University of Hull

Rather Useful Seminars

Sensing the world with Kinect 2

Rob Miles

The V1 Kinect Sensor

- Microsoft Kinect was released in 2011 as a new kind of controller for the Xbox 360
- Fastest selling gadget of all time
- Later released as a PC accessory

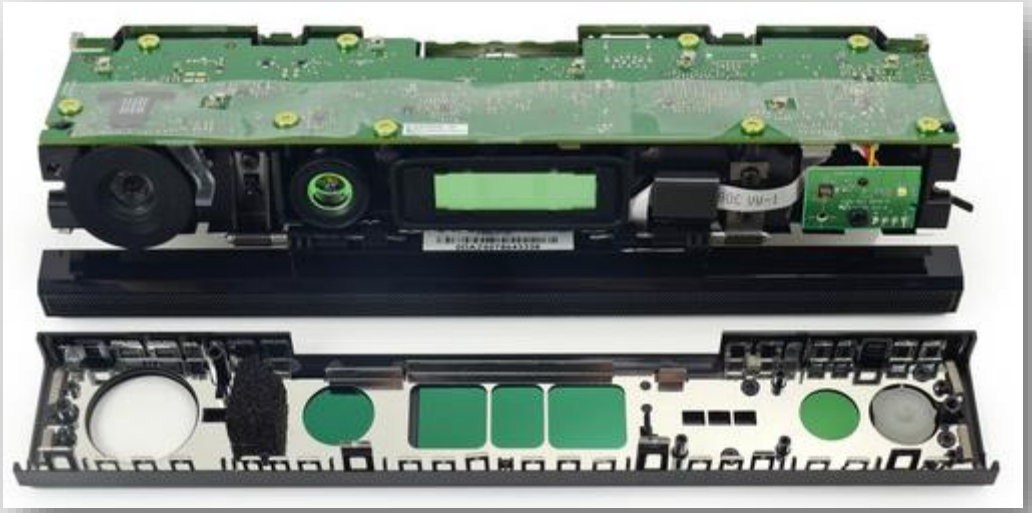
Kinect V1 Sensor

- The original Kinect contained two cameras, an infra-red projector and four microphones
- It is connected to the PC via a USB 2 port

The V2 Kinect Sensor

- Version 2 of the Kinect Sensor was launched with the Xbox One console
- Needs a USB 3 connection now…

Kinect V2 Sensors



- The Kinect V2 builds on the previous device and adds an infra-red camera to the device

What does the Kinect 2 do?

- There are loads of sensors in the Kinect 2
  - High quality colour video camera
  - Infra-Red (see in the dark) camera
  - Depth camera
  - Skeleton tracking
  - Four microphones for sound tracking
- These can be used from C# programs using the Kinect libraries in the SDK

The Kinect Video Camera

- The Kinect contains a high quality video camera with a wide field of view
- This will produce 1920x1080 high resolution video with a very wide field of view
- We can play with this in code

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DEMO 01

Ghost Camera

Working with Video Data

- You can regard a video image as an array of a very large number of 8 bit values
  - Red intensity
  - Green intensity
  - Blue intensity
  - "Alpha" intensity

Alpha data

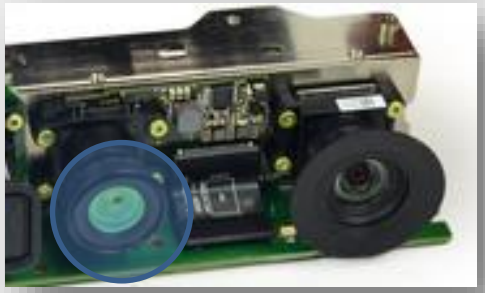
- Red, Green and Blue make sense, but what is alpha?
- Alpha is how "transparent" the image is
  - An alpha value of 0 means you can see through it
  - An alpha value of 255 means the image is opaque
- You would use this when layering images

Image data and Programs

- The program creates an array of values and then this is converted into an image for display

The Kinect Infra-Red Camera

- The Kinect V2 also contains an infra-red camera
- This allows it to see in the dark with 512x424 resolution
- The Kinect contains some powerful infra-red emitters to light up the scene in front of the sensor



