
GDC 11
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Shanghai Exhibition Center, China
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UBM

Rapid Prototyping Techniques for Kinect Game Development

What do I mean by "Rapid Prototyping"?

- Trying out new ideas quickly
- Being creative instead of being correct
- Fast iteration times

Why use "Rapid Prototyping"?

- It's Fun!
- Helps you find unique solutions
- Helps you jump start projects
- Great for learning new interaction models

Why use "Rapid Prototyping"?

- It's Fun!
- Helps you f

ls

Talk Overview

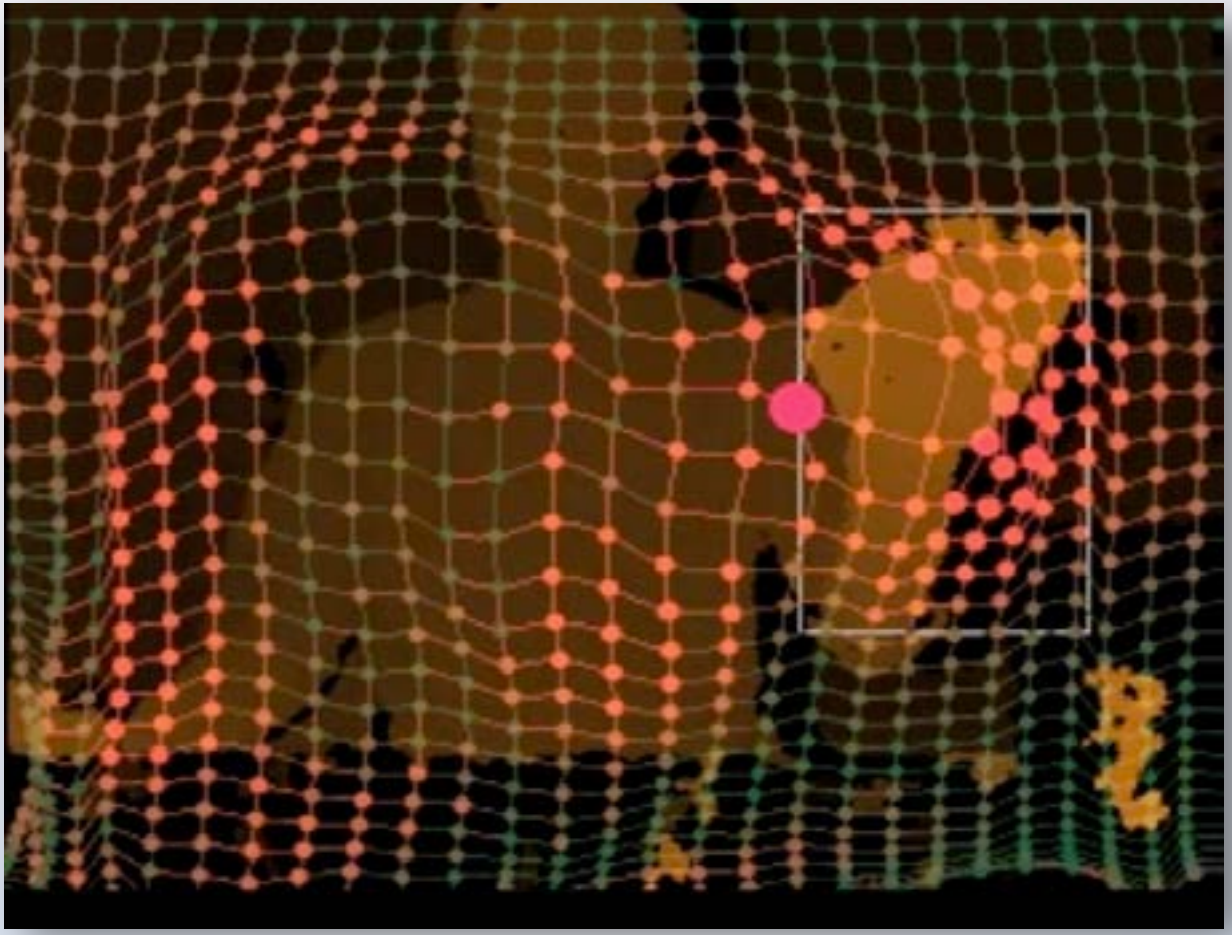
- Introduction to Double Fine

Talk Overview

- Kinect Capabilities and Limitations

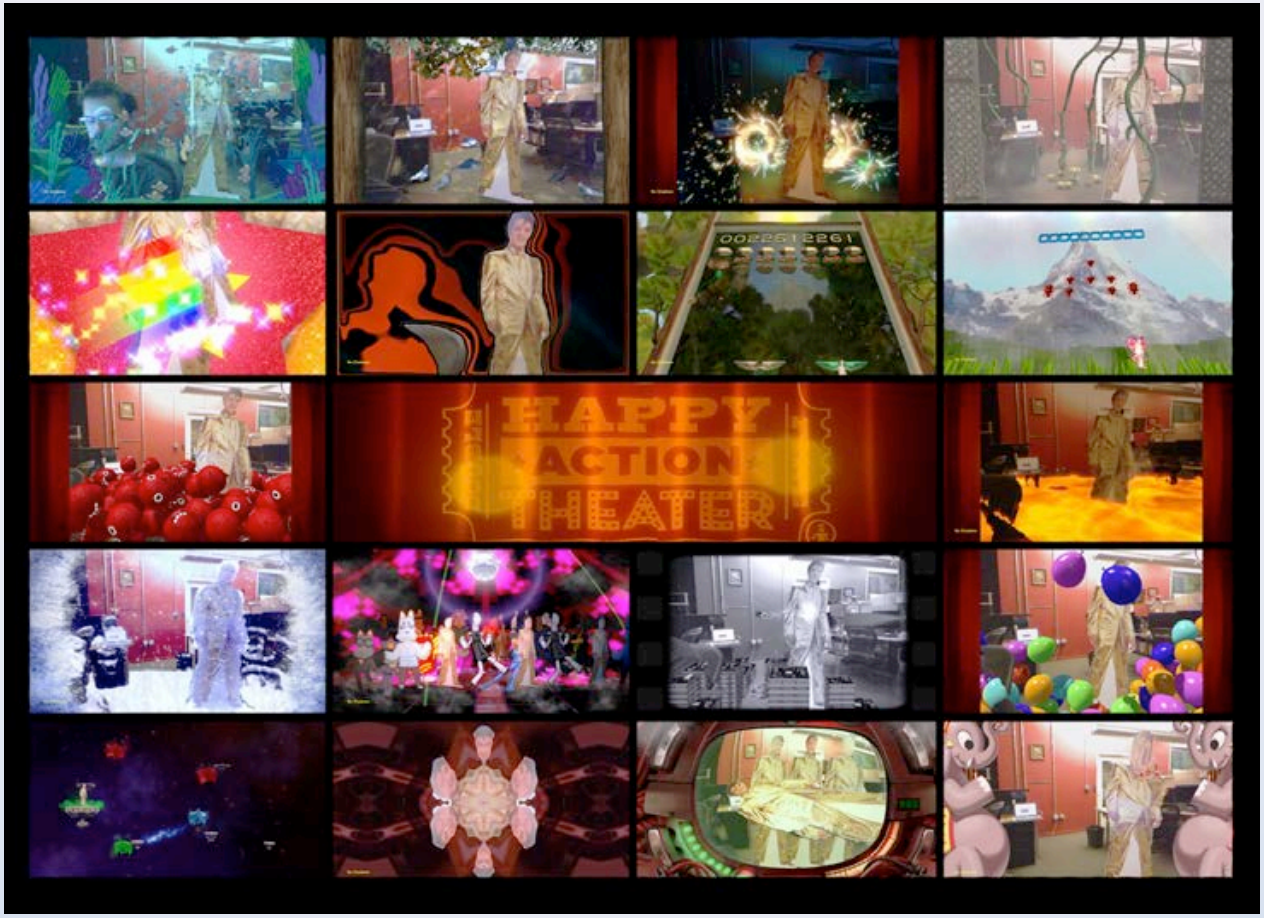
Talk Overview

- Rapid Prototyping Techniques



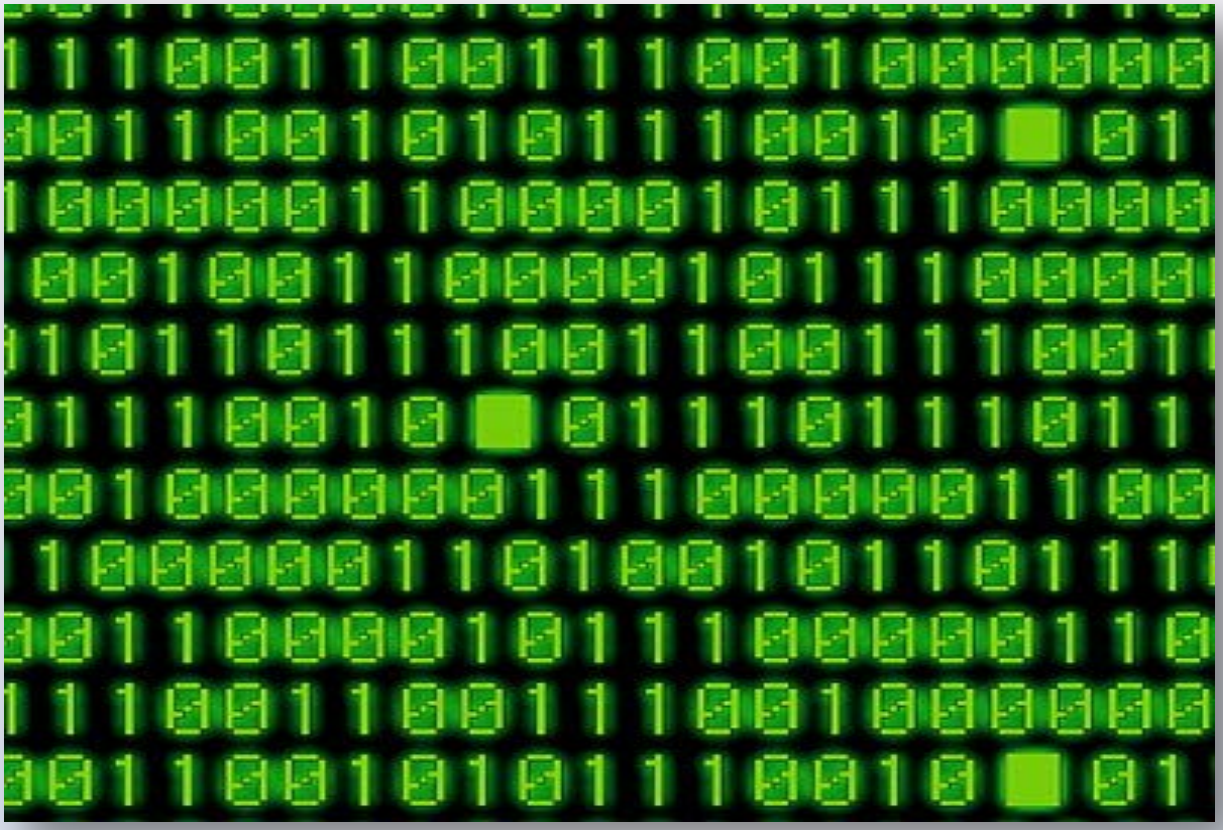
Talk Overview

- Rapid Prototyping Results



Talk Overview

- Software Links



Introductions

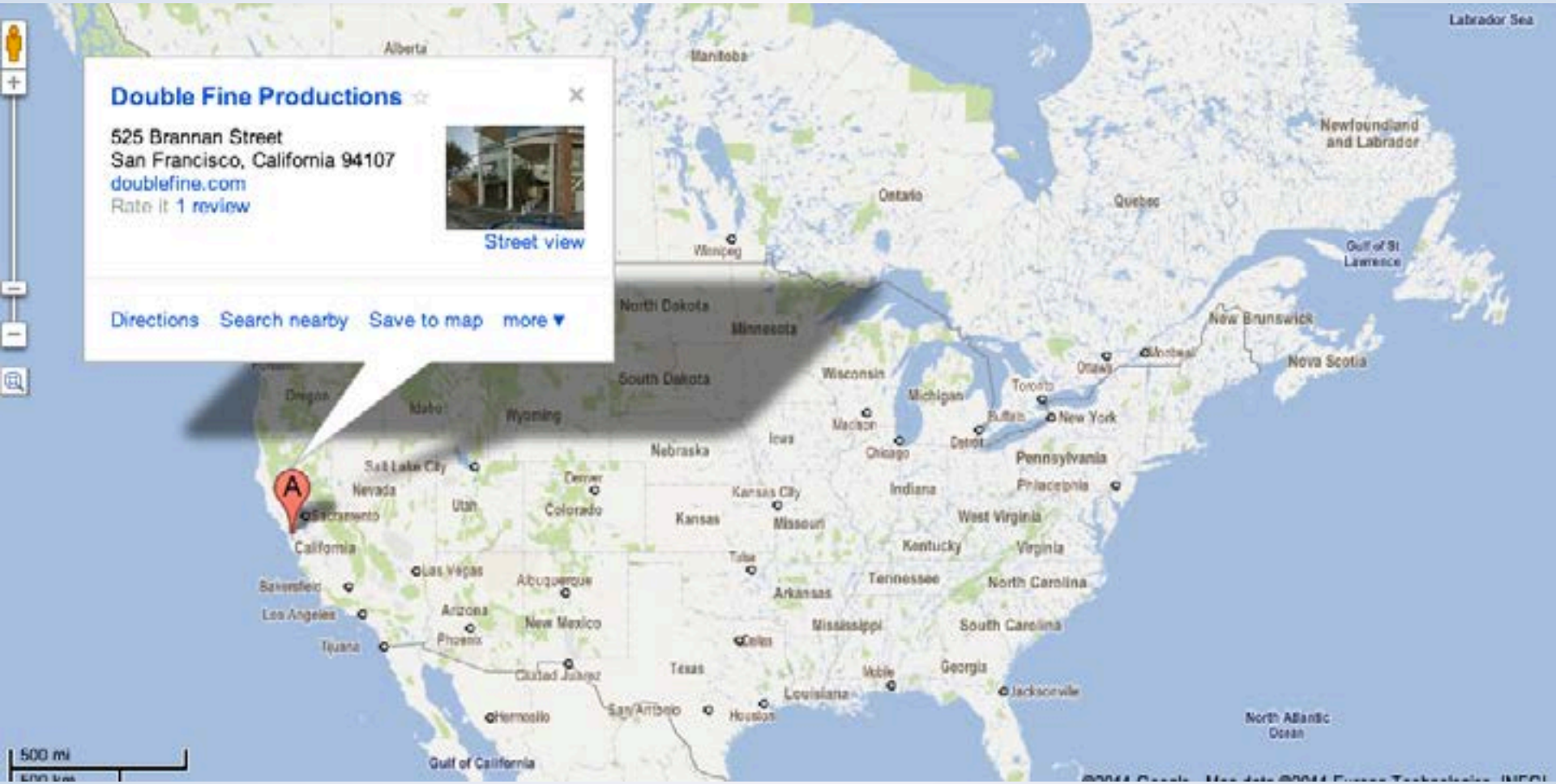
Introductions

- My name is Drew Skillman
  - Technical Artist at Double Fine Productions

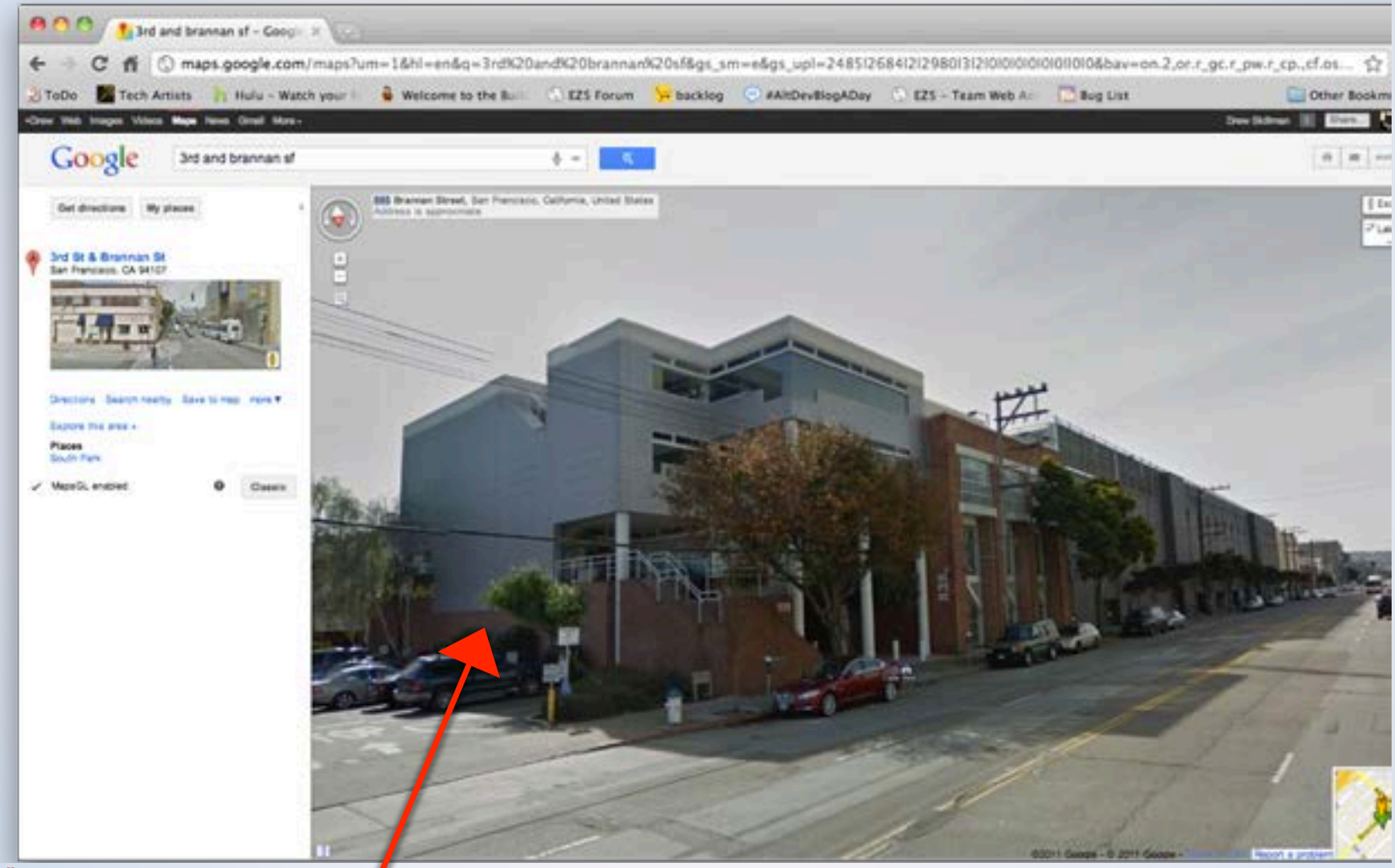
Introductions

- My name is Drew Skillman
  - Specialize in Visual Effects and Graphics

Introductions



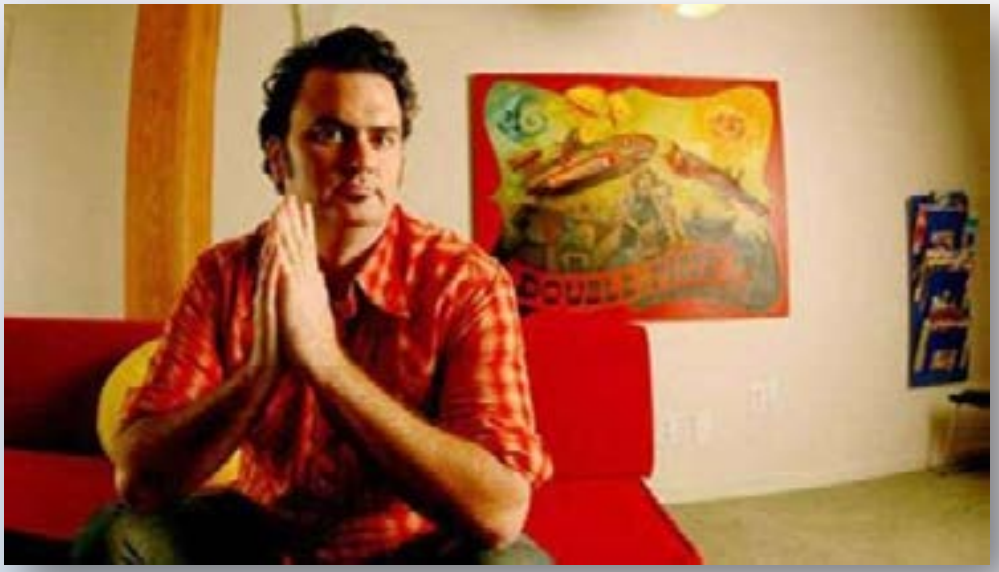
Introductions



We are here

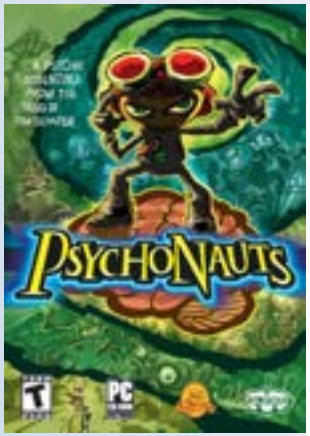
Introductio

- **Double Fine Productions**
