CORRELATION BETWEEN MUSCLE ACTIVITY AND TAEKWONDO MOVEMENTS: A PROPOSAL OF STUDY

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SUMMARY
This research aims to develop a biomechanical analysis through the correlation between muscle activity and kinematic analysis of movements performed by the Taekwondo athletes in a more objective way. For that, during the trainings, biomechanical parameters will be obtained through a movement analysis system based on infrared cameras and reflexive markers. Synchronously, the electromyography activity of the muscles will be collected using wireless electrodes to allowing the athlete's movement freely. A pilot study was carried out for testing the correct functioning of the wireless electromyography and the recording of the 3D coordinates by the cameras. Through this pilot study, it will be possible to evaluate the functioning of the system in order to preparing the setup for the complete research that will include several volunteers.

INTRODUCTION
The Taekwondo is an antique and traditional Korean martial art often used in personal defense, which in the past few years has been considered an Olympic sport. The Taekwondo is known as the ability of using hands and feet in high speed and amplitude scams in direction to the head and to the chest [1, 2].

Since 1983, it has been increasing the interest for martial arts among the young people, that search in this sport the equilibrium of mind, fitness, discipline, self-reliance, self-defense or an alternative therapy [3]. With an increase in the number of children and adolescents involved in this martial art, the number of injuries in this population is also increased [4]. It is estimated that there are approximately 80 million practitioners in the world [5] and 5% of Olympic athletes suffer some kind of injury during their competition[6, 7].

Currently the Biomechanics has been used as a way to prevent injuries and improve the performance of athletes.
The Biomechanics studies the athlete controls and compensates movement's patterns. And it is also possible to perform more functional evaluations of athletes through observation of parameters. These parameters can indicate, for example, the performance of the proprioceptive system, articular stability and muscle strength during specific movements [8].

This research aims to make a detailed analysis of biomechanical parameters. Thus, it will be developed a system of three dimensional image reconstruction associated with electromyographic signals acquisition via wireless. The system is able to detect the threshold between the athlete performance gain and the risk of injury. So, the coach can develop new training strategies to not compromise the athlete's health.

METHODS
The research began after its approval by the Ethics Committee of the Federal University of Uberlandia. The protocol number is 180.852 and the issue date is December 18th 2012. It will be analyzed 10 healthy athletes of genders, taekwondo black belt, aged between 16 and 30 years, who compete or have competed in major championships of this sport.

The athletes will receive information about the study finalities and the data collection procedures. Later, the volunteers who accept to participate on this study should sign the consent form and, after, it will have an evaluation based on a specific questionnaire about the physical condition of the athlete. After the evaluation and selection of volunteers, they will be conducted to a training to familiarize with the procedures of the trials. In the trials, it will be made kinematic analysis of movement and muscle activity analysis. The data will be obtained during the activities in the training of athletes.

The kinematic analysis will be evaluated through a movement reconstruction system, developed on the Federal University of Uberlandia. This system consists of eight infrared cameras *Natural Point* and reflexive markers. The cameras should be carefully positioned around the tatami and the markers should be fixed in the body of athlete. The positioning of cameras and markers can not obstruct or hide the movement of the fighters. This part is important to verify the gestures developed by athletes and to compare with the results obtained on the second part. And the electromyography signal will be collected using a wireless

acquisition system, *Shimmer*. The muscle activity will be collected only for the most recruited muscles during the movements performed on trainings.

Through biomechanical parameters; such as speed, acceleration and displacement movements and some features extracted from electromyography signals; such as amplitude and frequency of the signal it is possible to detect muscle fatigue and with that, injuries can be prevented and consequently, the athlete performance will be improved.

It is being developed software to analyze muscle activity, according to each movement registered by system cameras, to facilitate data analysis. At the end of the study, the data obtained by this software will be analyzed by statistical tools and it will be investigated, if necessary, new parameters that assist in the analysis of the movements. It is emphasized that, in this study, the results of each volunteer will be compared to himself.

Each volunteer will participate of four training sessions, and after each session, the data will be analyzed and, according to the results, it will be proposed new exercises to improve physical fitness and the performance of the fighter. At the end of the fourth session, it is expected that the movement analysis improve performance and prevent injuries among the fighters.

RESULTS AND DISCUSSION

Until now, there were the selection of research subjects and a pilot training with two of the volunteers. On that first training, electromyographic signals were collected on the vastus lateralis and gastrocnemius muscles, which present a high activity during the execution of the sport. The movements were registered using cameras of three dimensional reconstruction, for that, infrared markers were placed on the joints of athletes and the EMG signal was collected simultaneously.

Each volunteer did three trials. The first trial consists on the acquisition of the EMG of the muscle in repose, the second, on the EMG of muscle maximal contraction and the last trial consists on the acquisition of 1 minute and 30 seconds of the EMG signal and on the detection of the movements during their training (Figure 1).

Through the pilot test was possible to analyze how should be the fixation of the devices on the members of the athlete, and it will also analyze if the operation of the hardware for data collection was according to the expected.

The first version of the software was used for collecting and plotting data. It is now possible to perform data collection for up to three devices via Bluetooth, and to process the signal with the following functions: Fast Fourier Transform, DC Level removal and envelope of the EMG signal. These tools will be important to the main objective of research.

CONCLUSIONS

Through the pilot study, it was showed that the system is able to register successfully the analyzed data, i.e., the wireless electromyography and the recording of the 3D coordinates in a synchronized way. Thus, the preliminary results are promising for the achievement of the overall goal of the research, that is, to determine the correlation between muscle activity and the movement of the taekwondo athlete. Furthermore, it is believed that, with this research, will be possible to obtain the improvement of the performance of athletes and the prevention of injuries between taekwondo athletes or between athletes of other sports.

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(a)

(b)

Figure 1: (a) Some movie frames that movements illustrate of the athlete during the period of 1 minute and 30 seconds. **(b)** A three dimensional image, obtained by reconstruction software, with the trajectory of one the markers, in red.