A Low-Cost, Clutter-Cancelling Life Detection System for First Response after Natural Disasters

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Earthquakes are devastating natural phenomena which affect regions across the world. The recent Rome earthquake of 2016 or the memorable Nepal Earthquake of 2015 each claimed hundreds of lives, whereby a majority died buried under material before first-response excavation. In order to expedite the first-response procedure and save lives of victims, an elementary prototype was built last year to detect the oscillating heart and chest movements of humans, which ultimately failed because of the auxiliary signal: clutter. In through-wall applications, clutter is the strongest receive signal, causing over-saturation and decreased sensitivity to low amplitude/frequency vital signals. Therefore, an innovative clutter cancellation system was designed which finds the optimal phase and amplitude characteristics of a cancellation signal that can completely cancel the clutter. The new radar is followed by a cascade of amplifiers and filters and is processed with a Python Script, which down-samples, splits, filters, selects, and transforms a time-based data-set to a frequency spectrum. The system was tested on human subjects behind 2m. of plaster, 1m. of concrete, and 1.47m. of brick wall over three trials. Each trial yielded outstanding results which showed signs of heartbeats and respiration on-par with those predicted by medical literature, proving the system's field application. The ratio of these vital signals to noise was constant across materials, strongly suggesting the radar is capable of detection through even larger material. Future/Current work lies with designing a PCB version of the radar, testing through denser mediums such as boulders, and developing a real-time cancellation algorithm.

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