PERCEIVING AND MODELLING THE 3D WORLD

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And all of the excellent resources here at the University

And my excellent wife and children

MAIN THEMES OF RESEARCH

Working with 3D data and models

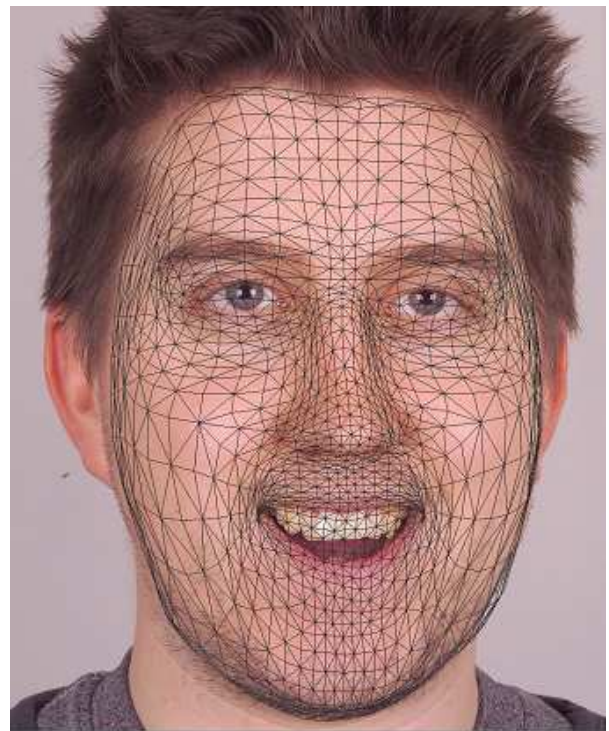Acquiring 3D data

Acquiring better 3D models

The future?

3D MODELS OFFER

Arbitrary viewpoints
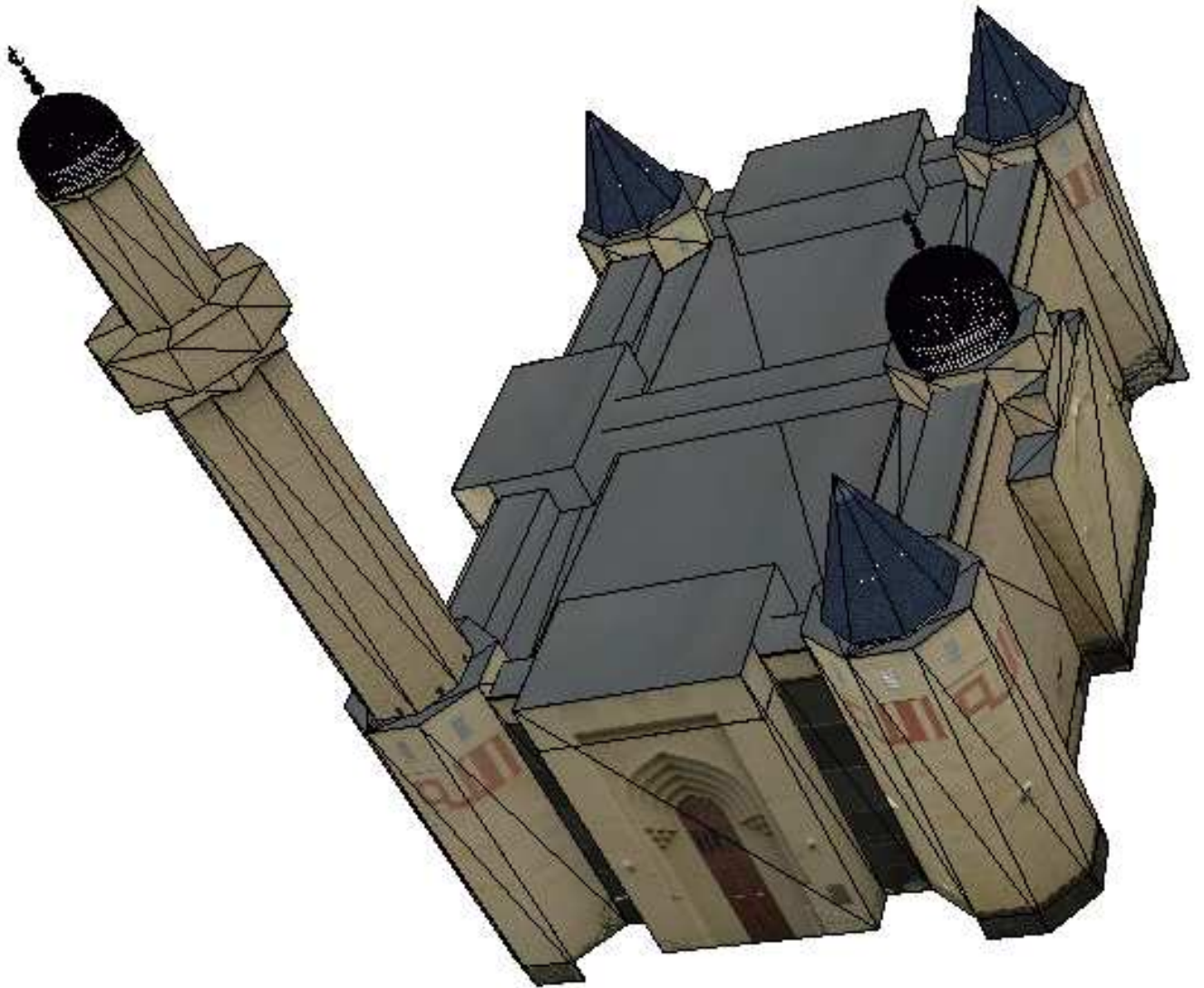
Model movement and deformation

