Sensor Report
Hamelin

IMDL Spring 2005
Matt King
April 19, 2005

Introduction

The main objective was to make my robot move according to different musical pitches. I built a tone detection circuit and I used an IR sensor to detect the edge-of-the-world or a black line for line following. I also used bump switches to prevent my robot from running into things. I will restrict this discussion to my special sensor, the tone detection circuit. The bump switches and IR configuration that I used were very straightforward and can easily be obtained off of any datasheet.

Special Sensor

Overview

My tone detection circuit consisted of a bank of 567 chips tuned to different frequencies. I used a small microphone to pick up the notes and then the signal went through an opamp before going to the 567s. I connected the outputs of the 567 chips to a grid of LEDs and then to the microprocessor.

567 Chips

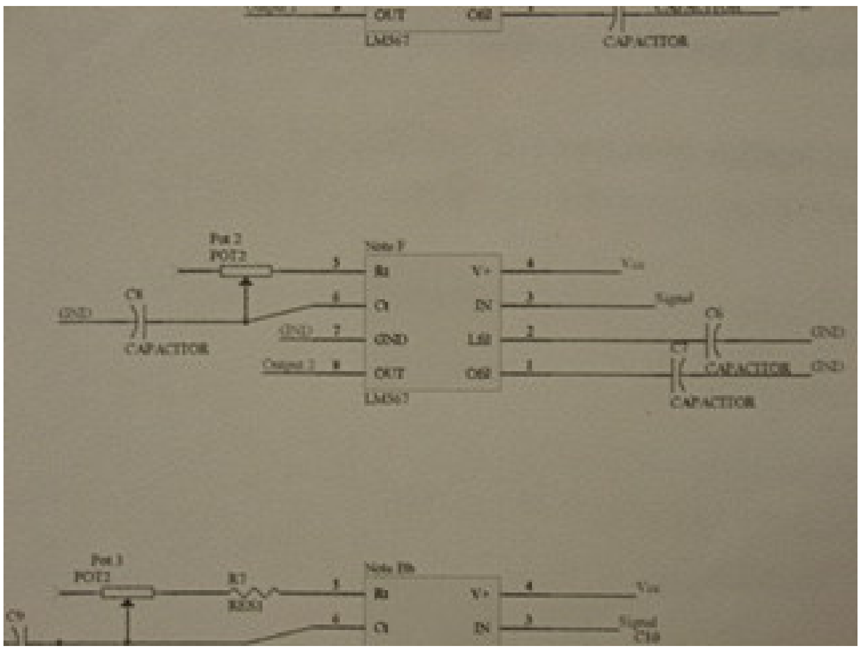
The 567 chips are 8 pin ICs. They utilize a phase locked loop design. They have an analog input and an active low digital output. Pins 5 & 6 set the characteristic frequency for each chip. A resistor is connected across pins 5 & 6 and a capacitor is connected to pin 6 and ground. To obtain certain frequencies I used the formula:

$$f=1/(RC*1.07)$$

At first I did extensive calculations and had to find common resistor/capacitor values to give me my desired frequency. I eventually realized that I should use 10K 15 turn potentiometers to tune the frequency. The chips are not that accurate and neither is any sound source. I realized that I got the best results by using a tone generator program and turning the pots till the LED activated. I then would play the note on my horn and have someone again tune the pots.

Pin 3 is the signal input and the datasheet recommends having a minimum of 200mV. Pin 8 is the output. It is normally 5V but when a frequency match occurs it goes to 0V and stays there until the frequency is no longer detected. I simply ran all of the outputs of the different chips into the external interrupt pins on the Atmega 128 and I set the interrupts to be low level triggered.

Pin 1 is the band limiting capacitor. It basically makes sure there are no spurious outputs. I used a 10uF capacitor. Pin 2 is the lowpass filter. I used a 1uF capacitor. The data sheet overstated the values and I obtained better results by using these lower values.



Opamp

I used a LM1458 dual opamp. I only used one side however. Pin 1 is the output. Pin 2 is the inverting input terminal. This is where I connected the signal. I connected a coupling capacitor of .47uF in between them. I found that if I used a 680K feedback resistor that it gave a good average gain value to allow my sax to be heard and ignore most ambient noise. Pin 3 is the noninverting terminal and I connected two equal resistors in a voltage divider configuration between 5V and ground. This biased my signal to be around the 2.5V range. I used another capacitor between the output of the opamp and input of the 567 chips of .01uF.

Microphone

I used a 9.7x6.6mm omnidirectional microphone manufactured by Horn in Japan. It had a sensitivity of -44dB and a signal to noise ratio of 60 dB. It worked better than the one that I started off with from Radio Shack but it was not a huge improvement.

Parts

Part	Distributor	Price
Microphone	www.digikey.com	$1.00
JRC567	www.digikey.com	$1.00 each
LM1458	www.digikey.com	$1.00
Potentiometers	Radio Shack	$2.50 each
Contact Switches SW132-ND	www.digikey.com	$2.50 each
IR Sensors OPB745	www.digikey.com	$3.00 each