

Underground M3

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THE LONDON UNDERGROUND TUBE NETWORK



Deep Tube Tunnels: 300km
 Cut & Cover Tunnels: 100km
 Bridges (number): 1000
 Embankments & Cuttings: 220km

- Area served: 3240km²
- 45km N-S 72km E-W
- line length: 392km
- 80% (110km) cast iron
- Deepest tunnel 67.4m bgl
- Average tunnel depth 24.5m bgl
- 2.5million passengers/ day

Existing Tunnels

- New construction interactions
 - pile driving nearby
 - neighbouring tunnel construction
- Long-term survival: what is the unexpired life?
 - chemical environment
 - earth and water pressures create ground loading
 - affected by construction, consolidation, creep, ageing
 - loads on lining must change as groundwater changes
- Design of new works
 - what ground actions to assume in what design life?
 - what influence from new construction activities?
- Network security

Monitoring

Limits of movement set for three main Parameters;

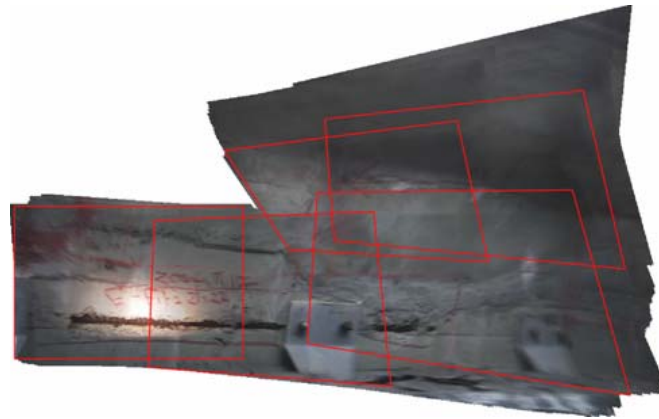
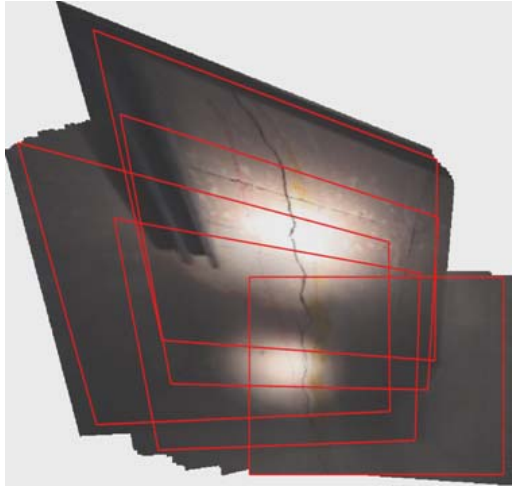
- Stress in tunnel lining
- Lining deformation/clearances
- Track geometry

Monitoring system must be tailor made to suit application and critical parameters e.g..

- Rate of movement
- Extent of influence
- Need for accuracy

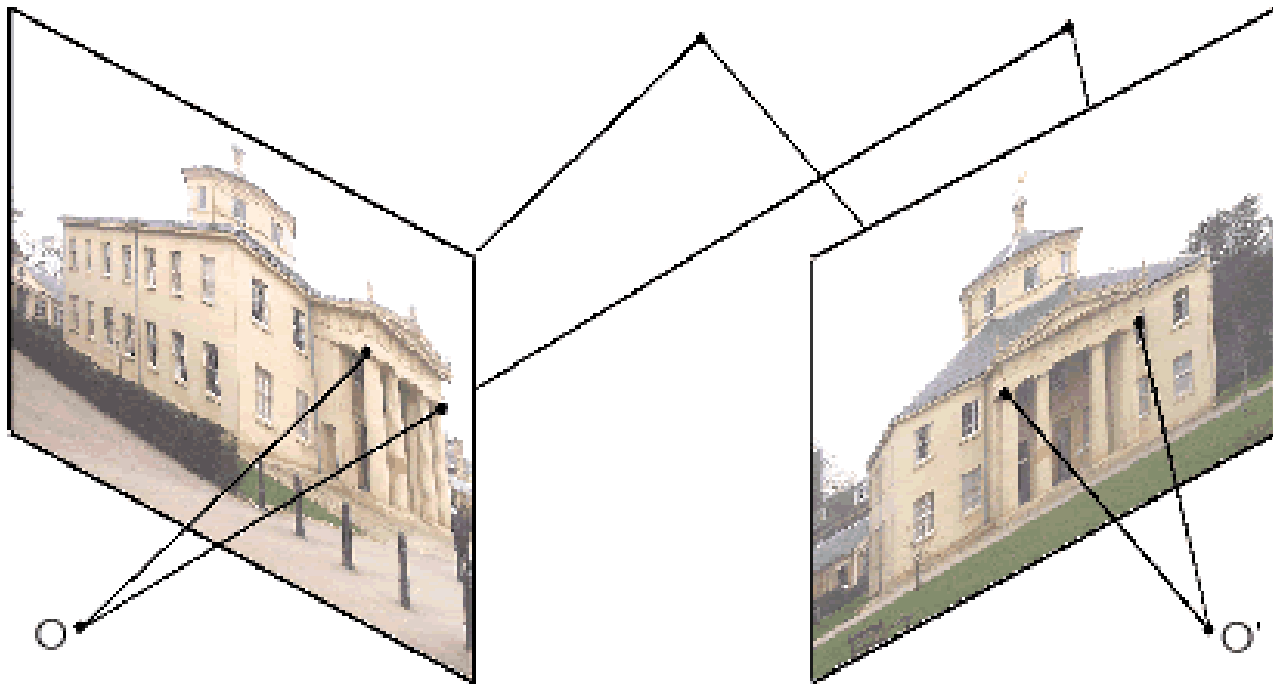
(1) MicroDetection using Computer Vision

