Artificial Intelligence Detects Parkinson's Disease and Its Severity from Nocturnal Breathing

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Problem and Motivation

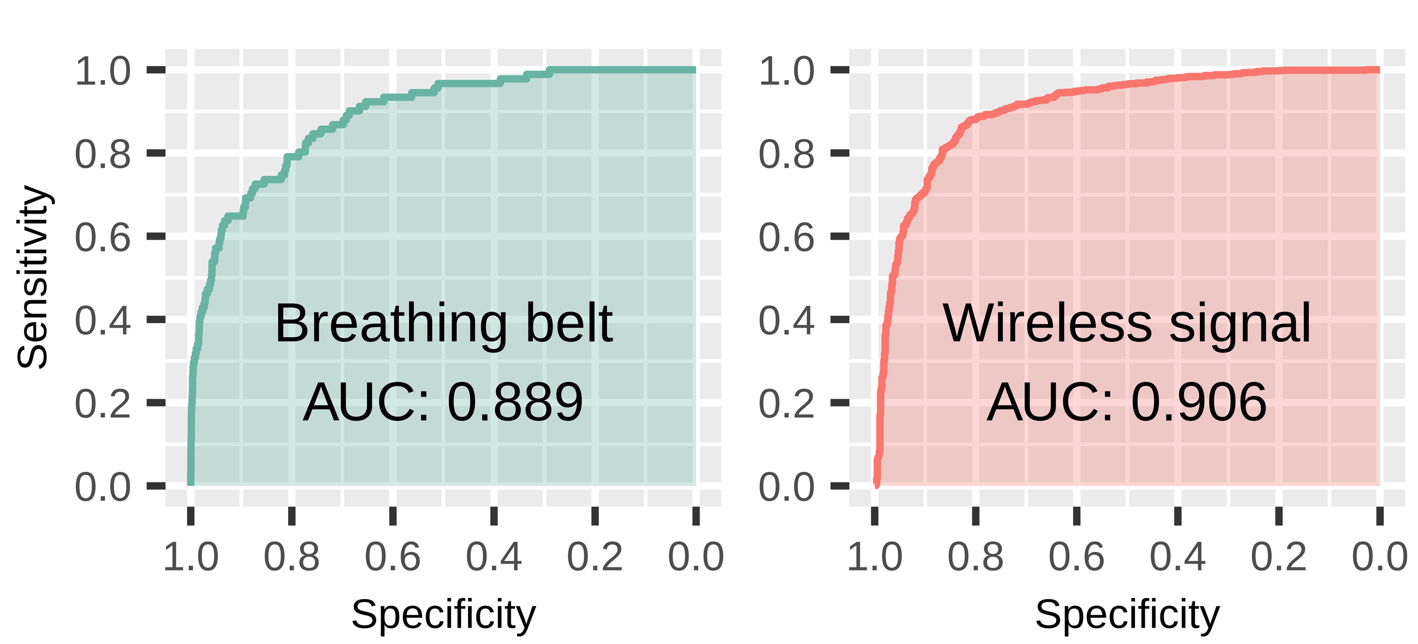
Parkinson's disease (PD) is the fastest-growing neurological disease in the world. Diagnosis is typically relies on motor symptoms such as tremor and rigidity, which tend to appear years after the onset of the disease, leading to late diagnosis. It is also difficult to track disease progression over time. Thus, there is a need for diagnosis and progression biomarkers.

Our Solution

We present the first AI-based solution that uses a person's nocturnal breathing signals to detect Parkinson's disease, estimate disease severity, and track disease progression. This is done using a device that looks like a home Wi-Fi router, which analyzes the radio signals in the environment and extract the subject's breathing without any body contact. The breathing signal is then fed to our AI solution to assess Parkinson's in a passive manner with zero overhead to patient and caregiver.

