

Fundació

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23rd SOCIAL RETURN OF THE RESEARCH  
Strokes and traumatic spinal cord and brain injury

## **VALORA: ASSESSMENT OF MOTOR FUNCTION WITH PROVEN FREE ACCESS TOOLS**

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## **1. Summary of the project**

Assessment of impairments in gait, posture, upper limb function and manual dexterity derived from neurological disorders such as stroke, multiple sclerosis or Parkinson's disease is usually performed in clinical practice using standardized scales and tests. Clinical tools are easy to administer and not time-consuming but can be based on subjective interpretations and be biased. Different instrumented tools have been proposed to overcome these limitations by providing quantitative measures of motor function. However, their high cost and space requirements have limited their use to large facilities with significant financial resources. Recent advances in entertainment technology have given rise to low-cost commercial devices that enable interaction with computer systems through body movements, weight transfers, or finger movements, with an accuracy comparable to that of laboratory systems. Project VALORA therefore aimed to develop low-cost instrumented tools to assess gait, posture, upper limb function and manual dexterity and to determine the validity of these tools compared to laboratory-grade systems and clinical instruments in various neurological populations and in healthy individuals. With this, the project has provided therapists and researchers around the world with the first open-access platform with low-cost instrumented tools to assess the motor function of individual with neurological diseases with quantitative and controlled data.

## **2. Results of the project**

Project VALORA gave rise to an open-access web platform that provides four instrumented tools to assess gait, posture, upper limb function, and manual dexterity using low-cost interaction devices such as Kinect v2 and Azure cameras, force platforms, such as the Wii Balance Board, and multi-touch devices, such as tablets. The developed tools guide therapists and professionals during the test and provide, depending on the nature of each variable, quantitative spatio-temporal and kinematic information, as well as absolute and comparative data with a paired sample of healthy subjects., In a total of 545 healthy subjects of different age ranges, 245 subjects with stroke, 54 subjects with Parkinson's disease, and 44 subjects with multiple sclerosis, the project investigated: the psychometric properties of the tools, including the inter- and intra-rater reliability; the convergent validity with clinical and instrumented scales

and tests; and the sensitivity of the tools to detect motor impairments. The results of the project show that the developed tools are in general reliable, consistent with the investigated clinical and instrumented tests, and able to detect and quantify motor impairments.

The developed tools can be accessed through the dedicated website:

<http://assessment.nrhbgroun.com/>

### **3. Relevance and possible future implications**

The accessibility of the developed tools in project VALORA and the investigation of their psychometric properties will provide therapists and researchers worldwide with instrumented motor assessment tools using low-cost devices with known properties. To date, instrumented tools are restricted to centers with high economic resources, mainly research centers. Project VALORA will promote the democratization of these tools, supporting their integration into the clinical practice as complementary tests and their standardization in research. In addition, current studies underway will determine the properties of the developed tools in other neurological pathologies, increasing their applicability and transference.

### **4. Scientific contributions**

#### **Journal papers directly derived from the project**

Latorre, J., Colomer, C., Alcañiz, M., & Llorens, R. Gait analysis with the Kinect v2: normative study with healthy individuals and comprehensive study of its sensitivity, validity, and reliability in individuals with stroke. *Journal of NeuroEngineering and Rehabilitation*, 2019. 16(1): 97. (IF:3.58, Q1)

Latorre J., Llorens R., Colomer C., Alcañiz M. Reliability and comparison of Kinect-based methods for estimating spatiotemporal gait parameters of healthy and post-stroke individuals. *Journal of Biomechanics*, 2018. 72 (2018): 268-273. (IF:2.66, Q2)

Alvarez, I., Latorre J., Aguilar, M., Pastor, P., Llorens, R. Validity and sensitivity of instrumented postural and gait assessment using low-cost devices in Parkinson's disease. *Journal of NeuroEngineering and Rehabilitation*, 2020.17(1):149. (IF:3.52, Q1)

Mollà, S., Borrego, A., Salinas, B., Llorens R., Serra, P. Validity, reliability, and sensitivity to motor impairment severity of a multi-touch app designed to assess hand mobility, coordination, and function after stroke. *Journal of NeuroEngineering and Rehabilitation*, 2021. 18(1): 70. (IF:3.52, Q1).

The impact factor and the quartile of the journal correspond to the year of publication or the last one available, as appropriate.

### **Journal papers derived from collaborations with research groups associated with the project**

Marco, A., Montesinos, L., Milán, L., Llorens, R., Navarro, X., García, X. Validation of Using Smartphone Built-In Accelerometers to Estimate the Active Energy Expenditures of Full-Time Manual Wheelchair Users with Spinal Cord Injury. *Sensors*, 2021. 21(4):1498. (IF:3.27, Q1).

Gonçalves, A., Borrego, A., Latorre J., Llorens R., Bermudez, S. Evaluation of a Low-Cost Virtual Reality Surround-Screen Projection System. *IEEE Transactions on Visualization and Computer Graphics*, 2021. *In press*. (IF: 4.56, Q1).

Gonçalves, A., Fernandez, M., Llorens R., Bermudez, S. A virtual reality bus ride as an ecologically valid assessment of balance: a feasibility study. *Virtual Reality*, 2021. (IF:3.63, Q1).

The impact factor and the quartile of the journal correspond to the year of publication or the last one available, as appropriate.

