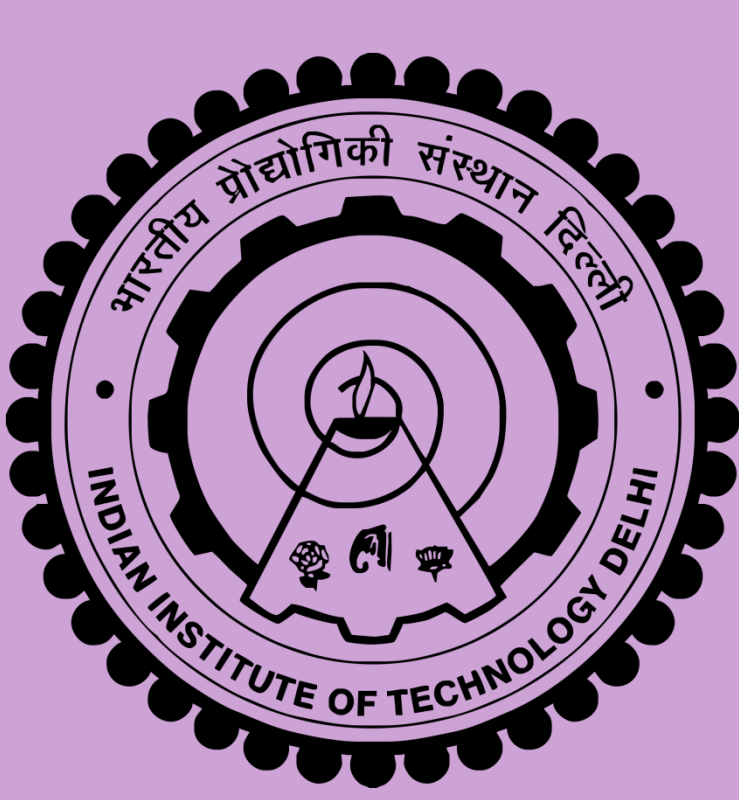


EARLY DETECTION OF PARKINSON'S DISEASE THROUGH SHAPE BASED FEATURES FROM 123I-IOFLUPANE SPECT IMAGING



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Introduction

➤ Non-availability of any definitive tests make **clinical criteria** the **sole basis** for diagnosing PD.

➤ The clinical diagnosis often happens with onset of motor, non-motor symptoms in the advanced stages correlated with **decline in 60-80% dopamine (DA) concentrations**.

➤ **Rapid deterioration** during the **early stages** of PD, make early detection important.

➤ **[123I]FP-CIT SPECT** has shown to be **sensitive** in **differentiating PD from healthy normal subjects**, even in the subclinical stages of PD.

➤ In this paper, image processing is carried out to compute **shape-based features which are radial and gradient features from SPECT scans from PPMI database, along with the striatal binding ratio (SBR) values, also provided by the PPMI as features** to classify between the healthy and early PD subjects using **Discriminant Analysis and Support Vector Machine (SVM)**.

Materials and methods

➤ For the presented work, **SPECT images of 163 early-stage PD (Hoehn and Yahr stage I or II) and 187 healthy normal subjects** from the **PPMI database** have been used.

