Human Respiration Rate Estimation using SFCW Radar System

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A stepped frequency continuous wave radar was developed for measuring motion characteristics for fall detection using the phase information (H. Wang, *et. al.* IEEE Topical Conference on BioWireleSS, 43-45, 2016). In the proposed work, this SFCW radar is utilized here for human respiration rate detection. The radar measured results are compared to commercially available contact sensor readings.

For further validation, a full-wave electromagnetic scattering model based on Fast Multipole Method (MoM-FMM) algorithm to investigate the vital signs monitoring errors due to subject's orientation, clothing and distance from the radar (L. Ren, *et. al.* IEEE APS/URSI, 2016) is utilized for calculating the scattered fields from a human model. To be consistent with the experimental setup, an SFCW radar is used in this model to investigate the vital signs of a subject. Using the human model, the vital signs of a human can be accurately evaluated and tracked from the simulated data. The effect of subject orientation, cloth and location in detected vital signs estimation inaccuracies have been investigated here as well.

The SFCW radar covers a frequency range of 2 GHz to 3 GHz with 20 MHz frequency steps, and the measured results agree very well with simulated ones. To investigate the effect of these parameters on measured results, vital signs for the same subject with different clothes, different orientations, and standing at distinct positions have been measured. Results indicate that the non-contact SFCW radar system is capable of accurate respiration detection with error rates less than 3% when the subject is within 1.5 m distance from the radar.

Both Simulation and measured results will be presented and effect of cloth, orientation, and position will be discussed in detail.