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February 20, 2006

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RE: ENSC 440 Design Specifications for a Digital Photo Album

Dear Dr. Rawicz:

The attached document is a design specification for a *Digital Photo Album* describing the designs of our product including high level, low level specifications of our development hardware as well as the designs for our final product that we would hopefully pursue later. We are developing a digital photo album equipped with a user friendly interface with large storage capacity and ample screen area for comfortable viewing. Our product will bring people a new way to enjoy their photos without worrying too much about cost and storage.

Our attached design specification elaborates on the design of each component necessary for our proposed product with its corresponding functionalities that our product should possess as a proof of concept. It also details the design specifications for the final product that our company will manufacture and eventually release to the market. Finally, our design specification includes a test plan that would verify the quality and the integrity of our product and as well as its durability under specific conditions.

Imago Solutions Corp is composed of four engineering science students: Timothy Chueh and Ali Rawshanaei doing Computer Engineering Option, Albert King doing Systems Option, and Patty Sa doing Electronics Engineering Option. If you have any questions, comments or suggestions, please contact us via email at ensc440-proj@sfu.ca or call me at (604) 805-9754.

Sincerely,

A handwritten signature in black ink that reads "Albert King". The signature is written in a cursive style and is positioned above a horizontal line.

Albert King
Imago Solutions Corp.

Enclosure: Design Specifications for a Digital Photo Album

Design Specification
for a
Digital Photo Album

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Executive Summary

The design specifications detailed in this document provide a set of descriptions for the design of Imago Solution's Digital Photo Album. The design specifications in the document focus on our proof-of-concept prototype, which correspond with requirements marked I and II in the document *Functional Specification for a Digital Photo Album*. Features that will only be part of our final design will be discussed when relevant.

This document shows our design choices for implementing our functional requirements from a hardware and software perspective. Other design options will be brought up where applicable, and our design choices will be justified over the alternatives.

Our chosen hardware platform is a System-on-Chip from Sharp called the LH7A404. This platform provides us with all the features we need, and provides robust interfaces for a display and controls. The LCD we have chosen is provided by Logic, and provides screen real estate similar to a 4x6" photo. Controls for our device will be limited to a Scroll wheel that can be depressed along with an additional button. Final hardware may provide alternate controls for ergonomic use even when holding the device differently.

The software for our device is designed in a way to be easily accessible to both those unfamiliar with common software norms as well as those familiar with typical consumer electronic devices. The software is menu driven and provides a visually intuitive experience. The flow of the software is described with diagrams along with tables describing the interaction between the controls and the software.

An overview of our test plans for our device will conclude the design document. Implementation of our design in order to complete a proof-of-concept prototype will begin immediately.

Table of Contents

Executive Summary	i
List of Figures	iv
List of Tables	iv
1 Introduction	1
1.1 Scope.....	1
1.2 Acronyms.....	1
1.3 Intended Audience.....	1
2 System Hardware	2
2.1 Microprocessor.....	2
2.2 Application Board.....	5
2.3 LCD Screen.....	8
2.4 Hard Drive.....	9
2.5 Control Hardware (Buttons).....	10
2.6 Power Supply, Enclosing, and Aesthetics.....	11
3 Software Design	13
3.1 High Level Design.....	13
3.1.1 <i>Main Menu</i>	14
3.1.2 <i>Date Menu</i>	15
3.1.3 <i>Category Menu</i>	17
3.1.4 <i>Album Menu</i>	19
3.1.5 <i>Options Menu</i>	20
3.1.6 <i>Memory Card Menu</i>	22
3.1.7 <i>Browsing Mode</i>	23
3.1.8 <i>Slideshow Mode</i>	25
3.1.9 <i>Add to Album</i>	26
3.1.10 <i>Create New Album</i>	27
3.1.11 <i>Remove from Album</i>	28
3.1.12 <i>Change Category</i>	29
3.1.13 <i>Create New Category</i>	30

3.1.14	<i>Copy to Device Menu</i>	31
3.1.15	<i>Confirmation</i>	32
3.2	<i>Low Level Design</i>	33
3.2.1	<i>Screen Output</i>	33
3.2.2	<i>Button Handling</i>	33
3.2.3	<i>File System</i>	33
4	Test Plan	34
4.1	<i>Hardware</i>	34
4.1.1	<i>Power Verification</i>	34
4.1.2	<i>Battery Life</i>	34
4.1.3	<i>Boot</i>	35
4.1.4	<i>CPU Clock Speed</i>	35
4.1.5	<i>Connection Verification</i>	35
4.1.6	<i>LCD Display</i>	36
4.1.7	<i>Navigation Buttons</i>	36
4.2	<i>Software</i>	36
4.2.1	<i>Low Level</i>	36
4.2.2	<i>High Level</i>	36
5	Conclusion	37
6	Referenced Documents	38

List of Figures

Figure 1: Hardware Component Interconnections	2
Figure 2: LH7A404 Card Engine Internal Architecture	4
Figure 3: Card Engine Boot-Up Process.....	7
Figure 4: Sharp Zoom™ SDK Application Board.....	8
Figure 5: Display Kit LCD	9
Figure 6: Seagate ST1 Series One-inch Hard Drive	10
Figure 7: Scroll Wheel and Back Button.....	11
Figure 8: Battery Mock Up (height = 2in and length =2.65in)	11
Figure 9: The Device Mock up	12
Figure 10: Software Hierarchy.....	13
Figure 11: Main Menu Screen	14
Figure 12: Date Menu Display.....	15
Figure 13: Submenu Screen.....	17
Figure 14: Category Menu Screen.....	17
Figure 15: Album Menu Screen.....	19
Figure 16: Memory Card Menu	22
Figure 17: Browsing Mode Screen	23
Figure 18: Slideshow Mode Screen.....	25
Figure 19: Add to Album Screen.....	26
Figure 20: Create New Album Screen.	27
Figure 21: Remove from Album Screen.....	28
Figure 22: Change Category Screen	29
Figure 23: Create New Category Screen.....	30
Figure 24: Copy to Device Screen.....	31
Figure 25: Confirmation Screen.....	32

List of Tables

Table 1: SOC Options (references: [1,2,3,4,5,7 and 8])	3
Table 2: Main Menu Controls	14
Table 3: Screen Menu Controls	15
Table 4: Submenu Controls	16
Table 5: Date Submenu Options	16
Table 6: Category Menu Controls.....	18
Table 7: Category Submenu Options	18
Table 8: Album Menu Controls	19
Table 9: Album Submenu Options	20
Table 10: Options Menu Controls.....	20
Table 11: Settings Selection Controls	21
Table 12: Settings and Options	21
Table 13: Options Menu Controls.....	22

Table 14: Memory Card Submenu Options	23
Table 15: Browsing Mode Controls.....	24
Table 16: Browsing Submenu Options	24
Table 17: Slideshow Mode Controls.....	25
Table 18: Add to Album Controls	26
Table 19: Create New Album Controls	27
Table 20: Remove From Album Controls	28
Table 21: Change Category Controls.....	29
Table 22: Create New Category Controls	30
Table 23: Copy to Device Controls	31
Table 24: Confirmation Controls	32

1 Introduction

Imago Solutions' Digital Photo Album is a consumer product that compliments digital cameras by helping a user take advantage of the benefits inherent to digital photos. The device provides a large amount of storage for digital photos compared to the memory typically used in digital cameras. This allows users to take additional photographs without the need to purchase additional expensive memory cards or have access to their personal computer. The device also provides a way to view photos in a size similar to a standard 4x6" photo without the need to pay for developing the photos.

1.1 Scope

This document is the design specification for Imago Solution's Digital Photo Album. It explains how the functional requirements that must be met are going to be implemented. A full set of the functional requirements are available in the functional specifications document. As described in the functional specification only a partial set of functional requirements is implemented for the delivered proof of concept device in April 2006.

1.2 Acronyms

PC	Personal Computer
LCD	Liquid Crystal Display
MCU	Micro Controller Unit
USB	Universal Serial Bus
SOC	System on Chip
SDK	Software Development Kit

1.3 Intended Audience

Design engineers will use this document for development and testing of the modules contained in the Digital Photo Album. The project manager will use this document to control the flow of the project in terms of achieving the development objectives and meeting the deadlines. Marketing personnel will use this document to develop initial promotional material.

2 System Hardware

The main hardware components that would be required for this project will be the following: a microprocessor (MCU: Micro Controller Unit), an application board, an LCD screen, a control hardware (buttons and switches), a hard drive (to be implemented on the final product), a battery and the hardware enclosure (casing and aesthetics). The application board is mainly a fabricated electronic board with various chips and devices that can be broken down into the following: LCD controller, memory controller, USB interface, power regulator, and chip memory. The main hardware interconnections excluding the physical enclosure are shown in Figure 1.

