Viano

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Agenda

- Review of Project
- MDR Deliverables
- Demo
- CDR Deliverables

Project Review:What is the Problem?

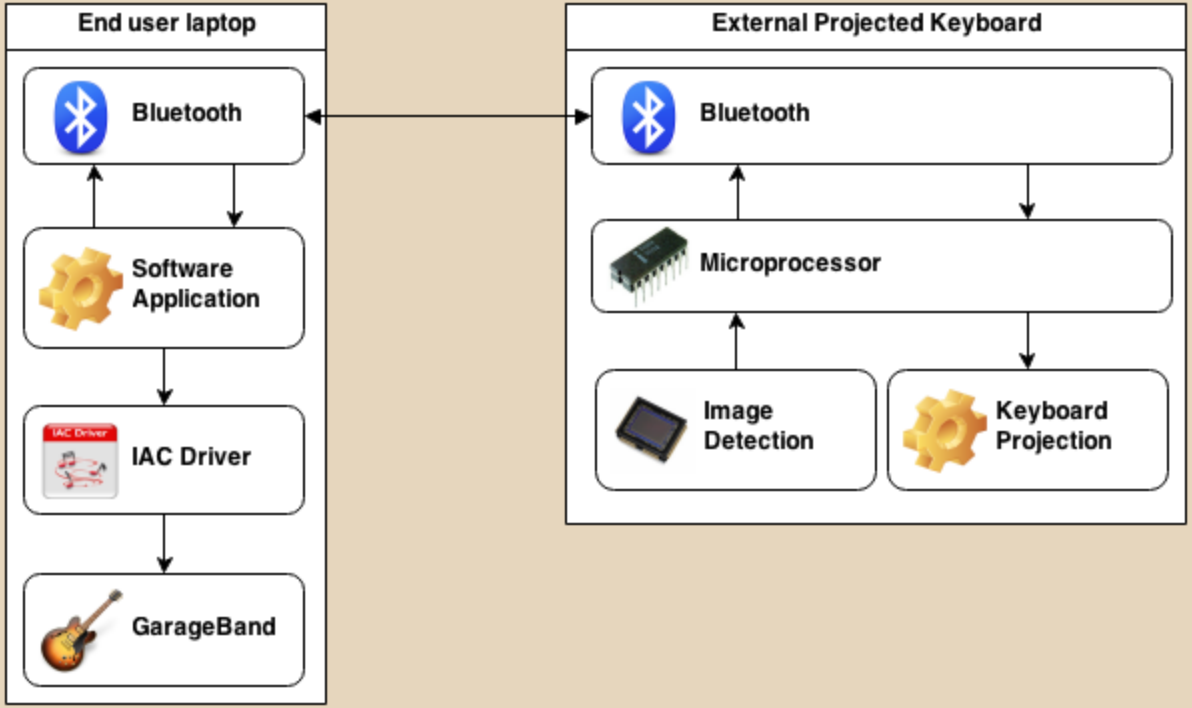
- GarageBand is limited by tradeoff between:
  - Qwerty keyboard
    - Less errors due to ‘Fat Finger’ problem
    - Difficult tool for composers
  - Piano keyboard
    - More errors due to keyboard size
    - Easy tool for composers

Our Solution: Pico-Projected Midi Controller

Specifications:

- Portable (fit in small bag, lightweight)
- Dimensionally-correct keyboard
  - Immediate goal: 2-Octaves
- Seamless integration with GarageBand

Our Solution: Block Diagram



Promised MDR Deliverables:

