# Multi-Touch Table with Object Recognition
## codename Planck

Group 14

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## Project Narrative Description

In recent years large software companies such as Microsoft, Apple, and Google have been moving toward highly intuitive, easy-to-use, touch based interfaces. However complex applications still require the use of traditional tools, such as mice and keyboards. Our goal is to remove the need for traditional input in favor of multi-touch gestures and real life objects that are in some way relevant to the application.

Planck is a consumer level optical recognition table capable of controlling complex systems where the end user may use a combination of their hands and supplementary objects. The aim of Planck is to create a novel tool set that can be integrated into several software solutions. Planck will be of sufficient size to accommodate multiple users simultaneously.

To showcase the tool set we plan to create a real time battle simulator. We chose this application because it offers an adequate test bed to showcase the innovative touch and fiducial techniques that Planck will be capable of. A fiducial is a unique pattern, that when placed in the field of view, can be interpreted as having meaning within the application (Fig 1.). These patterns can be attached to objects that are meaningful to the user when using the application. The pattern's orientation information can be used to supplement the functionality. Our application will be capable of taking in inputs such as touch, dragging, multi-finger gestures, fiducials for stamping, fiducials as stationary points, and fiducials as storage devices. With these techniques we will be able to provide a robust set of commands capable of being used in a variety of applications.

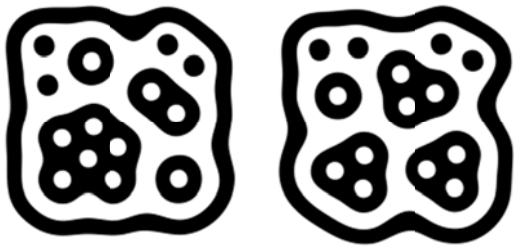
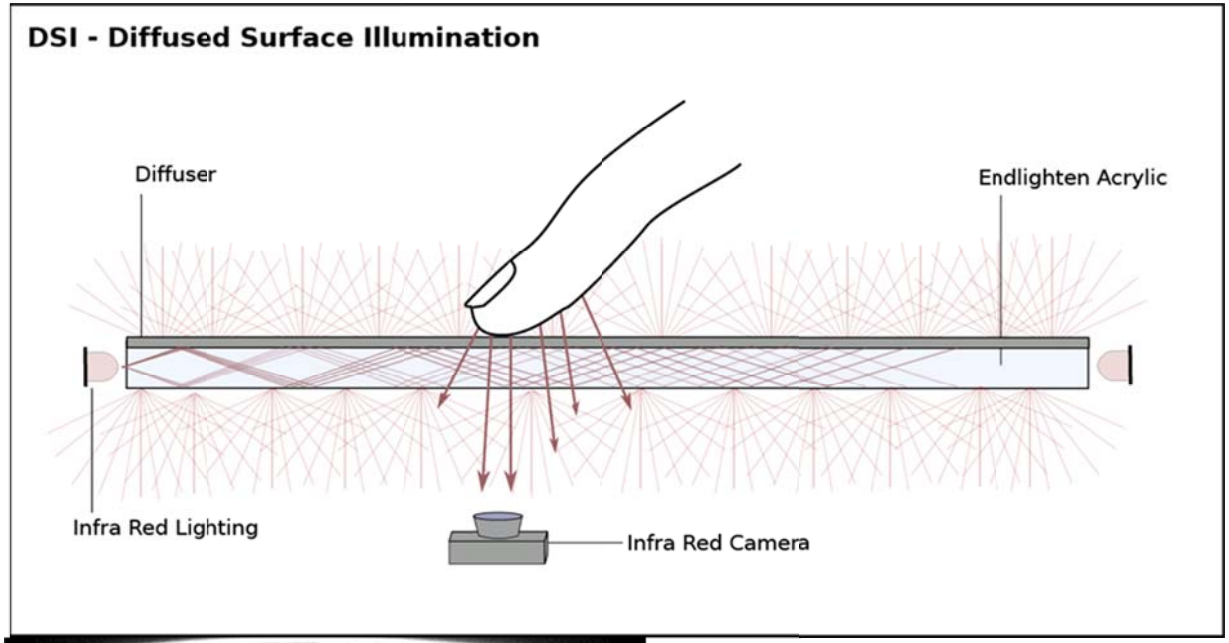
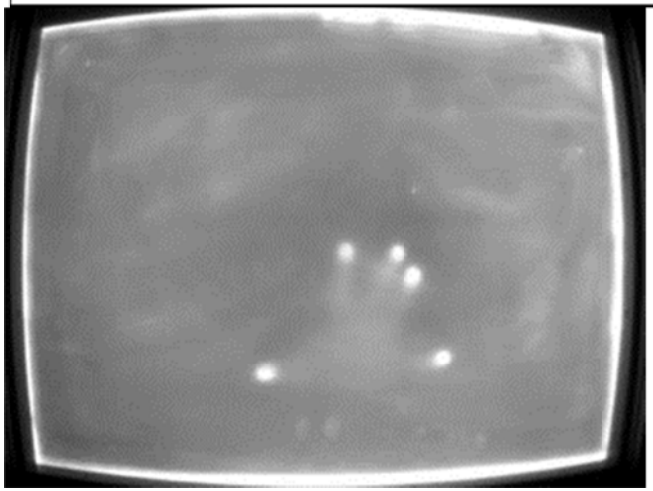


