5.8-GHz Noncontact Vital Sign Detection Radar with Respiration Harmonics Cancellation

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Microwave Doppler radar is capable of detecting human heartbeat and respiration or mechanical vibrations from a distance away. This noncontact detection method has many potential applications in healthcare, veterinary medicine, biology, industrial manufacturing, etc. Through understanding of its detection mechanism and advances in hardware and software, the once bulky Doppler radar systems can be miniaturized while achieving the same or even better performance. In this paper, a 5.8-GHz noncontact Doppler radar vital sign detection system is presented. The radio frequency signal is sent and modulated by the respiratory and heartbeat displacement when it hits the subject. A 2×2 patch antenna is custom designed to meet the requirement of the system. The phase-modulated signal is captured by the Doppler radar and then amplified by the gain stages at the receiver. An I/Q mixer is employed to down-convert the signal and to avoid the null point issue of the demodulated signal. The baseband signal is then sent wirelessly through Zigbee interface to the computer for further processing. Both time-domain and frequency-domain analysis are employed to extract the heart rate (HR) and respiration rate (RR). The Complex Signal Demodulation (CSD) is performed before the frequency spectrum analysis. HR and RR are measured by searching the highest peak within the typical HR and RR range in the frequency spectrum. Because respiratory displacement is very obvious, counting the number of respiration peaks within a certain time is utilized as a reference to RR measurement. For HR measurements, since the higher order harmonics of RR, generated by the demodulation method and the displacements, might appear near HR peak in the spectrum and cause error in HR measurement, a respiration harmonics cancellation method is implemented to increase the accuracy of the HR measurement. A finger-tip piezoelectric heart rate monitor is used as the reference. After signal processing, HR measurements can get an accuracy of over 90%.