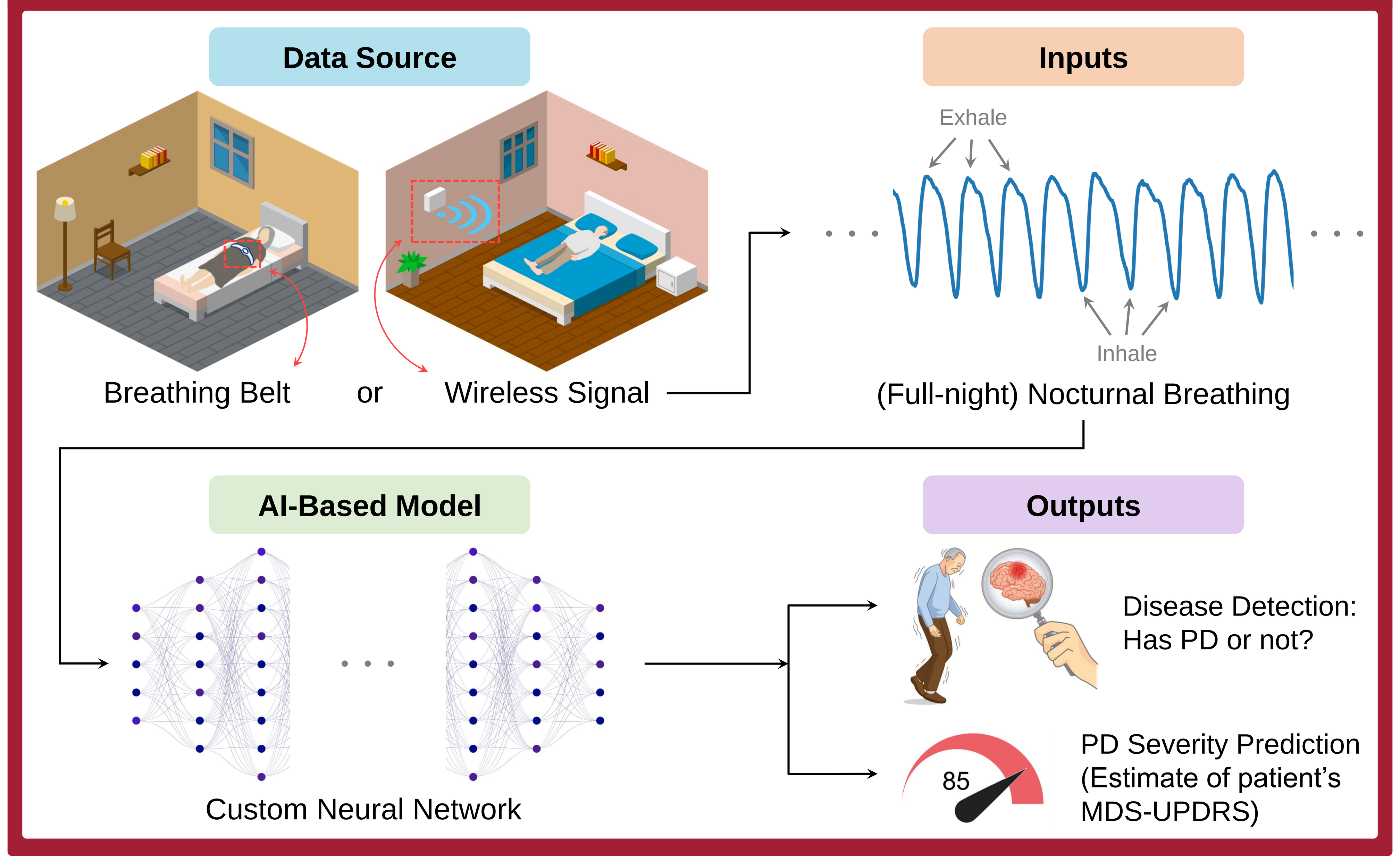
Result I: Diagnosis Accuracy

Evaluation using 6,660 nights of breathing data from 88 individuals with PD and 5,574 control individuals show that the AI-based solution can detect whether a person has PD with high accuracy (AUC = 0.89). The accuracy is equally high for breathing data collected passively using the radio signals that bounce off a subject body (AUC = 0.91, for 2,601 nights from 25 individuals with PD and 28 controls).



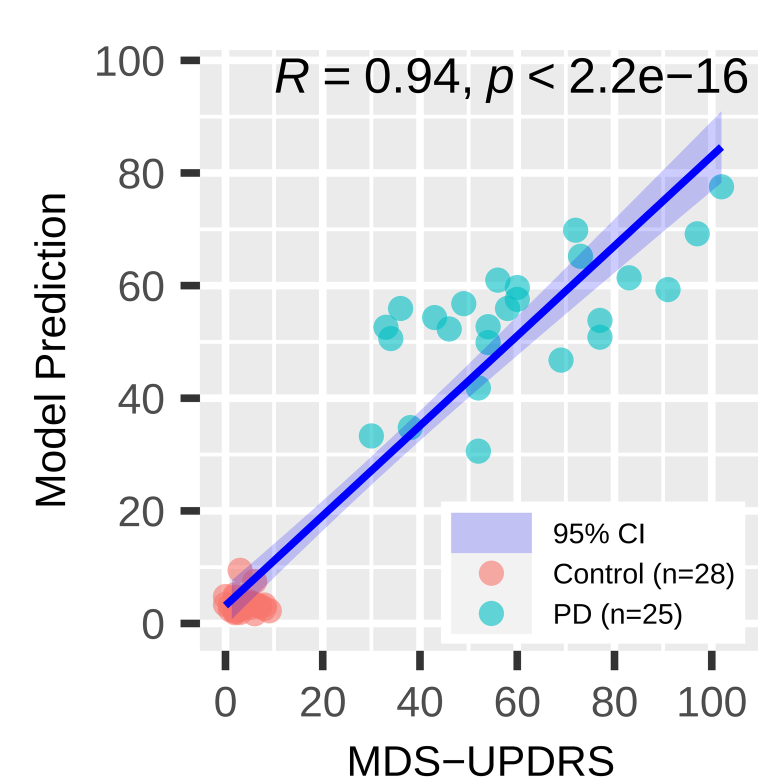
System Overview:

Our AI-based model takes nocturnal breathing as input, infers whether the patient has PD or not, and assesses PD severity



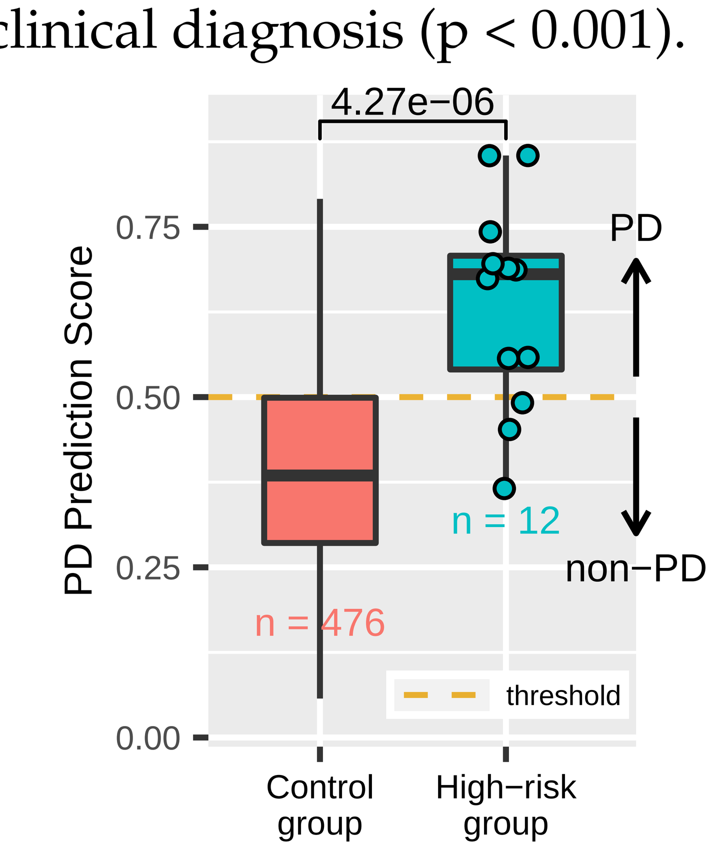
Result II: Severity Prediction

The AI-based solution estimates PD severity as assessed by the MDS-UPDRS (R = 0.94, p < 2.2e-16), which is a multi-section questionnaire that serves as the current gold standard for evaluating PD severity.



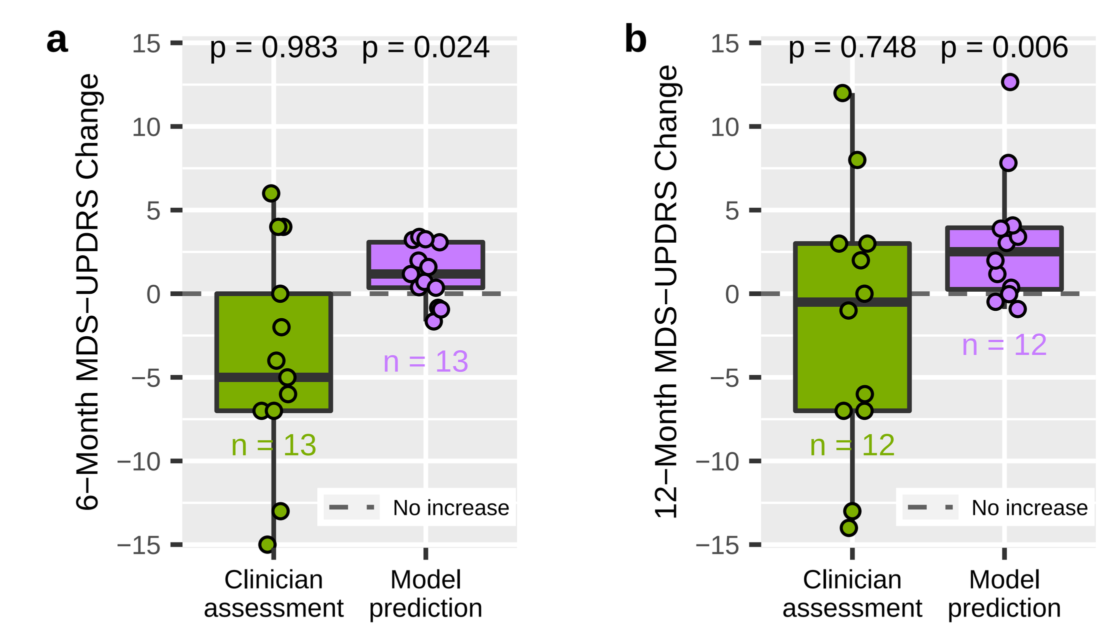
Result III: Pre-Diagnosis Risk Assessment