Changing illumination

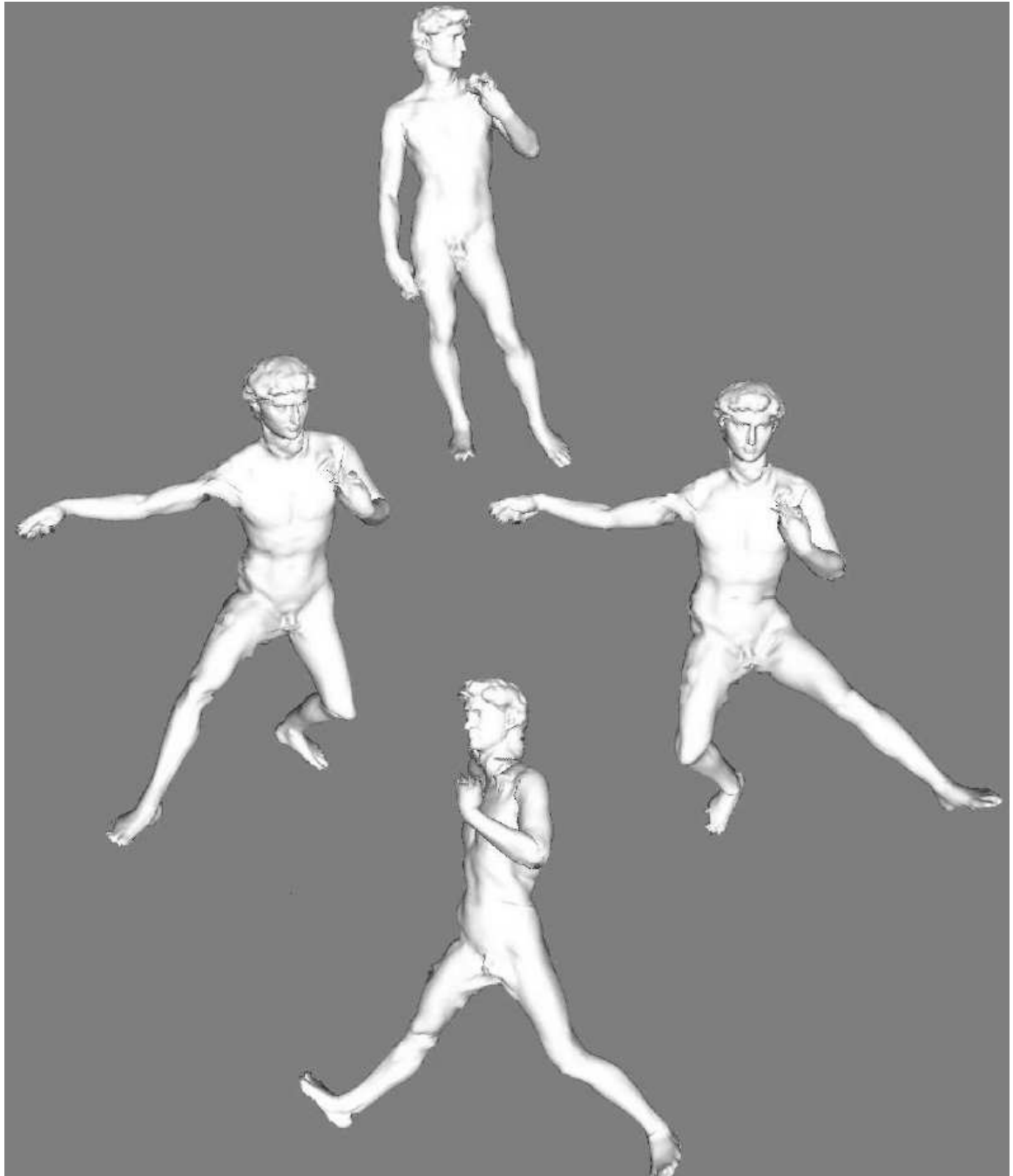Reusability and insertion into real scenes

(Tim Lukins)

Models = Geometry + Texture

(Noboyuki Bannai)

Model movement and deformation

(Adrian Hilton)

Reusability and insertion into real scenes

(Vincent Lepetit & Marie-Odile Berger)

Changing illumination

(Paul Debevec)

