Viano

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Abstract

The Viano, or virtual piano, allows music enthusiasts to play and record a tune on the go, via the OS X application, GarageBand. We introduce a portable, two-octave, dimensionally correct, projected keyboard, which provides an optimal playing experience. The Viano alleviates the struggle of trying to play/record music on smaller-size keys without the hassle of having to carry a full-size midi keyboard around—unlike any other portable alternative.

Block Diagram

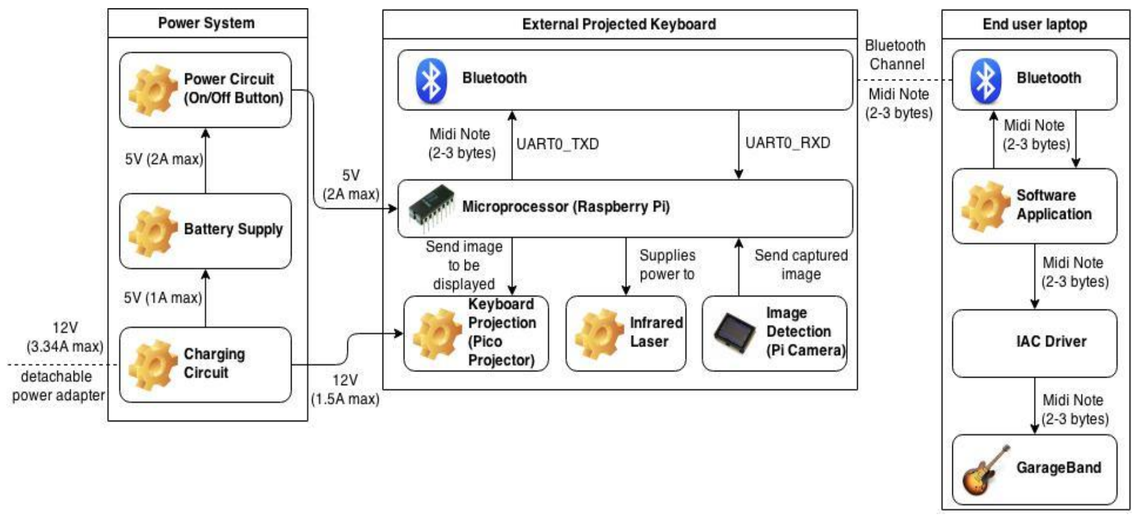
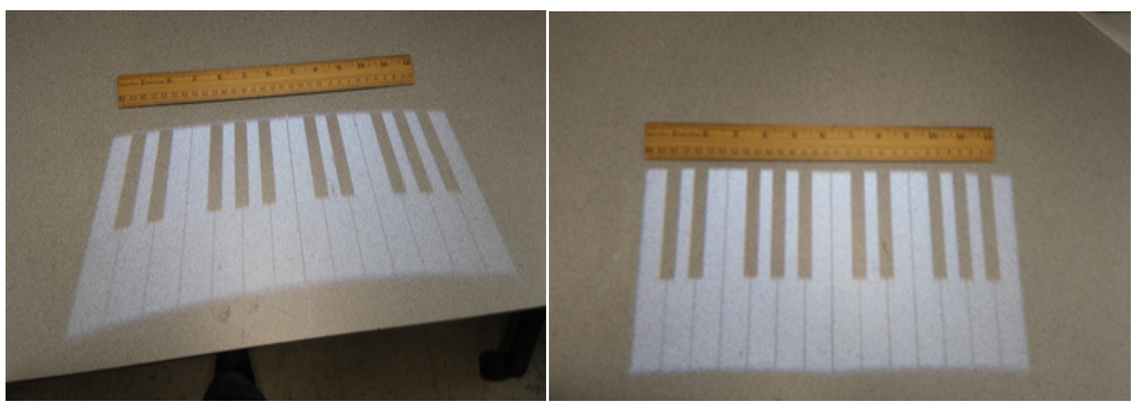


