SmartDesk

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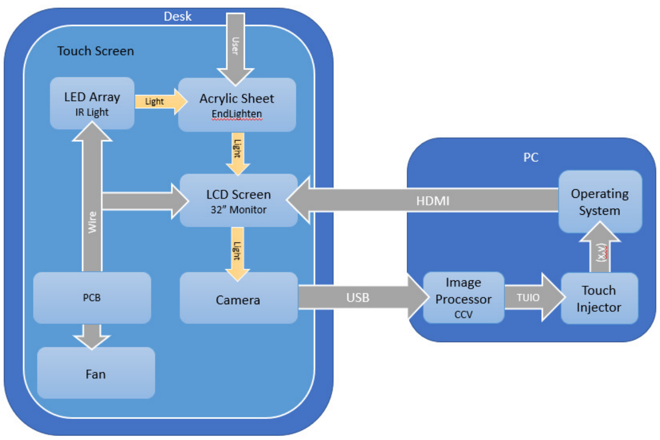
Abstract

SmartDesk offers the conventional functionality of a stand alone desk, but adds the utility of a touch screen surface. The SmartDesk benefits individuals ranging from students to professionals and even casual users by providing a functioning computer within the top of a desk. The main technical exploration is obtaining touch capabilities through IR light rather than through capacitive materials or other traditional implementations. This alternative would offer both a cheap and durable solution to touch screens that allow for a versatile SmartDesk.

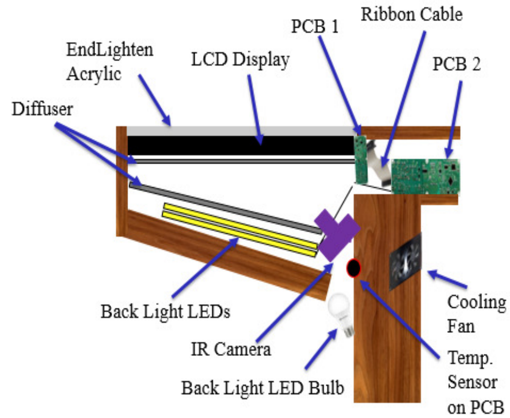
System Block Diagram



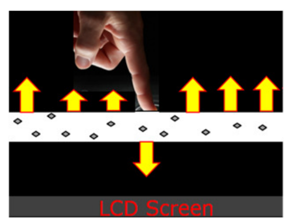
Specifications

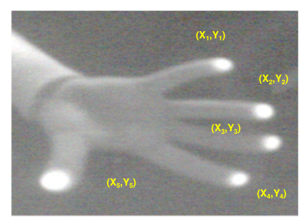
Requirement	Specification	Actual
Provide Accurate touch Inputs	Accuracy up to fingertip	6.35mm
Provide Increased Versatility	Maintain function of conventional desk, while offering touchscreen	Adequate desk space with working touch screen
Responses in real time	<100ms	8ms
Interface with current computer	Interfaces using standard computer methods	USB, VGA, HDMI
Power	Use the power of an average TV	110W

System Overview



- **Infrared light fills EndLighten Acrylic – a special material designed to evenly disperse light through top touch surface.**
- **Touch reflects the IR light downward through the LCD screen and diffuser layers.**
- **IR camera captures touch and screen coordinates are determined using Community Core Vision (CCV).**
- **Embedded temperature sensor controls fan circuitry for cooling.**





- **The final SmartDesk system meets desired touch specifications while also maintaining functionality as a conventional desk.**
  - **Accuracy: Mean touch distance from target empirically measured to be ~6.35mm.**
  - **Latency: Real time response measured to be ~8ms, well within human reaction time.**
  - **Brightness and Resolution: 32" 720p Sceptre LCD screen used, brightness ensured by adding additional backlighting and diffuser layers.**
  - **Durability: Relatively thick EndLighten acrylic offers a durable, water resistant surface.**
  - **Power: Reasonable power consumption of 110W, about the same as 2 incandescent bulbs.**

Acknowledgements

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Resolution Calculation

The resolution is the ratio between the actual length (dL) of the object(A) and its projected length (dl).

$$r = \frac{dl}{dL} \quad (1)$$

The first term considers the orientation of the objects surface. The highest resolution can be achieved when the surface normal corresponds to the direction towards the perspective center (PC).

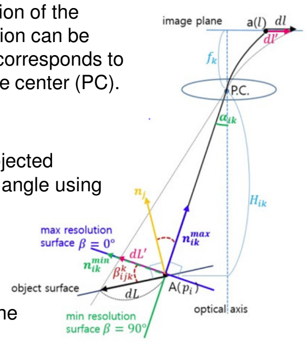
$$dL = \frac{dL'}{\cos(\beta)} \quad (2)$$

The second term transforms the projected length into the range of the incident angle using the arc length formula.

$$d\alpha = \frac{dL'}{H}\cos(\alpha) \quad (3)$$

A wide angle model for dl has been selected, where f is focal length of the camera.