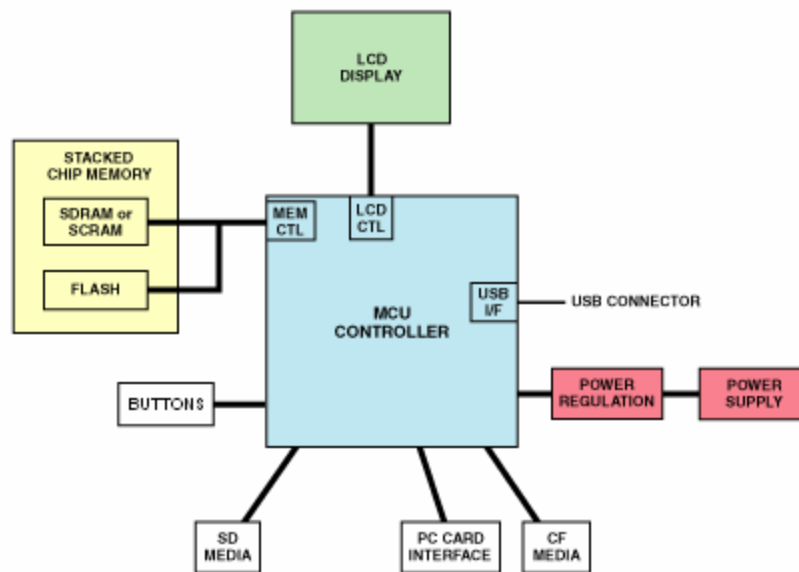


Figure 1: Hardware Component Interconnections

The white boxes on the figure above are the external components than can be interfaced directly with the MCU through some pins embedded on the application board. The design specifications and design requirements for each component will be broken up and discussed in more details in the next subsections of hardware design.

2.1 Microprocessor

The main function of our device is to display pictures. In order to do this, we would need a processor powerful enough to decode images from various formats and display them accordingly to an LCD. Another key feature of our product is its easy to use graphical user interface; a high speed processor would be required to achieve a smooth interface feel while using the device. Other features such as large storage, sound recording, sound playback, PC interface would need a multifunctional processor with all these control capabilities. So in looking for the main chip for our device, we have to keep in mind

these features and try to look for the hardware that would best support these requirements.

A certain kind of chip integration with micro-controllers can satisfy our needs; these chips are called SOC (System On Chip). We found several SOCs that could satisfy our requirements and they are shown on **Error! Reference source not found.** with their main features and key features.

Table 1: SOC Options (references: [1,2,3,4,5,7 and 8])

SOC	Main Features	Key Features
Portal Player PP5024	Dual 32-bit ARM7TDMI, 100MHz per core 128 KB SRAM, 8KB cache	LCD controller, TV output, Button I/O, Battery Charger, Audio I/O and Codec, USB 2.0 Host, SD/MMC Expandable Media
Sharp LH7A404	32-bit ARM9TDMI RISC core (up to 266MHz), 16KB 80KB SRAM	LCD controller, Touch Screen Controller, General I/O, Battery Monitor, Audio I/O and Codec, USB 2.0 Host, Smart Card Interface, Pulse Width Modulator, UART
Sharp LH7A400	32-bit ARM9TDMI RISC core (up to 250MHz), 16KB 80KB SRAM	LCD controller, General I/O, UART, Battery Monitor, Audio I/O and Codec, USB 2.0 Interface, Smart Card Interface
Hynix HMS30C7202	32-bit ARM720T 70 MHz core, 2KB Internal 32bit SRAM	LCD controller, Touch Screen Controller, USB interface, 8 pin General I/O, MMC SPI mode I/F CF interface PCMCIA bus interface, ADCx5ch 8bit DACx2ch
Equator BSP-16	16-bit RISC variable length co-processors, 32KB instructional cache	NTSC PAL high def output, MPEG decoder, Audio I/O 8 channel output, IDE interface, PCI bus, UART, serial I/O bus controller

Table 1 shows the SOCs that we found during our research; Table 1 is listed from top to bottom according to which chip we prefer the most. So, the top entry, which is the Portal Player PP5024, is our most preferred chip based on its features.

We picked our chip based on mainly three qualification factors: availability, affordability and the features we needed. As mentioned previously, the Portal Player chip has the best fit to the features that we needed. Unfortunately, when we tried to acquire a PP5024 development kit, we found out that they cost \$2500 with a \$500,000 commitment to buy more chips. Obviously, at this stage of development, we are in no position to go under this kind of deal. We then considered our second option; and luckily this time, there was a readily available development system for the Sharp LH7A404. The LH7A404 came in pre-built card engine that goes with its development board called the “Zoom SDK”. This development kit has most of the peripheral connectors that are supported features of the card engine. Among these peripherals are Ethernet, LCD, Audio In/Out, Compact Flash, USB Host, and USB device. The Zoom SDK also has a serial com port that can be used

as terminal communication tool for the software development stage. The LH7A404 card engine comes with an array of flash memory, EPROM, and SDRAM. The interconnectivities of the microprocessor with the various components in the card engine are shown in Figure 2.

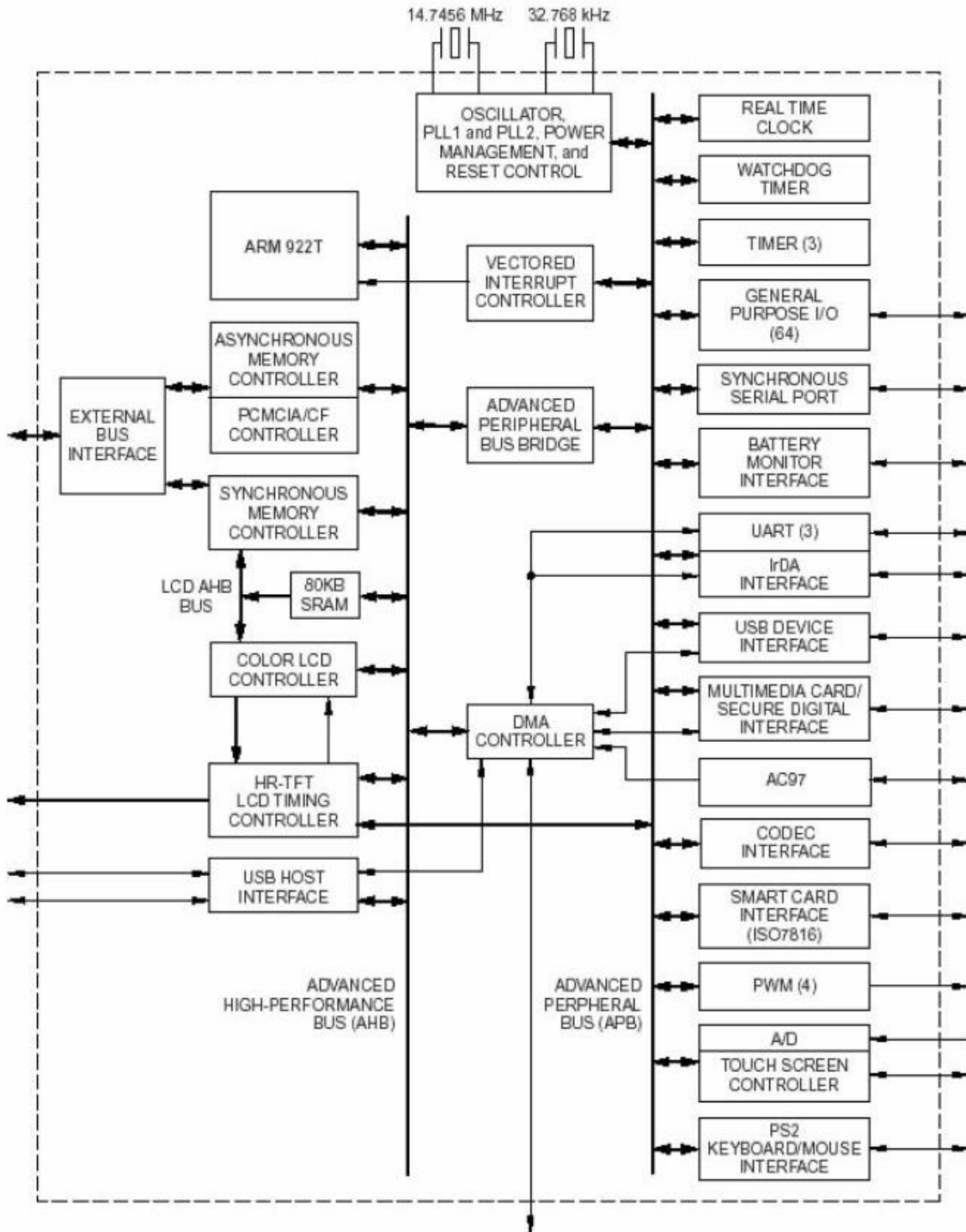


Figure 2: LH7A404 Card Engine Internal Architecture

The card engine flash memory sector 0 and sector 1 come preloaded with proprietary development software called the BootLoader™ and LogicLoader™ which are called BOLO and LOLO respectively. The BOLO being located at sector 0, which is the boot sector, will first be read by the processor. BOLO has the basic functions of a stripped down operating system; it has enough functions to be able to load a program or burn it onto the internal flash memory. BOLO reads a boot script and determines whether or not to proceed to a burned program or loads LOLO. LOLO is a more full fledged operating system with hardware test tools and UNIX type environment. The BOLO to LOLO boot process is described in the flowchart in Figure 3 [9].

