Computer vision:
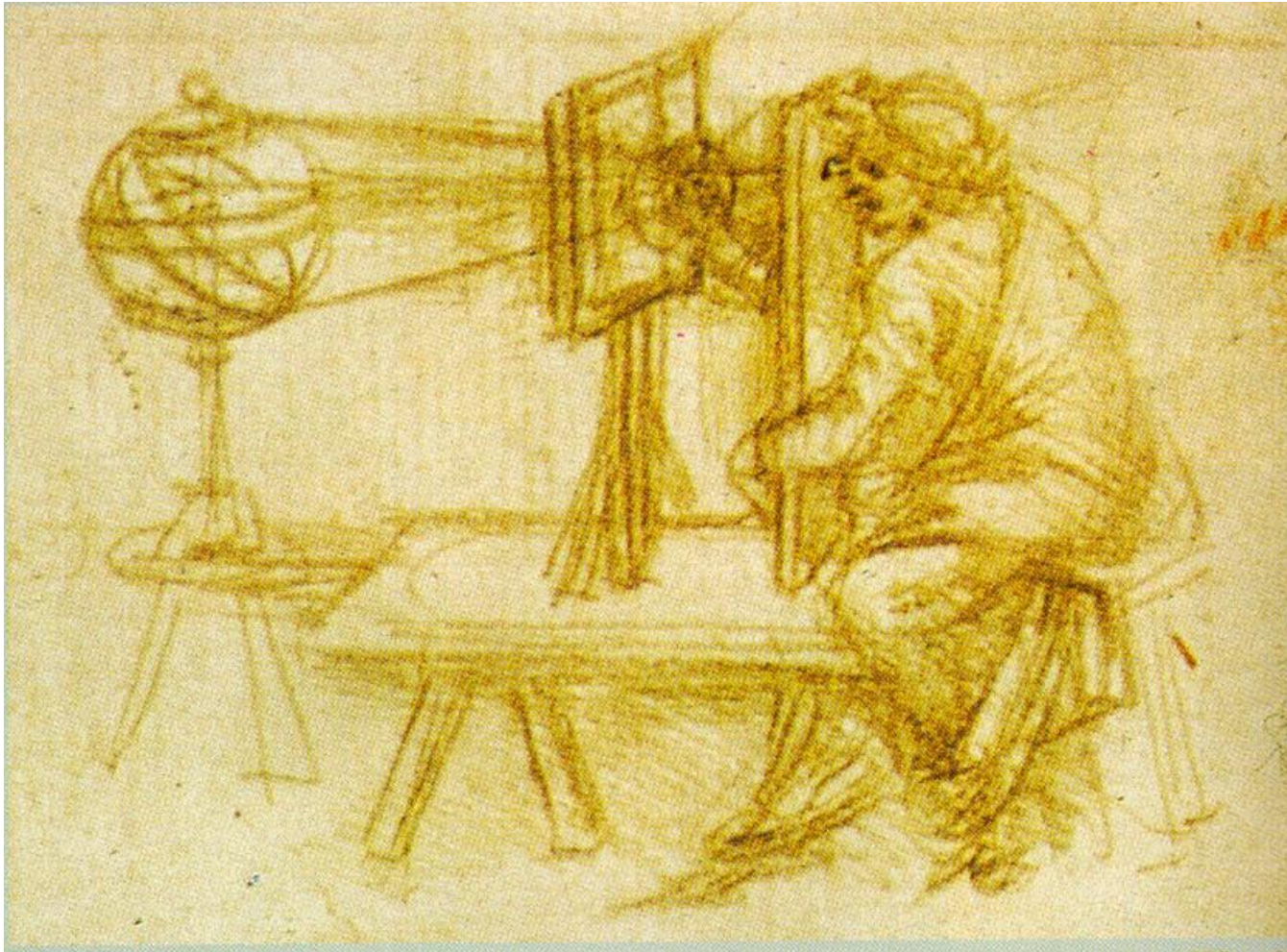
Image registration and 3D reconstruction
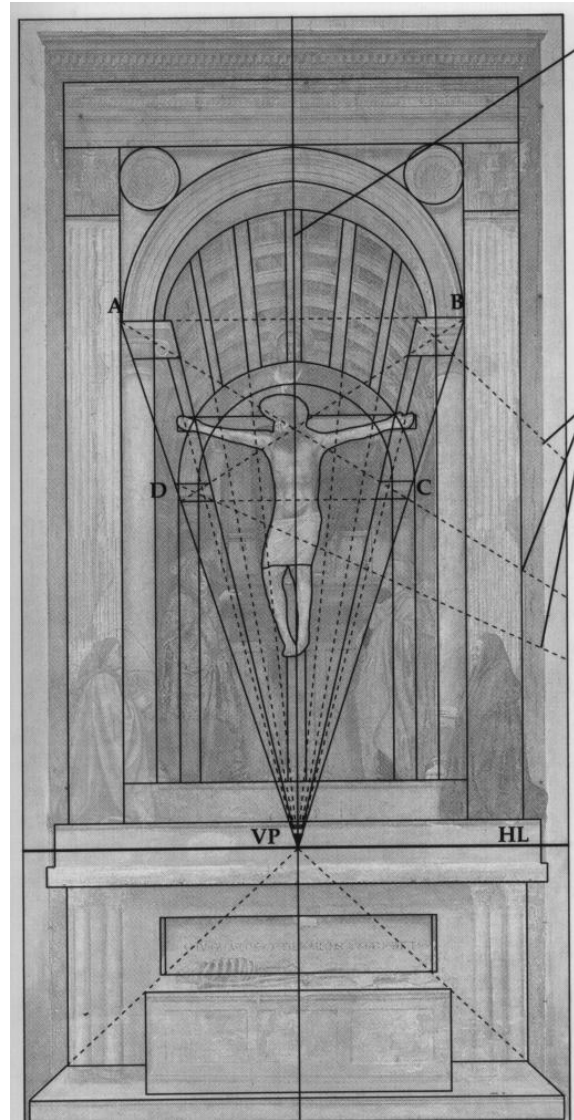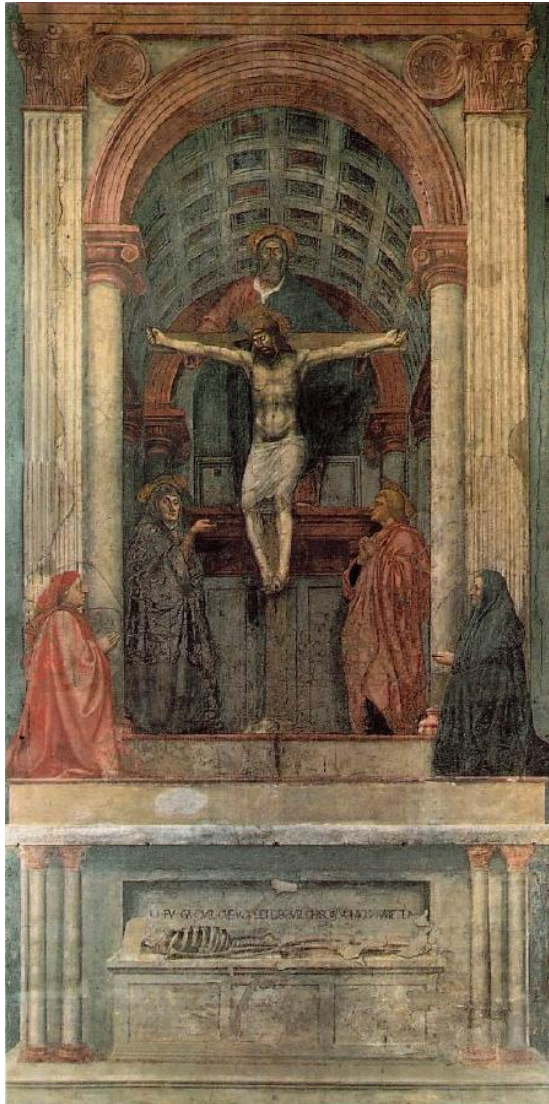
Roberto Cipolla