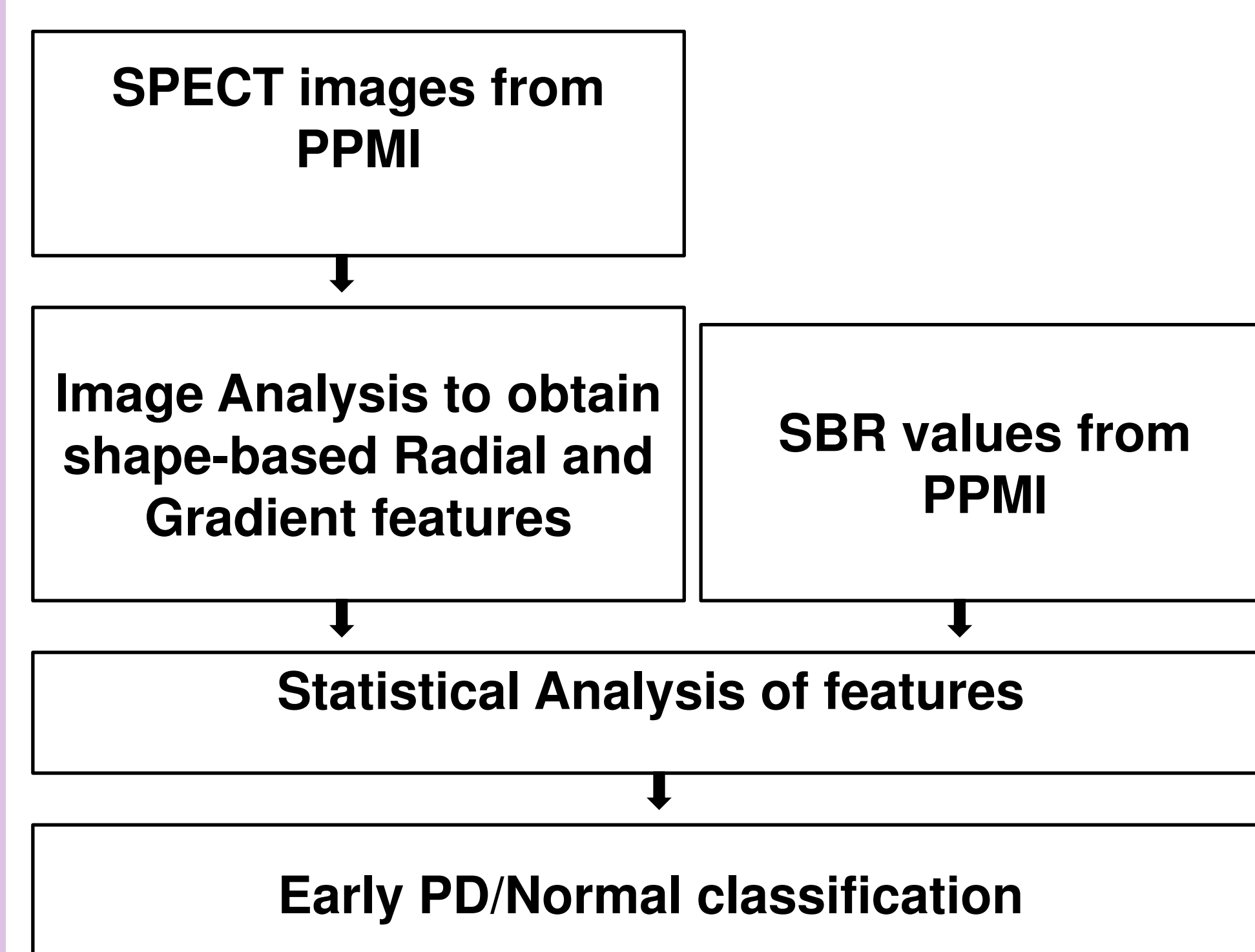


Fig. 1. Flowchart of the analysis carried out.

Image analysis and feature extraction

➤ **Off the 91 axial slices** for each scan, **42nd slice is selected** to be intensity normalized and segmented, followed by boundary extraction.

➤ The **boundaries** of the striatum were **visually assessed by experts**.