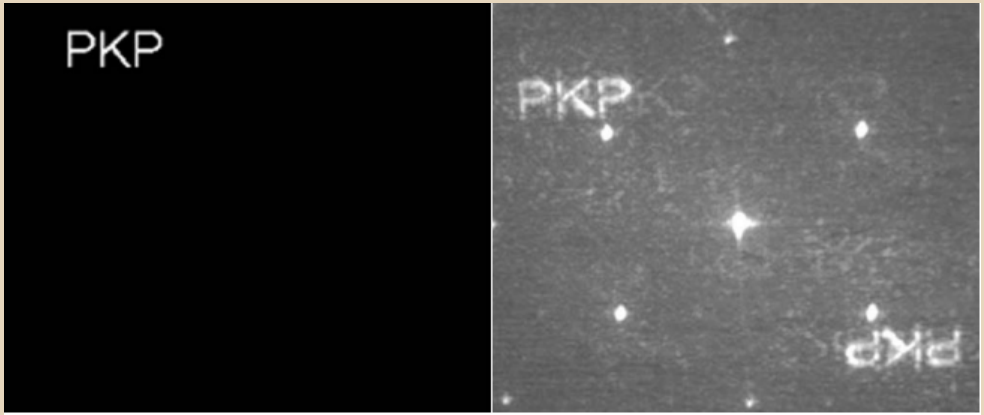
MDR Deliverable	Description	Who is Responsible?
Virtual Piano Image	Computer Generated Hologram designed and in the process of fabrication	Anna
Single finger localization	Track and display finger coordinates over image	Chi
Filtering Visible Light	Idealize the infrared light detection by filtering out visible light	Kelly
Coordinate conversion	Given P(x',y') in image, convert to P(x,y) in projection	Chi
Device Driver for OS-X	To allow for GarageBand integration with keyboard	Chris
Bluetooth	Functioning connectivity	Chris

Virtual Piano Image: Anna

Originally proposed a CGH

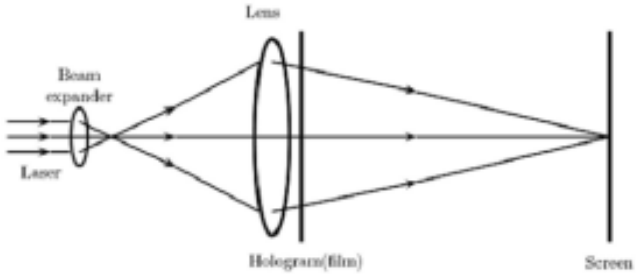
- Research yielded DOE and Pico-Projectors are expensive
- Problems with CGH
  - DFT to calculate the Fraunhoffer diffraction formula (far field amplitude calculation) increases calculation time ~ N^2
  - Reconstructed hologram has poor visibility and a mirrored image
  - For clear projection of reconstructed image, must have a specific laser wavelength & power, and lens magnification & position
    - In order to keep the Viano pocket-sized, realizing a clear image via CGH would require extensive time, research, and possible wasted spending on testing (different lenses and lasers)

Optical Reconstruction of Hologram



Original Image

Reconstructed Image



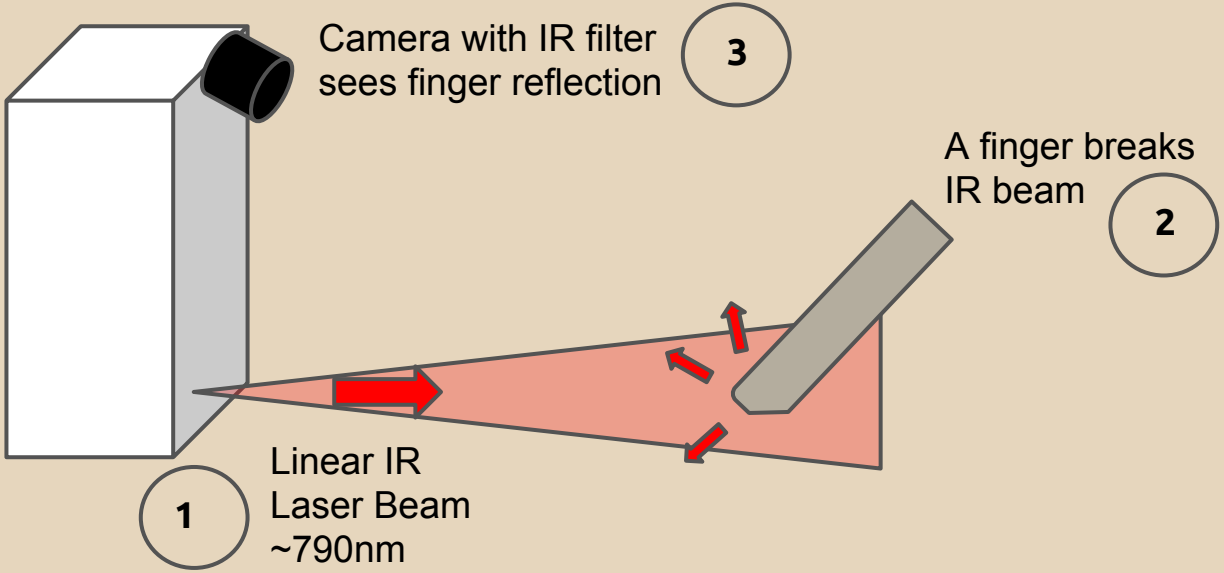
Schematic of Optical Reconstruction Setup

