The complex and unpredictable nature of movement disorders in patients with Parkinson's disease (PD) presents a formidable challenge to developing effective measurement tools for assessing motor function.

Current self-report methods, such as patient diaries, are less than optimal for tracking the variety of primary and secondary movement disorders in PD patients. These disorders can fluctuate uncontrollably as a result of long-term drug treatment.

The difficulty in accurately monitoring these movement disorders and medication states may impose a significant obstacle to properly managing interventions such as subthalamic DBS, which must be carefully adjusted during follow up.

Recent advancements in wearable sensor and signal processing technologies have improved the prospects for an unobtrusive Personal Status Monitor (PSM) to automatically track:

- the type and time course of specific primary and secondary movement disorders associated with PD (e.g. tremor, dyskinesia, bradykinesia);
- the changes in the ON/OFF motor fluctuations related to anti-Parkinson's medication, and
- the patient's physical mobility status (e.g. how often they walk, sit, stand, lie down, etc.).

We have developed a hierarchical plan to advance algorithm/software development for 3 activity stages:

- Stage 1: pre-planned, well-specified motor assessment tasks (as described in our Work to Date above);
- Stage 2: normal daily activities (e.g. sitting, standing, walking) that are constrained to specific times without overlap (i.e., "Singularity activities");
- Stage 3: normal daily activities which are performed extemporaneously (i.e., "Free-form activities").

We will develop trainable AI Algorithms to identify the various medication/movement disorder/mobility states from extracted signal features. The tools will include:

- Multiple Artificial Neural Networks (ANNs), based on results from a previous project (NIDRR Project No. H133G00168) for a wearable sensor system to automatically track activities of daily living in patients with stroke.
- Rule-Based System (RBS) for identifying the most likely mapping of states to temporal epochs.
- Iterative-Correlation Analysis for resolving identification problems due to the simultaneous presence of motor abnormalities and/or extraneous motor actions. This analysis is based on our previous work on the automatic decomposition of intramuscular EMG signals into motor unit action potential trains (NASA Grant 99E192; NIEHS-NCI-MRIR GRANT 1R42HD38536).

We will develop an IPUS Blackboard architecture of our own design (Nawab and Lesser, Symbolic and Knowledge-Based Signal Processing, 1992) to integrate the diverse AI techniques proposed above into a single PSM system (Figure 4).

The PSM system will be designed to ensure that its algorithms are trained with respect to a representative population of PD patients that does not necessarily include any of the actual users of the completed system.

Preliminary IPUS development will be followed by a performance evaluation phase to ensure that performance converges to 85% sensitivity and specificity with the use of no more than 4 hybrid sensors. This degree of accuracy was specified based on previous successes with a monitoring system for functional activities in stroke patients (NIDRR Pro. No. 133G50168).

Acknowledgment: supported by SBIR grants from NIH R44 AR47272 and R44 HD35412