3D DATA AT EDINBURGH
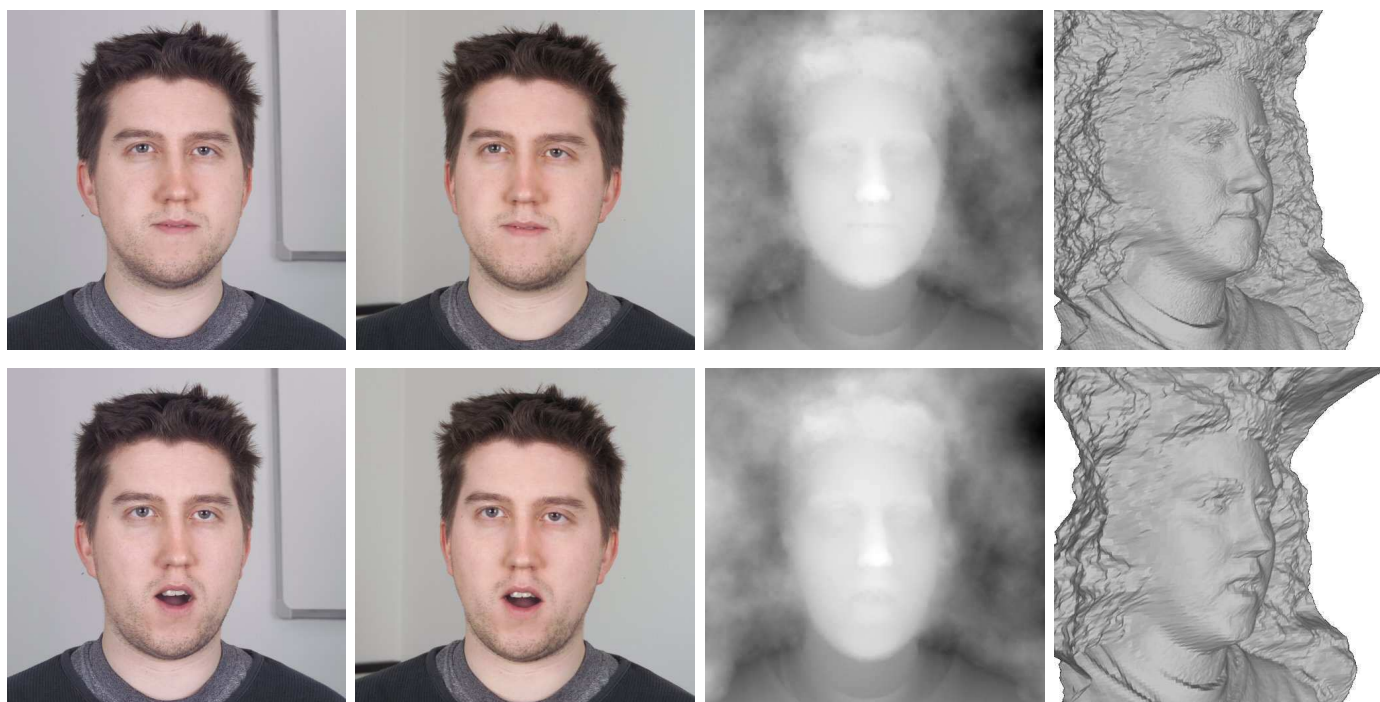
Stereo Cameras

Structured Light

Hand-held Sensor

Cheaper Hand-held Sensor
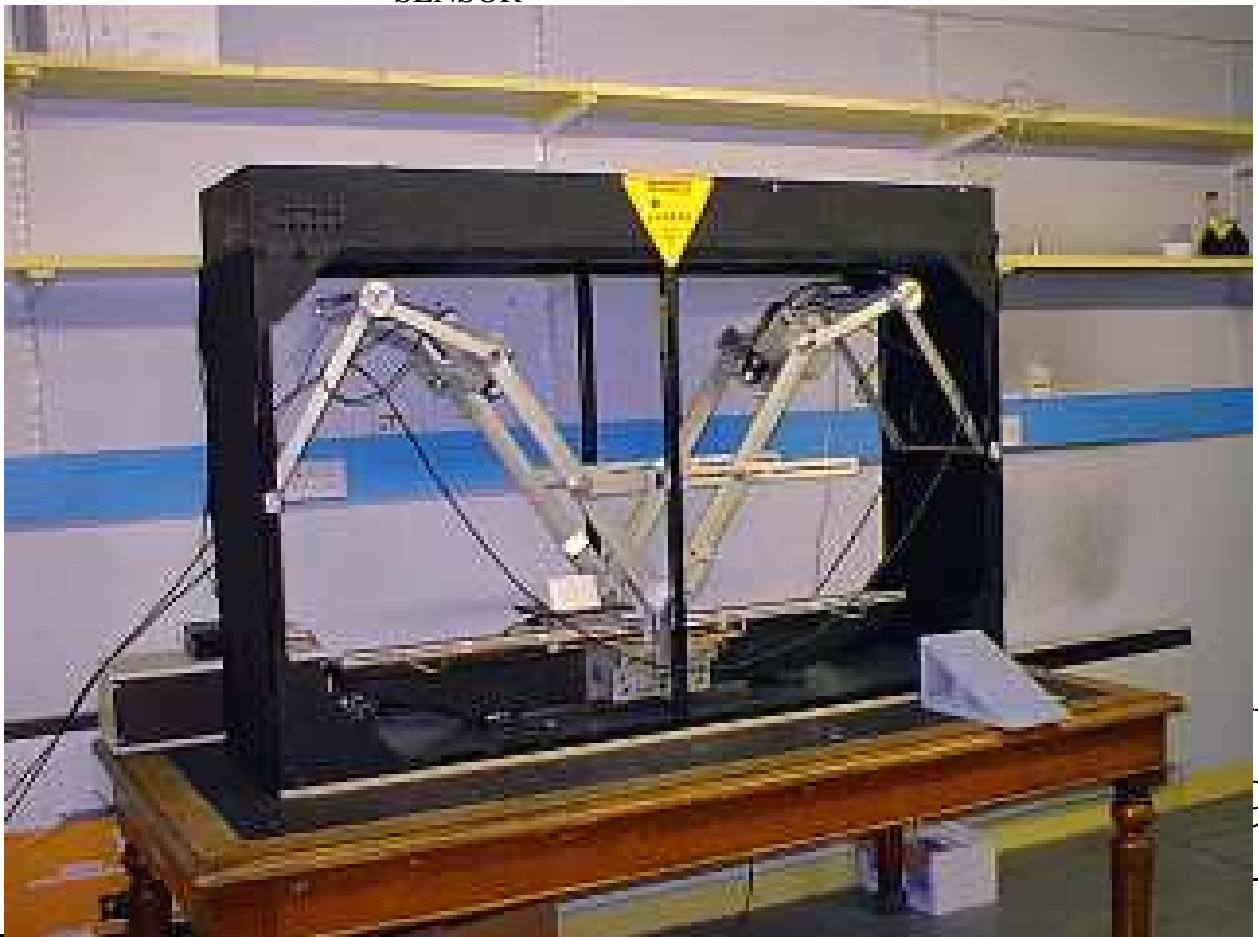
Stereo image capture
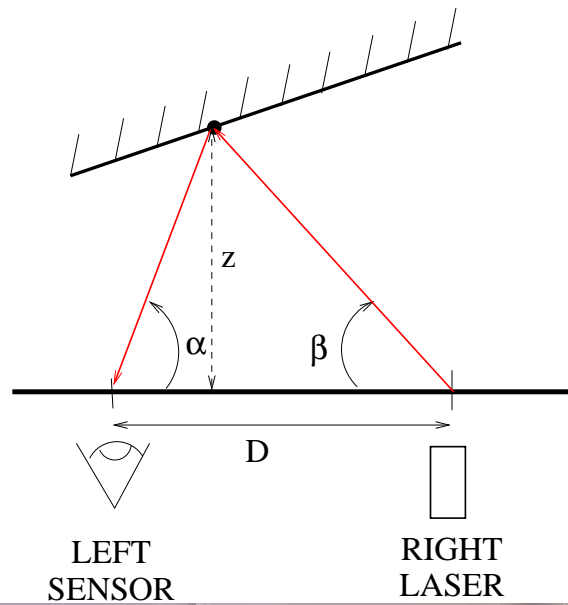
© Fisher 22/9/04
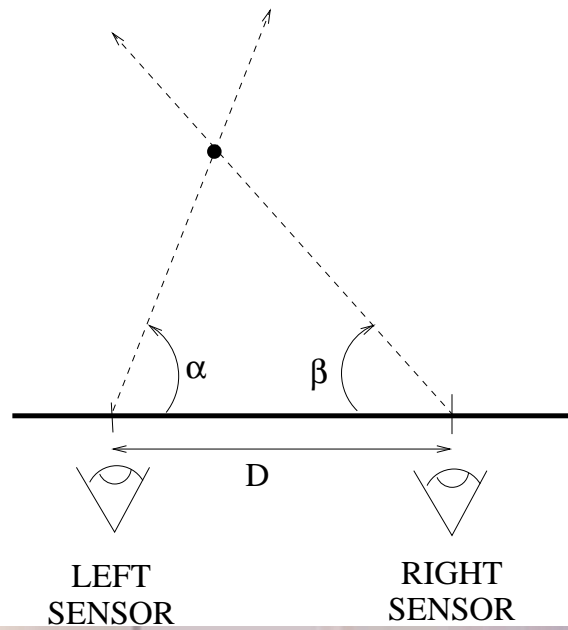
Stereo camera example

