Heart Rate Extraction From Respiration Rate in Multiple-Target Measurement Using Ultra Wideband Sensors

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The Ultra Wideband (UWB) system has been suggested for a variety of medical applications due to its high spatial resolution and strong material penetration capabilities. It can be used for contact-free estimation of human being vial-signs to aid in the health parameter monitoring and rescue operations. The technique is based on the detection of chest-cavity motion and heart muscle movement through the measurement of the received UWB signal displacements due to these motions. UWB sensors are low-power, portable and not require physical contact with the objects. They are ideal for emergency responders to make rapid diagnosis and triage decisions. UWB system also holds great promise to aid in the physiological detection of deception (PDD) and other security applications.

Previous research has shown that UWB sensors are capable of robust detection of the respiration rate from multiple targets. However, due to the high attenuation of the heart-rate signals as well as strong interference from the respiration-rate signals, the accuracy of heart-rate estimation is not nearly as good, especially in an obstructed object scenario. In this paper, we utilize accurate respiration-rate estimator to mitigate the interference introduced by respiration-rate signals in order to extract low amplitude heart-rate signals with different transformation schemes. We also investigate the benefit of multiple receivers to improve the accuracy of multiple targets estimation. We examine the performance in the presence of one and multiple targets and with physical obstruction between the subject and UWB antennas. Further, we present the real-time measurement results in a laboratory setting to verify our simulations.