Mosaicing and Super-Resolution



(1) MicroDetection using Computer Vision

Camera-Posing and Image Interpretation



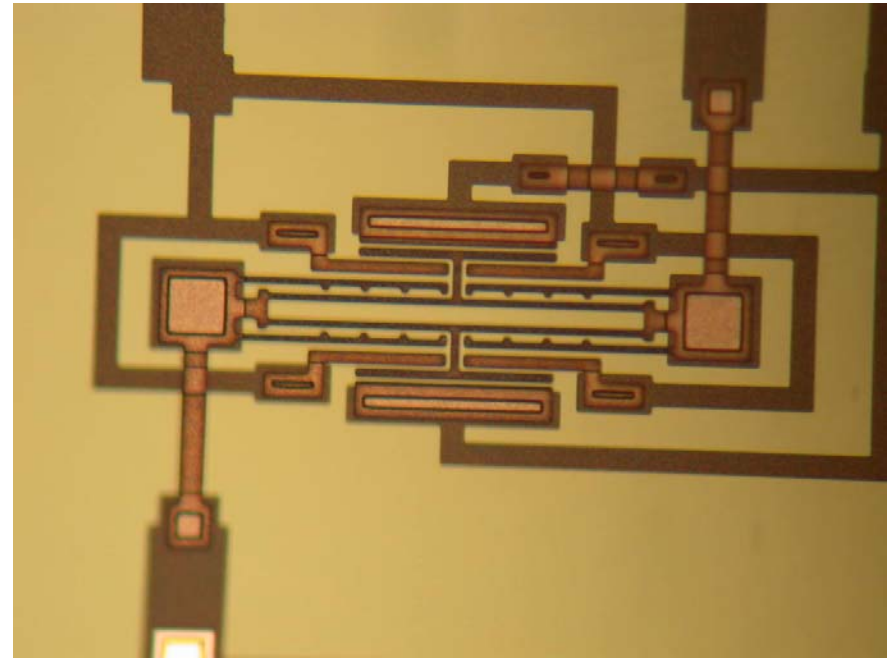
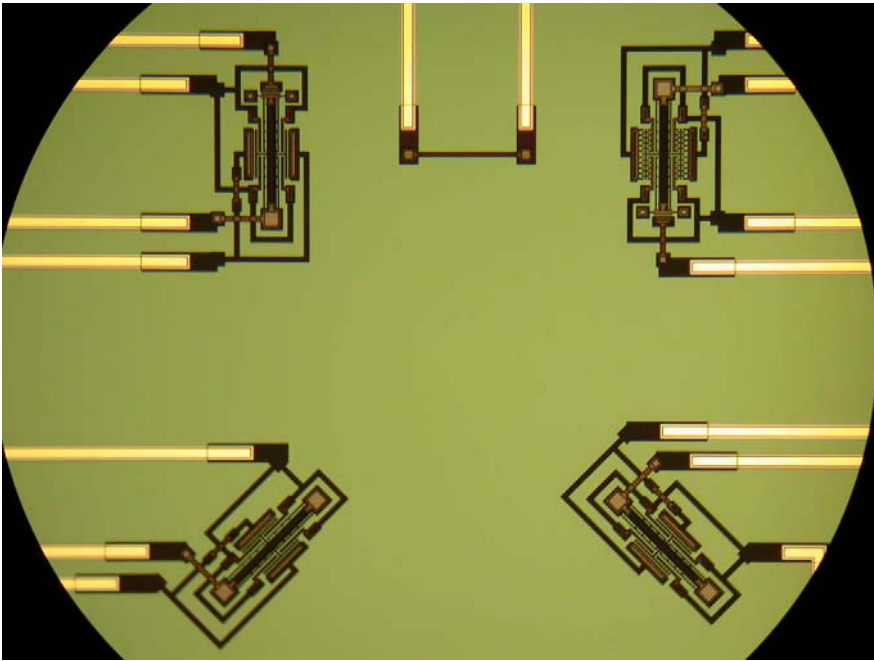
Issues:



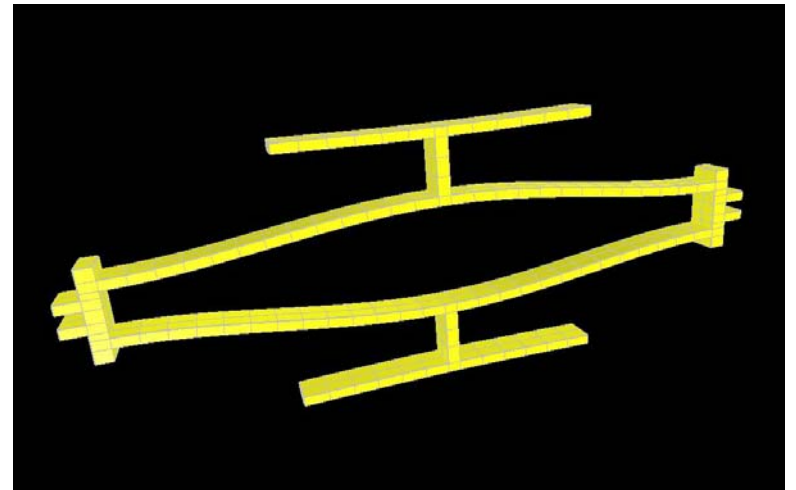
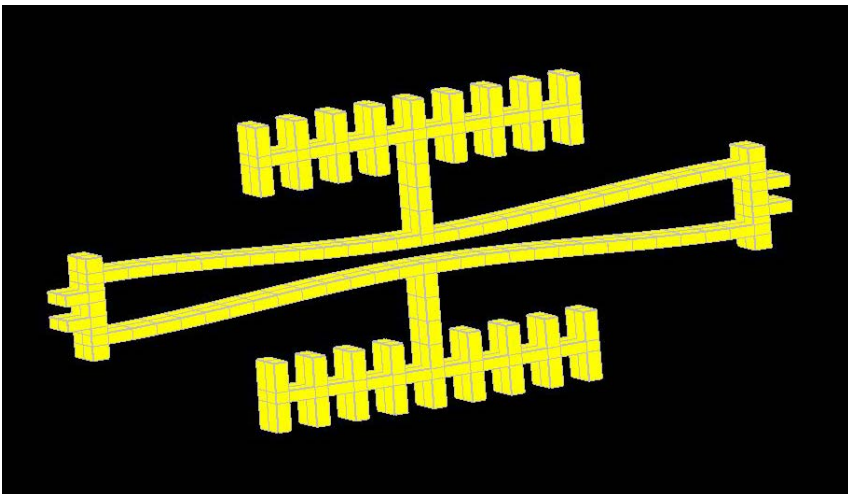
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(1) Accuracy, (2) Interpretation methods, and (3) User-interface

