E-Music Performance System

Project Proposal

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1.0 Introduction

1.1 Statement of Purpose

Printing costs for a large marching band get out of control, and managing a large repertoire of sheet music can be difficult for a performer in a marching band setting. An e-reader suited for the marching band would tackle both of these problems; no printing and the ability to easily and quickly manage a large amount of music. Also, it can be hard to hear a conductor's commands during a loud sporting event. Commands to turn to a specific page, or to play louder or softer can often be difficult to audibly convey. These functions can be implemented into the device, making it more than just an e-reader and more of a complete e-music-performance system.

1.2.1 Goals

1. Make a cheap, light, yet durable e-reader to display music to performers
2. Re-writable memory so music can be erased and updated
3. Give conductor the ability to communicate with performers by text, and automatically turn all performers' e-readers to the same page

1.2.2 Functions:

1. E-paper screen displays electronic sheet music
2. Flash memory to store electronic music files
3. Wireless remote to allow conductor to transmit information to performers
4. Interface with computer which allows wireless remote to transmit new music from computer to performers
5. Push-button interface for page turning in-performance
6. Battery powered

1.2.3 Benefits:

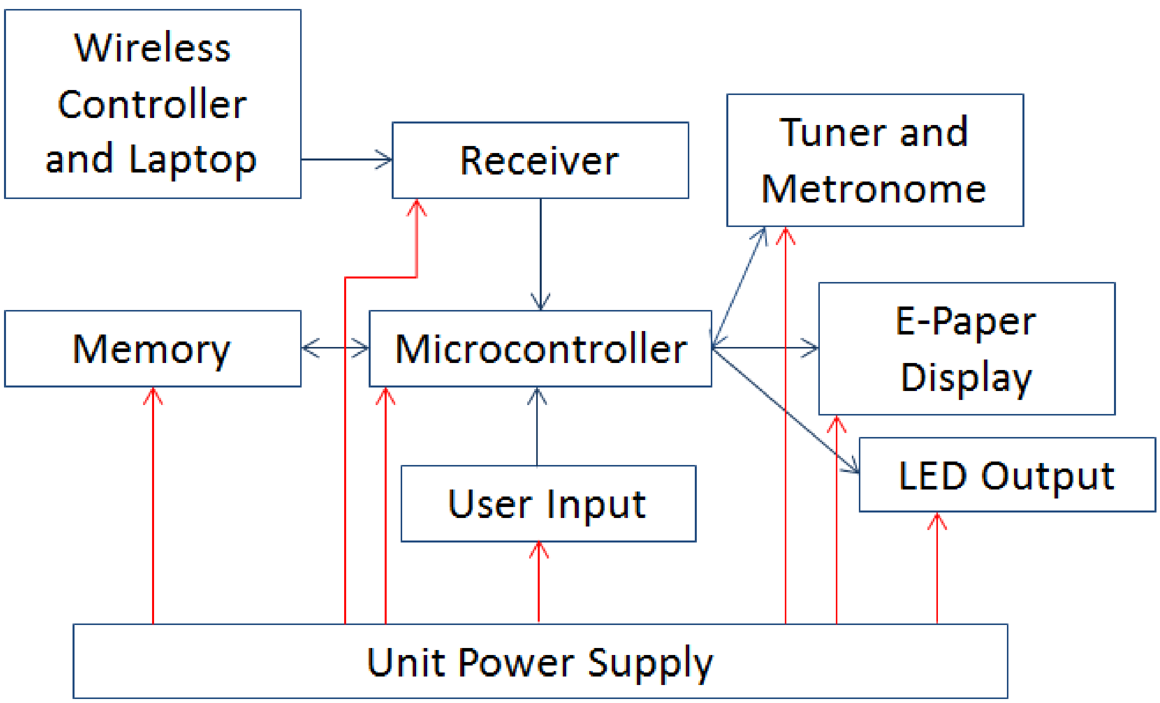
1. Easily manage large music repertoires; add and delete songs whenever
2. Specialized to reduce unit price; and will save greatly on printing over time
3. Pushing a button is easier and quicker than physically turning a page
4. Visual signals are easier to recognize than audible signals in loud environments

1.2.4 Features:

1. Sunlight readable display
2. Separate LED display lights to quickly display time-sensitive stylistic information
3. Central transmitter can control individual units and turn them to the same page
4. Tuner and metronome built into device

2.0 Design

2.1 Block Diagram



Note: In the diagram, red arrows indicate flow of power, while blue arrows indicate flow of information

2.2 Block Descriptions

Power supply: The entire system will be powered by a 3V DC battery similar to that used in several portable devices. Voltage regulators will be used to provide the specific components the appropriate amount of voltage. The battery will be rechargeable to minimize the upkeep cost of the reader unit. The power supply will be connected to all the other components via a PCB.

Microcontroller/PSoC: The Cypress PSoC microcontroller controls the Epaper display, LEDs, metronome, and tuner based on the inputs from the user and the central controller. All input to the device will be done via its 68 GPIO pins. Via the wireless receiver, the microcontroller gets information from the central controller. It can receive and store music in the flash memory, and can change the music at the controller's direction. It can also change pages given input via the user push-buttons. In addition to the visual displays, the microcontroller and the PSoC are also used to implement the tuner and the metronome. The PSoC will have analog input/output capabilities, making the input from the microphone and the output to the tuner and metronome much easier for the device to decode.

Flash memory: Stores non-volatile information, such as sheet music and software. Flash memory is used so the memory is not erased when the device is shut off. The memory will be connected to the microcontroller via GPIO pins and the PCB.

