Team SmartDesk
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Meet the Team

Aidan Fitzpatrick
EE, Team Leader and Hardware Lead

Dan Mathieu
EE & CSE
Software Lead

Tristan Koopman
EE
Hardware Lead

John Melloni
CSE
Website and Software Lead
Have you ever had a messy desk?
Is your desk full of books, folders, loose papers, keyboard, mouse, calculator, pens and pencils?
Has a messy desk impaired your ability to complete your work efficiently?

NO MORE!
Needs Analysis

• Assess Needs:
  • Must allocate desk space to physical resources.
  • Messy desks cause a lack of workspace and decreased efficiency.
  • Current solutions are expensive and lacking versatility.
Current Products

IDEUM Touch Table Pro

• HD LCD 49” Display
• Multi-touch capabilities
• 3840x2160
• $14,950
• Does not require computer
• Windows 10 OS
• 45.7”x27.3”x33.5”

Promethean ActivTable

• HD LCD 46” Display
• Multi-touch capabilities
• 1920x1080
• $8,260
• Does not require computer
• Windows 7 OS
• 47.2”x29.6”x28.5”

Advisor: Siqueira
Needs Analysis

• Problem Statement:
  • Difficult for users to be productive with a messy work environment.
  • SmartDesk eliminates need for physical resources by offering digital versions for both use and storage.
  • System maintains characteristics of a conventional desk while offering the functionality of a touchscreen that interfaces with your current computer.
System Specifications

1. Touch screen desk with accuracy up to a pen-point.
2. Design retains the versatility of a conventional desk.
3. Desk interfaces with a standard desktop computer via USB and HDMI.
4. System has applications which replace the need for physical resources.
5. Touch processing has real-time response.
6. Screen will have sufficient resolution and brightness.
7. Surface is resistant to scratches and spills.
8. Interface to control touch screen power.
## Design Alternatives

<table>
<thead>
<tr>
<th>LEDS</th>
<th>LCD SCREEN</th>
<th>PROJECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear acrylic over front</td>
<td>Insert cameras with IR filters on the back casing of LCD TV.</td>
<td>Project screen onto smoked acrylic with LED array.</td>
</tr>
<tr>
<td>Finger reflects light</td>
<td>Finger reflects light down to cameras when acrylic touched.</td>
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<td>down to cameras when</td>
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<td>acrylic touched.</td>
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<tr>
<td>LASERS</td>
<td>Clear acrylic over front of screen.</td>
<td>Project screen onto smoked acrylic.</td>
</tr>
<tr>
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Design Alternatives

- Insert cameras with IR filters on the back casing of LCD TV.
- Clear acrylic over front of screen with LED array.
- Finger reflects light down to cameras when acrylic touched.

![Diagram of LCD screen with LEDs and cameras]
Design Alternatives

- Project screen onto smoked acrylic with LED array.
- Put IR cameras around projector.
- Finger reflects light down to cameras.
Design Alternatives

LCD SCREEN

LASERS

- Clear acrylic over front of screen.
- Create coordinate grid on top using two lasers and many receivers.
- Finger disrupts lasers and movement tracked by receivers.

Department of Electrical and Computer Engineering  Advisor: Siqueira
Design Alternatives

PROJECTOR

- Project screen onto smoked acrylic.
- Create coordinate grid on top using two lasers and many receivers.
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LASERS

- Clear acrylic over front of screen.
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LCD SCREEN

- Insert cameras with IR filters on the back casing of LCD TV.
- Clear acrylic over front of screen with LED array.
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Back Casing

Projector

Laser Receivers

Smoked Acrylic

Lasers
Design Alternatives

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| • Sufficient leg room, high resolution, and highest touch accuracy.  
• Cost: ~$25 for LEDs  
~$80 for 4 IR cameras  
~$130 for 32” screen | • Minimal leg room, low resolution, but high touch accuracy.  
• Cost: ~$25 for LEDs  
~$20 for 1 IR camera  
~$80 for projector |
| • Maximum leg room, high resolution, but poor touch accuracy.  
• Cost: ~$40 for 2 lasers  
~$15 per receiver  
~$130 for 32” screen | • Minimal leg room, low resolution, and poor touch accuracy.  
• Cost: ~$40 for 2 lasers  
~$15 per receiver  
~$80 for projector |
Design Selection

**LCD Screen:**
- High Resolution
- Brightness
- Low physical space requirement

**IR LED strip with IR Camera:**
- High accuracy
- Image processing
- Multi touch capability

**Cost:**
- $25 for LEDs
- $80 for 4 IR cameras
- $130 for 32” screen
- $100 for Plexiglass Sheet

**Total Cost:** ~$340
Risk Analysis

Risk:
1. Noise from the LCD screen will not allow an accurate capture of the IR light.
2. Image processing not fast enough for real time detection and response to touch.
3. Space limitation will not allow camera to see entire screen.
4. Screen dissipates excessive heat, causing discomfort

Mitigation:
1. IR filter on cameras to filter out natural light.
2. Improve image processing to only detect differences between images.
3. Use multiple cameras in the corners of the screen and stitch the images together before image processing.
4. Cooling system
Block Diagram

- **Desk**
  - LED Array
    - IR Light
  - Acrylic Sheet
    - End Lighten
    - Abrasion Resistant
  - LCD Screen
    - 32" Monitor
  - Camera
    - 4 IR Cameras

- **Power Switch**
  - Hardware Switch

- **PC**
  - Operating System
  - Touch Applications
    - Calculator
    - CAD
    - Games
  - Mouse Driver

- **Image Processor**
  - CCV
  - USB
  - HDMI

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Department of Electrical and Computer Engineering

Advisor: Siqueira
Block Diagram: Subsystem Requirements

Touch Screen Requirements:
- IR light travels through surfaces
- Comfortably fits under the desk without impairing the ability to sit
- Cameras filter excess noise
- Surface is resistant to scratches and spills

Software Requirements:
- Responds in real time
- Multi touch capability
- Pen-point accuracy
- Applications replace physical resources
Assumptions:
- USB 3.0 with 5gbps
- Worst case of image concatenation time modeled using MATLAB
- Data pipelines between applications are modeled as instantaneous
- Image processing running at 20fps
- Graph from human benchmark project with over 55 million data samples
MDR Deliverables

- Working Test Bed:
  - Plexiglass and LED strip installed on surface of desk
  - LCD with backlight screen mounted underneath plexiglass
  - Power supply and PCBs installed on sides of desk
  - Drawer containing cameras and Raspberry Pi
FPR Deliverables

- Fully functional touch screen integrated into a desk
  - Multi touch capabilities
  - High touch accuracy
  - Minimal latency
- Expansive set of applications showing off utility
  - Integration with the Microsoft Suite of applications, as well as standard Windows apps
  - Custom-made software for organizational and entertainment purposes
  - Specific applications to be ironed out as the project progresses!
Thank You!

ANY QUESTIONS?
Team Member Assignments

- Aidan
  - Prototyping IR Detection
  - Plexiglass + IR LED Installation
- Dan
  - Prototyping IR Detection
  - Cameras with IR BPF
- John
  - Rasp Pi
  - Website
- Tristan
  - PSU
  - LCD Installation with LCD PCBs