Human Vital Sign Detection Using Fast Fourier Transform

Tuan Phan*, Quang Nguyen, Nghia Tran and Ozlem Kilic,

Department of Electrical Engineering and Computer Sciences
The Catholic University of America, Washington, DC 20064, U.S.A.
30phan@cardinalmail.cua.edu, 93nguyen@cardinalmail.cua.edu,
16tran@cardinalmail.cua.edu and kilic@cua.edu

Non-invasive detection of the human vital signs, such as the heart beat and breathing rate, plays an important role in security and surveillance operations, i.e. health monitoring, disaster rescue, counter terrorism. Among different radar system categories that have been considered for these applications, stepped-frequency continuous wave (SFCW) radars show advantages in terms of ease of implementation and wide bandwidth with high range resolution, but they typically require a long data acquisition time.

In this paper, the human respiratory rate and heart beat are detected by applying Fast Fourier Transform (FFT) on the received baseband signals of radar. A hybrid numerical technique for inhomogeneous multilayered media is proposed to compute the scattered fields off a model of human torso including the rib cage and the heart. For simplicity, we adopt a vibrating sphere to represent the beating human heart. An elliptical cylinder is used to model the human rib cage based on internal anterior-posterior rib cage diameter, lateral rib cage diameter and diaphragm height of the human. Although the heart and rib cage are both modeled as homogeneous medium, the whole object is inhomogeneous due to different dielectric constant between these two parts.

Each sub-homogeneous region (heart and rib cage) is solved independently using the Method of Moment (MoM), and the mutual coupling effects between the two regions are taken into account through the iterative procedure. The concept is capable of solving more complex inhomogeneous objects, i.e. three or more dielectric layers object. The range profile is also obtained by applying the inverse Fourier transform to determine the location of the object. Then the forward Fourier transform is conducted based on the location to show the respiratory rate and heart beat signatures in frequency domain.