ITC 2024 Cairo Keynote Talk

Exploring the Frontier of Non-Contact Health Monitoring Using MIMO Radar Technology

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ABSTRACT

This talk explores the application of Multiple-Input Multiple-Output (MIMO) radar technology for non-contact vital sign monitoring, utilizing a 77-GHz Frequency Modulated Continuous Wave (FMCW) system with 192 Time Division Multiplexing-MIMO channels. Originally developed to enhance data transmission rates and network capacity in wireless communications, MIMO technology is adapted here to improve the accuracy and reliability of remote heart rate (HR) and respiratory rate (RR) monitoring. We employ advanced signal processing techniques such as Maximal Ratio Combining (MRC) and Continuous Wavelet Transform (CWT), alongside a convolutional neural network (CNN) for automatic channel classification, to enhance the precision of vital sign detection. Experimental results demonstrate significant improvements in HR estimation accuracy, with over 20% reduction in root-mean-square error (RMSE) compared to traditional methods. These findings highlight the transformative potential of MIMO radar systems in medical diagnostics and remote health monitoring, offering robust, non-invasive solutions for continuous and accurate vital sign measurement.

BIO

Dr. Aly E. Fathy is the James W. McConnell Professor at the University of Tennessee (UTK) and the Director of the Microwave Labs at UTK. He is an IEEE Life Fellow and a prominent figure in the field of microwave engineering and communications. Dr. Fathy obtained his BSc and MSc from Ain Shams University, and his PhD from New York University.

Over the past decade, he has graduated 16 PhD students and has made significant contributions to the development of Ultra-Wideband (UWB) radars for Synthetic Aperture Radar (SAR) and Multiple Input Multiple Output (MIMO) applications.

Dr. Fathy specializes in time and frequency domains UWB and antenna measurements. His expertise extends to reconfigurable RF frontends, power combiners, and vital sign detection systems. He is globally recognized for his work in 5G technology, GPS, millimeter waves, and UWB radars. He is also a pioneer in reconfigurable antennas and has developed numerous microwave application technologies.

Dr. Fathy holds 12 patents and has authored over 250 publications He has received multiple awards for his groundbreaking work in microwave engineering and communications. His research in SAR radars, 3D imaging, multi-band reconfigurable antenna structures, and UWB technologies is internationally acclaimed.

Dr. Fathy is building state-of-the-art augmented reality (AR) and virtual reality (VR) lab facilities at UTK. He has collaborated with AT&T to establish an indoor 5G millimeter wave lab facility at UTK, advancing research and development in next-generation communication technologies. Dr. Fathy's extensive experience and innovative research have solidified his position as a leading expert in microwave engineering and wireless communications, driving advancements in UWB, 5G, and reconfigurable technologies.