  - Independent game studio
  - Led by Tim Schafer

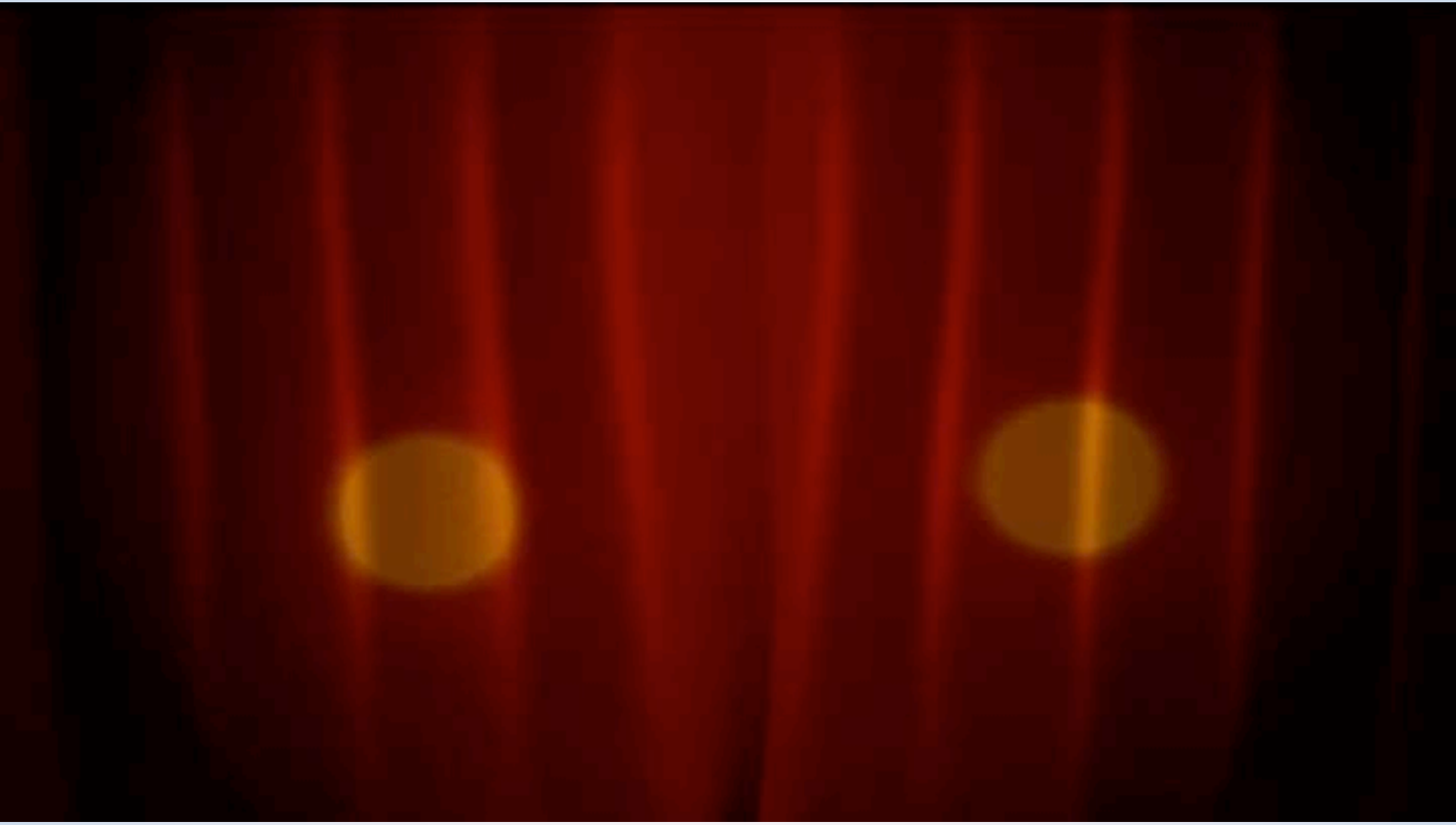


Introductions

- **Double Fine Productions**
  - 6 critically acclaimed titles:



Double Fine Happy Action Theater



DOUBLE HAPPY ACTION THEATER FINE

- Tim's Idea
- Target Audience
  - Children: 3 to 8 years old
  - 20 something's at a party
  - People passing a display kiosk

- Perfect situation for Rapid Prototyping
  - New input paradigm
  - Short schedule
  - Small team
  - Many games
  - *CRAZY CONCEPT ART!*


RAZ COSTUME OR JUST HAT
Goggalor - Play as giant Raz from Psychonauts, smashing tiny buildings in Lungfishopolis.
Or play as any giant movie monster and crush, crumble, and chomp your way through a city.
Werewolf Fog - Players walk through thick, Vincent Price movie fog, hanging low to the
YOU ARE SO ON FIRE!
OUCHY!
Hot Lava Living Room - Players see their own living room with
the warning: "Four Seconds until HOT LAVA!" When the count down hits
Dots on screen light up in order, touch lit up lights to reveal


DOUBLE
HAPPY
ACTION
THEATER
FEATURE

Kinect Overview

Why Bother?

- Over 10 million units sold
- Fastest selling consumer electronics device ever

Why Bother?

- New devices on their way

Where did it come from?

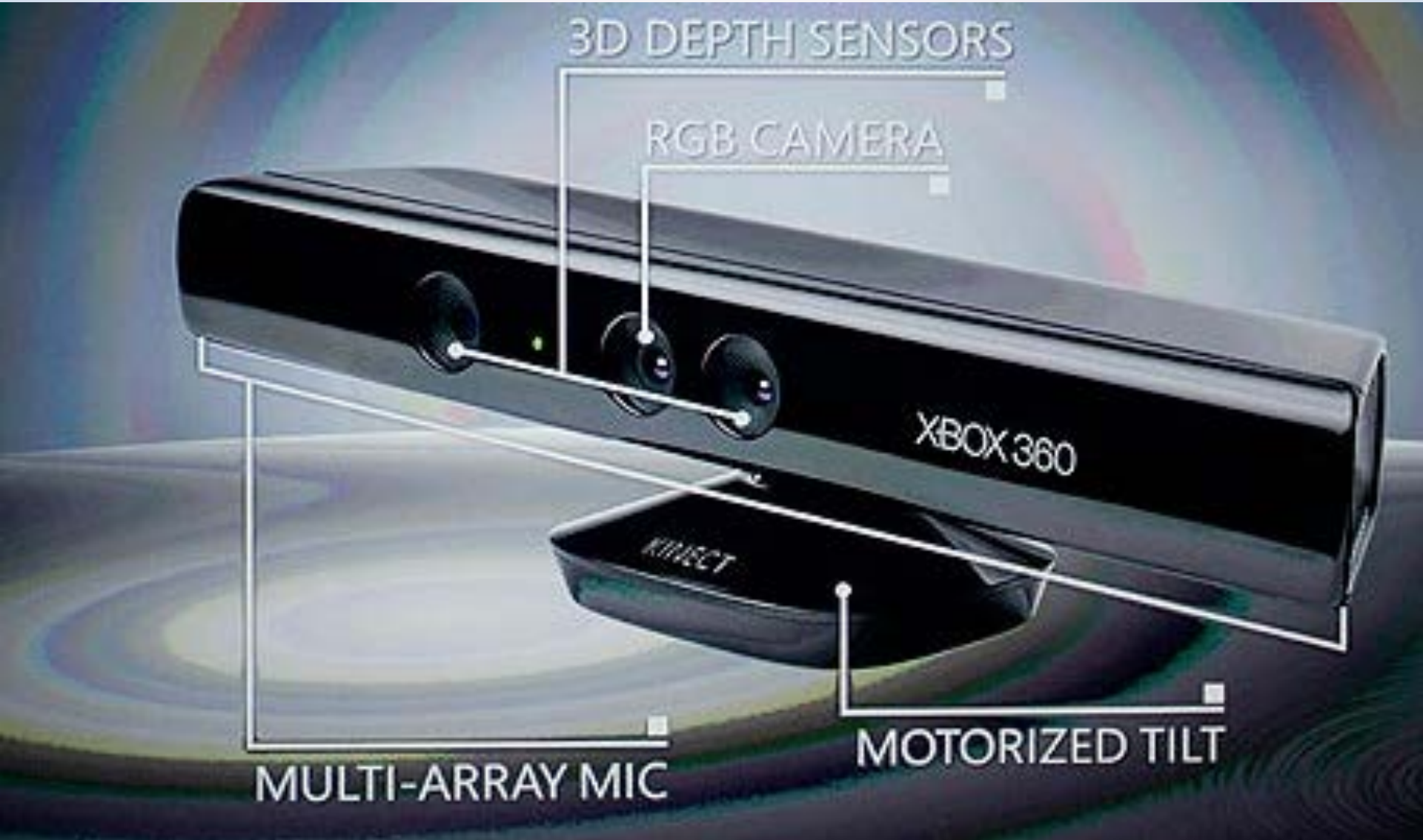
- Created by engineers in the Israeli Military