(Tim Lukins)

demo

Structured light shape capture

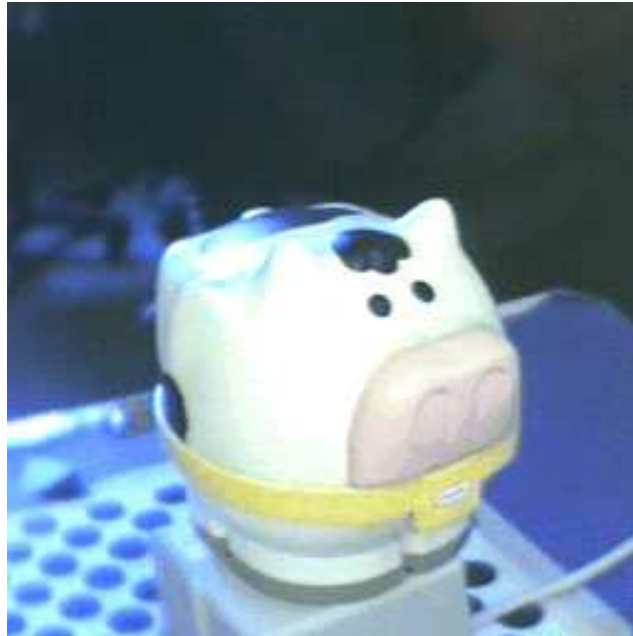# Structured light example
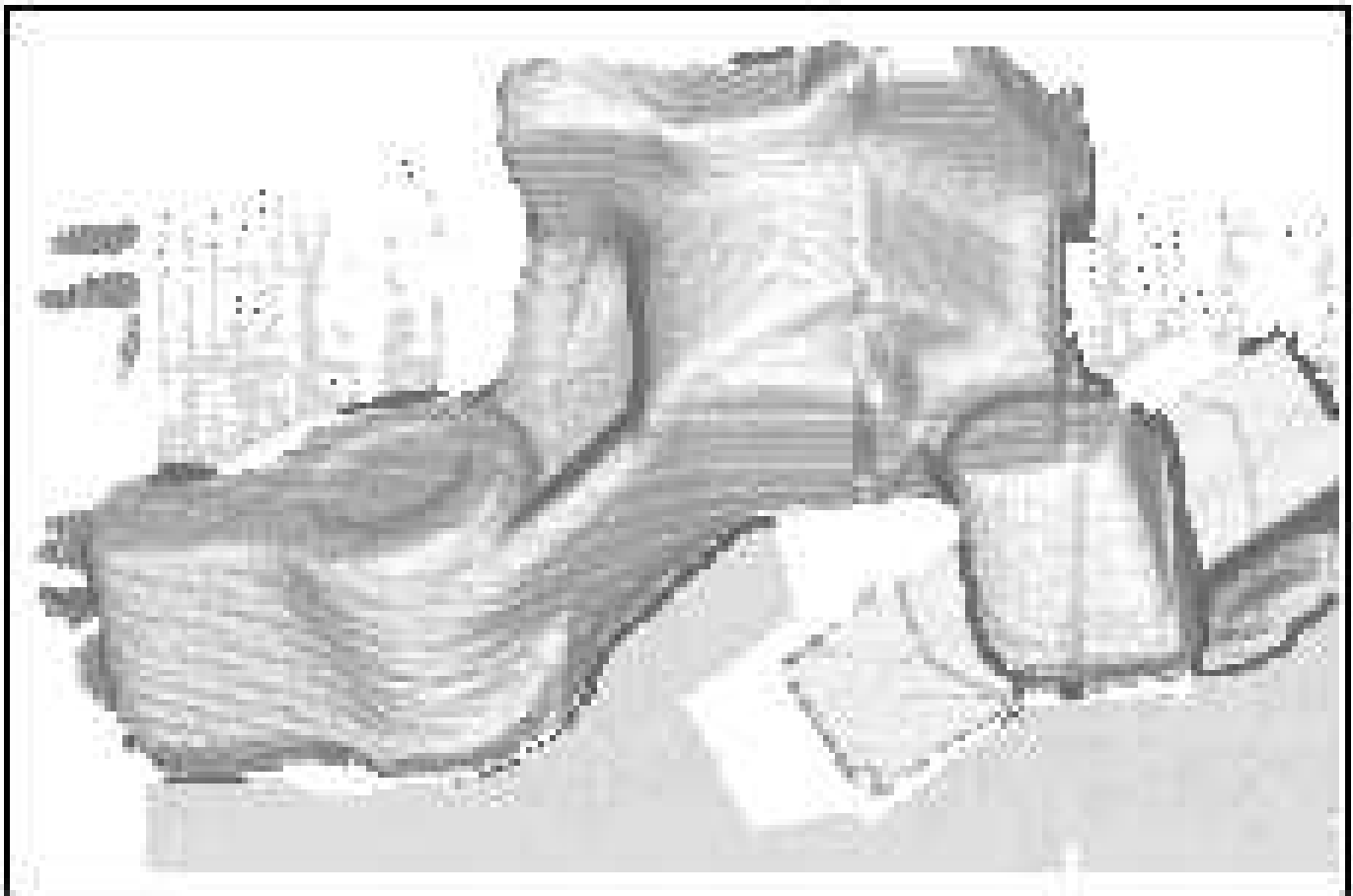
"Paint-brush" Hand-held Range Sensor

