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CS 190  
Final Project Write-up

## **Accelerometer-Controlled Electronic Keyboard**

### ***Project Abstract***

This is a small, accelerometer-controlled electronic keyboard that is controlled using the Z8 Encore. It features an LCD display for visual feedback, a speaker for audible feedback, and a two-directional accelerometer for user-input. By tilting the accelerometer along one axis, the note being played changes (along with the corresponding “bar” on the LCD, while the other axis is used to change the cursor on the screen.

### ***Status***

Originally, I had planned to develop a video game using these devices for input/output, but due to technical issues, this was not feasible. The larger LCD screen proved to be difficult to hook up, and after roughly two weeks, I decided that I needed to scale that part of the project down. As such, I switched from a 40x4 LCD screen, to a 16x1 model, which I was immediately able to power on and get basic feedback. The speaker wiring/programming was simply based off of a previous lab, so it caused only a few minor issues when integrating it with the accelerometer. It was fairly straightforward to hook up the two-directional accelerometer; the biggest issue was with calibrating the tilts because the “normal” position was skewed.

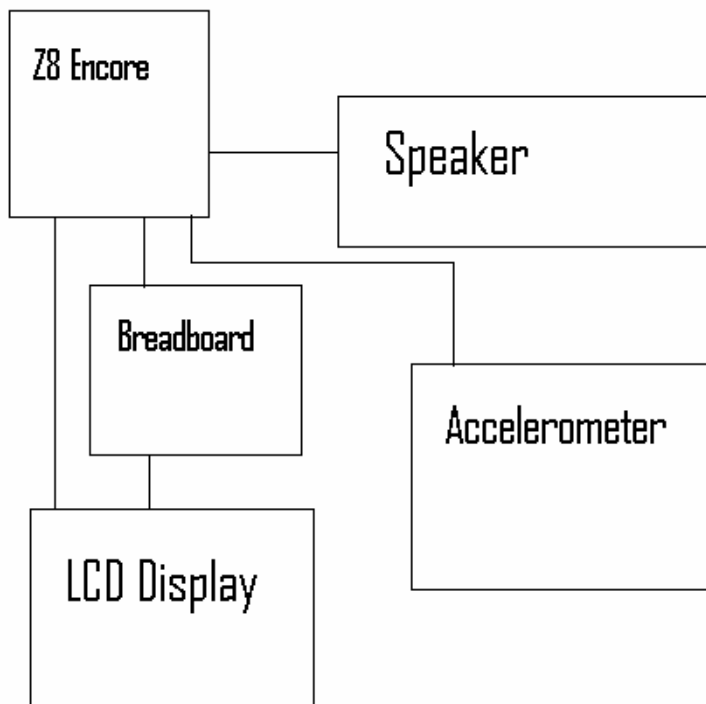
### ***Specifications***

The basic hardware components needed for this project are as follows: One Z8 Encore developer’s kit, one Accelerometer Breakout Board – ADXL202JE +/- 2g (available from Spark Fun Electronics), one two-wire computer speaker, a few resistors, one breadboard, one MDL(S)-16166 LCD display (or similar 16x1 display), and approximately 17 connector wires. I utilized several software modules for this program, including both ones that I wrote myself as well as some that I was provided with. As can be seen, the control for the accelerometer is done by monitoring the sensor’s pulse-width modulated output on both the X axis and Y axis. The LCD screen is controlled by using a modified version of 2 API’s originally created by Gadere Bloom. Specifically, the main loop of the program takes input from the accelerometer, and uses these APIs to output a specified cursor at a location on the LCD display. The speaker is controlled by a module that uses one of the Z8’s interrupts. Basically, the program checks the accelerometer’s output and counts the number of pulses (if they are being sent). It should be noted, however, that the accelerometer’s data is a bit skewed, and that should be taken into consideration when programming a module to control it. (An oscilloscope is useful for this.) Using this gathered data, the program then determines which way the sensor is being tilted in both

