Figure Follow: A Step by Step Liberating Device

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Abstract: *Figure Follow* (FF) is an award-winning project, envisioned to facilitate the learning of "Compulsory Figures", an individual discipline of Artistic Roller Skating. This idea has now become a prototype under development, which uses sensors to detect the athletes position over figure lines, and provides, in real time, information concerning the general performance of the athlete and a corresponding score, both sent to a mobile app. FF aims to help class teaching and personal training, creating a more playful way to progress and maintain young athletes motivation. The technological development process of this product is a perfect context to put to the test some sociological ideas about the relation between technologies and society, particularly in a time of accelerated, permanent and transformative innovation. Even if we are just confronted with one more gamification of a learning device, it is an opportunity to discuss the liberating effects of digital communication techs on society and personal lives.

Keywords: Sports Training**;** Skating Compulsory Figures; Computer-Assisted Technologies; Digitalized Embodiment

1. The idea

Artistic Roller Skating is a hard and demanding sport practice, where the athletes have to master their technique and skills in roller skates, while they express themselves by telling stories through a 2 to 5 minutes performance. In the individual category, there are 3 different disciplines: *Free Skating*, better known by the general public and involving jumps and spins; *Dance*, with various footwork and a special attention to the artistic component; and *Compulsory Figures*, centered in the technique and focused on the skater.

In Compulsory Figures, the athlete has to skate over a circular line drawn in the rink, with only one foot on the floor. There are 53 different figures, some of them comprehending several circles and having different variations in size as well. While skating all those figures, an athlete has to be stable and well balanced, needs to understand the "edges" and make sure they are valid, must know the kind of turn to be performed and how to keep a nice posture and focus during the entire performance. Although these skills are shared by every discipline of Artistic Roller Skating, they are most valued in Compulsory Figures. Moreover, the new scoring system institutionalized internationally, scores all those components as precision, technique, balance and mastery of the roller skates, making this discipline even more important for the Artistic Roller Skating world.

The really high standards of Compulsory Figures demand for an absolute dedication during all the athlete's lifetime. In general, the athletes begin training this discipline just after they learn the basics of skating, and they progress from the simplest figures to the more complex ones, following a list that is specific for each age group, until they reach the advanced level. By then, the number and complexity of the figures demands an increased commitment with long hours of training, so that the athletes can master the discipline. However, Compulsory Figures is an almost exclusively amateur sport with a large majority of female athletes, likewise the other disciplines in Artistic Roller Skating. So, in most cases, the athletes have to coordinate their training practices with their jobs, which means rigorous schedules and a limited time for practice and improvement. And many of these athletes have to train more than one discipline, making even harder their struggle with personal time management. All these constraints have a strong impact in the athletes' motivation to keep training and practicing the sport. As a result, the number of Compulsory Figures athletes has been decreasing in the last years and, consequently, the competitions have become not only smaller in number of athletes but also less frequent.

As for the trainers, they not only have to guide the skaters to guarantee their progress in each discipline they choose, but also to motivate them and keep training under these adverse circumstances. Often, they have to work with multiple athletes, which makes their job even more difficult, especially in Compulsory Figures. For example, in a 10 people practice of Compulsory Figures, if the coach is paying attention for 5 minutes to each athlete, it will take him 50 minutes to come back to the first athlete and assess what has been done. During those 50 minutes, the athlete could have been practicing towards improvement or making the same mistake

repeatedly, without really being noticed. Beginner's classes are generally 1 hour long, so the athletes can end the practice without all the needed guidelines and corrections.

In this paper we introduce the *Figure Follow* project, which explores the increasing role of ICT in sports education to develop a new e-training platform for Compulsory Figures. This platform is being designed to provide helpful information to the athletes every time they practice, by themselves or with their coaches, giving them the necessary feedback, spots to focus on training, and simulations of an actual competition, therefore supporting better training efficiency and use of time. The platform was envisioned to be used as a training complement that can guide the athlete's practices in and out of classes, but not to fully replace the coach work. By using the Figure Follow e-training platform, the athletes can increase their training hours, complementing what they learned in classes with an individual practice upheld by the platform.

2. The technology

As shown, the performance of an athlete in the discipline of Compulsory Figures is judged based upon how well the tracing is held, the quality of the edge running, takeoffs and the correct placement of the turns. The athlete's form and posture are emphasized as well. Consequently, the development of a useful computer-assisted training system requires not only new sensor technologies to capture the athlete's motion and movements, but also improved methods of motion analysis to assess the performance. In addition, it should involve innovative ways of presenting the training performance both to the athletes and to their trainers, in order to effectively stimulate the training and provide room for improvement. Furthermore, such computer-assisted training system should be easy to use and cost effective, so that it can be widely used.

Similar ideas have already been put into practice with great success for other sports, such as box (Worsey et al.,2019), skateboarding (Corrêa et al., 2017), ice hokey (Hardegger et al., 2015) or figure skating on ice (Bruening et al., 2018). However, Compulsory Figures presents a different set of challenges, not only due to the specifics of the discipline but also due to dealing mostly with amateur athletes that can be of all ages and training levels.