**Fig 1.** 'Amoeba' style fiducials

DSI - How It All works



DSI Parts List:

1. Mirror Particle Acrylic
2. IR LED's
3. Projection Surface
4. IR Camera

## Specifications

- System will be comprised of Diffused Surface Illumination technology (DSI)
- A special mirrored particle acrylic
- IR LED's to illuminate acrylic
- IR camera to detect 'blobs' on the acrylic surface
- Projector to transmit desktop image to a display below the mirrored particle acrylic
- Table to enclose all hardware
- System should be able to read fiducials 2"x 2" and bigger (up to screen size)
- The acrylic screen will have an LED spaced at least every inch encompassing the border
- Usable system screen size of 40 diagonal inches
- The border between the screen and acrylic edge shall be no greater than three inches

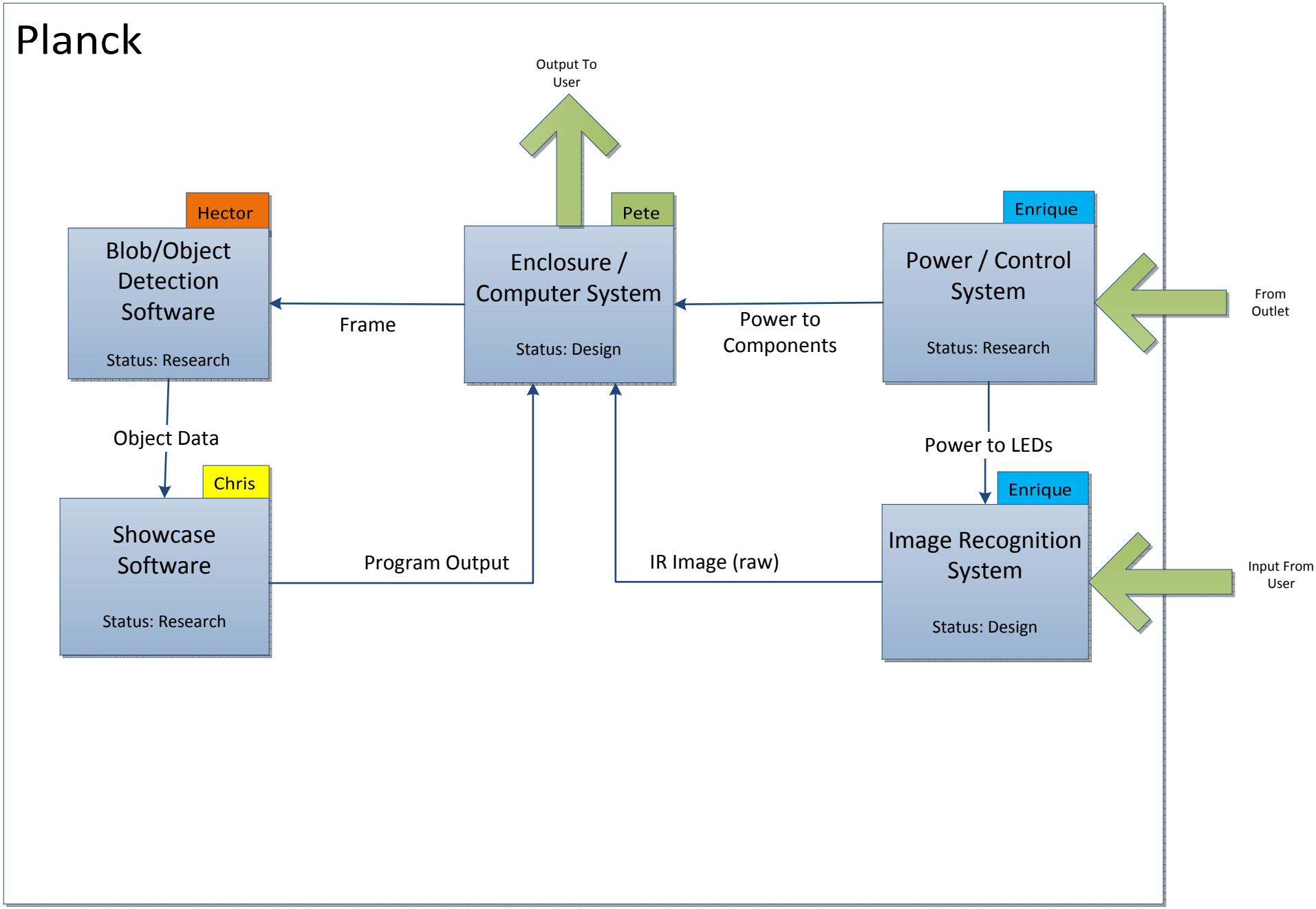
## Requirements

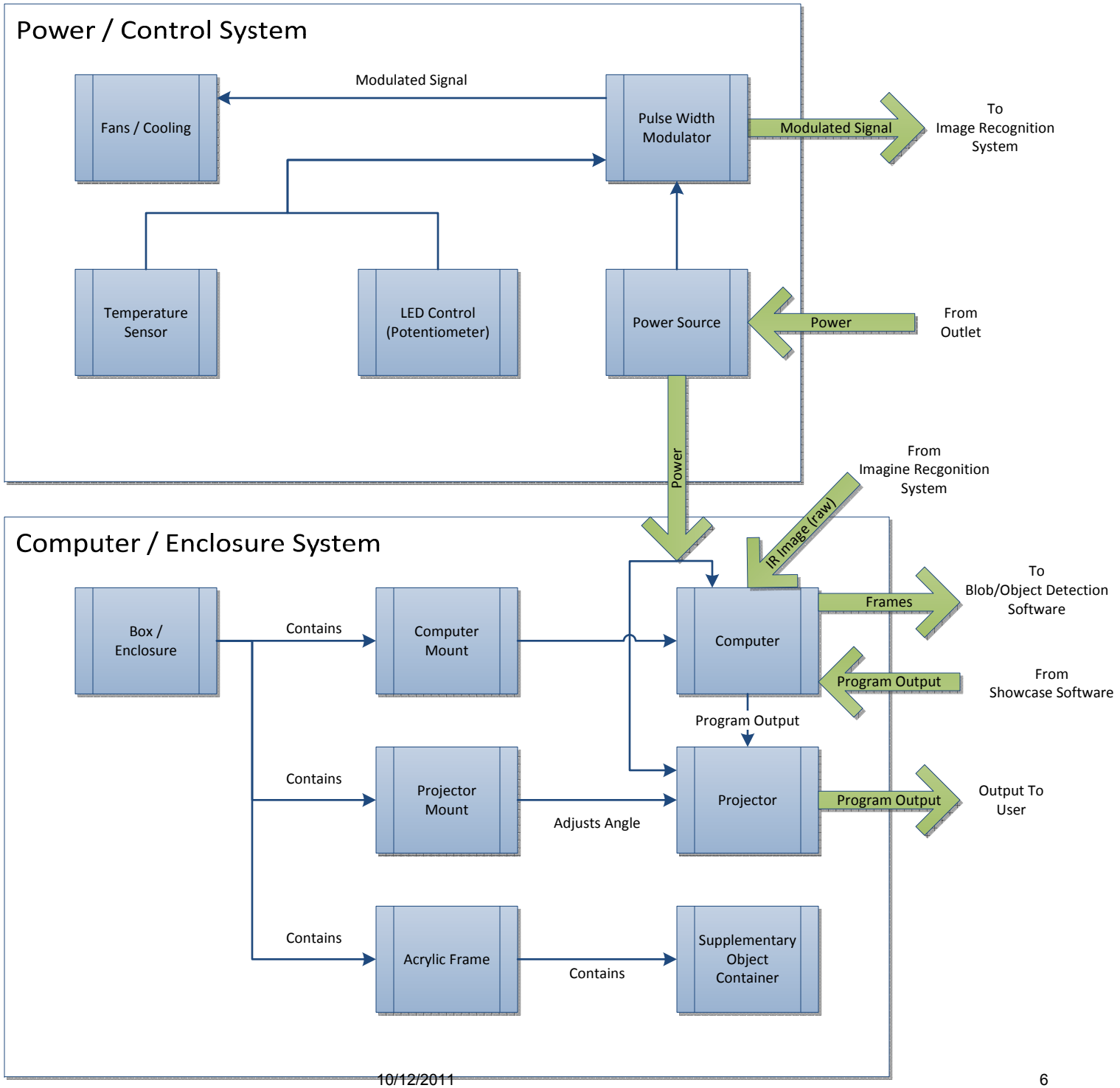
- Computer
    - The projector shall display an image onto the projection surface
    - The computer shall be fast enough to display the associated object from the finger touch in less than 10 ms.
- Enclosure
    - The internal temperature of the enclosure shall not exceed the highest operating temperature of any of the enclosed devices
    - The enclosure must be able to fit through a standard doorway
    - The enclosure must be big enough to house all hardware items
    - The enclosure and all hardware (the assembled product) must be lighter than 100 pounds so two people can carry.
    - The enclosure must have a doorway to access all internal parts
    - The enclosure shall not be constructed with a height higher than 4 feet.

