Vision Recognition for Mixed Reality Applications

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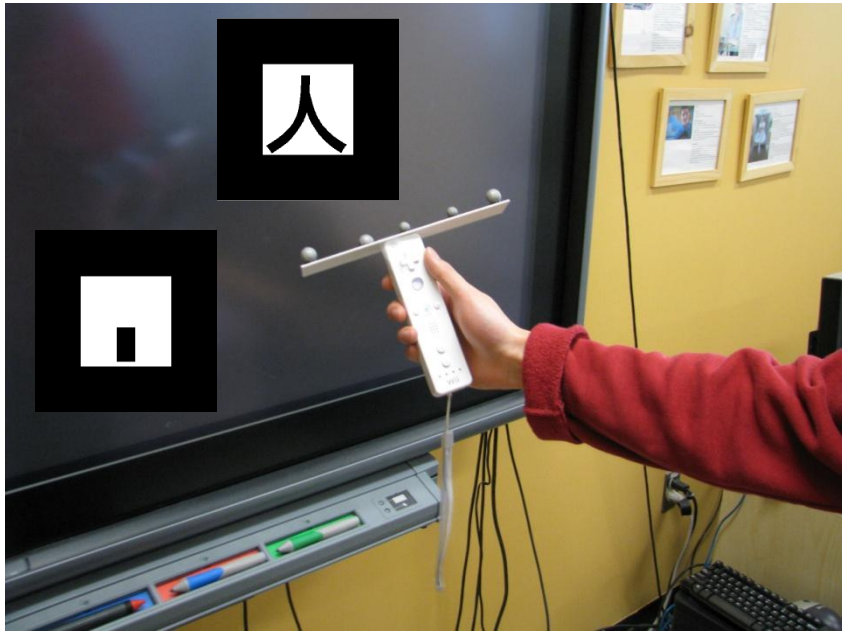
With annotations

Vision Recognition System



3. Application

2. Vision Recognition

1. Webcam Capture

Webcam

Some work better than others…

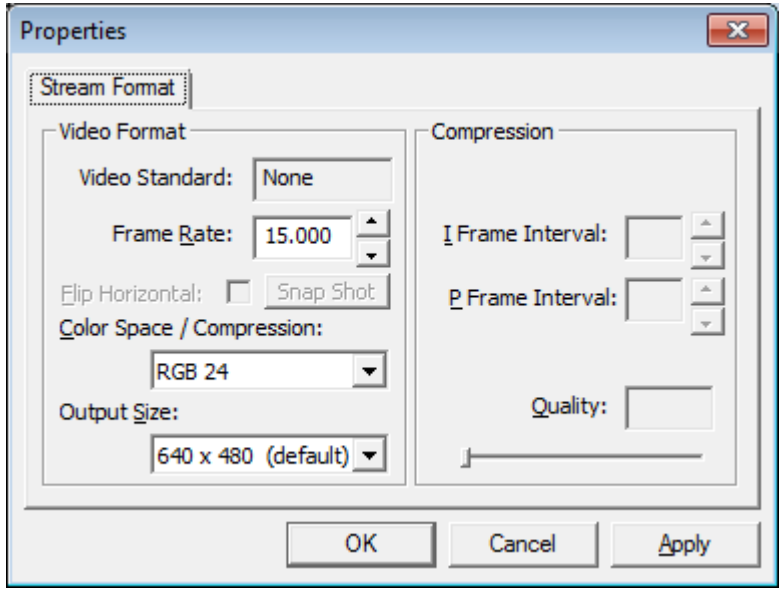
Logitech C905
QuickCam Pro for Notebooks

- Tried and tested
  - Design Interfaces Lab (Dr. Igarashi)
  - MIT Media Lab
- Characteristics
  - Wide angle lens
  - Auto focus
  - 800 x 600 @ 30 fps
  - 1600 x 1200 @ 10 fps

