Noise reduction techniques for human vital-signal radar sensors

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Abstract

Radar sensors detecting human vital-signals are presented. As there have been strong demands for remote non-contact vital-signal detectors, the sensors are gaining great importance, which can be applied to a variety of existing and new applications such as autonomous vehicles, occupancy sensing and health-care applications. Unfortunately, current radar sensors severely suffer from noises and environmental variations, which place a fundamental limit on the achievable accuracy and detection range. Specifically, there are two important cases in remote vital-signal monitoring: 1) sensing heartbeat and respiration in the presence of random motions, which can be used in vehicles, hospital rooms and exercise equipment and 2) sensing presence, location and respiration of a human, which is a key component in smart homes, buildings and hospitals.

In this presentation, the vital-signal radar sensors to overcome the hurdles in above two cases are described, in which dominant noises are reduced by the following proposed methods. For the first case, a differential radar to detect heartbeat and respiration in the large scale of body motions is introduced, which can cancel out common-mode noise between two receivers, similar to a differential circuit. To be applied in the second case, a cross-correlation detection technique and a switch-first low-IF receiver architecture are presented to reduce the intrinsic noise of the radar system. For a proof-of-concept, we aim at achieving heartbeat rate, respiration rate from a moving human body as well as detecting the presence and location of a person. Experiments show that the vital-signals can be detected at 1-m distance with over 30 cm body motions and at 6-m distance without any body motions.

Keywords: *Human vital signal, Radar sensor, Noise reduction, Motion artifact*

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Biography

Songcheol Hong (S’87–M’88) received the B.S. and M.S. degrees in electronics from Seoul National University, Seoul, South Korea, in 1982 and 1984, respectively, and the Ph.D. degree in electrical engineering from the University of Michi-gan, Ann Arbor, MI, USA, in 1989. In 1989, he joined the Department of Electrical Engineering, Korea Advanced Insti-tute of Science and Technology, Daejeon, South Korea. In 1997, he held short visiting professorships with Stanford Uni-versity, Palo Alto, CA, USA,, and Samsung Microwave Semiconductor, Suwon, South Korea. His research interests include microwave integrated circuits and systems including power amplifiers for mobile communications, miniaturized radar, mm-wave frequency synthesizers, and novel semiconductor devices