Automatic Exploration of Surface Fractures

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Goal

To detect cracks in extreme environment

Using multi-modal visual and tactile feedback and motion planning algorithm for optimal fracture exploration

Introduction

Detection of mechanical fractures performed in hazardous environments.

Typical fracture detection methods:

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

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

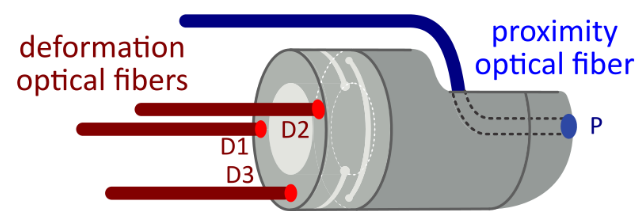
Tactile/Proximity Sensor

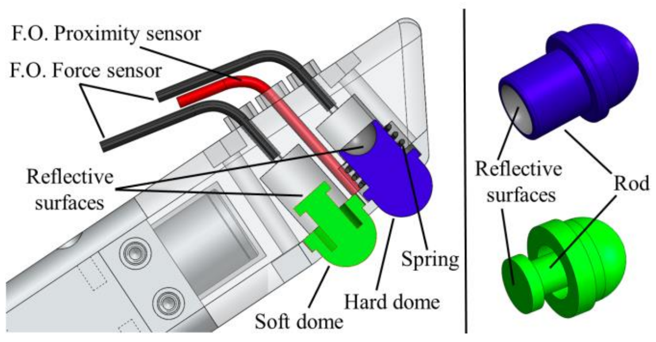
Tactile and proximity sensing:

- No on-board electronics
- Robust to radiation

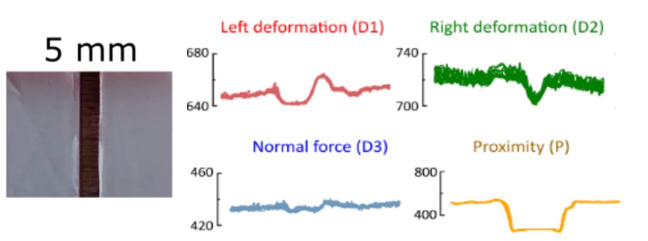
Measurement, 4 signals:

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





example of tactile crack measurements

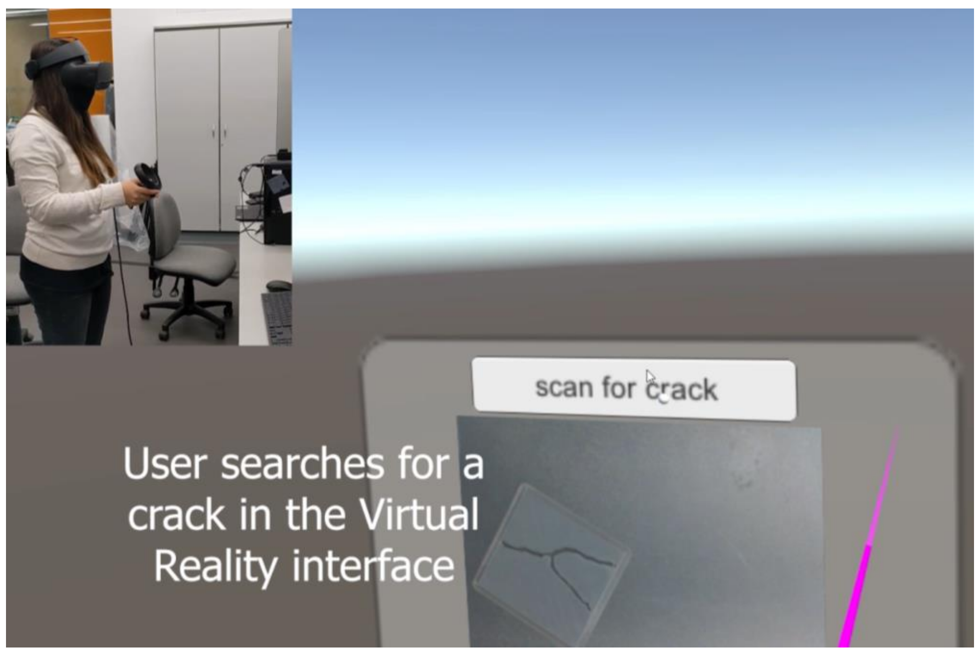


Methodology And Analysis

User in a VR interface searches for a fracture.

