Paper 4: Early Detection of Parkinson’s Disease usingContrast Enhancement Techniques and CNN

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Summary:

Parkinson's Disease is one of the most common CNS diseases in the world. The estimated population of people above the age of 50 suffering from Parkinson’s Disease in

India by 2030 will be 0.69 million . Parkinson’s disease affects human motor movement. It is a progressive nervous system disorder. Dopamine levels in the body drop due to nerve cell damage in the brain which lead to the symptoms of Parkinson's Disease. At the onset, a slight tremor is noticed in one hand. Tremors are a common symptom however as the disorder progresses, it causes stiffness or slowing of movement(bradykinesia) and loss of postural reflexes.The Hoehn and Yahr rating scale is widely used by doctors to classify the severity of symptoms of Parkinson’s Disease.The five stages of the Hoehn and Yahr scale help doctors evaluate how far the disease has advanced. Stage 0 indicates no signs of disease. Symptoms like tremors and difficulty in movement, generally exclusive to one side of the body(unilateral) are observed at stage 1. At stage 1.5 the patient experiences unilateral symptoms plus axial involvement (neck and spine). Stage 2 is considered to be a moderate form of Parkinson’s, and the symptoms are much more noticeable than those experienced in stage 1. Patients experience symptoms on both sides of the body without impairment of balance. At stage 2.5, patients experience mild symptoms on both sides of the body, with recovery when the doctor stands behind the person and asks them to maintain their balance when pulled backwards (pull test). At stage 3, patient needs assistance to prevent falling on pull test, but are physically independent. It can be regarded as a mild to moderate bilateral disease. Stage 4 patients experience severe disability, but are still able to walk or stand unassisted. Stage 5 patients find it impossible to stand or walk due to advanced stiffness in the legs which causes freezing upon standing, they may need a wheelchair or are bedridden unless assisted. Clinical methods like Magnetic Resonance Imaging (MRI), transcranial Doppler ultrasonography, positron emission tomography (PET), single-photon emission computed tomography (SPECT), morphometric MRI studies, tractography, functional MRI and perfusion imaging are used for detecting and identifying type of parkinsonism . These methods usually have to be performed by doctors and are painstaking for the patients. Identifying accurate biomarkers is an important research goal for neurodegenerative diseases. Many works have used speech processing, handwriting recognition and gait analysis for detection of Parkinson'sDisease . Parkinson's prediction based on speech uses sustained vowels and natural speech and requires high level of signal processing. By performing gait analysis, motor symptoms can be detected . In comparison to these methods, handwriting analysis proves to be a simple, quick and efficient way to diagnose Parkinson's Disease. Patient’s symptoms and quality of life can be significantly improved with early diagnosis and proper medication as there is no cure for Parkinson’s Disease. An analysis of handwriting and sketching abilities of patients and micrographia is used for early-stage diagnosis of Parkinson’s disease. Handwriting analysis is also an effective indicator for detection of Parkinson's disease. Handwriting of a person can be influenced by a number of factors such as education and language proficiency however sketching of a shape such as the spiral has been found to be a non-invasive and an independent parameter for measurement of onset of symptoms . Hence it may be considered as an objective, easy to administer non- invasive test to measure motor dysfunction in Parkinson disease (PD).

Conclusion

Many researchers have done different studies on Parkinson detection using CNN on Images. A custom Neural Network trained using Dynamic and Static spiral images to detect

Parkinson obtained an overall accuracy of 87% . Fine- tuned VGG-19 model used on the Parkinson's Drawing dataset obtained an accuracy of 88.5% on the dataset . AlexNet obtained an accuracy of 92.14% on the spiral images and 90% on the wave images . Multistage Classifier model used for detection of Parkinson's Disease obtained an overall accuracy of 93.33%.

In this work, the developed methodology and dataset,showed an overall accuracy of 96.67%. It has been observed that the results are in good agreement with the previously reported works. The significant improvement in the accuracy can be attributed to the optimal contrast enhancement technique used and that two different CNN models were used for predicting the spiral and wave patterns respectively. The condition that it should not classify Parkinson patients as healthy is satisfied.

The machine learning architectures using non-invasive biomarkers found to be an effective method for early detection of Parkinson’s disease. The developed models for spiral and wave sketches perform satisfactorily in classifying the sketches of healthy and Parkinson patients. The models obtained an overall accuracy of 96.67%, precision of 93.33% and a recall of 100%. The model does not misclassify any Parkinson patient in the data used in this study as healthy. The developed model can be employed in real life scenarios and stable production environments.