NeuroSyncNN: A Novel Multimodal Neurodegenerative Disease Diagnostics Framework Leveraging Computer Vision, Image Processing and IoMT Targeting Efficient, Real-Time Automated Brain Mapping and Neural-Signal Decoding

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Neurodegenerative diseases (NDDs), conditions characterized by damaged cell networks in the neurological system, are becoming increasingly prevalent as the global life-expectancy continually increases. Current technological solutions for neurodegenerative disease prognostics such as digital molecular biomarkers and computational pathology are insufficient due to a lack of spatiotemporal-information usage and multimodal data-source integration. The research aims to mitigate the rapid progression of cognitive diseases through early detection and iterative parameter monitoring. Excessive amounts of medical data were captured from varying data streams through reputable, publicly-accessible datasets. To diminish the current issues regarding structural imaging limitations and signal-quality for feature extraction, comprehensive signal processing and detection frameworks were developed which leverage bi-directional long-short-term memory networks (BiLSTMs) and Support-Vector Machines (SVMs) for enhanced anatomical source localization and biomedical signal interpretation. To augment the computational framework, a cost-effective engineered IoMT-sensor network using electronics and 3D-printed parts was developed to optimize model-extracted patient physiological parameters. The efficacy of the comprehensive deep learning-based system [NeuroSyncNN] was validated through a common set of industrially-viable statistical metrics to comparatively analyze performance against current market techniques. The signal-decoding model (Acc: 95%, Precision: 94%) and the detection model (Acc: 97%, MAE: <1%) integrated through ensemble model stacking indicates the framework’s potential in becoming clinically feasible, posing significant implications in neurodegenerative disease diagnostics.

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