The proposed e-training platform for Compulsory Figures skating addresses all these issues by adopting an architecture based on only two components that are implemented using off-the-shelf parts: a wireless sensor module, which is integrated unobtrusively into the roller skates, and the e-training software, to be run as a mobile app on a smartphone or tablet.

The wireless sensor module is responsible for capturing the data necessary to assess the motion of the athlete in the rink and transmit it to the training application backbone. Such data comprehends the linear and the rotational acceleration of the skate in the three dimensions, as well as the precision in following the figure trace. The motions of the roller skate are measured using a commercial available Inertial Measurement Unit (IMU) sensor chip: LSM9DS1. Conversely, the wireless sensor module uses an OmniVision OV2640 camera with a fisheye lens to capture the figure trace. This provides increased flexibility to detect the figure trace, since the figures not only can be painted using different colors but also over rinks with distinct lighting conditions and floor materials. All sensor data is collected by an ESP32 microcontroller and transmitted via Wi-Fi to the mobile device running the training app. We choose the ESP32 because this is a low-cost and ultra-low-power microcontroller that includes the complete set of peripherals necessary to implement the wireless sensor module, and it is powerful enough to cater all the requirements of the wireless sensor module. We decided to use a Wi-Fi connection to support the data transfers with the training software, because it can be implemented reliably and is present in almost all smartphones and tablets.

The e-training software makes available to the athletes and their trainers the data collected during the trainings. Moreover, it offers a set of tools that allow analyzing the performance of the athlete for a given training and comparing it against previous training values and related benchmark values. Such information is important not only to assess the performance progress due to training but also to correct mistakes and increase the motivation of the athletes. To further promote the athletes' motivation and training engagement, the software also exploits several gamification techniques, such as training goals, rewards (e.g. badges, accruing of points, leader boards, progression bars), and competition.

3. The impact

As other findings suggest [Liebermann *et al*, 2002; Macutkiewicz, 2011; Miah, 2017; Perl, 2011; Pope, 2009], it is our assumption that the use of these new technologies has a great potential enhancing performance, motivation and satisfaction among athletes and trainers, also in the discipline of Compulsory Figures in Artistic Roller Skating. Until now, training depended only on the eyes and experience of the trainers, the senses and intuition of athletes, and a few small artifacts and tricks used to help and correct corporeal posture, movement positions and shifts, during practice. What we are trying to do, without dismissing the vitality of experienced coaching and professional expertise, is to go beyond these sensory intuitions, these improvised material props, and permit practitioners to become observers of their own exercises, supporting training with more accurate and reliable data. The wireless sensor module that is currently being developed has this enormous added value of supplying data and supporting the learning process in real-time, transferring aggregated information to an e-training software installed on a mobile device, as the training sessions take place. The data can also be kept in archives, be shared between athletes and their coaches, and serve as documents to a latter analyze of accomplishments. It is a tool to be used by the coaches, as they obtain immediate useful information to design tasks that control, correct and model individual performances, but also by the athletes themselves that, individually or in small collaborative groups, can find flaws and new ways to deal freely with their technical problems. Specially, in this peer or group context, the tool can provide scores, rankings, and a kind of "gaming experience" (Deterding *et al*., 2011; Garris *et al.*, 2002) and, through this enjoyable competition, increment productive interaction and individual discoveries and outcomes. If this alternative form of gaming will be creatively explored in sports practice, as in many other fields, the cultural representations of computer games will change, and actual passive gamers will become more active gamers. In this sense, we are in a path that may in the future redesign, not only the nature and the practice of physical education but of a part of digital culture (Miah, 2017).

We follow a contemporary educational strategy that works upon what has been the accumulation of scientific concepts, like "human-computer interaction" (Card *et al,1983*) or "telemediatization" (Tomlinson, 2007), taking advantage of the proliferation of computers, mobile and communication technologies in all aspects of everyday life, the familiarity with which most people manipulate these common accessories, and the use they can make of accessible virtual spaces to enrich physical capacities and performances. There is a growing number of training programs that incorporate image and digital means to capture movement in different sports, like football, cycling, action or combat sports [Thorpe, 2016; Constantinou, 2016; Jaitner, 2006; Jones, 2011; Pires, 2018]. Like in those other modalities, we are increasing the techno-scientific capabilities of athletes in Artistic Roller Skating to know what their bodies can do and what they will need to learn to do better. According to Lupton (2015), the popularity of devices and apps like the ones we are creating will be responsible for the growth of all kinds of knowledges about the human performance of bodies that will become more and more configured by this kind of digital technologies. The future of many sports training will show the importance of this "digitalized embodiment", probably in a context where the internal logic of sports ecosystem will have been substantially changed, and virtual aids will be omnipresent and play a major, irreplaceable role in real practice.

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