Active Suspension System

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Project Summary

The purpose of this project is to design an active suspension test platform. The major components to this project will be a linear actuator, a microcontroller, and a sensor system that will allow us to monitor the displacement, velocity, and acceleration of the platform. An input wave will be sent into the system, via the microcontroller, and the platform will move according to the type of wave entered. The wave entered will be a single step, a square wave, or a sine wave with different options available for the user to control.

Overview

The project team is designing a system using a voltage controlled linear actuator to control the movements of an actuator to be used in the testing of active suspension systems. This actuator will be controlled using a microcontroller with a keypad and display. Desired motions will be entered using the keypad of the microcontroller and the display will show the maximum distance the platform moves, the maximum velocity and acceleration of the actuator, and the type of motion the it is undergoing (i.e. up or down). Sensors will permit monitoring and recording of the platform motion.

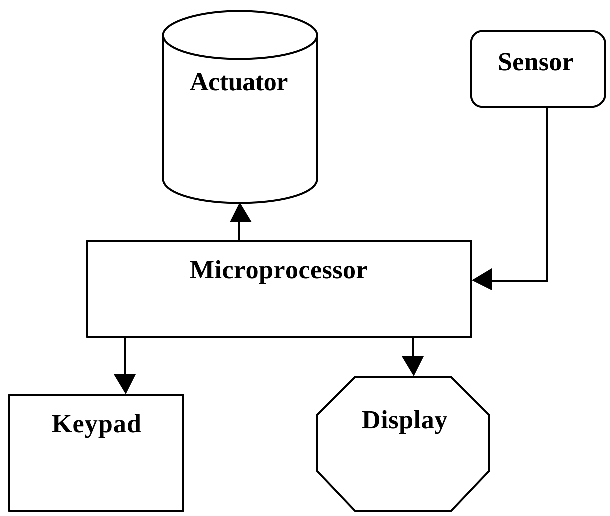

Figure 1: Block Diagram of Project

Parts

The parts that will be used to create the active suspension system are linear actuator, one motion sensor, a microcontroller, a keypad, and a display.

Since no hydraulic fluids will be permitted in the laboratory electrically driven linear actuator will be utilized. A low voltage linear actuator has been chosen because high voltage could be potentially dangerous to the design engineers. The rated speed of the actuator at full power is .5 in/s.

Inputs and Outputs

Inputs	Outputs
Keypad	Linear Actuator
Sensor	Display

Figure 2: Inputs and Outputs of the Active Suspension System.

The user will input the desired motion on the keypad. Information will be interpreted by the microcontroller and will cause the linear actuator to move a certain distance. The sensors will sense any motion made by the platform and report it to the microcontroller. After that the microcontroller will process the signal from the sensor and show the measurements on the display.

Software

The active suspension system project contain both software and hardware design. For the software portion of the project, there are three major portions of code: the motion module, calculation module, and the interaction module. There will be many smaller modules involved but these are the main groups. The motion module contains the software programs that provide the linear actuator with the necessary commands to make the platform move up or down. The calculation module obtains data entered by the user and uses that data to calculate the distance moved by the platform, the acceleration, and the velocity at the centroid of the platform.

The interaction module contains a module to initialize the LCD display, a module to display prompts to the user, and a module that will interpret the user input. Next, the user will be asked to enter the desired motion and the maximum distance the user would like the platform to move. The user's input will then be processed and the appropriate module will be executed. Figure 3 shows how this process will proceed.

