Project Maestro: A User-Friendly Animation Control System Interface for Rose Float

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Background

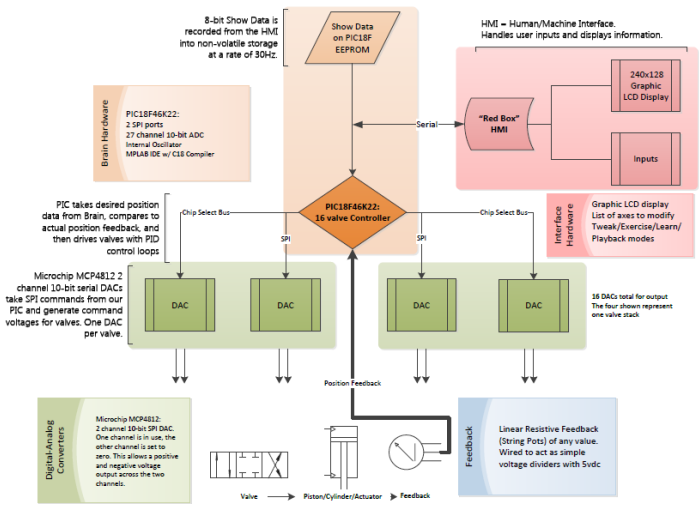
In recent years, the necessity of an easily accessible control system has become apparent due to the fast-paced nature of the Rose Float schedule. As experienced students graduate and new volunteers continue to replace them, the collective design philosophy and methodology of the organization shifts at a rapid pace. Inevitably, older electronic systems without proper documentation become forgotten over the years and thus must be replaced or redesigned. Unfortunately, the unnecessary reinvention of systems which are critical to the float can be both expensive and time consuming.

Objective

Project Maestro's purpose was to design a control system which allows any individual possessing no formal knowledge of electronic control systems theory to manipulate and program the movement of the mechanisms on board the Cal Poly Rose Float with as little technical instruction or training as possible. From an engineering standpoint, the control system should be durable and robust enough to withstand or circumvent possible damage as a result of human error. From a practical standpoint, the interface of the control system should be unintimidating, clean and uncluttered yet functional and efficient. The end product is a tool which is intuitive to use and thus will be repeatedly adopted by Rose Float design teams in the years to come.

System Design

The Maestro control system itself consists of a PIC18F46K22 microcontroller which commands the position of a series of valves through an array of digital to analog converter chips (DACs). Each DAC is fed valve position data from the microcontroller via serial peripheral interface busses (SPI). The resulting voltage output from each DAC (ranging from 0 to 2.048 V) is then amplified to a value which is more compatible with the hydraulic control valves (0 to 12 V). At any given time, the microcontroller knows the current position of each valve extension due to string potentiometers which are attached to the hydraulics under the influence of each valve. As the length of the hydraulic cylinder increases, so does the resistance of the string potentiometer. With a reference voltage (5 volts) placed across the potentiometer, the resulting attenuated voltage can be converted to a binary data value via the microcontroller's on-board analog to digital converter (ADC). This "current value" of the position is compared with the next "desired value" which is to be output to the DACs in order to obtain the error of the system. The error is taken into account by the microcontroller in order to readjust the output data via various control system algorithms.



Interface Design

When the microcontroller commands the valve positions, it can read its data from either one of two sources: stored memory or real time user input. These functions are both ultimately handled by the external control system interface module dubbed the "Red Box". The Red Box maintains serial communication with the microcontroller inside of the control box, and essentially lets users manipulate the control system data without needing to even open the control box. A pair of slide potentiometers within allows users to manually set two voltage values to be read into the microcontroller via ADC. The LCD display serves two purposes: to help walk the use through the functionality of the Red Box, and to display the value of the slide potentiometers in real time. Using the switches inside the box, the mode of the control system can be selected: exercise mode, record mode, and playback mode. In exercise mode, the user can use the slide potentiometers to simply move the hydraulics which are installed on the float. This feature is primarily used in order to check for safety and clearance between the animated mechanisms and the other components of the float. In record mode, the values read from the slide potentiometers are sampled at a uniform rate and stored into memory on board the microcontroller within the control box. When playback mode is initiated, the stored values are read from the microcontroller, allowing the user and any other individuals present to sit back and admire the performance of the animation which they programmed themselves.