

Lab 13 Controllers and Modulation

Logitech Extreme 3D Joystick

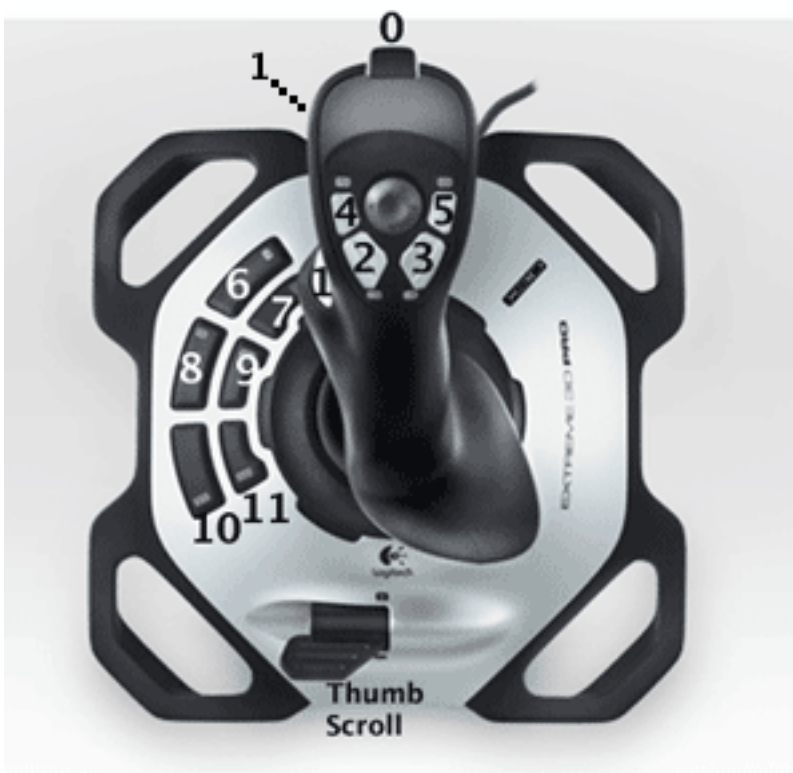
Connect the Logitech Extreme 3D Pro Joystick to a USB port.

Run joy.ck

It's in the m208Lab13 folder.

Button Mapping

Operate every button and joystick on the gamepad. You should see a messages appear in the Console Monitor for every action. The button numbers should be mapped as shown.



Joystick Buttons	Values	Notes
axis 0	± 1.0	east-west
axis 1	± 1.0	north-south
axis 2	± 1.0	twist
axis 3	± 1.0	thumb scroll

Buttons		
0	down, up	center trigger
1	down, up	thumb trigger
2	down, up	
3	down, up	
4	down, up	
5	down, up	
6	down, up	
7	down, up	
8	down, up	
9	down, up	
10	down, up	
11	down, up	

Modulation

Modulation is the process of varying one or more properties of a periodic waveform, called the carrier, with a another waveform called the modulator. The three key parameters of a periodic waveform are its amplitude, frequency, and duration. Any of these properties can be modulated by another waveform to obtain the modulated modulated. A musician modulates a tone (a periodic waveform) on a musical instrument through touch and pressure.

The Modulator and Carrier

Modulation requires two waveforms called the modulating wave and the carrier wave. The carrier wave is modulated (modified) by the modulator wave. The modulating wave can be either bipolar or unipolar. Typically the carrier wave is the higher frequency. Modulation is sample by sample multiplication.

Frequency Modulation

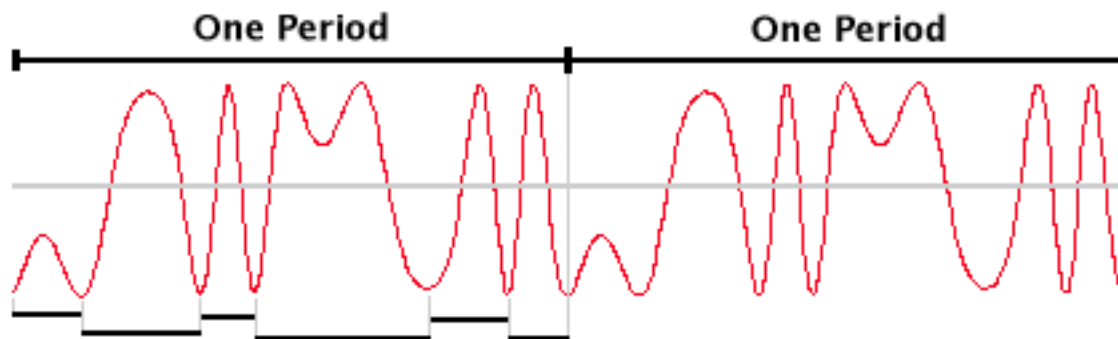
If you modulate the frequency of the carrier wave the technique is called Frequency Modulation (FM). It's the principle used in FM radio. Using Frequency Modulation to modify digital sound is called FM synthesis. The general formula for a FM waveform is shown below.

