Crack characterisation via graph theory for exploration with a robotic manipulator

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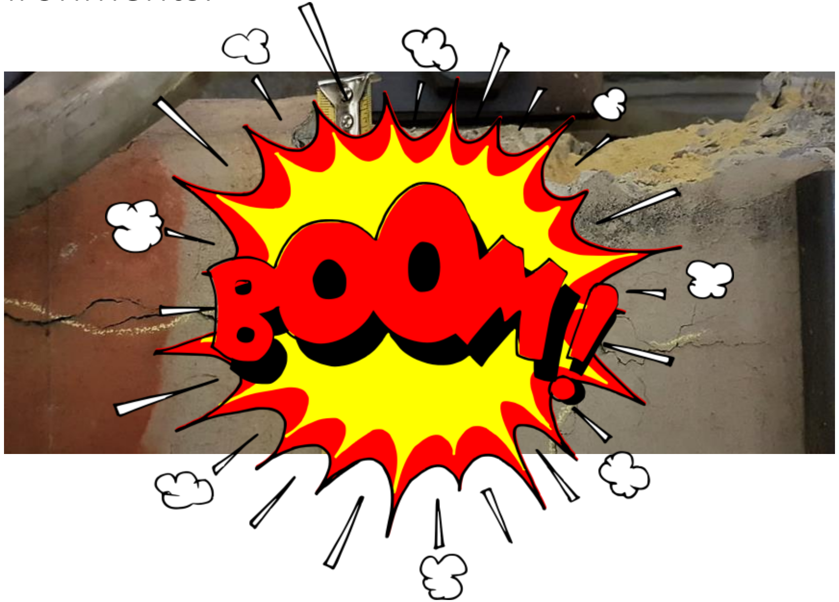
Fracture Detection

Detection of mechanical fractures on objects used for keeping chemical and radioactive waste often performed in remote hazardous environments.

Cracks may be caused by:

- Material degradation over time
- Environment changes (e.g. temperature or pressure)



The effects of non detected fractures may lead to larger macro-scale catastrophic failures.

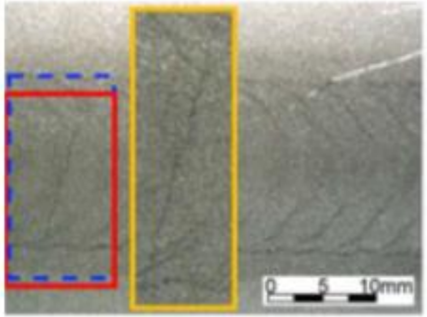
Fracture Detection

Existing Methods

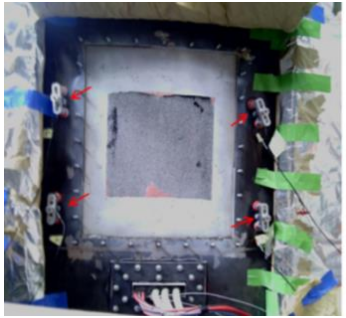
Typical fracture detection methods

- acoustic/electric: requires sensors installation
- computer vision: low accuracy
- manual inspection: not suitable for hazardous environments

Tactile and proximity sensing can provide information on material properties: shape, texture and hardness.



Chen et al, 2017



Iliopoulos et al., 2015

Effects of Radiation on camera

Tactile/Proximity Sensor

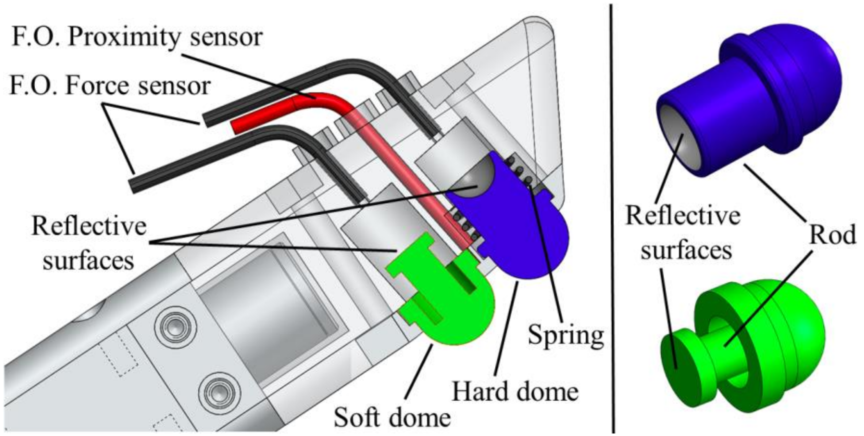
Based on Fiber Optics

Tactile and proximity sensing:

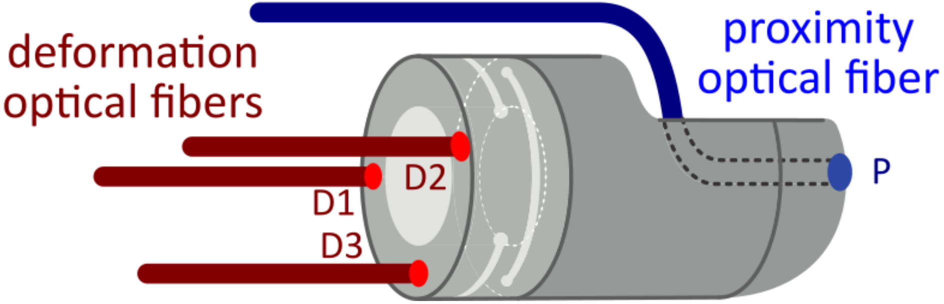
- No on-board electronics
- Robust to radiation

Measurement, 4 signals:

- 3 deformations (D1,D2,D3)
- 1 proximity (P)

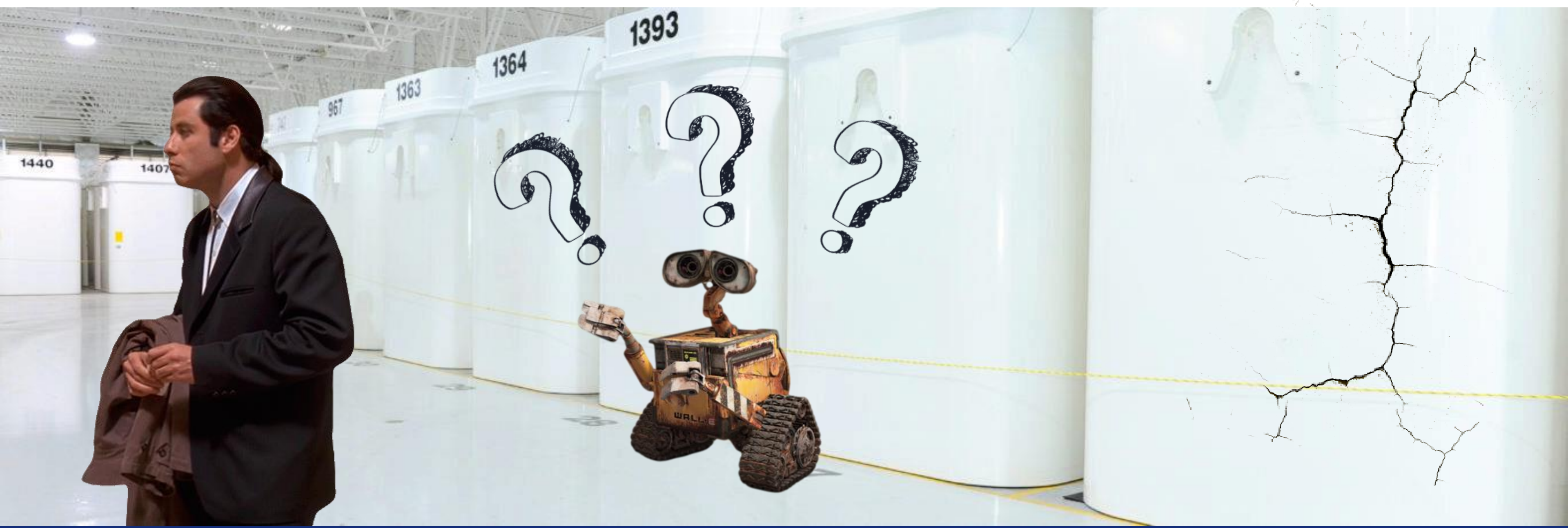


J. Konstantinova IEEE SENSORS 2017

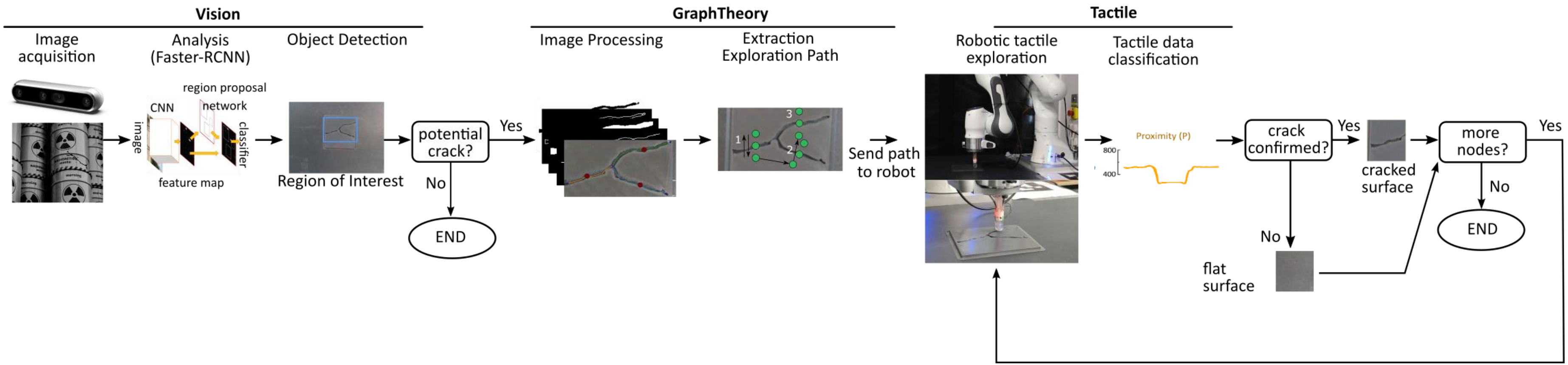


Multi-modal approach

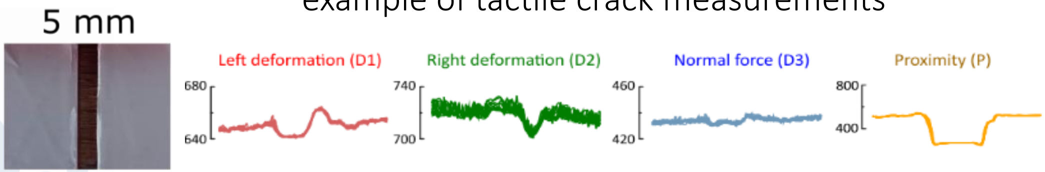
Problem: In real environment situation, exploring the whole surface with only tactile approach would be time consuming and may produce errors