DISPLAY

COMPUTER

DIGITISER

PAL-RGB CONVERT

GLOBAL POSITION
MASTER UNIT

STRUCTURED LIGHT
PROJECTOR

GLOBAL POSITION
SENSOR

SENSOR COORDINATE
SYSTEM ORIGIN

LIGHT
SOURCE

COLOUR CAMERA

GLOBAL COORDINATE SYSTEM
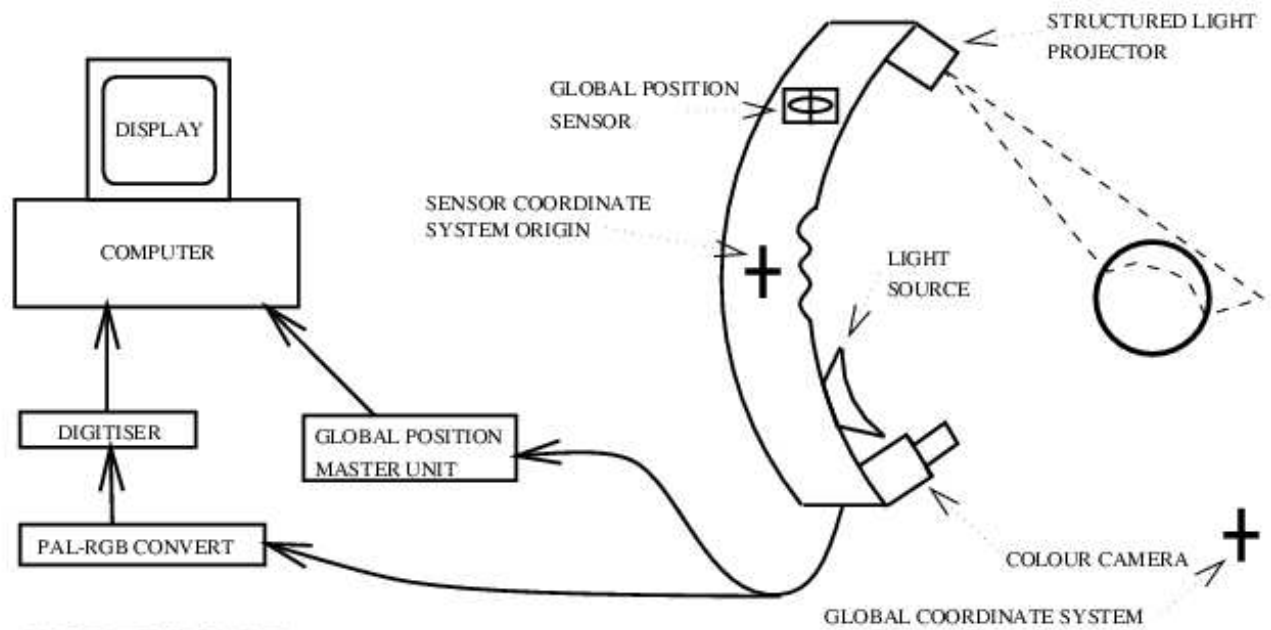
(NOT TO SCALE)

(APPROX. TELEPHONE HANDSET SIZE)

Handheld scanner example

(Andrew Fitzgibbon)

"Magic wand" hand-held range sensor

Point Light Source
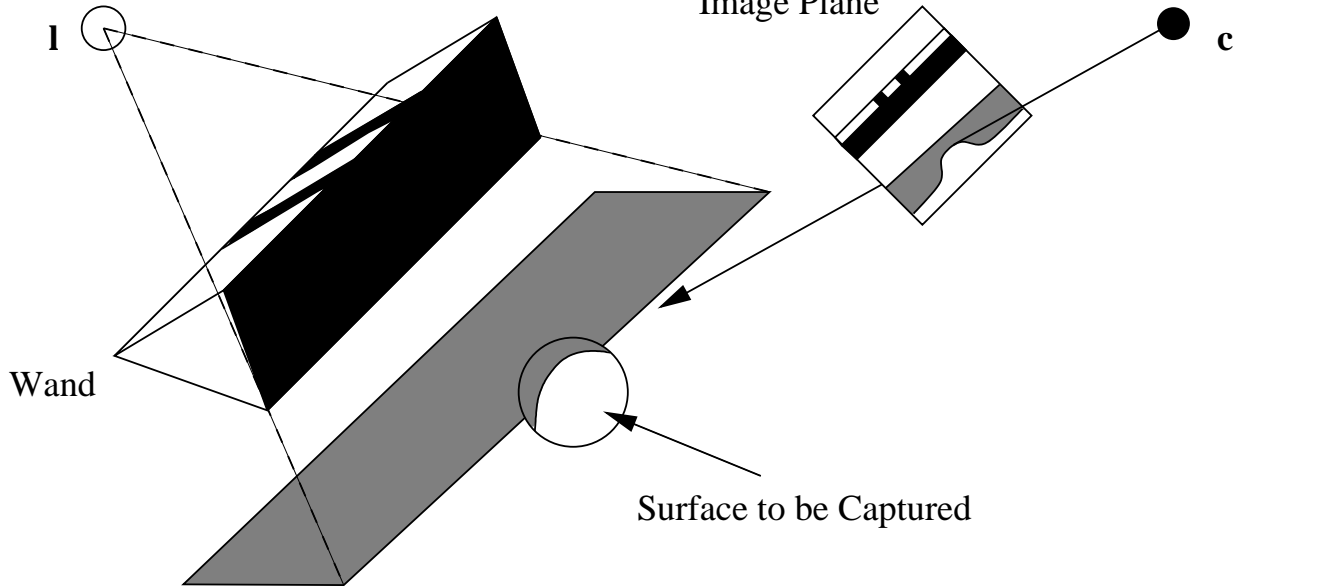
l

Image Plane

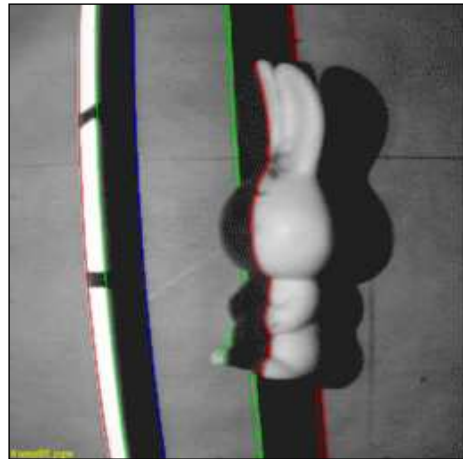Camera Centre
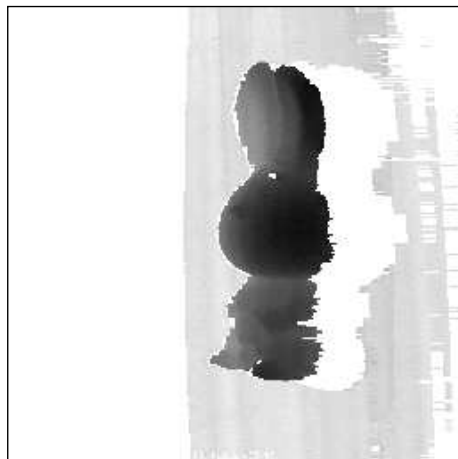
c

