Investigation and Modelling of Kinematics and Dynamics of a Handbike System for Rehabilitation Purposes

Some of the mobility vehicles such as the handcranking device are important since they support disabled people to follow an independent life. Generally speaking, handcycle (handbike) is an arm or arm-trunk powered three-wheel-device for disabled people (fig 1& fig 2). Most of the handbikes are only used for road purposes. However there are some models which have racing applications as well.

In contrast to hand rim wheelchair propulsion, and due to being more efficient and less physiologically straining, the handbike is used for long distances. Moreover it has been shown that the handbike has lower risk of repetitive strain injury than the handrim wheelchair propulsion.

Figure 1. Race handbike

Figure 2. Road handbike

Over the last decades, researches have shown interest in different aspects of synchronous handcycling. The handbike physiological features have already been well studied by previous scientists; however there are few researches that have focused on kinetic characteristics of handcycling motion. From previous studies it is known that several factors can influence the dynamic behaviour of this motion and some of them will be considered in this work.

The aim of this study is to present a dynamic model that considers the contribution of gravity, inertia and Coriolis effects in order to associate the forces measured on handles of the handbike to the corresponding shoulder and elbow torques. For this reason some subjects will be asked to perform a handcycling test at different powers by using an adjustable recumbent sport handbike, which is then converted into an ergometer (fig3). In addition, a vision system and passive markers will be applied to acquire the biomechanical data.

Figure 3. An adjustable recumbent sport handbike, which is converted into an ergometer

Finally, the posture of the arms, the crank position and the force on the handles will be measured with respect to the time, while velocities and accelerations will be assessed by numerical differentiation.

One of the purposes of this work is to develop a new analytic method to compute joint torques generated during handcycling, and compare the torques produce by inertia, gravity and the Coriolis effects, and those generate by muscles. Furthermore, some new indices will be identified to describe the performance of handbike athletes in a more precise way.