Solution: SVP PP003 Portable Pocket Projector

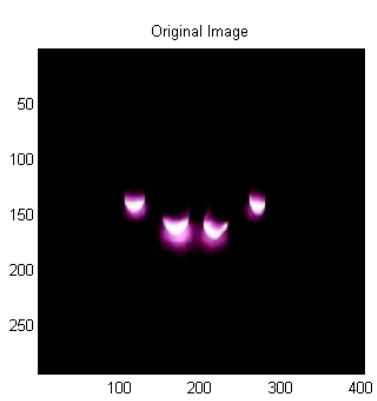
Product Description

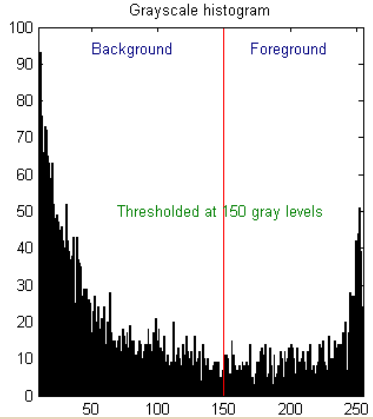
- Portable (Pocket-Sized)
- 4.2” deep, 2.2” wide, < 1” tall
- Image projection between 6-54” diagonally
- 6 lumens
- Weighs < 4oz.
- External Memory SD Card (projection source)
- 90 min continuous playing time
- $74.99

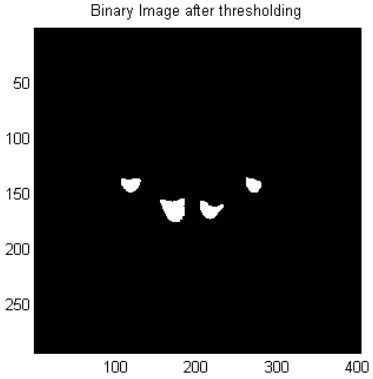
Single Finger Localization: Chi

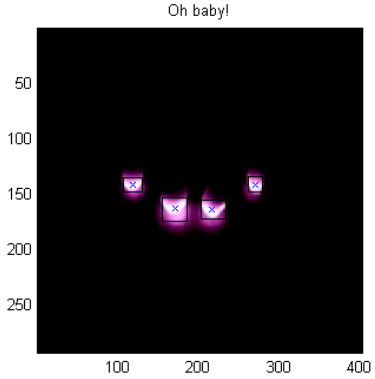


Single Finger Localization: Chi









- Fingers appear as blobs
- Analyze each blob to find area & centroid
- MATLAB simulation ~25 fps

