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Sensor data mining on the kinematical characteristics of the competitive swimming

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Abstract

The purpose of this study was to propose a new methodology for the automatic identification and the classification of the swimmers kinematical information during interval training of competitive swimming. Forty-five college swimmers attached the newly developed chest band sensor unit, which has a triple-axes accelerometer inside, and then performed a controlled interval training set with four stroke styles. The authors identified swimmer's states, such as the swimming/rest phases and the start, turn and goal touch events by using the trunk longitudinal acceleration (Ay). With the inductive inference based on the experimental results and the deductive inference based on the empirical rule on the interval training brought the estimation of the swimming time. For the classification of the swimming strokes, using the extracted swimming phase acceleration, the mean, variance and skewness of each bout were calculated. The authors compared different data mining algorithms for the stroke style classification with these descriptive statistics, such as mean, variance, skewness on the each axial acceleration as the independent variables and stroke styles as the depending variable. The accuracy of the stroke style classification by both the multi-layered neural network (NN) and the C4.5 decision tree were 91.1%.

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Competitive Swimming, Accelerometer, Data Mining, Classification, Neural Network, Decision Tree;

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1. Introduction

An interval training is the most popular training method in the competitive swimming. Coaches have used a stopwatch for swimming time measurement for more than half a century. In parallel with the time measurement, they have to instruct swimmers' stroke skills and count a number of strokes. However, it is difficult for them to accomplish all of those tasks for all swimmers. In order to improve the quality of the coaching, the authors propose a new approach for the daily training to assist both the swimmers and coaches. Brezmes, et al. (2009) introduced that a modern pedometer has a sophisticated algorithm not only for the step counting but also the estimation of the energy expenditure based on the motion classification. In swimming, Davey et al. (2008) proposed swimming event, time and stroke count/rate estimations using accelerometer. However, only single subject's result was introduced by their study. The authors aimed to develop a sensor tool for the training on the competitive swimming based on the data mining. The purpose of this study was to classify states of the swimmers in the interval training and quantify their swimming time using body-attached accelerometer. The term state here represents the *swimming* and *rest* phases, start, turn, goal touch events and stroke styles in the interval training as the qualitative parameters. In addition, the swimming time and stroke rate are also represented as the quantitative parameters.

2. Methods and Results

2.1. Experiments

A chest band style water proofed triple axis accelerometer was developed (Fig.1). The maximum measurement range and resolution of the accelerometer were 2g and 12bit respectively with 32Hz sampling rate. Forty-five well-trained university swimmers were recruited for this research. Following a warming up, subjects wore an accelerometer chest belt and then swam the controlled experimental interval training set, which was 16 times of 50m on 60 seconds cycle time. Each swimmer performed four stroke styles, such as butterfly (Bu), backstroke (Ba), breaststroke (Br) and freestyle stroke (Fr) with middle and fast speed for every two bouts. In order to observe the subject's motion, two video cameras were settled up from the side and bird's eye views.

2.2. Identification of the swimming time

Figure 2 shows the flowchart of our research procedure. In order to measure the swimming time, it is obvious to identify swimmer's start and goal touch events at the swimming wall. The authors hypothesized that the swimmer has two states during the interval training session, such as *swimming* and *rest* phases. The authors divided whole

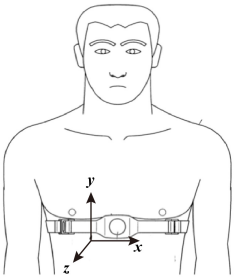

Fig. 1. Swim logger and its axis definition.

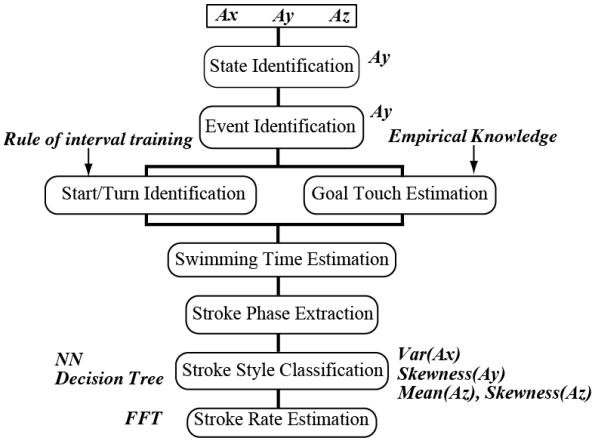

Fig. 2. Flowchart of the data analysis

interval training duration into these two states. For this procedure, both the knowledge of the interval training and