Action Sports Analysis Based on Local Cross Correlation and Action Measurement Units with GPS timestamp

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This paper proposes action measurement units and an analysis method of turn and aerial maneuvers of action sports to identify skill level and type of sports. Each unit records sensing data collected from accelerometer, gyroscope, and digital compass in three dimensional space with GPS timestamp. The units can be easily attached on any part of an athlete's body without any wired or wireless connections between them, because data collected from multiple independent units can be synchronized with GPS timestamp.

To identify actions in riding based on multiple time series data collected from the measurement units, we also developed a classification method with local cross-correlation function. To measure similarity between two ridings, a cross-correlation function gave a similarity measure. However, the function was not suitable for the measure when there was a big difference between two ridings in terms of speed, although they consisted of same actions. To avoid the problem of cross-correlation function on dataset composed of different riding speeds, we introduced a local cross-correlation function, because the local function can focus on important actions and ignore time duration between the actions. The similarity measure was defined as an average of the multiple local cross-correlation values on local maximum peaks, because the peaks depict important common actions between two ridings. However, computation time for the measure tended to increase with long time series data due to calculation of convolution between two time series. To reduce the computation time, we formulated an incremental calculation of the local cross correlation.

We analyzed three action sports (i.e., skateboard, inline skate and BMX) on a big air ramp. The competition attracts much public attention in part because big air snowboarding will be part of the Pyeongchang 2018 Olympic winter games. A big air ramp is composed of a kicker ramp for making straight jumps, a vertical ramp for aerial action and a slope to get enough speed to make big jumps and "get air" on the two ramps. An athlete made a turn or air in an easy direction (i.e., clockwise or opposite) at the vertical ramp. Skill levels of athletes are classified into three categories (i.e. beginner, intermediate and advanced). The total number of recorded ridings is 43. We categorized the riding data with our method and normal cross correlation. According to the result, the clusters with normal function contain different levels and types of ridings. On the other hand, we confirm that our method is able to properly categorize the same level and type of ridings into a sub cluster. The proposed method can successfully discriminate type of sport and level of skill, because it focuses on important actions only.