Single Finger Localization: Chi

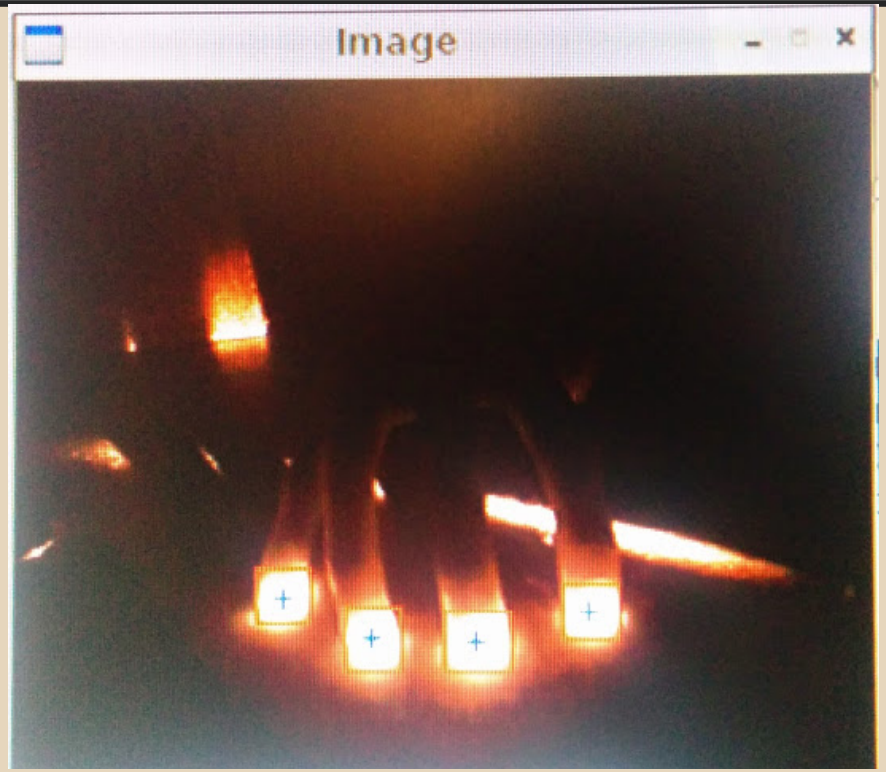
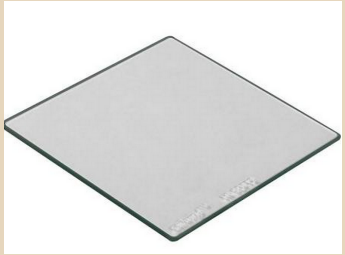


Image from our camera using ~790nm IR filter

- Now implement on Raspberry Pi with OpenCV
- Use camera CSI interface to utilize GPU and reduce impact on CPU
- Results: ~20 fps

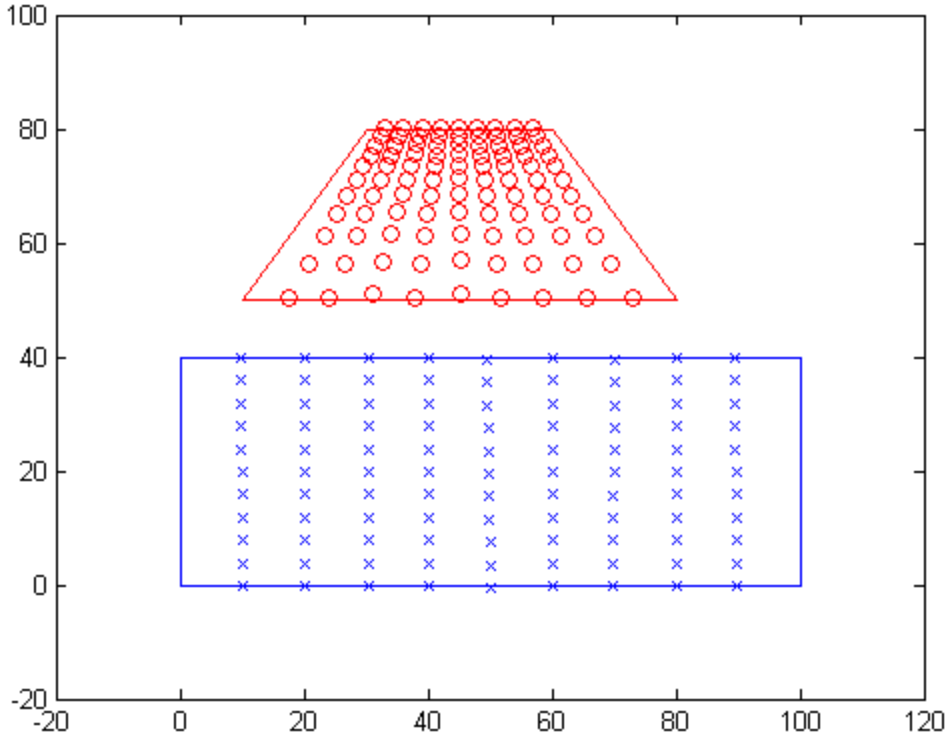
Filtering Visible Light: Kelly

- Need: IR Filter for 790nm IR beam
- Solution:
  - DIY IR Filter
    - Must be in front of Raspberry Pi camera lens due to thickness



