A Game-Based Approach to Monitor Parkinson's Disease: The bradykinesia symptom classification

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Leonardo Medeiros, Hyggo Almeida, Leandro da Silva, Mirko Perkusich and Robert Fischer

Federal University Of Campina Grande - BRAZIL

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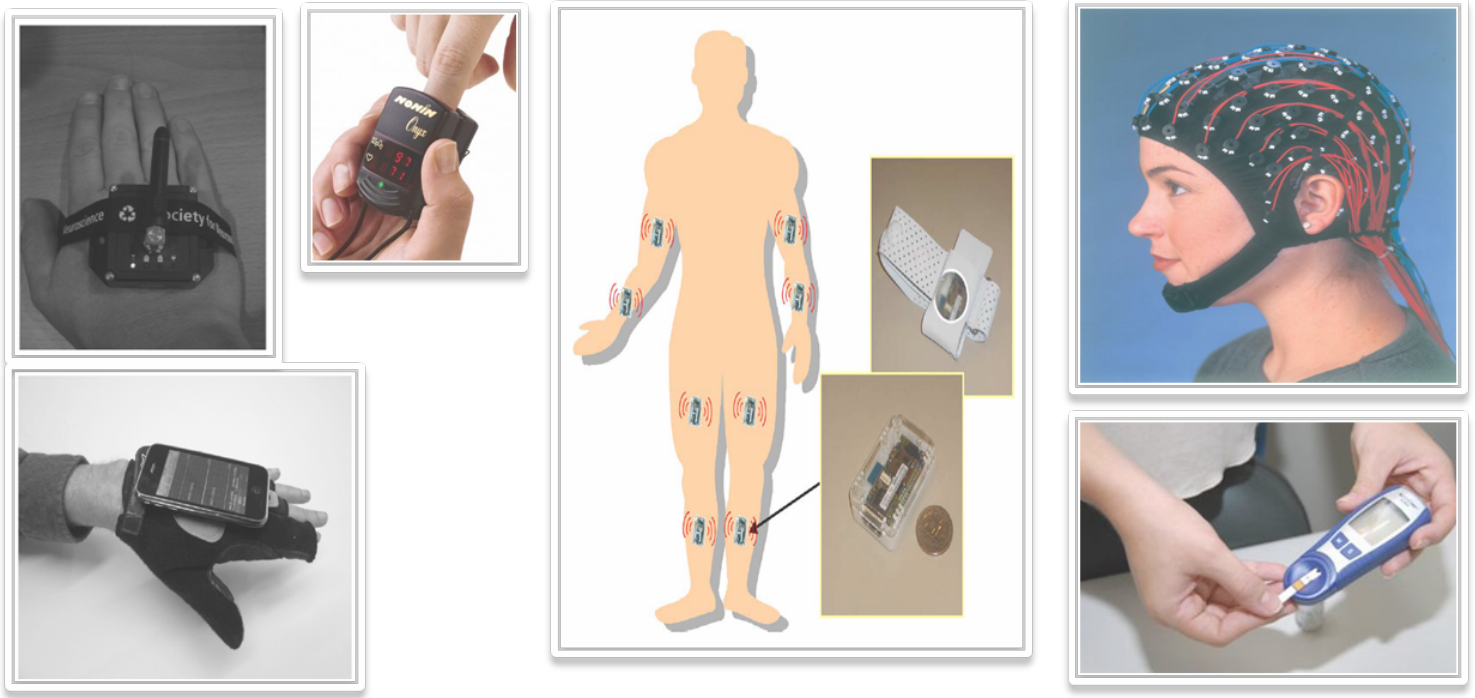
Summary

Health Monitoring Systems (HMS)

Designed to support continuous treatment by moving healthcare services from the hospital to the patients' home.

The HMS's Major Challenge



Parkinson Disease (PD)

The symptoms associated with PD are caused by a **degeneration of dopaminergic neurons** in the substantia nigra. Common treatment focuses on **drugs that activate dopamine receptors**. However, the medication's effectiveness decreases over the years **requiring higher dosages**

PD's Treatment and Disease Management

- Clinical trial evaluation: subjectively and sporadically;
- Motor fluctuations (*on/off* phenomenon).