It is also worthwhile to mention that this card engine has a low power consumption design. This SOC has power management control and power monitoring features which would be useful for such a handheld device. The core voltage of the processor is 1.8V and the rest of the IO peripherals are at 3.3 volts. This card engine has been rated to be able to sustain up to 5V before failing or becoming permanently broken.

2.2 Application Board

The application board we are using, the Zoom SDK, corresponds to the development kit that comes with the LH7A404 card engine. The Application Board has connections to all of the Card Engine specific peripherals via standard connectors or expansion headers. The Zoom SDK is composed of the following specifics in point form: [6]

- **LCD Display Connector** 60 pin integrated LCD, touch & backlight connector
- **Network Support** One RJ45 Ethernet jack (application/debug)
- **Audio** Stereo input and output jacks -3.5mm diameter
- **PC Card Expansion** Compact Flash Type 1
- **Serial Port** 115.2Kbps RS-232 debug serial port
- **USB** 1 Host and 1 Client port
- **Expansion Headers**
 - Standard 100 mil pitch header
 - Access to all Card Engine signals
- **Software**
 - Software Development Kits (SDK) available for Linux and Windows CE development depending on Card Engine MMU support
 - GNU cross development tools
- **Mechanical**
 - 4" (102 mm) long x 6" (152 mm) wide x .66" (16.8 mm) high

There are also several GPIO (General Purpose Input Output) pins exposed on the board surface for easy access and peripheral attachment. There is a reset button too on the board which could be really helpful during debugging and software development. This

application board can work as a good preliminary prototype for our actual device because of its size and the peripherals that come with it.

The only changes that we would make on the current application board going forward to the actual device motherboard would be trimming down the development peripherals that were provided for development. These would include the serial com port, the exposed GPIO pins, the Ethernet port, and the LCD connector pins. There some more tidying needed to be done here and there but generally, the size of the application board is about the size of the final product. Figure 4 shows our application board.

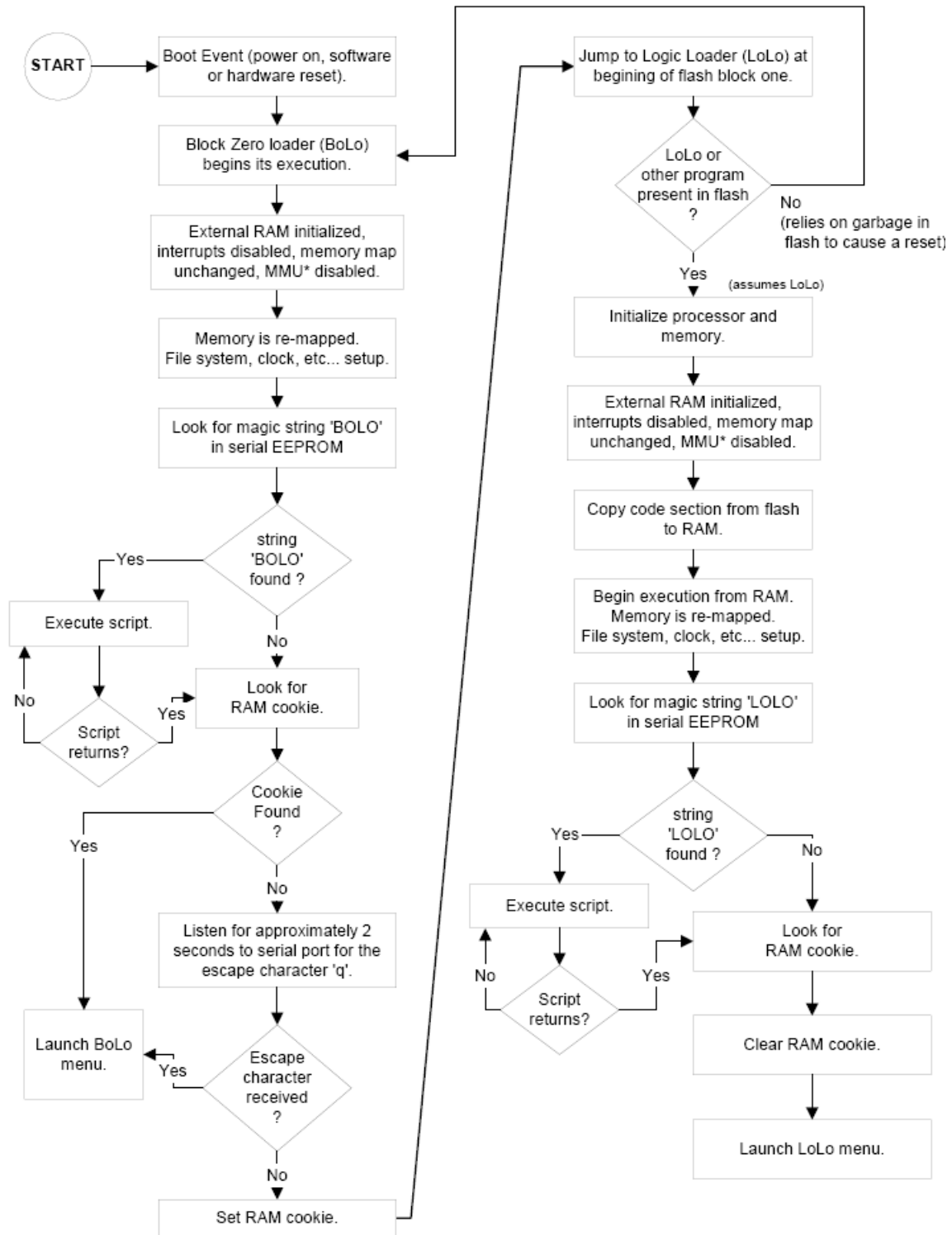


Figure 3: Card Engine Boot-Up Process

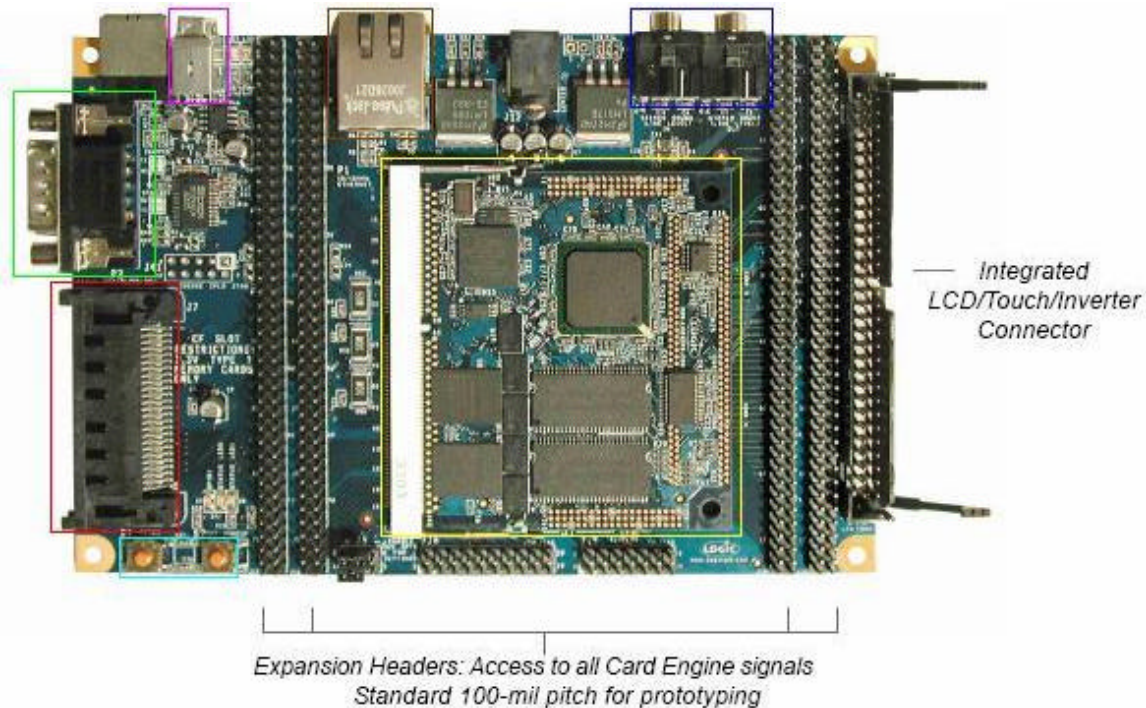


Figure 4: Sharp Zoom™ SDK Application Board

The multi-colored boxed components in Figure 4 highlights the various key components of this application board; these components are the following going clockwise: **reset and wakeup button**, **CF card slot**, **serial com port**, **USB port**, **Ethernet port**, **Audio input/output**, and **LH7404 card engine**. The other features of this board are already labeled clearly on the figure. This application board has 5V power supply.

2.3 LCD Screen

The advantage and also a feature of our product is its large viewable area through a 4"x6" LCD screen. In order to demonstrate the difference of viewing photos on a cell phone, PDA, or iPod from our proposed device, we are actually using a 4"x6" LCD screen. A high resolution screen would also be desirable in order to provide a more vivid rendition of the pictures. Also as part of our development, we chose an LCD screen that can be easily interfaced with our current hardware. The LCD screen that we have purchased also has touch screen capability; this only happened coincidentally that the most compatible LCD that we have found has this feature. This bonus feature in our hardware may or may not be part of the finalized device depending on the cost and usability factors of the touch screen in the finalized design. The image shown in Figure 5 is a picture from the manufacturer website showing how more or less the LCD screen actually looks like.



