

Radio-Frequency Technologies for Sensing and Imaging

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Abstract : Rapid, accurate, and safe sensing and imaging of physical quantities or structures finds many applications and is of significant interest to society. Sensing and imaging using radio-frequency (RF) techniques, particularly, has gone through significant development and subsequently established itself as a unique territory in the sensing world. RF sensing and imaging has played a critical role in providing us many sensing and imaging abilities beyond our human capabilities, benefiting both civilian and military applications - for example, from sensing abnormal conditions underneath some structures' surfaces to detection and classification of concealed items, hidden activities, and buried objects. We present the developments of several sensing and imaging systems implementing RF technologies like ultra-wide band (UWB), synthetic-pulse, and interferometry. These systems are fabricated completely using RF integrated circuits. The UWB impulse system operates over multiple pulse durations from 450 to 1170 ps with 5.5-GHz RF bandwidth. It performs well through tests of various samples, demonstrating its usefulness for subsurface sensing. The synthetic-pulse system operating from 0.6 to 5.6 GHz can assess accurately subsurface structures. The synthetic-pulse system operating from 29.72-37.7 GHz demonstrates abilities for various surface and near-surface sensing such as profile mapping, liquid-level monitoring, and anti-personnel mine locating. The interferometric system operating at 35.6 GHz demonstrates its multi-functional capability for measurement of displacements and slow velocities. These RF sensors are attractive and useful for various surface and subsurface sensing applications. This paper was made possible by NPRP grant # 6-241-2-102 from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the authors.

Keywords : RF sensors, radars, surface sensing, subsurface sensing

Conference Title : ICISI 2017 : International Conference on Instrumentation, Sensor and Interfaces

Conference Location : Tokyo, Japan

Conference Dates : November 13-14, 2017