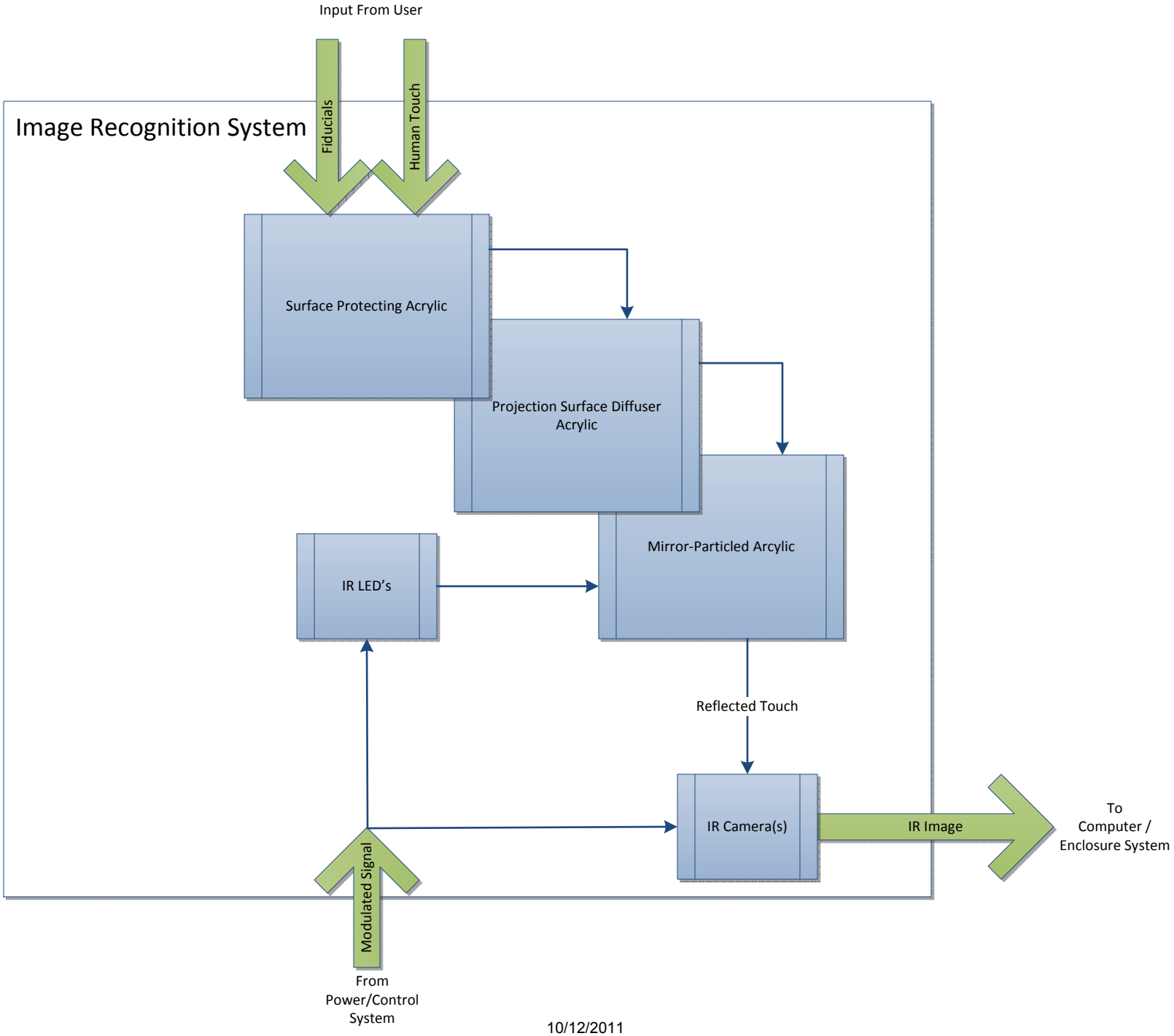
- Blob/Object Detection Software
    - The system shall detect fiducials.
    - The software shall detect a finger touch.