Figure 5: Display Kit LCD

This LCD screen has ribbon cable input so that it can be easily connected to a development board. It has 4:3 aspect ratio, 16 bit color, 140 left/right viewing angle, 110 up/down viewing angle, and 800x600 resolution.

The LCD we are going to use for the device would just be the screen with the specified screen area, without the aluminum case shown in Figure 5. And as mentioned before, the touch screen might or might not be implemented. There should also be a thin plastic on top of the LCD to protect it from scratches and at the same time it is thin enough and transparent enough so that it does not affect the output [11].

2.4 Hard Drive

The hard drive we are going to use should be small, has a big storage capacity and be energy saving as part of the key features of our product. The hard drive we are going to use for the final product will be the ST1 series hard drives made by Seagate. This hard drive is a one inch micro-HD that has a maximum capacity of 8GB. Other important specification of this hard drive is outlined as follows [10].

- Time-to-ready in 1.2 seconds
- Supports low-power modes
- Size only 42.8 x 36.4 x 5 mm

- Weighs only 19 grams (2/3 ounce)
- ATA Flex and CompactFlash interface

This hard drive also has high tolerance to shock and vibration; this would be beneficial for a portable device that can be dropped or used in moving environment such as being in a car or an airplane. Since our device was made to be portable, it will take advantage of this technology by Seagate. An actual size picture of the ST1 hard drive was taken from the Seagate website and is as shown in Figure 6.



Figure 6: Seagate ST1 Series One-inch Hard Drive

2.5 Control Hardware (Buttons)

The control hardware is mainly the buttons that will be used by the user to control this device. The touch screen capability of our LCD display may or may not be implemented depending on usability and more detailed production cost analysis, they are both to be done later on. In the analysis of our device features, we have determined that we would only need four buttons in order to fully control this device. The function of these buttons will be the following: **[Scroll up]**, **[Scroll down]**, **[Enter]**, and **[Back]**. A brief description of these functions is outlined as follows.

- **[Scroll up]** – for scrolling up, it moves the selection cursor up or from right to left
- **[Scroll down]** – for scrolling down, it moves the selection cursor down or from left to right
- **[Enter]** – used for selecting an item, a menu, or an option; when selecting a menu it brings the user to a submenu
- **[Back]** – used for canceling or going back one menu

There are two ways we thought of implementing these buttons. One way was to have four separate buttons for each. The other way was to have a scroll wheel that can be pushed in for the **[Enter]** function and a separate button for the **[Back]** function. We were also thinking that implementing it both ways might not be a bad idea because some people hate the scroll wheel while others love it; and since implementing the extra buttons will not cost that much more, it might actually be an advantage this way. Figure 7 shows how these buttons will more or less look like.



Figure 7: Scroll Wheel and Back Button

The scroll wheel diameter is $\frac{1}{2}$ inch long and the thickness of the wheel should be $\frac{1}{8}$ inch. The back button dimensions should be $\frac{1}{8}$ by $\frac{1}{8}$, square like with rounded edges. For the design with just four buttons, all four will be just like the back button described above. An alternate design we are considering is for the buttons to look more elongated; the height would be $\frac{1}{8}$ inch and the length would be $\frac{1}{4}$ inch. All the buttons will be made of plastic with rubber pads on the other end for the actual button trigger.

2.6 Power Supply, Enclosing, and Aesthetics

Our current power supply is a 110V AC adapter that goes to the wall socket; its output is 5.5V at a max of 3.8A. Our final product, we would be using a battery in order for the device to be portable. Of course the device would need to recharge sometime, so the same adapter specification would work on this device. Since our board operates at 5V, the minimum power that our battery has to supply 5V. But due to voltage drops during loading and other factors such as initial battery drain and so on, our battery would have 5.5V and a minimum of 1000mAh of battery life for long lasting photo viewing without having to recharge. The battery content would be preferably *lithium* or *nickel metal hydride* because these are the standard battery composition of most portable device. Using already available battery technology would save us research and development time and cost; using commonly used battery technology also means that there are many available suppliers competing for the same market which would mean competitive prices and lower cost for us. The battery can be recharged about 500 times, that is equivalent of charging and discharging the battery for about 1.5 years every day. The battery should look like Figure 8 close to the actual height and length; the width of the battery would be about $\frac{1}{4}$ of an inch.



Figure 8: Battery Mock Up (height = 2in and length =2.65in)

The overall enclosure of the Digital Photo Album will be nice and smooth with rounded edges all over. The case will have a hole in the middle for the LCD screen; there will also be holes on the sides for the buttons, for the power adapter, for the audio input/output, and also for the memory card input. The battery will be internally implemented and as of now, we have decided not to allow the user to change the battery. The cases will be available in black and white for now and we are still considering other colors that could go with our device that would maintain the products stylishness and integrity of the overall appearance. The overall dimensions of this device will be between 5"x7"x3/4" and 5"x7"x1/2" depending on how much integration can be done with the electronic circuit. The case will be made of high quality durable plastic with proper fittings internally that will hold the circuit and the LCD screen securely. Figure 9 shows a sketch of our device enclosure. Note that 0.5 inches were taken off from the length and height of the device; we estimated that it would that much space for the curvature of the device.

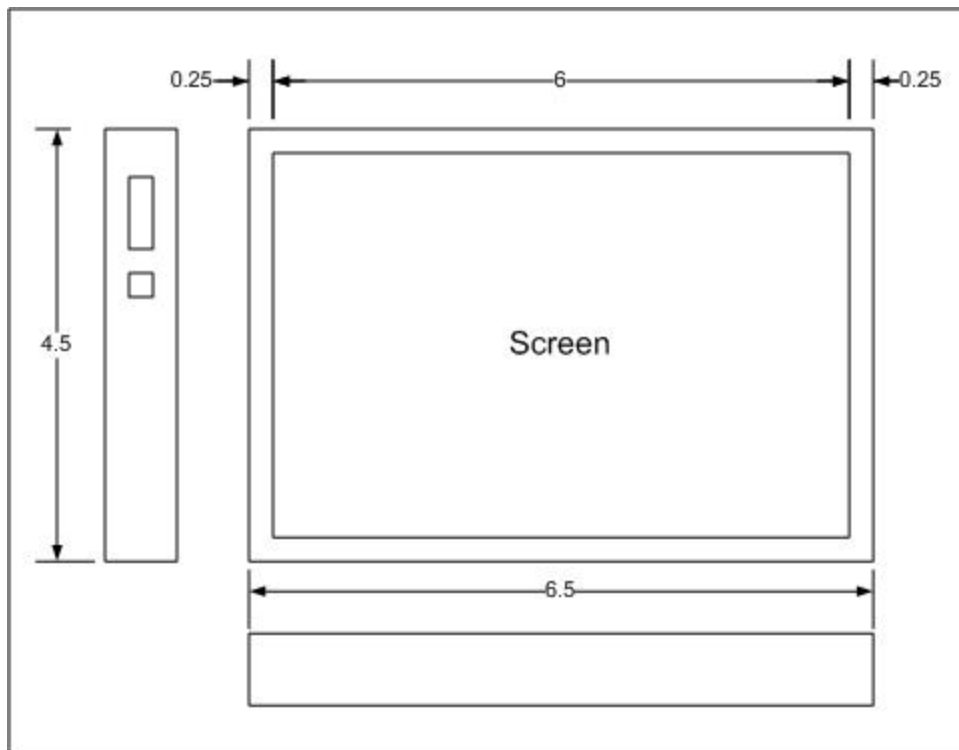


Figure 9: The Device Mock up

3 Software Design

Along with the controls, the software will provide the key interface between the user and the hardware. The software design section will be divided into high and low level designs. The key to the high level design is to hide the low level aspects of our device in order to provide a consumer friendly product.

3.1 High Level Design

This section will look at the design of our software from the perspective of a user. It describes how the user will view and interact with our device. The user interface and the controls of our device will be in focus. High level design will describe in detail how we will meet the functional requirements for our device.

This section will make references to the following controls: **[Scroll Up]**, **[Scroll Down]**, **[Enter]**, **[Back]**.

The software will be built as a hierarchy with limited depth. The overall structure of the software can be seen in the following figure. Each unit in the hierarchy will be described in the subsequent sections.