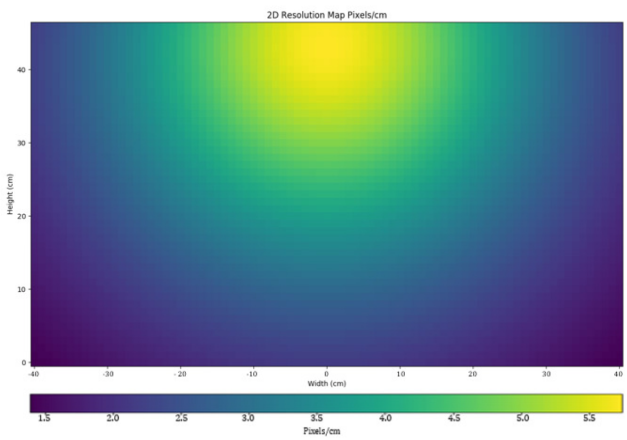
$$dl = f\cos\left(\frac{\alpha}{2}\right)d\alpha \quad (4)$$



Plugging Eq2, Eq3, and Eq4 into Eq1, an equation for the resolution can be determined.

$$r = \frac{dl}{dL} = \frac{f\cos\left(\frac{\alpha}{2}\right)d\alpha\cos(\beta)}{dL'} = \frac{f\cos\left(\frac{\alpha}{2}\right)\cos(\beta)\cos(\alpha)}{H}$$

Resolution Simulation



Cost

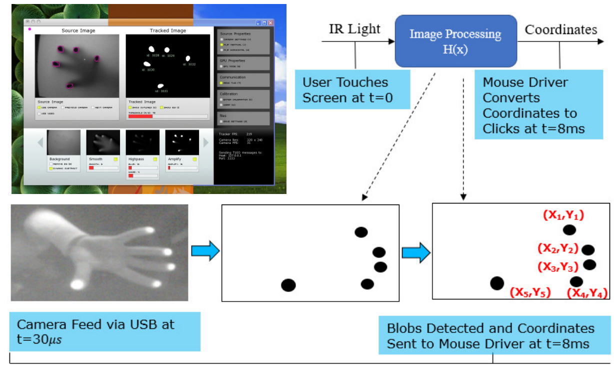
Development

Part	Price
Spectre 32" TV	$120
IR LEDs	$30
Sony PS EYE Camera	$2
IR BPF	$5
m12x0.5 lens mount	$10
Endlighten Acrylic	$115
Clear Acrylic	$12
Light Diffuser	$15
Additional Backlighting	$15
Trim	$10
Fan	$26
PCB Spin	$27
Total	$387

Production

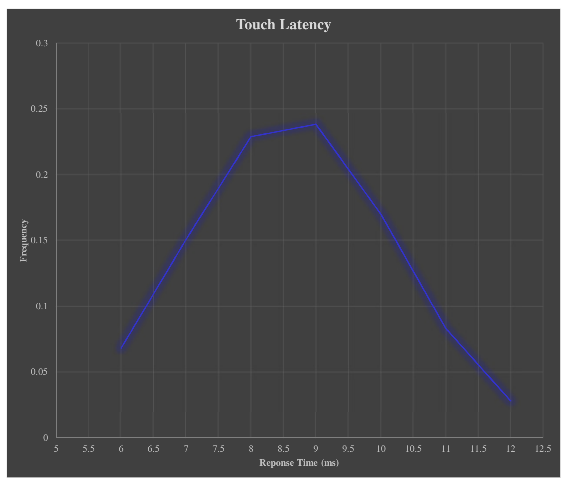
Part	Price
Spectre 32" TV	$120
IR LEDs	$30
Sony PS EYE Camera	$2
IR BPF	$5
m12x0.5 lens mount	$10
Endlighten Acrylic	$60
Clear Acrylic	$6
Light Diffuser	$8
Additional Backlighting	$15
Trim	$10
Fan	$26
PCB Spin	$9
Total	$301

Image Processing

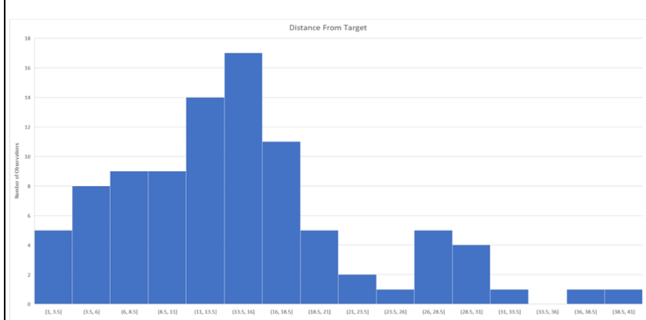


- **Our final design uses a wide-angled PS Eye camera equipped with an IR BPF and 1.8 mm lens.**
- **CCV (top left of above image) transforms the location of touch into X and Y coordinates.**
- **Those coordinates are sent to Touch Injector using the TUIO (Tangible User Interface Object) protocol and converted into mouse clicks.**
- **CCV allows for various filtering effects, such as high pass, blur, smooth, and amplification.**
- **CCV also has dynamic mesh calibration to allow for each user to customize the touch accuracy to their liking.**

Response Time



Experiment



Standard Deviation: 8.05 pixels   Mean: 14.37 pixels (6.35 mm)

References

[1] acrylite-shop.com, '*ACRYLITE - Shop*'. 2017, Available: https://www.acrylite-shop.com/US/us/acrylite-led/light-guiding-edge-lit-ga7iwmq7gnt.html. [Accessed: 015- Dec- 2017].

[2] "Playstation 3 Eye Camera". *Amazon.com*. 2018. [Online]. Available: https://www.amazon.com/PlayStation-Eye-3/dp/B000VTQ3LU [Accessed: 01-Feb-2018].

[3] "Raspberry Pi 3 Model B - Raspberry Pi", *Raspberry Pi*, 2018. [Online]. Available: https://www.raspberrypi.org/products/raspberry-pi-3-model-b/. [Accessed: 01- Feb-2018].