KUMITRON: Learning in Pairs Karate related skills with Artificial Intelligence support

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Summary of KUMITRON system

There are already several scientific articles that discuss the **need for intelligent tools applied to the teaching of psychomotor skills** ([1], [2]). The most recent and exhaustive search [3] on intelligent psychomotor tutoring systems shows the lack of this type of tools as only 9 systems were found to address this field. Two important challenges [1] related to technology and the acquisition of motor skills are pointed out: 1) modeling psychomotor interaction and 2) providing adequate personalized psychomotor support. Following the steps in [1] we have proposed the system KUMITRON to support learning Karate in pairs, as summarized in Fig. 1.

Figure 1: Description of KUMITRON in the four-stage framework to build intelligent psychomotor systems [1].

KUMITRON uses Artificial Intelligence (AI) techniques (mainly machine learning and computer vision) to teach psychomotor skills when two karatekas interact to each other in a karate combat (called kumite). The learning scenario in a karate combat offers additional challenges to other psychomotor learning scenarios since movements are not predefined and depend of the dynamic interaction of two practitioners moving around the tatami (space where the karate combat takes place). As described in [4], both learners and experts were surveyed to understand their needs and interest which are related to movements, technique, activity parameters and kumite strategy. In addition, the development of the system was inspired by state of the art: sensors to collect motion related data [5], existing karate systems ([6] and [7]) and sports ([8] and [9]), drones for dynamic video gathering ([10],[11] and [12]), and computer vision algorithms ([13] and [14]).

In this way, KUMITRON aims to support learning in pairs karate related skills with AI support in several way. In particular, this infrastructure can serve to analyze:

- **Psychomotor skills and physical condition**: the video, inertial and physiological sensors connected to AI algorithms (predictive and computer vision) can be used to improve motor skills, art technique, physical condition, attitude to stress situations, fatigue management avoid injuries…
- **Game strategy**: the monitoring of data combined with predictive algorithms can allow obtaining expert recommendations to win the game. For this purpose, KUMITRON connects to Machine Learning applications, exchanging data (respecting the GRPD [15]) in real time, to obtain expert advice that can be transmitted to the learner during training. As mentioned in Fig. 1, currently the delivery of feedback to the learner is performed with the "Wizard of Oz" to identify the personalized support required and train the intelligence of the system.
- **Motivation through innovation:** KUMITRON brings innovative capabilities and features that aim to enhance psychomotor education, turning the Dojo (martial arts gym) into a smart learning environment.

The system's potential impact

To understand the impact of Karate on the individual there is a fundamental reading by its founder [16]. There are also academic works (e.g. [17] and [18]) where the benefits of karate for people are explained. In this sense, KUMITRON can help in:

- Improving perception skills, specifically in terms of punch anticipation, so this extra time allows to better react to the punch, as suggested in [19].
- Placing and moving on the tatami, learning how to position on the mat thanks to the system's recommendations and anticipation work.
- Managing physical effort, so physiological parameters allow to determine when the learner is overexerting and recommend to reduce effort or vice versa.
- Managing emotions, keeping concentration and avoiding nervousness, thanks to physiological monitoring and combat performance.

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