DEVELOPMENT OF A MEASURING DEVICE FOR CONSTRUCTION FIELD WORKER'S WORK LOAD USING ACCELEROMETERS

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ABSTRACT: Construction workers are usually engaged in performing simple, repetitive motions using heavy material and tools in an uncomfortable posture and an unstable environment. These characteristics of construction work cause too much load to be placed on specific parts of the bodies of construction workers. Recently, the rapid pace of work resulting from mechanization has led field workers to be doing much more work. However, unlike manufacturing, which has a structured work environment, the environment of a construction site is not structured. Worse still, there are few tools to accurately measure the load on the musculoskeletal system, and the musculoskeletal disorders experienced by the workers have not been properly understood. As a result, it is urgently necessary to develop a tool to measure load on the musculoskeletal system. This research aims to present an MMI-based measuring device for construction field worker's work load that can measure factors of an industrial accident, such as a musculoskeletal disorders of the construction worker.

***Keywords**: Construction Worker, Musculoskeletal Disorders, Construction Safety, Work Efficiency*

1. INTRODUCTION

Musculoskeletal disorders refer to the disorders mainly reported in the neuromuscular system and surrounding parts caused by repetitive motions, poor working postures, immoderate use of strength, body contact with sharp face, and vibration and temperature. As there is low interest in safety of construction craft workers, a high incidence of musculoskeletal disorder among the workers could be vaguely estimated. Moreover, it is not easy to measure the diverse postures employed in the ceaselessly changing environment, which imposes restrictions on determining the actual condition. Hence, it is time to develop a method to measure the motions of the workers by utilizing advanced IT.

This research aims to present a scientific method of measuring the factors of industrial disaster, including musculoskeletal disorders, through the development of an measuring device workload from construction workers.

2. INDUSTRIAL DISASTER STATISTICS

According to a report on the current status of musculoskeletal disorders by the Bureau of Labor Statistics under the Department of Labor, the number of industrial disasters in the US has been decreasing, but musculoskeletal disorders accounted for about 34 percent of these. In Korea, the number of industrial disasters has been kept at a certain level, while the number of musculoskeletal disorders has been on the rise year after year. Hence, the incident of musculoskeletal disorders has increased over the years. It is also expected that the number of musculoskeletal patients will increase in the coming years.

There are restrictions in the extent to which construction craft workers can use tools to prevent such disorders. It is unavoidable for such workers to do their work in unnatural and uncomfortable postures repetitively in order to maintain continuity and sustainability. Unlike the manufacturing industry, little research on musculoskeletal disorders has been done in the construction industry.

3. SELECTION OF SUBJECTS FOR MEASUREMENT

Each task done by a carpenter, a structural steel worker, and a mason was analyzed twice in the field, and the body parts related to the musculoskeletal disorders affected by each work were also analyzed. The most affected part was indicated as the waist, but as the waist is linked to so many other joints, it is hard to accurately measure the extent to which the motion can affect the part. For this reason, wrist and shoulder were selected from the possible pain inducing body parts, since the two parts are relatively easy to measure [1].

Table 1 Possible pain inducing body part according to tasks by work type

	Carpenter (4)	Structural Steel worker (4)	Mason (5)	Total (13)
Head	0/4	0/4	0/5	0/13
Neck	1/4	1/4	3/5	5/13
Shoulder	4/4	3/4	5/5	12/13
Arm	1/4	0/4	0/5	1/13
Elbow	1/4	3/4	0/5	4/13
Wrist	4/4	4/4	5/5	13/13
Fingers	1/4	0/4	0/5	1/13
Waist	3/4	3/4	3/5	9/13
Knee	0/4	3/4	1/5	4/13

4. DEVELOPMENT OF MOTION MEASUING SYSTEM

4.1 Coordinate Transformation

In order to measure the motions at the wrist, elbow and shoulder, 4 sensors were attached at body, upper arm, the radius/ulna, and hand. For instance, when the upper arm is measured by the body standard, we can gain a vector value in the direction of tangent at the surface of the spherical coordination in the Cartesian coordinate system. Therefore, we can get the relative value of the motion at the joint by transforming the vector value into a spherical coordinate value appropriate for the circular movement.

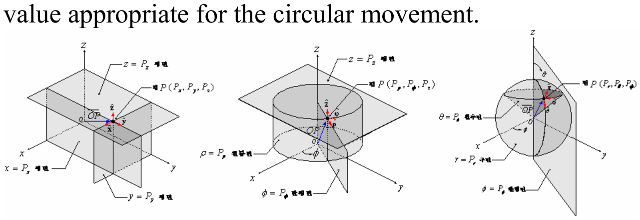

Fig. 1 Coordination System

4.1 Development and Verification of a System

In this research, a prototype was developed using an accelerometer, as shown in Fig. 2(a). The developed system was verified using a servo motor and an encoder. For verification, the servo motor was used to implement reciprocating rotary motions similar to the movement of a pendulum, ,and then the values A/B coming out of the encoder and the values coming out of the accelerometer were compared. Although the comparison results were similar, as shown in Fig. 2(c), the value from the developed device included a great deal of noise and errors. If the noise and errors build up, the errors become larger and larger, making it hard to accurately determine how much the joint moved. Hence, it is considered that to eliminate the noise and errors, the algorithm should be improved and the sensors also should be supplemented [2].

Fig. 2 Verification of a System

5. CONCLUSION

This research developed and verified a device to measure the movements of construction craft workers, which has previously been a difficult task. Acceleration sensors were used, but the test results had a great deal of noise and errors due to the restriction of the sensors. In order to eliminate the noise and errors, the algorithm and sensors should be improved.

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