Maestro™

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(Sheet Music Scanner)

Harmony Innovations Inc.

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Nikola Cucuk
Veronica Cojocaru
Cris Panaitiu

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Overview

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Motivation

- **How do novice musicians learn to play their instrument?**
- **Sheet music is complex**
- **Different learning styles**
- **Improvisation**

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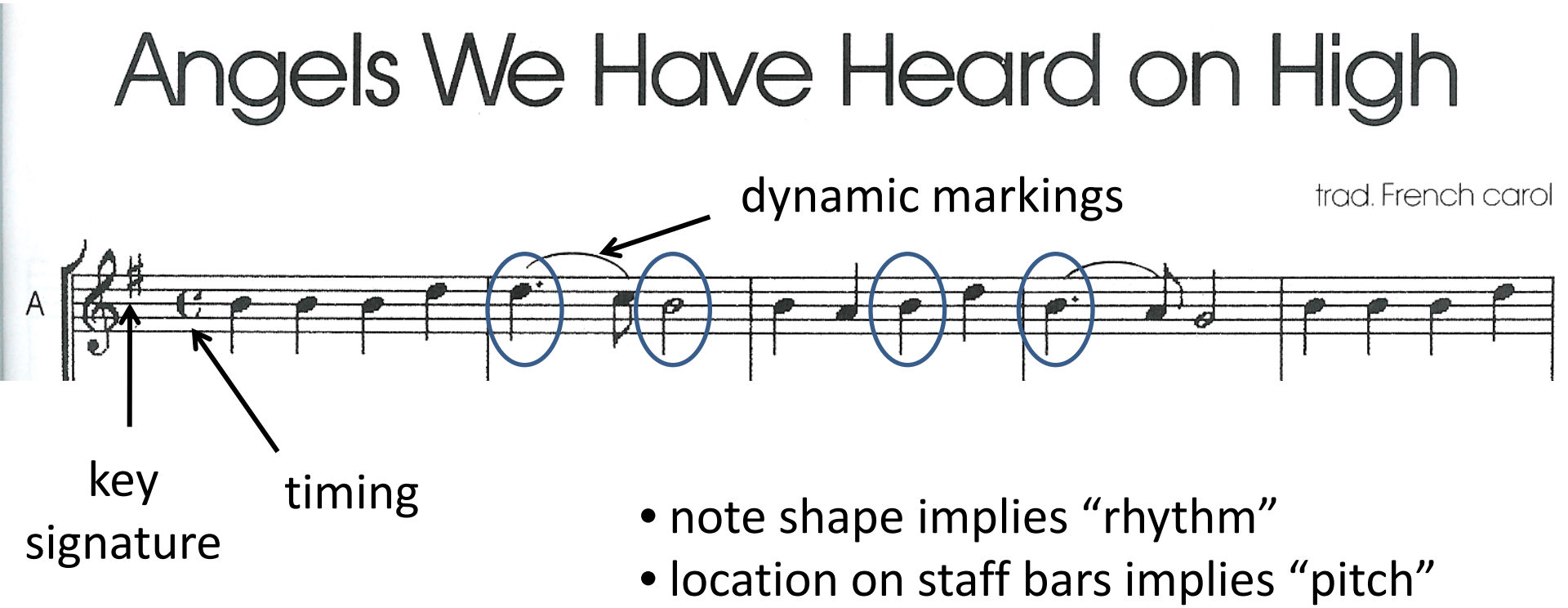
Sheet Music



- note shape implies “rhythm”
- location on staff bars implies “pitch”

Maestro™ Team

Sean Edmond

- 5th year Electronics Engineering student
- Was responsible for OCR software and sound module
- Lots of software and hardware experience in many languages
- Worked at MDA, Reconfigurable Computing Lab, PMC-Sierra

Nikola Cucuk

- 5th year Electronics Engineering student
- Was responsible for the camera module
- Experienced with embedded programming
- Worked at PMC-Sierra as HW designer and verifier

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Maestro™ Team

Veronica Cojocaru

- 5th year Electronics Engineering student
- Responsible for MIDI driver, user interface, system integration
- Experienced with MatLab, C programming
- Worked at PMC-Sierra and Research at SFU