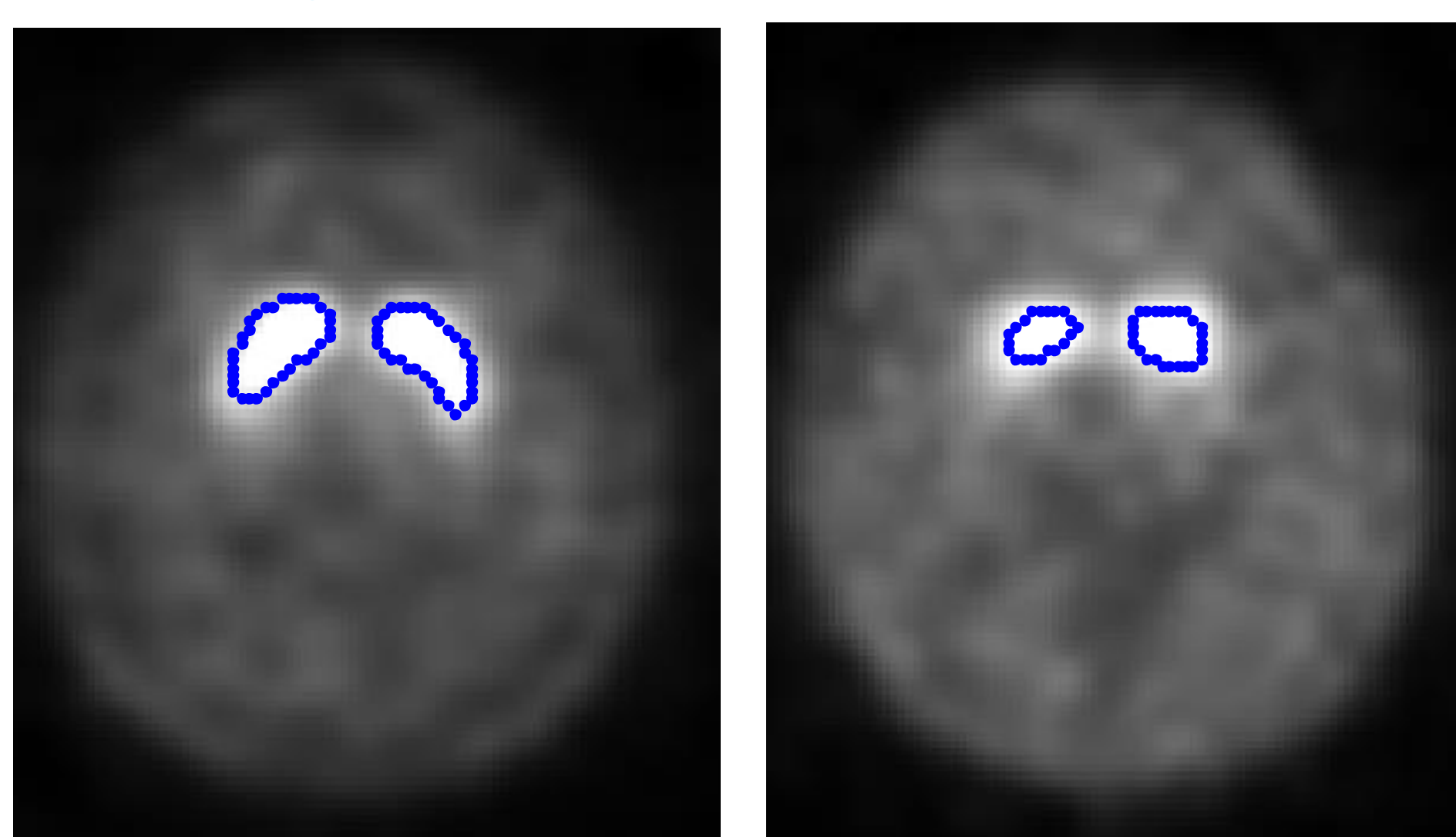


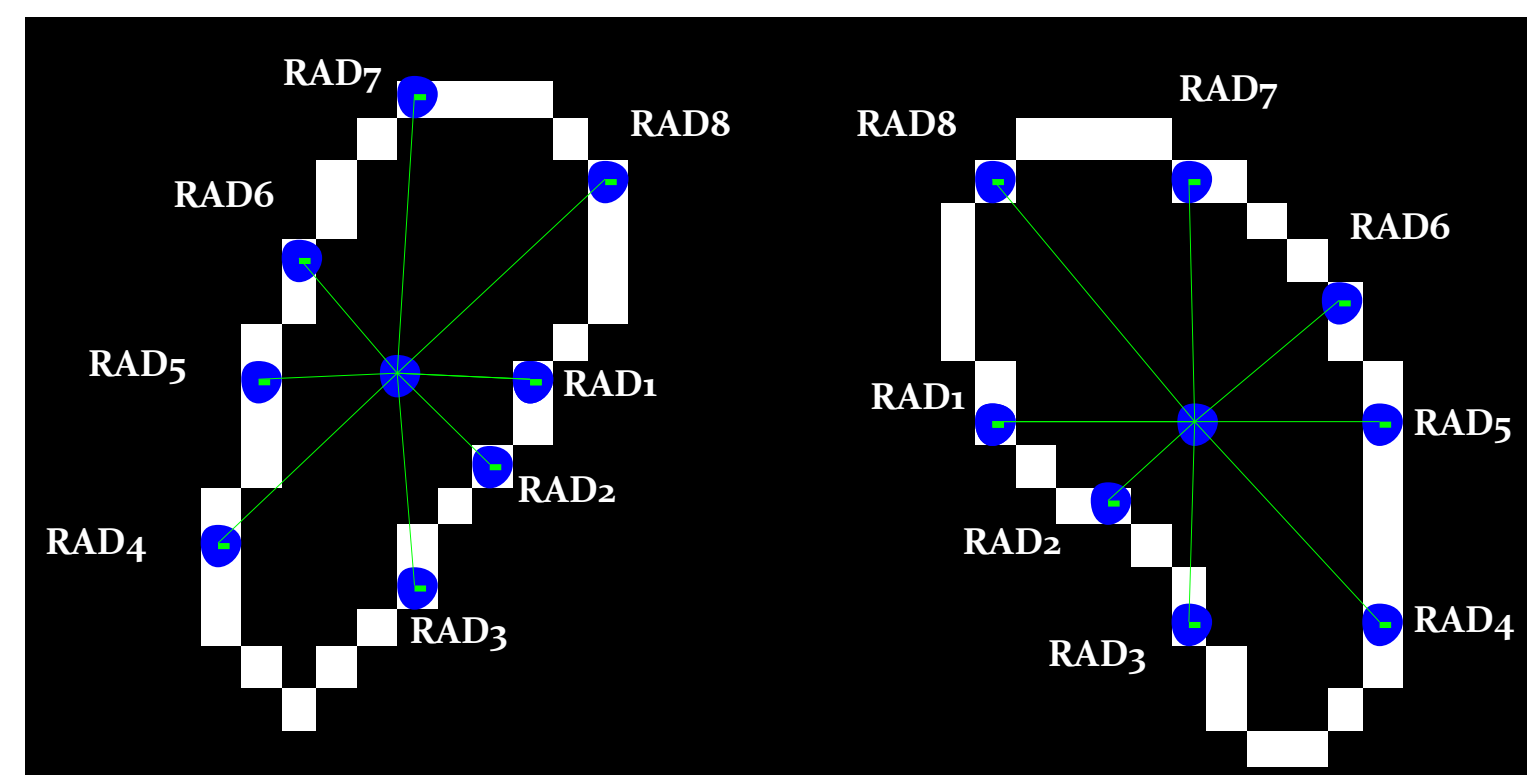
Fig. 2. (a) Control SPECT slice and (b) Early PD SPECT slice with blue boundary of the segmented regions.

Features and their statistical testing

Striatal Binding Ratios:

$$SBR = (\text{striatal region}) / (\text{occipital}) - 1$$

Radial features:



Gradient features:

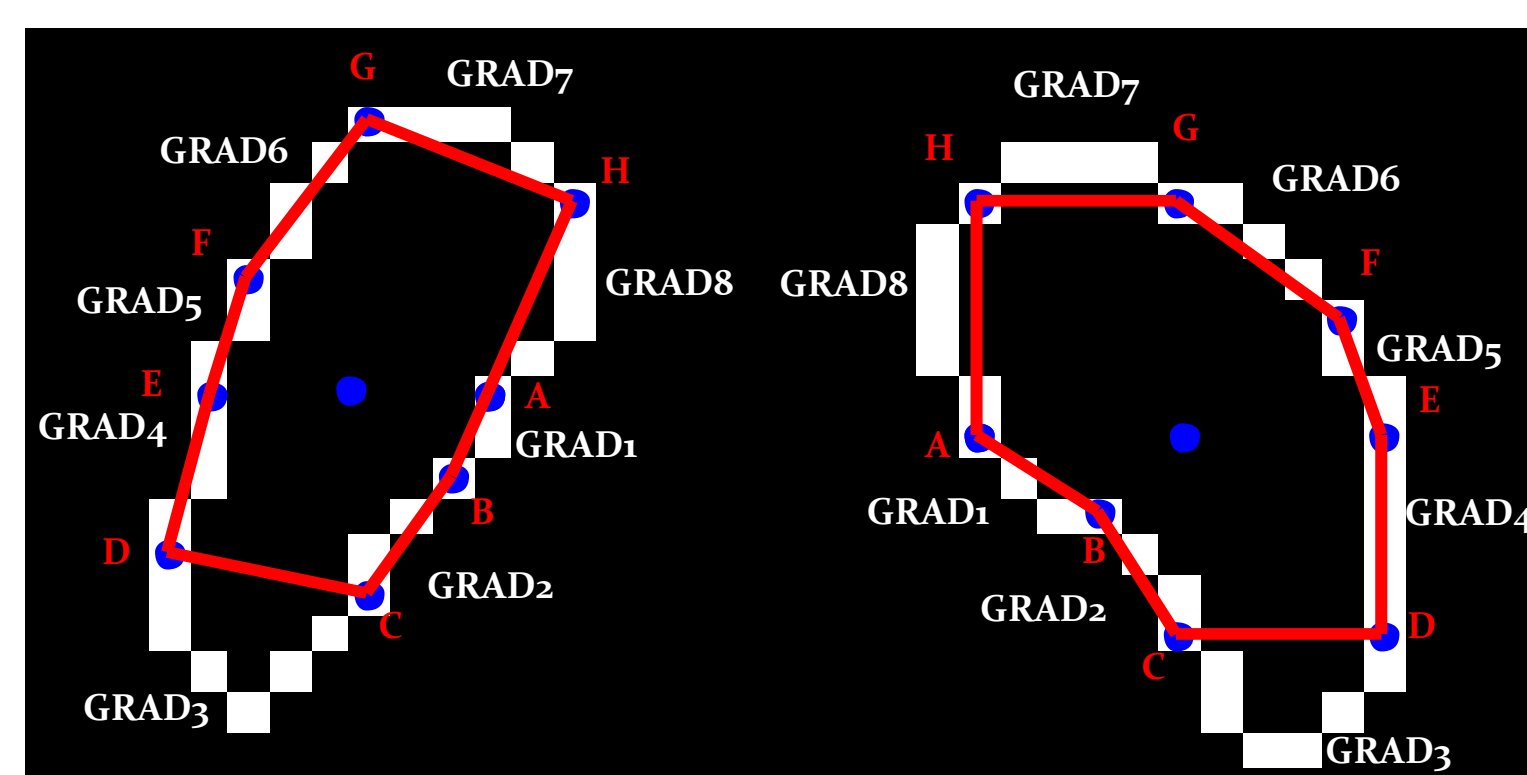


Fig. 3. (a) Rad1 to Rad8 are the radii of 8 sampled points with respect to the centroid. (b) Grad1 to Grad8 are gradients of the segments joining sampled points.

Table 1. Result of statistical testing of each feature.

Features	p value	z score	Features	p value	z score
SBRcaud	.000	-14.508	Rad8	.000	-16.103
SBRputa	.000	-15.980	Grad1	.000	-7.361
Rad1	.000	-8.733	Grad2	.000	15.271
Rad2	0.398	-0.846	Grad3	.000	4.073
Rad3	.000	-15.489	Grad4	.000	-15.541
Rad4	.000	-15.992	Grad5	0.434	0.782
Rad5	.000	-13.359	Grad6	0.159	1.407
Rad6	.000	-14.859	Grad7	0.002	3.148
Rad7	.000	-16.069	Grad8	.000	-15.08

Results

➤ **Radial feature perform better** compared to SBR and gradient feature.

➤ The **combination** of features has **improved** the **reliability** and **performance** of classification giving **accuracy** of around **99%**.

➤ **Higher accuracies** for **SVM RBF** kernel due to non linear mappings into **high dimensional space**.

Table 2. Classification accuracies with different classifiers.

Classifiers	LDA	SVM _{Linear}	SVM _{RBF}
Combined features	99.36%	99.42%	99.42%
SBR feature	96.72%	98.29%	98.85%
Radial feature (Rad)	99.41%	99.43%	99.43%
Gradient feature (Grad)	95.86%	97.29%	98.14%

Discussion

➤ **Changes** in **Grad5 and Grad6** are consistently **smaller** suggesting **degeneration** in **putamen** is **more** and **precede** changes in caudate substantially in early stages of PD.

➤ **degradation** of **posterior putamen** and **caudate head** does not shift the **centroid** of the striatum much making **no** considerable **changes** in **Rad2**. However they **reduce other radial distances** significantly **making radial feature** perform **better** compared to SBR and gradient feature.