Department of Engineering

Perspective projection

Perspective projection

Inverting perspective

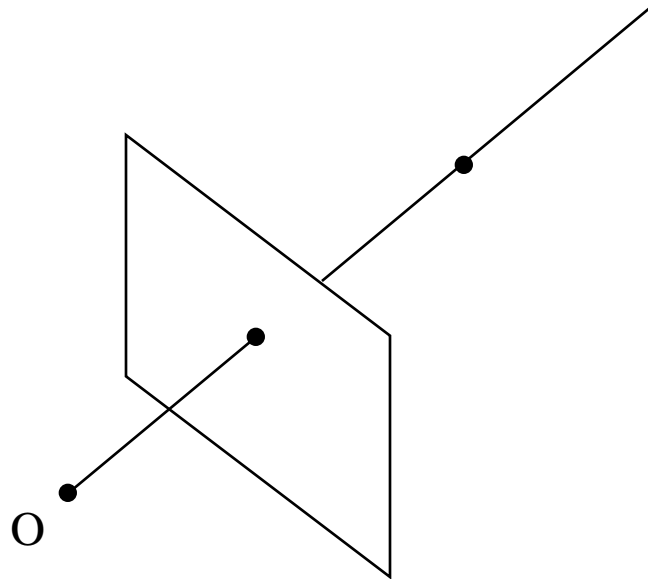# 1. 3D shape from uncalibrated images

3D model acquisition

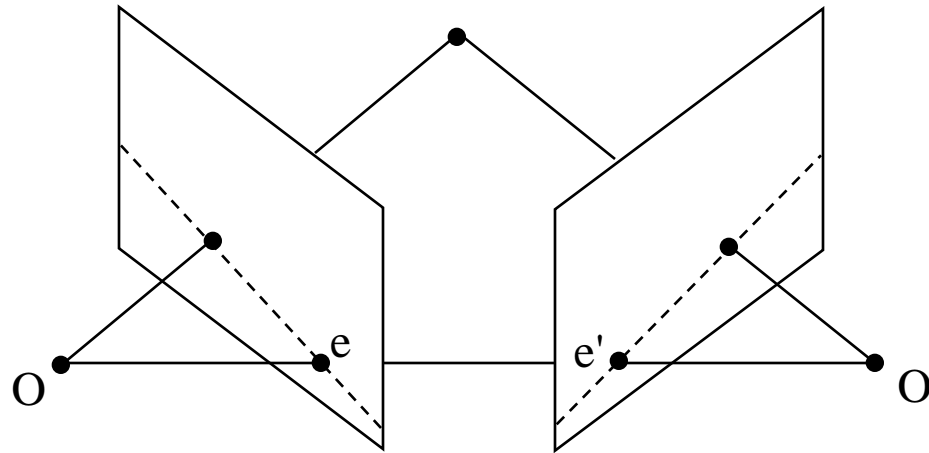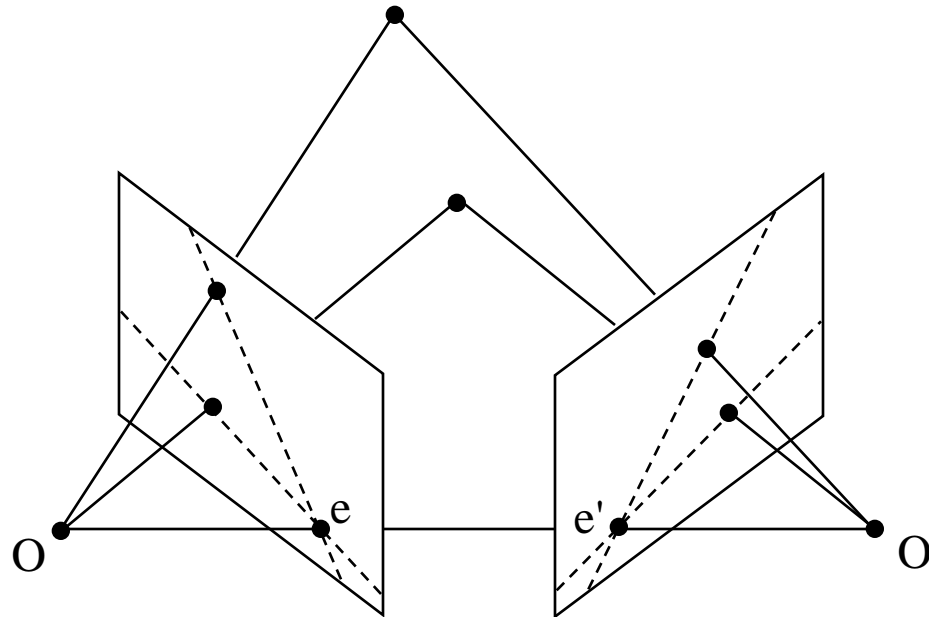Photorealistic models from uncalibrated images of architectural scenes

Ambiguity in a single view

O

$$\begin{bmatrix} \lambda u \\ \lambda v \\ \lambda \end{bmatrix} = K \begin{bmatrix} R & T \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

Stereo vision

$$\begin{bmatrix} \lambda u \\ \lambda v \\ \lambda \end{bmatrix} = K\begin{bmatrix} R & T \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \qquad \begin{bmatrix} \lambda u' \\ \lambda v' \\ \lambda \end{bmatrix} = K'\begin{bmatrix} R' & T' \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

Epipolar geometry

$$\begin{bmatrix} u' & v' & 1 \end{bmatrix} \begin{bmatrix} & & \\ & F & \\ & & \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = 0$$
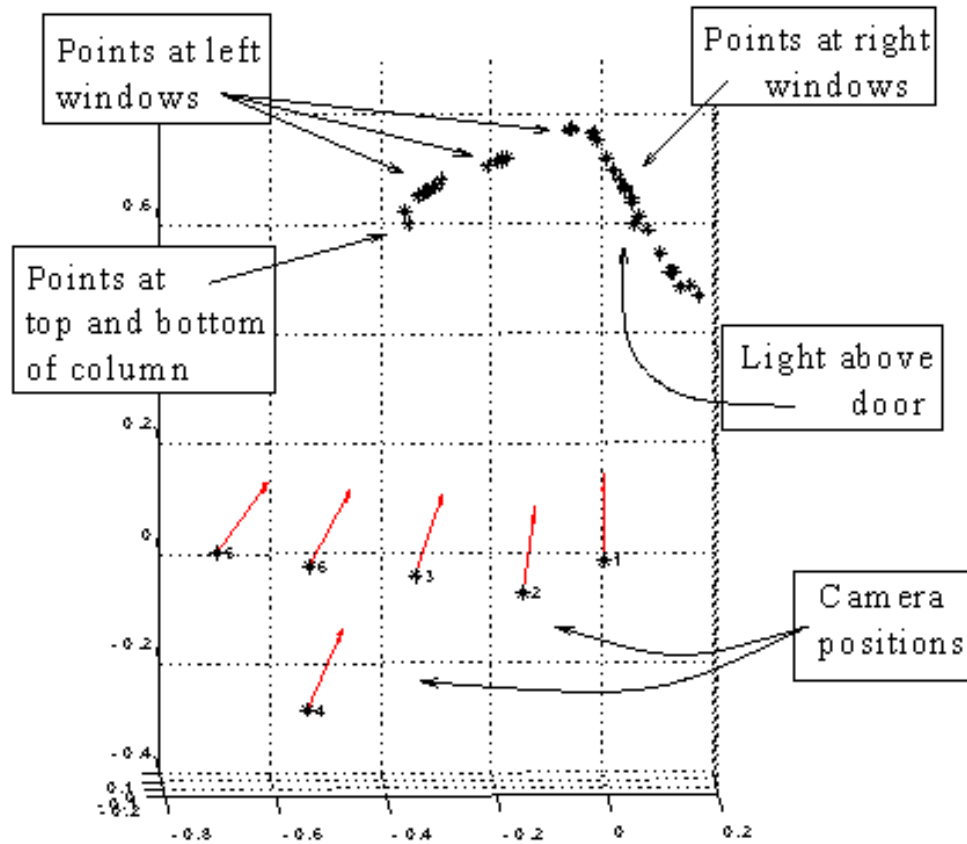
Uncalibrated Images

