Microwave Wearable Biosensing Utilizing Affordable Radar Phenomenology

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We previously proposed a method to measure the velocity of the blood and/or pulse wave velocity in the wrist using RF Doppler technology. The endpoint was detection of the frequency/phase shift of a return signal, thereby enabling calculation of the velocity of blood in target vessel. As the reflector, in this case blood, moves between each transmit pulse, the returned signal has a phase difference or phase shift from pulse to pulse, which allows for direct measurements of blood velocity and arterial shape as determinants of the BP estimate. In the previous study, an RF Doppler radar signals were transmitted via a small sized microstrip patch antenna of which frequency bandwidth is 7.2 and 10.5 GHz. Despite the successful demonstration of the speed measurement of liguid flow using the RF Doppler sensor, the patch antenna, however, was still too bulky to integrate into wearable form-factored devices.

It has long been a challenge designing robust antenna topologies for wearable platforms requiring low-mass, small-volume and flexible configurations. For such platforms microstrip patch antenna has been one of the best candidates because of its inherent advantages of such as low-profile, simple pattern and broadside beam radiation. However, in many cases the conventional half wavelength patch antenna is too bulky to be applied for array configuration in the wearable device. Therefore, research on the novel design techniques to minimize antenna size maintaining desired antenna performance is desperately needed.

In this paper, several antenna miniaturization techniques and their pros and cons will be discussed in terms of gain, bandwidth and polarization. Various antenna patterns realized by antenna miniaturization are investigated and finally selected for desired antenna performance and array configuration for radar sensing. Performance tolerance to flexible deformation caused by wearable loadings are discussed in the presentation. Finally, we will show a RF Doppler sensor prototype with different antennas with a wearable form factor to assess performance of the antenna we proposed.