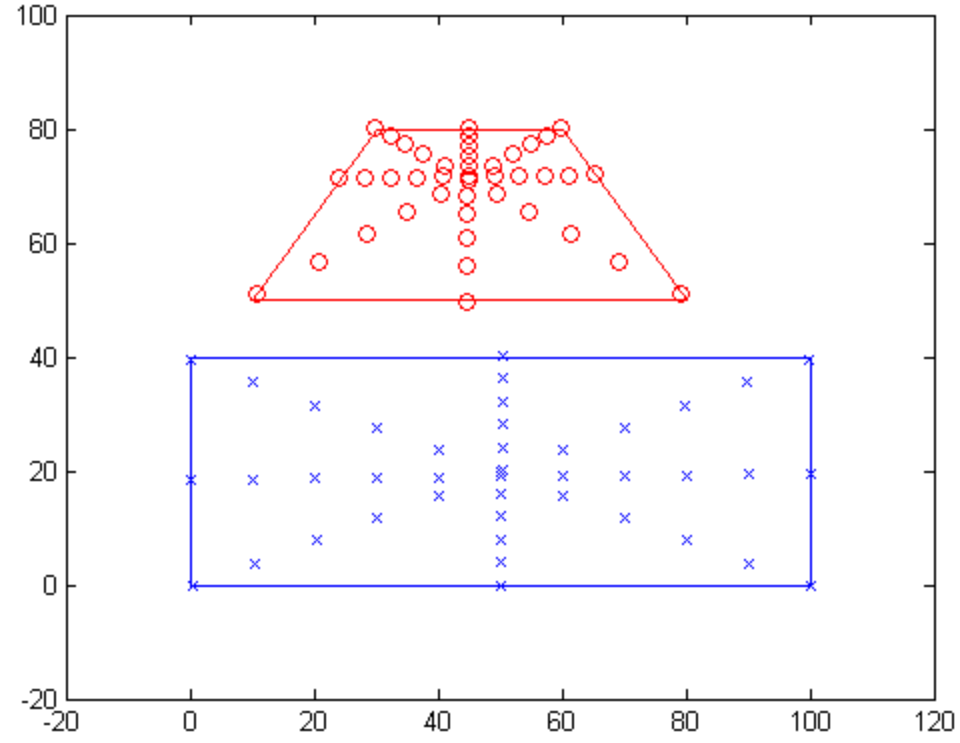
- More permanent solution:
  - Use Film IR Filter to be implemented inside R.P. Camera
    - Risk: Breaking Camera