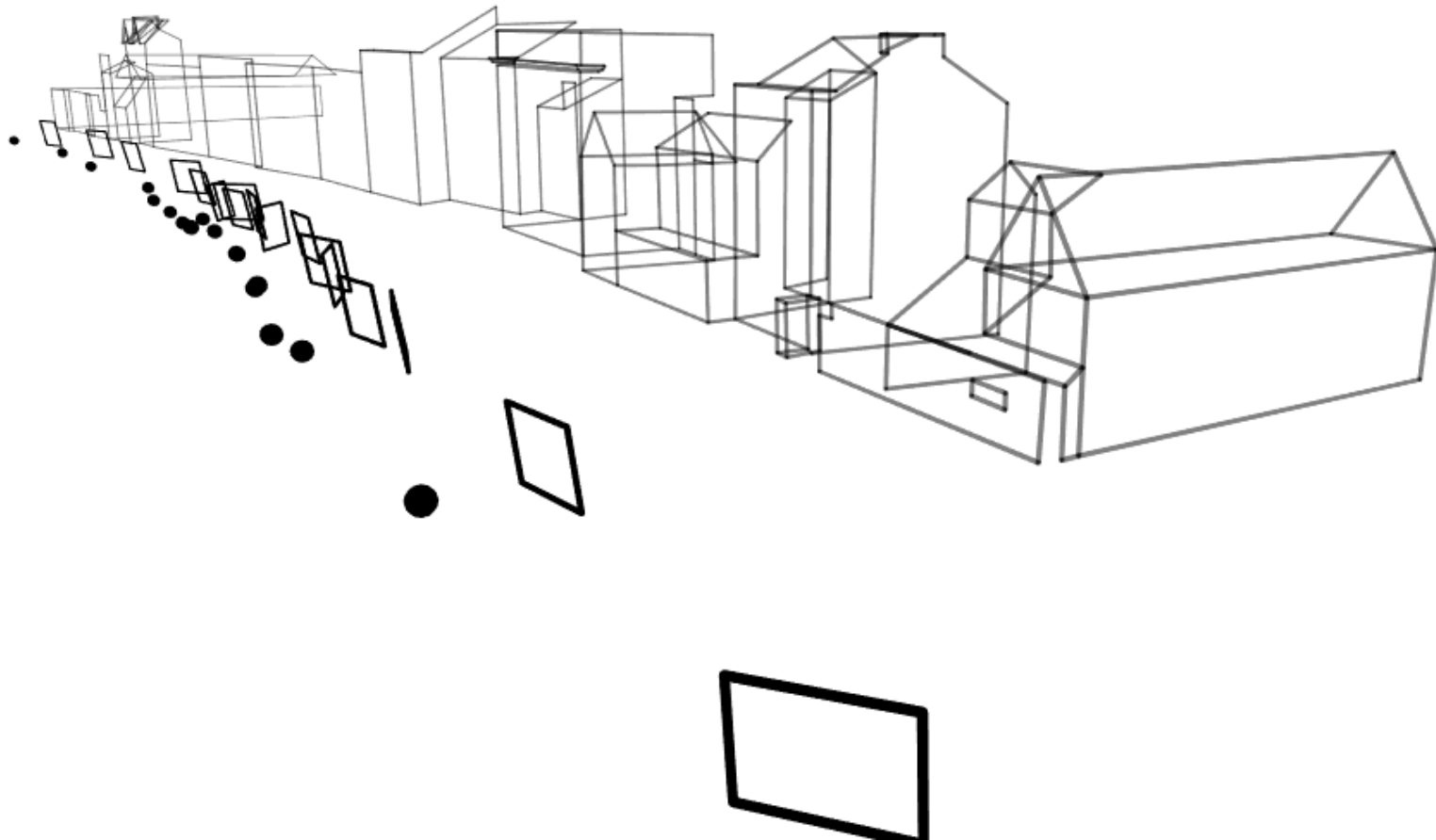# Point correspondences

Self-calibration

Trumpington Street Data

Camera pose determination

3D reconstruction

Reconstruction texture mapped

2. Image registration
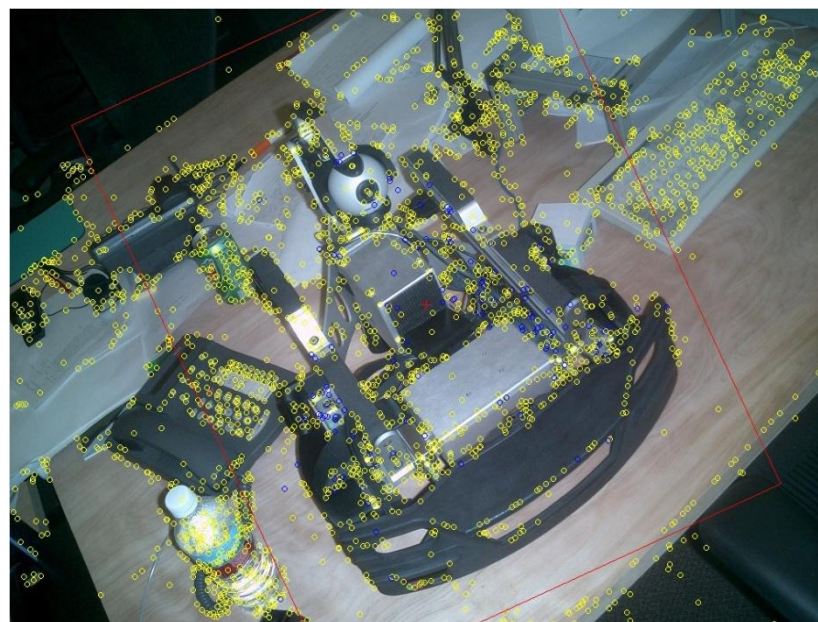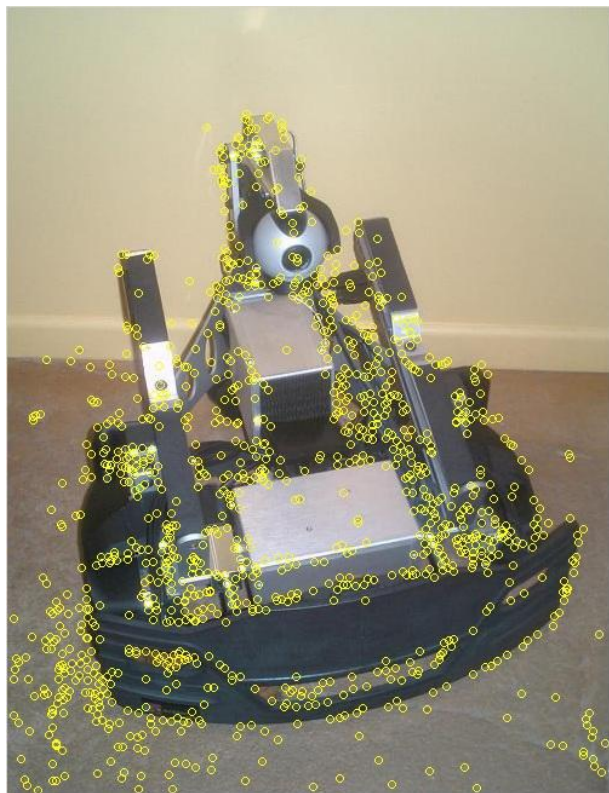
Finding image correspondences

