# 論文 / 著書情報
# Article / Book Information

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| 著者(和文) | WorkinehSisay A |
| Author(English) | Sisay A Workineh |
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# 論 文 要 旨

THESIS SUMMARY

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| 専攻：<br>Department of | Mechanical and Control Engineering 専攻 | 申請学位（専攻分野）：<br>Academic Degree Requested | 博士 (Philosophy)<br>Doctor of |
| 学生氏名：<br>Student's Name | Workineh, Sisay Ayichew | 指導教員（主）：<br>Academic Advisor(main) | 山浦 弘 教授 |
| | | 指導教員（副）：<br>Academic Advisor(sub) | |

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）


Since the first desktop computer was introduced, a lot of advancements have been achieved concerning computer speed, efficiency and size. However, there hasn't been a substantial development in the way we interact with computers at workplace. Studies indicated that discomfort at workplace negatively affects overall health and productivity, especially for people who spend most of their work-time seated at their computer. Thus, a novel concept of computer workstation, named Multi-Position Ergonomic Computer Workstation (MPECW), which allows users to work in multiple working positions was proposed to improve comfortability of a workstation. The core idea was that working position of users should not be restricted by the workstation setup; rather, the workstation should be able to follow the motion of users to allow different alternative working positions.

The newly designed Multi-Position Ergonomic Computer Workstation had 19DOFs, where 7DOFs were controlled by linear actuators that change the position parameters of the backrest, the seat, the footrest and the monitor-post. The workstation was designed to accommodate a population from 5th percentile female to 95th percentile male human size. The maximum safe load it can carry was 96kg of user body mass. Among multiple possible alternative positions, four working positions were selected: Upright, Zero-Gravity, Lean-Back and Lean-Forward positions. A prototype was also developed.

The mechanisms were governed by seven parameters - four angular and three linear - which were directly associated with the corresponding strokes of each of the seven actuators. The parameters were defined in the function of the corresponding strokes using direct kinematic equations. The position change sequences between the four working positions were determined by defining transitional positions that allowed interference-free and comfortable position changes. The control system estimated the current position from the values of the parameters and set new parameters

corresponding to the goal position. Simulations were carried out to test the position control system.

Evaluation of the prototype workstation was carried out by recruiting test subjects. A test protocol, named General User Comfort test, was used to assess the effects of the four selected working positions on the comfort of different body parts and on the overall comfort of a user. Participants rated body parts comfort on a questionnaire after working on each of the four working positions. Body parts were also grouped into three to identify if comfort was regional. The effect of the positions on the type of task performed was also analysed.

Another the test protocol, named Real Time User Comfort, was conducted to evaluate the comfort of different body parts and the overall comfort of users during working on the prototype and compare the results with working on a 'standard' workstation setup. Participants rated body parts comfort on a questionnaire after working on the MPECW for two continues hours; and again after working on a standard setup. The test also included the assessment of seven main workstation parts that had a major contribution to the overall comfort.

The findings from this study can be concluded as follows.

- The posture control system could achieve a smooth transition from the current position to the goal position.
- The longest time to change from one position to another was less than a minute (53 seconds) and the shortest time was 15 seconds.
- Different working positions provided different scale of comfort for different body parts. The type of task performed had an effect on the comfort of body parts in each position.
- The middle and lower extremity exhibited more comfort as the working position changes from upright position to reclined positions. However, the comfort of upper extremity (like shoulder, arm, wrist and hand) was affected negatively when reclined.
- There is a significant impact on overall comfort due to working positions, $p < 0.05$. Overall, the lean-back position was the most comfortable position and lean-forward position was the least comfortable position among the four positions.
- There was a significant improvement in the comfort of almost all body parts, $p < 0.05$, except wrists and hands ($p > 0.05$), compared to 'standard' setup. Especially, the comfort of lower extremity was significantly improved, and it was due to the comfort of footrest. Similarly, comfort of parts of the workstation were significantly different from comfort of

parts of a standard setup, except for keyboard and mouse.

- The overall comfort of users was significantly improved by working on the prototype workstation, $p < 0.05$.
- Automatic control delivered smooth and quick position change, and resulted a relatively equivalent comfort across body parts; but, it restricts the workstation to only four working positions. A manual control was suitable to work on many alternative working positions and fine-tune working position in proportion to personal height. So, a combined control system was recommended for this workstation design.