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6.101 Final Project Proposal

Analog Text Display

1. Introduction

The goal of this project is to create a system that can generate text characters like letters and numbers using an analog, x-y controlled display. For development purposes, the system will use the x-y display of an oscilloscope, but the ultimate goal will be to project the images using a laser galvo. In both cases, character shapes can be generated through the two signals that control the x- and y-deflection of the imaging beam. Varying the shape and timing of these two signals will change the shape of the images generated by the display.

2. Design Considerations

2.1 Digital v. Analog

One of the factors that makes this project challenging is that it attempts to use analog circuits to perform a task that is, in many ways, naturally digital. That is, there is no systematic way to translate a *value* of '1' into the *shape* of '1,' and so on for the rest of the characters the system might be expected to display. It seems unlikely that any system could produce a wide range of text characters on command, unless it somehow encodes the shape associated with each value. In light of this, the system will be designed as if it would be used by a digital controller, which might have a few bytes of shaping data associated with each character value. The idea, then, is that a digital circuit would be able to control or select different features of the display signals, such as frequency, shape, and phase shift, in order to produce different character shapes.

2.2 Scope

There are a wide variety of letter shapes, of course, and no family of simple geometric shapes can accommodate all of them. For example, many letter characters have shapes that can be found in the Lissajous curves, shown in figure 1. These curves are created by varying the frequencies and phase of the x- and y-control signals, and they are natural, simple shapes to produce with an x-y display. A system based on this family of curves could produce the majority of alphanumeric characters, but there are some characters which are difficult to create with this kind of approach, such as 'A,' 'G,' and 'Q.' Rather than try to exhaustively account for every such character, the core goal of the project will be to provide a Lissajous-like curve tracer that can represent the majority of text characters, and extra functionality for shaping more complicated characters may be added later if time permits.

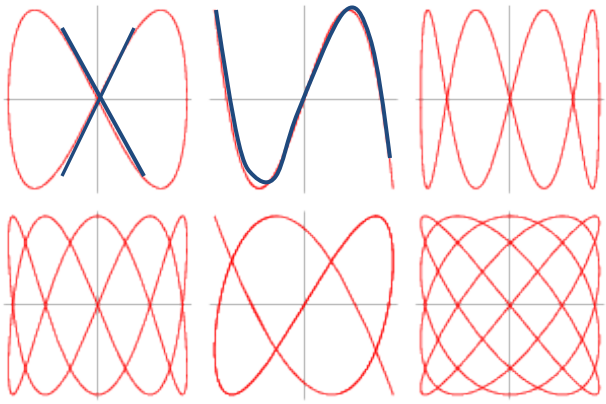

Figure 1: Lissajous Curves, with some character shapes highlighted

3. Design

3.1 Core Overview

These are the details of the minimal requirements and specifications that I plan to satisfy in order to have a system that could be considered correctly functional. This project allows for several more ambitious goals and improvements that can be confronted if time permits. These are described in the next section.

The core system consists of a pair of signal generators, whose outputs can be selected using control voltages. These outputs will be the x- and y- control signals for the display. In order to display a reasonable variety of shapes, each generator should be able to produce at least 4 harmonic frequencies, and a variety of waveforms, which will include triangle, sine, sawtooth/ramp, and pulse. A crucial element of the system will be the synchronization of these two generators. If they are not synchronized to a common clock, the signals will drift apart, and the displayed shapes will be unstable. A rough example of what one signal generation pathway might look like is depicted in figure 2.

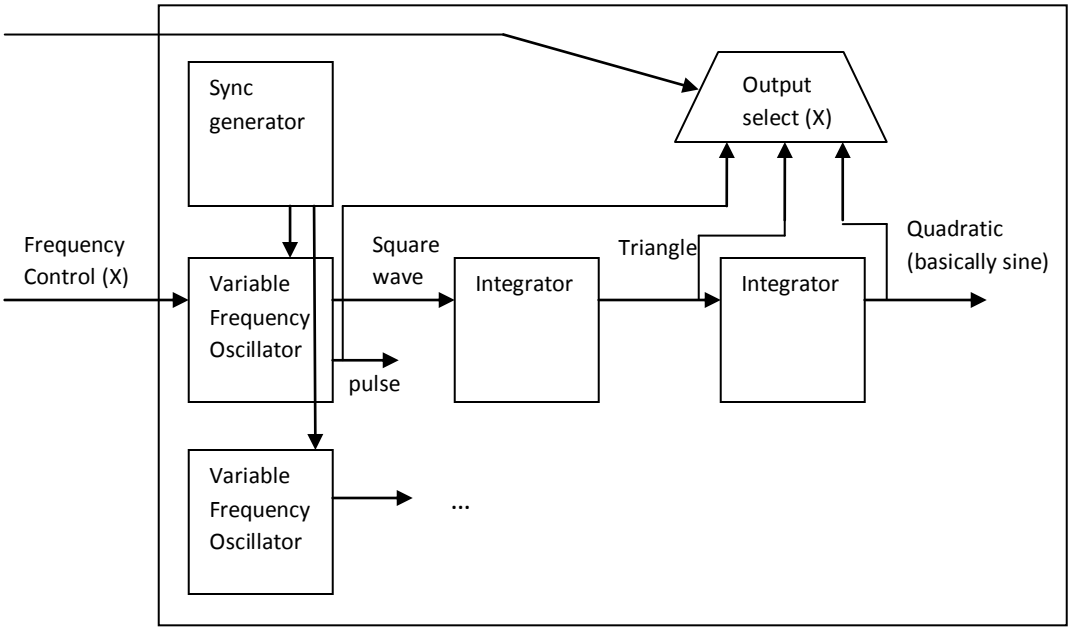

Figure 2: Signal generation block diagram

3.2 Secondary Goals, and Other Refinements

There are several improvements that can be made to the system once the core design is satisfied. The most immediate of these is to add circuits to produce the more complex signals that would be needed to produce odd characters like 'Y', 'P', or 'B.' Even more complicated signals would probably be required to produce 'A' or 'Q,' as mentioned before. Devising mechanisms to produce the complex waveforms necessary without wildly complicating the structure of the system will be a tough challenge, and generating the entire alphabet may be an overly optimistic goal. Just the same, I want to make the capabilities of the system as complete as reasonably possible.

Another goal for the project is to adapt it to use a laser galvo display. In principle, this would use the same process as displaying on an oscilloscope, but it would require scaling the output levels to drive the galvo's motors. The laser display also offers an interesting capability over an oscilloscope, in the ability to turn the laser on and off. This third degree of control could be exploited to simplify generation of certain characters and improve the aesthetic quality of the display.

A last goal, which I understand would contribute very little to the actual project grade, would be to use the analog display system with a digital controller. This would greatly improve the quality of the system demonstration, as the arduous task of manually adjusting control voltages could be performed very quickly by a microcontroller. It would be wildly cool if such a microcontroller could be programmed to step through the alphabet, or even to display strings of text. This addition would only be made as a personal endeavor to make the project as cool as possible, and will therefore only be attempted if extra time remains after satisfying the other analog-oriented goals of the project.