

Image Formation Through Walls Using A Distributed Radar Sensor Network

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Interest in methods for obtaining surveillance information through walls has been increasing for both domestic and military security applications. While detecting the presence of individuals inside a building structure is useful, being able to know where they are, and how the interior of the structure is laid out provides an additional important tactical advantage. Sensors that can form images through walls take away the ability of individuals to hide, reduce the risk to security personnel, and increase the probability that security operations will conclude without casualties.

The electromagnetic propagation properties of building materials, access to building surroundings, and operational requirements all play a role in defining imaging system operating parameters. Frequencies between 250 MHz and 3 GHz provide acceptable penetration for nearly all building materials, including concrete. Low frequency antennas with good resolution tend to be too large for practical application. Improving resolution through aperture synthesis from a moving platform can't always be achieved because of limited access to a building's surrounding area. System size and weight is always an issue because of the need for portability.

While we have demonstrated acceptable imaging performance by synthesizing a large antenna aperture from a portable, collapsible antenna array, these operational constraints have driven AKELA to a concept of operation where images are created by a distributed array of individual sensors. Each sensor is a high range resolution radar that can be either fixed in place or carried by an individual. The sensors are connected with a wireless communication network that distributes timing and control information, receives data, determines sensor location, and fuses the data from each sensor to generate imaging and motion detection information. The variable aperture achieved by allowing sensor movement reduces ghost images and improves resolution where needed. Coherent detection preserves phase information that is useful for determining the presence of metal and the breathing response of a stationary individual.

We have developed a frequency agile radar operating between 500 MHz and 2 GHz that has a maximum range of 250 meters and allows image formation at 10 frames per second. This radar is the sensor element in our networked concept. Recent experiments show that this new radar has the capability to detect the breathing response of a stationary individual through a wall at a distance of 5.5 meters.

Bio:

Allan Hunt received a B.S. Electrical Engineering from the US Air Force Academy, an M.S. in Electrical Engineering from Stanford University, and an M.B.A. from Cal State University. He has been working on applications of technology to security and law enforcement problems for the past 24 years. During that time, his research activities have included the development of neural network processing for surveillance sensors, development of instrumentation for CW treaty verification and contraband detection, development of analytical tools for the detection of weapons proliferation, and the development of expert system programs for security risk and vulnerability analysis. The focus of his activities over the past 8 years has been the application of wideband radar for concealed weapons detection, wide area surveillance, and through the wall imaging.