Webcam

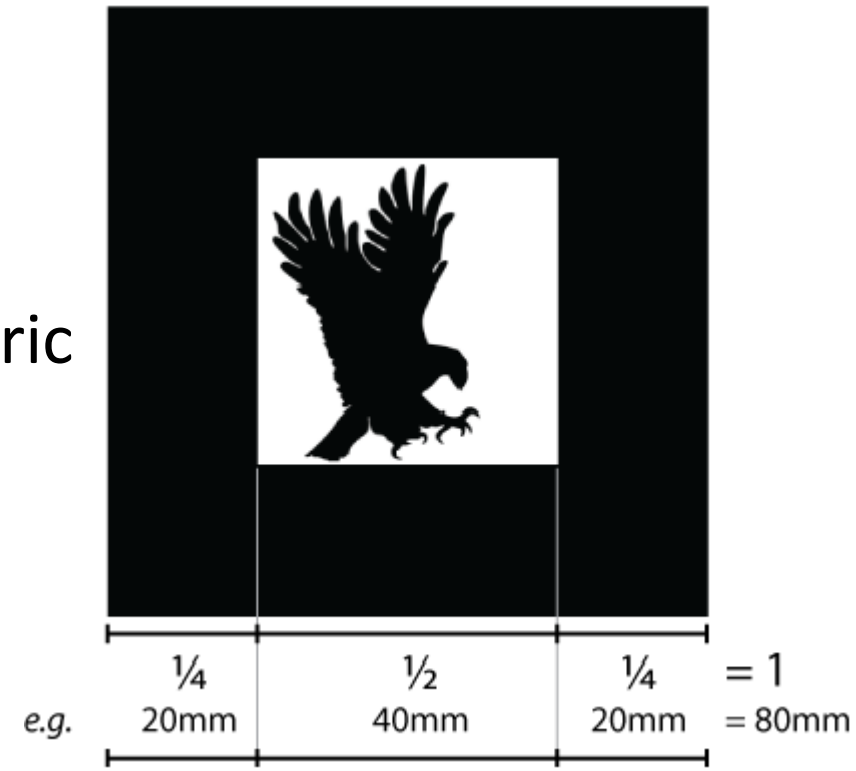
VirtualDub:

File > Capture AVI
Device > DirectShow
Video > Capture Pin



Markers

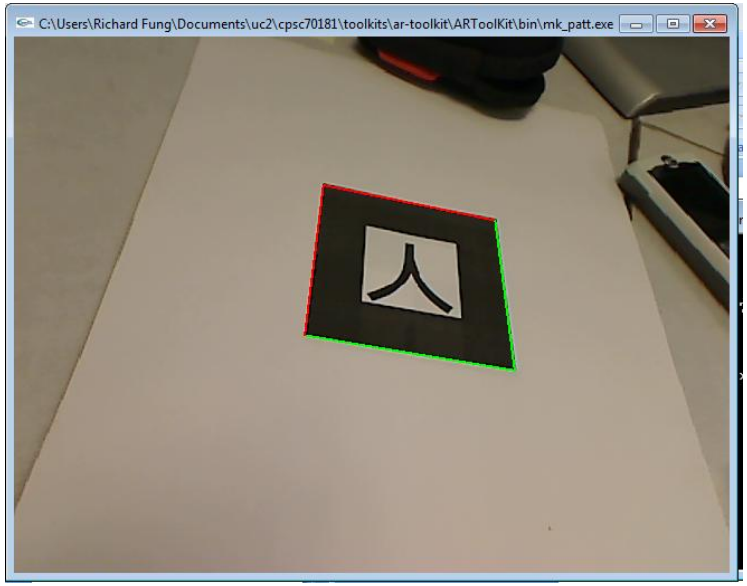
- Characteristics
  - Square
  - Continuous border
  - Not rotationally symmetric
  - Black border:



ARToolkit and variants

Markers

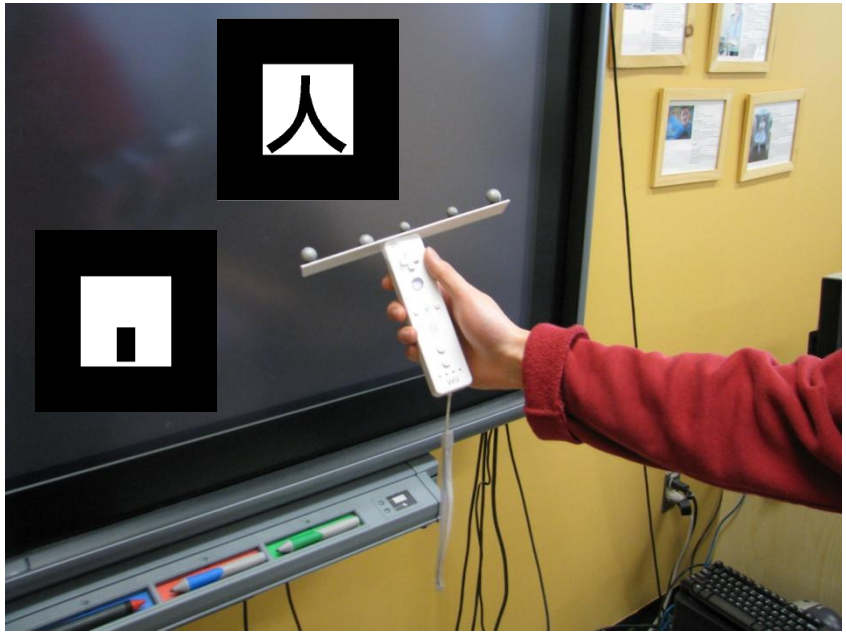
- Pattern design
  - From webcam
    - ARToolkit/bin/mk_patt.exe
  - Use existing patterns
    - ARToolkit/patterns
      - Hiro
      - Kanji
    - Search the web

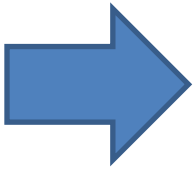


Markers

- Issues
  - Size of marker
    - further away = larger
  - Complexity of pattern
    - False positives
  - Reflection of light
    - Use felt instead of laser print
    - Print at low toner option

Vision Recognition System





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Various Packages

• ARToolkit	C++	open/proprietary
• ARToolkitPlus	C++	open
• ARTag	C++	proprietary
• NyARToolkit	Java, C#	open
• Goblin XNA	C#	open
• Igarashi	Java, C#	proprietary

NyARToolkit

- Setup
  - Calibration
  - Create marker definition files
- Issues
  - Incomplete
  - Documentation in Japanese

NyARToolkit

- Source code
  - Distribution 2.5.2.1
  - Added a new method: NyARDetectMarker.getCorners()
  - Download from iLab Cookbook

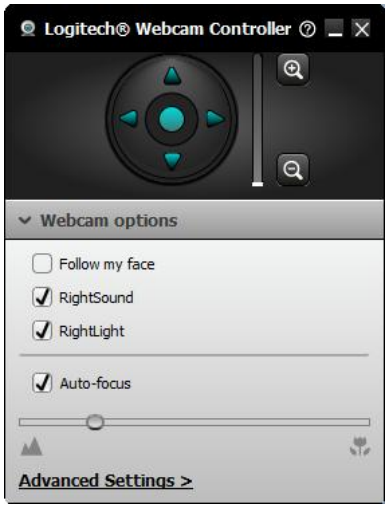
Dependencies

- Visual Studio 2008 or later
- Microsoft DirectX SDK 2002 to August 2007
  - Requires Managed Direct X 1.1
- Webcam
  - Next slide…