Wand

Surface to be Captured

Shadow Cast by Wand
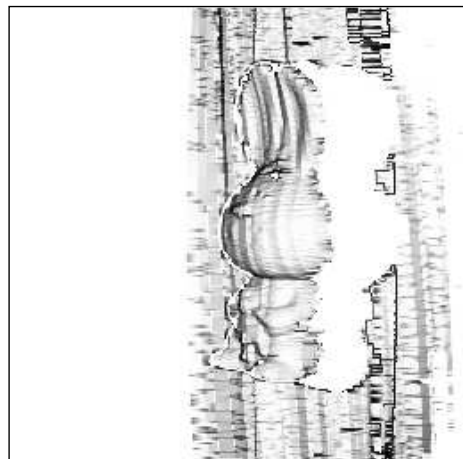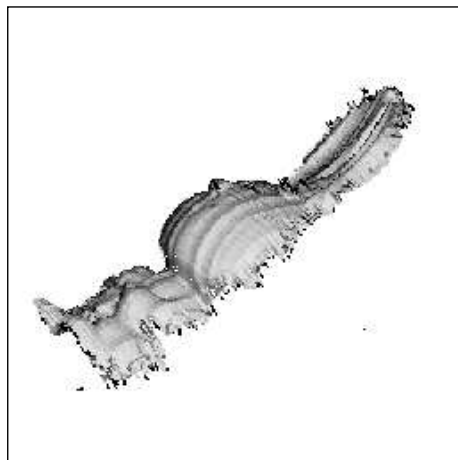
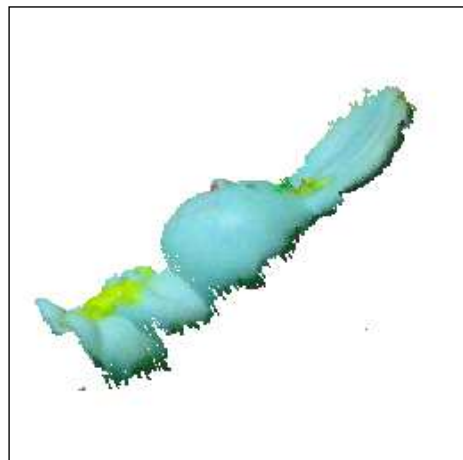# Handheld scanner example

(a)

(b)

(c)

(d)

(e)

(f)

(Anthony Ashbrook)

TECHNIQUES FOR IMPROVING MODELS

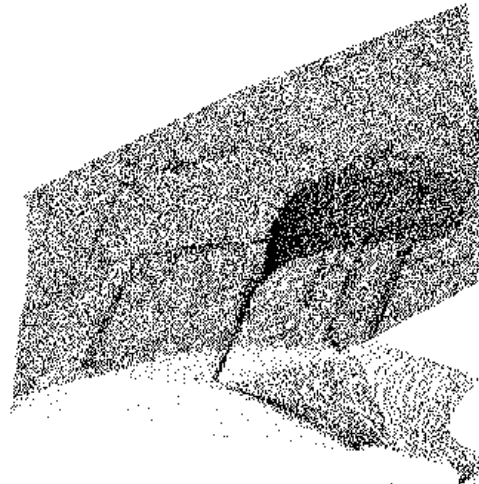Problems needing solutions (and some advances made here):
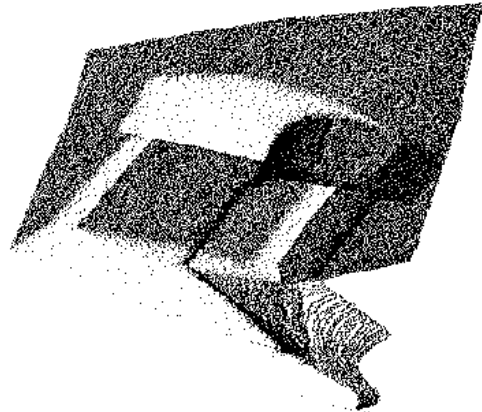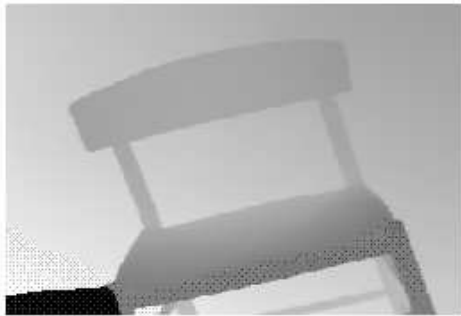
Incomplete data

Minor errors in models

Rigid data but moving objects

Inconsistent colours

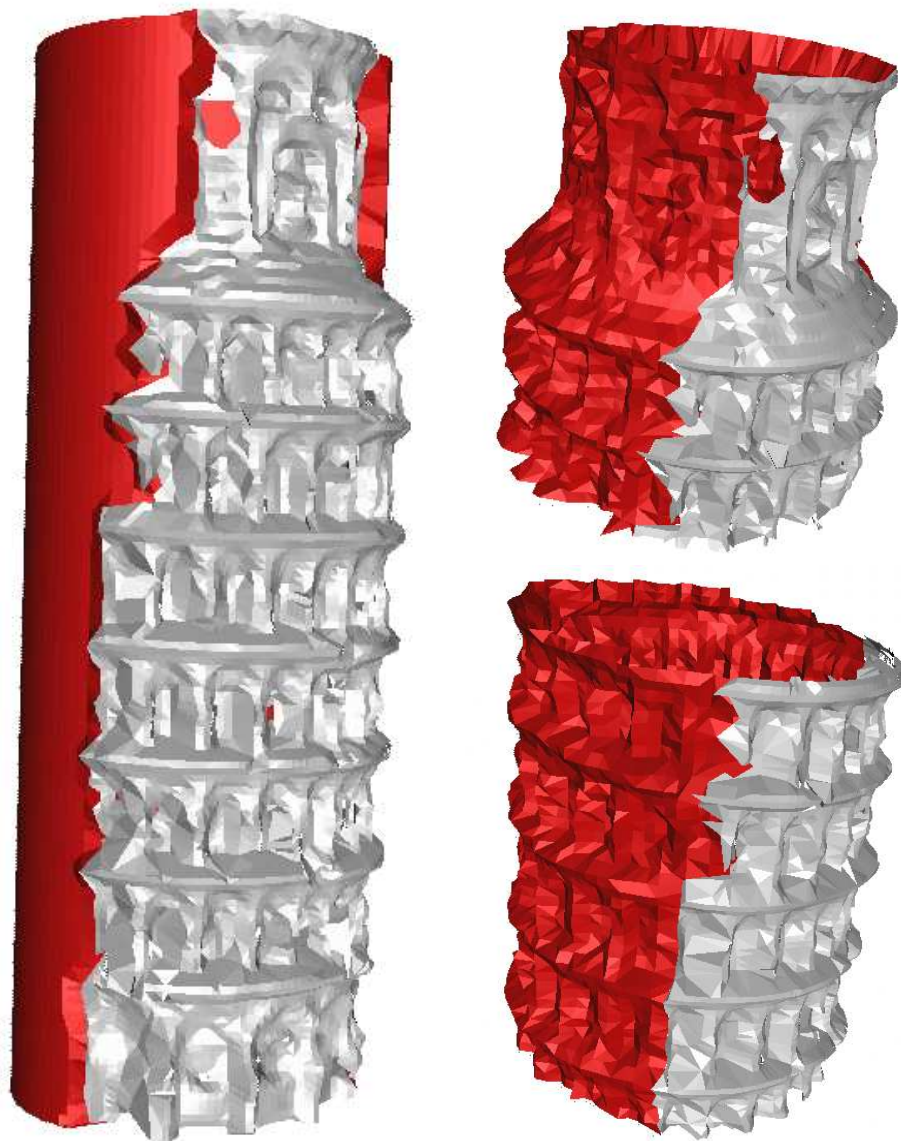# Knowledge-based surface inference: front surfaces

