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Wearable Antenna for Diagnosis of Parkinson’s Disease Using a Deep Learning Pipeline on Accelerated Hardware

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Abstract : Background: The development of compact, low-power antenna sensors has resulted in hardware restructuring, allowing for wireless ubiquitous sensing. The antenna sensors can create wireless body-area networks (WBAN) by linking various wireless nodes across the human body. WBAN and IoT applications, such as remote health and fitness monitoring and rehabilitation, are becoming increasingly important. In particular, Parkinson’s disease (PD), a common neurodegenerative disorder, presents clinical features that can be easily misdiagnosed. As a mobility disease, it may greatly benefit from the antenna’s nearfield approach with a variety of activities that can use WBAN and IoT technologies to increase diagnosis accuracy and patient monitoring. Methodology: This study investigates the feasibility of leveraging a single patch antenna mounted (using cloth) on the wrist dorsal to differentiate actual Parkinson's disease (PD) from false PD using a small hardware platform. The semi-flexible antenna operates at the 2.4 GHz ISM band and collects reflection coefficient (Γ) data from patients performing five exercises designed for the classification of PD and other disorders such as essential tremor (ET) or those physiological disorders caused by anxiety or stress. The obtained data is normalized and converted into 2-D representations using the Gabor wavelet transform (GWT). Data augmentation is then used to expand the dataset size. A lightweight deep-learning (DL) model is developed to run on the GPU-enabled NVIDIA Jetson Nano platform. The DL model processes the 2-D images for feature extraction and classification. Findings: The DL model was trained and tested on both the original and augmented datasets, thus doubling the dataset size. To ensure robustness, a 5-fold stratified cross-validation (5-FSCV) method was used. The proposed framework, utilizing a DL model with 1.356 million parameters on the NVIDIA Jetson Nano, achieved optimal performance in terms of accuracy of 88.64%, F1-score of 88.54, and recall of 90.46%, with a latency of 33 seconds per epoch.

Keywords : antenna, deep-learning, GPU-hardware, Parkinson’s disease
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