KSAS: An AI Application to learn Martial Arts Movements in on-line Settings

Alberto Casas-Ortiz & Olga C. Santos
Computer Science School, UNED. Madrid, Spain
acasas148@alumno.uned.es, ocsantos@dia.uned.es

Introduction

The practice of martial arts entails diverse benefits for their practitioners, including: i) physical benefits [1–5] (e.g., elasticity, coordination, balance), ii) mental benefits [2, 4–7] (e.g., self-esteem, stress-relief) , iii) physiological and metabolic benefits [2, 4, 5, 8] (e.g., increase of oxytocin, enhancement of immune system), iv) social benefits [8–11] (e.g., cooperation, socialization), and v) educational benefits (e.g., physics theories, anatomy) [12–14]. Multiple applications can derive from those benefits like fall prevention [1–4] or treatment of medical problems like osteoarthritis, osteoporosis, [2, 4] or cardiac and stroke rehabilitation [2].

However, last year during the COVID-19 pandemic, activities that involve the learning of motor skills (such as martial arts) had to stop physically due to the breakouts that occurred worldwide. Videoconference and e-learning systems have been suggested as a temporal solution to that. However, this solution entailed some disadvantages when learning motor skills. With the purpose of identifying those disadvantages, we conducted a survey with 29 volunteers. The main disadvantages identified were technical problems with the Internet connection, lack of interaction and feedback between teachers and learners, and difficulty to observe 3D movements in a 2D screen. Advantages were also identified in this survey, such as the possibility of learning at home at any time, the use of videos and the possibility to pause or rewind them.

Previous research has suggested that Artificial Intelligence (AI) can be used to build psychomotor systems that personalize the learning of motor skills [15, 16] In this work we consider that AI could also be a solution to many of the disadvantages identified in the mentioned survey, also evoking the advantages. With the purpose of easing the developing of systems and applications to learn motor skills on-line in a personalized way, we proposed a framework called mCMAR^2 (motion Capture, Modelling, Analysis, Response and Report) that is formed by five interconnected phases: i) the motion is captured, ii) the captured motion is modelled, iii) the models and the captured raw information are analyzed, iv) the information extracted from the analysis is used for deliver personalized feedback, and v) the information about the execution of the learner is used to generate a motion report that the teacher and the learners can use to enhance the learning. The flow of information in the mCMAR^2 framework is shown in Figure 1.

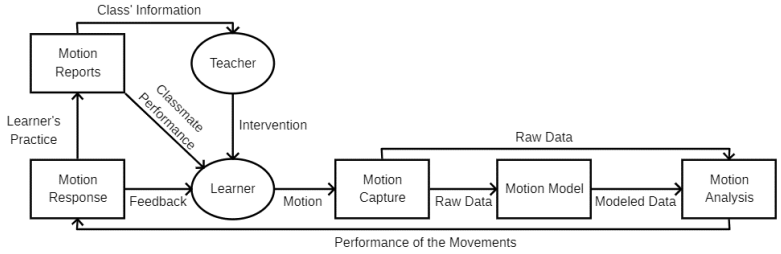

Figure 1. Flow of information between the different phases of the mCMAR^2 framework.

KSAS: Kenpo Set Assisting System

Using the mCMAR^2 framework, we have developed KSAS (Kenpo Set Assisting System), a mobile application that is able to assist in the learning of a set of movements of American Kenpo Karate, known as Blocking Set I [14]. We have selected this martial arts because it entails many of the characteristics common to other psychomotor activities like coordination of different parts of the body, the use of objects or the interaction with other practitioners. This application is able to teach the order in which the movements are to be executed.

As shown in the adjunct video, KSAS is able to capture the movements of the arm using the inertial sensors of an Android device, obtaining a set of 18 values each 20ms (Phase 1 – Motion Capture). The captured movements are then modelled as temporal series and smoothed using the Exponentially Weighted Moving Averages algorithm (EWMA) (Phase 2 – Motion Modeling). A Long Short-Term Memory (LSTM) neural network has been trained using data captured from 20 volunteers to analyze the movements and is then used as a classifier of movements (Phase 3 – Motion Analysis). Using information extracted from the analysis, the application is able to give verbal indications and feedback to the user, as well as haptic feedback (Phase 4 – Motion Response). Finally, a report is generated using information from the execution with the purpose of showing the progress of the learner to the teacher and, if desired, to other learners (Phase 5 – Motion Reports). Thus, using this application, the learners can practice the movements at home and the results of their training can be shared in real time.

Discussion

This system could help to learn not only martial arts movements, but also other psychomotor activities like playing musical instruments (e.g., violin or contrabass), drawing, medical training (e.g., learning to do a laparoscopy or CPR) or other sports like archery, swimming (using waterproof devices), or tennis, as discussed in [17]. The device could also be used as wearable in other parts of the body like the waist, as it is done in [18]. This system could be used anywhere at any time, helping learners to practice whenever and wherever they want, and allowing the teachers to see the progress of the learners at any moment and helping them to organize their classes. The proposed framework (mCMAR^2) can be used to develop different and novel systems and applications able to teach any of the previously mentioned psychomotor activities using different techniques in each phase (e.g., using optical sensors for capturing movements, modelling actions using grammars, analyzing movements using machine learning methods, provide feedback using displays, or generating reports using data analytics techniques). Further, this framework can be used to categorize and understand existing systems and applications.

Further, this application can be used to foster gender equity in martial arts (and other sports and psychomotor activities). Women have been underrepresented in martial arts despite all the benefits that these arts can provide. We conducted a survey with 23 volunteer women that did not practice martial arts. The results of the survey indicate that, even when most of them (91%) think that they would feel safe practicing a martial art, 30% think that they would feel uncomfortable joining a class formed mainly by men. Also, the lack of previous knowledge is an issue that would influence the decision of joining a martial art for 43% of women. Applications such as KSAS could be used to allow women (and anyone who have doubts when joining a martial art), to practice the basic movements and learn the basic concepts before joining a martial arts class. They could also help learners that struggle with learning the movements by allowing them to practice at home, allowing the teacher to follow their progress and help them, either in a face-to-face class, or by videoconference.

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