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Market Research

- Performed market research at music stores
- " Musicians are always looking for a way to skip learning sheet music "
- Sheet music packaged with CDs
- Software tools for computers
- Majority of string musicians purchase an electronic tuner
- MIDI is standard in electronic music devices
- Nothing like our device

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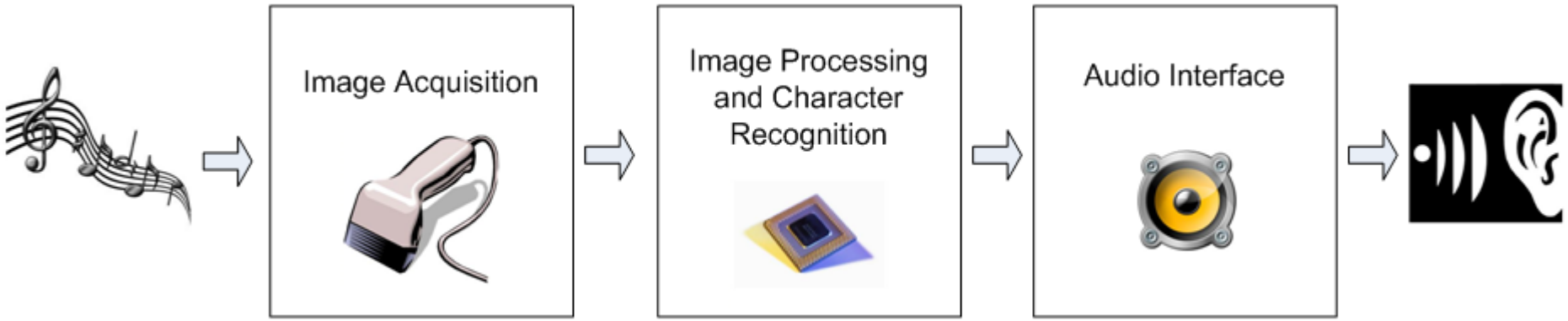
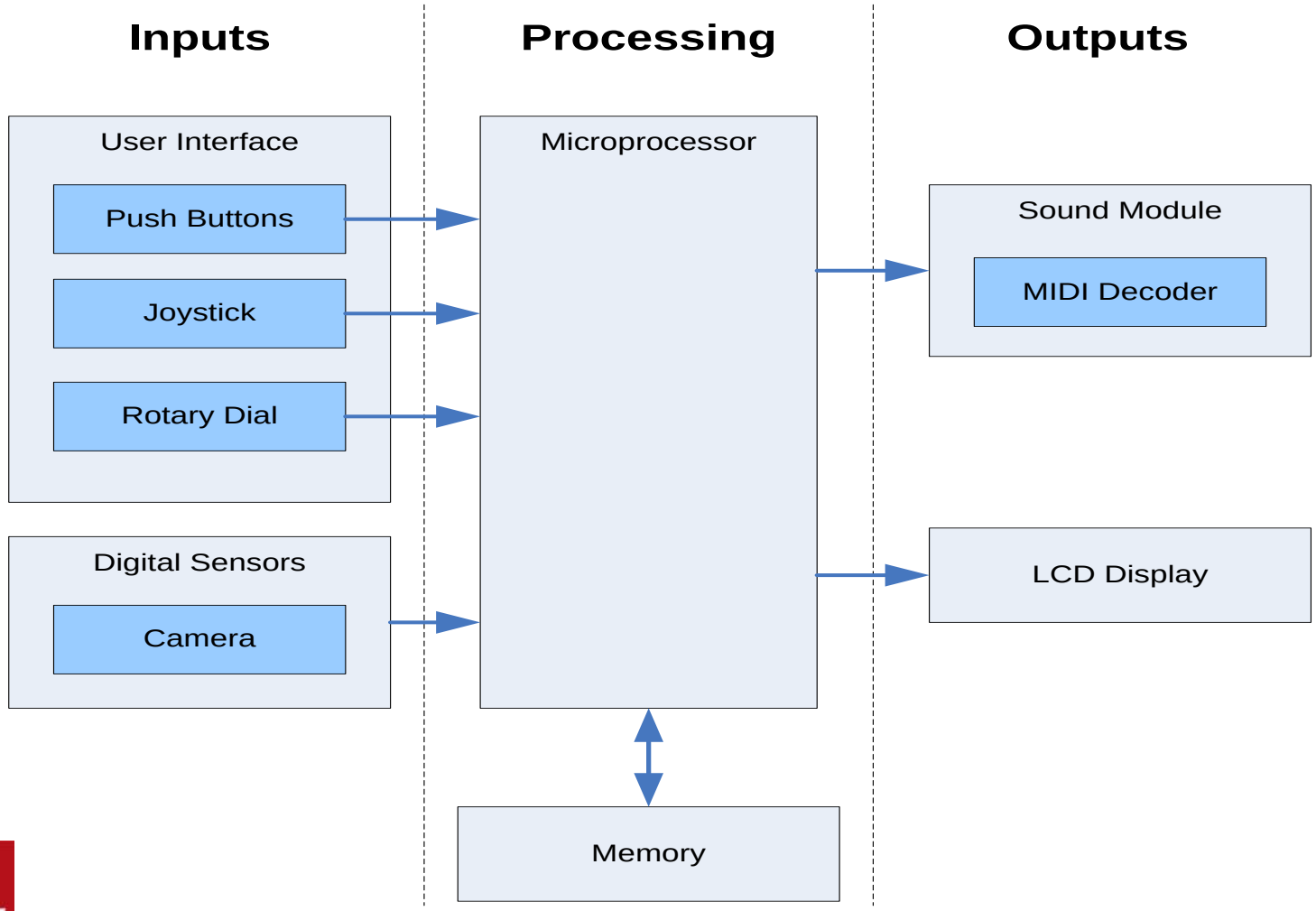
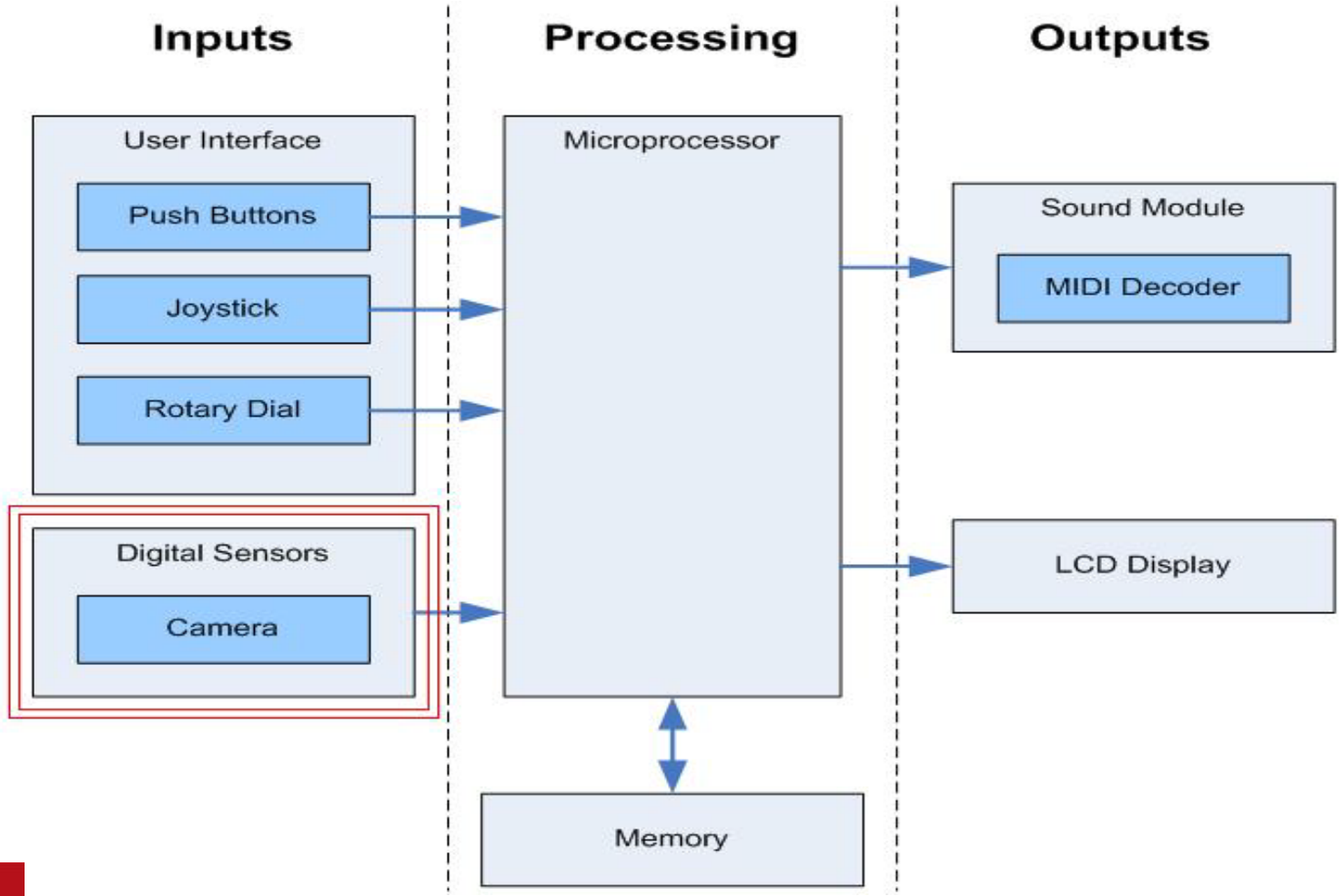
High-Level System Overview



