

Classification of handwritten drawings of people with Parkinson's disease by using histograms of oriented gradients and the random forest classifier

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INTRODUCTION

Parkinson's disease (PD) is a neurological disorder that is progressive and causes losses of dopaminergic neurons from the substantia nigra, a region in the human brain. The decrease of dopamine in this area implies the worsening of motor symptoms such as tremors, bradykinesia, rigidity, gait impairment, and non-motor symptoms such as depression, loss of cognitive functions, sleep problems and nerve pain [1].

PD affects 1% of the world's population aged 60 years and over, and despite scientific advancement, the disease remains incurable. The diagnosis of PD is complex, with a seasoned specialist being necessary to make it [1, 2].

Tremors are a common symptom in PD and it can be classified into many types: resting tremor, postural tremor, kinetic, essential, cerebellar, and others. Each type manifests in different situations and frequency ranges [3].

This work proposes to classify images of handwritten drawings collected from healthy individuals and people with PD. The identification and discrimination of motor symptoms in PD is a fundamental step in the diagnosis and follow-up of the disorder.

MATERIALS AND METHODS

The Federal University of Uberlândia's Research Ethics Committee approved the research under the number 07075413.6.0000.515.

In the study, 51 images were collected from each group, i.e., healthy individuals and people with PD. A total of 102 images were available.

Table 1. Characterization of the studied groups.

Group	Total	Sex (F/M)	Age (years)
Health	12	8/4	60.08 ± 6.13
PD	15	7/8	65.33 ± 9.17

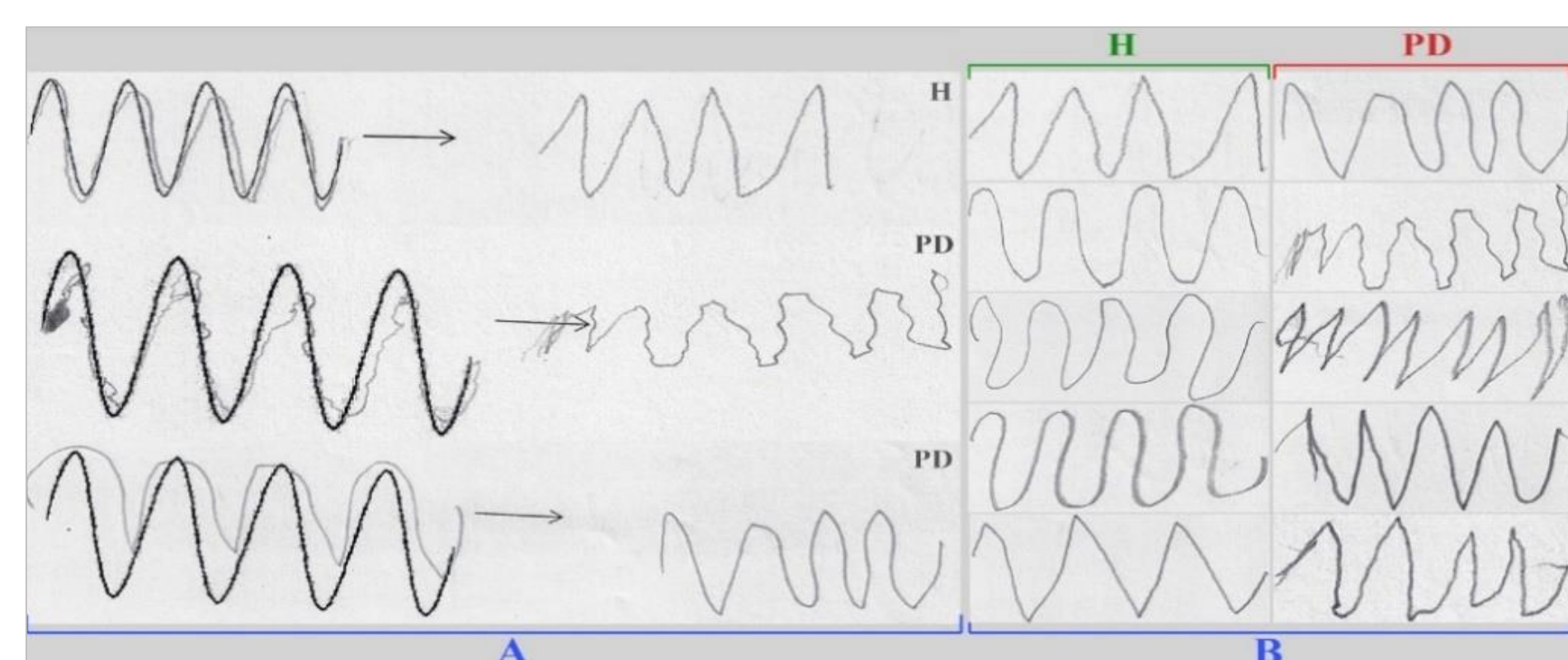


Fig. 1. (A) Samples of handwritten drawings collected from people with Parkinson's disease (PD) and healthy individuals (H); (B) Pre-processed images for each group (H and PD).

