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Use of Ground Penetrating Radar for detection of trapped and buried people

L. Reindl (1), F. Schilling (2), T. Ostertag (1), L. Chen (1), and M. Wilde (1)

(1) IMTEK, University of Freiburg, Germany (reindl@imtek.de), (2) BOS Berlin Oberspree Sondermaschinenbau, Berlin, Germany

In this contribution we discuss the first results of the project I-LOV, within the German national research program for civil security funded by the German Federal Ministry of Education and Research (BMBF) concerning improved time efficiency and reliable novel detection systems for search and rescue.

Ground penetrating RADAR is well known for the detection of all kinds of obstacles buried in the ground. But for use in search and rescue activities it is necessary to distinguish between living people and other unknown burried objekts. In our presentation we show how the movement of the chest from respiration can be used to distinguish between living people and static objects.

The breath width of the thorax is typically between 2 to 5 cm and typical respirations are 12 to 50 times per minute. The working principle of the sensor is interferometric. The change in phase of the scattered portion of a CW signal in the ultra-high-frequency (UHF) band is detected. The detection is challenging because the dynamic portion of the signal response is close to the transmitted carrier frequency. A typical signal is 120 dB weaker than the transmitted carrier signal strength with an offset of only 0.2 to 0.3 Hz from the carrier which correspond to the respiration frequency.

Field trials with the first prototype showed, that artifacts from trees swaying in the wind and helpers in the field cause false positive results. The range at which an artifact can be detected is more than 10 times longer than the operating range into the ground. This is due to the attenuation that is significantly less in free air than in gravel covering the victim.
Furthermore, the radar cross section of the moving obstacle can be significantly larger than the victims thorax moving. A distinction of the artifacts and the desired signals is required and can be achieved through a distance resolution. This is solved using a frequency modulation (FM) of the CW signal, resulting in a FMCW radar. By switching the carrier frequency in 256 steps of 1:5 MHz an unambiguous range of 100 m and a distance resolution of better than 1 m can be achieved. The known maximal depth a rubble pile may have, helps to detect respiration signals since the search can be limited to the range of 0 m to 10 m. All signals that are located at a range beyond 10 m can be discarded since they are most likely clutter. To search for the optimal frequency of operation more than 100 measurements have been made in artificial rubble piles and a blasted building. The results were used to set up an statistic channel model.