Substrate-Integrated Waveguide (SIW) Based Antenna in Remote Respiratory Sensing

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In a hospital environment, continuous monitoring of respiratory activity in a patient moved from intensive care unit may prevent incidence of central sleep apnea (CSA). CSA is difficult to predict and can be life-threatening. Some of the existing respiratory monitoring methods require direct contact with the patient; such as placing electrodes on the skin or wearing a monitoring belt around the chest. Other monitoring devices are bulky and invasive such as the spirometer which involves the patient breathing through a mouthpiece; and is thus, inconvenient. Additionally, the aforementioned monitoring methods/devices are not suitable for critically ill patients that may not tolerate a mouthpiece, or burn-injured patients that cannot tolerate wearing a monitoring belt. Consequently, there is a need to develop remote/non-contact devices to continuously monitor respiratory activity in a reliable and non-invasive way. Optical techniques have been utilized for remote respiratory monitoring with reported high sensitivity; however, they cannot penetrate clothing. Therefore, microwave techniques have been explored due to their inherent advantage of penetrating clothes.

This work presents a leaky-wave array antenna to be used in a remote respiratory sensing application. The operating frequency range is 8-9 GHz. The proposed antenna is simple and PCB based with a beam-scanning ability along the length of a patient's bed (approx. 2.3 m). The antenna's beam width sufficiently covers the width of the bed (approx. 1.1 m). The antenna scans along the length of the bed to locate the patient's chest. The antenna incorporates substrate-integrated waveguide (SIW) technology. SIW is a relatively new, cost effective, low loss signal transmission technology that is starting to replace conventional bulky waveguides, especially in high operating frequencies.

Leakage of the array antenna is obtained by introducing periodic set of transverse slots on the top metal of the SIW (J. Liu et al., IEEE Trans. Antennas Prop., 60, 20-29, 2012). The transverse slots are closely spaced; i.e. the period of the slots is small compared to the wavelength so that the antenna radiates from the dominant mode of the SIW.

This work will show the simulated array antenna achieving a gain higher than 10 dB and radiation efficiency higher than 50% between 8.3-8.9 GHz.