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Effects of multiple working positions on user comfort: A study on multi-position ergonomic computer workstation

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Abstract

Many people spend the greater percentage of a day working on computers in many different line of work. Some kinds of works even require continuous prolonged time for seated work on computers. Thus, a computer workstation should be comfortable as working long time in same sitting position could lead to a repetitive strain injury. To increase comfort of computer workstation, a workstation capable of multiple working positions by implementing ergonomic principles was proposed and a Multi-Position Ergonomic Computer Workstation was developed. Positions of this workstation were controlled using linear actuators. A working position of the workstation was a combination of positions of each part, namely seat, backrest, footrest and monitor post. In this paper, effects of multiple working position on user comfort were investigated using the developed ergonomic computer workstation. Four types of working positions were selected to compare the corresponding effects on comfort. Subjective evaluation methods were used to assess comfort in multiple working positions. The subjective evaluation was conducted by using selected volunteer people that tested the workstation for a given time interval. Test subjects answered questionnaire by rating the comfort scale of the workstation for major body parts based on their feelings in each working position. Results showed that different working positions have different scale of comfort; and in particular, one kind of position gives better comfort for specific body parts than another position. On the other hand, one kind of position was very suitable for some kind of tasks but not as suitable for different kind of tasks.

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Keywords: Multiple working positions; Comfort; Computer workstation

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1. Introduction

As we have become a society that sits for a greater percentage of the day, it has made the office chairs critical components in determining our overall comfort and health. So, these tools need to give comfort for the user since improper position could lead to a very serious Repetitive Strain Injury (RSI) especially for those who work very long time per day [1].

The problems concerning uncomfortable computer workspace are reflected on health and productivity. Improper sitting position for long time may lead to serious RSI by creating pain around neck, shoulder, lower back, arm, wrist, leg and also other parts of the body. In 2006 nearly half a million people in the UK suffered from some form of RSI [2]. The productivity of very long time workers per day will be reduced due to uncomfortable work place. Moreover, RSI is not limited to computer work but also distresses aircraft pilots [3], wheel chair users [4], car drivers and any type of work which involve sitting for prolonged time.

Ying Zheng and John B. Morrell [5] propose a real-time haptic feedback system that actively senses and guides a person to proper upright posture by using 7 force-sensitive resistors (FSRs) for posture detection and 6 vibrotactile actuators ("tactors") for haptic feedback; but it was limited to one position and it forced users to use a single sitting position. On the contrary, Paul Allie and Doug Kokot [6] studied about the natural motion of human body, especially movement of spine, while seated to offer a new thinking of dynamic back support in chair design. The researchers recommended that the design of a chair should follow the motion of the body to allow different postures. The impact of different reclined seating postures on typing performance and comfort for people with lower back pain was investigated and posture had impact on typing performance. But, the authors suggested more experiment and improved fixtures [7].

In this research, effects of multiple working position on user comfort were investigated using an ergonomic computer workstation. Four types of working positions were selected to compare the corresponding effects on comfort. A new workstation capable of multiple positions following the posture of a user was used as a study apparatus. This new multi-position ergonomic computer workstation was designed and developed in previous work [8]. It was designed by implementing ergonomic principles to fit user body in multiple positions so that it can provide better comfort for long time work on computer.

2. Methodology

2.1. Study equipment

A previously developed prototype of multi-position ergonomic computer workstation, which had 19 Degrees of Freedom (DOF) actuated by seven linear actuators, was used as a test equipment. Positions of the workstation were controlled by changing strokes of each actuator in different stroke combinations. These actuators with mechanisms changed the position of the workstation parts, which are the headrest, backrest, seat, armrest, footrest, monitor and keyboard, to get a required working position. The actuators had a different velocity and the positions were controlled separately. A control panel was assembled on the left hand armrest for easy access at the tip of fingers. The actuator and the control switch were connected to the control box. The control switch had two switches for extension and retraction motion of each actuator. Each actuator had its own control switches on the control panel and they were controlled separately. The workstation could accommodate from 5th percentile female to 95th percentile male human size.

The workstation was designed to have multiple positions from lower limit of leaning forward to upper limit of leaning backward. However, four different working positions were selected for this evaluation. These preset working position were chosen for their different features and speculated ergonomic advantages as stated below.

- *Upright Position (UR)*: This is the common position where the spine is vertical. The angle between torso and thigh; and between thigh and leg is approximately 90degrees (Fig. 1a).
- *Lean Back Position (LB)*: This is a position where the user reclines back from the backrest to a certain designated angle and stretch leg to the front above the ground. It minimizes the stress at the lower back and seat by allowing even weight distribution. The spine will be supported following its neutral profile (Fig.1b).