FOUNT²: Aerial localization system for rescuing buried persons

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Detection of vital signs via EM waves

Some basics …

\[ Z_{\text{in}}(\ell) = Z_0 \frac{Z_L + Z_0 \tanh(\gamma \ell)}{Z_0 + Z_L \tanh(\gamma \ell)} \]

Detection of vital signs via EM waves

- Some history ...

Table 1. History of Microwave Sensing of Physiological Movement and Volume Change

| Volume change in biological objects [Moskalenko, 1960] |
| Ventricular volume change [Johnson and Guy, 1972] |
| Lung disease management [Süsskind, 1973] |
| Respiration rate and apnea detection [Lin, 1975] |
| Lung volume change/pulmonary edema [Pedersen et al., 1978] |
| Apexcardiography [Lin et al., 1979] |
| Arterial wall movement [Stuchly et al., 1980] |
| Brain volume/brain edema [Lin and Clarke, 1982; Clarke and Lin, 1983] |
| Pulse-wave sensing [Lee and Lin, 1985] |
| Life sign detection (heart rate and respiration rate) [Chen et al., 1986; Sharpe et al., 1986; Chan and Lin, 1987] |


# Applications in search and rescue

<table>
<thead>
<tr>
<th>System</th>
<th>Meder</th>
<th>LifeLocator</th>
<th>Leader Scan</th>
<th>Sensors and Software</th>
<th>Biken</th>
</tr>
</thead>
<tbody>
<tr>
<td>electronic board</td>
<td>antenna</td>
<td>sensor unit</td>
<td>sensor unit</td>
<td>sensor unit</td>
<td>sensor unit</td>
</tr>
<tr>
<td>Size</td>
<td>25 x 30 x 6 cm</td>
<td>45 x 45 x 22 cm</td>
<td>43 x 24.4 x 34.1 cm</td>
<td>53 x 32.5 x 32.5 cm</td>
<td>42.9 x 37.9 x 27.6 cm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.35 kg</td>
<td>13 kg</td>
<td>6.7 kg (incl. Battery 621g)</td>
<td>7.9 kg</td>
<td>&lt; 10 kg</td>
</tr>
</tbody>
</table>
The FOUNT² project

- Deploying the bioradar on a UAV
Project consortium

Gebäudeinstürze Verschüttete Menschen

Unterstützung Einsatzkräfte

UAVs BioRadar Navigation Lokalisierung

OSM Maps Mission Planning

HerSi Electronic Development

Technology Arts Sciences
TH Köln
The UAV

- **Specifications**
  - Weight: 5 kg
  - Flight time: 45 minutes
  - Payload: 250 g

- **Features**
  - Partially autonomous
  - Redundant flight controls
  - Adaptive landing gear for uneven landing
Landing site recognition

- **Mapping**
  - Open Street Map based UI
  - High resolution 3D mapping

- **Semi autonomous operation**
  - Path planning for navigation to target points
  - Automatic classification of landing sites
  - Neural networks trained on lab and real data

Uni Freiburg, AIS 2018
Bioradar integration

- **Antenna miniaturization**
  - Lightweight construction
  - GPR-A design
  - Microwave frequencies

- **Detection algorithm**
  - ~100 MHz bandwidth
  - Time frequency analysis
  - CFAR detection
Outlook

- Systems integration and intra-communication
- Performance evaluation
- Public events
  - **October 2018**
    - End user training and education workshop
  - **Mid 2019**
    - Field exercises and final tests
- R&D to be completed by end of 2019
Thank you!

Questions?