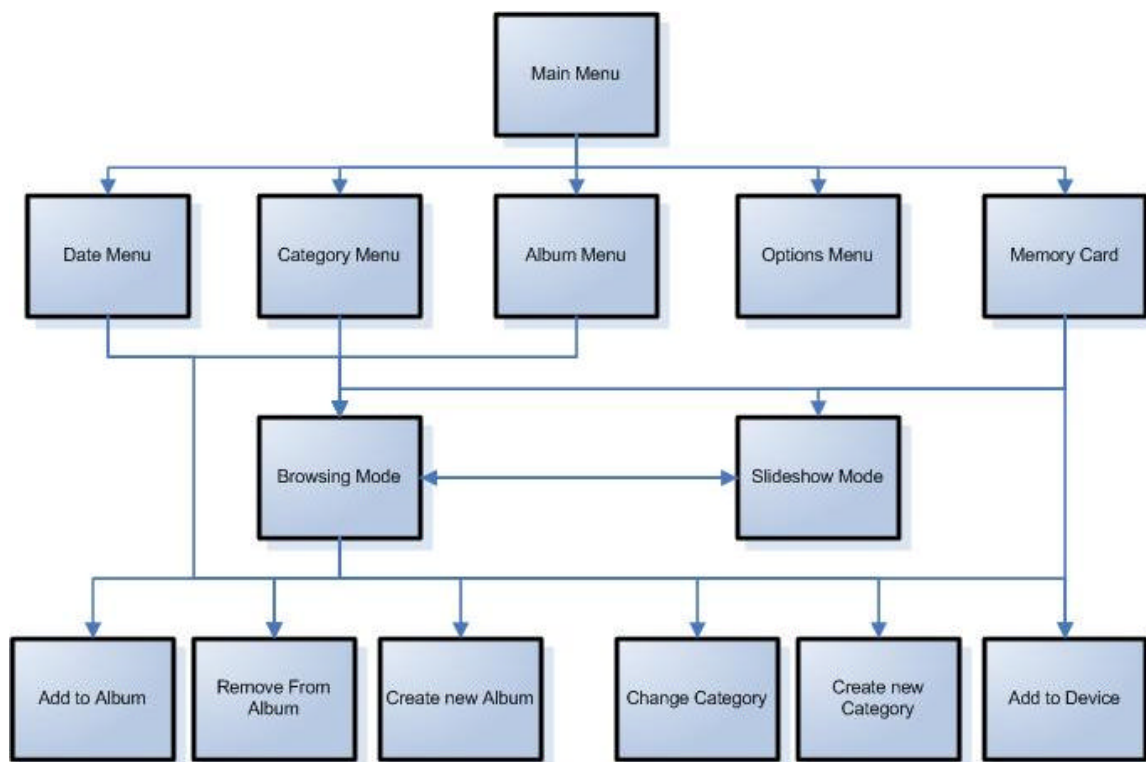


Figure 10: Software Hierarchy.

3.1.1 Main Menu

The main menu acts as the top level of our software structure and it can be reached from anywhere within the software by pressing **[Back]** one or more times. At the main menu, the screen is as show in Figure 10.

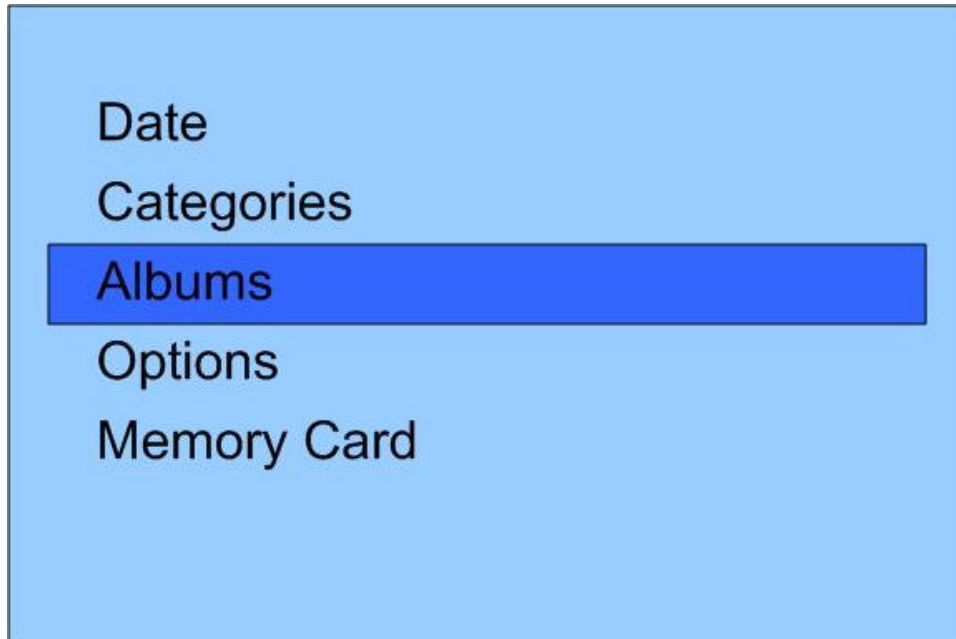


Figure 11: Main Menu Screen

The controls interact with the main menu as described by the following table.

Table 2: Main Menu Controls

Control	Action
[Scroll Up]	Highlights the menu option above the current selection. No action if the current selection is the top menu item.
[Scroll Down]	Highlights the menu option below the current selection. No action if the current selection is the bottom menu item.
[Enter]	Enters the menu of the current highlighted menu item.
[Back]	No action.

3.1.2 Date Menu

The date menu is displayed on screen when the date option is selected from the main menu. This screen organizes all the photos stored on the device by the date they were taken. A thumbnail picture from a photo in a specific date is displayed when that date is highlighted. The following figure is a mockup of the displayed screen.

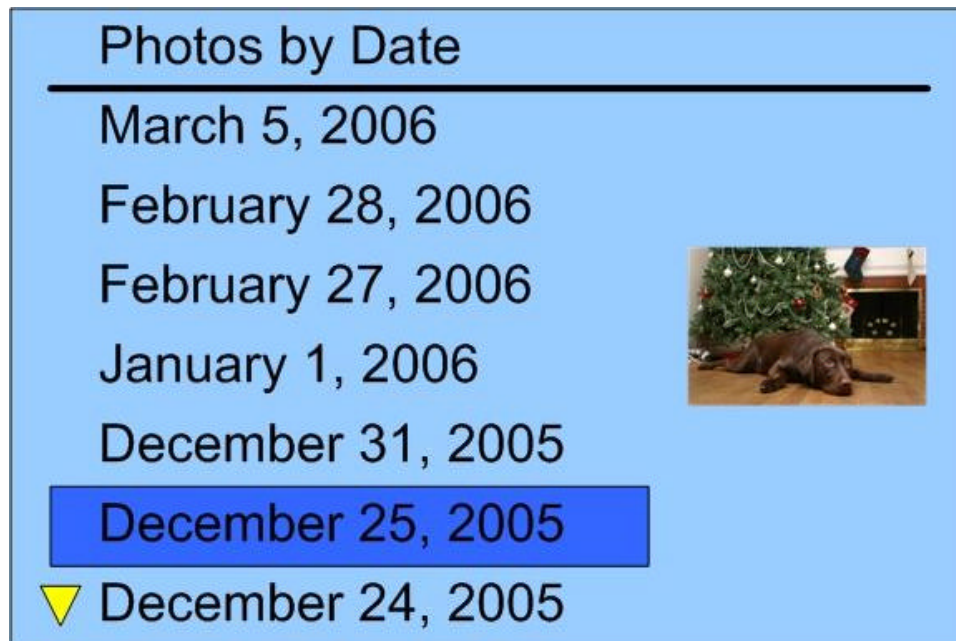


Figure 12: Date Menu Display

One difference to note between most menus and the main menu is that these menus can scroll due to the number of options.

The functions of the controls while in this screen are described in the following table.

Table 3: Screen Menu Controls

Control	Action
[Scroll Up]	Highlights the date above the current selection. No action if the current selection is the top date.
[Scroll Down]	Highlights the date below the current selection. No action if the current selection is the bottom date.
[Enter]	Brings up a menu of actions for the highlighted date.
[Back]	Return to main menu.

Unlike the main menu where pressing [Enter] takes you to a new screen, pressing [Enter] on a highlighted date brings up a submenu. Submenus will be used in other

circumstances and they all have the same control scheme as described in the following table.

Table 4: Submenu Controls

Control	Action
[Scroll Up]	Highlights the menu option above the current selection. No action if the current selection is the top menu item.
[Scroll Down]	Highlights the menu option below the current selection. No action if the current selection is the bottom menu item.
[Enter]	Executes the highlighted action
[Back]	Close the Submenu.

Opening the submenu for a selected date brings up the following options. The bold option signifies the default highlighted option.

Table 5: Date Submenu Options

Options	Actions
Start Slideshow	Begins full screen viewing of the photos.
Open	Enters browsing for the group of photos for that date.
Add to Album	Enters "Add to Album" menu
Change Category	Enters "Change Category" Menu
Copy to Memory Card	Copies all photos from selected date to memory card after confirmation.
Delete All	Deletes all photos from selected date after confirmation.
Play Audio	Option available if an audio clip has been associated with this date
View Text	Option available if a text note has been associated with this date
Record Audio	Record Audio note to associate with this date

The following figure shows how submenus appear throughout our user interface.