(Fabio Dell'Acqua)

Solution: Use knowledge to project surfaces into unseen areas

Knowledge-based surface inference: back surfaces

(Toby Breckon)
Solution: Use knowledge and observed data to hypothesize missing model
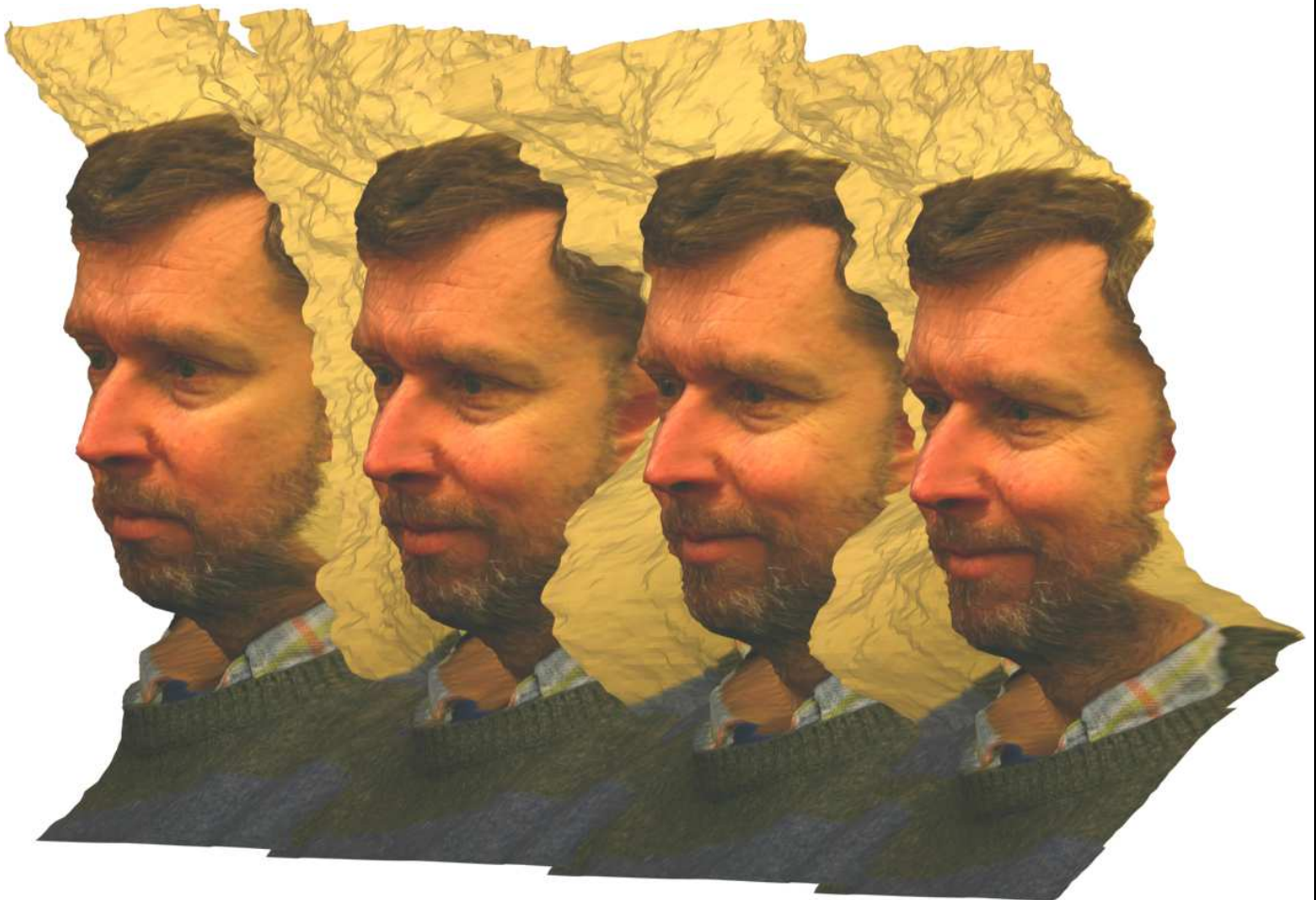
What's the problem: Models have irregularities

(Helmut Cantzler)