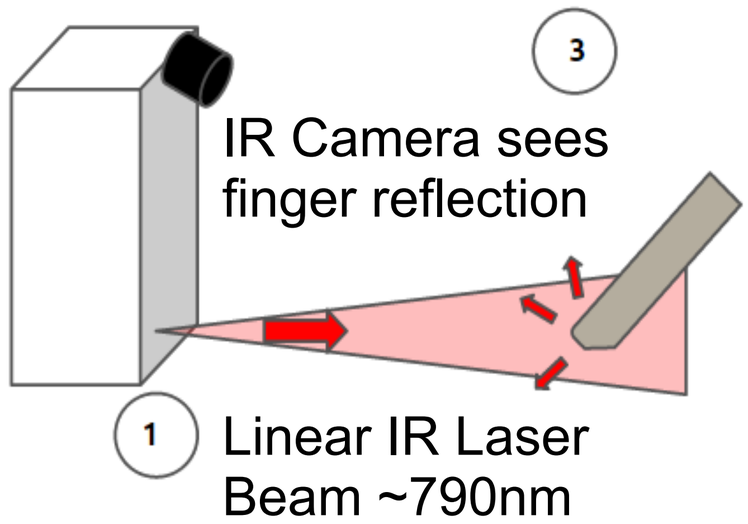
Image Projection

- Pico Projector needs wide-angle lens to display piano image from a low height
- Lens introduced a fish-bowl effect that was corrected by a warp-transformation



Before After

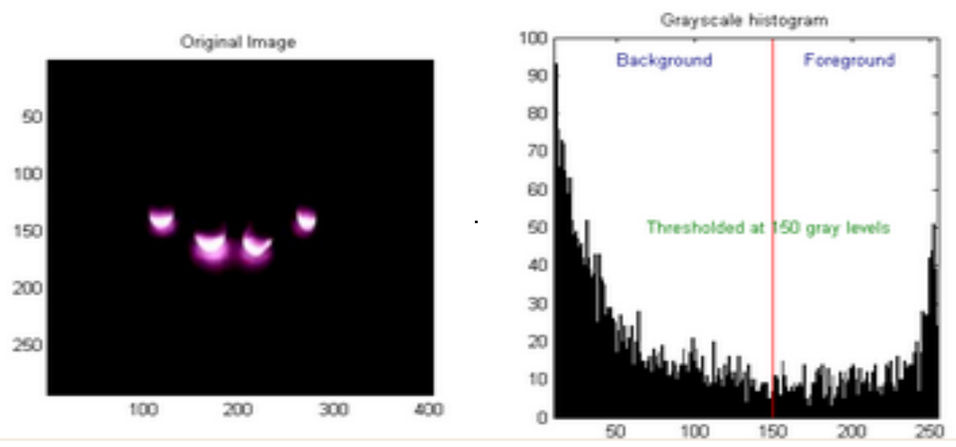
Finger Tracking



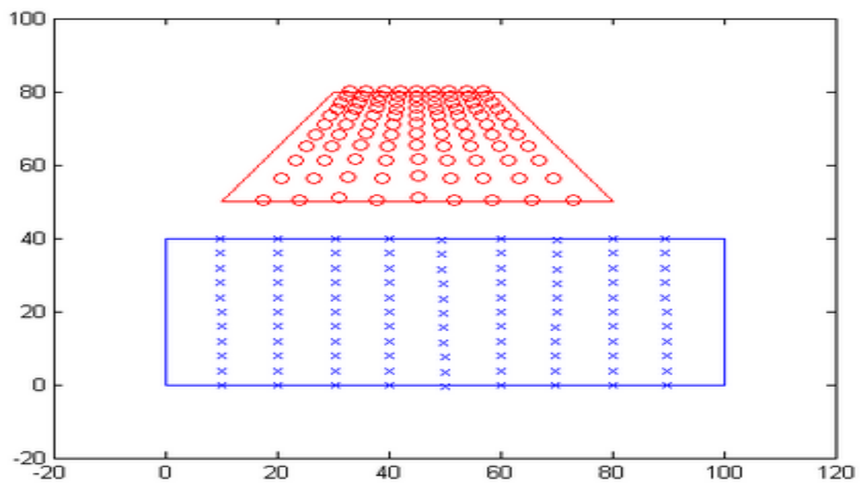
A Raspberry Pi and IR camera rapidly capture images of the playing surface.