Image matching

Mosacing

Matching features in images

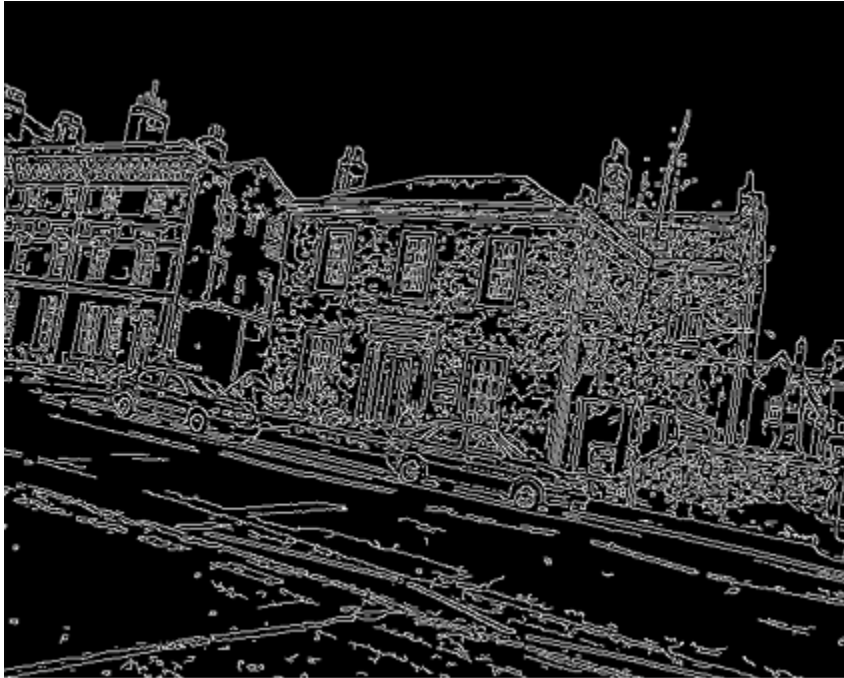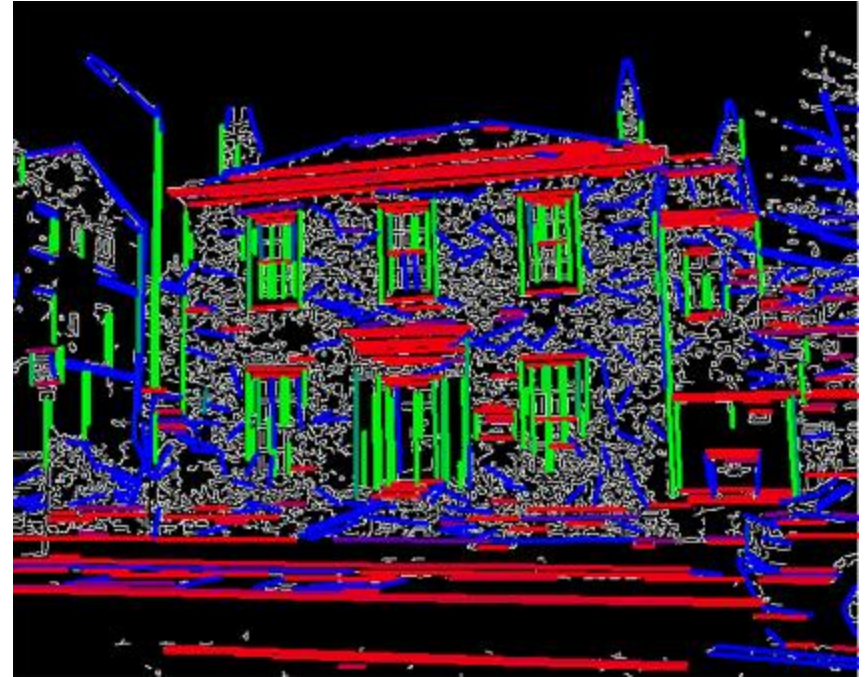# Wide-Baseline Matching
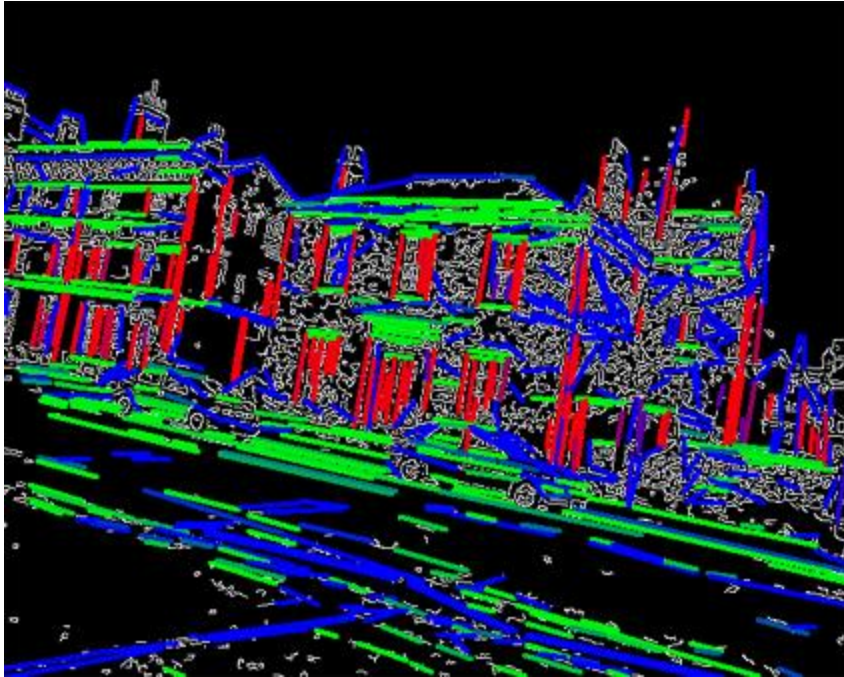
Wide-Baseline Matching

Wide-Baseline Matching

Wide-Baseline Matching
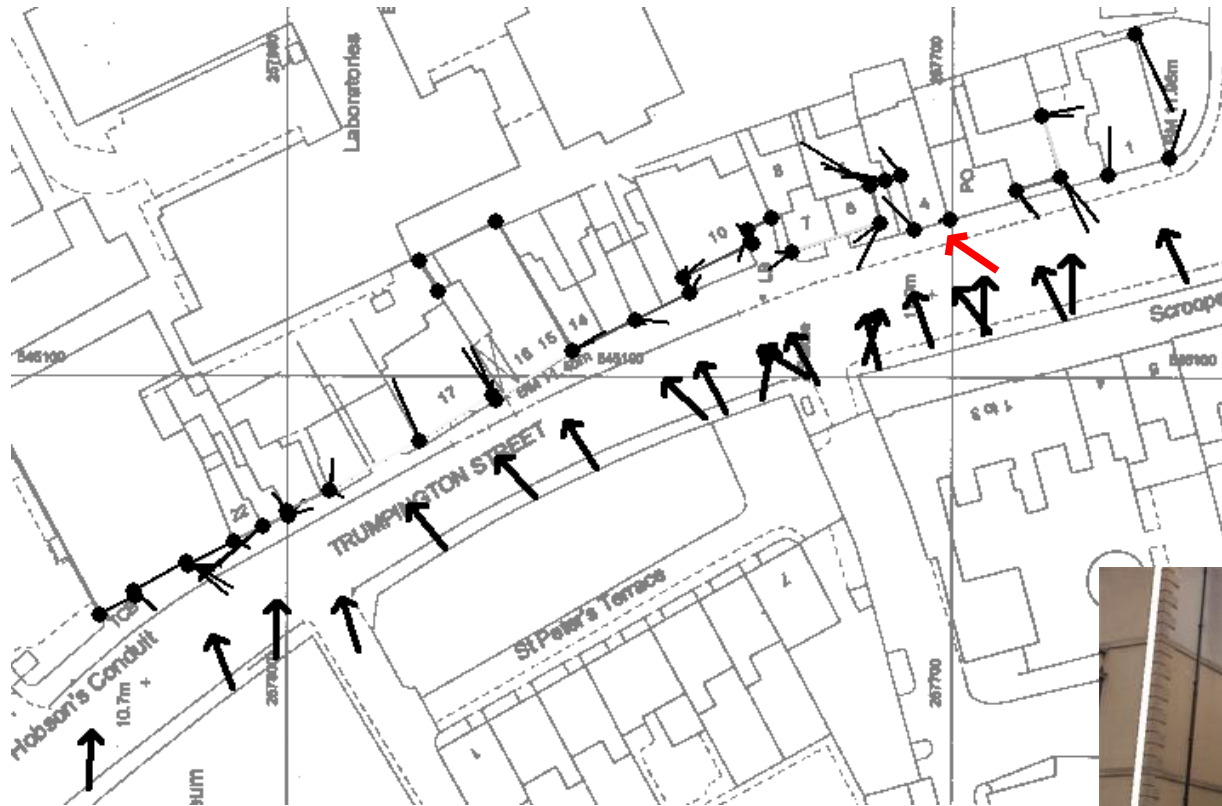
Wide-Baseline Matching