Bradykinesia Symptom

- Bradykinesia describes a slowness in the execution of movement. It is one of the four key symptoms of parkinsonism, which are bradykinesia, tremor, rigidity, and postural instability
- The tremmor is the most visible PD's motor symptom, but the bradykinesia is the most

Main Objective

A non-invasive HMS for Parkinson's Disease motor symptoms based on games to continuously provide data regarding patient, without reminding the disease's treatment

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2. Use of a popular consumer electronic device as input to have a non-invasive, cost-effective solution for home use.

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- Neurologist and physiotherapist responsible for patient's treatment.

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- The HGM Server process the user's data and identify the occurrence of the PD's disease bradykinesia symptom;
- Then, the **neurologist visualize** the **user's health information** to assess the patient's **level of motor deficiency**.

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- The development of the HGM Server, responsible for processing the data and making the results available to the health professional;
- Experimental studies with target users.

Qualitative Research Analysis

The respondents suggested focusing on the bradykinesia motor symptom due to its debilitating progress. Thus, treatment benefits could be correlated with the **increase of amplitude and angular velocities of an arm's adduction and abduction movements**.

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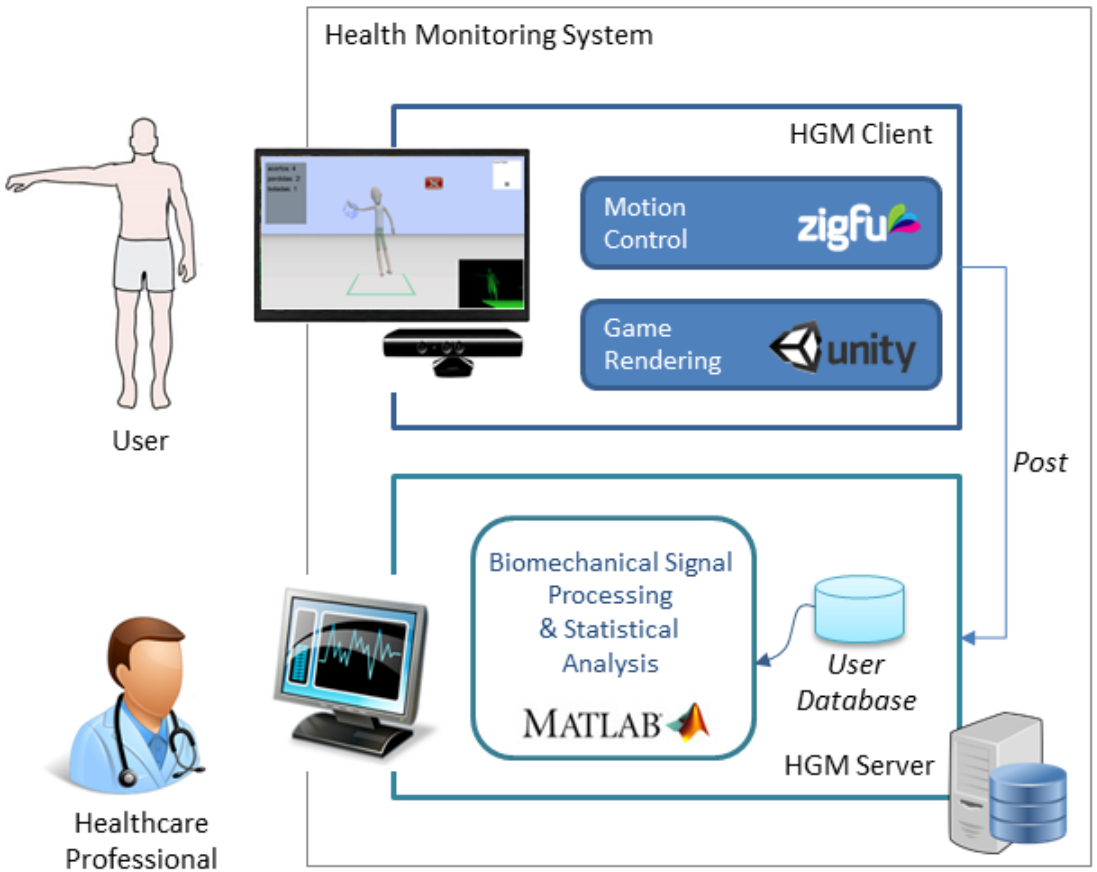
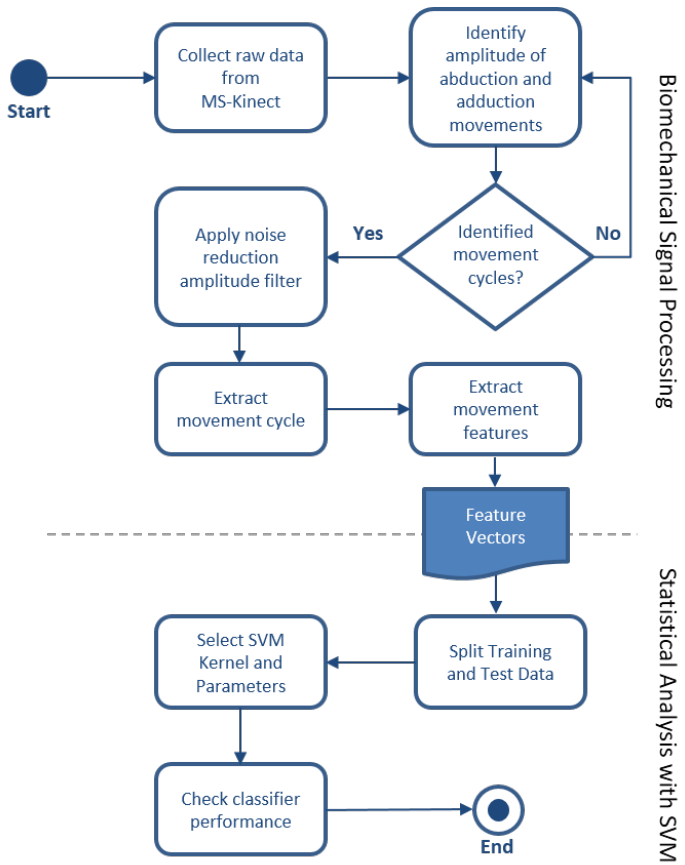
- Provide a informative visual way to the healthcare professional

