• Research feeds our teaching
• Topics covered
  – Micro and nano manufacture
  – Texrad – medical image processing – spinout
  – Fluorescence microscopy
  – Biometrics
  – Security – target tracking
• Active Topics not covered
  – Healthcare informatics, Big data, Smart cities, Smart grids, Networks, Mathematical Modelling
Research Collaborations and Exchanges with 26 Countries
iiisp Graduated 51 Doctoral Students from 27 Countries
Our Research Feeds into our Teaching

- MSc/ and 4th year MEng, BEng 3rd year: 2015
  - Cybernetics and Neural Networks; 15 credit course
  - Advanced Manufacturing Technology; 15 credit course
  - Fibre Optic Communications; 15 credit course
  - Satellite & Space Systems; 15 credit course
  - Advanced Digital Signal Processing; 15 credit course
  - Image Processing; 15 credit course
  - Advanced Electronic Systems; 15 credit course
  - Power Systems; 15 credit course
  - Electronics Technology; 15 credit course
  - Computer Networks; 15 credit course
Some statistics

- Grants and contracts ≈ £10 million - EPSRC, EU, Industry
- Journal papers: 295
- Books: 2
- Book chapters: 17
- Refereed conference papers: 325
- Professional memberships:
  - IET, IEEE, IOP, OSA, EOP, BCS, ACM, IMechE
The *h-index* is an index that attempts to measure both: the productivity and citation impact of the published body of work of an engineer, scientist or scholar.

**Professor Chris Chatwin** – h#24
**Dr Rupert Young** – Reader – h#21
**Dr Phil Birch** – Senior Lecturer – h#14
**Dr Tai Yang** – Reader – h#22

**Hirsch h-index**

![Graph showing the h-index concept](image)
UV Microstereolithography System Diagram 1996 – 2001 EPSRC & EU,[1], [2]

- UV LASER (351 or 363nm)
- T132 Shutter controller
- D.O.E (0.1ms resolution)
- Frame Grab (Ultra-II drive)
- SunSparc (DUCT CAD/CAM)
- IBM PC (Main control)
- RS-232 I/O Interfacing (AT-MIO-16DE-10)
- I/O Ports (PC-DIO-10)
- Encoder driver Card (37-1039)
- Encoder Module
- Translation Stage
- Serial Interface of data acquisition
- DDI
- Parallel Interface of data acquisition
- Resin Bath
- Mirror
- Polarizer
- Lens
- SSD Interface of data acquisition (15)
- (7)
- Sync
- Network (ftp) or GPIB Interfacing
- µ-component
Spatial Light Modulator (SLM)

- Features
- VGA and SVGA
- Ultra-II PCI Frame Grab with video and VGA Frame buffers (2Mb each)
- CCIR/PAL camera
- Overlay display

SVGA SLM 800x600 pixels
Micro-component Prototyping

- Lithographic Lens
- Photo-polymer Bath
- Microstereolithography System
- SLM
- UV light path
Main Programme Control Panel

Control Program for the Three Dimension Rapid Prototyping System

Display for System performance

Stop

Translation Stage Position

1.15400 mm

Control for the Image Slices to LCD in SLM

Shutter Control (T132) for Normal Close

Translation Stage Control using DC Servo
(For a 3µm MOVING STEP)

Power

Actual Position

0.09500

Target Position

0.09500

Start

LabVIEW
MicroSLA System
Micro-components built using 351nm UV

A micro-gear (50 micron layers)

Micro-motor case (50 micron layers)

A helix (50 micron layers)

Double helix (50 micron layers)

Micro-pyramid (35 micron layers)

Micro-pyramids (50 micron layers)
Micro-fabrication for micro-robots

Gear 50 microns diameter
Achievements

• A new micro-stereolithography process was developed
• It operates in the UV
• It used an SLM as a dynamic lithographic mask
• We can manufacture micro-parts which are complex in shape that could not be manufactured with either conventional stereolithography or silicon processing methods
• The build time is 30 seconds per layer, with further optimisation this time will be reduced
• Our system is built components with a 5 micron layer thickness
Cell sac, fabricated employing a point-by-point MPP of an organic-inorganic material.

