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Initial Evaluation of a Pose-Analysis System for Education of Disability Prevention with Stretch

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Abstract: Comprehension of disability prevention promotes learner's performance and motivation for continuity of physical learning/training. We designed a system for an educational program of the prevention associated with self-learning of specified stretch-poses through image analysis of the pictures captured by a smart device. The system detects the slight changes of muscle hardness due to narrowed movement range between body parts on the picture-images. Learner can obtain the awareness with appropriate stretch contents of disability prevention from the system in interval training and rest-time before/after training. The paper describes the reliability of system about extraction of movement range from the analysis result compared with the advanced measurement methods including goniometer and motion capture for baseball players as the initial evaluation. Additionally, we evaluated the difference between leaner's recognition from perception and measurement data for cognitive improvement.

Keywords: Stretch, awareness support, image analysis, precision evaluation, smart device

1. Introduction

Comprehension of disability prevention with an educational system promotes learner's performance and motivation for continuity of physical learning/training (Otsuka et al., 2011). In particular, Appropriate stretch in rest time before/after training or interval training, is desirable for the purpose of avoiding disability. Besides, generally, it is difficult to be aware of a problem of "tight muscle" which arises progressively in daily exercise subjectively based on fog of perception. For this reason, it is required for a learner that an educational program of the disability prevention which a learner can recognize the body change as an improvement point easily and objectively. Therefore we designed a system for the support of prevention associated with self-learning of specified stretch-poses through image analysis of the pictures captured by a smart device. The system detects the slight changes of muscle hardness due to narrowed movement range between body parts on the picture-images. Learner who is also player, can obtain the awareness with appropriate stretch contents of disability prevention from the system in interval training and rest-time before/after training. Heretofore, the measurement of movement range between body parts is often conducted by using the traditional methods of motion capture or goniometer (Johnson et al., 2002). For this reason, as a precondition, the reliability of precise measurement based on proposal with smart device including general-purpose should be revealed. Thus, this study describes the reliability of system about extraction of movement range from the result compared with the traditional and manual measurement method including goniometer for baseball players as the initial evaluation. Additionally, we evaluated the difference between leaner's recognition from perception and measurement data for cognitive improvement.

2. Preliminary Discussion

2.1 Scope of Target Poses

Although there are, in fact, different considering points according to characteristic of sports category, some players (i.e.: baseball, basketball, swimming, throwing events like shot-put) need the tenderness

of the neighboring muscles around the shoulder (Werner et al., 2001). We consider that the system can extract the flexibility of movement range related the tenderness while teaching how to stretch their body. We focus on three type of stretch around shoulder movement peculiar to scapula. They have influence on cowl and rhomboid muscle. Our system provides diagnosis which explains to tightness of muscle as a numerical score of movement range (e.g., 25 [cm]) through analysis like the left side of Figure 1. It also shows one of stretch poses as our targets.

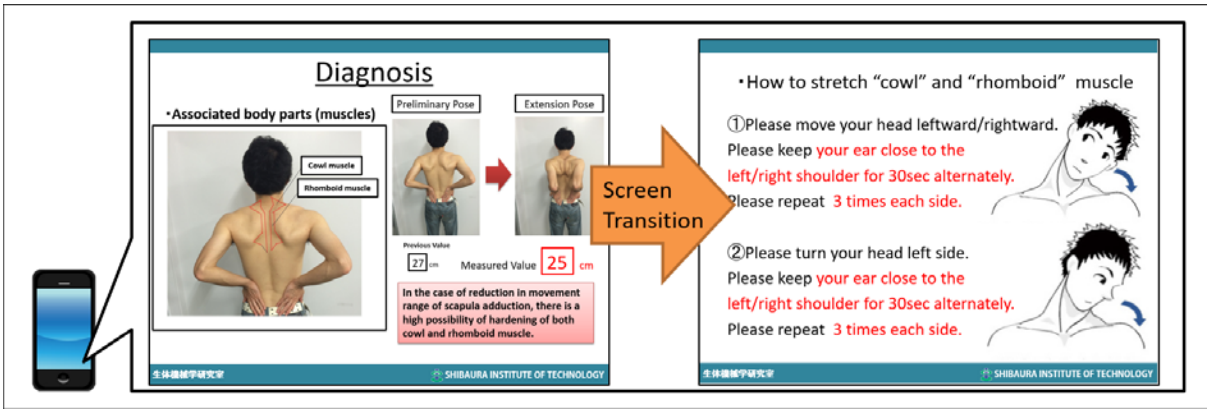
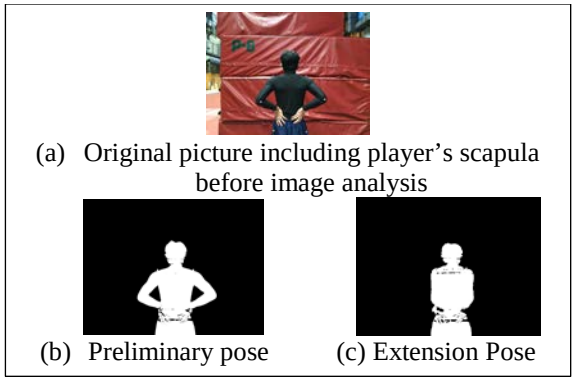


Figure 1. Example of analysis result and indication material about "How to Stretch" on smartphone