Area of interest is sent to object detect algorithm which detects location of possible crack.

VR environment



Object Detection

The ROI is further analysed

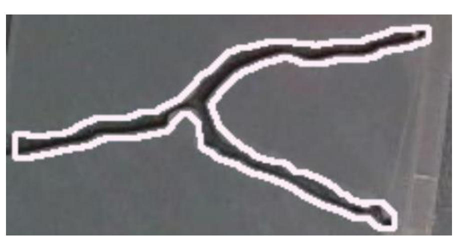
Extract crack geometry to calculate an optimal path for tactile exploration

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

Original Image

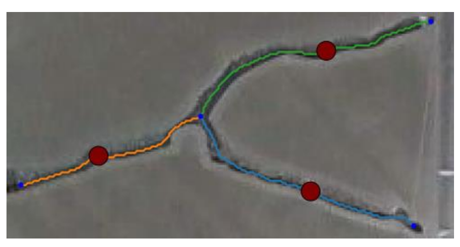
Contour Extraction



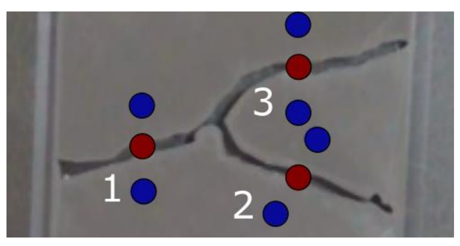
Mask

Skeleton

Graph



Trajectory

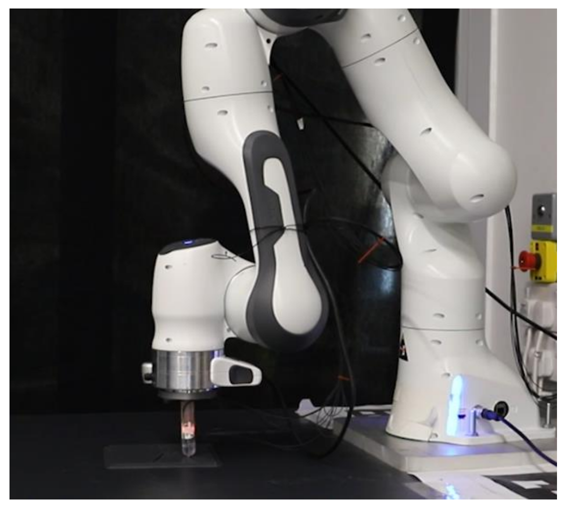


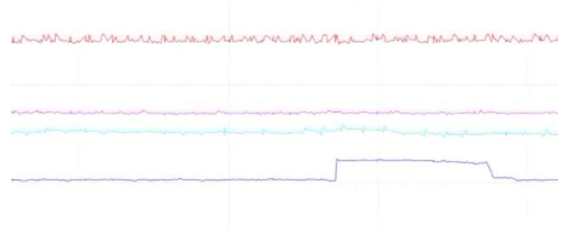
Results

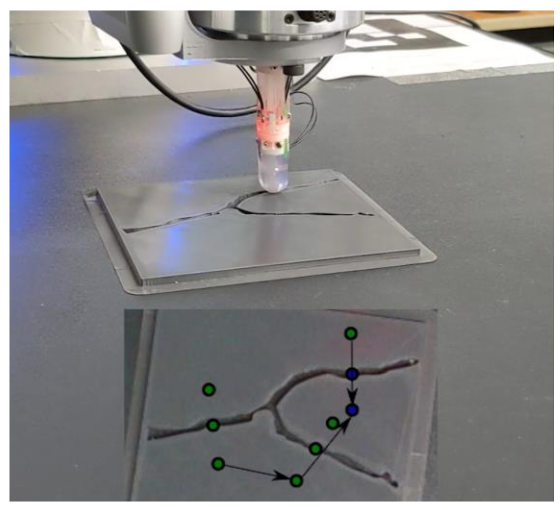
Goal. Explore all the possible nodes with the smallest cost. Minimum Spanning Tree.

Each node of the graph is explored only once and the minimum path from the starting node is found.

Experiment performed on 25 fracture images. Time required to explore fractures reduced by 12 times with graph theory.







Conclusion

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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