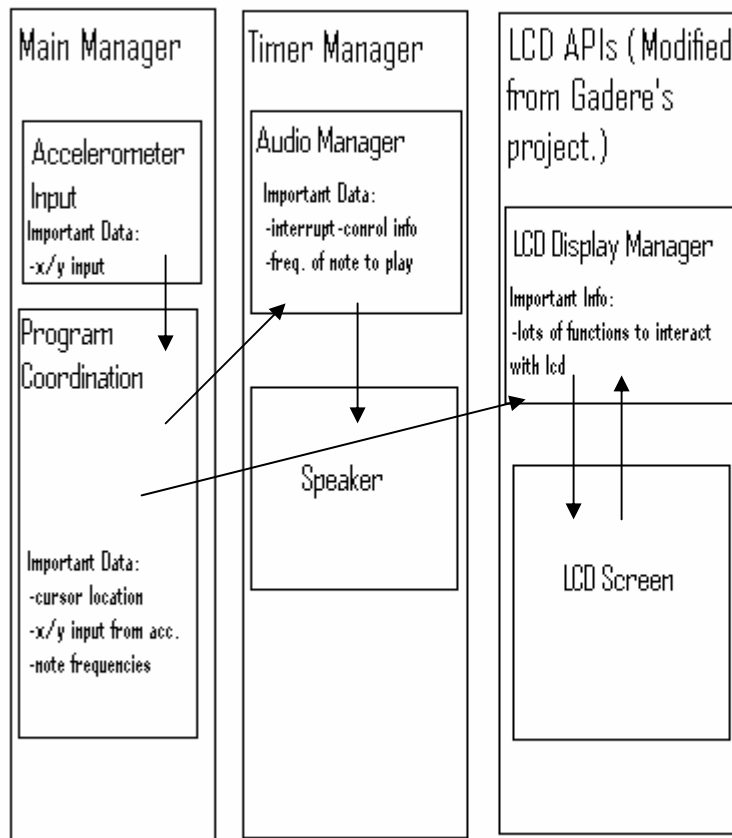
the X and Y directions by checking whether or not the data values are greater than their respective thresholds. (The threshold values for this were determined by trial-and-error.) The main loop then updates the cursor location variable (and changes the cursor being displayed if necessary). Following this, a note is played on the speaker by using the current cursor's location plus an offset (for the array). Next, the LCD is issued a command to update the cursor's location on the screen. Information on setting up the unit can be found below, and part-specific schematics can be found in the parts' respective data sheets.

## ***Implementation & Construction***

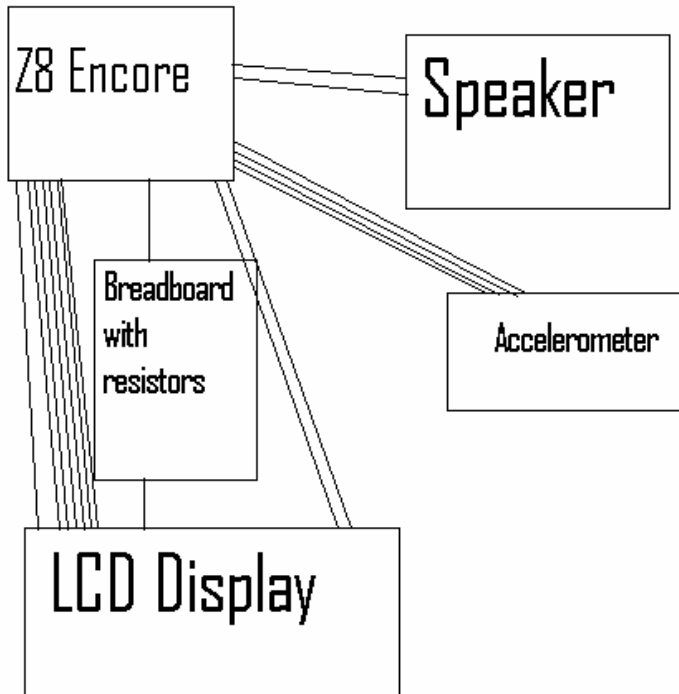
### **Final Block Hardware Diagram**



# Final Software Block Diagram



## Schematics:



**To wire the LCD display into the Z8 Encore (taken from Gadere's LCD\_API.h):**

Z8:	GND	VCC	GND	VDD	PF0	PF1	PF2	NC	NC	NC	NC	PB4	PB5	PB6	PB7	NC	NC
				\\ /													
				10K													
				POT													
LCD:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	Vss	Vcc	V0	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	--	--	

