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Feasibility of Automated Assessment of Manual Dexterity in Parkinson's

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***Abstract*— In previous work [1], an automatic assessment system was presented for the evaluation of patient progress and effectiveness of the therapy, that is based on the Box and Blocks Test (BBT) of manual dexterity. In this article, a study of the feasibility to use in Parkinson treatment is presented. The results advocates the use of automated methods in physical rehabilitation assessment.**

I. INTRODUCTION

The physical functionality assessment is commonly performed by health professionals themselves, using standardized test in order to have objectivity in the evaluation, but which are subject to the subjectivity of the observer. In some cases, the evaluation methods are composed of well-defined exercises based on numerical scales, which may be susceptible to be automated. In order to evaluate the performance of the Automated BBT (ABBT), in a real situation, an extension of the first pilot trial but with more individuals was conducted at a health-care facility. Five subjects with Parkinson disease were selected by medical professionals to carry out several training sessions by using serious games. The ABBT was used to perform both the initial and the final assessment.

II. MATERIAL AND METHODS

A. The Box and Blocks Test

BBT is a clinically validated system for the individual measure of gross manual dexterity and coordination. The test is made up of a wooden box with two 290 mm side length square compartments, and 150 wooden cube-shaped blocks of 25 mm. A 100 mm high partition located between the two compartments must be overcome with the user's hand to count the block as valid. The objective of the test is to transport from a one compartment to the other the maximum number of blocks in one minute. For the score, the therapist must count the number of cubes transported.

B. The Automated Box and Blocks Test (ABBT)

The proposed ABBT [1], has two targets: to automated the scoring of the traditional BBT, and to enable the autonomous test administration, with minimal participation of medicals or without it. To address the first aim, a Kinect V2 for Windows sensor is used for monitoring the test development and for detecting the cubes displaced. The data acquired is processed on Matlab®. To count the blocks, first the border of the box is detected by using the depth data and a height threshold. Based on that, both the left and right compartments are identified. A region of interest (ROI) is cropped from the color frame according to the evaluated hand. A series of morphological operations are applied to the ROI to detect the cubes. The automatic test administration is addressed through a graphical interface, which guides the subject during the test developing. Also, it is able to show and to record results.

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TABLE I: Demographics of the participants and trial results

User	Age	Gen.	Initial*		Final*		ϵ_{max}
			DH	NDH	DH	NDH	
1	45	M	55 / **59**	47 / **51**	54 / **55**	46 / **48**	0.09
2	55	M	38 / **42**	32 / **35**	45 / **53**	47 / **49**	0.15
3	54	F	45 / **46**	39 / **42**	46 / **53**	41 / **42**	0.13
4	57	F	46 / **50**	41 / **45**	41 / **46**	42 / **47**	0.10
5	72	M	29 / **32**	25 / **29**	48 / **49**	40 / **40**	0.13
ABBT success:			91%	93%	96%	91%	

* Scoring for the ABBT and the BBT (bold) grouped by dominant hand (DH) and non-dominant hand (NDH)

III. RESULTS AND DISCUSSION

Demographics data of the participants and the trial results are shown in Table I. Also, a comparative between the scoring obtained by using the traditional method (BBT) and by using the automated method (ABBT) is shown. This results are grouped by dominant hand and non dominant hand. The results show an average success rate in the counting of blocks of 91% in the worst case.

Even more, the ABBT acquires extra information such as the time in which the cube has been detected. The analysis of this information can be related to indicators of coordination or dexterity. The possibility of having a tool like the ABBT, that would allow to improve the assessment by focusing attention on the subject and not on the test, has been highlighted by the medical professionals. For example, the physician may detect if the individual performs some type of compensation to assist in the movement, such as leaning the trunk forward or forcing the shoulder. In this way, the rehabilitation therapy could be redirected to correct these conditions.

Taking into account the maximum error in the measurement (ϵ_{max}=15%) and the additional information obtained using the ABBT, the results suggest that the proposed system can be used as a manual dexterity assessment tool.

REFERENCES

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