2.2 Analysis and Learning Method

Simple and contactless sensor based on skeleton model (e.g., Kinect) is often used as similar method. However, in the near future, we will also tackle the detail measurement focusing on undulating surface of body with lighting technologies (i.e., angle of incident light, light wavelength) because such a skeleton model has accuracy problem. Therefore, in this time, we chose the image analysis model. Captured image like Figure 2 (a) on smart device is sent to server and processed by image analysis module which illustrates Figure 2 (b) and (c) based on Intel Open CV. The system can derive the numerical score from specified coordinates which defines movement range (e.g., a distance between elbows on Figure). The coordinates are different depending on stretch types. The body height is inputted in the system preliminarily, and picture should be taken in the way of containing every part of the body. After that, the system proposes how to stretch like the right side of Figure 1 as the learning material.



(a) Original picture including player's scapula before image analysis

(b) Preliminary pose (c) Extension Pose

Figure 2. Flow of Image Analysis

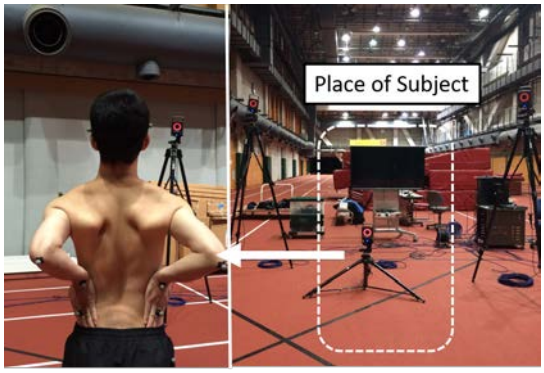


Figure 3. Measurement by motion capture

3. Initial Evaluation

3.1 Evaluation Method

We conducted an initial evaluation related to accuracy comparison each method with 11 players who has enough baseball experience. All the subjects are young male (average age: 22.3 ± 0.8 [years old], height: 170.2 ± 5.1 [cm] weight: 63.2 ± 8.4 [kg]). Apple iPhone 5S was chosen as smart device. We took comparison which consists of one of manual and two automatic-measurement methods. In the case

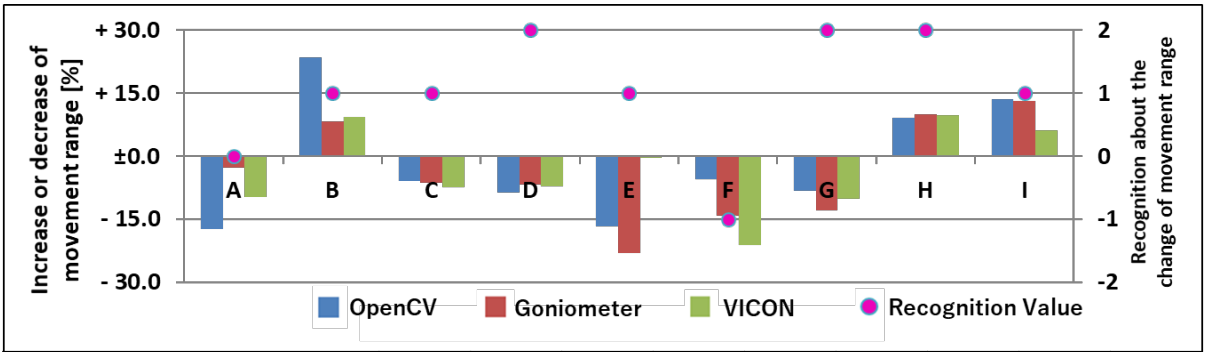
of manual method, the range was measured by a biaxial goniometer or measuring tape. On the other hand, as automatic measurement, we prepared the proposal system and motion capture VICON on Figure 3 with optical markers. The sampling rate was 250 [Hz]. Each subject had 50 trials of throwing. Before and after the throwing activity, we measured 3 types of stretch poses including Figure 3. Moreover, subjects answered questionnaire which mentions the question of recognition about the change of movement range defined as five stages (-2: feel narrowed, 0: same, +2: expanded).

3.2 Evaluation Result

Figure 4 shows the evaluation result except for 2 subjects who could not complete due to bad health. Basically, measurement accuracy of motion capture is the highest within 1 [mm] without relation to the result. Direction of vector which means positive and negative are same about all methods. The result of questionnaire makes it clear that 5 subjects felt “same” or “expanded” regardless of change which the range becomes narrowed.

3.3 Consideration

Proposal method with smart device had approximately equivalent accuracy compared with other advanced methods. Also it was confirmed that there were possibility of recognition about difference between perception and measurement score.



Subject		A	B	C	D	E	F	G	H	I
Increase or decrease of movement range [%]	OpenCV	-17.4	+23.4	-5.9	-8.7	-16.8	-5.4	-8.3	+9.0	+13.7
	Goniometer	-2.7	+8.3	-6.3	-6.8	-23.1	-14.2	-12.9	+10.0	+13.1
	VICON	-9.7	+9.4	-7.4	-7.3	-0.5	-21.2	-10.2	+9.7	+6.2
Recognition about the change of range		0	1	1	2	1	-1	2	2	1

Figure 4. The evaluation of recognition about movement range and measurement score each method

4. Conclusion

We will proceed the development of the system with consideration about difference of recognition.

Acknowledgements

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