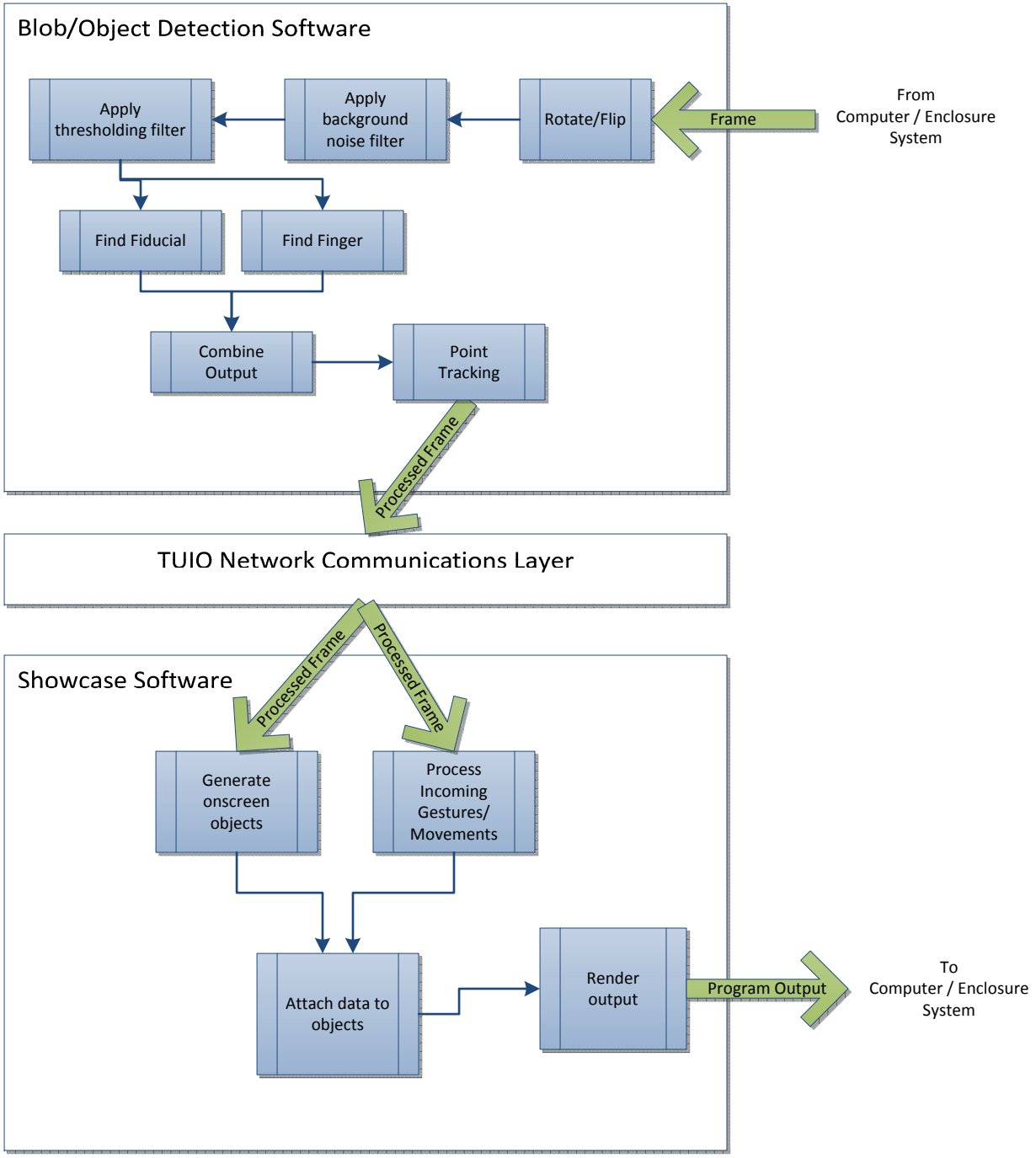
- Image Recognition System
    - The surface touch system shall detect fingers and fiducials in an indoor, dimly lit environment
- Power
    - The power supply must provide enough wattage to power the system (LED's, Computer, camera, projector)
- Showcase Application
    - Software application shall be able to drag multiple objects simultaneously
    - Application must run on a Windows platform