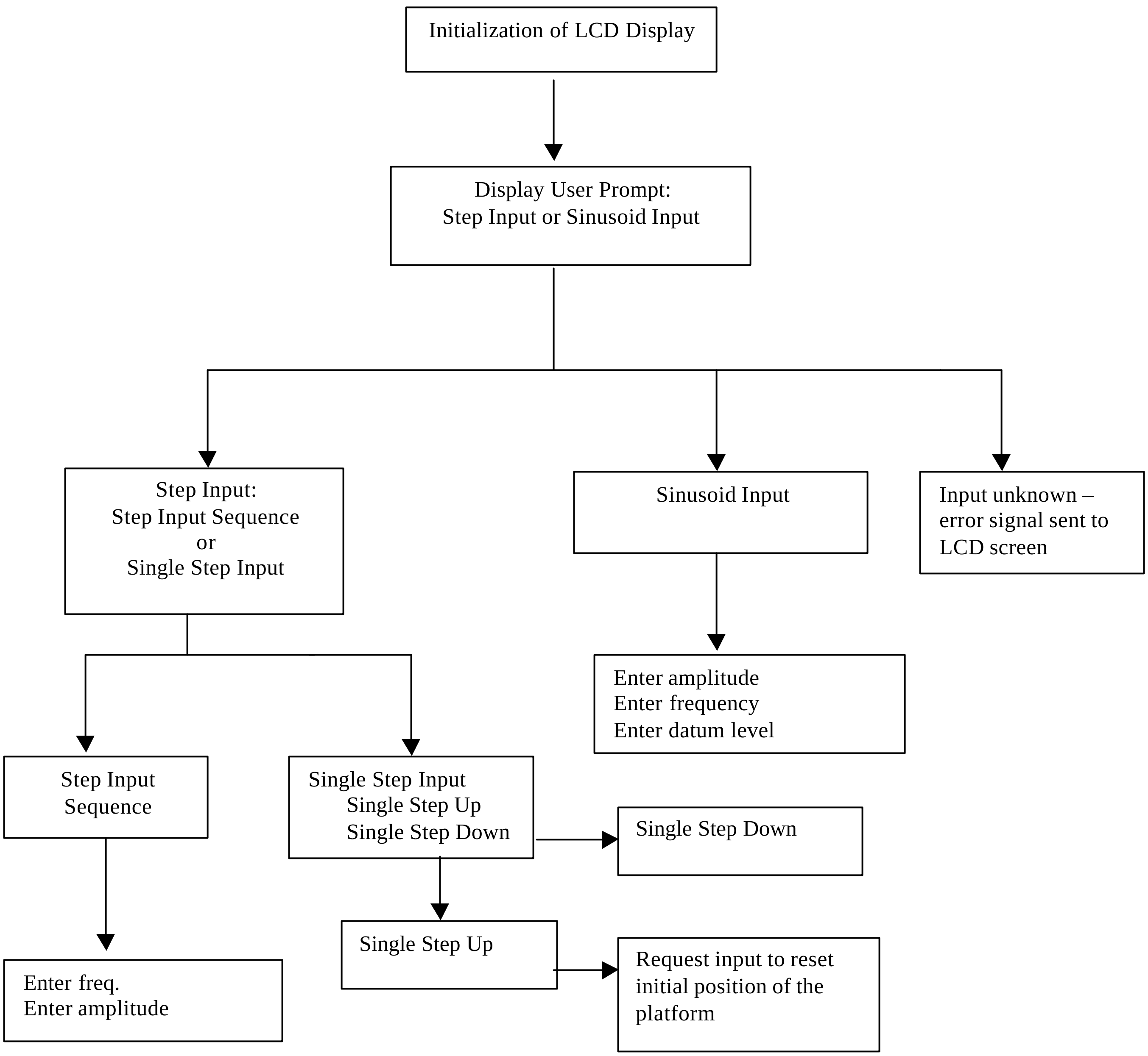

Figure 3: The software flowchart for Linear Actuator Behavior Selection

If the input entered by the user is recognized, a program is chosen; if not an error message is displayed. If the platform is unable to perform the requested motion an error message will also be displayed.

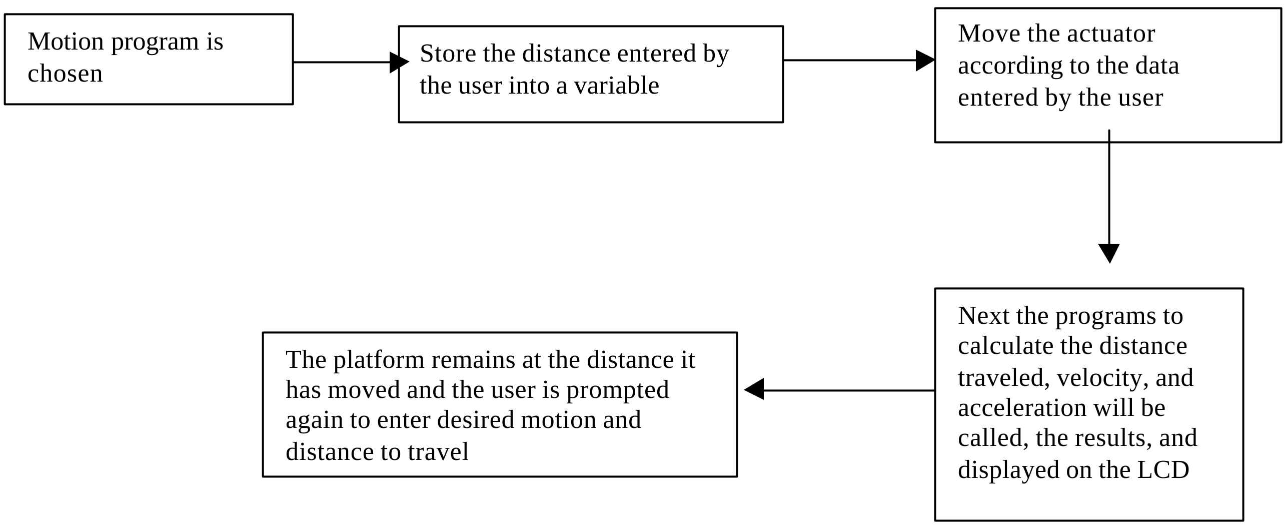

Figure 4: The flowchart for the motion modules

Regardless of which input is selected, the software modules follow the same sequence of commands. But the platform will perform different movements depending on which type of input is selected. If a sinusoidal input is entered the platform will move in a continuos motion up and down in relation to the input data entered about the amplitude and frequency. A step input will make a single step up whereas a square wave will make steps up and down in relation to the amplitude and frequency.

