Parkinson's Disease Diagnosis using Deep learning

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Introduction

This project aims to automate the Parkinson's Disease (PD) diagnosis process using deep learning, recursive neural networks (RNN) and convolutional neural networks (CNN), to differentiate between healthy and PD patients. The project's objectives are:

1. Develop predictive models to differentiate between healthy people and people with PD.
2. Examine which imaging datasets (each one related to a different PD drawing test) are more useful for training predictive models.
3. Investigate which time series datasets are more useful for training predictive models.
4. Explore whether imaging datasets or time series datasets are more effective as a basis for discrimination.
5. Study and analyse different deep learning models, including CNNs and RNNs.

Implementation Workflow

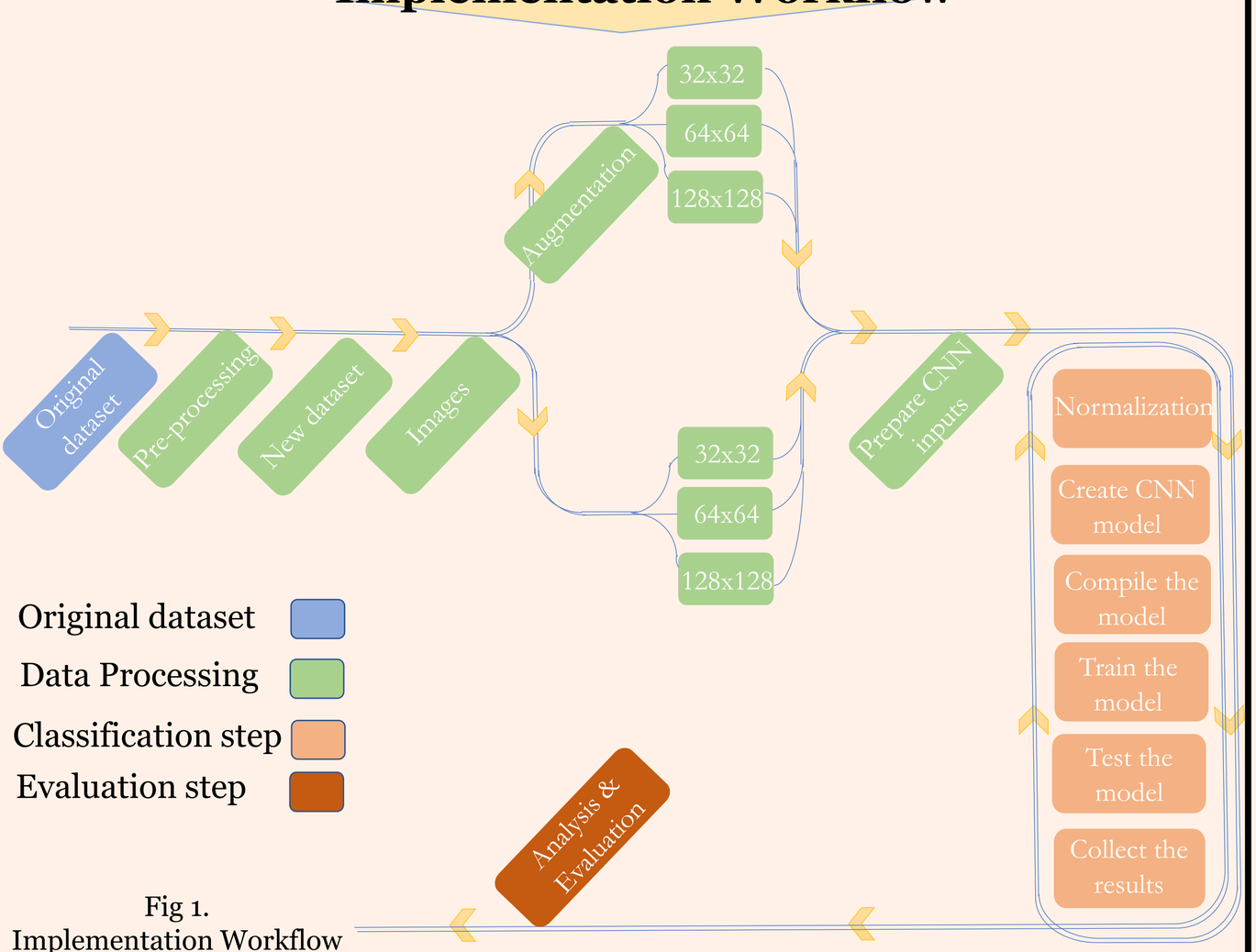


Fig 1. Implementation Workflow

Experiments

▪ RNN Experiments

These experiments are grouped as follows:

- Experiments without zero-pressure consideration.
- Experiments with zero-pressure consideration.

timestamp	x coordinate	y coordinate	pen angle in x plane	pen angle in y plane	pressure
0	0.60061515525	0.5797397931	0.675101995	-0.495138138	0.052785925
8	0.6006889060	0.5797397931	0.675101995	-0.495138138	0.075268819
9	0.6007874100	0.5797397931	0.669257223	-0.505829691	0.092864125