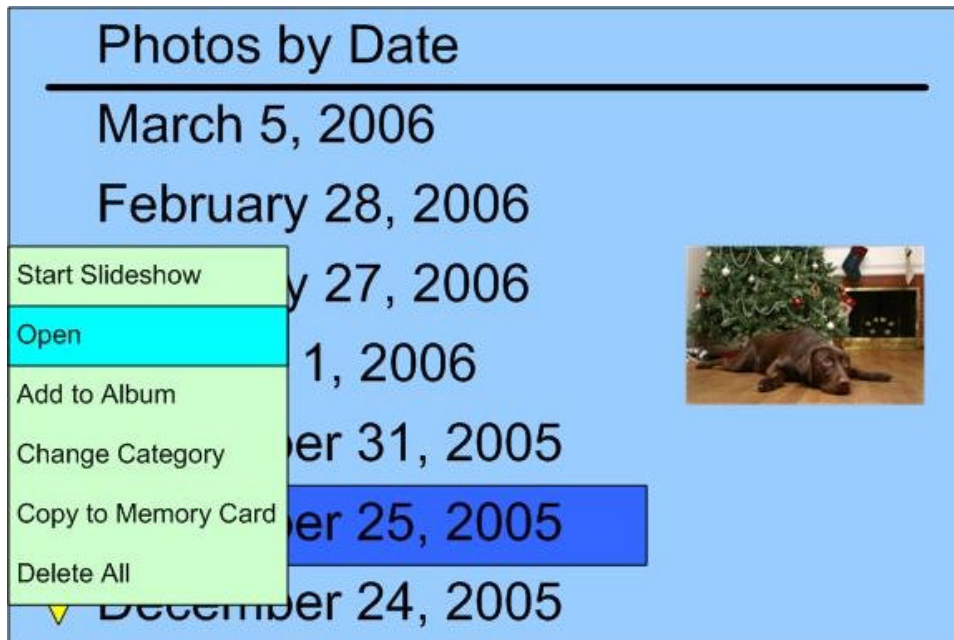


Figure 13: Submenu Screen

3.1.3 Category Menu

The Category Menu is displayed when Categories is selected from the main menu. Every photo stored on the device is assigned category when first copied on. The following figure is a mockup of the displayed screen.

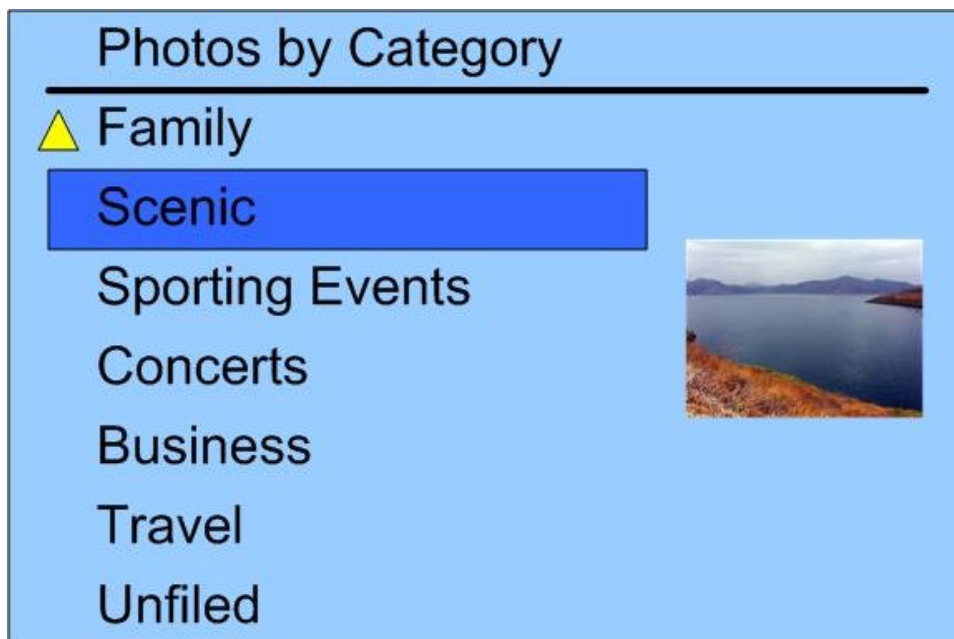


Figure 14: Category Menu Screen

As with the Date Menu Screen, a thumbnail of a picture from each category is displayed when the category is highlighted. Controls are also similar, and are described in the following table.

Table 6: Category Menu Controls

Control	Action
[Scroll Up]	Highlights the category above the current selection. No action if the current selection is the top category.
[Scroll Down]	Highlights the category below the current selection. No action if the current selection is the bottom category.
[Enter]	Brings up a menu of actions for the highlighted category.
[Back]	Return to main menu.

The controls for the submenu of actions when pressing [Enter] on a category can be referenced in Table 7. The submenu for categories contains the options described in Table 7. The default option is in bold.

Table 7: Category Submenu Options

Options	Actions
Start Slideshow	Begins full screen viewing of the photos.
Open	Enters browsing for the group of photos for that category.
Add to Album	Enters "Add to Album" menu
Change Category	Enters "Change Category" Menu
Copy to Memory Card	Copies all photos from selected category to memory card after confirmation.
Delete Category	Deletes the category and places all photos under the Unfiled category after confirmation.
Delete All	Deletes all photos from selected category after confirmation.
Play Audio	Option available if an audio clip has been associated with this Category
View Text	Option available if a text note has been associated with this Category
Record Audio	Record Audio note to associate with this Category

3.1.4 Album Menu

The Album Menu is displayed when Albums is selected from the Main Menu. Albums allow users to create customized groupings of photos. Any photo on the device can belong to one or more albums, or non at all. The following figure is a mockup of the displayed screen.



Figure 15: Album Menu Screen

A thumbnail of a picture from each album is displayed when the album name is highlighted. Controls are described in the following table.

Table 8: Album Menu Controls

Control	Action
[Scroll Up]	Highlights the album above the current selection. No action if the current selection is the top album.
[Scroll Down]	Highlights the album below the current selection. No action if the current selection is the bottom album.
[Enter]	Brings up a menu of actions for the highlighted album.
[Back]	Return to main menu.

The next table describes the submenu that appears when pressing **[Enter]** on a highlighted album.

Table 9: Album Submenu Options

Options	Actions
Start Slideshow	Begins full screen viewing of the photos.
Open	Enters browsing for the group of photos for that Album.
Add to Album	Enters “Add to Album” Menu.
Change Category	Enters “Change Category” Menu
Copy to Memory Card	Copies all photos from selected album to memory card after confirmation.
Delete Album	Deletes the album but not the pictures contained in the album after confirmation.
Delete All	Deletes all photos from selected album and the album itself after confirmation.
Play Audio	Option available if an audio clip has been associated with this Album
View Text	Option available if a text note has been associated with this Album
Record Audio	Record Audio note to associate with this Album

3.1.5 Options Menu

The Options menu provides one consistent interface for allowing a user to adjust all available settings.

On the screen, you see the name of each setting down the left hand side along with what it is currently set at down the right hand side. The controls while in this screen as described in the following table.

Table 10: Options Menu Controls

Control	Action
[Scroll Up]	Highlights the setting above the current selection. No action if the current selection is the top setting.
[Scroll Down]	Highlights the setting below the current selection. No action if the current selection is the bottom settings.
[Enter]	Brings up a menu of available options for the highlighted setting.
[Back]	Return to Main Menu.

Every setting will have two or more options it can be set at. When pressing **[Enter]** on a setting, the controls for the menu that appears is as given in the following table.

Table 11: Settings Selection Controls

Control	Action
[Scroll Up]	Highlights the option above the current selection. No action if the current selection is the top menu option.
[Scroll Down]	Highlights the option below the current selection. No action if the current selection is the bottom option.
[Enter]	Sets the current option and closes the menu.
[Back]	Closes the menu.

The following table lists the settings that are available to a user and what options are available for each setting.

Table 12: Settings and Options

Setting	Options
Backlight	On Off
Contrast	1 2 3 4 5 6 7 8 9 10
Automatic Transitions	Off 3 Seconds 5 Seconds 10 Seconds
Auto-off	Off 30 Seconds 1 Minute 2 Minutes
Sort by Date	Oldest First Newest First

3.1.6 Memory Card Menu

Different digital cameras store files differently on memory cards, however, the majority of devices have a two level hierarchy. The top level contains one or more folders, and all the photographs are contained the next level down within one of those photographs. When entering the Memory Card Menu, users view a list of options available to them that mirrors this file structure. The following figure is a mockup of a potential displayed screen for the Memory Card Menu.