PrimeSense

- Almost ended up here

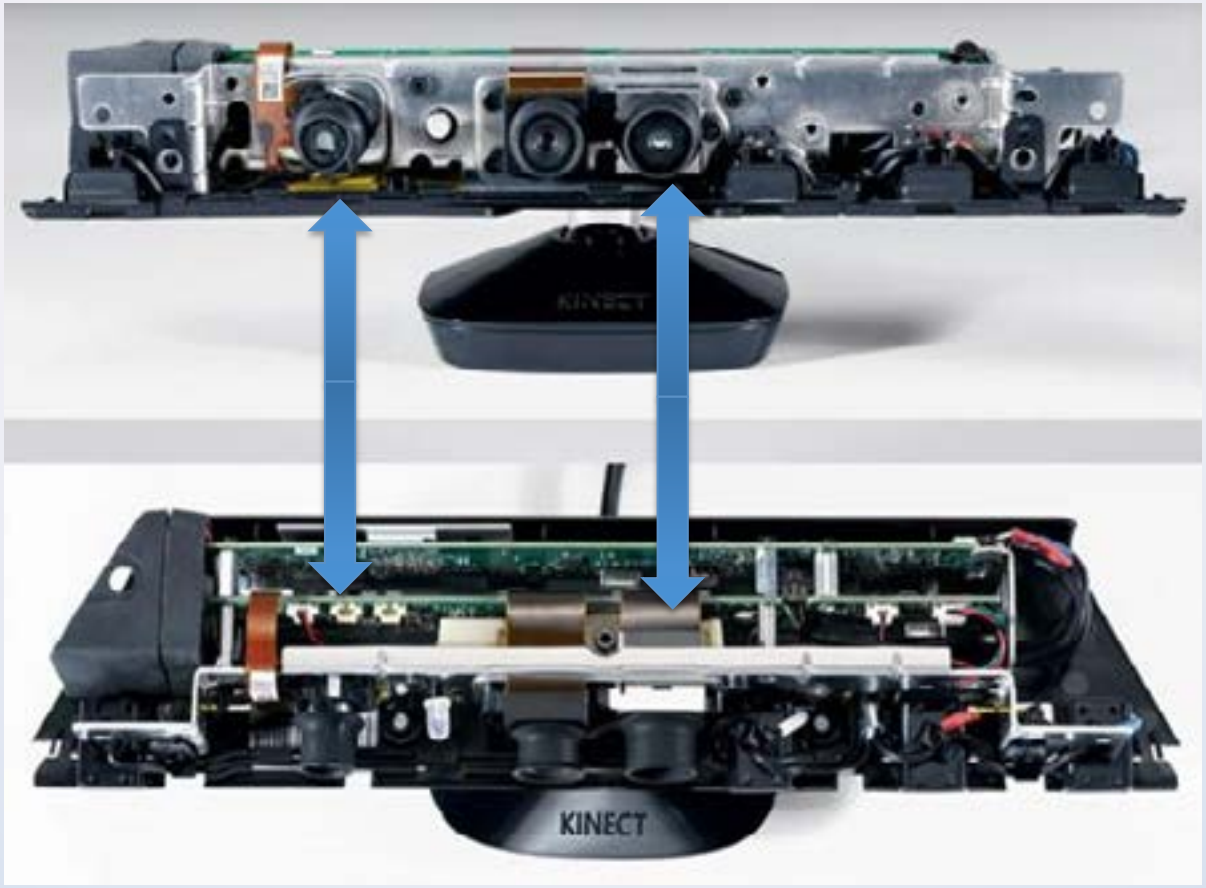
- But they got it

Capabilities



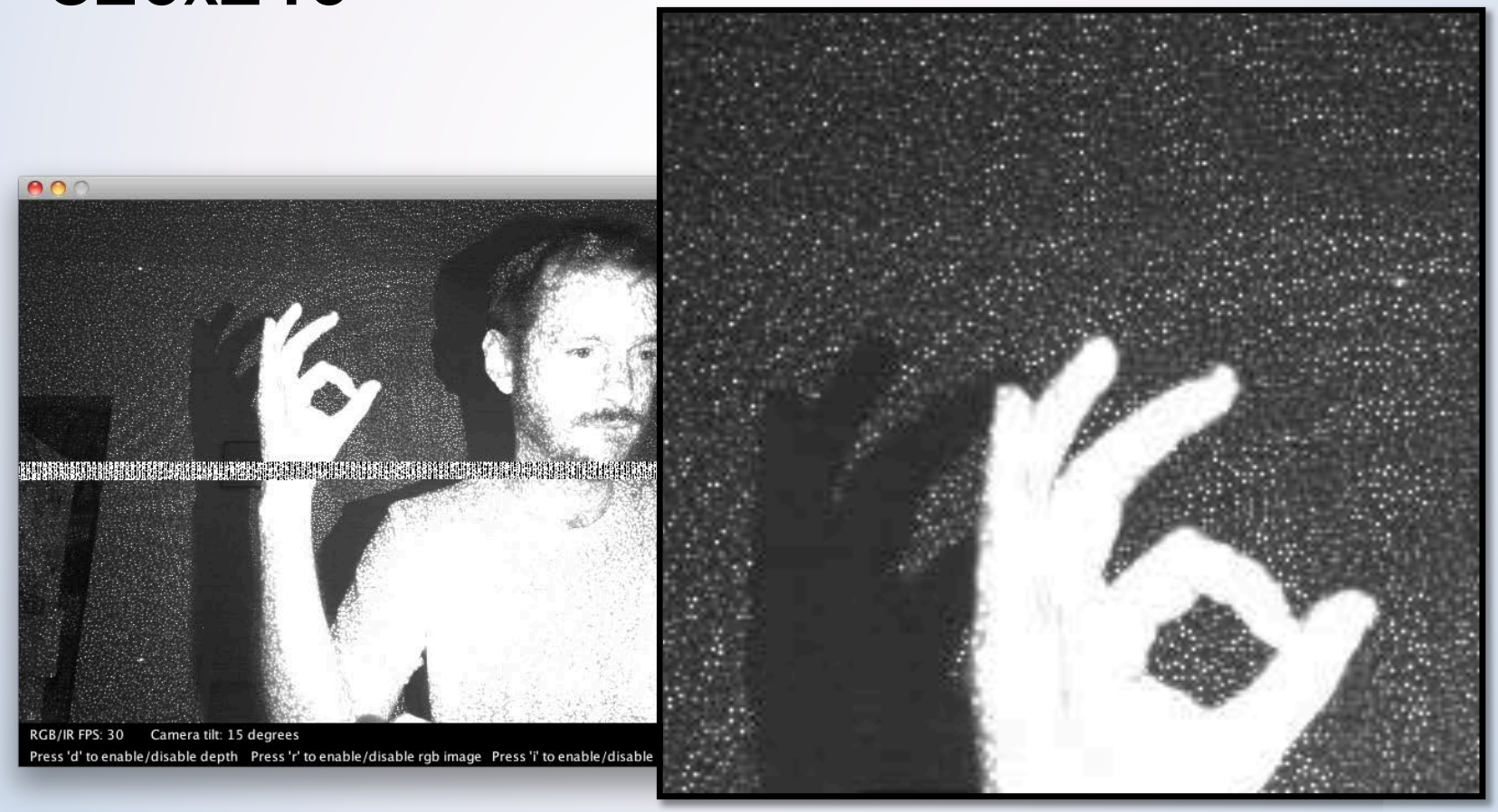
Depth

- **Infrared emitter/receive pair**



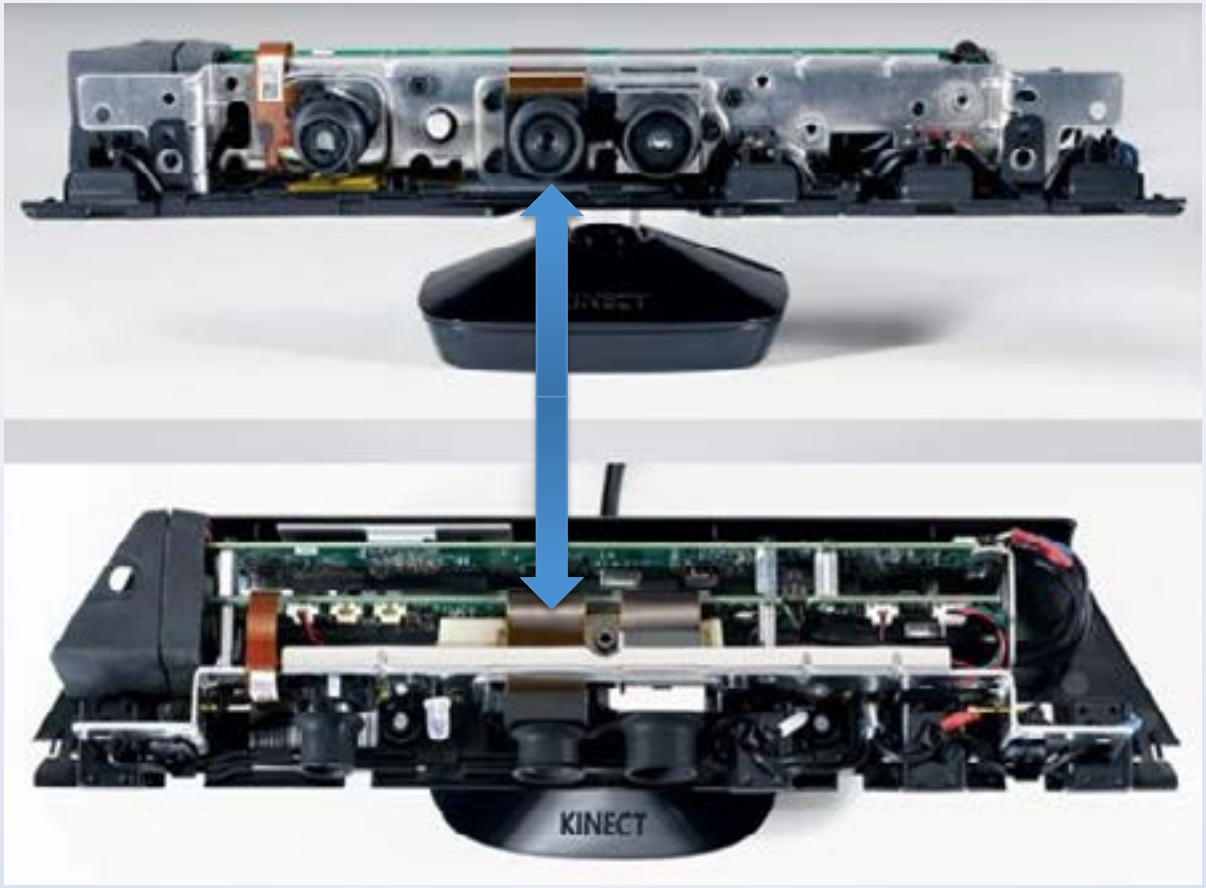
Depth

- Infrared emitter/receive pair
- 320x240



Color

- Color RGB Camera

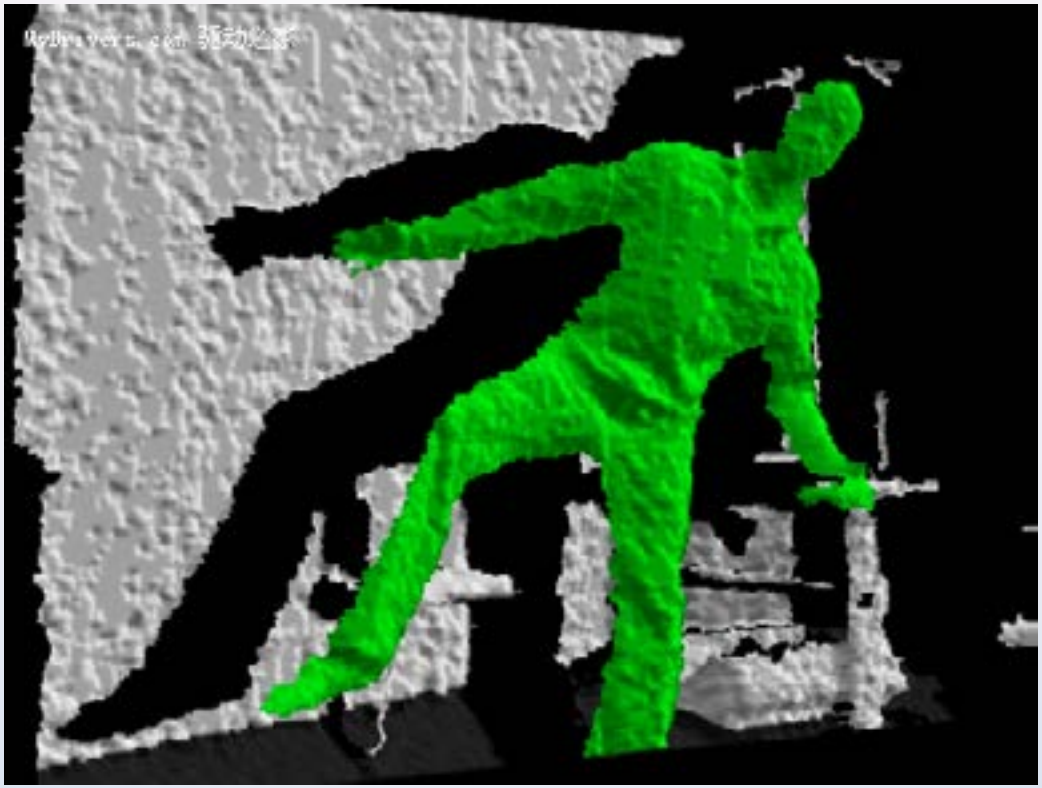


Color

- Color RGB Camera
- 640x480

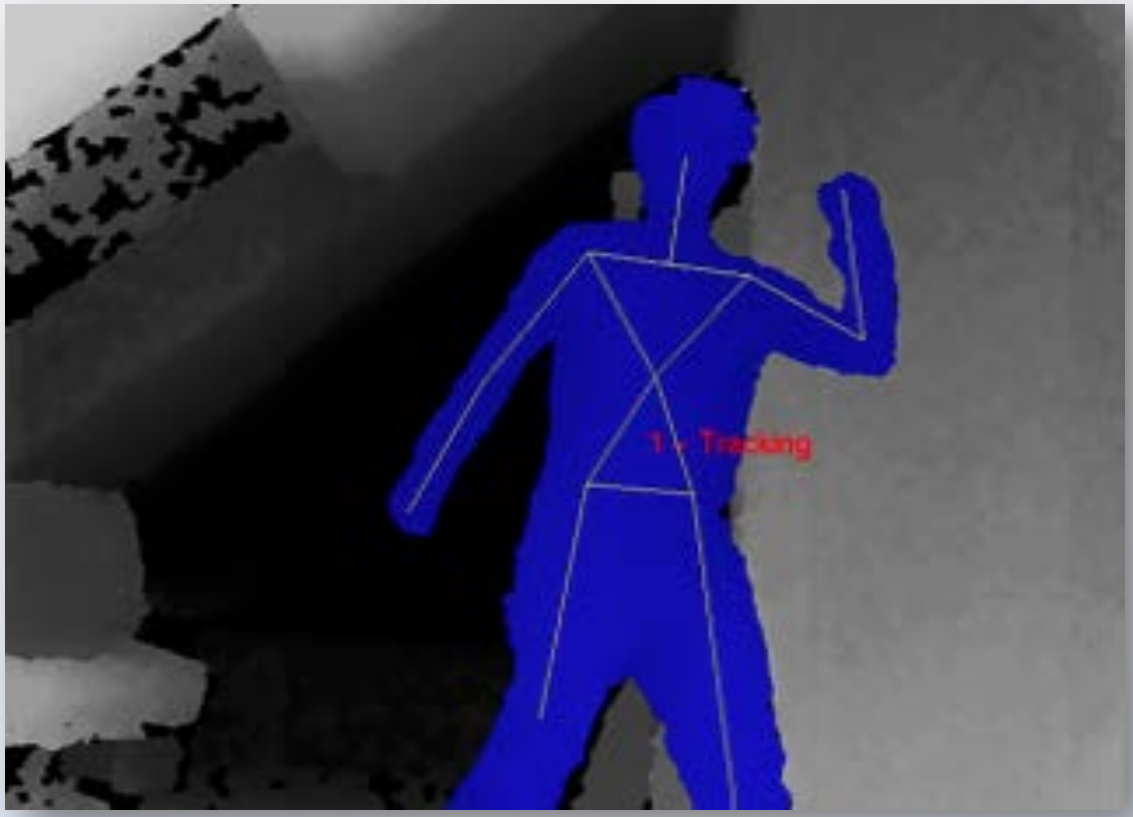
Segmentation IDs

- Human shapes are identified
  - These are called "Segmentation ID's"
  - Or sometimes just "Player Blobs"



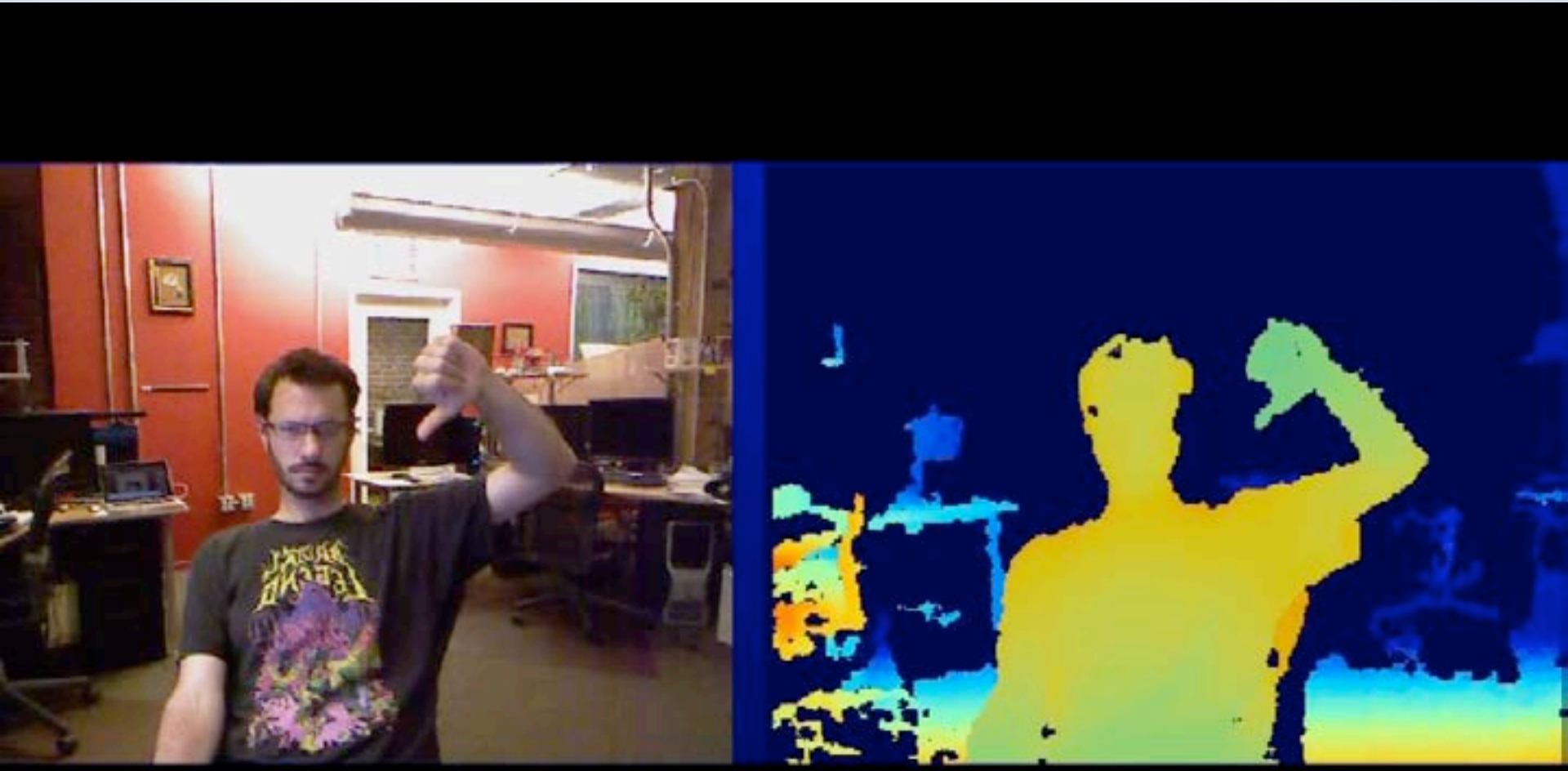
Joint Tracking

- Algorithms extract joints from depth data
  - XDK, PrimeSense give you this data