The histograms of oriented gradients (HOG) is extracted from the images, and the data is ready to be classified by a Random Forest Classifier (RFC).

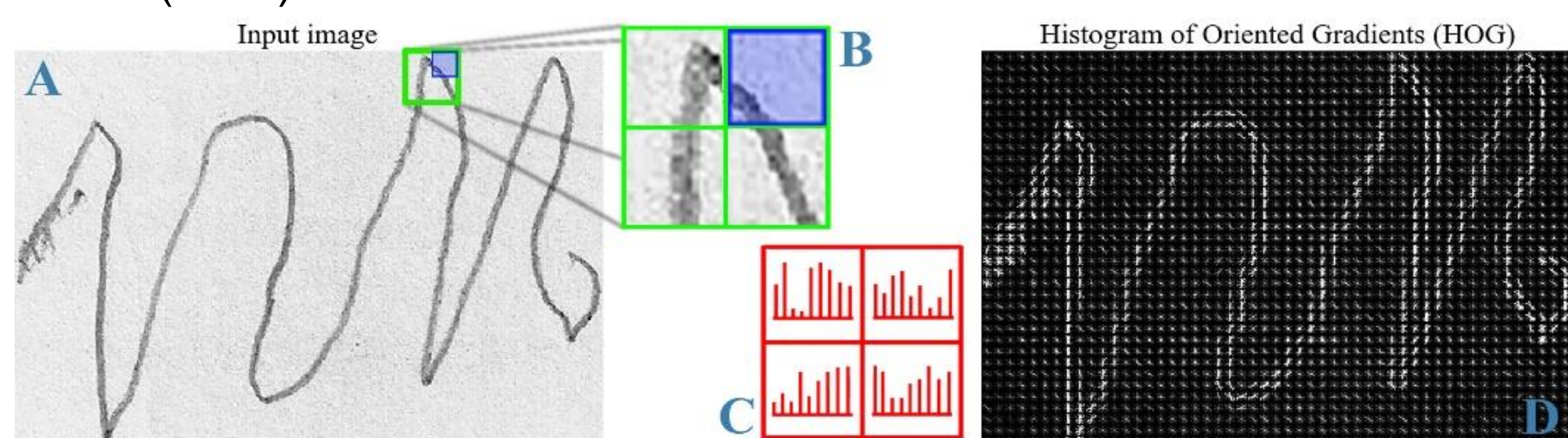


Fig. 2. Raw input image (A), the block of 2x2 cells (B), gradient histogram of each cell (C), and HOG feature extracted from the image input (D).

RESULTS

Table 2. Classification results for distinct configurations of the Random Forest Classifier.

Set of trees	Total of runs	Accuracy			Sensitivity			Specificity		
		Min	Max	Average	Min	Max	Average	Min	Max	Average
100	10	0.63	0.76	0.70	0.64	0.83	0.71	0.61	0.79	0.70
	50	0.60	0.80	0.69	0.60	0.83	0.69	0.59	0.82	0.70
	100	0.57	0.83	0.70	0.57	0.82	0.69	0.56	0.85	0.70
200	10	0.67	0.77	0.72	0.67	0.75	0.70	0.67	0.79	0.74
	50	0.60	0.80	0.70	0.59	0.80	0.70	0.61	0.80	0.71
	100	0.60	0.80	0.70	0.61	0.80	0.70	0.58	0.80	0.72

The result in CM shows that the diagonal cells correspond to observations that are correctly classified, and the off-diagonal cells correspond to incorrectly classified observations. At the bottom right of the CM is the cell with the overall accuracy.



Fig. 3. Confusion matrix test average. A1, A2, and A3 are from the RFC tests with 100 trees with 10, 50, and 100 runs, respectively. In the same way, RFC tests with 200 trees are represented by B1, B2, and B3, respectively in 10, 50, and 100 runs.

DISCUSSION AND CONCLUSION

In this work, the drawings collected from healthy individuals and people with PD were classified by RFC. The proposed method employed pencil drawings digitized from ordinary sheet of paper, making it very simple to be applied in the context of scarce financial resources.

Despite the small number of images in the available data set (51 per class), the obtained results were satisfactory and accurate by discriminating drawings of healthy people from those with PD.

HOG parameters were tested in default values (10x10 pixels per cell, 2x2 cells per block and 9 bins in the histogram with 0-180° orientation) focus on good performance showed by Dalal and Triggs [4] and the HOG result was passed to the classifier.

This is the first reported study considering the application of HOG estimates in combination with the RFC applied to the automatic classification of data obtained from people with PD.

In the future, it will be necessary to obtain more image drawings and different shapes to increase the database and test more parameters.

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