The sensor, which is integrated with the actuator hardware, will obtain the linear position of the platform and store the position in another variable. This variable and the will be used in the calculation module to compute the distance moved by the platform, the acceleration, and the velocity at the centroid of the platform. This sequence of events is shown in figure 4.

When the microcontroller is first started, the platform will start at an initial position. The platform will move the desired distance entered by the user and then moves to the initial position entered by the user and waits for another instruction from the user. When another desired motion is entered, the platform will return to the initial position and then perform the desired motion, as shown below in figure 5. The distance module will subtract the starting position from the distance entered by the user. This will provide the desired distance the platform is to be moved. However, this distance will need to be compared with the initial linear position as recorded by the sensor minus the linear position of the actuator when the motion is started.

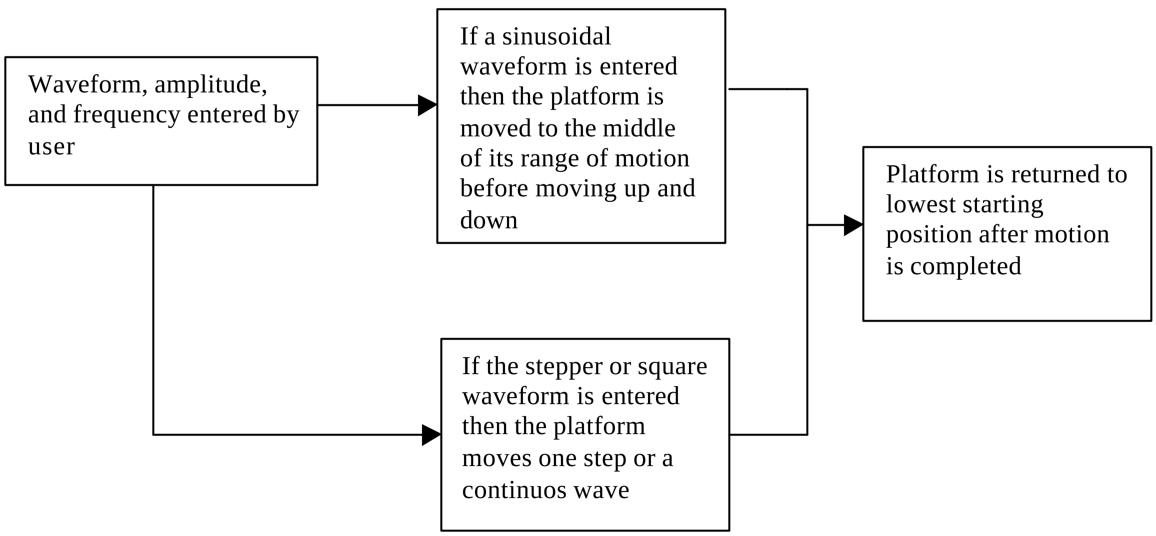

Figure 5: Flow chart for Displacement

The next module will be the velocity measurement (refer to figure 6). This module will calculate the distance per second that the platform moves.

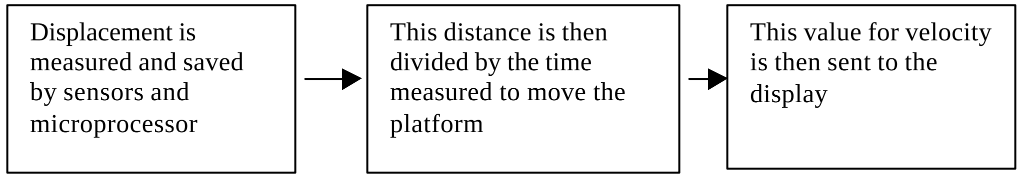

Figure 6: Flow chart for Velocity Calculation

The final calculation is acceleration (figure 7). Since acceleration is the derivative of velocity, dividing the velocity calculated above by the time will give the acceleration measurement.