# Planck


Output To User
Hector
Blob/Object Detection Software
Status: Research
Pete
Enclosure / Computer System
Status: Design
Enrique
Power / Control System
Status: Research
From Outlet
Frame
Power to Components
Object Data
Power to LEDs
Chris
Showcase Software
Status: Research
Program Output
IR Image (raw)
Enrique
Image Recognition System
Status: Design
Input From User


Power / Control System
Modulated Signal
Fans / Cooling
Pulse Width Modulator
Modulated Signal
To Image Recognition System
Temperature Sensor
LED Control (Potentiometer)
Power Source
Power
From Outlet
Power
From Imagine Recgonition System
IR Image (raw)
Computer / Enclosure System
Box / Enclosure
Contains
Computer Mount
Computer
Frames
To Blob/Object Detection Software
Program Output
From Showcase Software
Program Output
Contains
Projector Mount
Adjusts Angle
Projector
Program Output
Output To User
Contains
Acrylic Frame
Contains
Supplementary Object Container


Input From User
Image Recognition System
Fiducials
Human Touch
Surface Protecting Acrylic
Projection Surface Diffuser Acrylic
Mirror-Particled Arcylic
IR LED's
Reflected Touch
IR Camera(s)
IR Image
To Computer / Enclosure System
Modulated Signal
From Power/Control System


Blob/Object Detection Software
Apply thresholding filter
Apply background noise filter
Rotate/Flip
Frame
From Computer / Enclosure System
Find Fiducial
Find Finger
Combine Output
Point Tracking
Processed Frame
TUIO Network Communications Layer
Processed Frame
Processed Frame
Showcase Software
Generate onscreen objects
Process Incoming Gestures/ Movements
Attach data to objects
Render output
Program Output
To Computer / Enclosure System

## Budget

| Major Electronics | Projected Cost |
|---|---|
| | |
| Computer | $1,100.00 |
| Short Throw Projector | $1,450.00 |
| Cameras | $300.00 |
| | |
| Enclosure Materials | |
| Endlighten Acrylic | $230.00 |
| Rear Projection Acrylic | $220.00 |
| Mar Resistant Acrylic | $75.00 |
| Wood | $300.00 |
| Misc(screws, glue, etc) | $50.00 |
| | |
| Electronics | |
| LEDs | $100.00 |
| Fans | $50.00 |
| Other Components | $200.00 |
| | |
| Development Board | |
| Acrylic | $150.00 |
| Electronics | $50.00 |
| | |
| Other Costs | |
| Shipping & Cutting | $500.00 |
| | |
| Total | $4,775.00 |

**Fig 2.**

Due to the heavy processing power required for Multi-touch, the computer that will be doing the processing will likely have to be reasonably high end. This will probably mean the purchase of a second-gen Intel i-core. The video card will have to be powerful enough to run our openGL graphics main application. The goal is to never allow the computer to be the bottleneck of the system. The power supply for the computer will also likely control the power for all other components so it will have to be big enough to power both the quad core computer system, the modulation controller, the LED's, and the enclosure fans.