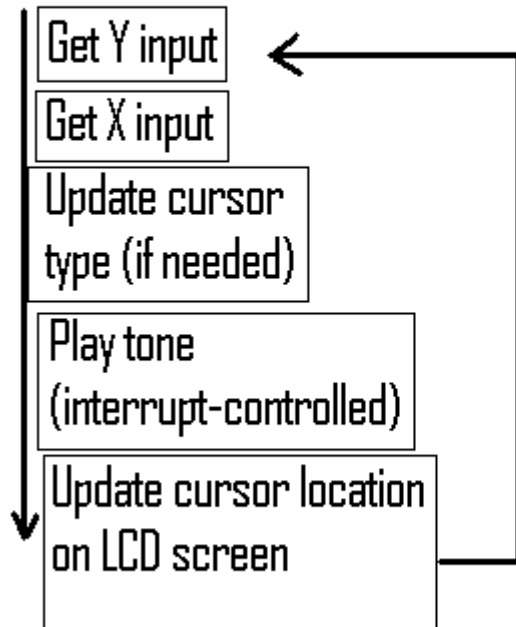
**To wire the speaker into the Z8 Encore:**

Connect the wires to pins PC0 and PC1.

**To wire the accelerometer into the Z8 Encore:**

- 1.) Connect GND on accelerometer to GND on Z8.
- 2.) Connect VDD on accelerometer to VDD on Z8.
- 3.) Connect YP on accelerometer to PD3 on Z8.
- 4.) Connect XP on accelerometer to PF6 on Z8.

# Program Flow Diagram

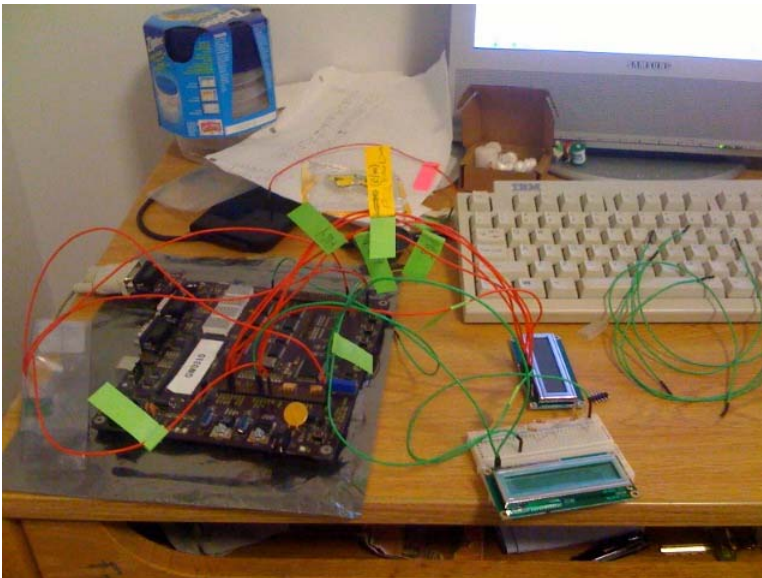
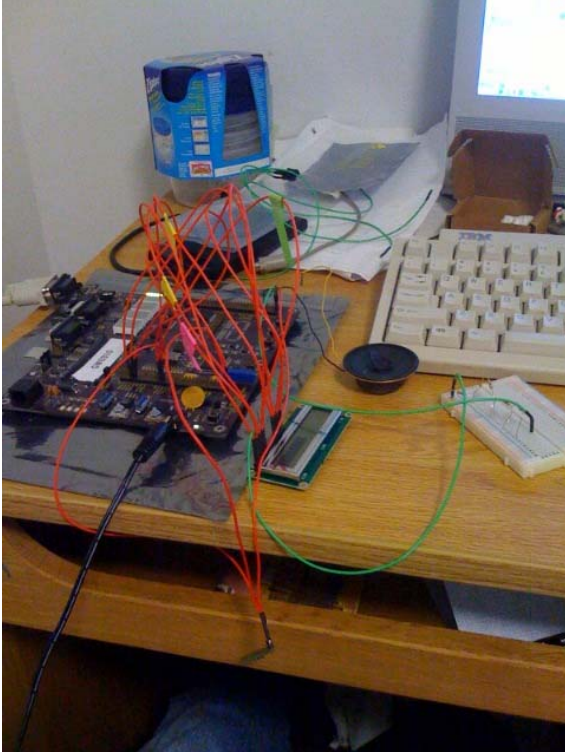