Wide-Baseline Matching

3. Where am I?
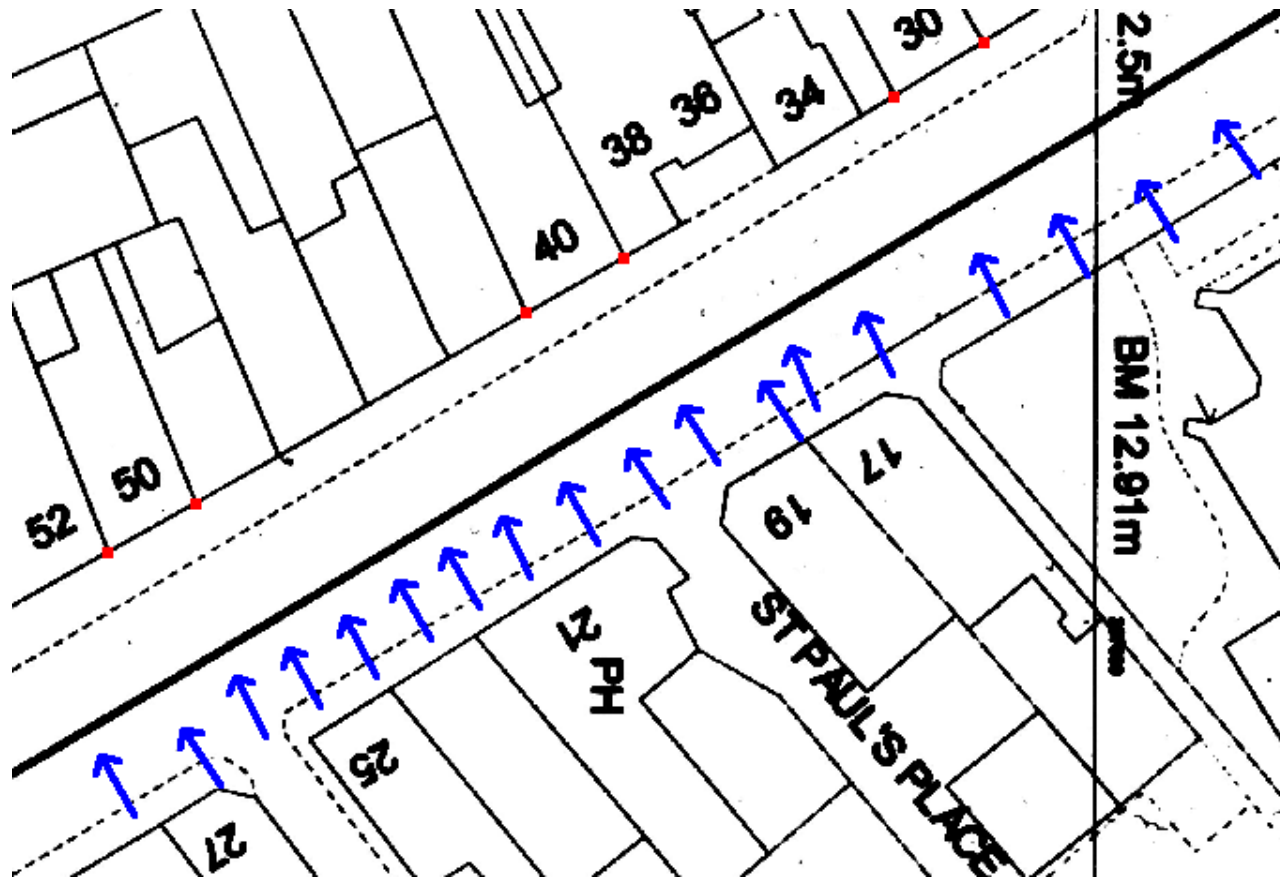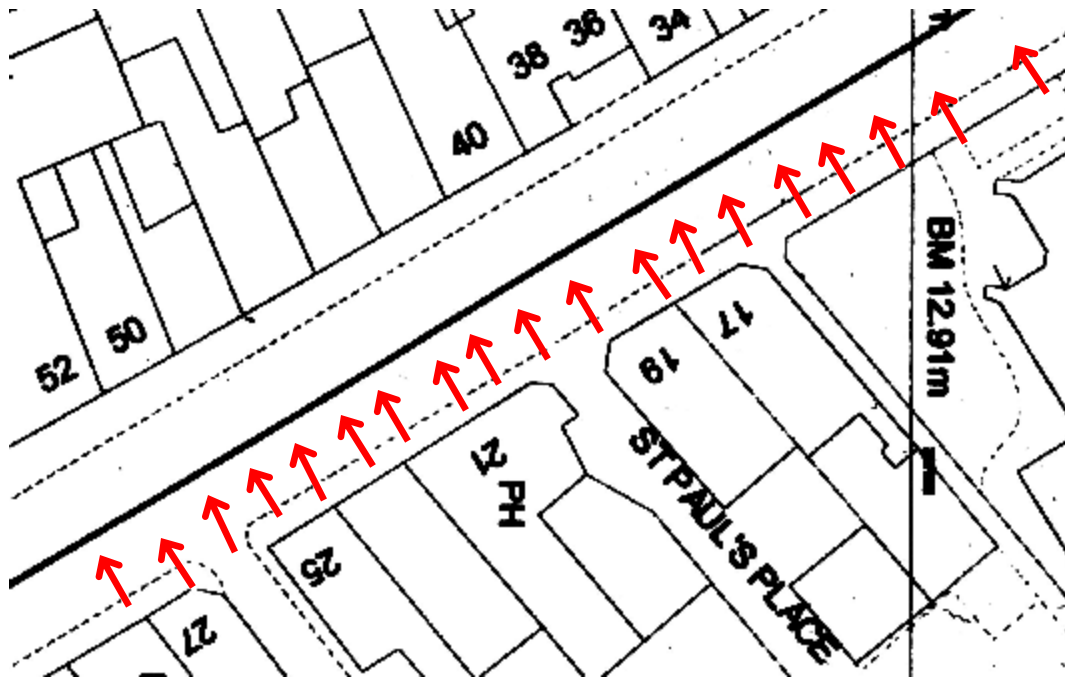
Image-based localisation

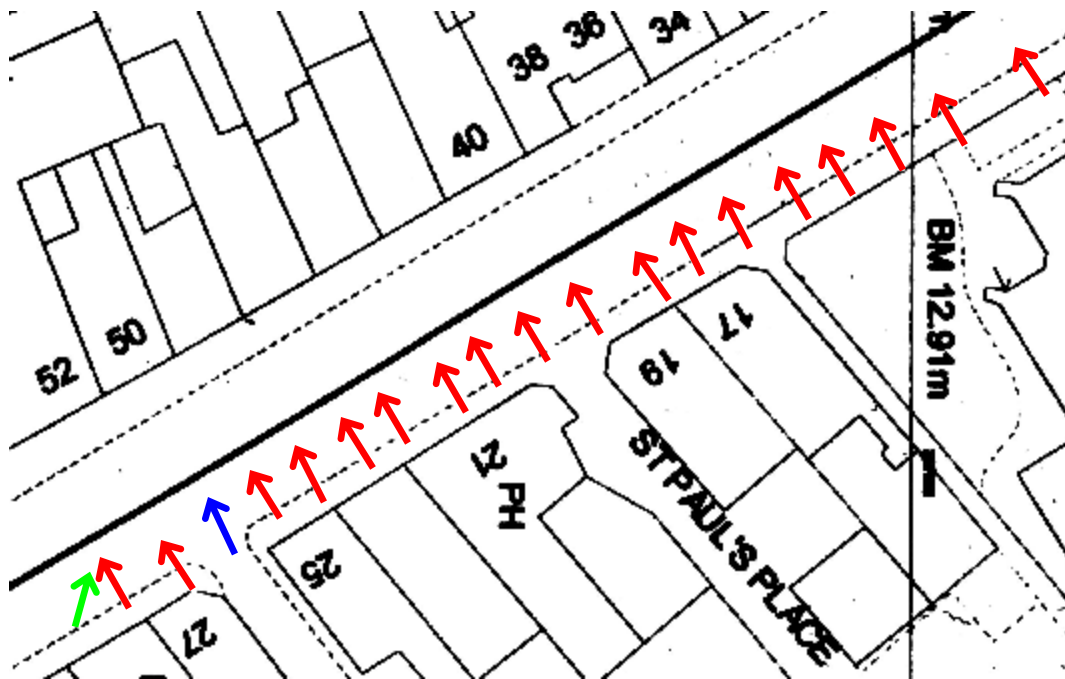# Image-based localisation

Image-based localisation

...

Image-based localisation
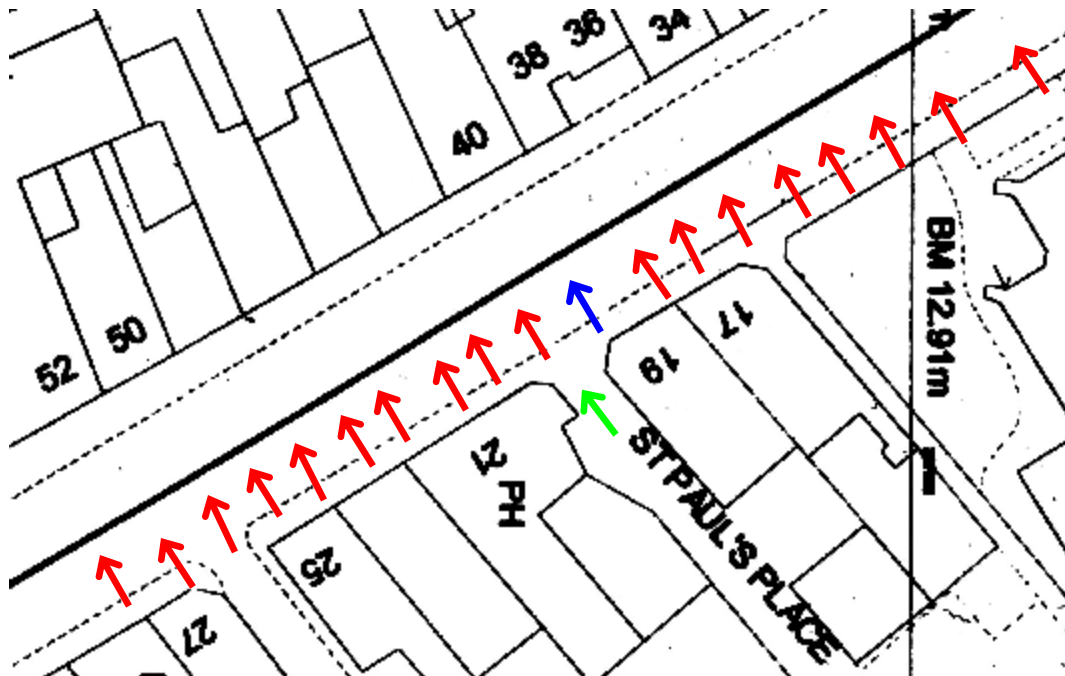
Image-based localisation