It's unclear yet the kind of cameras we will need to use, either USB or firewire. The cameras will have to have a minimum of 30fps and 640x480 resolution. We also have the option of potentially using multiple cameras stitched together, which could significantly vary the cost.

The projector is needed to display the application to the user. The short-throw projector is needed over a long-throw due to the limited space in the enclosure. Short-throw projectors are all similar in resolution specifications and have similar throw distances. The costs are closely the same as

well. Short-throw projectors can cost as much as $1500 online due to advanced technology used to produce such a short throw.

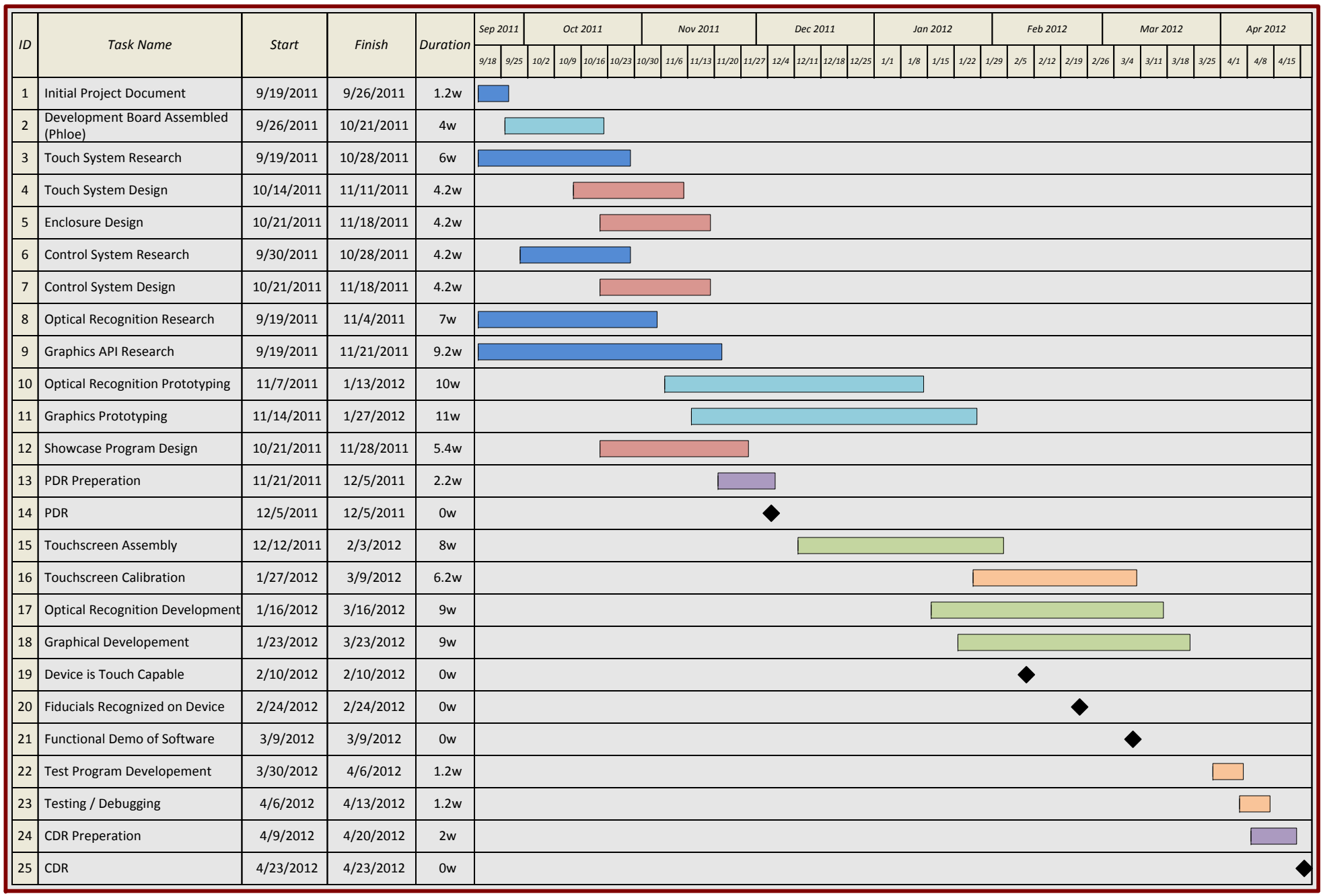
Estimates for all acrylic were made for a 50" diagonal screen. It hasn't yet been determined if the LEDs will be spaced along the edge at inch intervals or half inch intervals. This would effectively double the cost of the LEDs.

