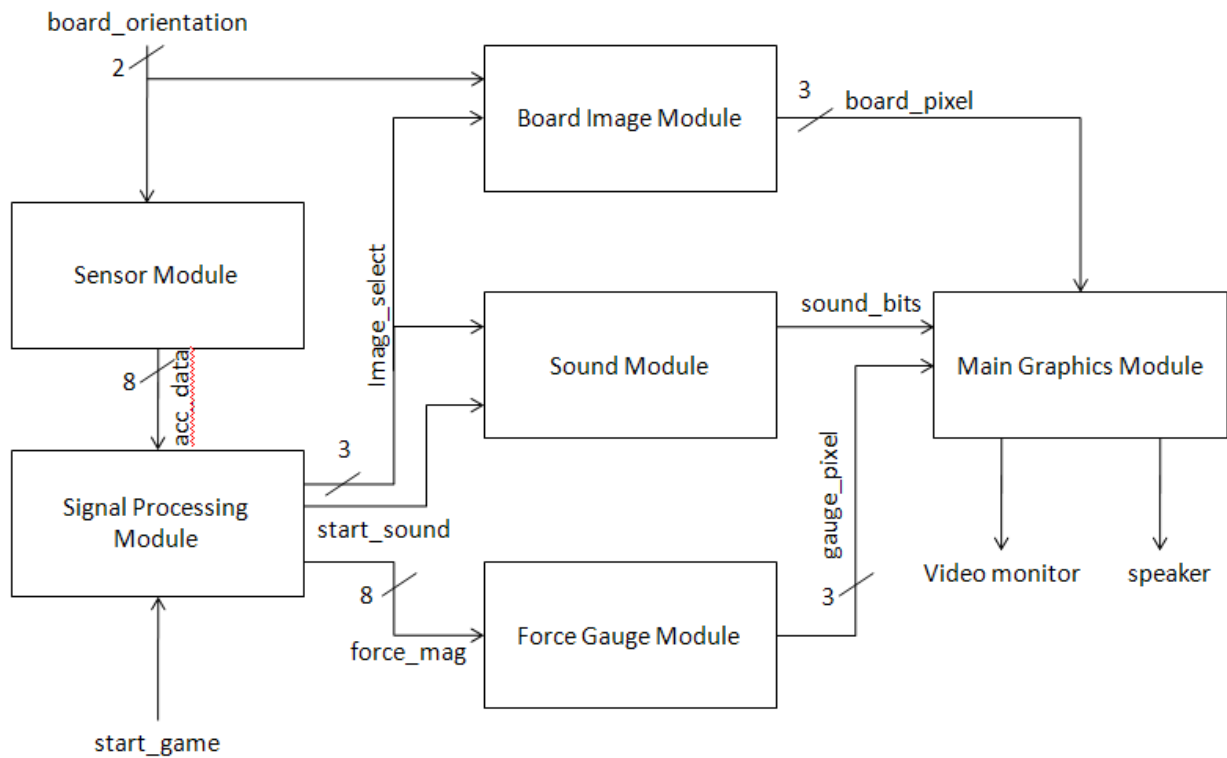


Figure 1. Full System Flowchart

6. Testing

The sensor module will be tested by tracking the output of the module and comparing the output with the types of waveforms seen using the oscilloscope to track the output of the analog to digital converter.

The signal processing module can be tested by inputting sample waveforms in ModelSim and comparing the resulting outputs with the expected output.

Sample inputs will be simulated to check from correct sound playback, image display and force gauge magnitude displays. Each of these modules will be tested separately before testing them as a whole together in the main graphics module.

7. Enhancements

Time permitting, we would also like to see this implemented for use with feet and head, which allow for the user to choose different modes of operation of the game. In addition, we could add to the system by allowing the user to select the thickness of the board to create more difficult levels. Other ideas include adding a top 10 scoring list and displaying a force versus time graph on the display.