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SPECTRAL ANALYSIS OF HUMAN TREMOR DURING COGNITIVE TASKS

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INTRODUCTION

Many stresses occur in our daily lives. Certain body tremors may be related to the stresses. There are two types of tremor; pathological and physiologically normal. The pathological tremor is often observed in patients suffering from stroke, head injury or Parkinson's disease. The physiological tremor is present in healthy subjects during both rest and motion conditions and may be related to daily life stresses. These tremors are usually recorded by a one-dimensional accelerometer. The vibrations recorded from healthy subjects are very small amplitude, invisible, motions ranging from 8 to 12Hz[1].

In this study, we recorded three-dimensional body displacements with a motion capture system while subjects were performing the tasks of intent listening, resting, reading and mental arithmetic calculations.

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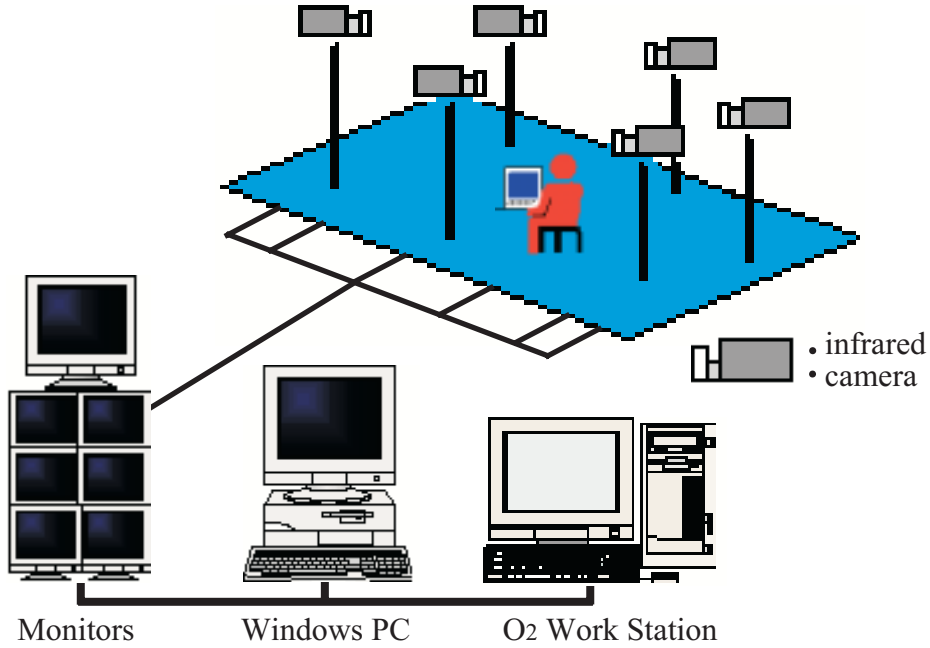
SYSTEM DESCRIPTION



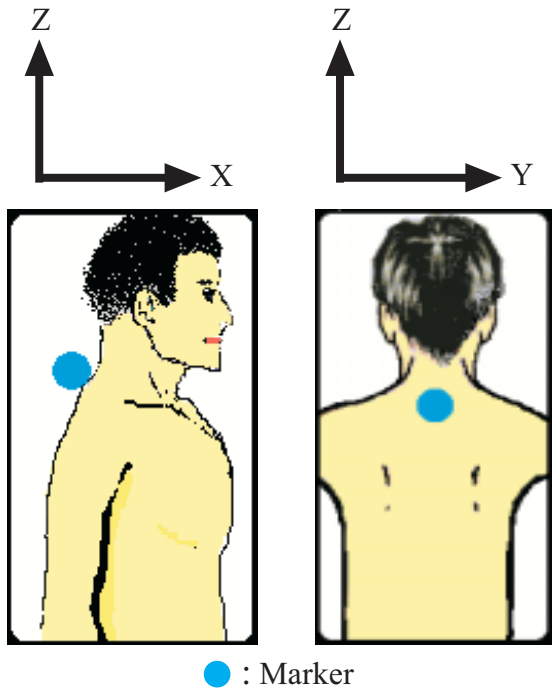


Figure 1. the three-dimensional body displacement recording system. The system consists of an infrared optical motion capture system(Motion Analysis Corporation, HiRES 3D) and a personal computer(Toshiba, Dynabook 4030X). The motion capture system consisting of 6 infrared cameras, a windows PC and a work station, is used to record the real-time X(back and forth direction), Y(left and right direction) and Z(perpendicular direction) three-dimensional body displacements, with minimal or no time delay. The data sampling frequency is 60 Hz and the spatial resolution is within 0.1mm.