There will be pulse width modulation controlling the brightness of the LEDs. It is possible that additional components may be decided on later to control the fan speed.

The development board (PHLOE) is designed to be a cheap internal tool to allow for multiple people to do software development without interaction with the full scale device. The parts decided for it will be scaled to the budget, rather than the budget scaled to meet specifications.

The project will be financed by Workforce Central Florida. A single member of the group will be designated the accountant to keep track of, and approve spending. Until the sponsorship from Workforce Central Florida is received, members may pay for parts out of their own pocket at their own discretion and be reimbursed if the team agrees.

| ID | Task Name | Start | Finish | Duration |
|---|---|---|---|---|
| 1 | Initial Project Document | 9/19/2011 | 9/26/2011 | 1.2w |
| 2 | Development Board Assembled (Phloe) | 9/26/2011 | 10/21/2011 | 4w |
| 3 | Touch System Research | 9/19/2011 | 10/28/2011 | 6w |
| 4 | Touch System Design | 10/14/2011 | 11/11/2011 | 4.2w |
| 5 | Enclosure Design | 10/21/2011 | 11/18/2011 | 4.2w |
| 6 | Control System Research | 9/30/2011 | 10/28/2011 | 4.2w |
| 7 | Control System Design | 10/21/2011 | 11/18/2011 | 4.2w |
| 8 | Optical Recognition Research | 9/19/2011 | 11/4/2011 | 7w |
| 9 | Graphics API Research | 9/19/2011 | 11/21/2011 | 9.2w |
| 10 | Optical Recognition Prototyping | 11/7/2011 | 1/13/2012 | 10w |
| 11 | Graphics Prototyping | 11/14/2011 | 1/27/2012 | 11w |
| 12 | Showcase Program Design | 10/21/2011 | 11/28/2011 | 5.4w |
| 13 | PDR Preperation | 11/21/2011 | 12/5/2011 | 2.2w |
| 14 | PDR | 12/5/2011 | 12/5/2011 | 0w |
| 15 | Touchscreen Assembly | 12/12/2011 | 2/3/2012 | 8w |
| 16 | Touchscreen Calibration | 1/27/2012 | 3/9/2012 | 6.2w |
| 17 | Optical Recognition Development | 1/16/2012 | 3/16/2012 | 9w |
| 18 | Graphical Developement | 1/23/2012 | 3/23/2012 | 9w |
| 19 | Device is Touch Capable | 2/10/2012 | 2/10/2012 | 0w |
| 20 | Fiducials Recognized on Device | 2/24/2012 | 2/24/2012 | 0w |
| 21 | Functional Demo of Software | 3/9/2012 | 3/9/2012 | 0w |
| 22 | Test Program Developement | 3/30/2012 | 4/6/2012 | 1.2w |
| 23 | Testing / Debugging | 4/6/2012 | 4/13/2012 | 1.2w |
| 24 | CDR Preperation | 4/9/2012 | 4/20/2012 | 2w |
| 25 | CDR | 4/23/2012 | 4/23/2012 | 0w |




Research
Prototyping
Design
Testing
Developement
Preperation

## References


1. Senior Design Poker Table 2009 - http://eecs.ucf.edu/seniordesign/su2009fa2009/g04/
2. Bespoke Software Research multi-touch table - http://www.bespokesoftware.org/publications/56110523.pdf
3. Natural User Interface Group website - http://nuigroup.com/forums
4. DSI Explanation - http://iad.projects.zhdk.ch/multitouch/?p=90