Computer vision code, written using OpenCv in C++, then identifies each finger's coordinates within the camera image using the following :

- ❑ **Color space conversion**
- ❑ **Image thresholding**
- ❑ **Blob detection & analysis**



Coordinate conversion maps from the camera to world frame of reference using perspective transforms



Acknowledgments

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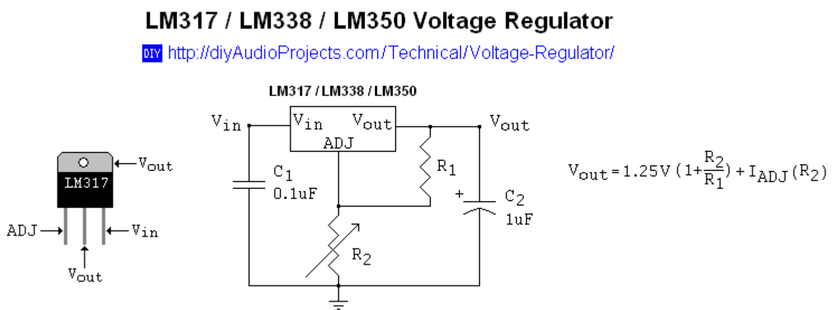
Specifications

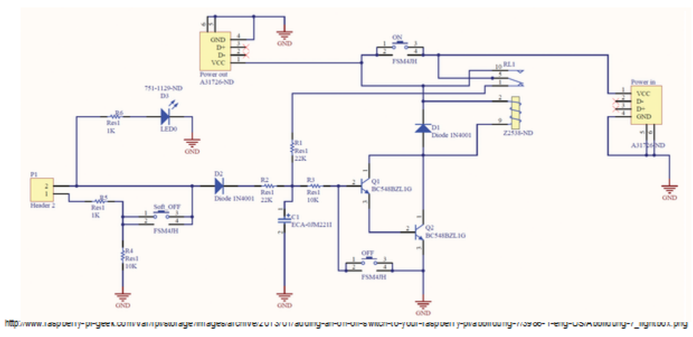
Specification	Goal	Actual
Lightweight	<5 lbs	3.2lbs
Portable	Pocket-Size	Small bag-size
Dimensionally Correct Keys	White: 23.5mm Black: 13.7mm	22.2mm 12.7mm
Number of Octaves	2	2: always displayed 8: using buttons
Integration with GarageBand	Seamless	Seamless

Power Circuitry

- Pico Projector has internal battery pack
- Raspberry Pi uses an external battery to enable portability
- A charging circuit is used to replenish both batteries from a single source



- Raspberry Pi's operating system may become corrupted if not shut down before disconnecting power
- Power button includes safe shutdown feature