Limitations

- Depth is very noisy

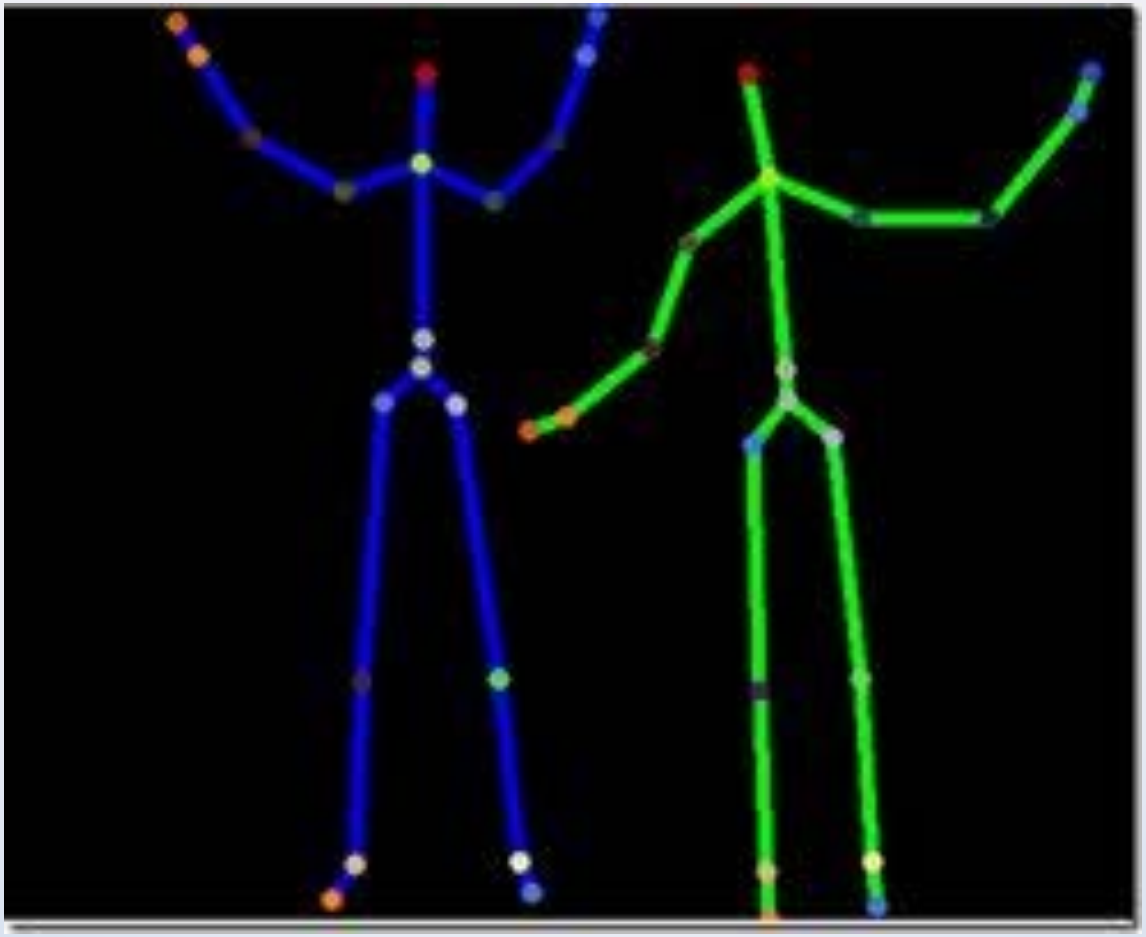


Limitations

- Color is webcam quality

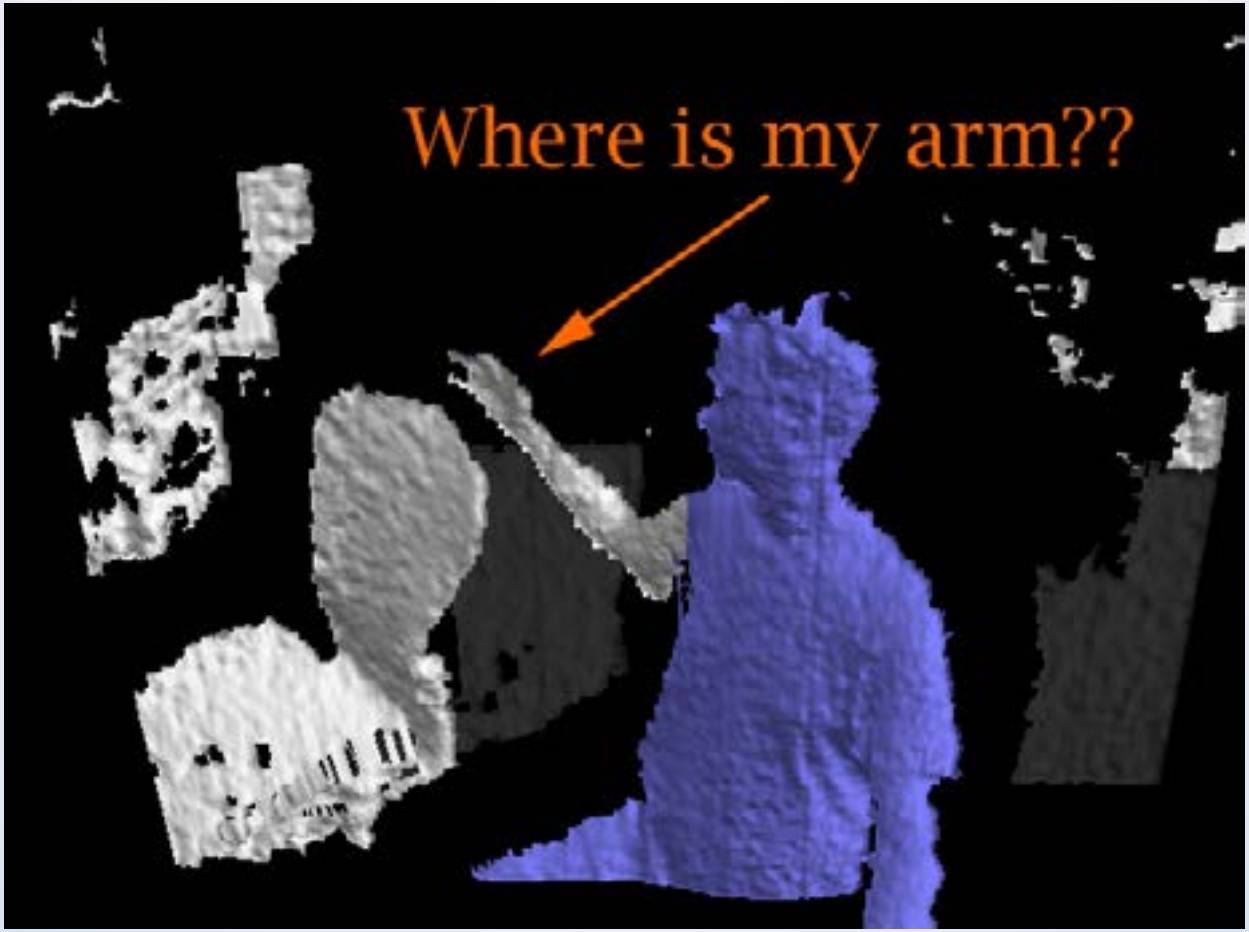
Limitations

- Skeletal tracking supports only 2 players



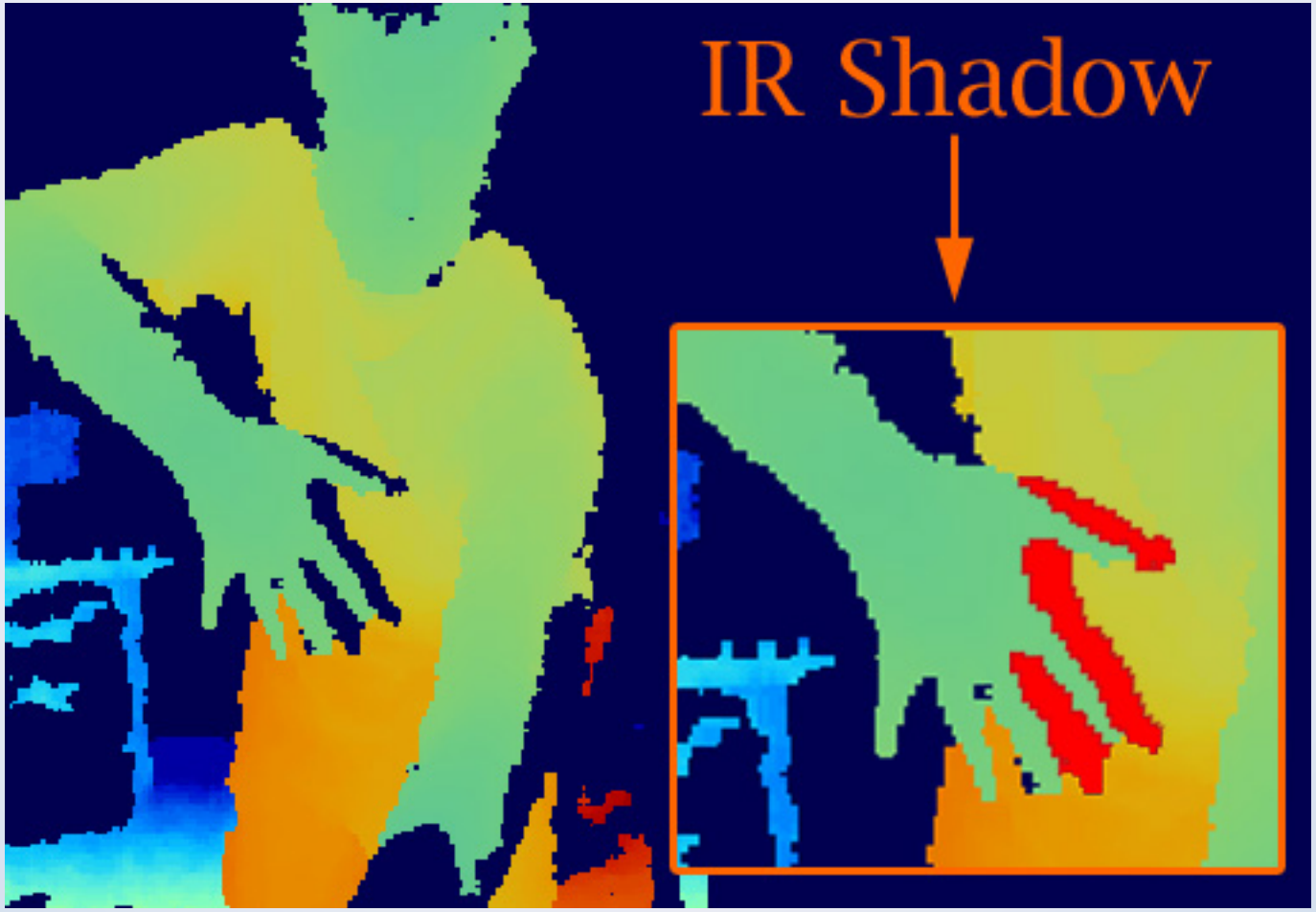
Limitations

- Segmentation data is inaccurate



Limitations

- Offset emitter, receiver causes IR Shadows



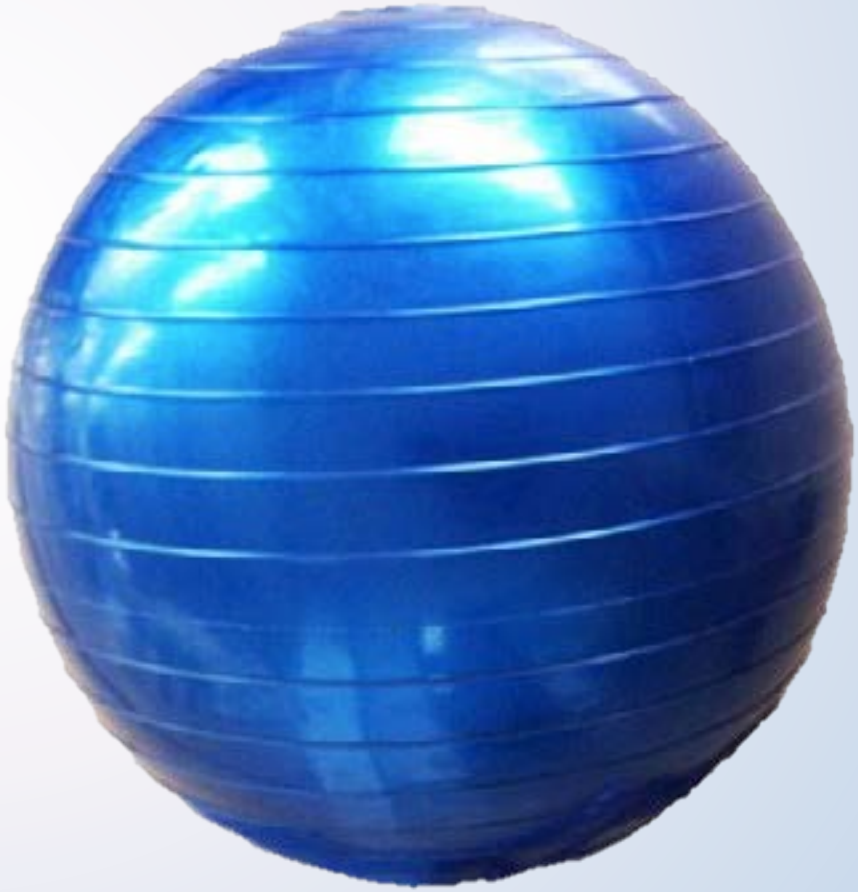
Note About Testing

- Skeletal tracking on cardboard cutouts
- Helpful for testing

Note About Testing

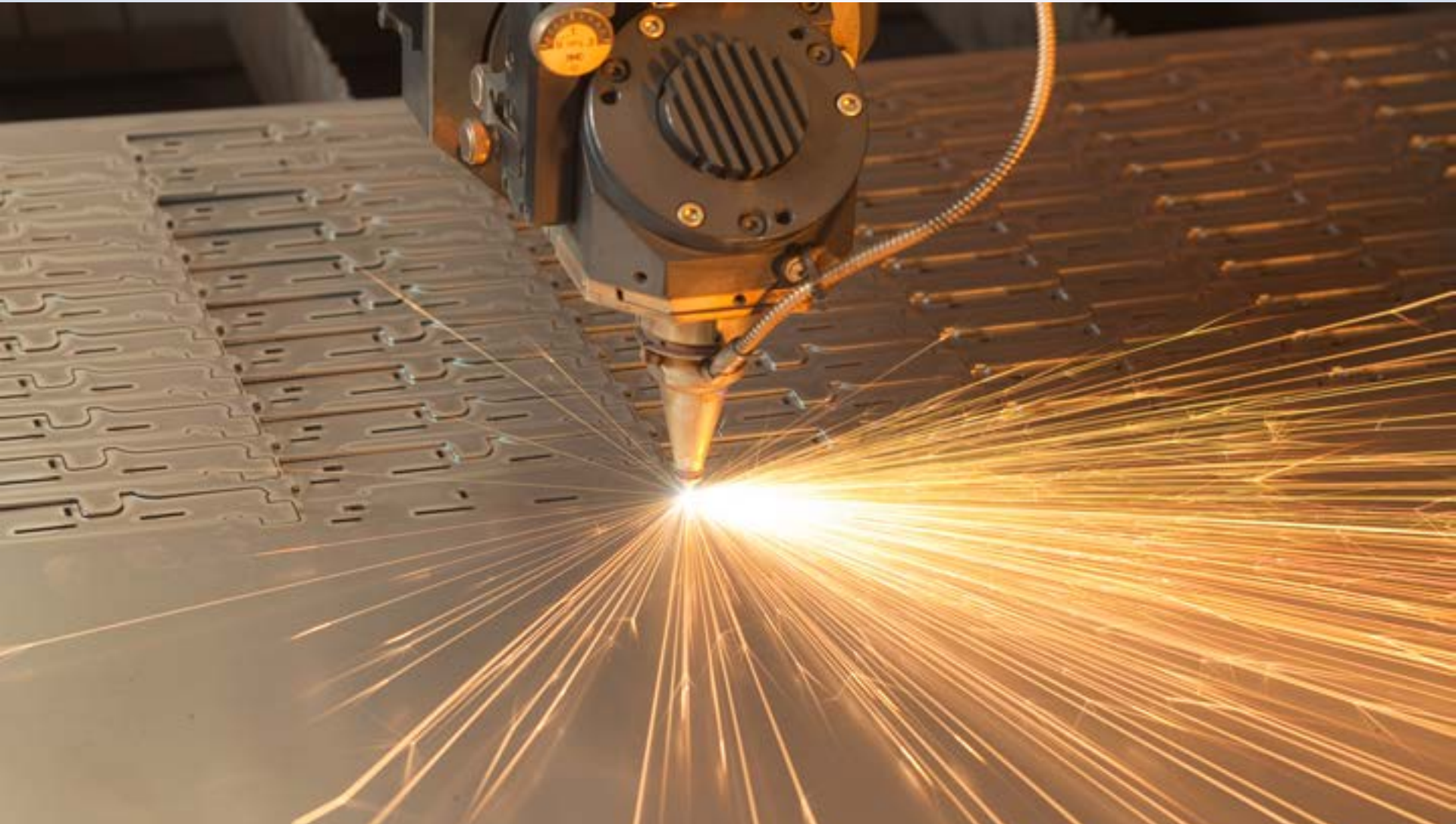
- Skeletal tracking on cardboard cutouts
- Helpful for testing

- Yoga ball also works!?




XBOX 360
ifixit

Rapid Prototyping Techniques

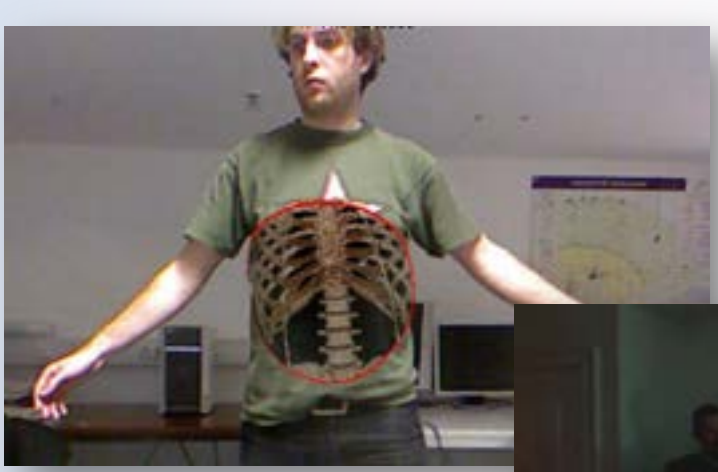


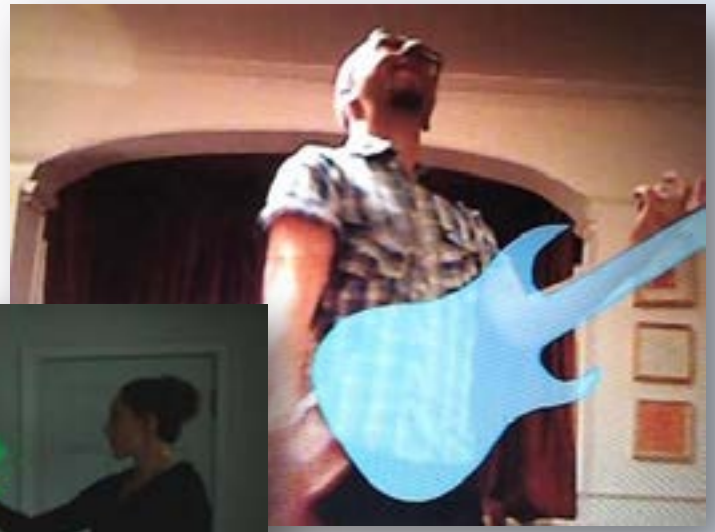
What do I mean by "Rapid Prototyping"?

- Trying out new ideas quickly
- Being creative instead of being correct
- Fast iteration times

Rapid Prototyping

- Kinect “Hackers” are excellent at this





Kinect “Hacking”

What software do Kinect Hackers use?