Image-based localisation

Image-based localisation

Image-based localisation
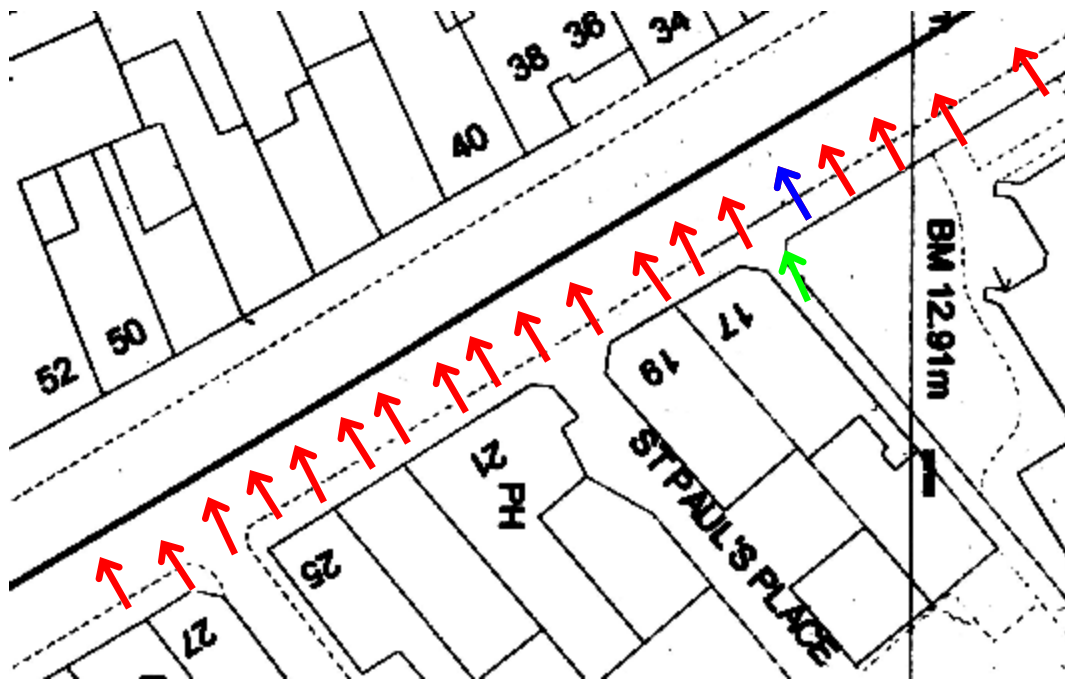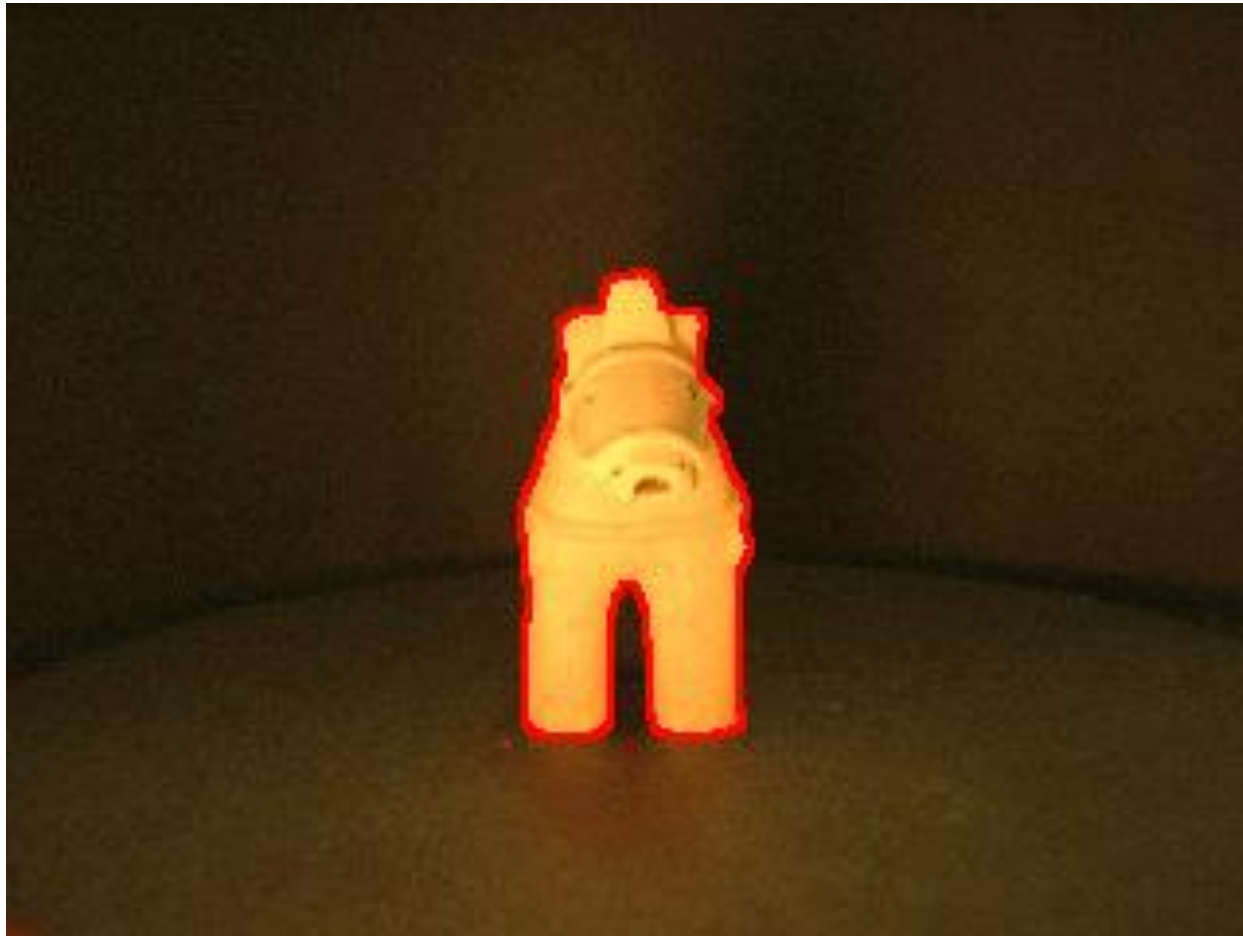
Image-based localisation

4. Complex geometries

Shape and motion from profiles

3D model acquisition

Outline and Motivation

- 3D model acquisition from uncalibrated images

- Outline (or silhouette) is the dominant image feature

- **Real-time visual tracking of articulated structures in multiple views**

- Generic mathematical (geometrical) framework and practical implementation.