High-Level System Overview



Camera Module



Camera Module (uCAM-232)

- CMOS Digital color camera
- RS232 interface
- Package size 28x32 mm
- 160x120 resolution
- Smallest pixel size 5.6um^2
- 2-bit gray colour conversion
- 0.4 fps
- 90° lens

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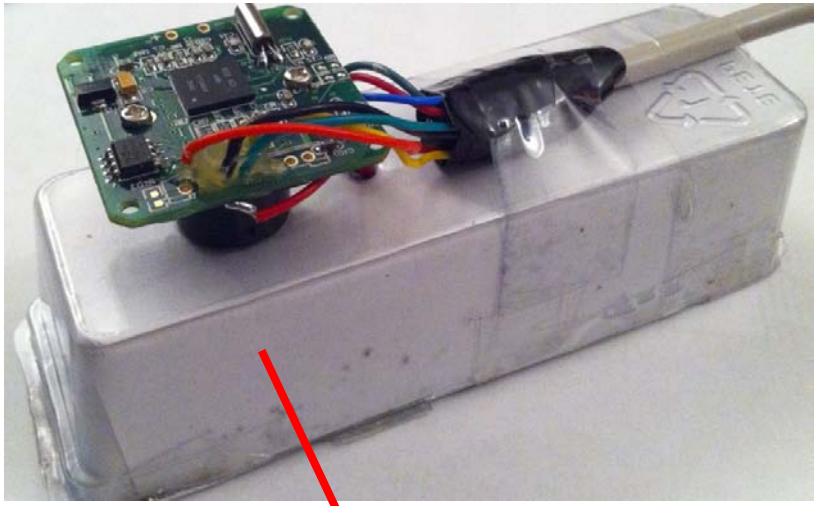
Camera Mudule Enclosure

- Separate mobile module
- Illumination box
  - Aluminum foil + white paper
  - 3x MAGlite bulbs
- Rectangular box for ease of straight line scan