- "Creative Coding" languages
- Focused on art applications
  - Art Installations
  - Interactive audio performances
  - Interactive video performances

Creative Coding

- Open Source Libraries
  - Physics
  - Audio
  - Computer Vision
  - Graphics
  - Rendering
  - Data Visualization

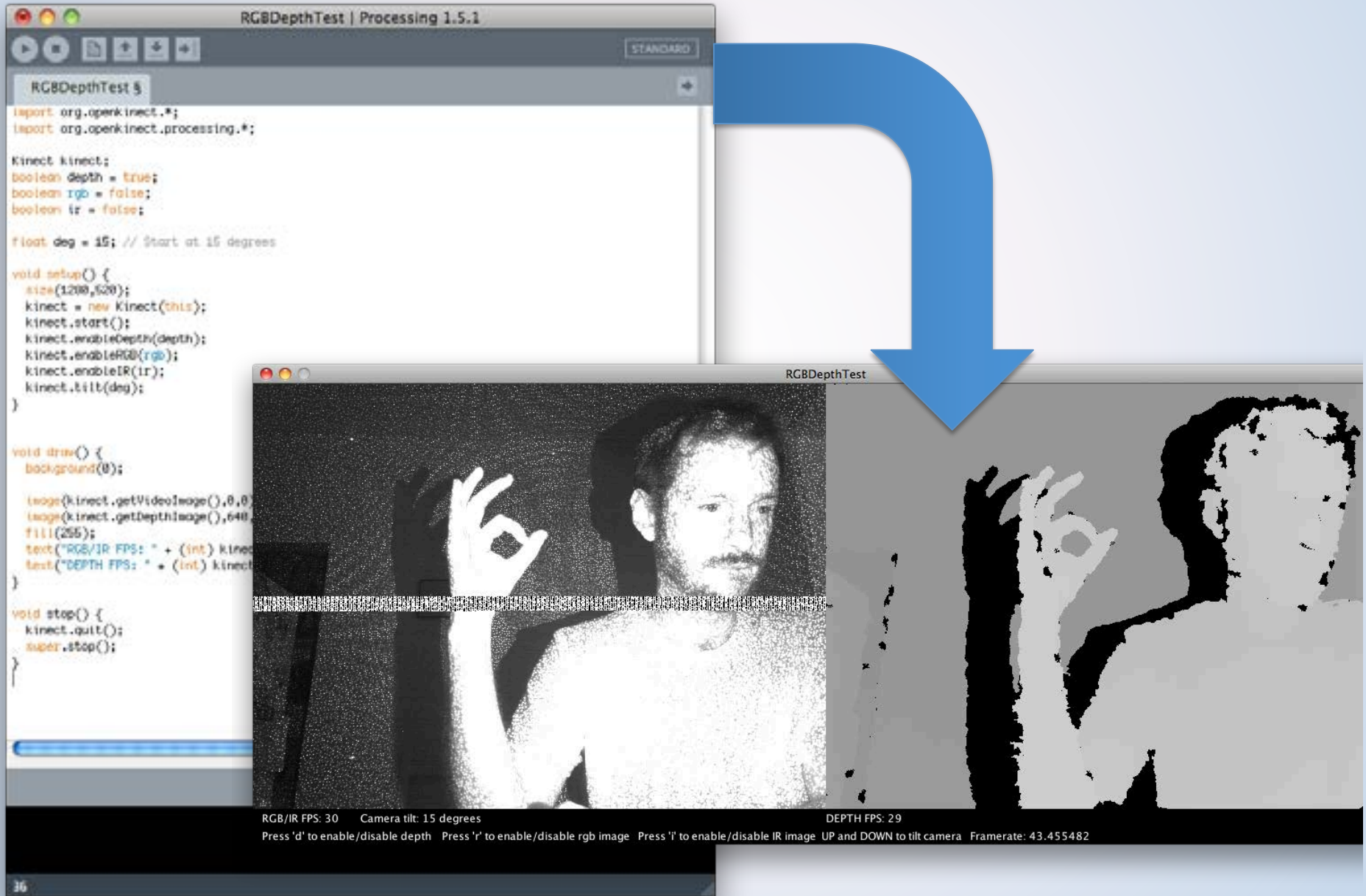
Creative Coding

- Goals are similar to Rapid Prototyping
  - Short schedules
  - Technically challenging
  - Adopt new platforms quickly
    - (iPhone, iPad, Android, Kinect, etc…)
  - Creative Applications

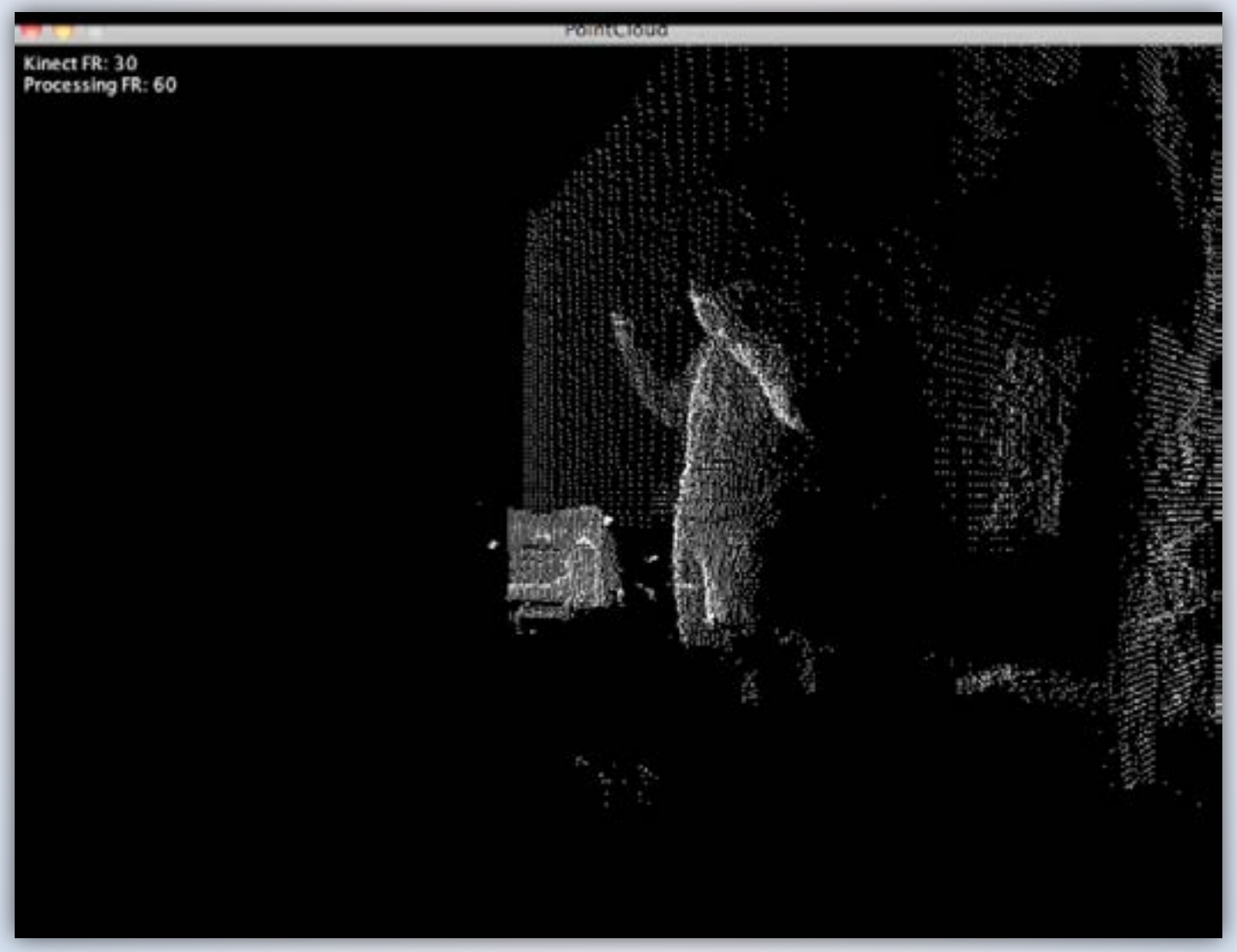
Creative Coding

- Open Frameworks
- VVVV
- Cinder
- Unity
- **Processing**

Processing


RGBDepthTest | Processing 1.5.1
STANDARD
RGBDepthTest §
import org.openkinect.*;
import org.openkinect.processing.*;
Kinect kinect;
boolean depth = true;
boolean rgb = false;
boolean ir = false;
float deg = 15; // Start at 15 degrees
void setup() {
size(1200,520);
kinect = new Kinect(this);
kinect.start();
kinect.enableDepth(depth);
kinect.enableRGB(rgb);
kinect.enableIR(ir);
kinect.tilt(deg);
}
void draw() {
background(0);
fill(255);
void stop() {
kinect.quit();
super.stop();
}
RGBDepthTest
RGB/IR FPS: 30
Camera tilt: 15 degrees
DEPTH FPS: 29
Press 'd' to enable/disable depth
Press 'r' to enable/disable rgb image
Press 'i' to enable/disable IR image
UP and DOWN to tilt camera
Framerate: 43.455482

Processing



Examples

- Rapid Prototyping

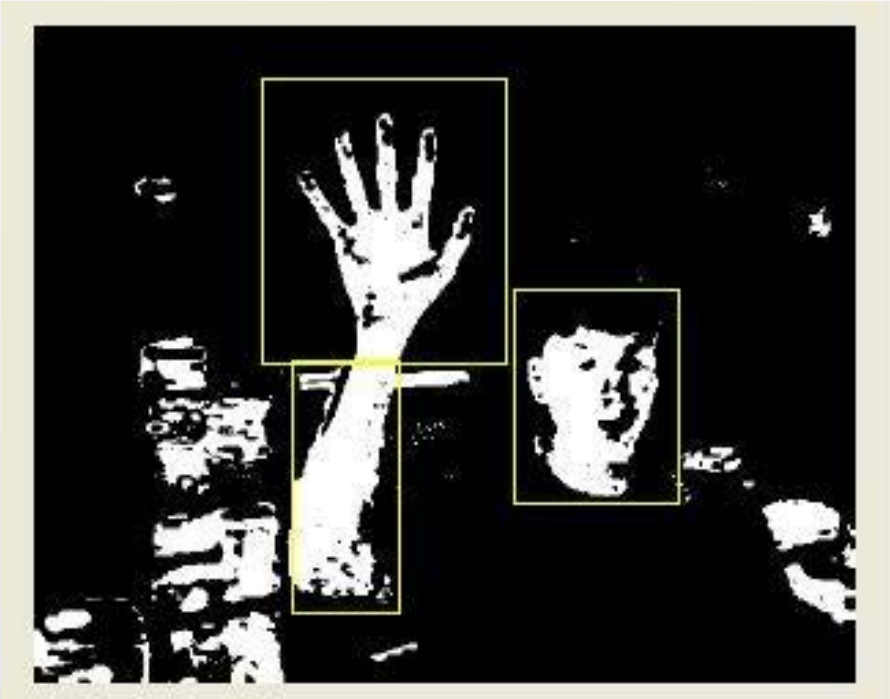
- Using Processing

First Challenge

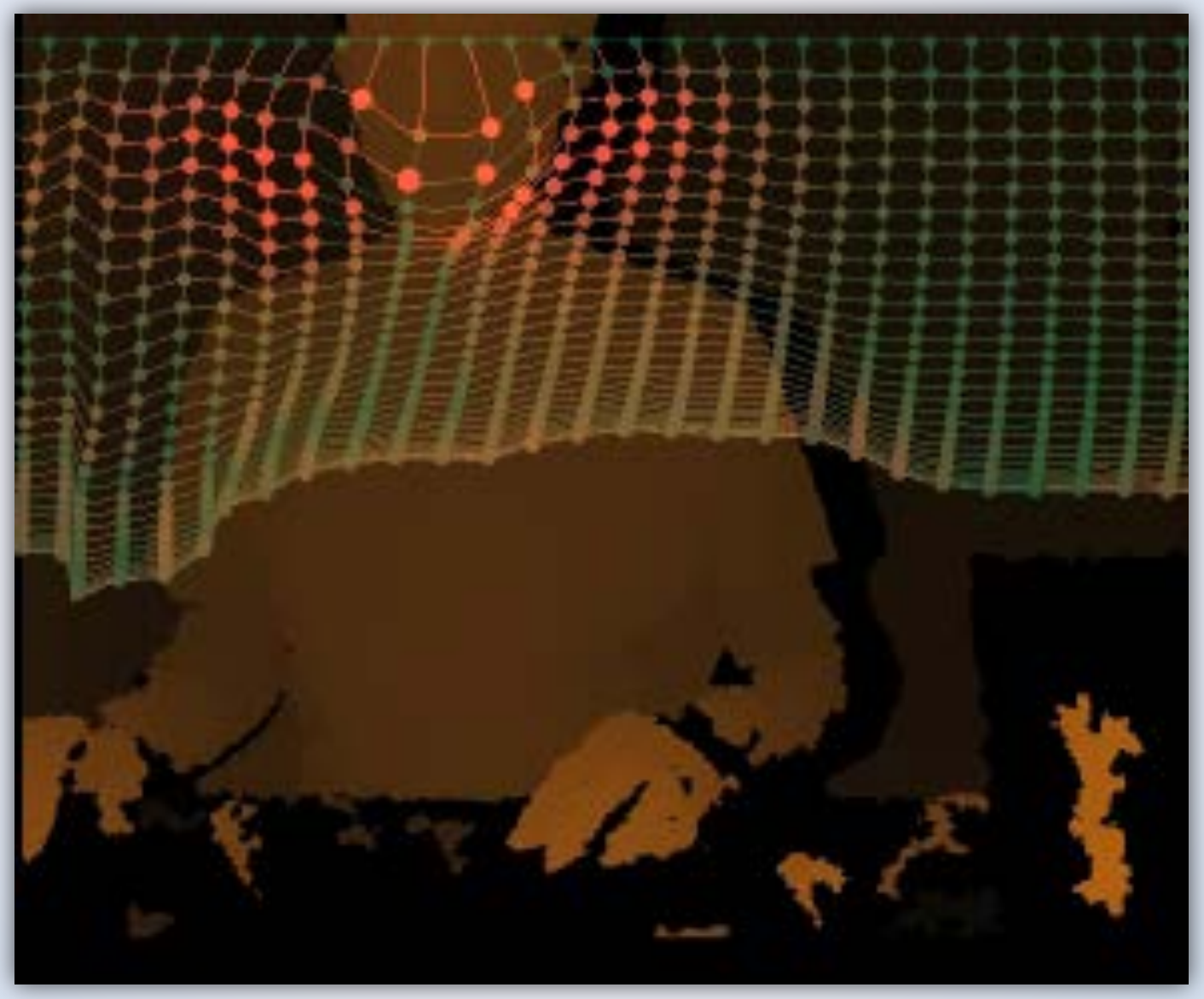
- Kids!

Party Chaos

- How do we get around 2 player limitation?
- Let's try "Motion Blobs"
- Existing libraries make it easy to test



2D Motion Blobs



Libaries Used

Quick! One person, one afternoon.

3D Motion Blobs

- Can we track blobs in 3 Dimensions?
- Yes – 3D velocity, 3D position

3D Motion Blobs

- Can we track blobs in 3 Dimensions?
- Yes – 3D velocity, 3D position

3D Motion Blobs

- Used in many of our shipping activities

Second Challenge

- Data is noisy
- Can we use it indirectly?

Libraries Used

OpenCV
(Computer Vision)

GLGraphics
(shaders and off screen render targets)

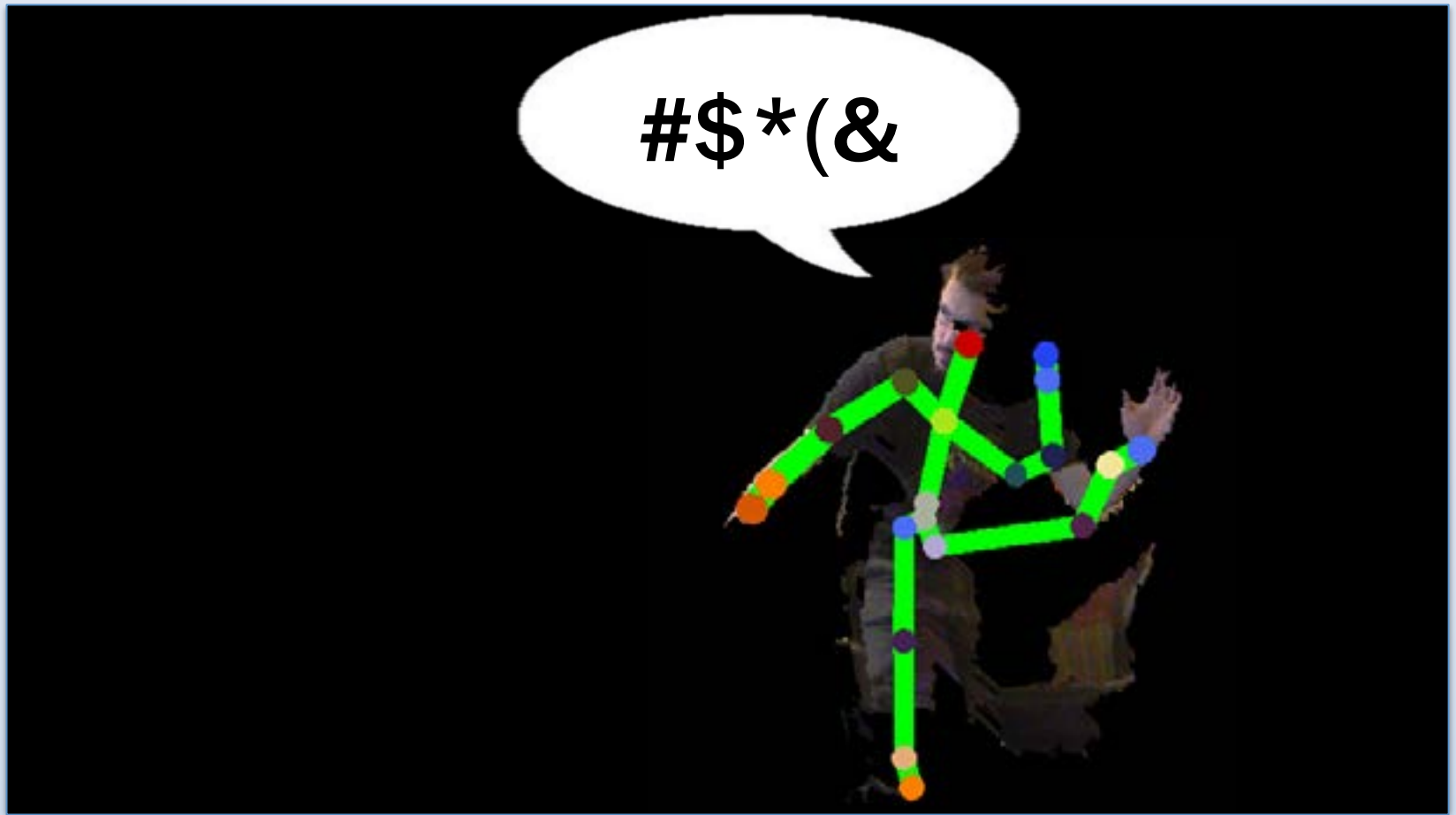
msafluid
(Fluid and Particles)

OpenKinect
(Kinect Depth)

Also quick! One person, One evening.