5. Object detection

Hand detection system

3D articulation
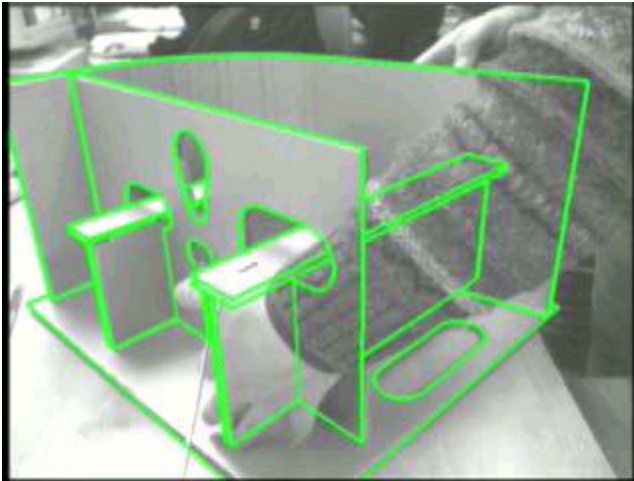
Conclusions

- 3D model acquisition from uncalibrated images

- Wide baseline matching and image registration

- Mobile phone localisation

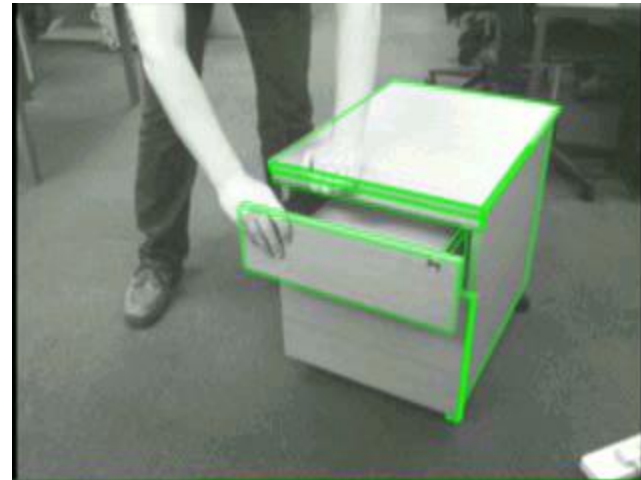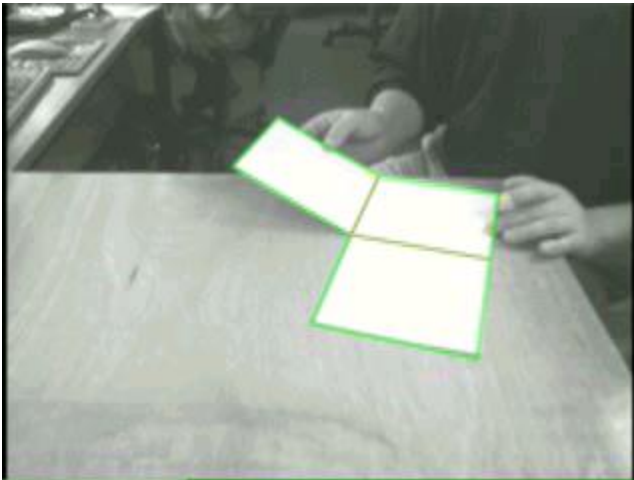- Technology is ripe for adaptation and exploitation