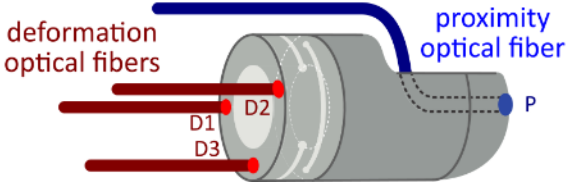
Multi-modal approach



example of tactile crack measurements

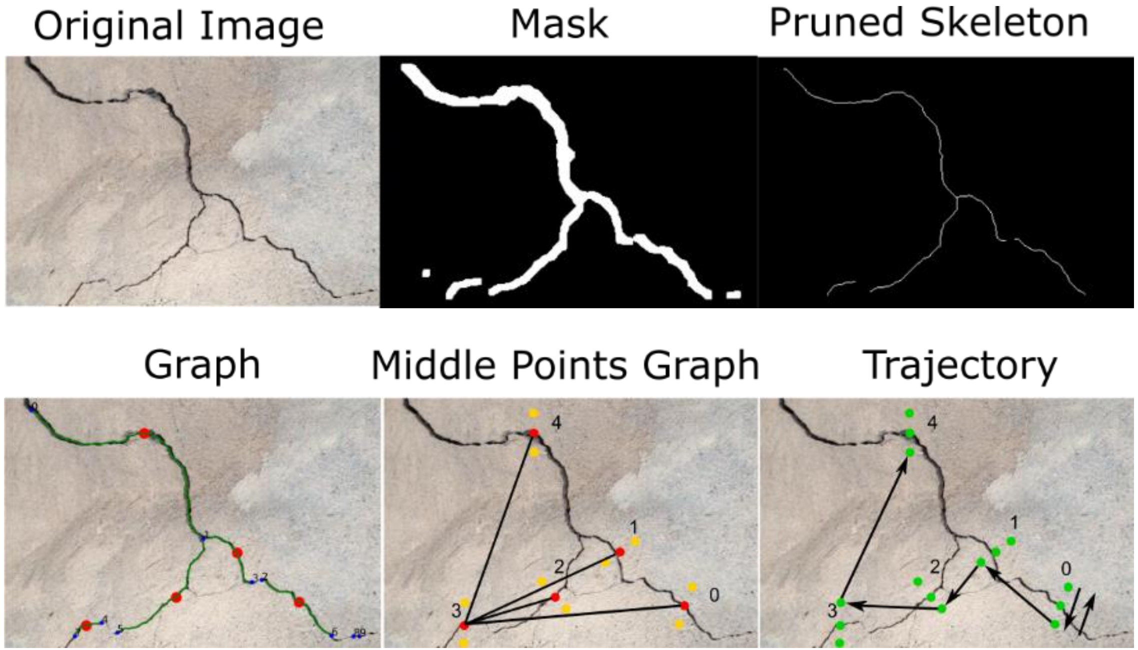


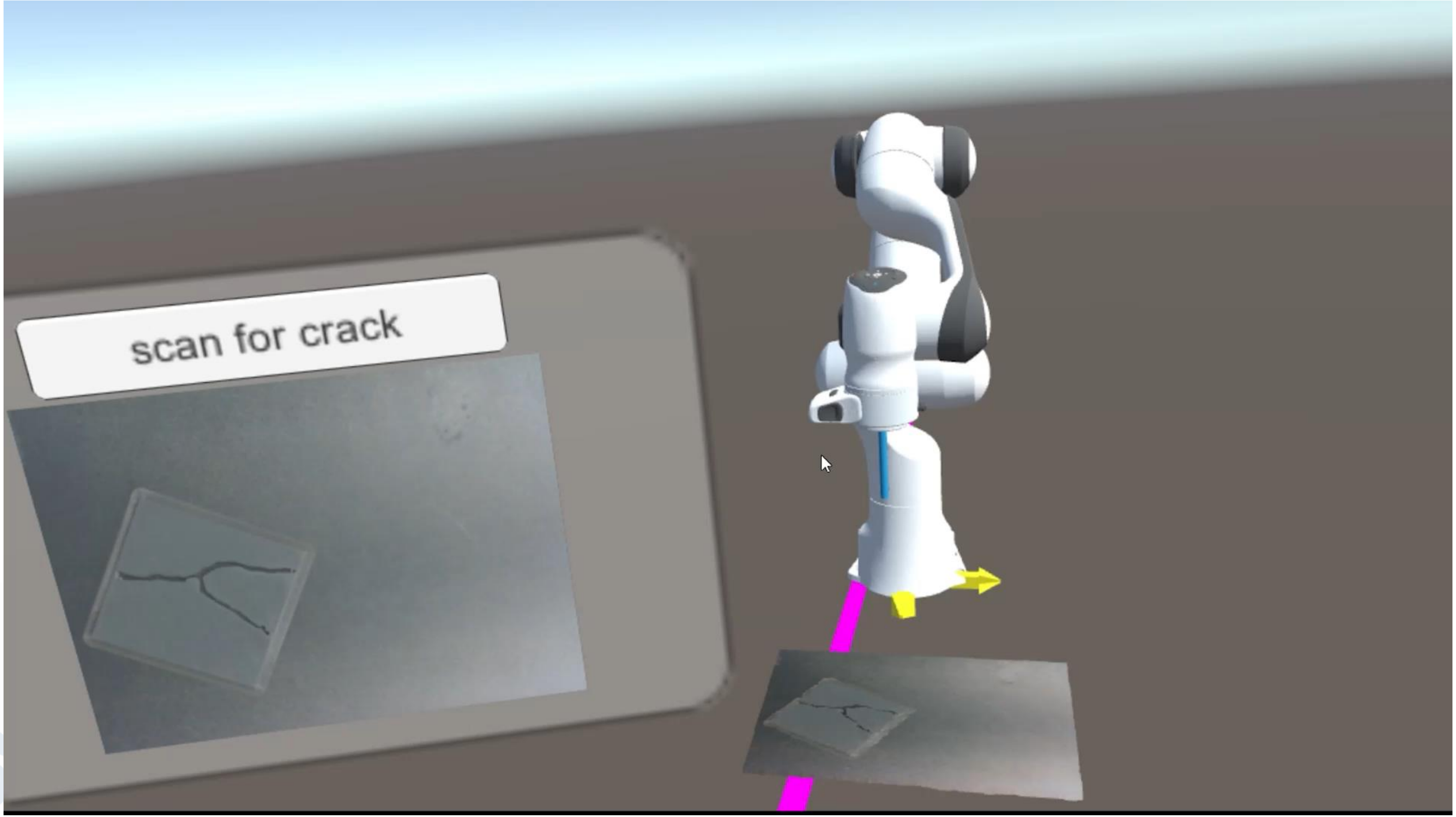
QMUL optical fibre-based tactile and proximity sensor