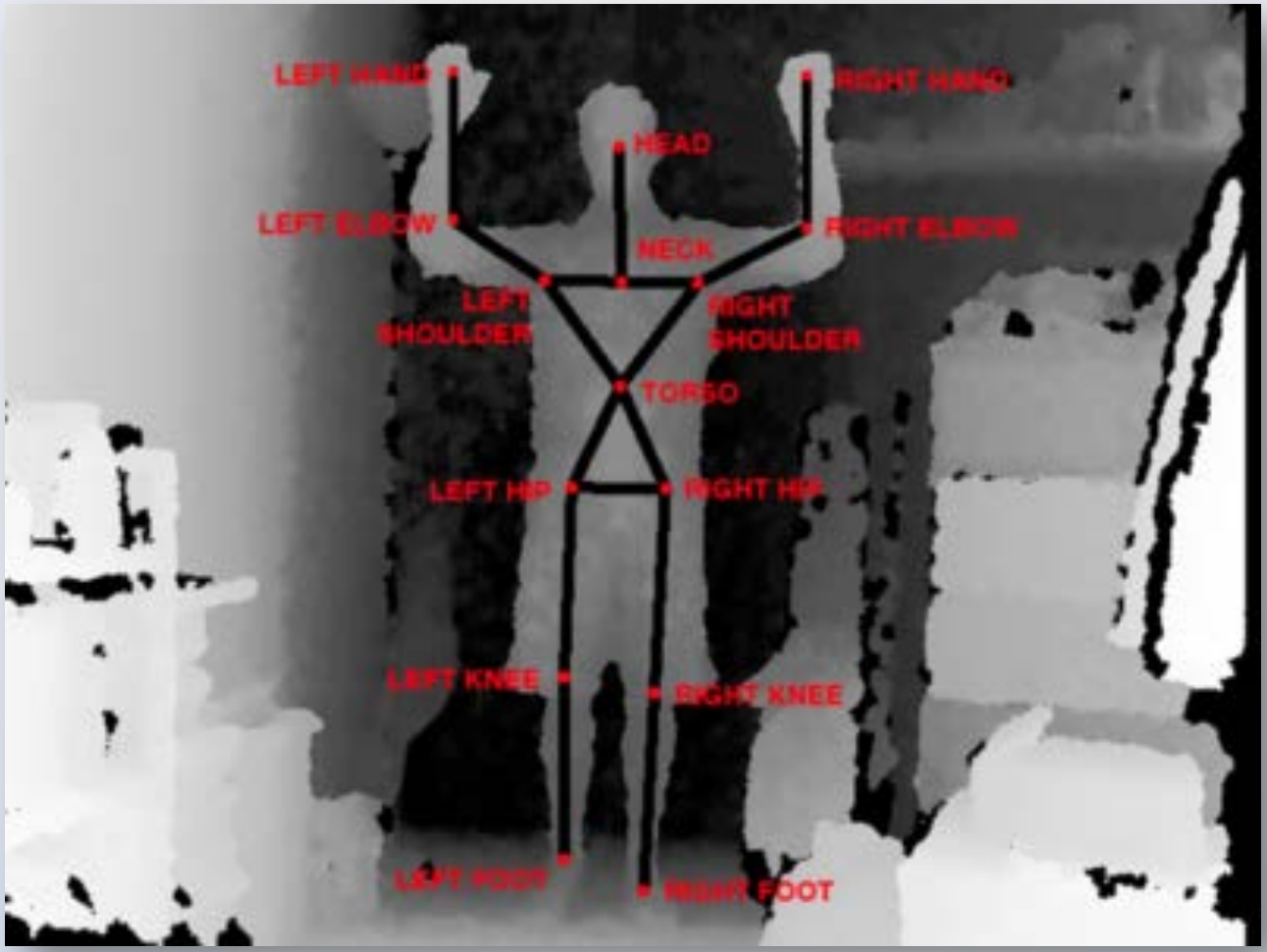
Third Challenge

- What is possible with joint attachments?



Joint Attachments

- Open source libraries let us iterate quickly



Joint Attachments

Libraries Used

Fisica
(JBox2D wrapper)

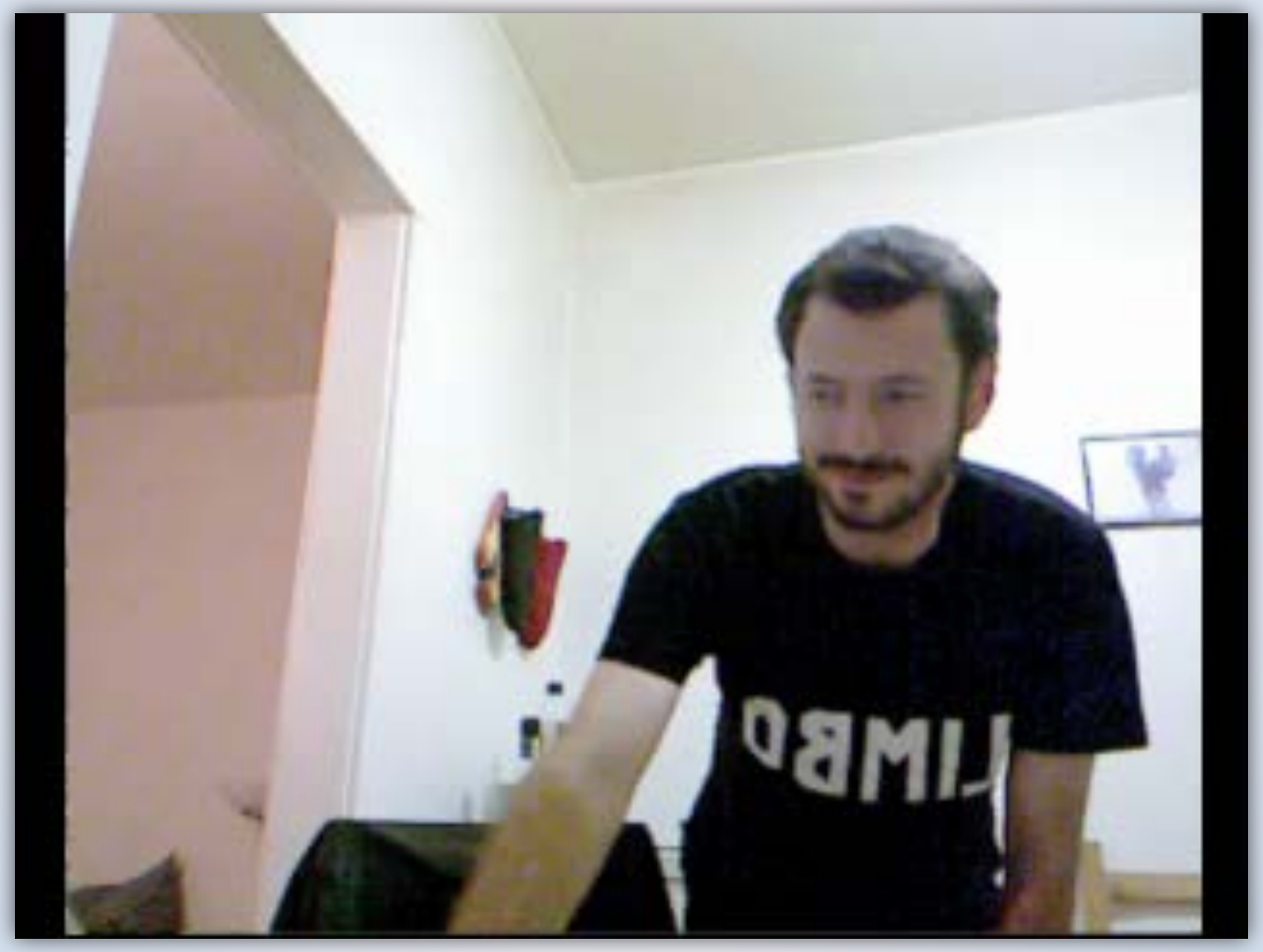
Simple-OpenNI
(Kinect + PrimeSense)

Just a few hours to make.

Fourth Challenge

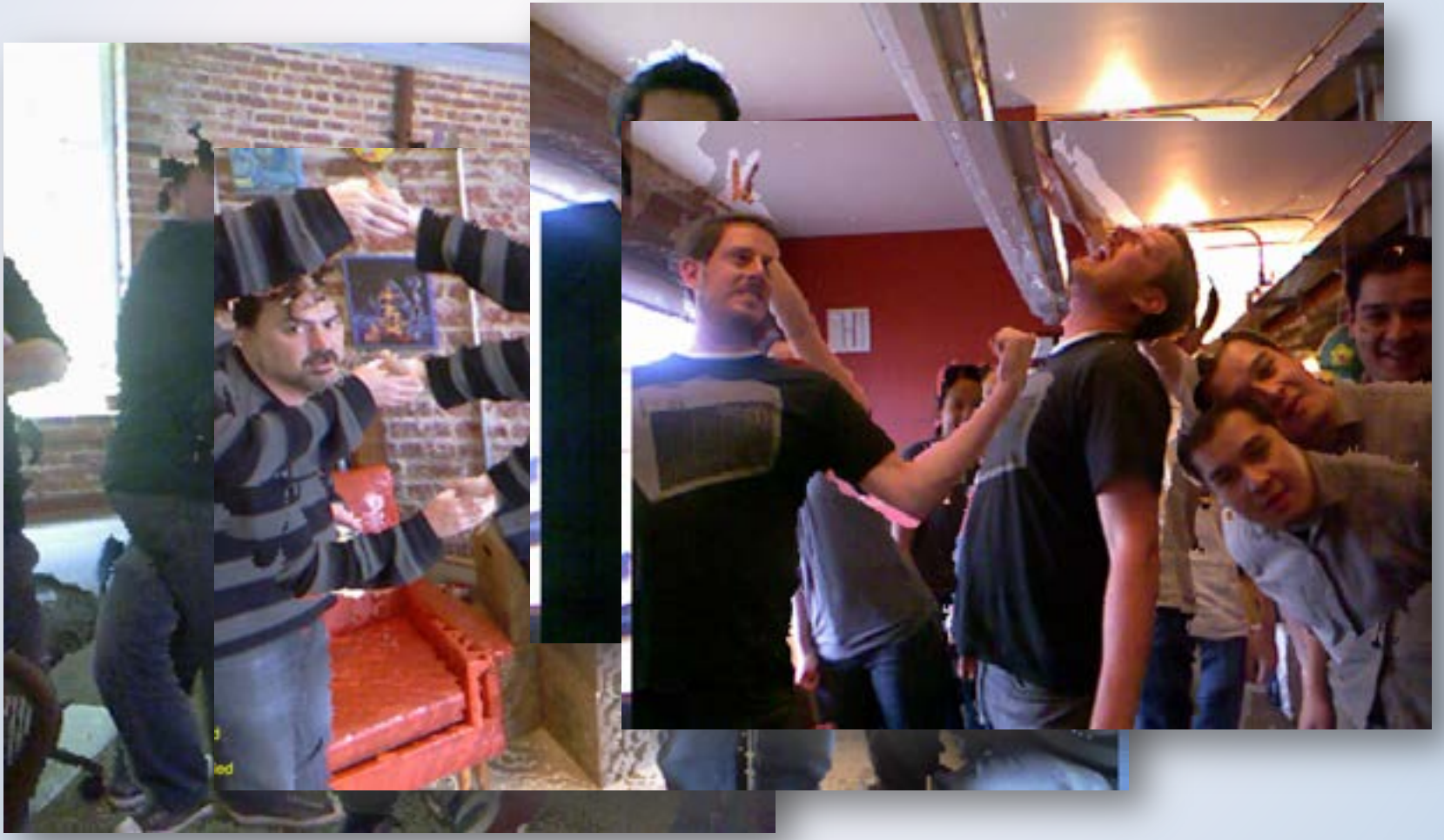
- Compositing Depth and Color

Depth Compositing



Depth Compositing

- We had fun with this

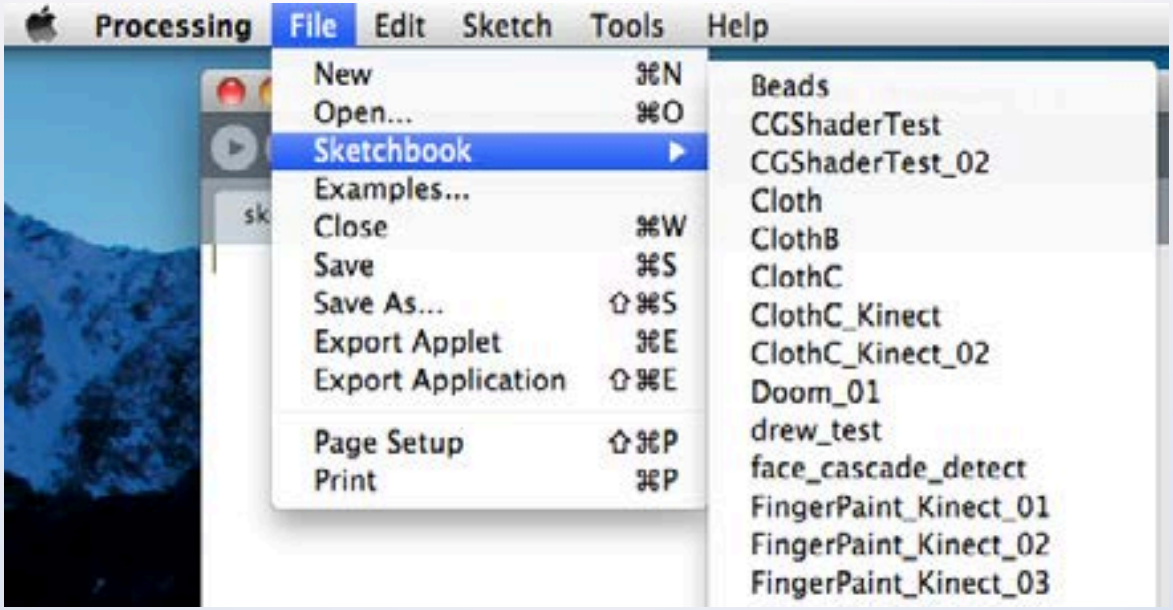


Libraries Used

Just a few hours to make.

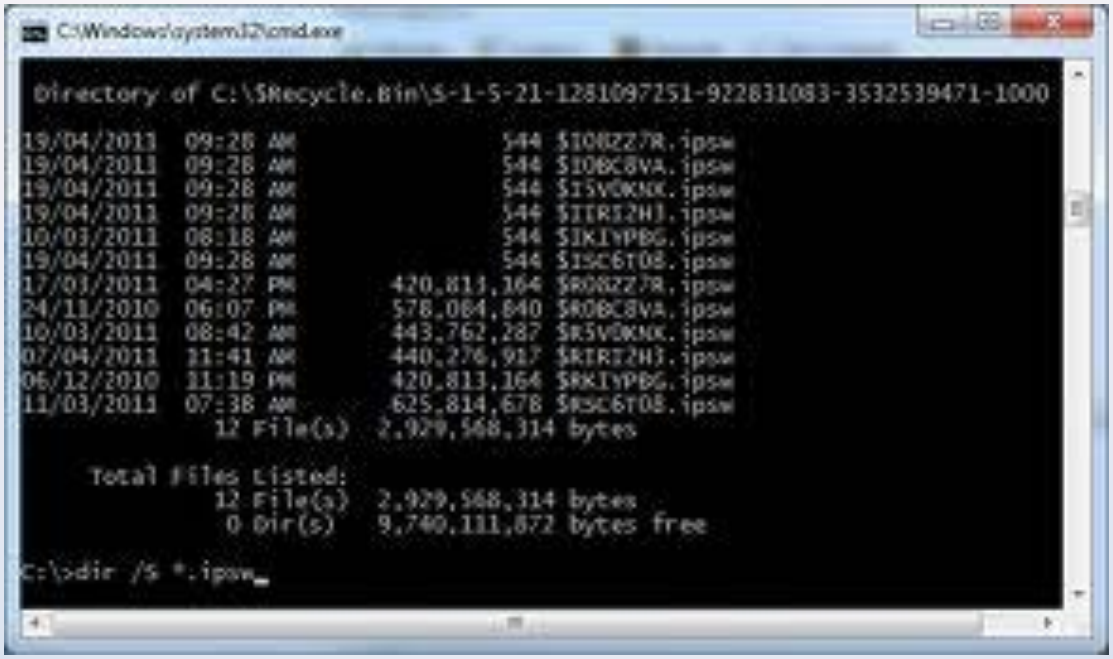
Sketches

- Encapsulates all data and code for prototype
- Makes starting prototypes easy



make_new_activity.py

- Python script to create mini games
- Let us make prototypes quickly
  - Similar to Processing “Sketch”



Rapid Prototyping

- Great way to test new ideas!
- Side effect:
  - we had early demos for our publisher

Rapid Prototyping Results

Rapid Prototyping +

=


HAPPY
ACTION
THEATER

(This section is focused on Shaders and Graphics)