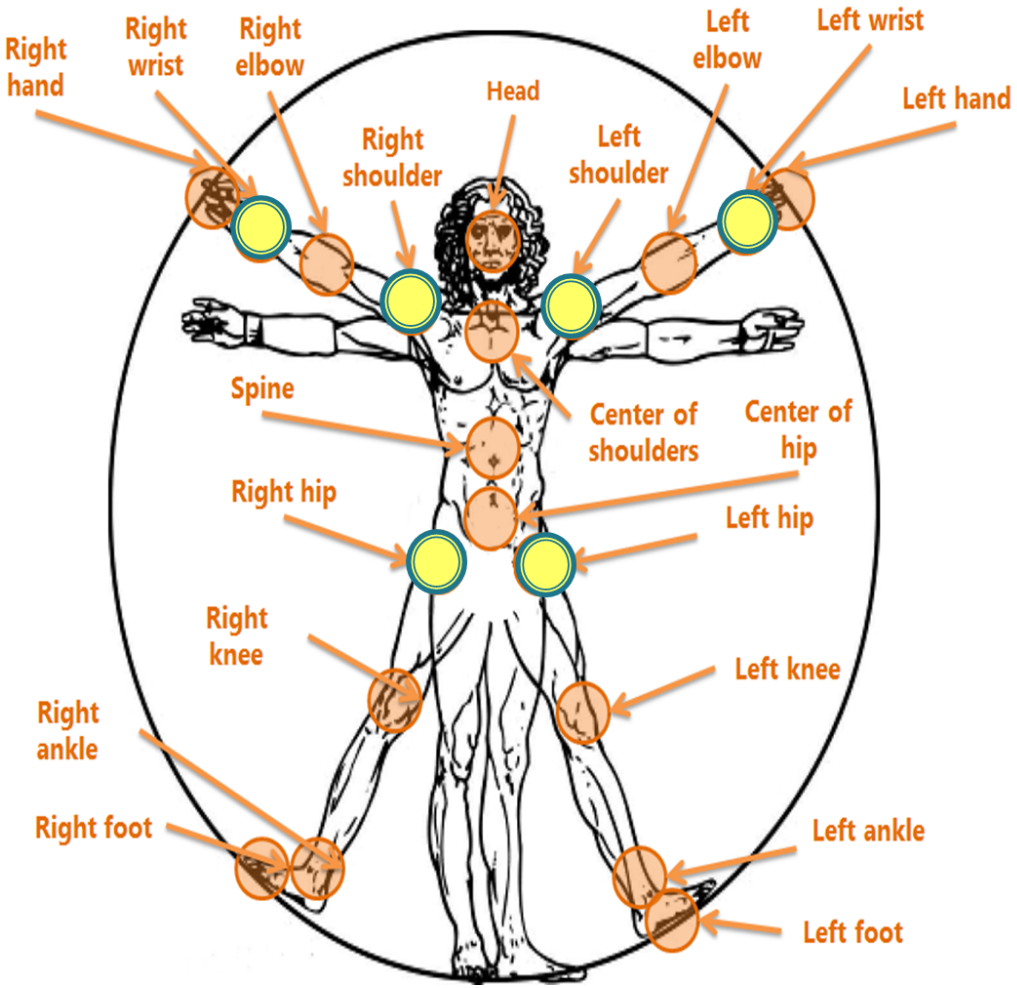
System Architecture



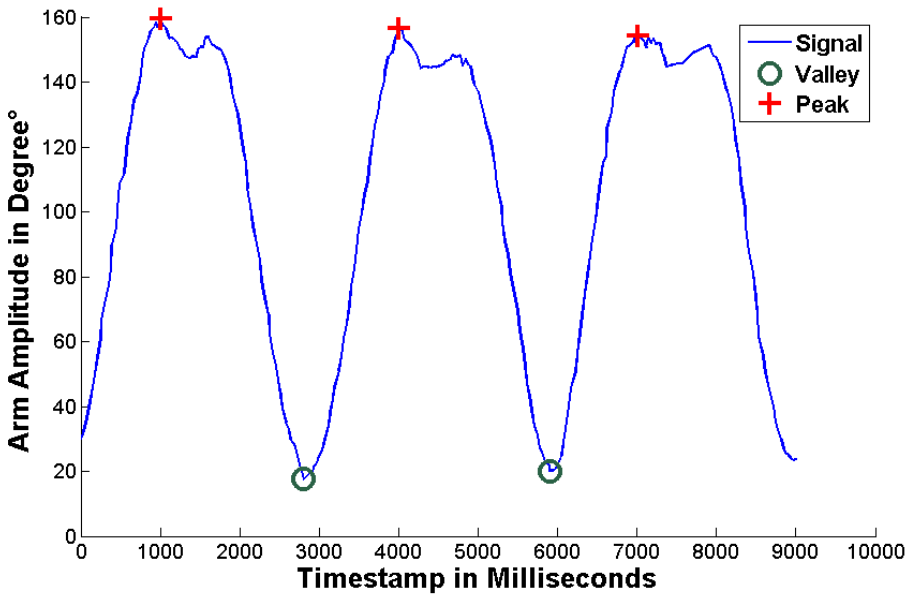
Biomechanical signal processing



Ms-Kinect Joints Acquisition



Angle over time with the peak and valley detection technique



The cycle movement and transform the MS-Kinect data into angles. Thus, we calculate the **angular motion** of the adduction and abduction movements.