$$\text{FM}(t) = \overset{\text{Amplitude}}{\underbrace{A_c}} \cos \left(\underbrace{(2\pi f_c t + \phi)}_{\text{Carrier}} + \underbrace{(\text{idm} * (A_m \cos(2\pi f_m t + \phi)))}_{\text{Modulator}} \right)$$

The same formula is sometimes called Phase Modulation.

$$\text{FM}(t) = \overset{\text{Amplitude}}{\underbrace{A_c}} \cos \left(\underbrace{(2\pi f_c t + \phi)}_{\text{Carrier}} + \underbrace{(\text{idm} * (A_m \cos(2\pi f_m t + \phi)))}_{\text{Phase}} \right)$$

In this plot of frequency modulation, you can see the valleys of the waveform being stretched and squeezed. The frequency is being modulated.



Variable frequency spacing of valleys

ChuckK comes with three examples of FM synthesis. Try them all. They're in the m208Lab13 folder.

fm.ck
 fm2.ck
 fm3.ck

Experiment changing the carrier frequency, modulator frequency, and index of modulation.

Chuck comes with a fourth example of fm using the mouse or trackpad:

mouse-fm.ck (hold a mouse button down and move the mouse)

Logitech Extreme 3D Joystick

Let's try controlling the carrier, modulator, and index of modulation with the Logitech joystick. But first we need to see how to respond to the Joystick buttons and controls.

joystickExample1.ck

```
// joystickExample1.ck
// John Ellinger, Music 208, Spring2013
// modified from
// http://chuck.cs.princeton.edu/doc/examples/basic/fm2.ck
// http://chuck.cs.princeton.edu/doc/examples/hid/joy.ck

// make HidIn and HidMsg
Hid hi;
HidMsg msg;

// which joystick
0 => int device;
// get from command line
if( me.args() ) me.arg(0) => Std.atoi => device;

// open joystick 0, exit on fail
if( !hi.openJoystick( device ) ) me.exit();

<<< "joystick '" + hi.name() + "' ready", "" >>>;

// basic FM synthesis using sinosc

// modulator to carrier
SinOsc m => SinOsc c => dac;

// carrier frequency
220 => c.freq;
// modulator frequency
20 => m.freq;
// index of modulation
200 => m.gain;
```

```

// phase modulation is FM synthesis (sync is 2)
2 => c.sync;

function float scaleData( float val, float inMin, float inMax, float
outMin, float outMax )
{
    inMax - inMin + 1 => float inRange;
    outMax - outMin => float outRange;
    return outMin + (outRange * val / inRange);
}

// infinite event loop
while( true )
{
    // wait on HidIn as event
    hi => now;

    // messages received
    while( hi.recv( msg ) )
    {
        // joystick axis motion
        if( msg.isAxisMotion() )
        {
            <<< "joystick axis", msg.which, ":", msg.axisPosition >>>;
            if ( msg.which == 3 ) // thumb scroll
            {
                scaleData(msg.axisPosition, -1,1,1,4000) => c.freq;
            }
            else if ( msg.which == 0 ) // north south
            {
                scaleData(msg.axisPosition, -1,1,1,4000) => m.freq;
            }
            else if ( msg.which == 2 ) // twist
            {
                scaleData(msg.axisPosition, -1,1,1,4000) => m.gain;
            }
        }
    }
}

```

```

// joystick button down
else if( msg.isButtonDown() )
{
    <<< "joystick button", msg.which, "down" >>>;
}

// joystick button up
else if( msg.isButtonUp() )
{
    <<< "joystick button", msg.which, "up" >>>;
}

// joystick hat/POV switch/d-pad motion
else if( msg.isHatMotion() )
{
    <<< "joystick hat", msg.which, ":", msg.idata >>>;
}
}
}

```

Thumb Scroll controls carrier frequency.
 North South motion controls modulator frequency.
 Twist controls gain.

Have fun.

MUSC 208 Winter 2014
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