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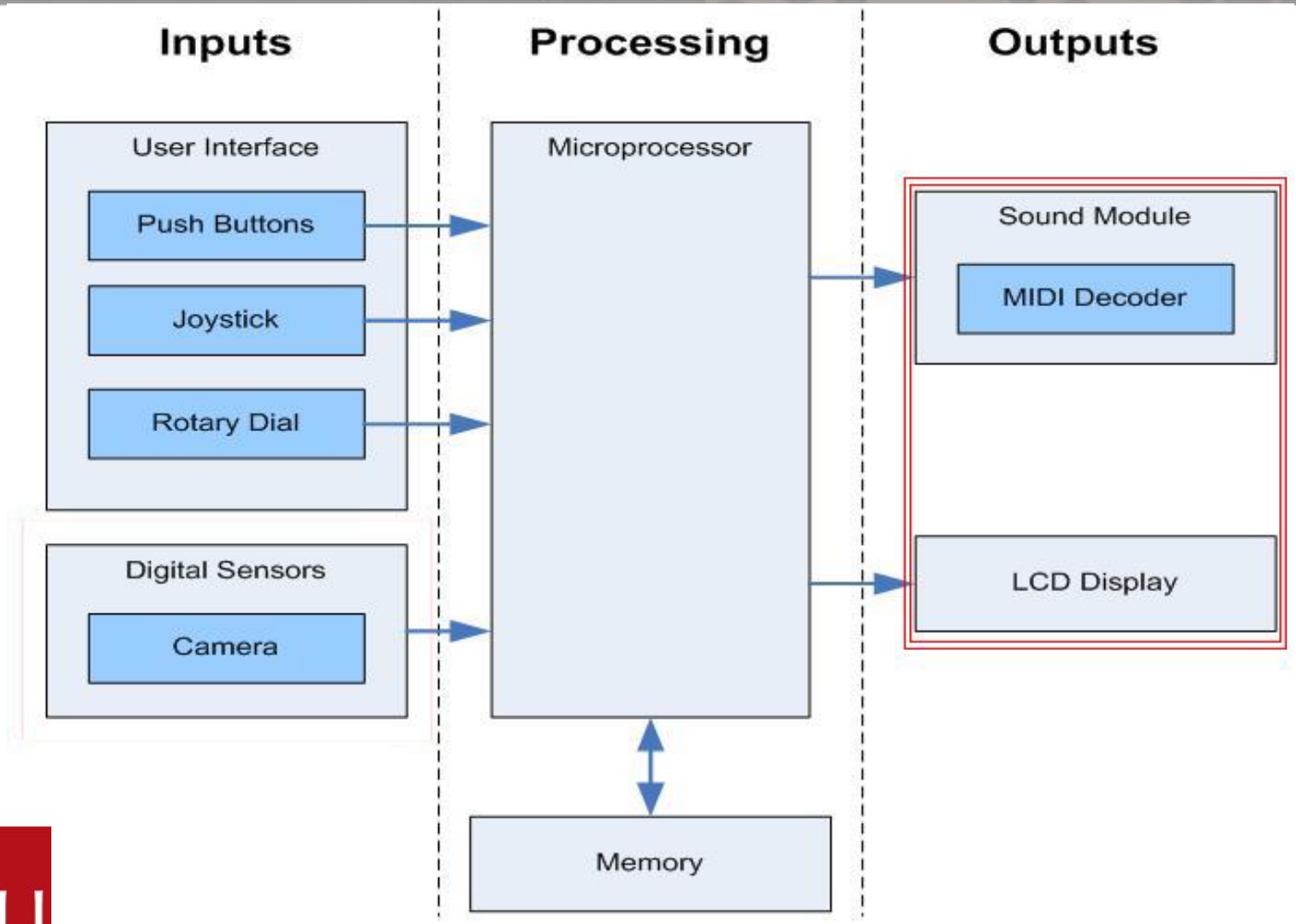
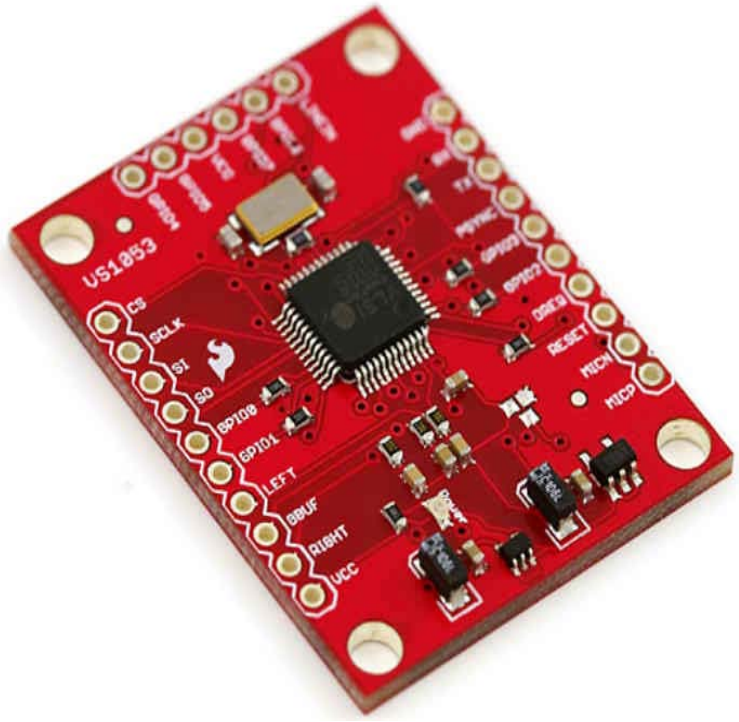
Sound Module