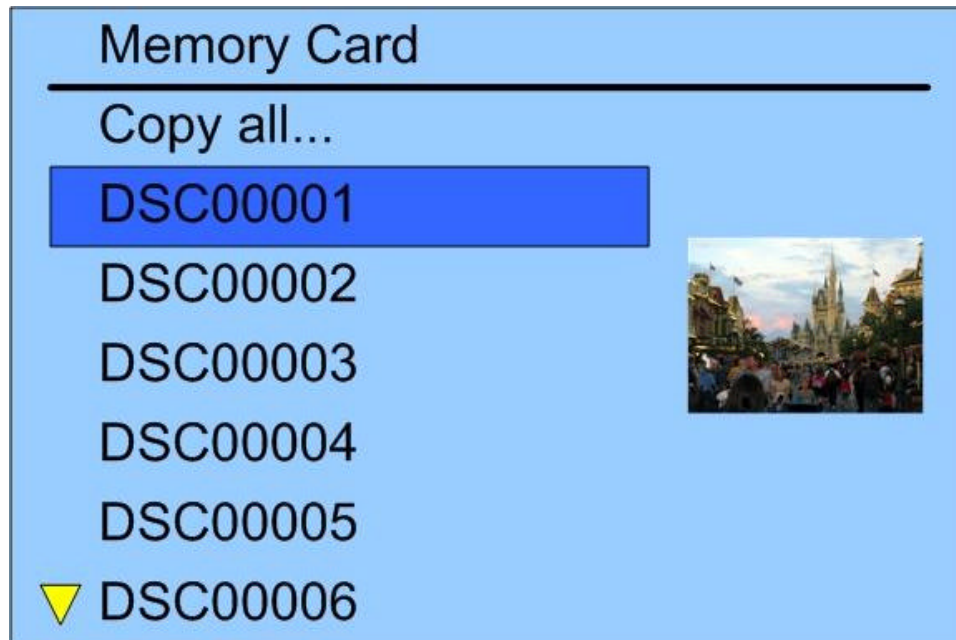


Figure 16: Memory Card Menu

While in this menu the controls for the device are given in the following table.

Table 13: Options Menu Controls

Control	Action
[Scroll Up]	Highlights the item above the current selection. No action if the current selection is the top item.
[Scroll Down]	Highlights the item below the current selection. No action if the current selection is the bottom item.
[Enter]	Brings up a menu of available options for the highlighted item. Enters Copy to Device Menu is "Copy All to Device" is selected.
[Back]	Return to Main Menu.

The submenu that appears after pressing **[Enter]** on a selected item is described in the following table.

Table 14: Memory Card Submenu Options

Options	Actions
Start Slideshow	Begins full screen viewing of the photos.
Open	Enters browsing for the group of photos contained in the folder.
Copy to Device	Enters the Copy to Device Menu.
Delete All	Deletes all photos from selected folder after confirmation.

3.1.7 Browsing Mode

From Date, Categories, Albums or Memory Card, a selected grouping of photos can enter browsing mode. In Browsing Mode, the group of photos is presented on screen as thumbnails, such that multiple photos can be seen on screen at the same time. The following figure is a mockup of the displayed screen.



Figure 17: Browsing Mode Screen

Scrolling in Browsing Mode moves left and right first, then up and down at the beginning and end of each row. The controls for Browsing Mode are described in the following table.

Table 15: Browsing Mode Controls

Control	Action
[Scroll Up]	Highlights the photo to the left of the current selection. If the current selection is the leftmost photo in its row, the highlighted photo becomes the rightmost photo in the row above. If this is also the top row, no action occurs.
[Scroll Down]	Highlights the photo to the right of the current selection. If the current selection is the rightmost photo in its row, the highlighted photo becomes the leftmost photo of the row below. If this is also the bottom row, no action occurs.
[Enter]	Brings up a menu of available options for the highlighted Photo.
[Back]	Return to the previous menu.

Similar to many of the menus, pressing **[Enter]** on a highlighted photo brings up a submenu of actions available to the user. These actions are described in the following Table.

Table 16: Browsing Submenu Options

Options	Actions
Open	Starts the slideshow at the highlighted photo.
Add to Album	Enters "Add to Album" Menu.
Remove from Album	Enters "Remove from Album" Menu.
Change Category	Enters "Change Category" Menu.
Copy to Memory Card	Copies the highlighted photo to an inserted memory card after confirmation.
Delete	Deletes the highlighted photo from the device after confirmation.
Play Audio	Option available if an audio clip has been associated with this Photo
View Text	Option available if a text note has been associated with this Photo
Record Audio	Record Audio note to associate with this Photo

3.1.8 Slideshow Mode

Slideshow Mode can be entered through a variety of means, and can even start in the middle of a group of photos. In Slideshow Mode, photos are viewed full screen. The following figure is a mockup of the displayed screen.



Figure 18: Slideshow Mode Screen

You will notice the overlay with information regarding the photo. This can be turned on and off and can display a variety of information regarding the photo stored on the picture file by the Camera that took the photo. The following table describes how the controls interact in Slideshow Mode.

Table 17: Slideshow Mode Controls

Control	Action
[Scroll Up]	Changes the screen to the previous photo in the grouping. No action if this is the first photo.
[Scroll Down]	Changes the screen to the next photo in the grouping. No action if this is the last photo.
[Enter]	Toggles the information overlay. Information available depends on the camera the photo was taken with.
[Back]	Return to Browsing Mode.

3.1.9 Add to Album

Whenever one or more photos are selected to be added to an album, the user is presented with the following screen.



Figure 19: Add to Album Screen

This screen gives the user a list of all albums on the device as well as an option to create a new album. While at this screen, the controls are as follows.

Table 18: Add to Album Controls

Control	Action
[Scroll Up]	Highlights the option above the current selection. No action if this is the top option.
[Scroll Down]	Highlights the option below the current selection. No action if this is the bottom option.
[Enter]	Adds the selected photo(s) to the highlighted album and returns to the Previous screen. Enters Create New Album if "New..." is selected.
[Back]	Return to Previous screen.

Choosing to create a new album will bring the device to a new screen in order to name the new album.

3.1.10 Create New Album

After choosing to create a new album, the user must name the album. The following figure is a mockup of the displayed screen.



Figure 20: Create New Album Screen.

Naming the album requires picking letters one at a time and selecting “Done” when complete. The following table describes the controls at this screen.

Table 19: Create New Album Controls

Control	Action
[Scroll Up]	Scrolls to the previous letter in the alphabet, symbol, “Done”, or Backspace.
[Scroll Down]	Scrolls to the next letter in the alphabet, symbol, “Done”, or Backspace.
[Enter]	Selects the current letter and moves on to the next letter. Completes the title if “Done” is selected. Returns to the previous letter if Backspace is selected.
[Back]	Acts like Backspace and returns to the previous letter. If currently at the first letter, Returns to Previous Screen.

Once “Done” is selected, the new album is created and the selected photo(s) are added to the new album.

3.1.11 Remove from Album

When a photo has been selected to be removed from a certain album, the user is presented with the following screen.



Figure 21: Remove from Album Screen

The screen lists all the Albums the selected photo is a part of. From here, the user may select the album she would like to remove the photo from. The controls on the screen are as follows.

Table 20: Remove From Album Controls

Control	Action
[Scroll Up]	Highlights the album above the current selection. No action if the current selection is the top album.
[Scroll Down]	Highlights the album below the current selection. No action if the current selection is the bottom album.
[Enter]	Removes the photo from the highlighted album after confirmation.
[Back]	Returns to the previous screen.

3.1.12 Change Category

Whenever one or more photos are selected to have their category changed, the user is presented with the following screen.



Figure 22: Change Category Screen

This screen gives the user a list of all categories on the device as well as an option to create a new category. While at this screen, the controls are as follows.

Table 21: Change Category Controls

Control	Action
[Scroll Up]	Highlights the option above the current selection. No action if this is the top option.
[Scroll Down]	Highlights the option below the current selection. No action if this is the bottom option.
[Enter]	Moves the selected photo(s) to the highlighted category and returns to the Previous screen. Enters Create New Category if "New..." is selected.
[Back]	Return to Previous screen.

Choosing to create a new category will bring the device to a new screen in order to name the new category.

3.1.13 Create New Category

After choosing to create a new category, the user must name the category. The following figure is a mockup of the displayed screen.

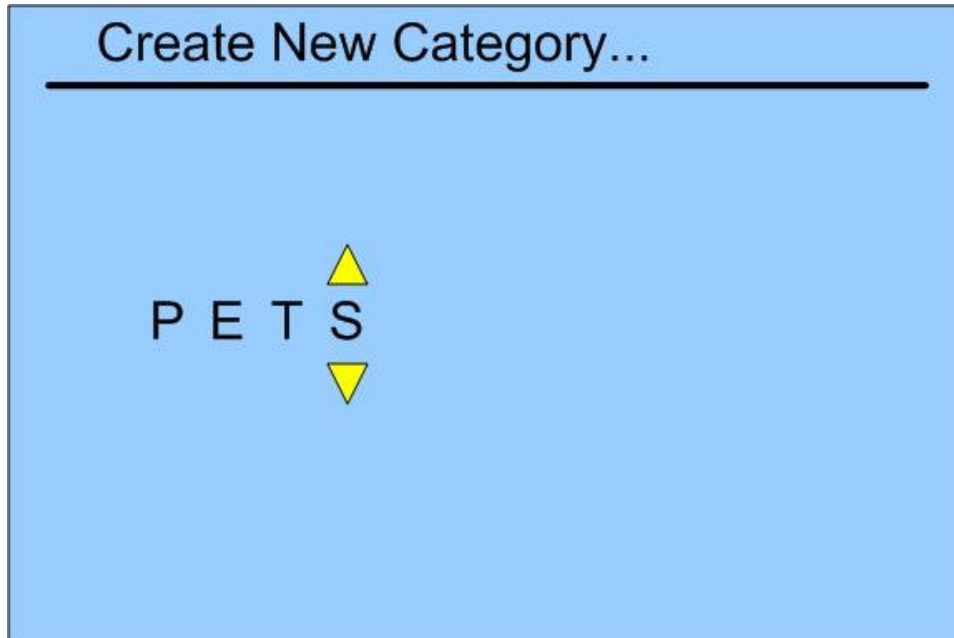


Figure 23: Create New Category Screen.