Solution: Use knowledge and observed data to correct model
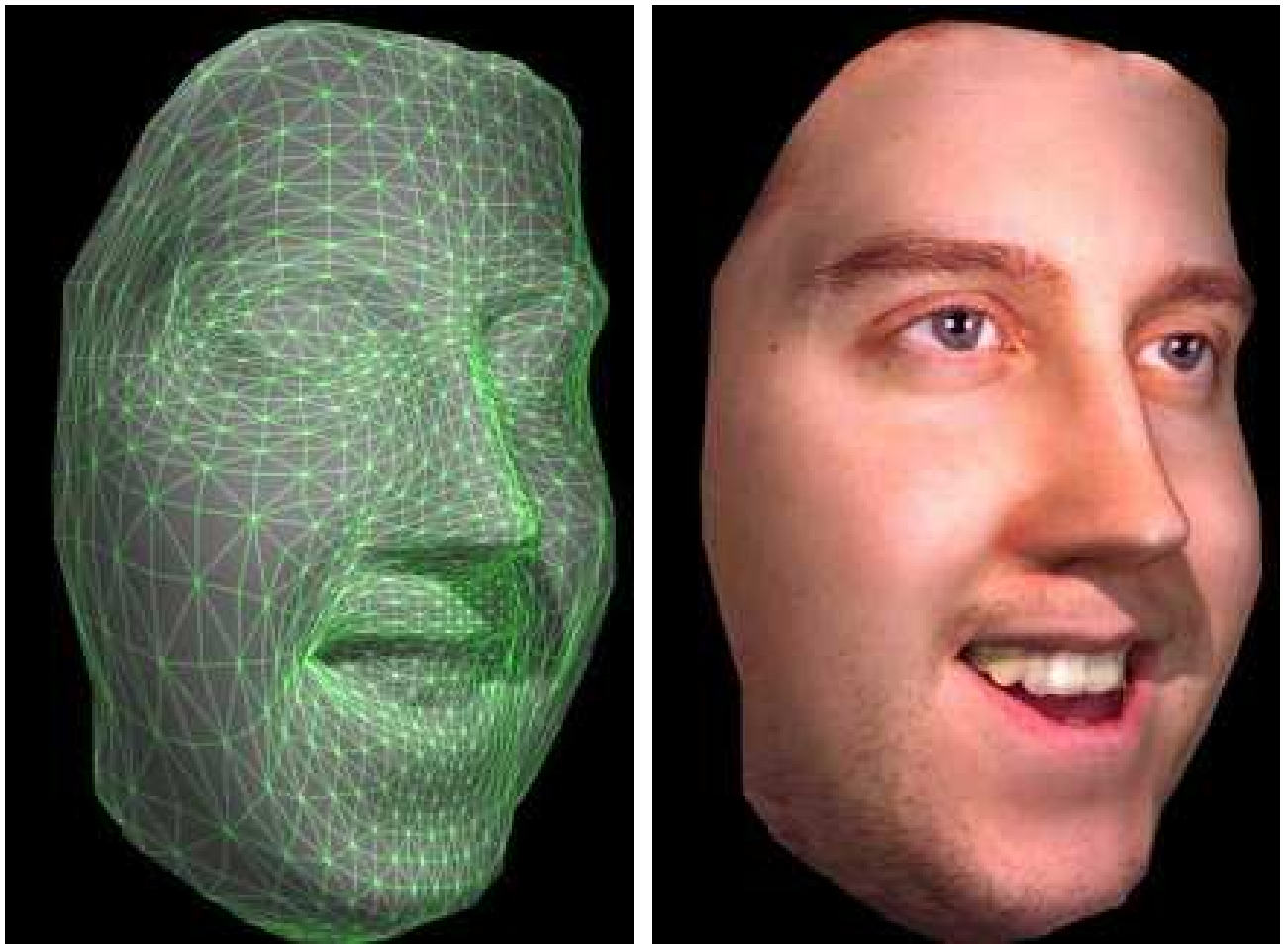
What's the problem: Objects are flexible

(Tim Lukins)

Solution: Capture multiple views quickly

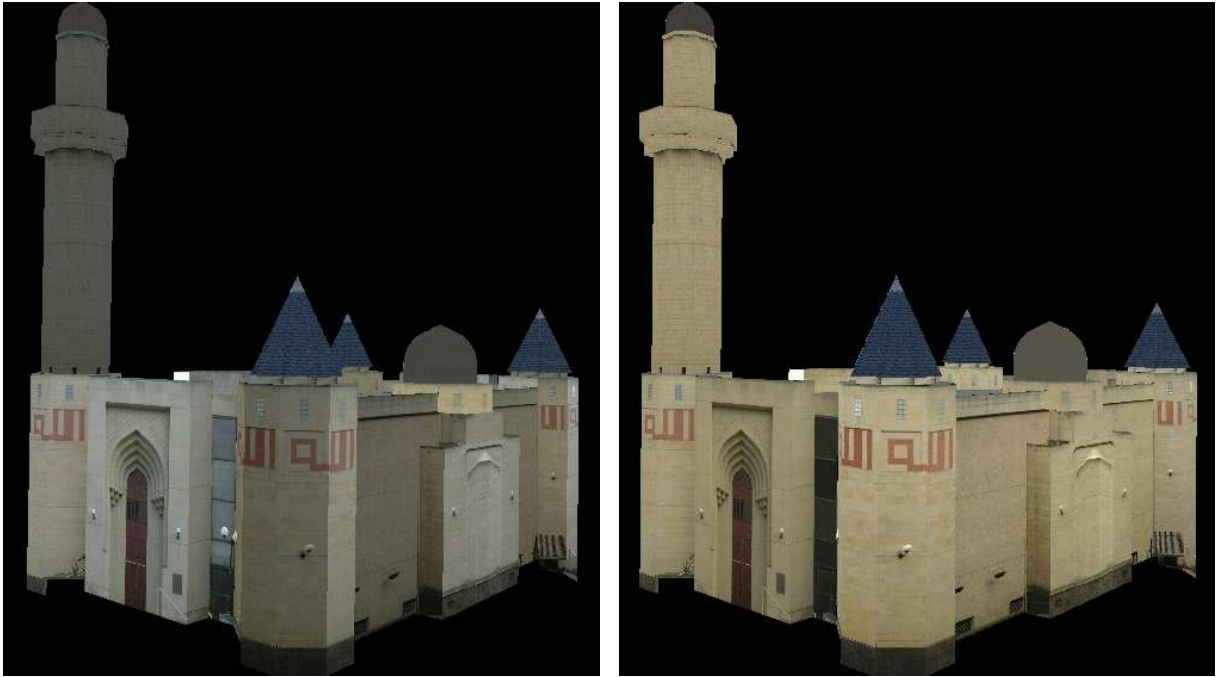# What's the problem: Combining individual snapshots

(Tim Lukins)

Solution: Integrate and blend between views

demo

What's the problem: Data colours

(Noboyuki Bannai)

Solution: optimise the colour relationships
between patches

demo

Where are we?

Starting to get photo-realistic models

- 3D shape data reliably from a variety of sensors

- Reasonable partial models of observed scene

- Can tidy shape errors using knowledge

- Consistent colours independent of lighting

Technology maturing and much commercial activity starting, especially for computer games and cinema

Current problems?

- Less manual effort

- Incomplete data

- Model scale

But: Incremental work

Harder:

Realistic dynamic models: joints, soft tissue
and clothing, timing of movements

Current problems?

Enabling widespread use?

- Realistic models are big

- Don't need to use model of whole building if in one room

- Don't need all the detail for distant objects

- Hard to navigate from location to location

Not really vision problems: onward to graphics!

Speculation: Objects will carry their own models, uniquely identified by "URL". Compose scenes by reference, rules for manipulating the models.