Introduction to COSC450

COSC450

Lecture 1

Administration...

Lecturers and contacts:

- Steven Mills (steven@cs.otago.ac.nz)
- Stefanie Zollmann (stefanie.zollmann@otago.ac.nz)
- CS feedback (feedback@cs.otago.ac.nz)

Lecture notes and resources

- Paper website – `https://cs.otago.ac.nz/cosc450`

Usual stuff we need to talk about

- Academic integrity – links on assessment page of website
- Class representatives – volunteers by email to me

Unusual stuff we need to talk about

- Covid-19/Coronavirus

Visual Computing

Computer Graphics

Input Model(s)

Output Image(s)

Simulation

Input Model(s)

Output Model(s)

Image Processing

Input Images(s)

Output Image(s)

Computer Vision

Input Images(s)

Output Model(s)

Mixed and Augmented Reality

A continuum:

- Reality – you should know about by now
- Augmented reality – some virtual elements added to a view of the real world
- Augmented virtuality – some real elements added to a virtual world
- Virtual reality – entirely generated immersive content

Mixed reality requires an interesting mix of computer vision and computer graphics

- Camera modelling and calibration
- Camera and object tracking and pose estimation
- Reconstructing 3D models of the world from images
- Rendering virtual objects with realistic lighting
- Supporting interaction through gesture recognition etc.

Expected Background

COSC342 is very helpful, but not required

- Will review important parts
- You can follow along with COSC342

There will be mathematics

- Vision and graphics are mostly maths
- Not particularly advanced, but pervasive
- Linear algebra, geometry, statistics, a bit of calculus, numerical methods...

There will be programming

- Mostly in C++

$$\mathbf{u} \equiv \mathrm{K}[\mathrm{R}|\mathbf{t}]\mathbf{x}$$

$$k \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & s & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_1 \\ r_{21} & r_{22} & r_{23} & t_2 \\ r_{31} & r_{32} & r_{33} & t_3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$f(x + \Delta_x, y + \Delta_y) \approx f(x, y) + \frac{\partial f}{\partial x}\Delta_x + \frac{\partial f}{\partial y}\Delta_y$$

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

The Structure of COSC450

Similar to last year

- AR as a general theme
- Space for options at the end

Basic breakdown similar though...

- Three main blocks of lectures
- Two assignments

Assessment

- 60% exam (3×20 mark questions)
- Two 20% assignments

Main lecture topics:

- Computer Vision for AR
- Computer Graphics for AR
- Other topics (TBC)

Assignment topics:

- Tracking for AR
- Rendering for AR

These will cover a number of generally useful methods from computer vision and graphics

Lectures 1 – Computer Vision for AR

Many techniques required

- Camera models and calibration
- Feature detection and tracking
- Camera pose estimation
- 3D reconstruction and SLAM

These are useful in many other applications

- (Mult-view) stereo vision
- Robot navigation
- Object tracking

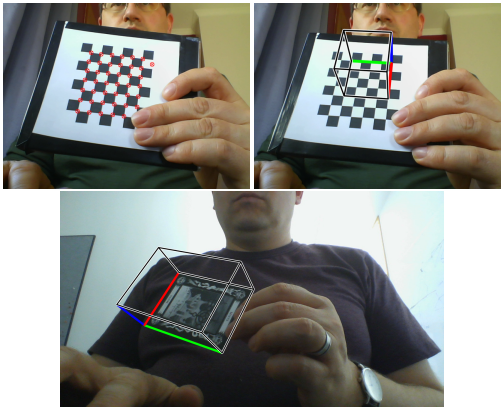
Assignment 1 – Tracking for AR

Sample AR program has no real tracking

- Target detected in each frame
- Chessboard is fragile with occlusion
- Feature-based method is slow (∼5fps)

Implement changes to improve on this

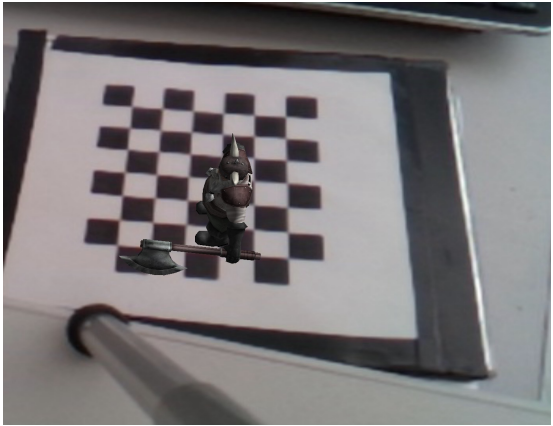
- Try different feature detection methods
- Use proper feature tracking
- Need to recover from tracking failures

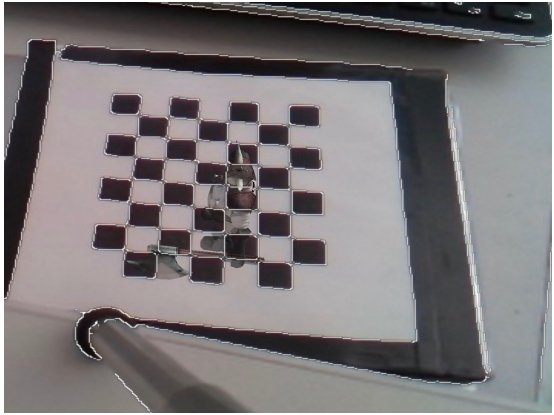


Lectures 2 – AR Techniques and Visualisation

- AR technology and hardware
- Rendering and visualisation for AR
- Challenges and applications of AR

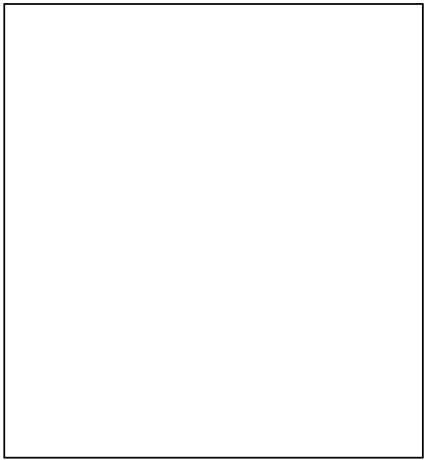
Assignment 2 – Rendering for AR





Lectures 3 – Topics in Vision and Graphics

What do you want to do?



Possible topics:

- Shape analysis
- Deep learning (but 420)
- Stereo vision / panoramas
- Gesture Recognition
- Animation principles
- Real-time ray tracing
- ...