Sound Module

- Vs1053b packaged on break-out board
- MIDI decoder
- 2 x SPI interface
  - Serial Control interface
  - Serial Data Interface
- Sound output to standard headphone jack
- Package Size 7x7x1.4mm



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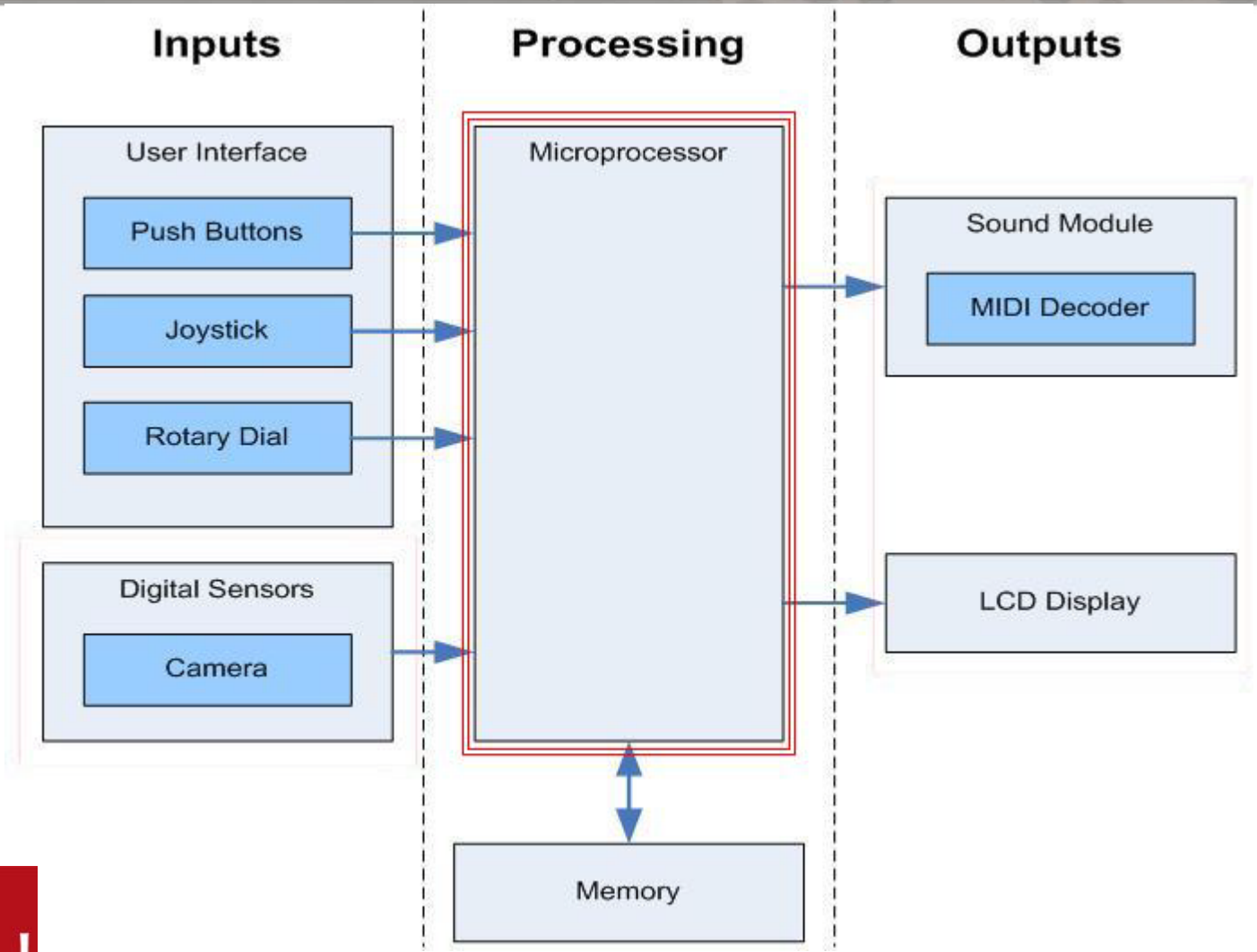
Software