Receiver: Receives commands and content from central controller (based on a laptop) to control the information displayed to the user. Sends information received from the central controller to the microcontroller via GPIO pins and PCB

User Input (buttons): Buttons down one side provide context-dependent actions for the microcontroller to perform. The buttons will send the microcontroller the signals for “next page”, “previous page”, and etc. by wiring the buttons to GPIO pins.

LED Output: LEDs provide output to the user for applications the e-paper display’s timing constraints do not permit. These include signals to play faster, slower, louder, softer, stop playing, etc. These LEDs are controlled by the microcontroller through GPIO pins via the PCB.

Epaper display: Provides the main output to the user, displaying the context-sensitive actions and the music. The music is stored in the flash memory, which is connected to the display via the microcontroller interface. The nature of e-ink does not require backlighting or any brightness control, thus adding ease and cutting cost for our project.

Tuner and Metronome: Implemented within the PSoC, these provide basic musical aids to the user. A low-quality microphone takes a signal from the musician, which is processed to determine if the musician is in tune, and displays information in the LEDs. A metronome ticks the LEDs in time with the specified beats per minute.

Central controller: A central controller can issue commands to multiple devices within range. Using a transmitter attached to a laptop or tablet allows much more flexibility in the controlling software. The controller can order many devices to all display their part to a specified piece of music, or deliver a text message from the director. It will also be the main medium through which music is distributed to the individual devices.

2.3 Performance requirements

This project must be usable and reliable for the end user to safely replace and enhance the functions of a conventional flipfolder. To adequately replace the functionality of a flipfolder, it must be able to manage display pieces of a large repertoire of music to the user (>150 pages). Additional features beyond the capabilities of paper are to be added, encompassing the functionality of basic music aids, such as a tuner and a metronome. These aids must be accurate to within the limits of human perception. Also, the communication system must be adequate to reliably convey information across a large football field or parade route (>75 yds). Finally, the battery must be able to last an appreciable amount of time (>9 hours). Fortunately, all these performance requirements can be met by using reasonable quality components. The cost of these components is discussed in part 4.

3.0 Testing

3.1 Verification of Subsystems

Power supply: The device is run continuously under one battery charge, with periodic inputs and usage. Battery life is measured in hours and minutes.
Flash Storage: The storage is loaded with music until the storage is full to test capacity. Then, we will try to delete certain files. If successful, this will prove that memory is being referenced correctly, and that it is rewritable.
Communication system: Commands are repeatedly sent at long distances. Percentages of received commands are plotted against distance in order to give an idea of the device range.
Display: A simple image will be sent to the display via direct stimulation of pins. If the image on screen agrees with the transmitted image, the display system is functional.
Tuner: Tones at different pitches around the reference pitch are generated, for several different reference pitches. The tuner system will be hooked up to a simple LED, which should light up when the sample pitch is near the reference pitch

Metronome: Output from the metronome system is hooked up to a simple LED indicator. Beats are counted, and time drift from a known good clock are recorded at different beats per minute settings.

3.2 Tolerance analysis:

The communication system implements most features that are above and beyond the capabilities of the flipfolder. It has to be reliable at long distances, as the controller and the device can be far apart in normal usage. Ninety yards is about the distance between the fifty yard line and the corner of the football field. For a command to be received most of the time by a device, the reliability must be 99.67% reliable. The communication protocol between the controller and the line can be adjusted until it fits this reliability on multiple days, to account for possible daily variations in signal-to-noise ratios.

4.0 Cost and Schedule

4.1 Cost Analysis

Per device cost:
Battery: 1 x $5.00 = 5
Voltage regulators: 3 * $0.60 = 1.8
Tactile switches: 5 * $0.10 = .5
LED: 3 * $0.50 = 1.5
E-paper display: 1 * $45.00 = 45
Microcontroller: 1 * $8.00 = 8
Receiver: 1 * $35.00 = 35
PCB: 1 * $30.00 = 30
Cost per device: $126.80

Other: transmitter (hardware and software): 1 x $30

Labor cost:
150 hours per engineer
$35 dollars an hour
2.5 x Multiplier
$13125 per engineer
$26250 in labor

Total Cost: 3 * $126.80 + $30 + $26250 = $26660.40

4.2 Schedule

Week	William Karcher Tasks	Hans Banerjee Tasks
2/3	Finish Proposal Research Power Supply Research Receiver	Finish Proposal Research Microcontroller Research Memory
2/10	Design Power Supply Design/Set up Receiver	Order Parts Microcontroller Configuration
2/17	Controller Device Software Prepare for Design Review	Reader Device Software Prepare for Design Review
2/24	Design Review Build Power Supply Build Receiver	Design Review PCB Design Microcontroller Configuration
3/3	Design device test software	Assemble PCB, Connect Blocks
3/10	Ensure Proper Subsystem Com. Continue Controller Device Software Individual Progress Report	Ensure Proper Subsystem Com. Continue Reader Device Software Individual Progress Report
3/17	Spring Break Continue Controller Device Software	Spring Break Continue Reader Device Software
3/24	Test Software on Device Begin Making 2nd Prototype	Test Software on Device Begin Making 3rd Prototype
3/31	Test Controller-Reader Comm. Battery life testing	Test Controller-Reader Comm. Memory storage testing
4/7	Test Tuner/metronome Debug Software Spring Game Test 4/12	Test display Debug software Spring Game Test 4/12
4/14	Test long-distance comm. Accommodate feedback from tests	Test long-distance comm. Accommodate feedback from tests
4/21	Prepare for Demo	Prepare for Demo
4/28	Prepare for Presentation	Prepare for Presentation