Webcam Capture

- Windows: Microsoft DirectShow
  - API provided by toolkit

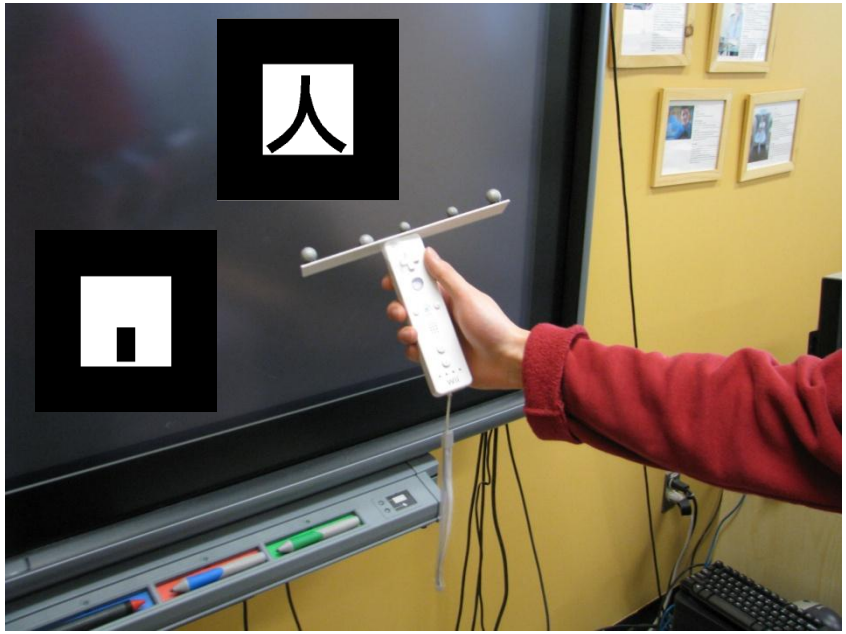
- Issues
  - Auto focus blur
  - Image: Contrast, lighting, flickering
  - Colour image vs. B&W




Logitech® Webcam Properties
Logitech Webcam 905
Webcam Control
Advanced Settings
Device Info
Follow my face
RightSound
Find my face (for widescreen viewing)
Auto-focus
Logitech
Restore to defaults
Save
Cancel


Logitech® Webcam Properties
Logitech Webcam 905
Webcam Control
Advanced Settings
Device Info
Image Quality:
RightLight
Exposure
Gain
Auto
Brightness
Contrast
Color Intensity
Anti-flicker:
Off
NTSC - 60Hz
PAL- 50Hz
Image orientation:
Normal
Mirrored
Logitech
Restore to defaults
Save
Cancel

Vision Recognition System



3. Application

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1. Webcam Capture

Vision Recognition

- Runtime
  - Initialization
    - Select a webcam ← next slide…
    - Load webcam parameters to NyARToolkit
    - Load pattern(s) to detect

```
using NyARToolkitCSUtils.Capture;
using NyARToolkitCSUtils.NyAR;

 public partial class MainWindow : Window, CaptureListener
{
        private CaptureDevice m_cap;

        public MainWindow()
        {
                […]
                CaptureDeviceList cl = new CaptureDeviceList();
                CaptureDevice cap = cl[0];
                m_cap.SetCaptureListener(this);
                m_cap.PrepareCapture(800, 600, 30);
                […]
        }

        void CaptureListener.OnBuffer(CaptureDevice i_sender, double i_sample_time,
                                      IntPtr i_buffer, int i_buffer_len)
        {
        }
```

Callback interface

Enumerate webcams

Width, height, frame rate

Callback method

```
using jp.nyatla.nyartoolkit.cs;
using jp.nyatla.nyartoolkit.cs.core;
using jp.nyatla.nyartoolkit.cs.detector;

public partial class MainWindow : Window, CaptureListener
{
        private NyARDetectMarker m_ar;

        public MainWindow()
        {
                […]
                //AR用カメラパラメタファイルをロード
                // AR camera parameters file to read
                NyARParam ap = new NyARParam();
                ap.loadARParamFromFile("../../data/camera_para.dat");
                ap.changeScreenSize(800, 600);

                //AR用のパターンコードを読み出し
                //AR's pattern to detect from the webcam
                NyARCode code = new NyARCode(16, 16);
                code.loadARPattFromFile("../../data/patt.kanji");
                this.m_ar = new NyARDetectMarker(ap,
                        new NyARCode[]{code}, new double[]{80.0}, 1,
                        NyARBufferType.BYTE1D_B8G8R8_24);
                this.m_ar.setContinueMode(false);
```