METHOD

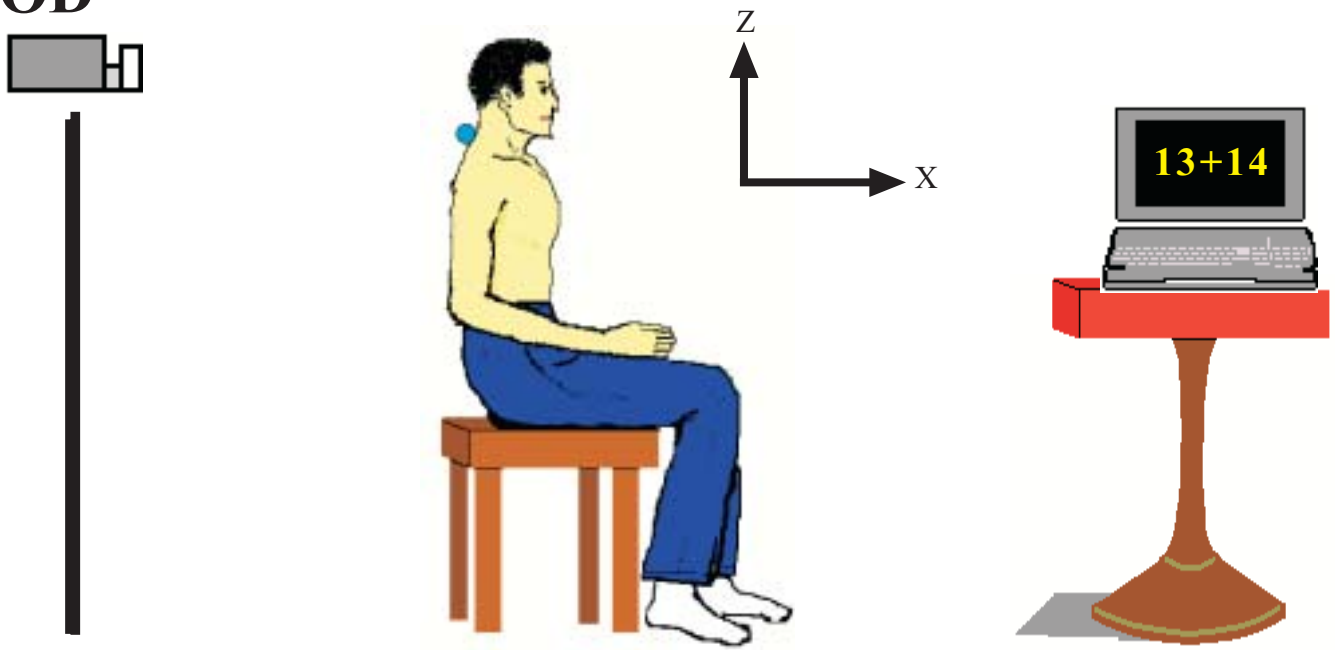


Figure 2. The experimental method of the three-dimensional body displacements. The healthy subject, who has an infrared marker reflector attached on the root of the neck for detection of the three-dimensional body displacements, sits on a stool, with hands placed the upper legs, while performing the tasks of resting, intent listening, reading and mental arithmetic calculations. The reading text and arithmetic equations are displayed on the screen at intervals of 20 seconds and 1 second, respectively. The personal computer is used to play relaxation music and to display the test routines, such as a newspaper text reading and mental arithmetic equations consisting of double figure addition and subtraction. The duration of each record is 70 seconds.

