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This doctoral dissertation is titled "Development of a Single-camera Markerless Optical Motion Capture System for Biomechanical Analysis" and comprises five chapters.

Chapter 1, Introduction. The main objective of this research is to develop a single-camera markerless optical motion capture system for daily training. This system was based on image registration. It was used to overcome the limitations of the marker-based system. For example, markers attached to the subject can affect the subject's movements, and the time required for marker placement could be excessive. The system's main advantage is that it needs only one camera, so the camera placement is easy and simple. Furthermore, there is no required camera arrangement for image acquisition. Therefore, the experimental setup for daily training could be done quickly. Another advantage of the present system is that it does not need any computational learning because it is based on image registration.

Chapter 2, Construction of Basic System and Validation for Running Motion. This section discusses the methodology used in building the basic construction of a markerless system. This construction will then be used for running and other more complicated movements. The basic construction generally consists of image segmentation, model generation, image matching, and identification of right and left limbs. First, image segmentation obtains the foreground from the background images. The next step is to generate a human body consisting of segments connected by a corresponding joint. Image registration is a process of matching silhouettes and model images. The last step is using the least square method to identify the right and left limbs. An experiment to record running movement was conducted to evaluate the methodology. The adaptive background mixture model technique segmented the recorded images. The participant's body was modeled into eight segments. In image matching, particle swarm optimization was used to obtain the optimum segment angles. Finally, the correlation coefficient between the references and the result of identifying the right and left limbs was evaluated. The lowest correlation coefficient was 0.977, which implied the accuracy of the developed system was acceptable. Besides, the system's result was also validated by the marker-based system. Their lowest correlation coefficient and highest RMSE were 0.931 and 7.24 degrees, showing good agreement between both systems.

Chapter 3, Extension to Bilaterally Symmetrical Swimming Stroke. The butterfly stroke was targeted since it is considered bilaterally symmetric in motion. A variable thresholding method was used in the image segmentation. Before the matching process, the human body was modeled as a series of

nine segments. To minimize the degree of freedom in image matching, the available joint motion in the swimming human simulation model (SWUM) was used as a priori information for kinematics data of the swimming motion. As a result, the segment angle's correlation coefficients between the references and the result of the matching process were around 0.95 for the trunk, thigh, shank, upper arm, forearm, and hand and 0.78 for the head, hip, and foot. The rotation angle and the velocity of the center of mass were put into the SWUM for a dynamics analysis. The simulation results show that the velocity obtained in the experiment corresponded to the fluid force exerted on the lower and upper limbs. Consequently, the proposed system of obtaining the joint motion of the butterfly stroke is suitable for daily training and coaching.

Chapter 4, Extension to Asymmetrical Swimming Stroke. The procedure in this system was similar to that in the butterfly stroke. The difference lies in the number of body segments in the model generation, an image segmentation method, and the method of identifying the right and left limbs. The human body was modeled into 15 segments. Due to excessive bubbles, the image segmentation used a Gaussian Mixture Model method. The right and left limb identification was conducted with the least square method. The intraclass coefficient between the results of the developed system and references was evaluated. All body segments, except the head and trunk, had a correlation coefficient higher than 0.95. Then, the dynamics analysis by SWUM was conducted. The simulation implied that the developed system was suitable for the daily training of athletes and coaches due to its simplicity and accuracy.

Chapter 5, Conclusion. The system is tried out in three main applications, i.e., running motion, bilateral symmetrical swimming stroke, and asymmetrical swimming stroke to investigate the system's accuracy and reliability. The main advantage of this system is that it is relatively simple and cheap. Moreover, the system also provides semi-automatic tracking instead of manual tracking to reduce swimming motion analysis processing time. Therefore, it is expected that athletes and coaches could use the proposed system for daily training in a shorter time than manual tracking to obtain an athlete's body motion.

備考：論文要旨は、和文2000字と英文300語を1部ずつ提出するか、もしくは英文800語を1部提出してください。

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