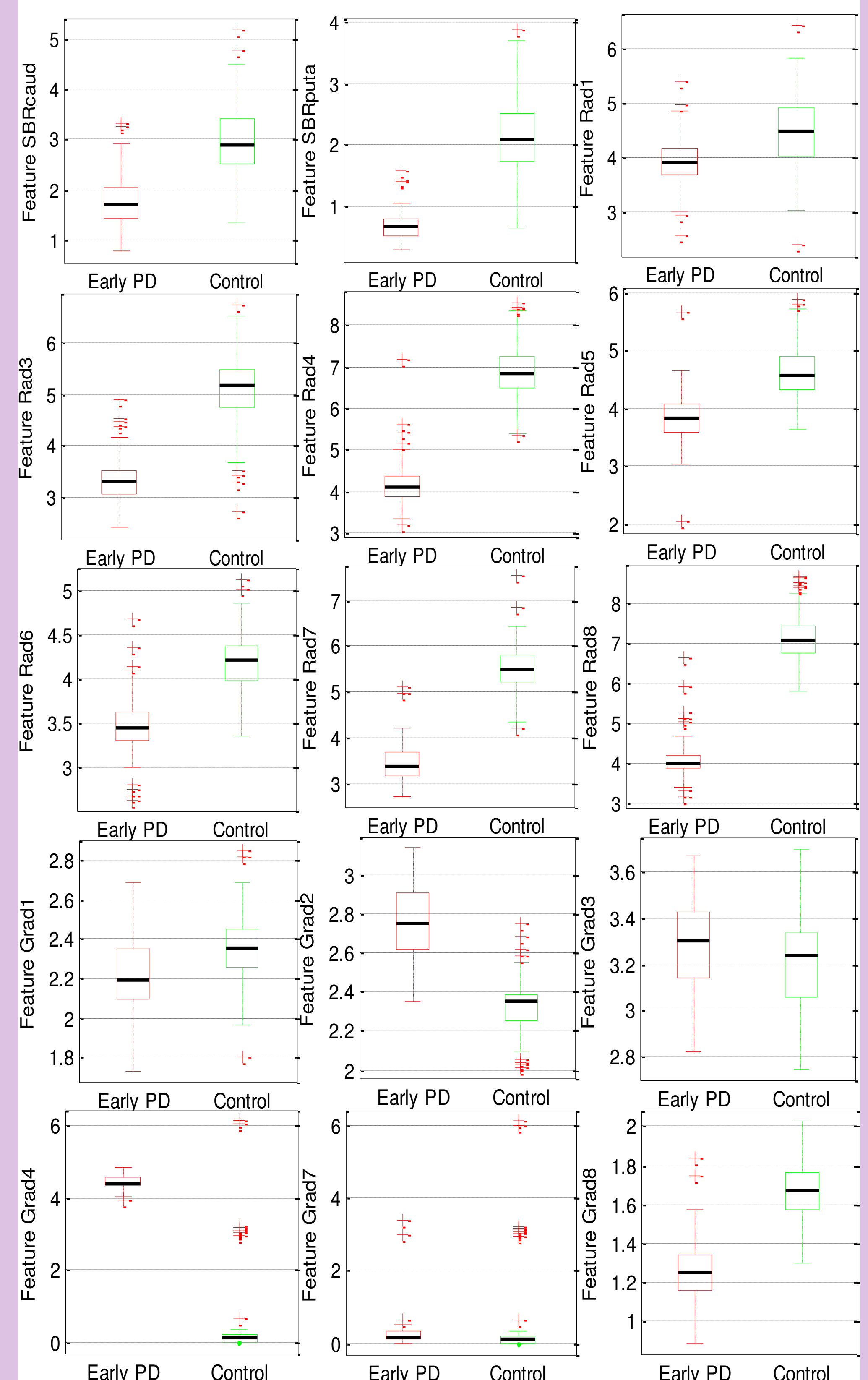


Fig. 4. Box plots of the 15 significant feature vectors for Normal and Early PD.

Conclusions

➤ The **biomarkers** presented prove **helpful** in **detection** of the disease in early stages.

➤ The **striatal binding ratios, radial distribution features along with gradient features** give **99% accuracy** and thus can aid the medical community.

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