Naming the category requires picking letters one at a time and selecting “Done” when complete. The following table describes the controls at this screen.

Table 22: Create New Category Controls

Control	Action
[Scroll Up]	Scrolls to the previous letter in the alphabet, symbol, “Done”, or Backspace.
[Scroll Down]	Scrolls to the next letter in the alphabet, symbol, “Done”, or Backspace.
[Enter]	Selects the current letter and moves on to the next letter. Completes the title if “Done” is selected. Returns to the previous letter if Backspace is selected.
[Back]	Acts like Backspace and returns to the previous letter. If currently at the first letter, Returns to Previous Screen.

Once “Done” is selected, the new category is created and the selected photo(s) are moved to the new category.

3.1.14 Copy to Device Menu

One or more photos can be copied to the device from a memory card. When this action occurs, the user must first choose a category to add the photos into. In that sense, copying photos onto the device is much like changing the categories for existing photos. The following is a mockup of the screen a user would see when copying photos onto the device.



Figure 24: Copy to Device Screen

When at this screen, the device controls operate as described in the following table.

Table 23: Copy to Device Controls

Control	Action
[Scroll Up]	Highlights the option above the current selection. No action if this is the top option.
[Scroll Down]	Highlights the option below the current selection. No action if this is the bottom option.
[Enter]	Adds the selected photo(s) to the highlighted category and returns to the Previous screen. Enters Create New Category if “New...” is selected.
[Back]	Return to Previous screen.

If a new category is desired, the user is taken to the Create New Category screen and the photos are added onto the device in the new category.

Whenever photos are copied onto the device, the user will be given a confirmation screen asking whether they would now like to delete the photos from the memory card.

3.1.15 Confirmation

Many of the actions, particularly the ones that deal with deletion, require confirmation from the user before the action proceeds. The following is a mockup of a potential confirmation screen.



Figure 25: Confirmation Screen.

Confirmation screens provide a question of confirmation, such as “Are you sure you would like to delete the selected photo?” Questions are followed by two potential responses, such as “Yes, delete the photo. / No, do not delete.” Responses will always provide a short descriptor of what action (or inaction) corresponds with that response.

Along with the question and answers, information regarding the decision will also be displayed on screen if applicable. This can include information such as whether the photo will be permanently lost, as well as a thumbnail of a photo in question. Controls on this screen are as described in the following table.

Table 24: Confirmation Controls

Control	Action
[Scroll Up]	Highlights the answer currently not highlighted.
[Scroll Down]	Highlights the answer currently not highlighted.
[Enter]	Executes the action corresponding to the current highlighted option.
[Back]	Returns to the previous screen.

3.2 Low Level Design

The low level design deals with all the underpinnings between what the user sees and does and how that will actually interact with hardware. We have identified three major hurdles in the interaction between our device software design and the hardware. The following sections will discuss these topics.

3.2.1 Screen Output

Since the device is going to use Windows CE as its operating system, anytime the word kernel is used it refers to Windows CE running on the device.

Most of user interactions with the Digital Photo Album will result in a photo or some kind of instruction to be displayed on the display LCD. A C Language module will be responsible for that. The module will have several parameters including the file location, type, location on the screen, and more. It will use C Library system calls along with the parameters to display the screen output.

3.2.2 Button Handling

The concept behind button handling is very similar to the keyboard for PCs. Anytime a button is pushed by the user, an interrupt is generated. Accordingly, the interrupt handler is invoked and is run by the kernel. Most of the user interactions will result in displaying a photo or some kind of instruction on the screen. Therefore, the interrupt handler will need to call the display module either directly or indirectly. The scheduling of the processes is done by the kernel of Windows CE.

3.2.3 File System

Again since we are using Windows CE, the file system will be similar to the one in other Windows operating systems such as XP. The parent node will have a node underneath which will be the hard drive and another optional node which will be the flash card. The hard drive could contain several folders representing the albums of the user. Because, logically a user should not have an album inside another album, all albums or folders should be at the node right below the hard drive node. This means that all the nodes below the album nodes will be photo files. In other words, there will be no folders inside folders. Deleting an album will result in deleting the corresponding folder from the hierarchy and all photo files underneath that folder.

4 Test Plan

The steps to which the major design parts are tested for both the hardware and software are described in the following sections. Note that for future reference a sample size will be specified for the test plans in order to ensure stability. Finally, the results of each test plan are evaluated as pass or fail.

4.1 Hardware

Major components and areas tested for the hardware will include power, battery life, boot, CPU, connections, LCD display, and navigation buttons.

4.1.1 Power Verification

To verify the right power is supplied to the hardware the following procedures are to be performed by the test engineer:

1. Create power nodes for the adapter cord
2. Connect a DMM to the power node and verify the minimum power supply is 5V, we should also create a virtual load and make sure that the current and power specifications are met too.

The power verification test is very important and needs to be passed to perform some of the other tests.

4.1.2 Battery Life

To perform the battery life test the power verification test has to be passed first. To verify the battery can sustain the specified life cycles under different circumstances, the following sets of tasks are to be performed by the test engineer:

1. Life Cycle on Standby
 - i. Turn on the device and wait for standby mode
 - ii. Leave the device in standby mode for 7days
2. Life Cycle on Maximum Usage
 - i. Turn on the device
 - ii. Repeat a set of tasks (e.g. Turn the LCD backlight on and off) for 12 hours (This task is ideally done by a machine or a dedicated software)

The battery life of both sets is checked and must satisfy the specified testing time.

4.1.3 Boot

The device has to boot and be ready to go within a certain time period, to ensure this the following tasks are to be performed by the test engineer:

1. Cold boot the device and time the time it requires to fully boot: maximum 15 seconds
2. Do a regular boot on the device and time the time it requires to fully boot: maximum 5 seconds

The boot time has to be within both time specifications to be considered passed for this test.

4.1.4 CPU Clock Speed

It is crucial that the CPU clock speed is fast enough to perform the device's desired operations, to ensure this the following are performed by the test engineer:

1. Using the benchmark built into the device, run a loop counter for 1 second.
2. Compare the loop counter value to verify the clock runs at 200Mhz within acceptable error range

If the value is within the error range the test is passed

4.1.5 Connection Verification

There are various connections on the device that has to be functional including the adapter cord, CF card slot, and USB port. Since power and connection are closely interrelated the power tests has to pass before performing the connection verification. The following sets of tasks are then to be performed by the test engineer:

1. Adapter Cord
 - i. Connect the adapter cord to the wall socket and to the device
 - ii. Check the power nodes to see if the right voltage is present
2. CF Slot
 - i. Insert the CF card
 - ii. Read a file from the card
 - iii. Eject the card and repeat steps i and ii for 10,000 times
3. USB port
 - i. Connect a USB device (e.g. an USB flash disk)
 - ii. Read from the flash disk or verify the device has recognized the USB device
 - iii. Unplug the USB device and repeat steps i and ii for 10,000 times

All three connection types has to be passed for the connection verification test to be considered fully passed.

4.1.6 LCD Display

The LCD is tested to see if the desired image can be displayed properly with all the main pixels working. The following are performed by the test engineer:

1. Load a sample picture with most commonly used RGB colors
2. Check for significant dead pixels that would hinder the picture as a whole

Small flaws are allowed but significant errors that hinder the display as whole will not be considered as pass.

4.1.7 Navigation Buttons

The navigation buttons on the device has to sustain a certain amount of usage. The following are to be performed by the test engineer:

1. Scroll
 - i. Scroll the button up 100,000 times and down 100,000 times
2. Buttons
 - i. Click / press on the button 100,000 times (ideally this is performed by a dedicated machine)
 - ii. Repeat i for each of the buttons

Both of the above has to pass before the navigation button test is considered passed.

4.2 Software

4.2.1 Low Level

A program will be written to test the file structure integrity. For example when copying a file to another location, the program has to test to see if nothing is left behind and the file is completely copied to its desired destination. Several other areas will be tested to make sure the lower level of the software is rightfully performing its task

4.2.2 High Level

Different test cases will be constructed to test the different categories and menu branches that are programmed into the device. These test cases will each have a specific flow of instructions the test engineer follows. An example is shown below.

Main Menu → Categories Menu → Unfiled Category → Start Slideshow → Return to Main Menu

Each of the test cases has to be passed before the whole section is considered passed.

5 Conclusion

Imago Solutions is committed to innovating and focused on creating smart solutions for day to day problems. For our first line of product, we are trying to make photo viewing a more comfortable and luxurious experience that you can take anywhere you go. The design specifications in this document are intended to fulfill our proposed functions in the functional specs. The main focus of our designs and functions were to make a photo viewing album as user friendly as possible but at the same time fulfilling its ultimate purpose—making photo viewing a better experience. In this design specification document, we believe we have met these requirements and we are looking forward to implementing a successful product.

6 Referenced Documents

- [1] PP5024 Digital media management system-on-chip
http://www.portalplayer.com/products/documents/5024_Brief_Mar05.pdf
- [2] Product Information Sharp: LH7A404 System-on-Chip
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