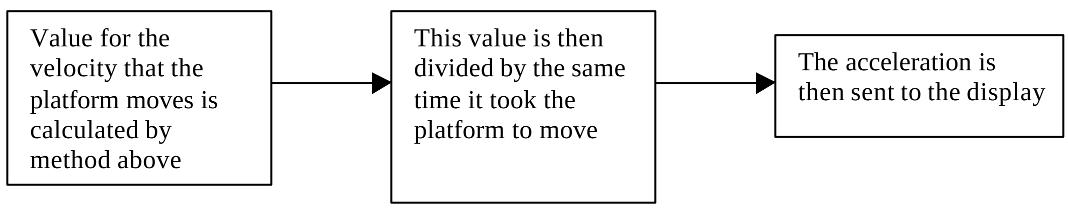

Figure 7: Flow chart for Acceleration Calculated

Hardware

A block diagram with the necessary hardware is shown below. A sine wave, square wave, or step wave will be fed to the input to provide a range of motion that can be selected. The actuator will move in accordance with what is selected. A maximum and minimum height will be designated for a range of motion to keep the platform from exceeding its limits. For a sine wave, the platform will be raised to the center of the range of motion and then begin to move. For the other input waveforms, the starting point will be the lowest possible point in the range of motion.

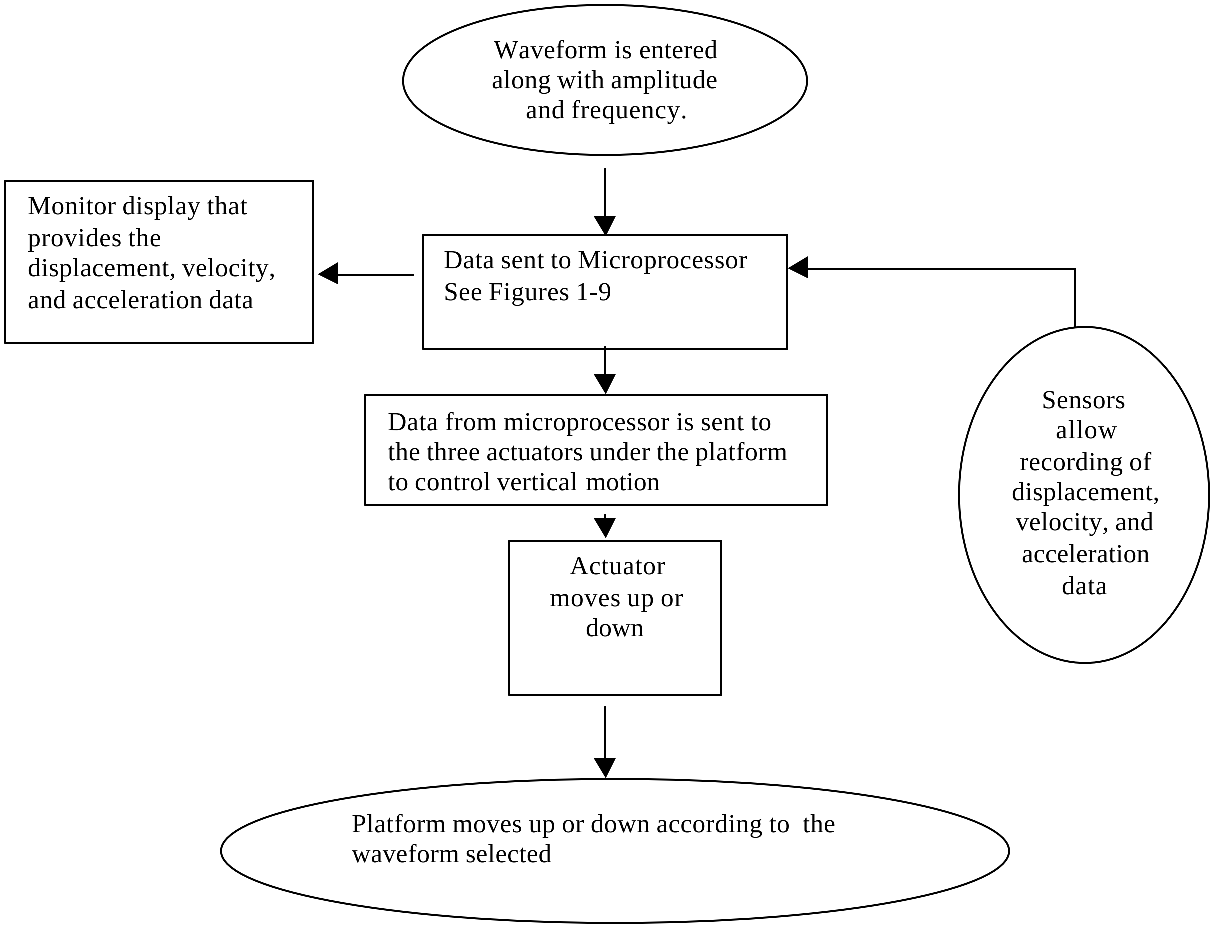

Figure 8: Block Diagram of Hardware