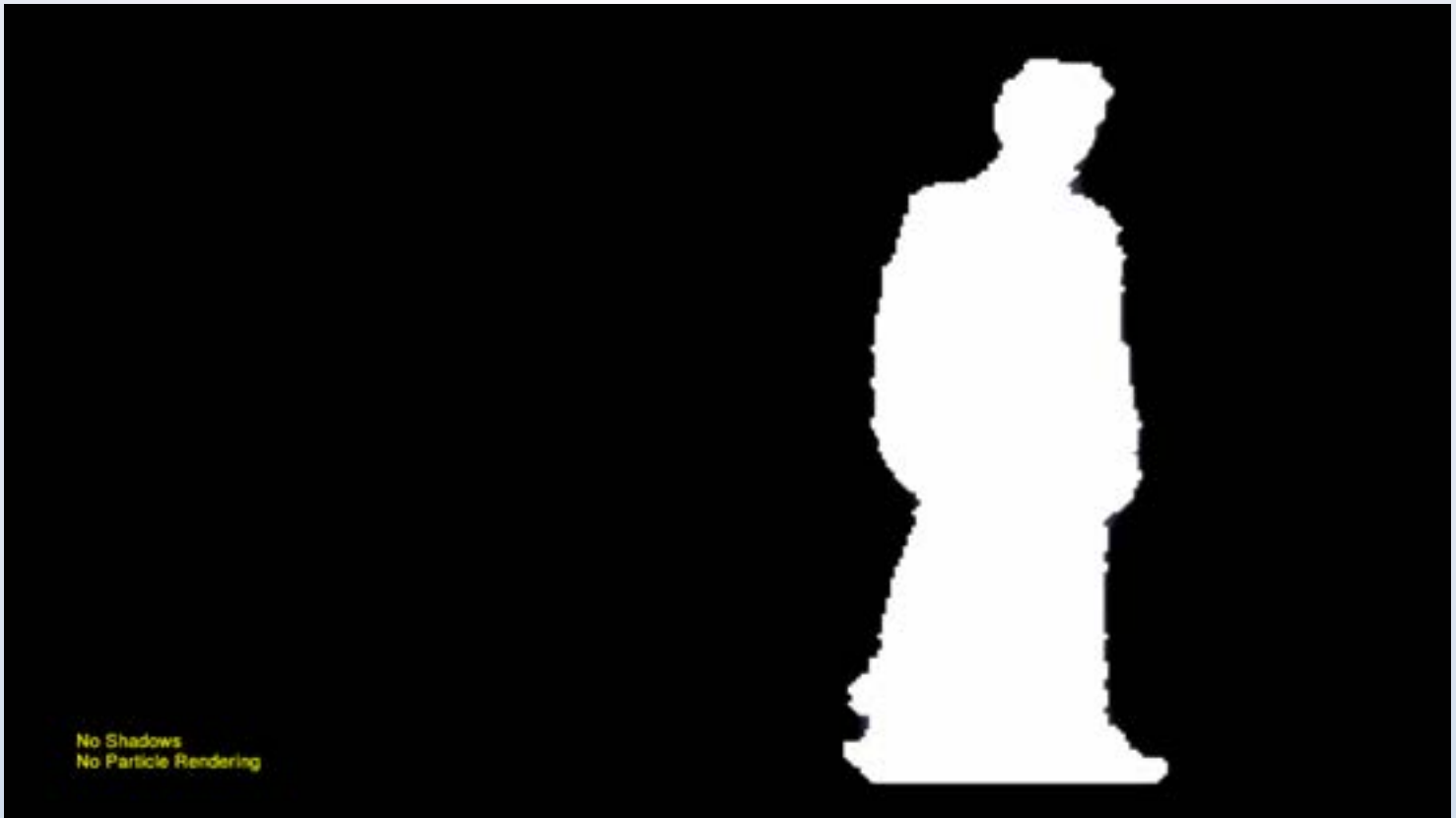
Dance Party

Player Extraction

- Use segmentation IDs to identify players

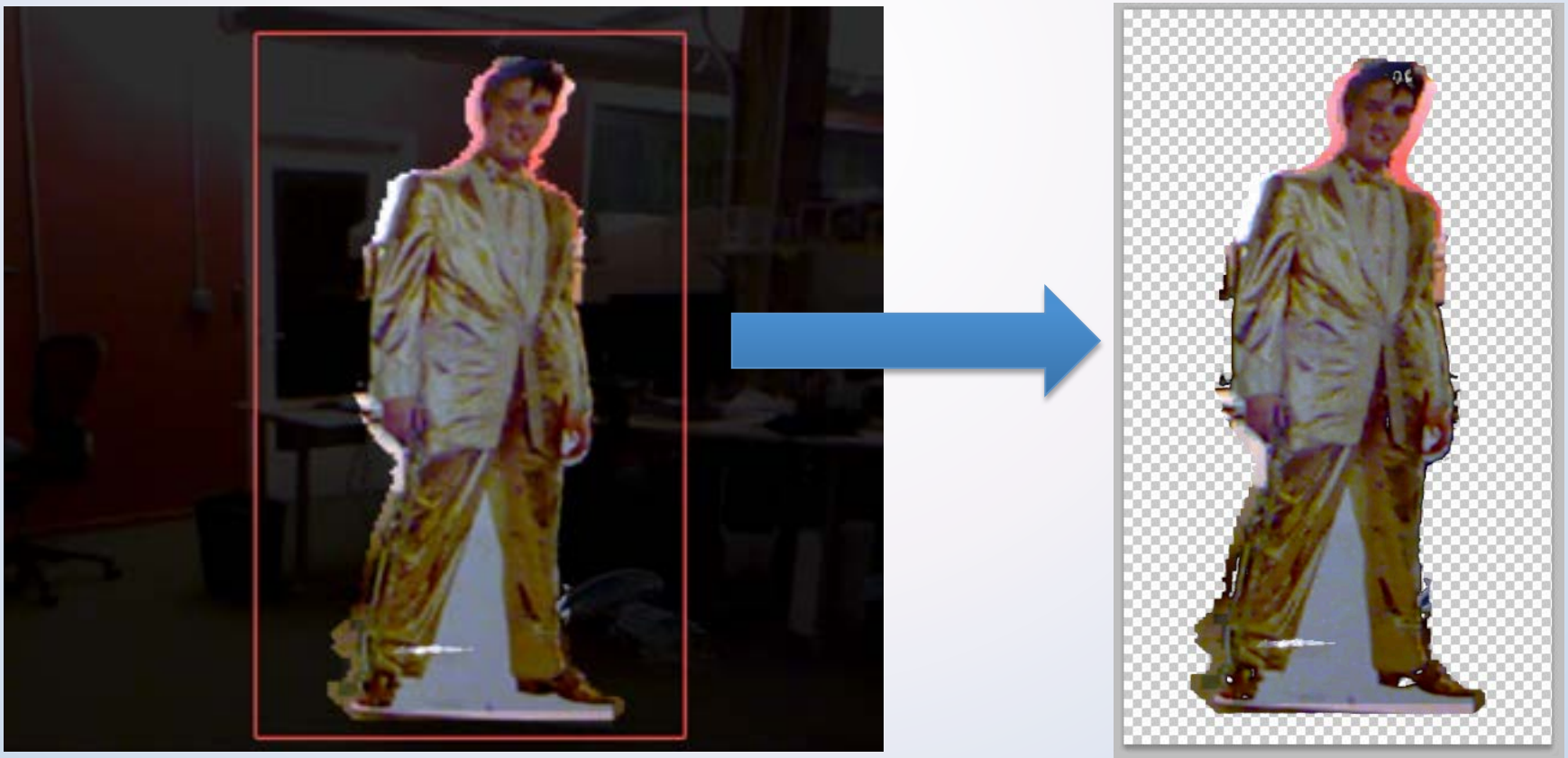
Player Extraction

- Use segmentation IDs to identify players



Player Extraction

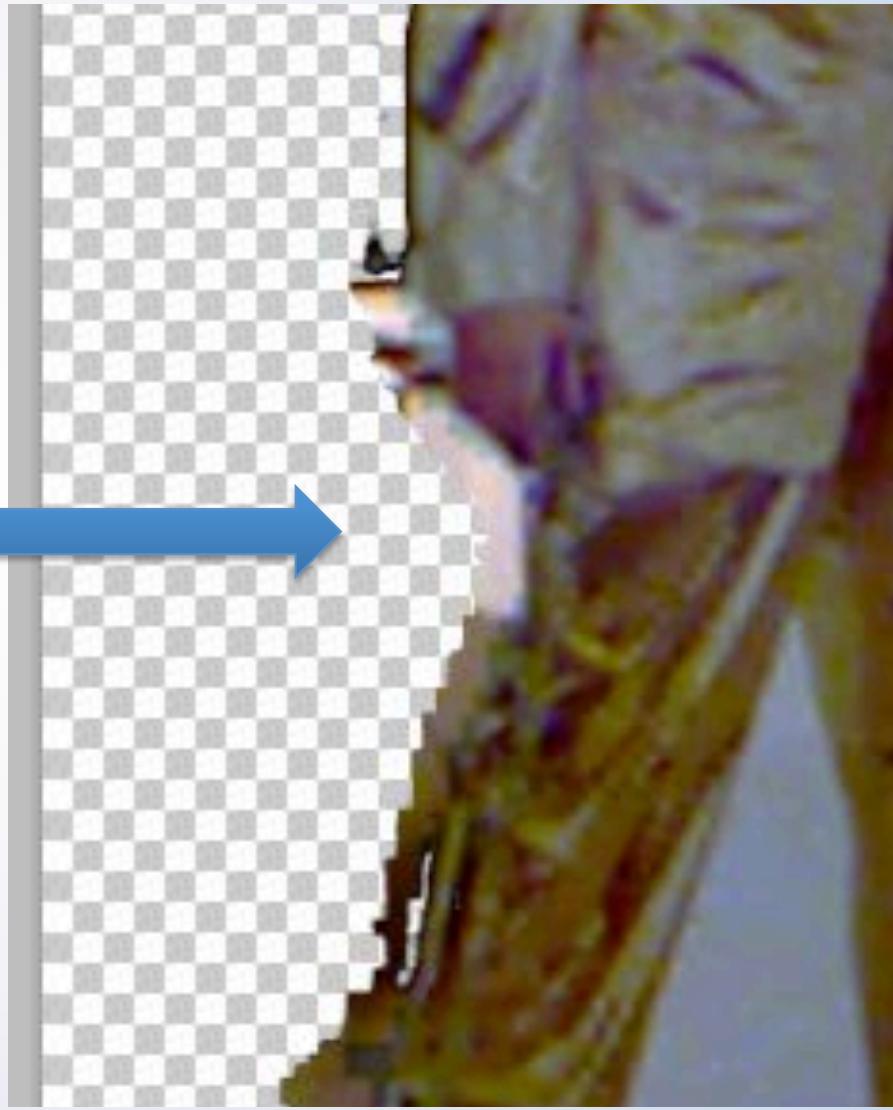
- Use segmentation IDs to identify players



Player Extraction

- Video is 640 x 480
- Depth is 320 x 240

Rough Edges!



Smoothing Segmentation ID Edges

Averaged Over Time

Thresholded

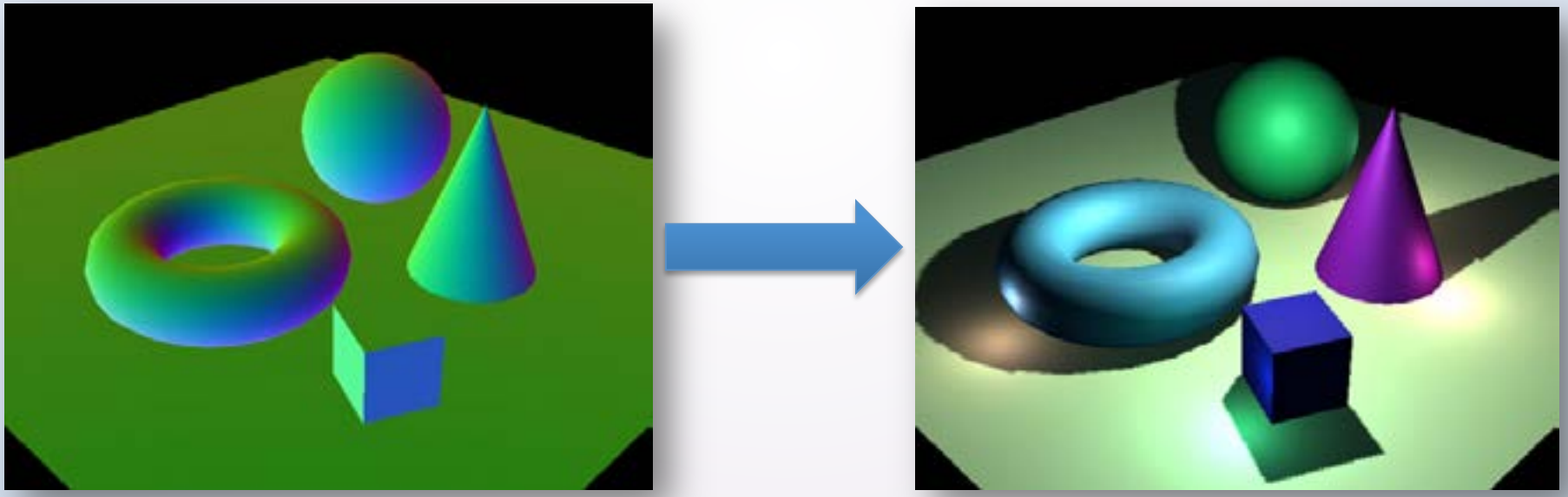
Using the Extracted Texture

Using the Extracted Texture

Fireworks

Deferred Lighting

- Requires a normal buffer



Deferred Lighting

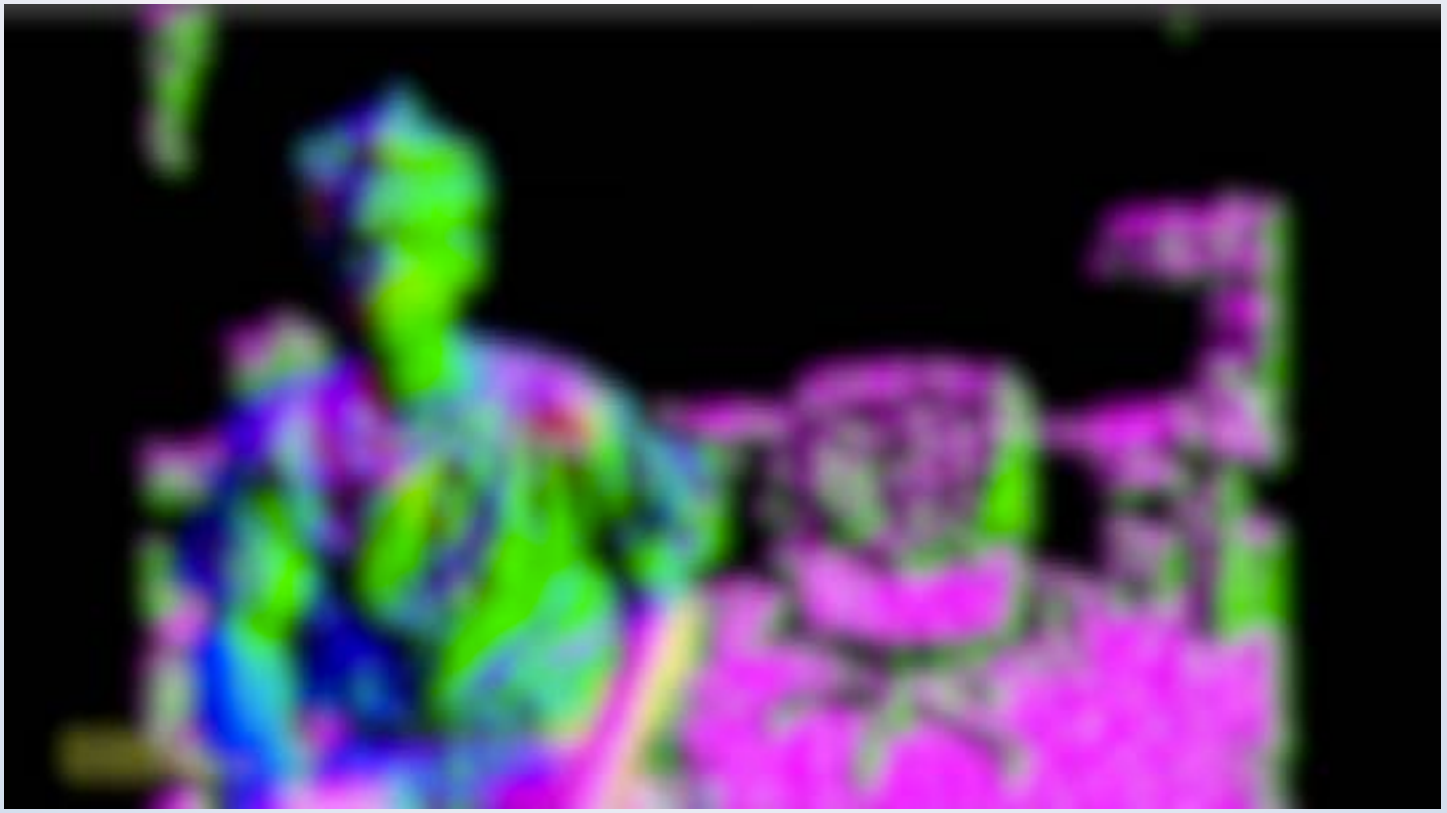
- Can we get normals from the depth feed?

Deferred Lighting

- First attempt looks bad
  - This depth is sobel filtered

Deferred Lighting

- Can we just blur it??



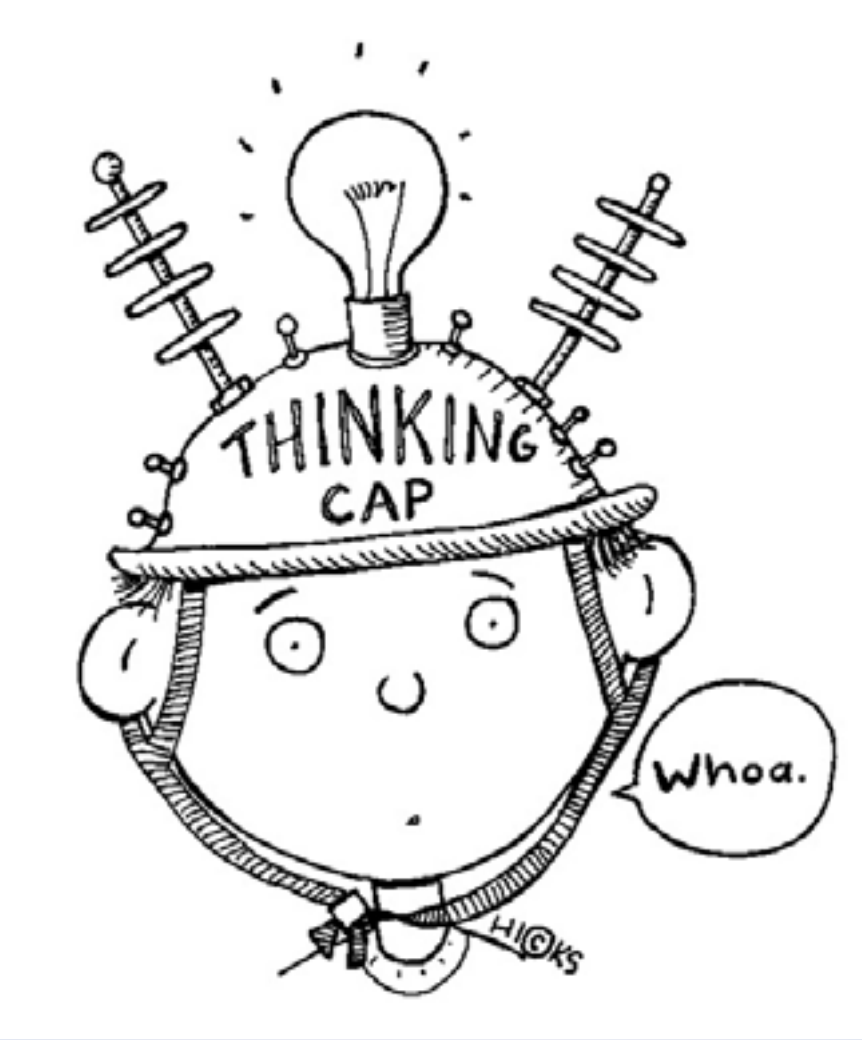
Deferred Lighting

Deferred Rendering

- Also works with projected lights

Deferred Rendering

What else can we do with surface normals?