## Steps Taken:

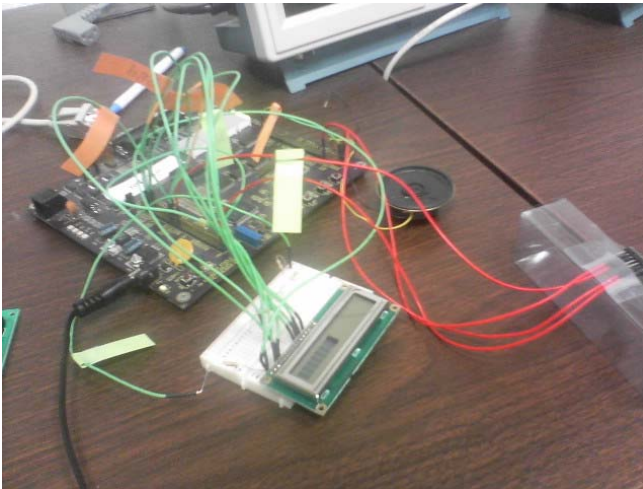
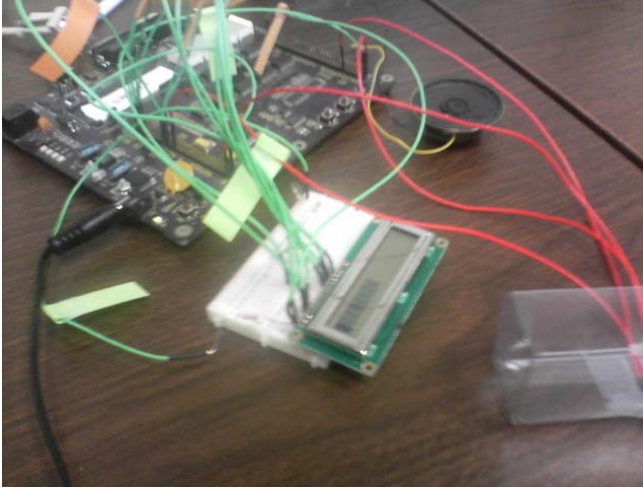
- 1.) Try to hook up 40x4 LCD screen to Z8 Encore.
- 2.) Step 1 failed (but learned about LCD wiring/programming process); resorted to hooking up 16x1 LCD to Z8 Encore.
- 3.) Hooked up accelerometer to Z8 Encore and wrote software to control it.
- 4.) Wired speaker into Z8 Encore and reused/modified my previous lab's code to control it.
- 5.) Debugged:
  - a. Sounds emitted from speaker were not correct.
  - b. Accelerometer control was too touchy/not sensitive enough.

# Photos:

(in progress)



**(completed)**



## ***Retrospective***

This project was the culmination of several months' worth of working with hardware. Although I had to change my final project from the initial plan (which was a video game), I feel that I was able to successfully put together an entertaining device using similar hardware. The larger LCD screen issues set me back a bit, and I would have liked to have gotten it working because it would have allowed for more diverse output, and thus more intricate applications. Also, if I had more time, I would have written my own API's for the LCD, instead of modifying existing ones. One of the harder decisions I had to face was the choice to give up on the 40x4 display (for the reasons mentioned above). Now that I have this experience, if I was to begin a similar project, I would start by creating my own APIs for whatever LCD I have. In addition, I would more carefully calibrate my accelerometer (in the software) so that the control would be very precise (which is needed for a video game).