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Development of an ergonomics checklist for the evaluation of medical tablet personal computers

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Abstract

This paper focuses on the ergonomics evaluation of Medical Tablet Personal Computers (MTPCs). The research questions for the study were "What are the key ergonomics issues in the safe and effective use of a Medical Tablet PC" and "How can we evaluate new Medical Tablet PC concepts in the early stages of the design process". The aims of the study were to develop an ergonomics checklist for the evaluation of MTPCs and to identify key ergonomics issues in the design as well as in the usage of MTPCs. In the first step of the study we undertook an overview of the checklists developed for computer workstations and mobile computer devices that are found in the human factors literature. This overview resulted in a categorization of checklists based on their organizations, rating scales, general purposes and level of detail. In the second step of the study an interview was conducted with 29 doctors; with a wide variety of specialization; in various hospitals to explore important issues as well as problem caused by computer usage. As the result of the analysis of answers given to interview questions and analysis of other checklists based on computers and medical devices 5 key concepts were chosen as the structural elements of the ergonomics checklist that is the primary output of this study, These key concepts are mobile usage, portability, office usage, cleaning and disinfection and hardware evaluation.

*Keywords:*Ergonomics checklist; Medical tablet computers; Mobile computing

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1. Introduction

Medical Tablet Personal Computers (MTPC) are novel and innovative products in the field of computers with a focus on professional usage. They are developed and designed for the informational and computational needs of medical doctors (MD) as well as other medical personnel who are employed mainly in hospitals where the user has a high mobility during his professional activities.

However, as mobile computers, MTPC's can be a serious source of potential health problems for their users. Mobile usage of any of computer-based device occurs mainly in unnatural postures and positions that may cause serious health problems. Actions such as touch-screen usage, electronic-pen data entry and single-hand holding during usage cause different potential health problems for the user. Most consumer tablets are highly similar in terms of industrial design of the body, however in contrast to this fact the, purpose-builtMTPC`s the design differencesare more evident and imply different user-interaction typologies for their users. A large number MTPC designs can be found in the industry-focused websites such as Medical Expo [1]. A quick examination of various designs clearly shows that the physical interaction possibilities of MTPS`s are larger than consumer tablets or laptops. Inevitably, these new usage possibilities will result in new health problems in users. In terms of technical infrastructure they do not differ greatly from commercial leisure-based versions. They usually operate EMR software from a central server found in the hospital Therefore they must have an uninterruptible connectivity with the server. On the other hand these devices have a wide potential usage spectrum besides EMR software.

This study is based on the physical ergonomics evaluation of MTPC designs and is the first stage of a larger scale research that is planned by the first author. The scope of this study is to identify user needs for MTPC concept designs and to develop an ergonomics checklist to be used in the planned future research related with this study. The aim and the focus of the planned research will be to study and explore the ergonomics hazards and risks resulting from long-term usage of MTPC designs and will include stages such as concept refinement, detailed design, design prototyping and ergonomics and usability testing. The interview data constituted input for an industrial design workshop to generate MTPC concept designs to be used in the future planned study. Because the outputs of the design workshop will constitute core input data for the future planned research, they are not presented and included in this paper.

2. Ergonomics issues in mobile computer usage

The ergonomics issues related with the usage of MTPC`s cannot be separated from other types of computers and computer based mobile products. It can be said that tablets filled the user-need gap between laptop computers and smartphones. Although there is a product evolution beginning with desktop computer workstations towards tablets, standards are mostly based on desktop computer workstations. The regulations and the ergonomics literature such as Hünting et al. [2], Stammerjohn [3], Grandjean [4], Sauter et al. [5], Berqvist et al. [6], HSE [7], ANSI/HFES [8], ISO [9], Brand [10] are mostly based on desktop computers and laptop computers. Although the ergonomics considerations for laptop computers are covered in these documents and studies the general approach is to prevent users to use laptop computers in mobile contexts and to give some recommendations to transform these devices to desktop computers by adding external monitors, keyboards and other input devices such as mice or trackballs.

In comparison to laptop computers, tablets can be considered as computers more dedicated to the concept of mobility because of their limited size and limited capacity of information processing. However, in terms of academic research, study based on tablets is very limited. Most of the research done for tablets are in the marketing field. Lozano et al. [11] studied kinematic and kinetic measure when interacting with touch-screen tablets. Their research findings showed that these interactions affect the entire shoulder system and gestures involving two fingers can increase muscle activation levels. Young et al [12] investigated head and neck posture for various usage configurations adopted by users and how neck and head posture varies with different tablets and their case designs with different tilt angle settings. They indicate that the observed head and neck flexion angles were far from neutral angles that can be found in human factors literature. In a following study,Young et al [13] studied postures of the shoulders and wrists and their associated muscle activities during tablet usage. They findings tells us that the use of touch-screen tablet users generate unnatural wrist and shoulder postures along with high forearm extensor muscle activity in some configurations. Stawarz and Benedyk [14] studied the health effects and possible risks of tablet