HOLOGENESIS will pursue vascular regeneration – 2015 EU pending

It will demonstrate the fabrication of a shape-controlled 3D Elastin-like Recombinamers (ELRs) platform that can be tuned to modulate angiogenic paracrine responses of adult stem cells.

Traditional MPP is slow, as it relies on a point-by-point scanning system. Holographic 3D printing will solve this issue; 100nm resolution is possible.

Courtesy of Maria Farsari
• Research to address the detection of weak structured signals from within highly variable cluttered imagery, originally for vehicle tracking, is being used to identify textural variations in organ tissue. (vehicle tracking later in presentation)

• The technology was spun out into a company, TexRAD Ltd in 2011.

• On Friday 16 May 2014 TexRAD was one of two companies bought by Feedback plc, an AIM-listed company specialising in medical imaging tools.
TexRAD can use existing data

- The TexRAD software has workstation, server and cloud-based versions.
- The clinical evidence generated was sufficient for the first stage of the FDA (USA) and CE (Europe) approvals process ISO-13485 quality and FDA/CE approval expected in 2015.
- TexRAD’s texture analysis is a relatively inexpensive and simple process by which tissue abnormalities, and hence prognosis, treatment plans and response to treatment, can be monitored and acted upon without invasive procedures or further images being required.
TexRAD was reversed into Feedback plc - market capitalization – £3.15 Million

**FDKB FEEDBACK PLC ORD 0.25P**

**FEEDBACK** Currency GBX

<table>
<thead>
<tr>
<th>SUMMARY</th>
<th>INTERACTIVE CHART</th>
<th>PRICES AND TRADES</th>
<th>FUNDAMENTALS</th>
<th>TECHNICAL ANALYSIS</th>
<th>NEWS ANALYSIS</th>
<th>NEWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>High</td>
<td>Low</td>
<td>Volume</td>
<td>Last close</td>
<td>+/-</td>
<td>Var %</td>
</tr>
<tr>
<td>1.65</td>
<td>1.65</td>
<td>1.48</td>
<td>507,896</td>
<td>1.65 on 17-Apr-2015</td>
<td>+0.18</td>
<td>+11.88%</td>
</tr>
</tbody>
</table>

**Bkd**

- 1.50

**Offer**

- 1.80

**Trading status**

- Market Close

**Special conditions**

- NONE

**Learning Centre**

Our educational programme aims to provide investors with an understanding of how the products and services offered by LSEG can be used in practice.

**As at 19 Apr 2015 19:58:29 - All data delayed by at least 15 minutes.**

**LATEST NEWS**

Select source: Regulatory

- Collaboration with the Oxford Stone Group 13 Apr 15
- Half Yearly Report 13 Feb 15
- Result of AGM 20 Nov 14
- Posting of Report & Accounts and Notice of AGM 30 Oct 14
- Final Results 28 Oct 14

**COMPANY INFORMATION**

<table>
<thead>
<tr>
<th>Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 5, Granga Park, Broadway, Bourn, CB23 2TA, United Kingdom</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company website</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.fbk.com">http://www.fbk.com</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market cap (millions)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>£3.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit of Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
</tr>
</tbody>
</table>
TexRAD Cancer Diagnostics using Biomarkers $iisp$ & BSMS, [3], [4]

- LoG Filtered CT Liver Images
TexRAD Launch – 2011

TEXCAD
Select the anatomy of interest for estimating the disease risk

Human Anatomy
- Brain
- Oesophagus
- Breast
- Lungs
- Liver
TexRAD: Potential predictive imaging biomarker of response to treatment in metastatic renal cancer

TexRAD PRE-TREATMENT

Screenshot of the Renal TexRAD highlighting ‘Right lobe liver’ metastases (pre-treatment) on the conventional CT image (top-left), followed by the derived texture maps superimposed on the conventional CT image – fine (red), medium (green) and coarse (blue) texture.
TexRAD: Potential predictive imaging biomarker of response to treatment in metastatic renal cancer

TexRAD POST-TREATMENT

Screenshot of the Renal TexRAD highlighting ‘Right lobe liver’ metastases (post-treatment) on the conventional CT image (top-left), followed by the derived texture maps superimposed on the conventional CT image – fine (red), medium (green) and coarse (blue) texture.
Fluorescence Light Sheet Microscope without sample chamber, [5]