Detection object

Webcam Calibration

Width, height again

16 blocks inside black border

80 mm marker size

Recognize on a 24 bpp bitmap

Vision Recognition

- Runtime
  - New frame event
    - B & W threshold
    - Marker detection ← next slide…
    - Application logic
  - Better design
    - Marker detection + logic in a timer loop

```
void CaptureListener.OnBuffer(CaptureDevice i_sender, double i_sample_time,
                              IntPtr i_buffer, int i_buffer_len)
        {
            // calculate size of the frame bitmap
            int w = i_sender.video_width;
            int h = i_sender.video_height;
            int s = w * (i_sender.video_bit_count / 8); // stride

            // thresholding […]

            // detectMarkerLite requires BGR image from DirectX
            // m_threshold 0-255
            int detectedMkrs = this.m_ar.detectMarkerLite(ra, m_threshold);

            // save the result of the detection
            NyARSquare square = null;
            if (detectedMkrs > 0)
            {
                // vertices of the square are returned
                NyARTransMatResult transMat = new NyARTransMatResult();
                NyARDoublePoint2d[] points = m_ar.getCorners(0); // RichF
                square = new NyARSquare();
                square.sqvertex = points;
            }
```

square ← application logic for recognized marker

```
void CaptureListener.OnBuffer(CaptureDevice i_sender, double i_sample_time,
                              IntPtr i_buffer, int i_buffer_len) {
[…]
AForge.Imaging.Filters.FiltersSequence seq =
                                        new AForge.Imaging.Filters.FiltersSequence();

// order here is important, pipe and filters design pattern
seq.Add(new AForge.Imaging.Filters.Grayscale(0.2125, 0.7154, 0.0721));
seq.Add(new AForge.Imaging.Filters.Threshold(127));
seq.Add(new AForge.Imaging.Filters.GrayscaleToRGB()); // 24 bit image

// run the threshold algorithm
AForge.Imaging.UnmanagedImage srcImg =
         new AForge.Imaging.UnmanagedImage(i_buffer, w, h, s,
         System.Drawing.Imaging.PixelFormat.Format32bppRgb);
AForge.Imaging.UnmanagedImage outputImg = seq.Apply(srcImg);
```

Grayscale
+ B/W threshold

Original camera
Image from
DirectShow is 32 bpp

Move Aforge.imaging bitmap → NyARToolkit bitmap

```
[…] thresholding

// load a RGB buffer into the NyAR format, which we copy from AForge.Imaging
NyARRgbRaster_RGB ra = new NyARRgbRaster_RGB(w, h, false);
byte[] destArr = new byte[outputImg.Stride * outputImg.Height];
System.Runtime.InteropServices.Marshal.Copy(outputImg.ImageData, destArr,
                                                0, outputImg.Stride * outputImg.Height);
ra.wrapBuffer(destArr);

// detectMarkerLite requires BGR image from DirectX
// m_threshold 0-255
int detectedMkrs = this.m_ar.detectMarkerLite(ra, m_threshold);

[…] application logic
```

Examples

- WPF:
  - My example

- Packaged examples:
  - NyARToolkitCS-2.5.2.1\forFW2.0\sample

Examples

- RawTest
  - bitmap data + recognizer
- CaptureTest
  - webcam + recognizer + System.Drawing.Bitmap
- SimpleLiteDirect3d → 2 patterns
- SingleNyIdMarkerDirect3d → 1 pattern
  - webcam + recognizer + Direct3D

Where to go?

- ARToolkitPlus — Fudicials with built-in ID
- Goblin XNA — Extends ARTag
.NET
- Igarashi Detection — Orthogonal viewing
Smaller marker sizes

Thanks

- Miaosen Wang — ARToolkit example
- Paul Lapides — webcam info & ARToolkitPlus