Using graph theory for faster tactile exploration

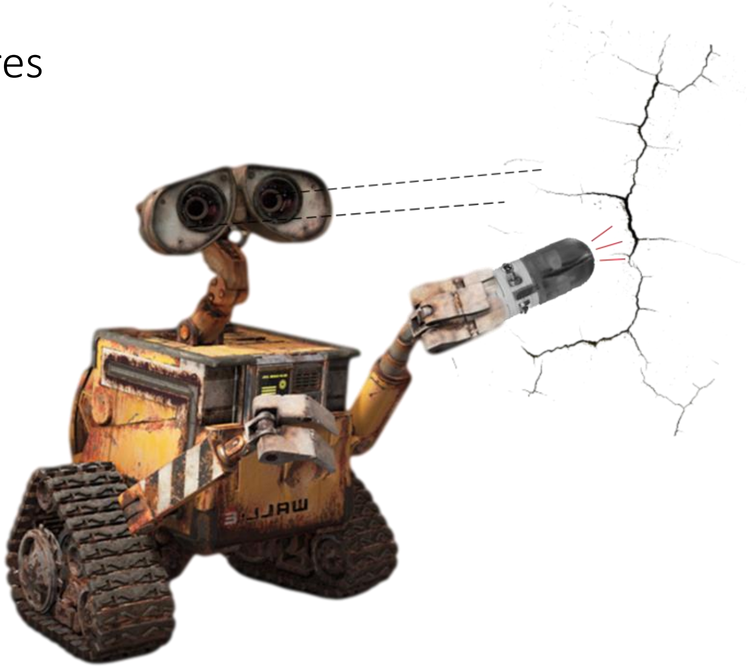
- Extract crack geometry to calculate an exploration path
- Image processing and computer vision techniques to find the location of cracks branches and nodes
- Graph theory applied to find the shortest tactile exploration path




scan for crack

Conclusion

Presented a multi-model with visual and tactile features for crack localisation and recognition and edge detection and graph theory for motion planning trajectory



Future research

- Remote Inspection
- Visual reconstruction

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