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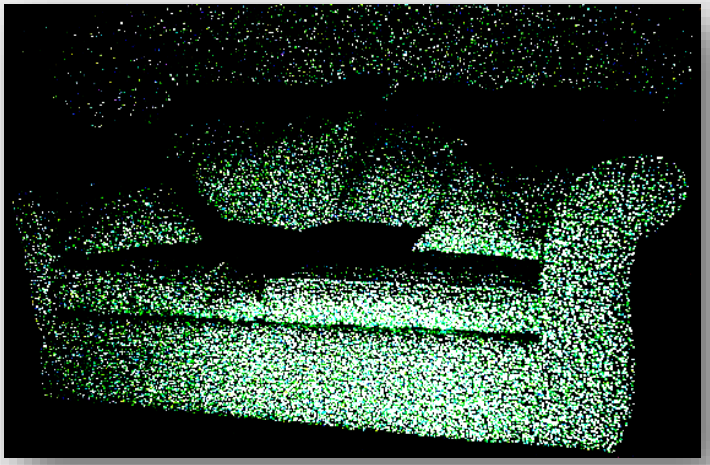
DEMO 02

Infra Red Camera

The Kinect Depth Sensor

- What makes the Kinect really interesting however is the “depth” sensor
- This allows the device to see in 3D and make sense of the world in front of it
- Software can use the depth map of the view to detect and track people in front of the sensor

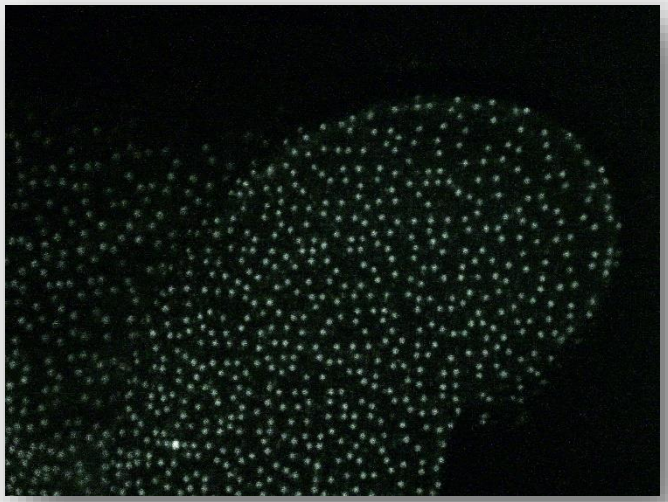
View from the Depth Sensor



- The image on the right shows the depth camera view of a scene
- The sensor projects an array of infra-red dots onto the scene in front of it

From Dots to Depth

- The pattern of dots that is used to measure depth may look random but it is repeatable
- The further away the dot is reflected, the more it is displaced in the image the camera sees



Depth Camera Limitations

- Because of the way the camera works some parts of the scene will be in "shadow" and their distance can't be measured
  - These are shown as having a distance value of 0
- The resolution of the camera reduces as objects get further away from the sensor
  - The camera interpolates distances between the points that are reflected

Kinect 2 vs Kinect 1 depth sensor

- The Kinect 1 used a special lens to produce the infra red dots
- The Kinect 2 uses multiple IR emitters and rapidly switches between them to allow the use of different dot patterns
- This improves the resolution threefold
  - Can now do finger tracking and detect if a hand is open or closed

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DEMO 03

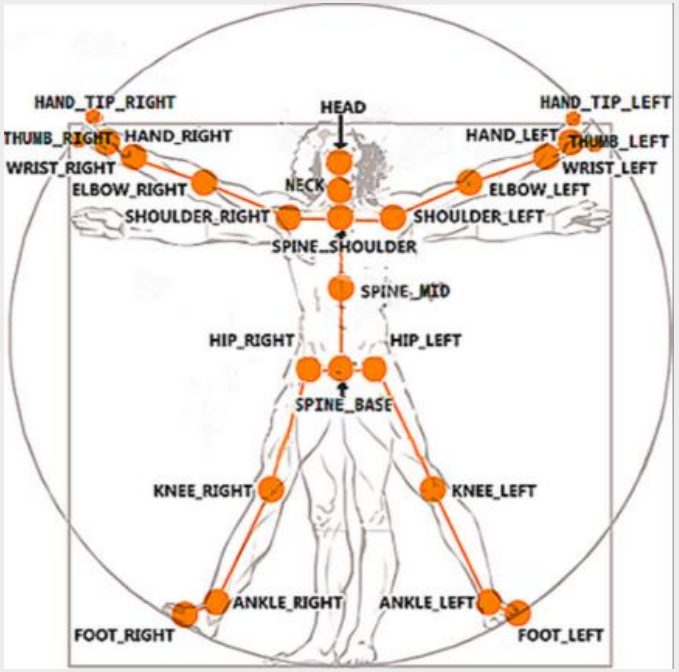
Carbonizer

Kinect Skeleton Tracking

- The Kinect SDK uses the depth information to track the position of people in front of the sensor
- The software can track up to 6 people
  - It can now work if they are sitting as well as standing

