LCD and Touchscreens for Use with Raspberry Pi

Introduction

LCDs have been ruling the world since the late 90s, and their prominence is surpassed only by the vast quantities of microprocessors in all kinds of appliances. LCDs are a kind of flat panel light display using liquid crystals. They can be used to display arbitrary images, like in a computer screen, or have a preset architecture of which to display parts of on/off (e.g. in a calculator or digital clock) [1]. Prevalent in almost any kind of consumer electronic, LCDs are the main medium from which we experience the digital world, which is essentially a layer of the real world. This technical review summarizes the commercial applications of the LCD, how the underlying technology works, and the building blocks for implementing them. The main focal point of researching LCDs is to understand how it works and is compatible with the Raspberry Pi controller.

Commercial Applications of LCDs

Pure LCD Display

Naturally, LCDs are a good fit for visually representing a vast range of electronic components and appliances. As for usage with the Raspberry Pi, a specially made LCD/Touchscreen must be developed or purchased in order to connect to the microcontroller. However, the first candidate can be translated to any platform with an HDMI interface. The IPS HDMI displays quite a large screen with high resolutions and wide viewing angles. The 5/7 inch displays have a resolution of 720 x 1280 and a viewing angle of up to 178 degrees, while the 10.1 inch displays have a resolution of 1200 x 1980 with the same viewing angle [3]. Small, light, portable, and widely compatible, the HDMI IPS LCD Display is a seamless option that has no need for drivers or setup.

LCD Touchscreen

Next up, the Raspberry Pi 7 inch Touchscreen Display gives us a touch option for our LCD, and similarly to the last display, is easily viewed at a distance at good resolution. The 7 inch monitor allows its users to create one-machine, integrated projects with the system, including tablets, infotainment systems, and embedded projects. The display is slightly less, at 800 x 480, which connects with an adapter board that handles the power and signal conversion [3]. In this design, the connections made are specific to the connections allowed on the Raspberry Pi, which consists of the power (Pi's GPIO port) and display (Pi's DSI port) signals, the latter using a ribbon cable.

Workings of the Underlying Technology

LCD Characteristics

Displaying a small number of individual digits or symbols can be implemented with independent electrodes for each segment [4]. On the other hand, variable or arbitrary displays are implemented with pixels arranged in a matrix, with rows connected to one side of the layer and columns connected on the other side, making it possible to address each pixel individually. Matrix addressing of this kind consists of going down row by row and filling out each pixel in a column, to generate whatever image is needed on the full extent of the display. The various matrix addressing methods include passive-matrix and active-matrix addressed LCDs.

Display Inconsistencies

Until around 2006, manufacturers wouldn't even agree on a single base glass size, and different manufacturers used slightly different sizes and thicknesses in the same time span. In the context of assembling projects, larger glass sizes are better suited to making larger displays. An LCD Module, an LCD immediately available for usage, may not be made along with LCDs in the same factory either. Until standardization for the generations of LCDs that followed, it was difficult to synchronize the modules with whatever trait was desired in a project or implementation [5], [6].

Building Blocks for Implementation

Understanding how LCDs are illuminated is important to achieving the most visibility and readability for any project. LCDs can either be backlit or reflective and require an external source to bring light to the picture. The cheapest method makes use of a reflective process to reflect the ambient light so that it displays the information. Computer monitors and LCD TVs are lit with this kind of external light source, which usually consists of many built in micro-fluorescent tubes of just a few millimeters in size. LED based LCDs can also be edge lit with local dimming, capable of impeccable picture quality whilst using a low amount of energy [2].

Smaller displays with a number of individual digits or fixed symbols are usually implemented with independent electrodes for each segment. Larger displays are implemented with pixels arranged in matrices of independently addressable rows and columns. In passive-matrix displaying, panels rely on the display's persistence in maintaining the state of each pixel element between screen refreshes. For active-matrix, the display acts as an array of switches that controls the current flowing through each pixel, signaling to each how brightly it should shine [2].

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