Millimeter-Wave Remote Biometric Identification and Tracking (RBIT) System for Security Applications

The Millimeter-Wave Remote Biometric Identification and Tracking (mmW RBIT) System for Security Applications addresses one of the nation's top homeland security concerns: the need for real-time, remote surveillance of aspects of human behavior to help identify terrorists. Such monitoring involves the collection, measurement, and interpretation of biometric data from individuals, such as their heart rate, breathing rate, and movement. This mission of conducting constant surveillance on a large number of human subjects is difficult and complex. It needs to be performed at a variety of critical locations (e.g., airports, border portal entrances, cargo inspection harbors), so the machine should be portable, easy to deploy, and able to operate in all types of weather. The task is especially difficult because the human targets are moving and should not know they are being monitored; thus, automated motion tracking and biometric surveillance from a distance are required. The tool must be noninvasive (i.e., not touch the target) and work through clothing and perhaps walls. It must provide accurate results almost immediately. This system has two other critically important applications: It could be used in the battlefield and at disaster sites to aid in triage and response and recovery operations.

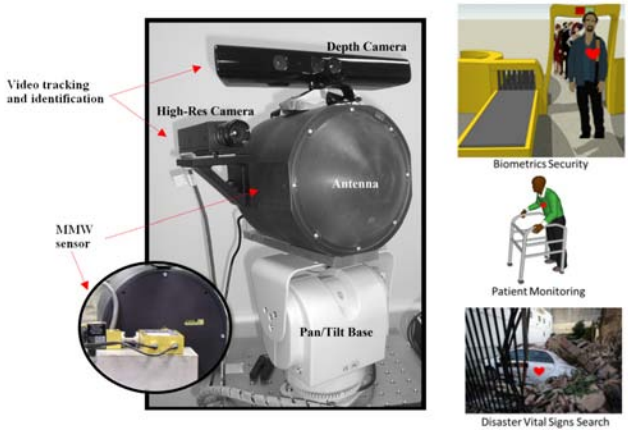

Figure 1 *mmW RBIT system (left) and some potential applications (right): Top graphic illustrates the principal biometric security application for remote tracking, identification, and stimulus response characterization; middle graphic shows how it might be used in a hospital or home healthcare application, for remote monitoring and diagnostics based on heartbeats, respiration, and movements in real time; and the bottom graphic indicates its use after a disaster to assist in search and rescue operations.*

We developed this first remote heartbeat, respiration, and body motion identification and tracking system on the basis of modern mmW techniques. Some of its beneficial features and capabilities are:

- Novel: It's the first system to remotely identify and persistently track a subject while recording his or her heartbeat, respiration, and movement.
- Nonintrusive: It senses through clothing and many common optically opaque materials, including masonry.
- Able to conduct long-range surveillance: It can take measurements from tens of meters away, and the camera maintains its aim when obstructions partially or temporarily block its field of view.
- Operates under harsh conditions: It works in darkness and daylight and is not affected by atmospheric conditions, such as moisture, dust, and smoke.
- Portable: The entire system can be rapidly deployed and adapted to covert operations.
- Fast response time: It provides real-time, on-the-spot measurements of biometric data.
- Reliable and secure: It uses advanced feature-extraction and data-analysis algorithms that are nearly 100% accurate in identifying humans and more than 98.8% accurate in identifying heartbeat and respiration patterns.
- Adaptable: It can be integrated with existing vision-based biometric and video surveillance systems.
- Many potential applications: It can be used for biometrics security, battlefield triage, to search for vital signs after disasters, to monitor a patient's heart condition and movement, to combat identity theft, for on-line monitoring of operating machinery, and to monitor vehicles to avoid collisions.

The mmW RBIT product is a combination of three interoperational subsystems: (1) a 94-GHz mmW interferometric Doppler displacement sensor; (2) a depth sensor and an optical video camera tracking subsystem; and (3) real-time, interactive, graphical user interface (GUI) software. With the aid of the depth sensor and optical video camera tracking subsystem, the servo control system guides (rotates and tilts) the mmW Doppler displacement sensor to the appropriate location near the heart of the subject, and the real-time software analyzes the reflected mmW signal with feature-recognition algorithms, providing persistent monitoring of the subject's biometric measurements.

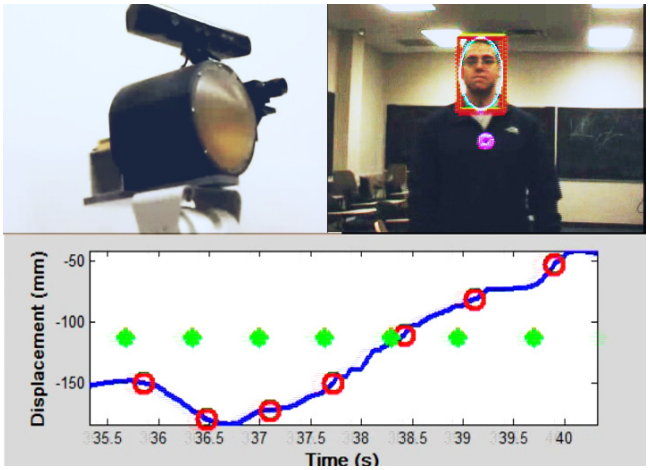

Figure 2 *Results from an experiment on a moving male subject (There is excellent agreement between the heartbeat data extracted by the mmW RBIT system [red] and the data detected by an ECG [green].*

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