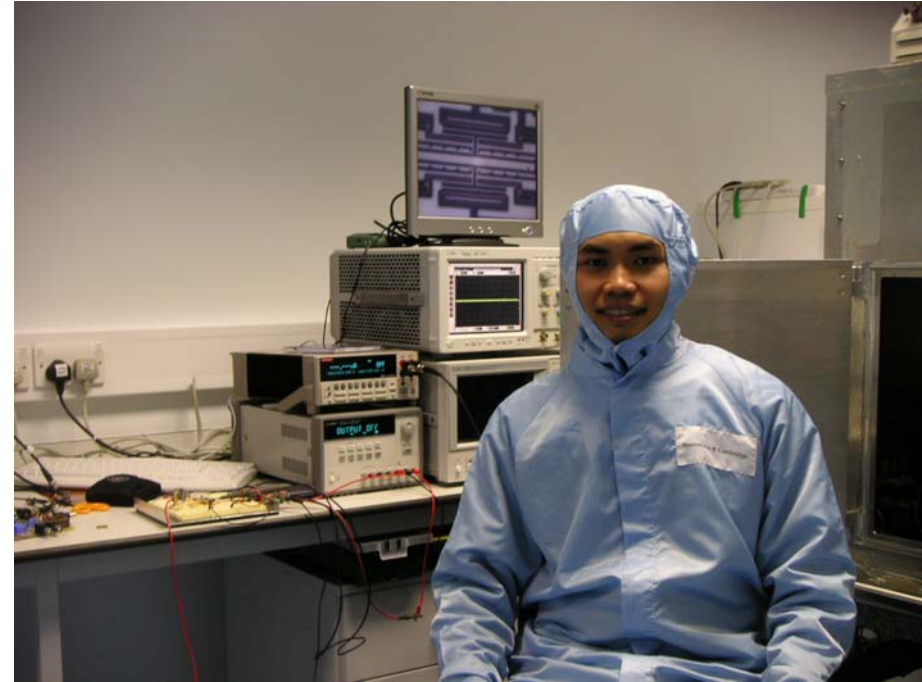
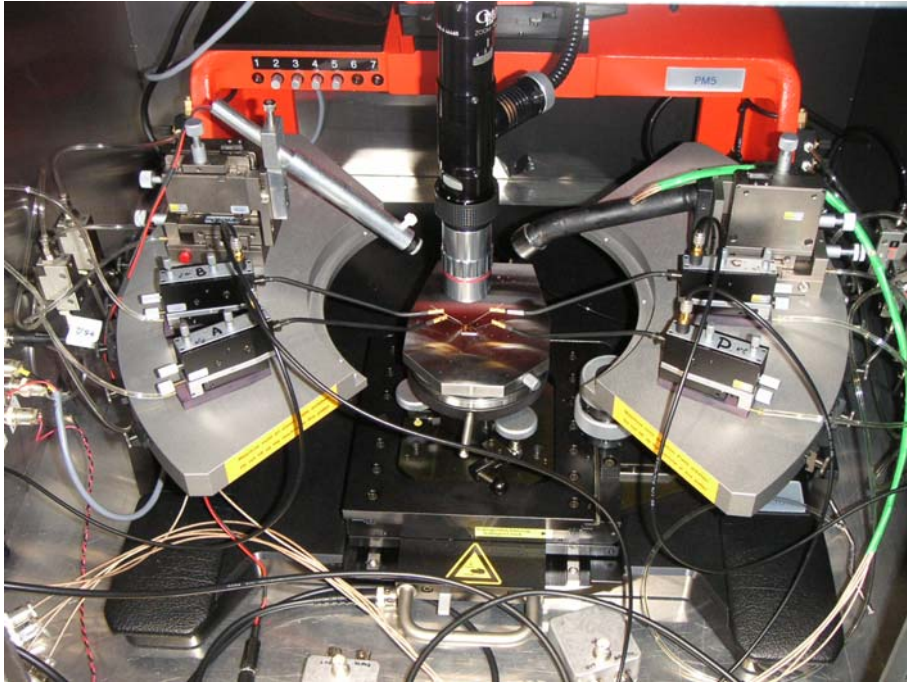
(2) MicroMonitoring using MEMS