Diode Laser
Beam optics
Illumination Objective
Sample Chamber (not shown)
Imaging Objective
Imaging Fluorophores in a Fruit Fly’s Heart,
Mobile Iris Biometric ID System
2004- 2005 - industry funding, [7]

Acquire & Convert Iris Biometric into Data

Locate Iris Image

Acquire Iris Image

Transmit Iris Data

Convert Iris Data

Store Iris Data

Mobile Scanner

Microchip

Datamatrix

Remote Database

Local Database
Mobile Iris Biometric ID System, [8]

Scan to Compare Iris Biometric with Remote & Local Database (Iris/Microchip/Datamatrix)
Mobile Iris Biometric ID System

Camera View

Demonstrator Model

Display
Mobile Iris Biometric ID System

(a) Phone Screen Display

(b) Iris Captured for processing

(a) Screen display of successful Iris capture & processing less than 1 second.

(b) Captured image for processing with grid overlay
Vein pattern recognition hardware

14 Infrared LEDs with 810nm wavelength
USB powered (5V-500mA max)

Finger placed on its dorsal side

CMOS webcam
Infrared (plastic) filter to cut-off visible light
Vein pattern image enhancement

Image without using the infrared pass filter

Image after using the pass filter
Vein pattern recognition software

- Captured Image
- Image Conversion (RGB to Gray)
- Image Enhancement
- DoG Filter
- Edge Elimination
- Processed Image
- SDF Filter
- Identification

Image Resolution
320 x 240
When the Synthetic Discriminant Function (SDF) filter is applied to the image then the identification process occurs.

Vein pattern not identified (threshold 0.35)

Vein pattern identified (threshold 1)
Security – Tracking DSTL

- User selects object
- Algorithms tracks it
- Must cope with
  - Scale
  - Rotation
  - Occlusions
  - Lighting
  - Clutter
The OT-MACH Tracker - Features

• Optimal Trade-off Maximum Amplitude Correlation Height (OT-MACH) filter used as a robust tracker.
• Scale, Orientation and Velocity invariant robust tracker.
• Performs in real-time on both colour (visible) and infra-red band scenarios.
• Conveniently trainable for real-time target tracking applications.
• Dynamic filter updatability, making the algorithm robust for tracking.
Filter Initialization

• User interface developed for selecting a target in run-time
• Three types of user selection designed and tested
  – Rectangular
  – Circular
  – Assisted active contour
• Rectangular and Circular target selection found to be less accurate compared to active contour based selection
• The filter function is developed for three different scales of the target after scaling the selected target.
Target selection methods

Rectangular

Circular

Active Contour
Active Contour Target Reference

- Active contour selected target used to create a blank background reference image
- The reference image is rotated -6 to +6 degrees and 7 reference images are created (2 deg increments)
- The reference images are scaled for three different scales and triple filter function bank computed.
- A rotationally multiplexed OT-MACH filter is then created using the reference image sets.
• The filter is automatically updated selecting the current target every update interval set by the end-user (we did this every 25 frames for visible, every 5 frames for IR)

• Rotational multiplexing and triple filter bank increases tolerance of the filter to changes in target orientation and scale changes

• The maximum correlation height values are used to estimate if a filter update is possible or not in the next update interval

• A threshold of 85% of the maximum height value is used to locate the target
Example result and correlation plot

Cross-hair on target

Correlation plot
Kalman filter limitations

- Unlike the OT-MACH tracker, the Kalman filter method is not a suitable estimator for noisy frames, varying velocity targets and extreme scale changes.
- A colour based particle filter method was also investigated and compared with the OT-MACH tracker.
Kalman filter to distinguish between target and non-targets

Kalman filter (red) and OT-MACH tracker (yellow) result
Colour based Particle filter to distinguish between target and non-targets, \([10]\)

Particle filter (blue particles and red tracking) and OT-MACH tracker (yellow) result
OT-MACH tracker results
Blurred Video of Truck OT - MACH

Gaussian blurring 7x7 kernel, sigma = 2.0
Salt and pepper noise (45% noise) results
References

1. C Chatwin, M Farsari, S Huang, M Heywood, P Birch, R Young, “UV microstereolithography system that uses spatial light modulator technology,” Applied optics 37 (32), 7514-7522, 1998