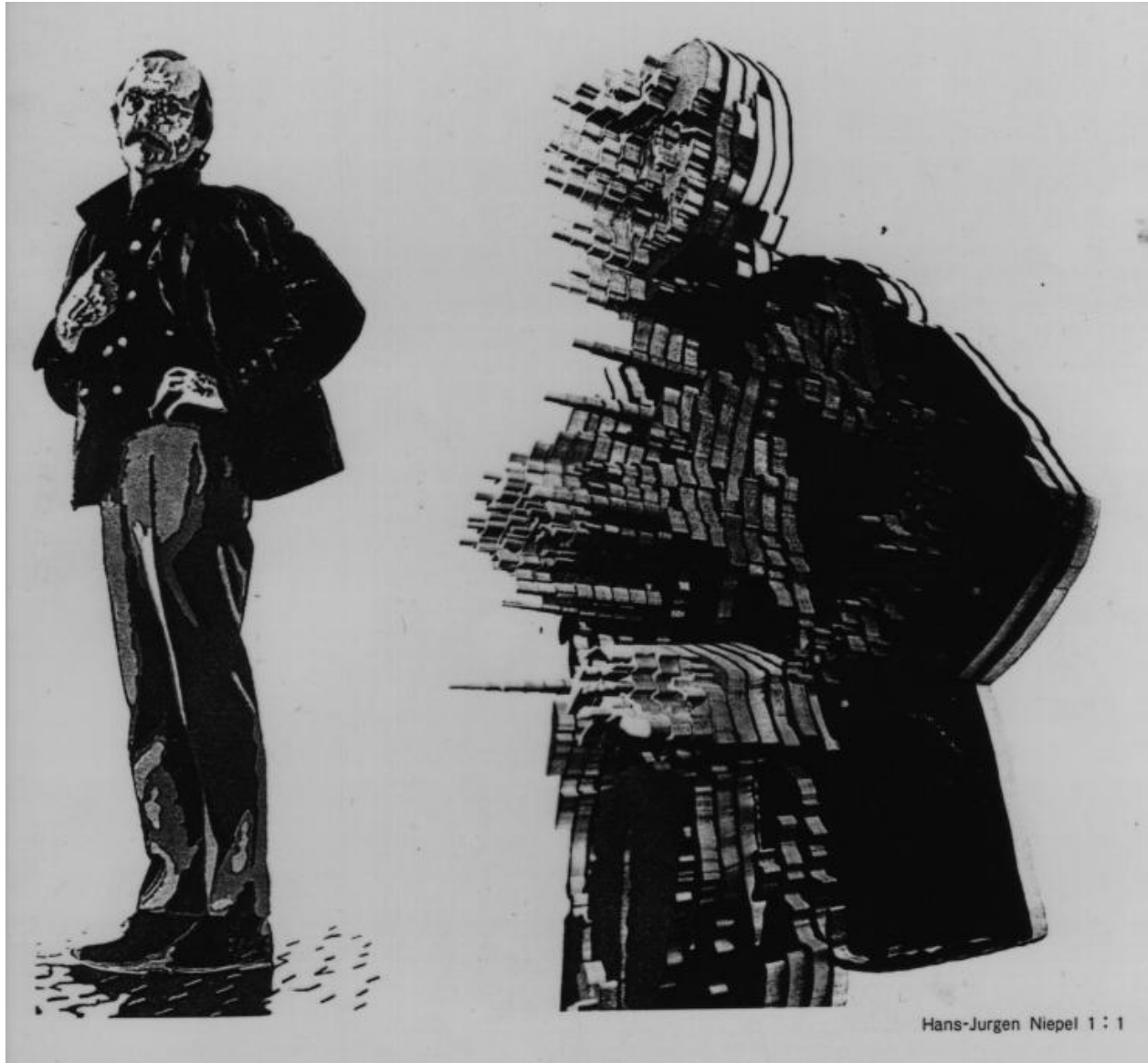# Real-time tracking using 3D models

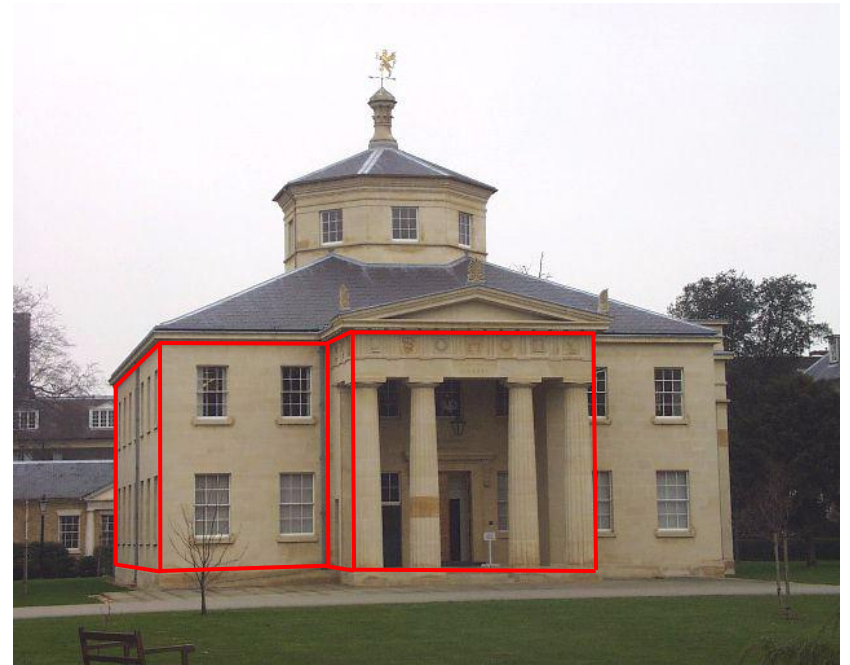# Articulated structures
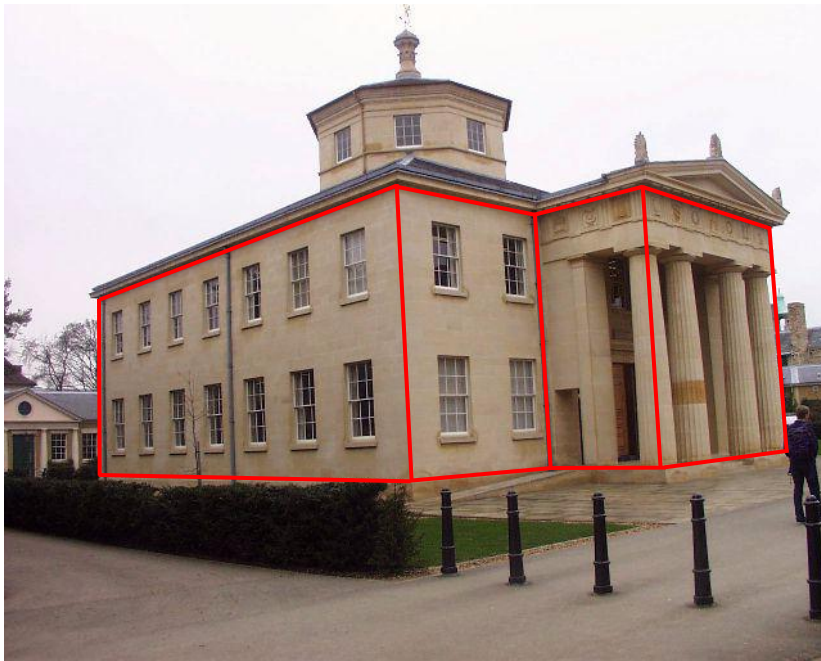
Amiguities in a single view
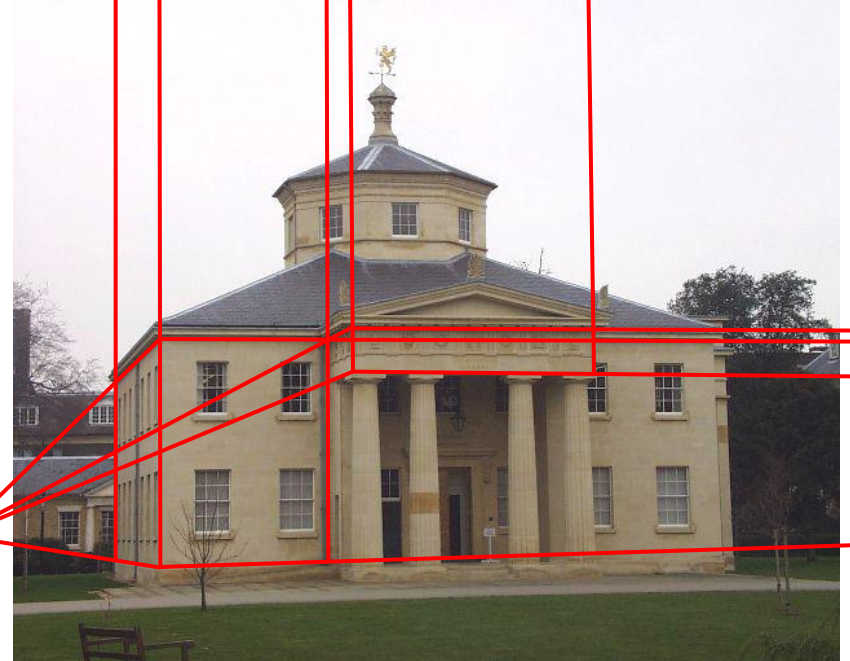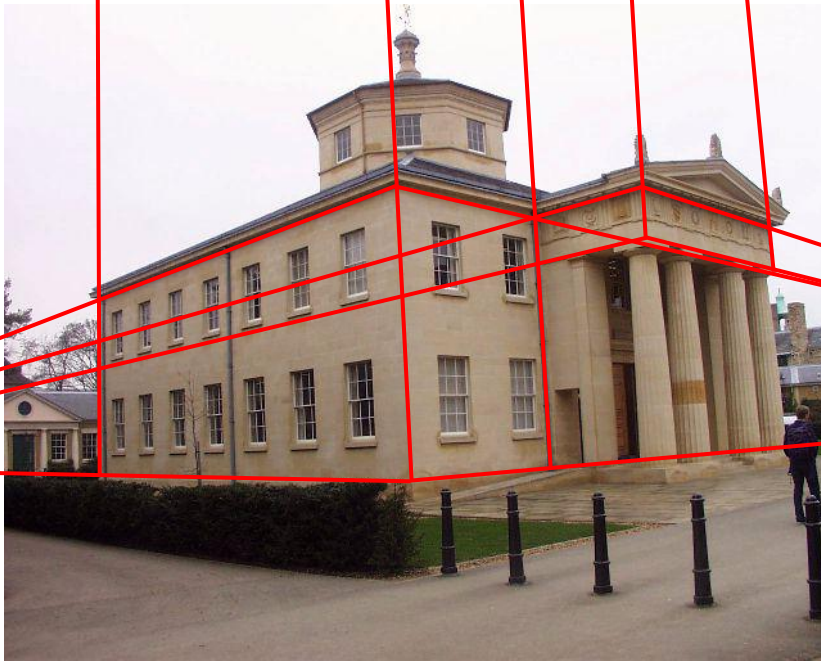
Multiple views

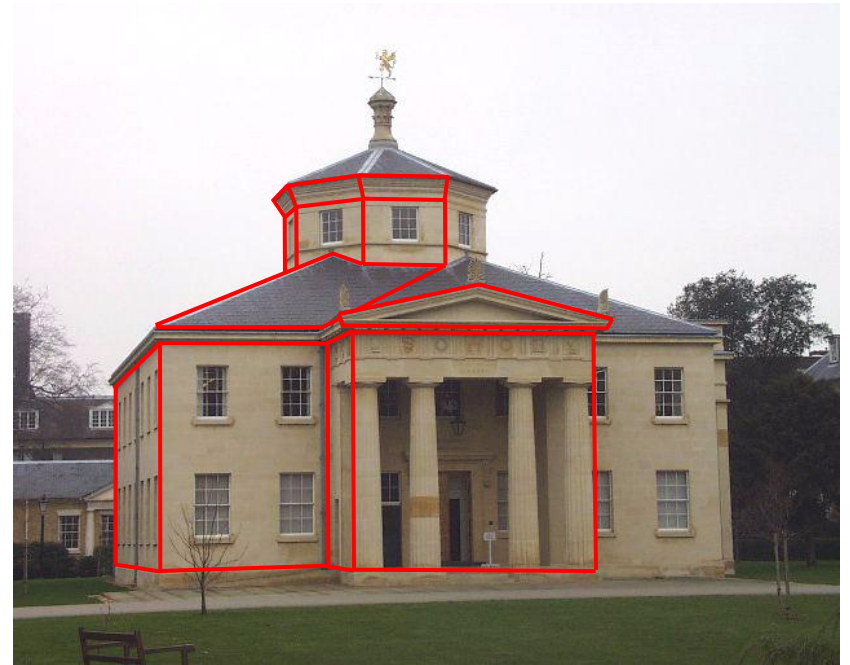Hans-Jurgen Niepel 1 : 1

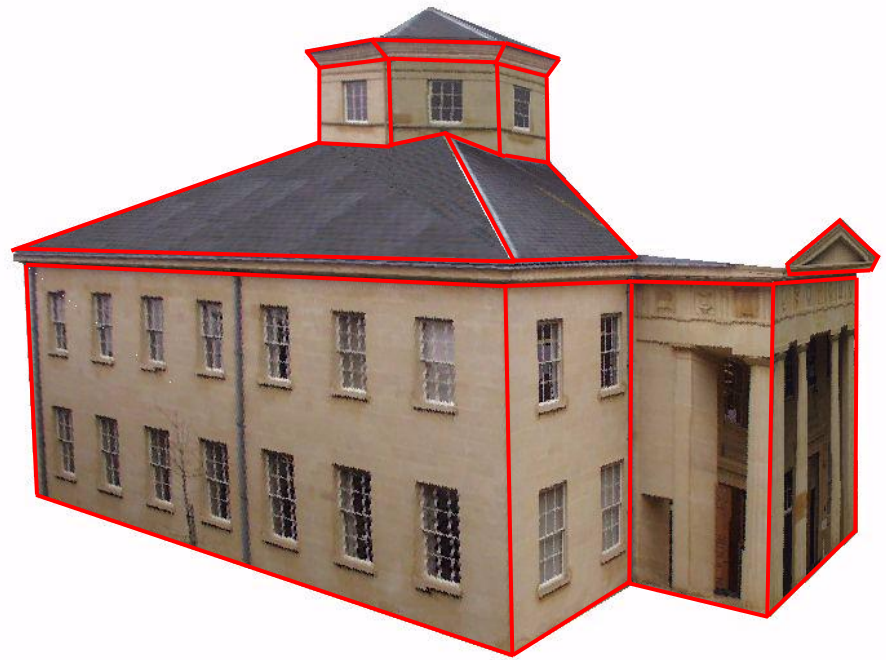# Uncalibrated images

Self-calibration

Vanishing points

Finding correspondences

Reconstruction

Multiple views and ray bundle adjustment