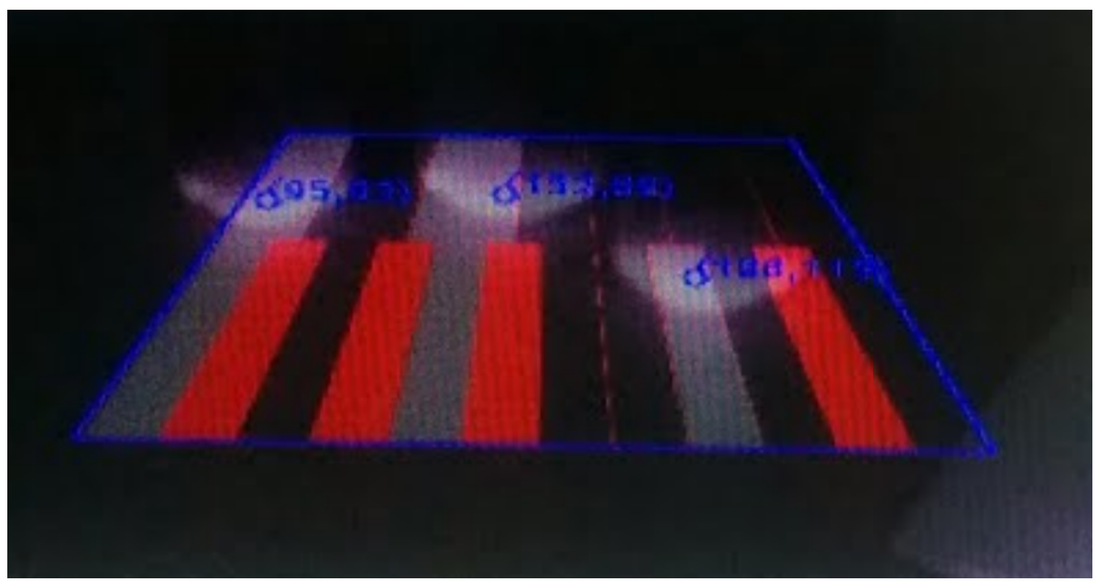


Cost

Part	Development	Production (1,000)
Lenses	$20	$2
Bluetooth Chip	$10	$10
Battery Pack	$50	$25
Infrared Laser	$9	$2
Pico Projector	Free Sample	$150
Charging PCB	$11	$4
On/Off Button	$5	$1
Raspberry Pi 2	$35	$35
Misc. Hardware	$120	$60
3D-Print Housing	$240	$140
Total	$500	$429

MIDI Message Generation

- Keyboard layout programmed in 2D Euclidean space, using C++
- Layout includes piano keys and control buttons
- Determines whether a key or a button is pressed, using a list of current finger coordinates and a binary search algorithm
- Automatically generates MIDI messages following a key or button event
- Embedded a visual simulator environment into keyboard for testing and verification, using OpenCv



Results:

- MATLAB simulation: ~25 fps
- Raspberry Pi + OpenCv/C++: ~30 fps

Bluetooth Communication

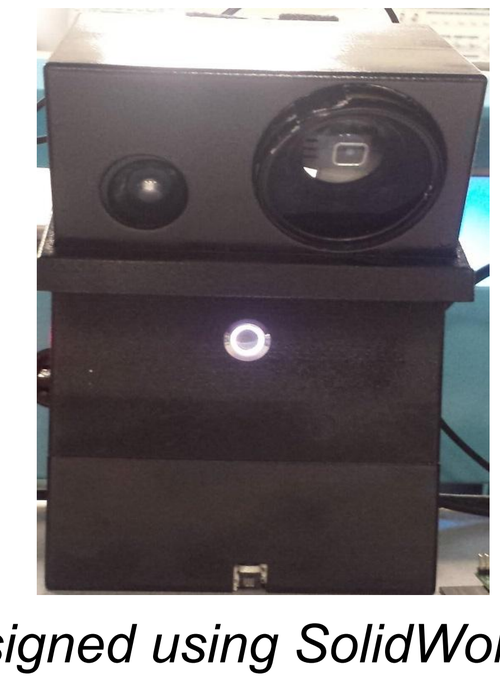
Transmitter (Raspberry Pi)

- Bluetooth slave adapter connects to serial UART port
- Programmed to seamlessly transmit MIDI notes over channel
- Current transfer rate ~300 notes/s

Receiver (Laptop)

- Running Java App to receive/process transmitted data
- MIDI Notes synthesized via GarageBand

Final Product



Designed using SolidWorks™