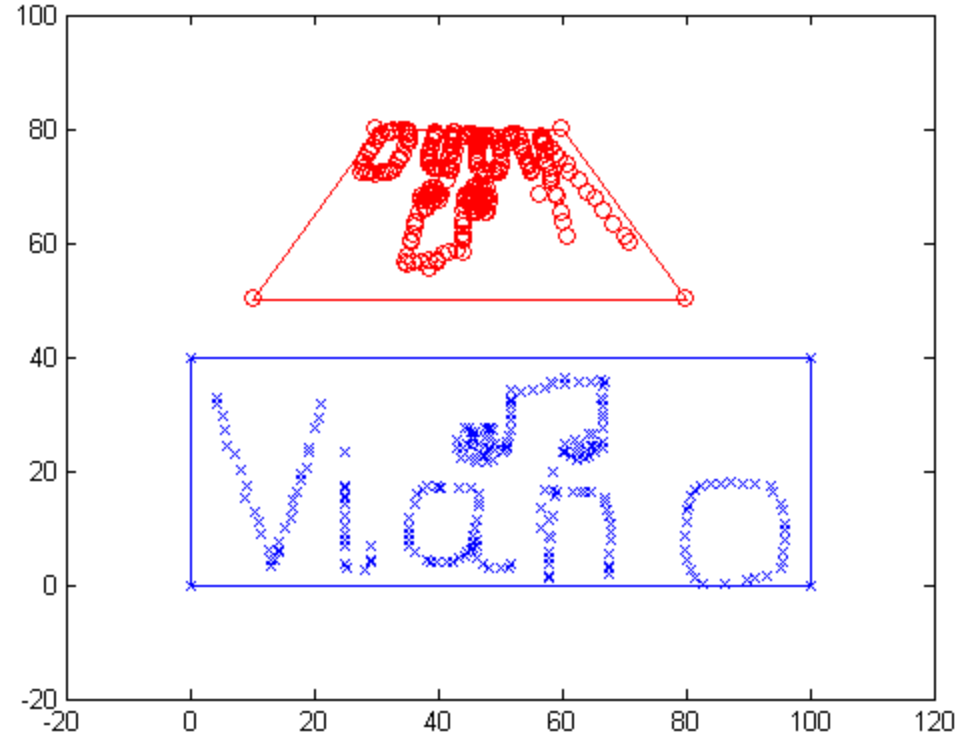
Coordinate Conversion: Chi



- Map coordinates between two arbitrary convex quadrilaterals
- Perform perspective transform
- MATLAB proof of concept
- Implement with OpenCV

Coordinate Conversion: Chi





Device Driver for OS-X: Chris

Initial plan:

- Create device driver(kernel extension) to communicate piano with GarageBand

Problem:

- CoreMIDI framework needed to implement this is not available at the kernel level

Device Driver for OS-X: Chris

Compromise:

- Command line tool
  - bridges piano with GarageBand through IAC driver
  - provides minimal user interaction
    - serial port
    - midi destination

```
1) /dev/cu.Bluetooth-Incoming-Port
2) /dev/cu.Bluetooth-Modem
3) /dev/cu.HC-06-DevB
Select input port (e.g. 1): 3
You have selected Port: /dev/cu.HC-06-DevB
1) IAC Driver
Select destination port (e.g a): 1
You have selected device: IAC Driver
```

Bluetooth Connectivity: Chris

Subsystem Tests:

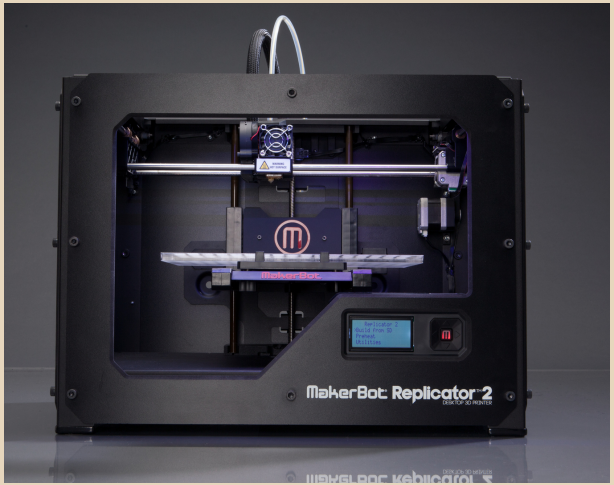
- Simulated piano with arduino
- Sending piano notes from external device to GarageBand App
  - Passed:
    - bluetooth
    - USB connection

Distribution of Responsibilities for CDR

Kelly Design housing unit and wide-angle solution for projecting image	Anna Design and Build a Power Circuit
Chi Implement Keyboard and KeyEventProcessor classes	Chris Gui application on laptop and sending information from Raspberry Pi

CDR Deliverables: Kelly

- Design housing unit for Viano
  - Using MakerBot Software for Replicator 2x 3D Printer
  - Used in ELab I-Makers Space
- Wide-Angle Solution for projection
  - Need to project image from lower height



CDR Deliverables: Anna

- Transition all power sources onto single power circuit to minimize external wires
  - one IC for: Pico-Projector, Raspberry Pi, IR-Laser
  - Looking into battery-life options

CDR Deliverables: Chi

- Implement 2-octave Keyboard
- Implement class for KeyEventProcessor
- User calibration at start-up

CDR Deliverables: Chris

Communication- Piano to GarageBand

- Raspberry Pi
  - Create interface for
    - sending notes to computer via bluetooth
- Gui application for OS X
  - interprets bluetooth signal from Raspberry Pi
  - sends notes to GarageBand App
  - allows user to change the velocity of the notes