Inputs
Processing
Outputs
User Interface
Push Buttons
Joystick
Rotary Dial
Digital Sensors
Camera
Microprocessor
Memory
Sound Module
MIDI Decoder
LCD Display

The Development Board

- EVK1100
  - Atmel 32-bit processor
  - SDRAM
  - LCD
  - Pushbuttons
  - joystick
- Drivers available for many standard interfaces
- Large online user community

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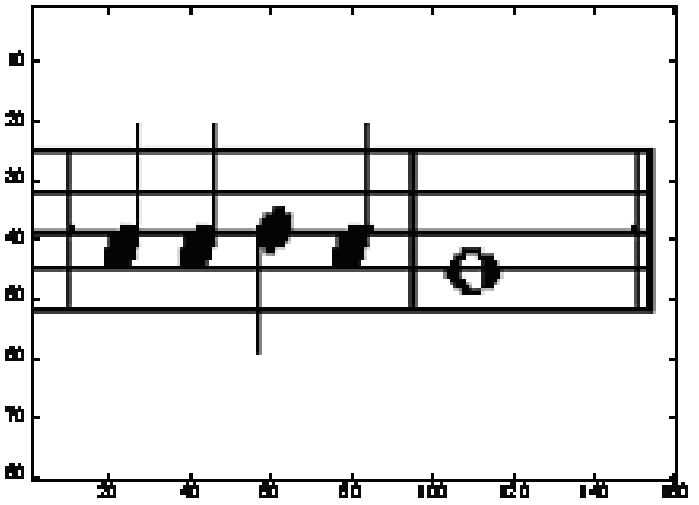
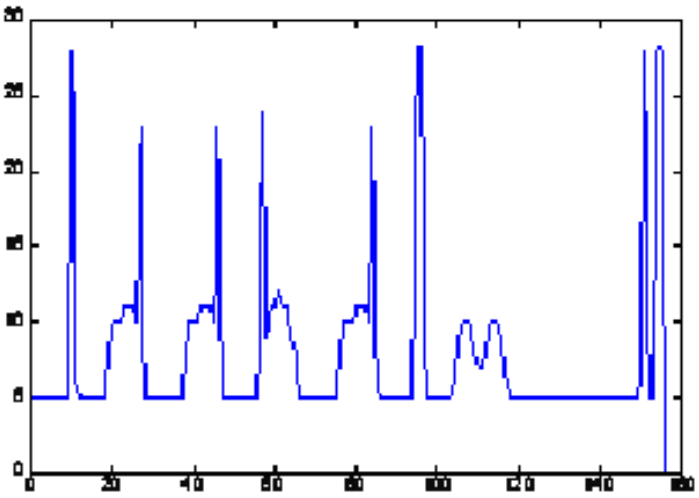
Optical Character Recognition

- Character recognition performed with “black pixel histogram” comparison
- Mosaic algorithm stitches images
- MIDI file created from detected features
- Algorithm was prototyped in Matlab





