Introduction

The clinical evaluation of the ambulation impairments is useful for the detection of neurological diseases such as multiple sclerosis (MS) and for the follow-up of patients. Most of the patients with MS have walking difficulties and they often present these difficulties as the most important source of disability [1]. Moreover, ambulation impairments appear during the early stages of the disease and the magnitude of the gait modification is a good indicator of the disease activity. Therefore, the clinical evaluation of the gait can help to know if the drugs and rehabilitation methods have a positive effect.

Often, the examination of the patient’s ambulation impairments is not instrumented at all, or the measures are very limited, because of the constraints of clinical routine. In the case of MS, clinicians mostly focus on a velocity measurement. Such tests are limited since no relevant conclusion could be drawn on the evolution of MS if the speed evolution between two consecutive visits is less than about 20% [2–3]. Thus, we need more information.

GAIMS [4, 5] is a multidisciplinary project involving engineers from the University of Liège and neurologists from the University Hospital of Liège. Its goal is to develop a new gait measuring system designed to meet the clinical routine constraints and to overcome the previous limitations by measuring a large variety of gait characteristics ([4] for now). It measures the lower limbs extremities (denoted “feet” hereafter) trajectories with range laser scanners placed in the corners of the examination room, and derives the speed, the inter-foot distance, the deviation from the followed path, the cadence, the stride length, the gait asymmetry, the temporal variability, the proportion of double limb support time, etc. GAIMS is insensitive to the lighting conditions. It does not require the patient to be equipped with any marker or sensor, and it analyzes both the swing and the stance phases. We also develop methods that help to interpret the measures taken by GAIMS. This poster focuses on the longitudinal follow-up of MS patients.

As in [6], the pairs with a gait modification have been obtained, for practical reasons, by inducing ataxia in 23 healthy subjects with alcohol in their second visit. Note that cerebellar ataxia is known to be a major component of the gait impairments in MS. For the pairs of tests in which the first one was recorded before alcohol intake and the second one after it, we expect to have an amplified gait impairment. The pairs for which the impairment is reduced are obtained by swapping the two visits in the previous pairs. We tried to reach the same peak blood alcohol concentration (BAC) for all participants, using a normogram related to the gender and the weight. As the mean BAC (measured with a breathalyzer) is 0.67 %V/V, the most important modifications are behavioral. The gait disorder specialists present during the acquisitions had difficulties to see any difference on feet movements induced by ethanol. Therefore, the gait modifications considered in this work are weak.

Results

Our results have been obtained by leave-one-out, and with the ExtraTrees [8]. The attributes describing the pairs of tests are inspired by [6]. We learn two models (classifiers): one predicting the probability of gait modification based on any pair of tests and the other one predicting the probability of gait improvement, assuming a gait modification. We apply a correction to the output to compensate for the imbalanced learning sets [9].

Conclusion

With the quantitative and objective gait characteristics measured by GAIMS, it is possible to help the neurologists in the follow-up of their patients with neurological diseases in which there is some ataxia, such as the multiple sclerosis. We have developed a cascade of two binary classifiers in order to discriminate between the three classes “gait deterioration”, “no modification”, and “gait improvement”. In each area, the majority of the points are correctly classified, indicating the merits of our approach.

References


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