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RESULTS

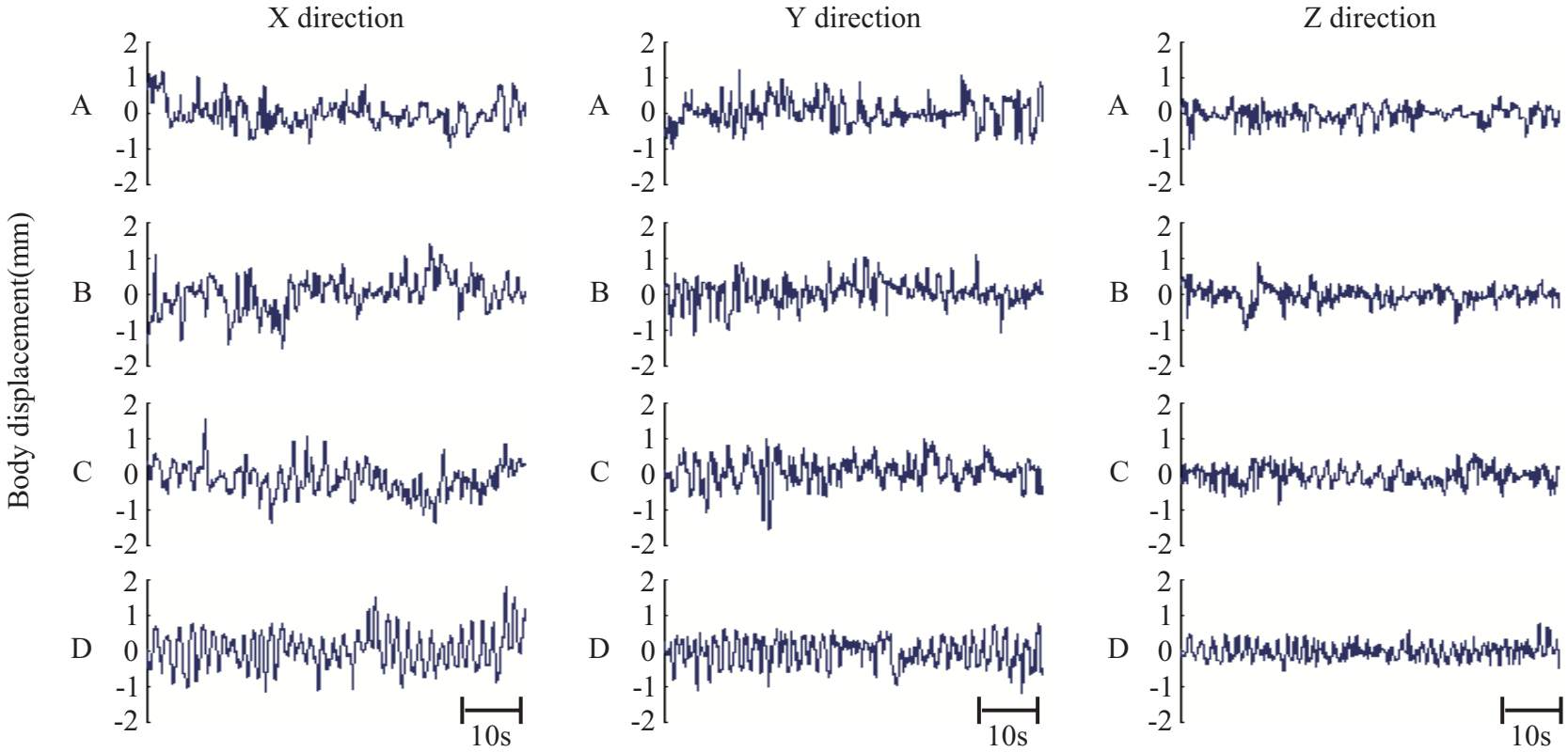

Figure 3. The typical X,Y and Z three-dimensional body displacements for resting(A), reading(B), intent listening(C) and mental arithmetic calculations(D). The X,Y and Z directional body displacements during the mental arithmetic calculations showed larger periodic vibrations than produced by the other tasks.