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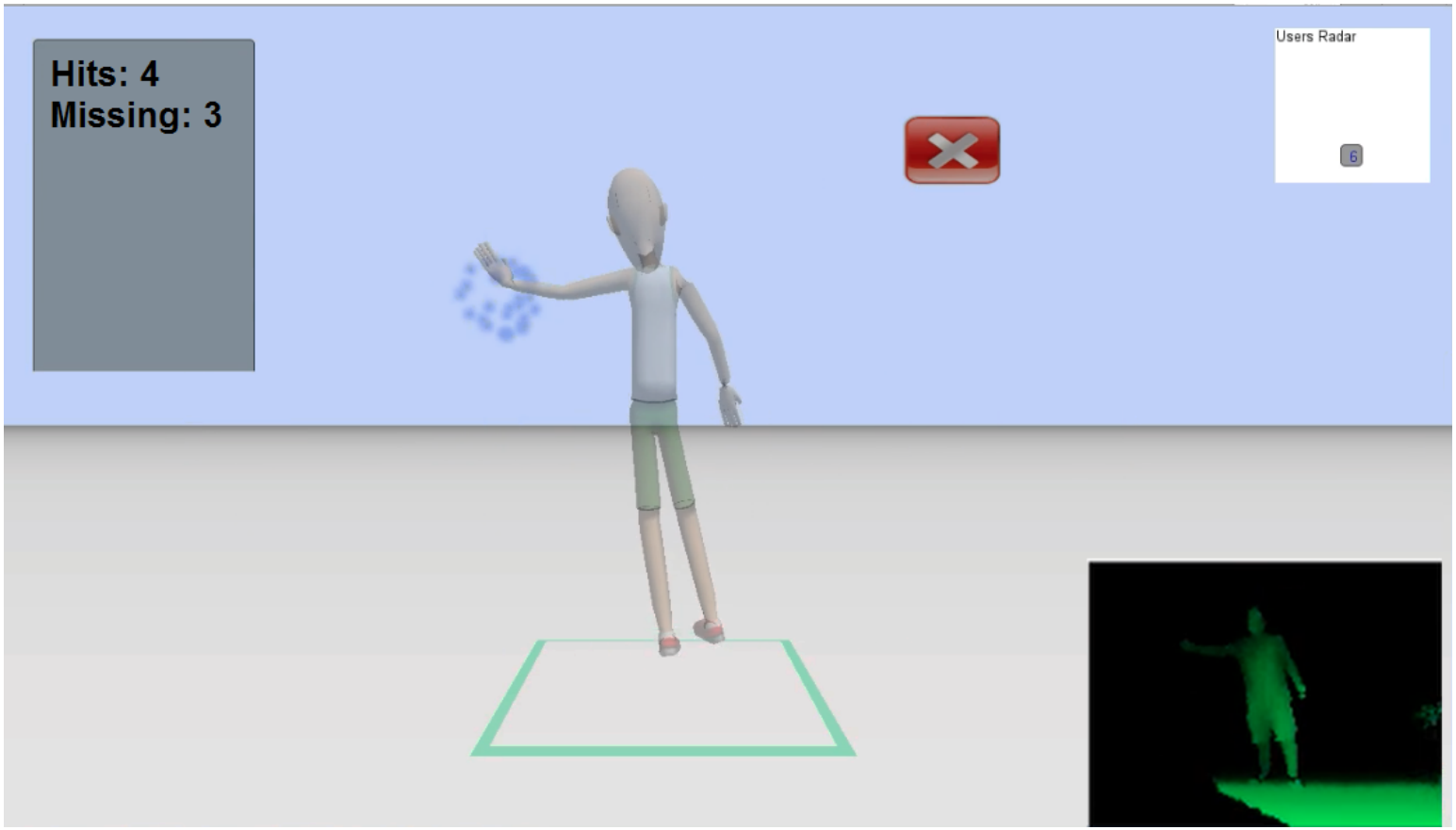
Developed Health Game Monitor: Catch the Spheres



Case Control Study

A total number of 30 subjects participated where 15 subjects for each group.

- PD' Group: 10 men and 5 women, between 51 and 65 years (mean: 58);
- Control Group: 11 men and 4 women, between 50 and 65 years (mean: 57).

Procedure for Data Collection

The subject stands at distance of 2 meters from the motion sensor at a place marked for that purpose on the ground;

The subject faces a projection of the game on a wall, centered over the motion sensor;

The subject plays the game *Catch the Spheres* for 5 minutes;

The subjects end the game by reaching the virtual exit button.

Data Classifier: SVM

In this work, we used Support Vector Machine (SVM) as the supervised learning method. SVM seeks to find a margin that separates all positive and negative example.
We choice this algorithm because he has **a good generalization to discriminate between two classes**.

SVM Classifier Performance

	Predictive Class	
	Parkinson	**Control**
Parkinson	12	3
Control	1	14

Classifier Metrics	
TpRate	80.00%
FpRate	6.67%
Accuracy	86.67%
F-score	85.71%
Precision	92.31%

Goal Question Metric (GQM) for User Acceptance

Based on the GQM paradigm, we defined two goals:

- G1 : Analyze our HMS PD approach for the purpose of evaluating with respect to usability from the view point of the patients in the context of the game *Catch the Spheres*
- G2 : Analyze our HMS PD approach for the purpose of evaluating with respect to fit to daily routine from the view point of the patients in the context of the game *Catch the Spheres*

GQM Results

The measurements were collected we obtained the following result indicating:

- 90% of the users felt motivated with the game;
- 80% would add this game-based monitoring approach into their daily routine;
- 75% considered it safe for elderly users.

Conclusion

In this work we presented a game-based approach to monitor with a symptom classification *Precision* of 92.31%. Moreover, 90,00% of the patients considered our approach non-invasive and easy to integrate into their routine.

Questions ?