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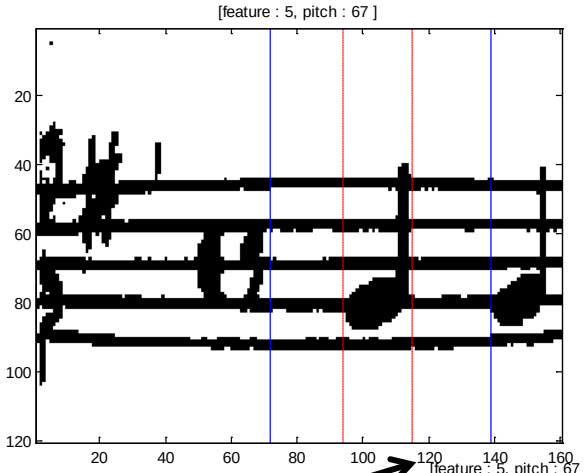
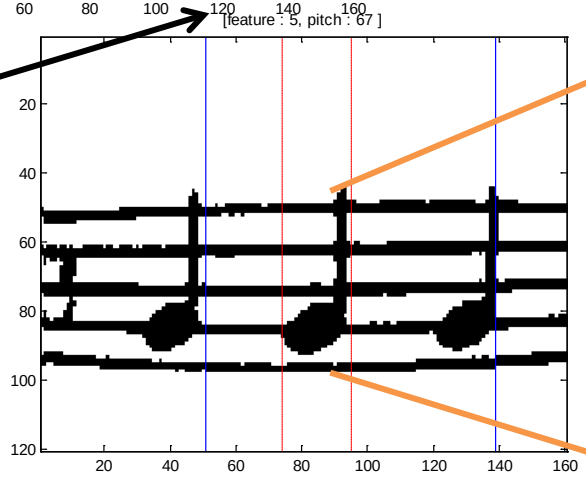
Sample Matlab Output

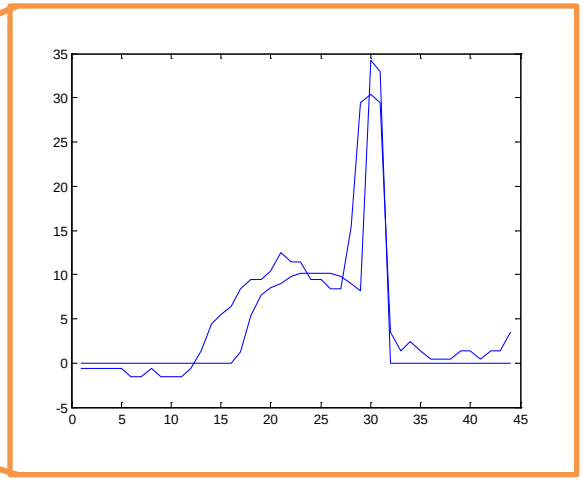


- Blue is the “search region”
- Red is feature edge detection

Sample “black histogram” comparison

Point of overlap determined by mosaicing algorithm





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Finances

Equipment List	Cost
Microcontroller & EVBD	$129
Sound module	$44.93
Camera_A Camera_B1 Camera_B2	$60 $105 $105
Microcontroller programmer	free
Electronics	$160
Miscellaneous	$150
Total Cost	**$753.93**

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Challenges

- Microcontroller couldn’t meet timing requirements of initial camera
- Second camera fried due to a short
- Tools were error prone
- MIDI specifications not readily available
- Resources shift required to complete sound module
- Scan area illumination challenges
- Ex-group member reporting false progress
- Processing speed

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What We Have Learned

- Optical recognition software is challenging!!!
- Software development should employ “extreme programming” practices
- Project management
- Image processing requires a high speed processor
- Don’t rely on firmware to capture high speed interrupts use hardware instead

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Future Work

- Is this viable?
- Dedicated hardware to accelerate firmware and algorithm
- Better camera with higher speed interface
- More compact design with PCB and custom parts
- Digital switch for illumination
- Improve algorithm
- Iphone app?

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Acknowledgments

- Lakshman (Lucky) One
- Adrienne Jacobs (painting)
- Sean roomates ☺

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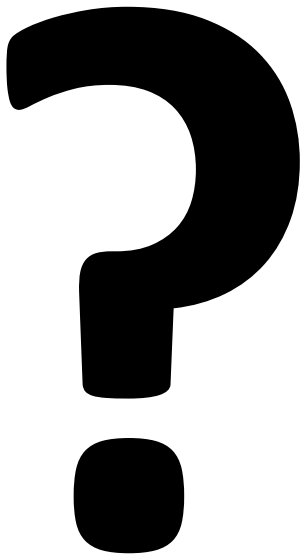
Questions…



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