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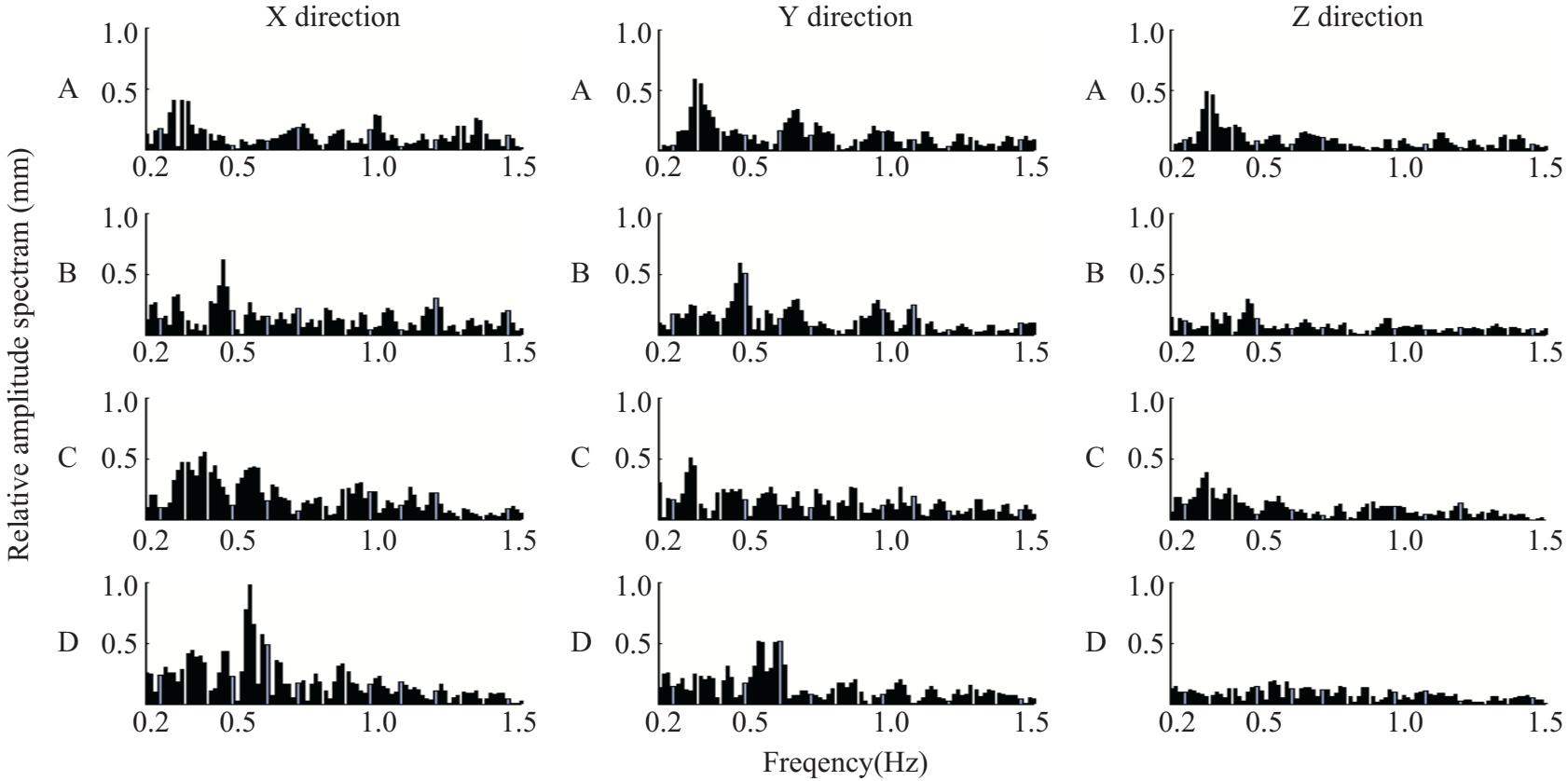

Figure 4. The amplitude spectrums of the X, Y and Z directional body vibration displacements from 0.2 to 1.5 Hz for all tasks. For resting, listening and reading the body vibration amplitude spectrums showed peaks in a frequency range up to 0.45 Hz. These components were recorded from all directions. However, the X and Y amplitude spectrums during the mental arithmetic calculations increased significantly in the frequency range of 0.5 to 0.7 Hz.

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CONCLUSION

Tremor is defined as the rhythmic movement of certain muscle groups and is similar to a very fast circadian rhythm. In this study, we recorded three-dimensional body displacements while subjects were performing the tasks of intent listening, reading and mental arithmetic calculations. The results indicated that the maximal body vibration was due to the mental arithmetic calculations. These tremor data, as well as the invisible general body micro-vibration, were obtained from the X and Ydirectional displacements.

REFERENCES

1) Tokuda Y., Yamamoto T., Sugata K., Isu N., and Simizu T.: Analysis of Stressful Change in Microvibration Components.: TECHNICAL REPORT OF IEICE. MBE96 - 108 (1997 - 01)