Fig 2. Some rows from a timeseries dataset

▪ CNN Experiments

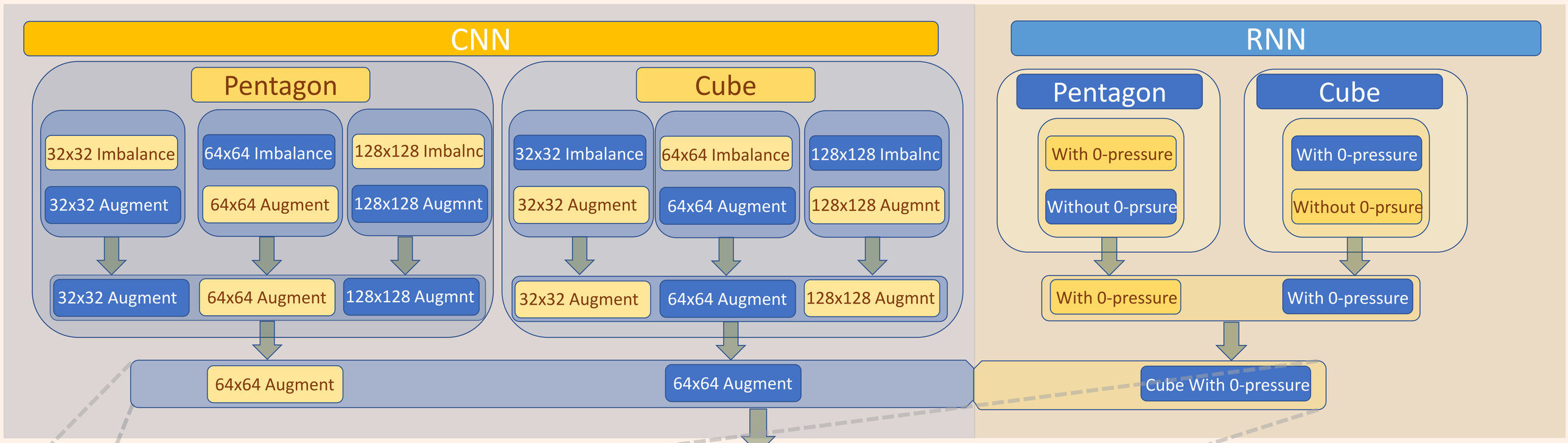
These experiments are grouped as follows:

- Experiments with imbalanced datasets.
- Experiments with balanced datasets (i.e. with augmentation).

Fig 3. Pentagon and Cube Drawings from imaging dataset

Evaluation

Fig 4. Experiments & Comparisons



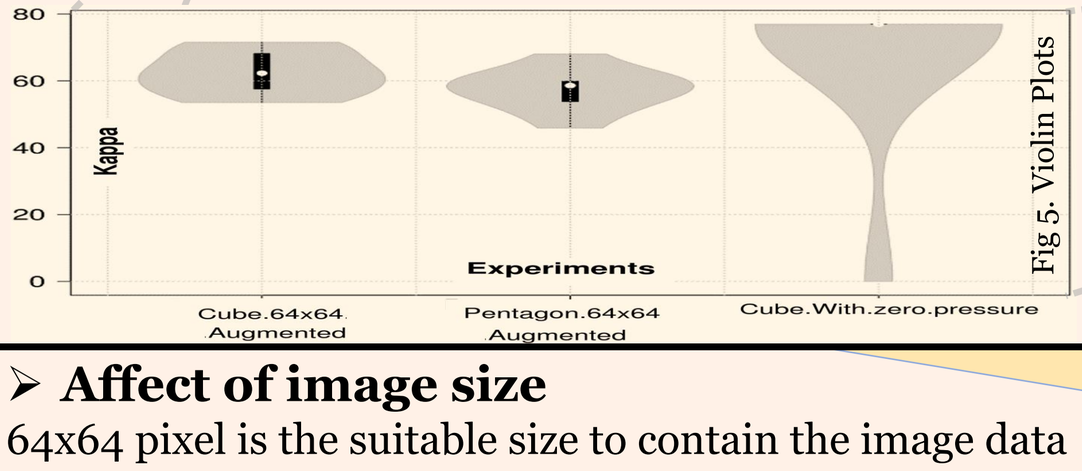


Fig 5. Violin Plots

Cube With 0-pressure

	precision	recall	f1-score	support
0 (Control)	0.75	1.00	0.86	3
1(Patient)	1.00	0.83	0.91	6
avg / total	0.92	0.89	0.89	9

Kappa: 76.92%
Accuracy: 88.89%
Specificity: 100%
Avg-Precision:98%
2.34 Hr

Fig 6. Best model's confusion matrix and results

Results

➢ Affect of image size

64x64 pixel is the suitable size to contain the image data under our CNN configurations.

➢ Affect of deep learning technique and dataset type

The harder disease exam is more discriminative and effective to distinguish healthy subjects from individuals with PD.

➢ Affect of augmentation

Datasets with augmentation (i.e. balanced datasets) in all cases lead to better results than the imbalanced datasets.

➢ Affect of removing zero pressure

Keeping the zero pressure information is meaningful in terms of the differentiation between patients and healthy subjects.

Limitations

- Using patients' repeated drawings as separate samples.
- Not using early stopping.
- Disconnecting and resources exhaustion.

Future work

- Using the metadata.
- Using the Truncated Backpropagation Through Time.
- Investigate classifying disease stages.
- Extract knowledge from the trained models.