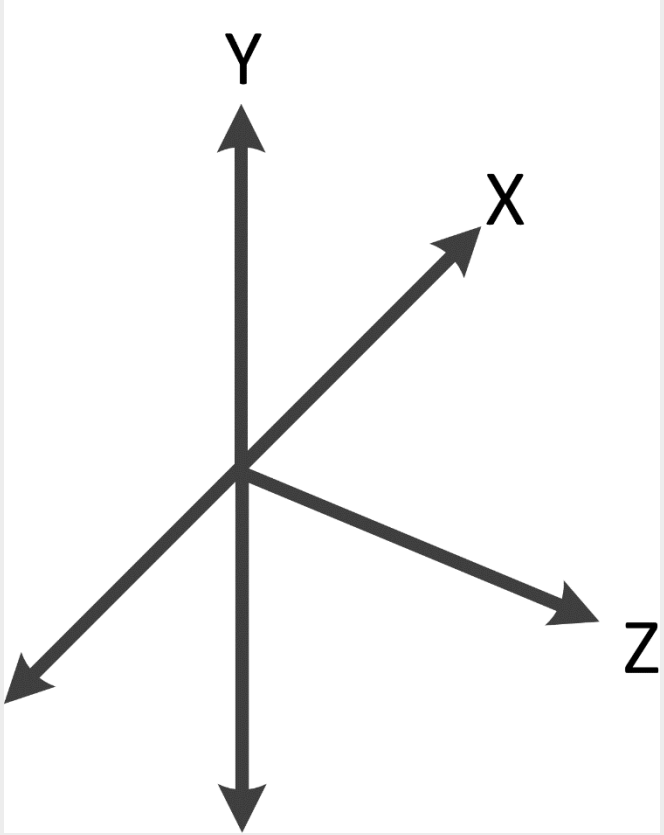
Kinect Skeleton Data

- A Kinect skeleton is made up of 25 joints connected by "bones"
- Each joint is positioned in 3D space relative to the Kinect sensor



Kinect Joint Data

- The position of each joint is given as an offset from the Kinect sensor
  - X is left-right
  - Y is up-down
  - Z is away from the sensor
- The values are given in mm



Using Body Data

- A program can use the body data as positions in 3D space
- Alternatively the joint positions can be mapped into the 2D depth frame or colour frame coordinate space

Detecting Gestures

```
private float jointDistance(Joint first, Joint second)
{
    float dx = first.Position.X - second.Position.X;
    float dy = first.Position.Y - second.Position.Y;
    float dz = first.Position.Z - second.Position.Z;
    return (float)Math.Sqrt((dx * dx) + (dy * dy) +
                            (dz * dz));
}
```

- This method use trigonometry to measure the distance between two joints

Tin Head

```
float d = jointDistance(body.Joints[JointType.Head],
                        body.Joints[JointType.HandRight]);

if (d < 0.4f && oldDistance > 0.4f)
{
    dingPlayer.Play();
}
```

- This plays a ding sound when a person touches their head with their right hand

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DEMO 04

Kinect Tin Head

Other Uses

- You can use a Kinect to create augmented reality, isolating players from a background
- You can use the directional microphones to track sounds and eliminate background noise
- You can mount Kinect on robots and make them able to navigate by themselves

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DEMO 05

SDK Browser and Kinect Fusion

Playing with Kinect

- You can buy a Kinect sensor for Windows which will work with a PC
- You'll need a fast USB3 port for it to work best
- The Kinect SDK is a free download

Old vs New

- If you have an old Kinect sensor you can have quite a bit of fun using it with a PC
- There is also a “Kinect for Windows” device based on the old platform

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- I recommend this book…

Resources

- www.microsoft.com/en-us/kinectforwindows/

Also available....

www.robmiles.com