### **Conference papers**

Garcia-Marti V., Latorre J., Ortu E., Llorens R., Coghe G., Pau M., Cocco E. Postural assessment using the Wii Balance Board. A feasibility study with healthy adults and patients with multiple sclerosis. *Research in Multiple Sclerosis Annual Conference*

2020 (RIMS 2020). Leuven, Belgium. Dec 4-5th, 2020.

Also published in *Multiple Sclerosis Journal* (IF: 5.42, Q1):

Verónica García; Jorge Latorre; Elena Ortu; Roberto Llorens; Giancarlo Coghe; Massimiliano Pau; Eleanora, Cocco Postural assessment using the Wii Balance Board. A feasibility study with healthy adults and patients with multiple sclerosis. *Multiple Sclerosis Journal*, 2020. 26(2): 46.

Ignacio Álvarez; Jorge Latorre; Miquel Aguilar; Pau Pastor; Roberto Llorens. Feasibility of instrumented low-cost assessment of posture and gait in Parkinson's disease. *XXIV World Congress on Parkinson's Disease and Related Disorders*. Praga, República Checa. 7-10th, 2020.

Also published in *Parkinsonism and Related Disorders* (IF: 3.926, Q1):

Ignacio Álvarez; Jorge Latorre; Miquel Aguilar; Pau Pastor; Roberto Llorens. Feasibility of instrumented low-cost assessment of posture and gait in Parkinson's disease. *Parkinsonism and Related Disorders*, 2020. 79(1):50-51.

Latorre J., Mollà S., Salinas B., Borrego A., Alcañiz M., Colomer C., Llorens R. Multi-touch-based assessment of hand mobility, dexterity and function. Preliminary study of validity, reliability and sensitivity to upper limb impairment severity in individuals with stroke. *International Conference on Virtual Rehabilitation 2019 (ICVR 2019)*, 2019. Tel-Aviv (Israel). July 21st-24th, 2019.

Garcia-Marti V., Latorre J., Ortu E., Llorens R., Coghe G., Pau M., Cocco E. Feasibility of a low-cost system based on the Microsoft Kinect to investigate spatiotemporal gait parameters in people with Multiple Sclerosis. *24th Annual RIMS Conference (RIMS 2019)*. Ljubljana, Eslovenia. June 20th-22<sup>nd</sup>, 2019.

Also published in *Multiple Sclerosis Journal* (IF: 5.42, Q1):

Garcia-Marti V., Latorre J., Ortu E., Llorens R., Coghe G., Pau M., Cocco E. Feasibility of a low-cost system based on the Microsoft Kinect to investigate

spatiotemporal gait parameters in people with Multiple Sclerosis. *Multiple Sclerosis Journal*, 2019. 25(7):1054.

J. Latorre, C. Colomer, M. Alcañiz, R. Llorens A low-cost Kinect for Windows v2-based spatiotemporal gait analysis system. Efficacy study with healthy subjects and individuals with stroke. *Proceedings of the 12nd International Conference on Disability, Virtual Reality and Associated Technologies*, Nottingham, United Kingdom. September 4-6, 2018. pp 205 – 208.

E. Noé, J. Latorre, C. Colomer, B. Moliner, J.M. Climent, C. Rodríguez, P. Ugart, A. Borrego, E. Crespo, R. Llorens, J. Ferri. Validez de un sistema de análisis instrumental de la marcha de bajo coste en sujetos hemiparéticos. *XXXV Reunión de la Sociedad Valencia de Neurología*, 2018.

Also published in *Revista de Neurología* (IF: 0.562, Q4):

E. Noé, J. Latorre, C. Colomer, B. Moliner, J.M. Climent, C. Rodríguez, P. Ugart, A. Borrego, E. Crespo, R. Llorens, J. Ferri. Validez de un sistema de análisis instrumental de la marcha de bajo coste en sujetos hemiparéticos. *Revista de Neurología*, 2019. 66(6):202.

### **Theses**

Jorge Latorre Grau. Valoración del equilibrio y la marcha mediante sistemas de realidad virtual de bajo coste en sujetos con ictus. Universitat Politècnica de València, 30 de noviembre de 2021. Directores: Roberto Llorens Rodríguez, Mariano Alcañiz Raya.

### **Master theses**

Bárbara Salinas Martínez. Valoración de la destreza manual mediante tecnología táctil para tablet en pacientes con ictus crónico. Master Oficial en Rehabilitación Funcional en Fisioterapia. Universitat de València, 29 de junio de 2018. Directores: Pilar Serra Añó, Roberto Llorens Rodríguez.

Rubén García Criado. Estudio de la validez de un sistema de bajo coste para la valoración de la marcha en pacientes con ictus. Master Oficial en Rehabilitación

Funcional en Fisioterapia. Universitat de València, 29 de junio de 2018. Directores: Marta Inglés De la Torre, Roberto Llorens Rodríguez.

Nuria Navalón Sánchez. Fiabilidad en una herramienta no invasiva de bajo coste para la valoración de la función del miembro superior. Máster propio en cuidados médico-quirúrgicos y de rehabilitación del paciente neurológico. Facultad de ciencias de la salud. Universidad CEU-Cardenal Herrera, 11 de diciembre de 2020. Director: Roberto Llorens Rodríguez.