Homework #4
Design Constraint Analysis and Component Selection Rationale

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Introduction

The “Digital Picture Box” functionally is used to display to a VGA monitor a database of pictures stored remotely on a personal computer via the Internet. The status LED is used to indicate the device has power, and also indicates when a picture is being transferred. The push buttons are used to cycle through the pictures stored on a remote PC. The remote control will have the same functionality as the push buttons. The picture box is designed to connect directly to any standard VGA monitor or LCD screen. The box must have a custom TCP/IP server running with it’s own custom image transfer protocol in order for the data exchange with the PC to work. A JPEG decoder will be used to decrease network bandwidth requirements of the images.

The “Digital Picture Box” design basically consists of a small cubicle casing that has push buttons and a status LED on the front. On the rear of the casing there is a VGA connector, RJ-45 network connector, power connector, and also a connector for an antennae.

In the following section all of the key requirements pertaining to the proposed project are discussed. The required features of the major components are described in detail. The third section lists the actual components selected, explains why they suited the project, and compares them to the closest alternative. There is a detailed Excel sheet of all major parts that were ordered. Finally, a list of all references to the datasheets of the components discussed is included.

Design Constraints

The two major constraints of the project are the micro-controller and the graphics processor.

The micro-controller must have a large amount of I/O pins if it is going to be interfaced with a graphics controller chip due to the size of the address bus and data bus of modern VGA graphics controllers. The micro-controller ideally should integrate as many features our design requires as possible. It should include a network adapter, extra I/O pins to interface to the graphics chip as well as the RF remote chip, have enough computational power to perform JPEG decoding, and finally an efficient development environment. The controller should have enough resources available to buffer the information coming from the Ethernet adapter and the data going to the graphics controller.

The graphics chip needs to have all of the necessary hardware to display an image on the VGA port. It will be responsible for creating the analog signals necessary to constantly refresh the image to the screen. It should have a frame buffer large enough to store a high-resolution image, so that once the image is sent to the controller it will be able to hold the image on the screen. If the frame buffer is external to the chip, it must have a dedicated interface to the graphics controller using readily available standard DRAM memory.

Finally, the picture box should also try and meet other design constraints. The Digital Picture Box is made to reside on a desk as a stand-alone device. Therefore it should be as aesthetically pleasing as possible. Portability is not a key issue, but the smaller and more lightweight the device is the better. The components should not cost more than an absolute maximum of a couple hundred dollars to be marketable.

Summary of Micro-controller Requirements

- Large number of general I/O pins to interface with a graphics controller
- Integrated network adapter
- Efficient development environment
- Large amounts of processing power to decode JPEG and buffer video data

Summary of Graphics Controller Requirements

- Ability to create all necessary analog RGB signals for a standard VGA adapter and refresh the image automatically
- Integrated frame buffer that is large enough to hold a SVGA image
- Standard EDO DRAM data bus for interfacing external memory chips

Rationale for Component Selection

The final decision for the graphics controller was narrowed down to the Epson S1D13505 "Embedded RAMDAC LCD/CRT Controller" and the Cirrus Logic CL-PS7500FE "System-on-a-Chip with CRT/LCD Controller." Both chips have analog RGB outputs for a standard VGA CRT monitor, support for an external frame buffer using standard EDO DRAM chips, and a standard input bus for data transfer. The Cirrus Logic in addition supports a 32-bit ARM microprocessor, hardware floating-point unit, PS/2 serial ports, a 16-bit ISA bus, and serial CD quality digital sound. All of these features, which are not essential to the proposed criteria of the project, translate into the Cirrus Logic chip having almost twice as many pins as the Epson chip. Putting the overkill of features aside, the Cirrus Logic chip is not supported nearly as well as the Epson counterpart. The only document available for the CL-PS7500FE chip was a product bulletin that merely contains an overview of features, compared to Epson's 500+ page technical manual on their chip. Epson included timing diagrams for interfacing the chip with several different micro-controllers, pin descriptions, memory

timing diagrams, and many other important details. There are also several documented student design projects on the Internet that successfully implemented the Epson controller.

It was considered very important that the project contain some type of Ethernet capability, so it seemed obvious to pick a variant of a Rabbit micro-controller with integrated 10Base-T Ethernet. Since the Epson controller requires 46 I/0 pins for it's data and address busses alone, the RabbitCore 3000 is a perfect match. It contains 56 general-purpose I/O pins. This would leave 10 pins for the keypad interface and a few extra for debugging purposes. In order to maximize the speed that an image is loaded onto the display, all of the data should be sent to the graphics controller in a parallel fashion if possible. The Epson controller's RAMDAC operates at 40Mhz on a 16-bit bus. The Rabbit 3200 operating at 55Mhz should be able to keep pace with the Epson when transferring a high-resolution uncompressed image.

Comparison of Epson and Cirrus Logic graphics controllers

Epson S1D13505

- Analog VGA output
- External frame buffer using Standard DRAMs
- Digital input bus
- 128 pins

Cirrus Logic CL-PS7500FE

- Analog VGA output
- External frame buffer using Standard DRAMs
- ISA bus
- 240 pins
- 32-bit ARM microprocessor
- Digital serial sound output
- PS/2 Serial Interface

Digital Picture Frame Component List

Vendor	Part Description	Part Number	Unit Cost	Quantity	Total Cost
Arrow Electronics, Inc.	Epson Graphics Controller	S1D13505F00A100	$14.40	2	$28.80
G-Link Technology	256Kx16 4MB EDO DRAM	GLT440L16	Sampled	1	$0.00
Rabbit Semiconductor	Rabbit 3000 LQFP Microprocessor	668-0010	$14.50	2	$29.00

List of References

Rabbit 3000 LQFP Microprocessor:

http://www.rabbitsemiconductor.com/documentation/docs/manuals/Rabbit3000/UsersManual/R3000UM.pdf

Epson Embedded RAMDAC with CRT/LCD Controller (registration required):

http://www.erd.epson.com/vdc/pdf/1355/TM/s1d13505tm.pdf

Linx Technologies Keyfob Transmitter:

http://www.linxtechnologies.com/ldocs/pdfs/cmdkey.pdf

KH Series RF Receiver/Decoder:

http://www.linxtechnologies.com/ldocs/pdfs/khrxmanual.pdf

Cirrus Logic System-on-Chip with CRT/LCD Controller:

http://www.cirrus.com/en/pubs/proBulletin/7500-003.pdf