Buried Utility Infrastructure
ATU’s Advances in In-Pipe Sensing

1. Dept of Civil Engineering
2. Dept of Automatic Control and Systems Engineering
3. Dept of Mechanical Engineering
   University of Sheffield
Condition Assessment of pipes from in-situ internal measurements

Directed ultrasound for **plastic pipes**

- Demonstrated the ability undertake condition assessment on pressurised small scale pipes from internal measurements
- Detect voids in the ground external to pipes: Critical for assessing potential future life
- Ability to detect and analyse pipe surface and through wall defects

<table>
<thead>
<tr>
<th>Grooves, Width X depth in mm</th>
<th>Through wall slots, width in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 X 2</td>
<td>1 mm</td>
</tr>
<tr>
<td>2 X 1</td>
<td>2 mm</td>
</tr>
<tr>
<td>2 X 2</td>
<td>100</td>
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</tbody>
</table>

### Table:

<table>
<thead>
<tr>
<th></th>
<th>1 MHz</th>
<th>5 MHz</th>
<th>10 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB sand</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
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<tr>
<td>Gravel 9.5mm</td>
<td>![Image]</td>
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</tbody>
</table>
Condition Assessment of pipes from in-situ internal measurements

Resonant acoustics for metal pipes

Ability to detect areas of unsupported / partially supported metal pipes

CI pipe, with supported and unsupported sections

Spatial spectogram of pipe response to acoustic excitation
PipeSLAM

Demonstrated the ability to **navigate** a robot along a feature sparse pipe environment

Features from the attached sensors are used both for **condition assessment** but also as a **map** to allow for navigation
PipeSLAM - Sensor Fusion

- Real world **spatial context** is provided by the addition of a 9-degree of freedom Inertial Measurement Unit (IMU)
- Fused using **Bayesian methods**
- The techniques allow for the inclusion of any **prior information** about the location of pipes (GIS)
- Prior information gives better estimates