In a population of 12 PD patients and 476 age and gender matched control subjects, the AI-model accurately predicts the risk of PD up to 5 years prior to clinical diagnosis (p < 0.001).



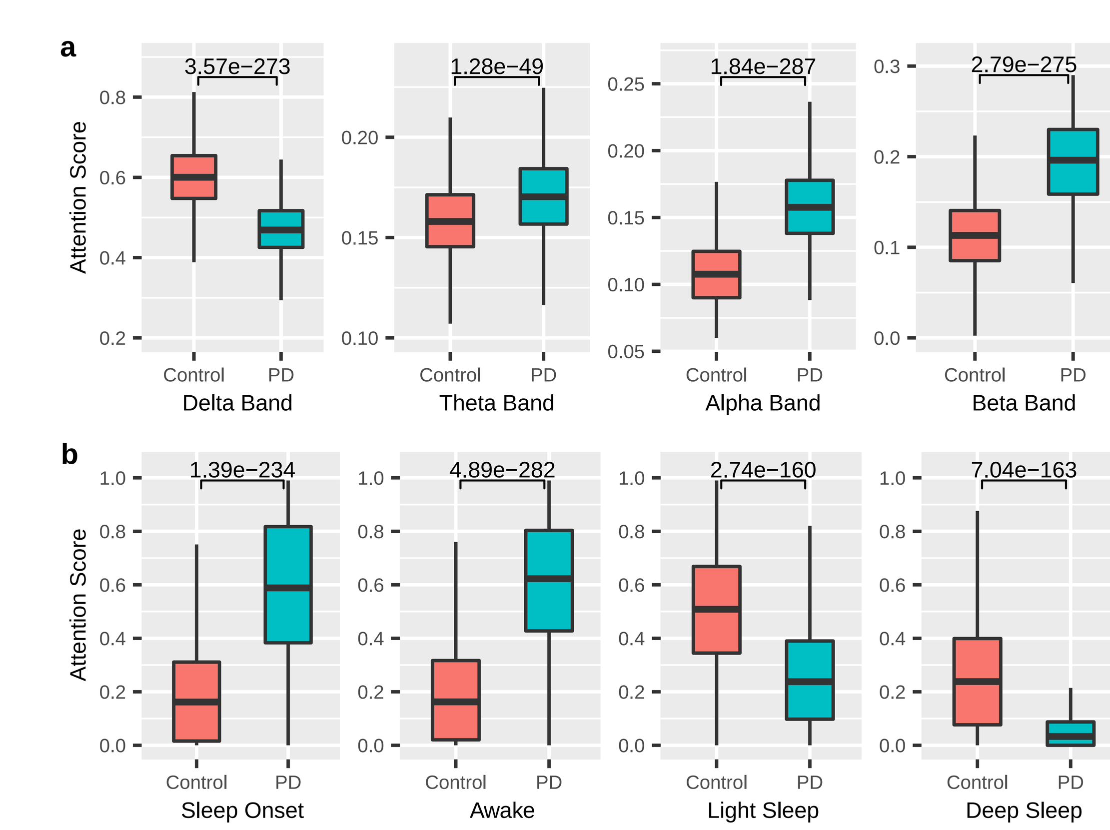
Result IV: Progression Tracking

Our model can detect statistically significant changes in PD severity in less than 6 months (p = 0.02). So far, no other measure has shown statistical significance in tracking changes in PD over such a short interval, even the MDS-UPDRS.



Result V: Model Interpretability

The AI model is consistent with the medical literature in that it recognizes controls by focusing on their light/deep sleep periods, while attending more to sleep onset and awakenings in PD patients. Also, it focuses on periods with high qEEG Delta activities for controls, while focusing on high Beta activities in PD patients.



Implications

The research can help in early diagnosis of PD. It can also help drug development by providing a sensitive digital biomarker of disease severity and progression.