Snow Accumulation

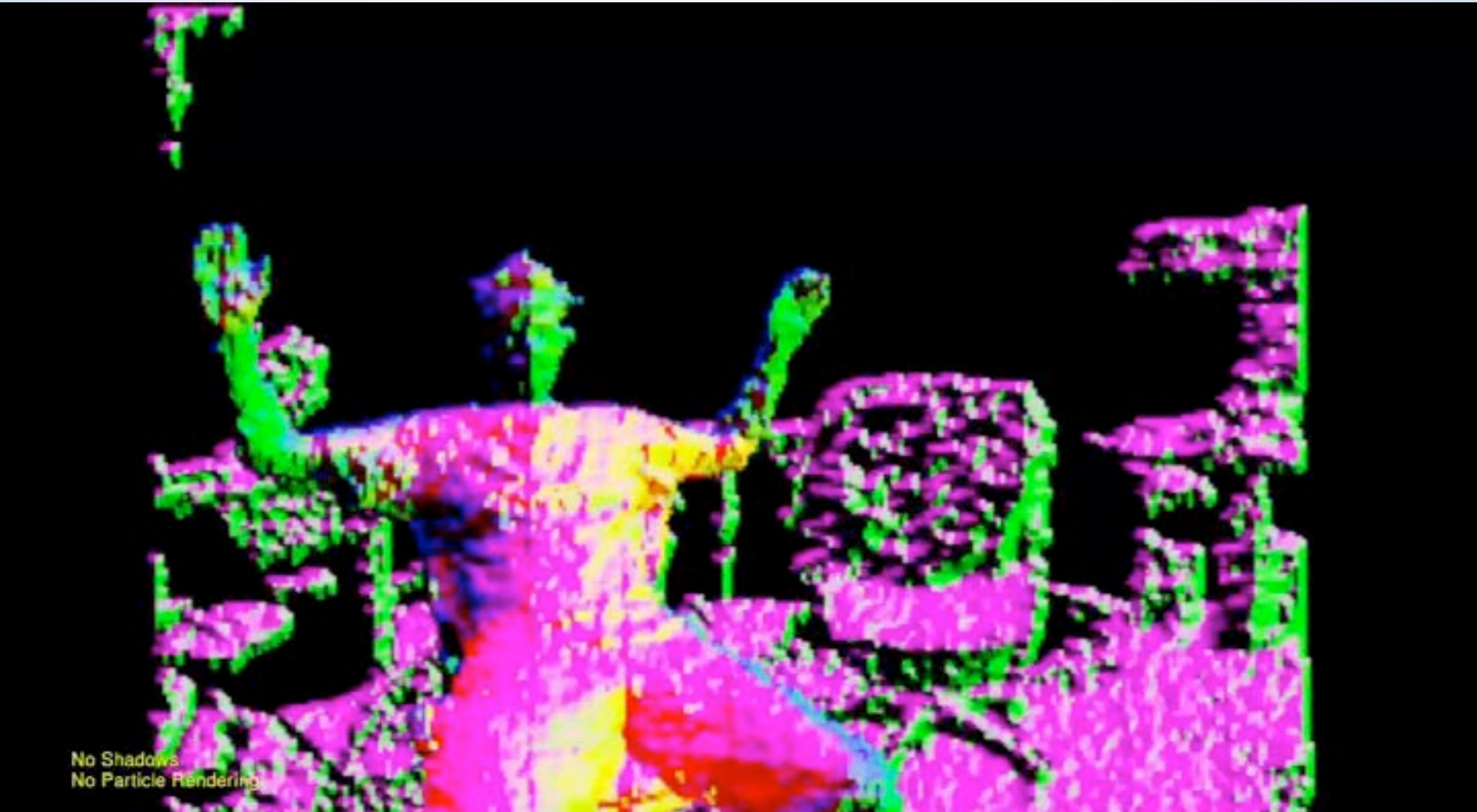
- Accumulate snow on upward facing surfaces

First Attempt

- Raw depth

First Attempt

- Sobel filtered normals



First Attempt

- Isolating upward facing surfaces

Accumulation

- Snow Accumulation reduces noise

Shading: The Fun Part

- Blur the entire accumulation texture

Shading: The Fun Part

- Approximate illumination from normals

Shading: The Fun Part

- Shift normals up to round out the snow

Shading: The Fun Part

- Shift entire snow texture upward

Shading: The Fun Part

- Apply post processing

Shading: The Fun Part

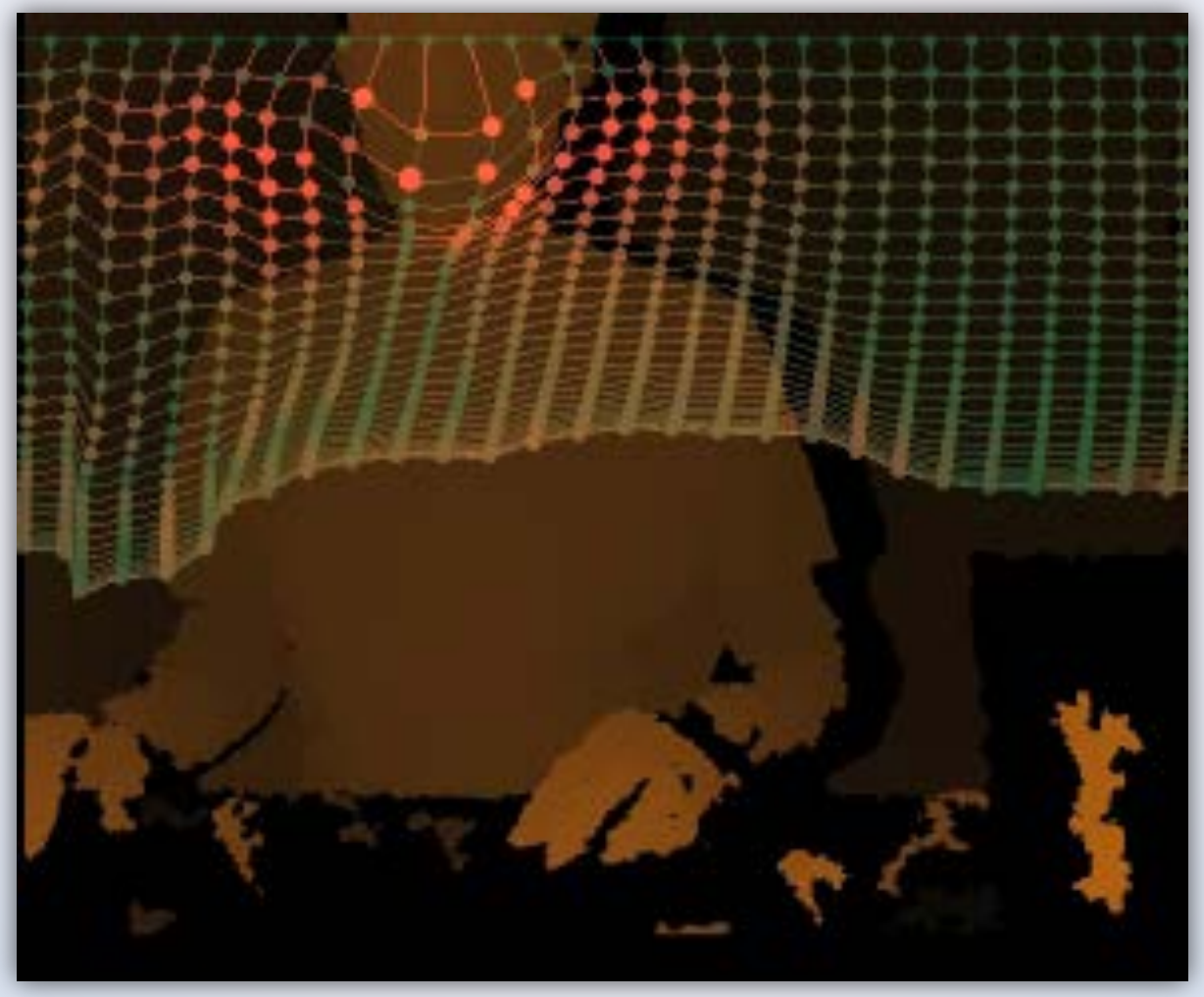
- Particle effects

Fog

- It does not work well...

Snow Erasing

- Remember those motion blobs?



Snow Erasing

- Remember those motion blobs?

Final Result

Fish Tank Hook

Background Texture

- Simple concept:
  - Find non player pixels
  - Draw them into texture

Kinect Color Feed

Background Texture

Background Texture

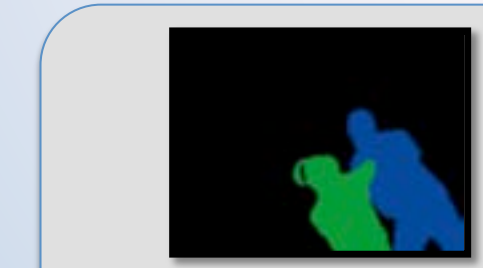
- Edge Cases
  - Players too close to camera
  - Players too far from camera
  - Moving environmental objects.

Background Texture

- Kept a per-pixel confidence value to address those issues.
  - We had to McGarry it!
  - Outside the scope of this talk.

Background Texture

Color



Segmentation ID

Per Frame Composite

Background Texture

Background Texture

Color

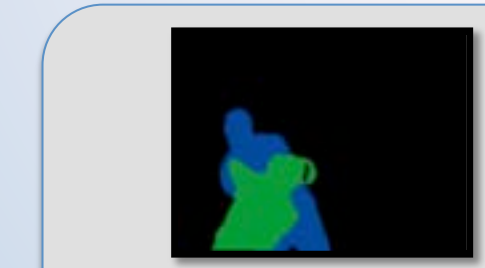
Segmentation ID

Per Frame Composite

Background Texture

Background Texture

Color



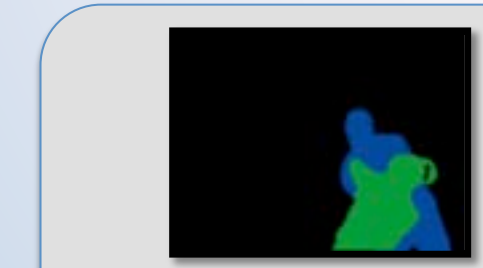
Segmentation ID

Per Frame Composite

Background Texture

Background Texture

Color



Segmentation ID

Per Frame Composite

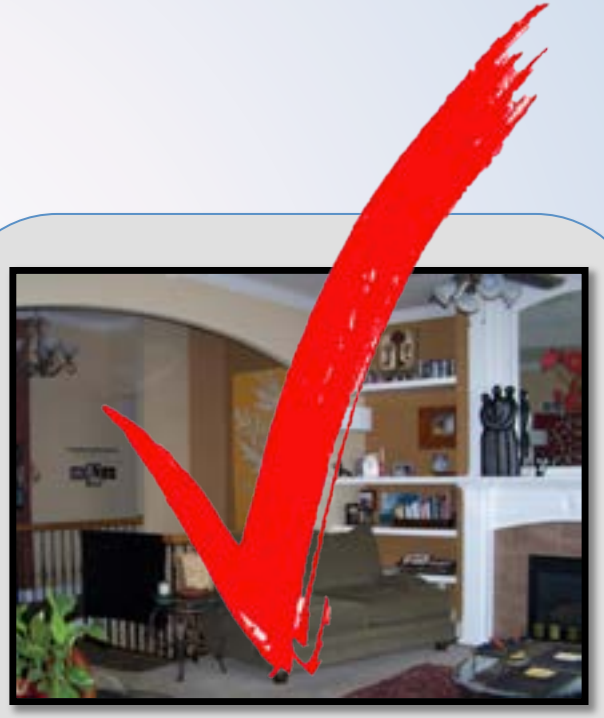
Background Texture

Background Texture

Color

Per Frame Composite

Segmentation ID



Background Texture

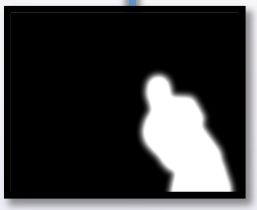
Erasing the Player

- Lerp between color feed and background

Lerp

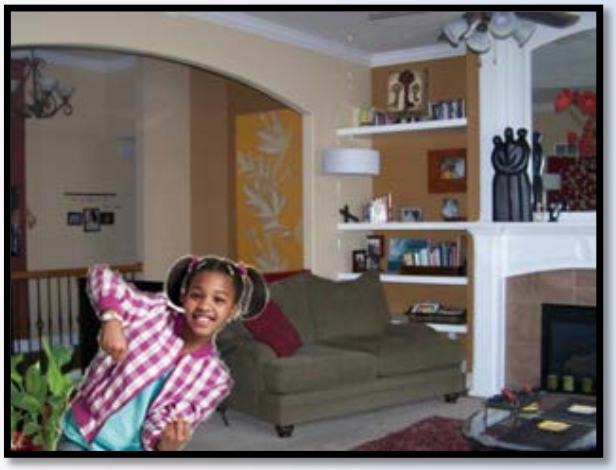
Kinect Color Image

Background Texture



Mask Texture

Lerp



Player Erased

Mask Generation

Segmentation IDs

Isolate Player to Erase

Grow mask with a Gaussian Blur

Compositing the player elsewhere

- Warp player UVs and draw again
- Optionally include player depth

Fish Tank Hook

Background Texture

- Useful for lots of different things!

Background Texture

- Remember the earlier fire prototype?

Funhouse

Hookes Law

- Force on a spring: $F = -K \times x$

  K is "*Hookes Constant*"

  X is spring length

Hookes Law

- Force on a spring: F = -K * x
- In HLSL:

```
// retrieve this frames simulation texture
float4 CurrentFrame = ToWorldUnits(tex2D(g_samSourceA, Tex));
float2 dist = CurrentFrame.xy;
float2 velocity = CurrentFrame.zw;

// hookes law
velocity -= 1 * normalize(dist) * pow(length(dist),2);

// damping
dist = dist * .95;
velocity = velocity * .95;

// Step simulation
dist += velocity * dt;

// output
vCurrentFrame = ToTextureUnits(float4(dist.xy, velocity.xy));
return vCurrentFrame;
```

Displacement Texture

Weak Springs


HAPPY
ACTION
THEATER

Rapid Prototyping Setup for Kinect + Processing

- Computer

- Kinect

Rapid Prototyping Setup for Kinect + Processing

- Processing
  - www.processing.org
- Simple OpenNI
  - code.google.com/p/simple-openni
- Drivers and Libraries
  - OpenNI, NITE, PrimeSensor, SensorKinect
  - All downloadable from:
  - code.google.com/p/simple-openni/wiki/Installation

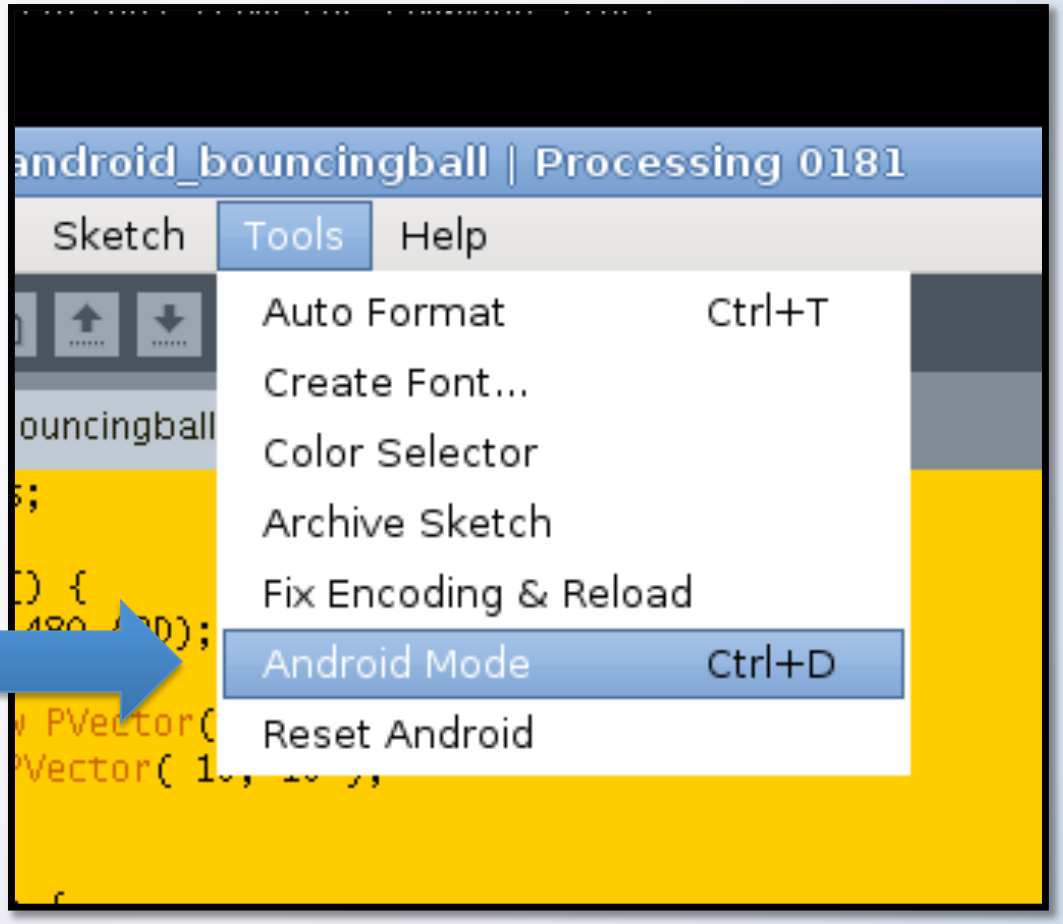
Other Kinect Libraries for Processing

- OpenKinect (Mac OS X Only)
  - http://www.shiffman.net/p5/kinect
- dLibs_freenect
  - http://thomasdiewald.at/processing/libraries/dLibs_freenect

Libraries Used in the Examples

- Fluid Simulation: `msafluid`
  - http://www.memo.tv/msafluid_for_processing_v1_3
- Blob Detection: `OpenCV`
  - http://ubaa.net/shared/processing/opencv/
- Open GL: `GLGraphics`
  - http://glgraphics.sourceforge.net/
- Spring Physics: `traer.physics`
  - http://murderandcreate.com/physics
- Box2D Physics: `fisica`
  - http://www.ricardmarxer.com/fisica

Another place you might try Rapid Prototyping



Thanks to the Double Fine Happy Action Theater Team

- The presented work was a team effort

Questions?

Thanks for listening!

Slides: www.drewskillman.com/GDC_China_2011

Email: drew@doublefine.com

Double Fine: www.doublefine.com

Software Links:

- Processing: www.processing.org
- Simple OpenNI: code.google.com/p/simple-openni
- Fluid Simulation: http://www.memo.tv/msafluid_for_processing_v1_3
- Blob Detection: http://ubaa.net/shared/processing/opencv/
- Open GL: http://glgraphics.sourceforge.net/
- Spring Physics: http://murderandcreate.com/physics
- Box2D Physics: http://www.ricardmarxer.com/fisica

Video Credit: Kinect hacking video created by Johnny Lee