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Biomechanics Sensor Node – BSN: a wearable device controller of virtual environments from gestural interaction for functional neurorehabilitation therapy improvement

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Introduction: During a rehabilitation treatment, mainly in neurological patients, it is expected a therapy that offers the greatest possible independence for these patients, in relation to activities of daily living. Recently, virtual reality solutions, based on gestural interaction, have been explored for rehabilitation purposes. The aim of this study was to develop control devices for these solutions, namely, a biomechanics sensor node (BSN).

Materials and Methods: The BSN device was developed from a controller board and an Inertial Measurement Unit (IMU) with 9 degrees of freedom, including the original development of the Integrated Circuit Board layout (BIOX Sensor). Initially the external packaging of the device was printed on Acrylonitrile Butadiene Styrene (ABS), 3D printing, and the final version was packaged in flexible and antimicrobial material.

Results: A BSN device was developed, allowing human-computer interaction through gestures. The device has the of a bracelet, allowing recognition of patient gestures (both upper and lower limbs), gestures' calibration to control the virtual reality environment, and measurement of movement kinematics (number of movements performed, axis / plane of execution, raw data of displacement in the space). A communication protocol, using Bluetooth Low Energy – BLE [1,2], was integrated into the device, ensuring low power consumption and native support with mobile operating systems, such as Android (Google). This communication protocol converts patient movement into the input for e-Street and e-House, virtual reality software tools which simulate the urban and residential environments respectively.

Discussion: The tests performed with the BSN device allow its indication as a complement to conventional rehabilitation therapy due to personalization in relation to each patient's motor limitation and applicability to controlling virtual reality software. Unlike devices such as a Leap Motion [3], which allows manual tracking from infrared sensors, or Kinect [4], which allows body tracking from a depth camera (RGBD), the BSN recognizes the user's movement from a wearable device and allows association of a real (even partial) movement to a complete movement in the virtual environment. Thus, the patient performs a movement within his/her limitation, and in the virtual environment the same movement is identified as complete, offering a positive feedback to the patient, and indirectly eluding the brain with a visual feedback of movement completeness.

Conclusion: The use of the BSN device in physical and neurofunctional rehabilitation therapies can increase patient motivation by inducing greater adherence to treatment and reducing avoidance during therapy. It is hoped that with this approach, greater brain reorganization will occur, such as to find the best way to perform the functions lost after a stroke. Indeed, our next steps are to evaluate brain reorganization of patients undergoing rehabilitation therapy using the developed BSN device.

References: [1] Davidson R et al., Getting Started with Bluetooth Low Energy: tools and techniques for lower-power networking, 2014; [2] Nordic Semiconductor, Getting Started with Bluetooth Low Energy wireless design, 2010; [3] Leap Motion, How controller work?, 2014; [4] Kinect Sensor, Microsoft robotics: Depth camera webcam sensor, 2015; [5] https://doi.org/10.1155/2017/6261479.