FE modelling



(2) MicroMonitoring using MEMS

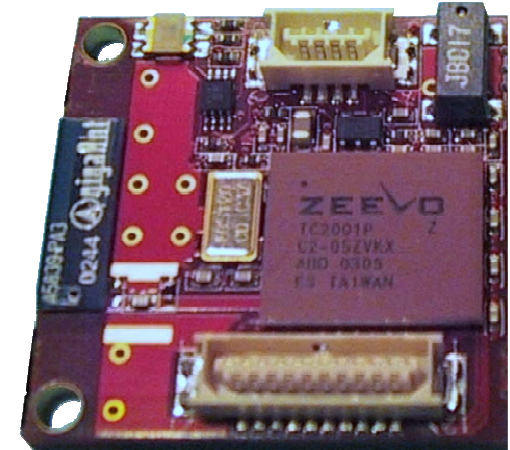
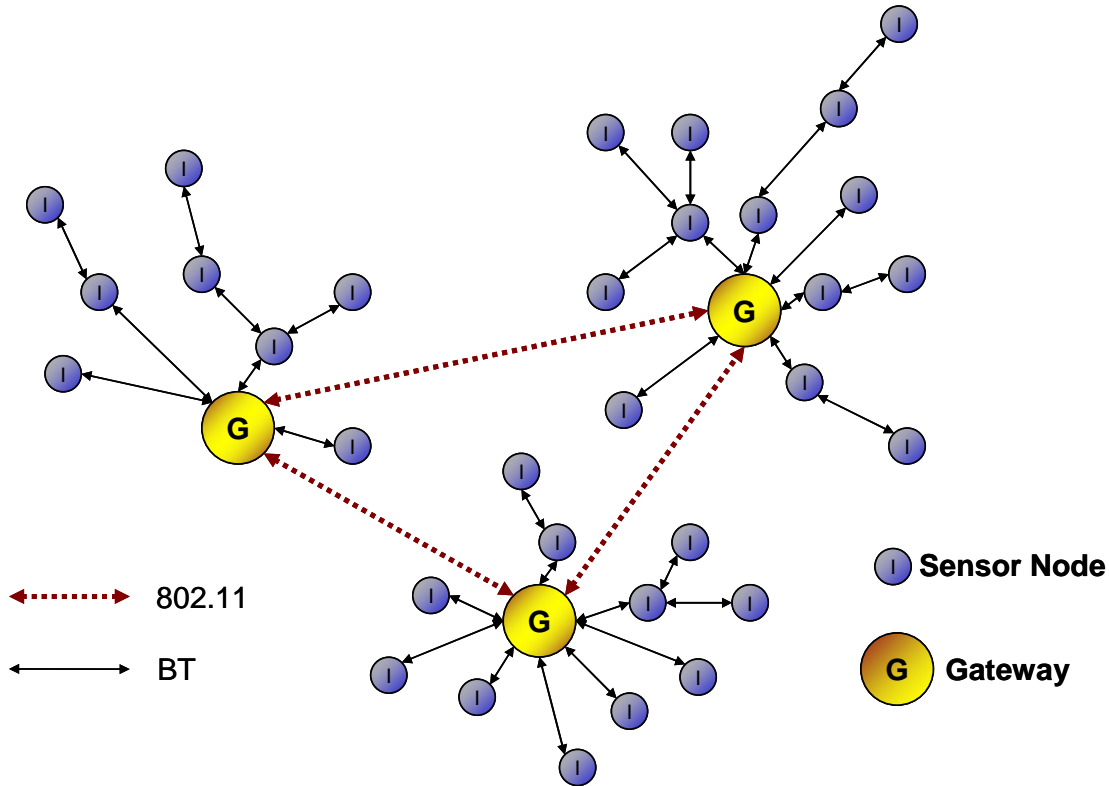


Issues:



(1) Packaging, (2) Attachment, and (3) Power Harvesting

(3) MicroCommunication using WSN



Intel Imote



Intel Stargate

(3) MicroCommunication using WSN

- Low-cost and fast deployment, especially in difficult-to-access areas
- Scalable: Enable dynamic system growth and extension
- Adaptive network configuration and operation in case of failure and unexpected events, resulting into improved reliability
- Take advantage of low-cost and low-power sensors



(a) Micro-Detection

Computer Vision

Cambridge (Leader)

(b)

Micro-Monitoring

MEM strains sensors

CRN (Leader)

(c)

Micro-Communication

Wireless communication

+ Power harvesting

Cambridge (Leader)

Czech

CRN

(d) Data Analysis and Expert System

Catalunya (Leader), Czech

(e) System Safety, Adaptation and Field Application

Czech (Leader), Catalunya, Cambridge

Business Plan and Integration

Cambridge (Leader), CNR, Catalunya and Czech

Associated Partners

Tube Line, Trans4M, Prague Metro, Barcelona Metro, Madrid Metro, GLOBAL, SOLDATA, Katholieke Universiteit Leuven

Data Analysis/Expert System



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- Software for management of field data
- Code for estimation of parameters and evaluation of structural integrity & damage
- Development of a decision support system

System Safety, Adaptation, Field Application



- Evaluate the existing state of underground structures by different methods of site investigation
- Develop health, safety and security document for installing new sensors in underground infrastructure.
- Develop the best practice guideline on infrastructure monitoring and assessment.

Field Trials

- Prague Metro
 - starting this October
- London Underground – Tubelines and Metronet-Alliance
 - starting next January
- Barcelona Metro and Madrid Metro
 - Year 3

Progress so far...

- July 2006 - Kick-off meeting in Barcelona
- July 2006 – Meeting with MetronetAlliance on MicroDetection
- August 2006 – Meeting with Tubelines on MicroCommunication
- August 2006 – Czech-Cambridge, preparation for field trials
- September/October 2006 – CNR-Cambridge meeting on MEMS
- End of October 2006 – General Meeting in Prague