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主 論 文 の 要 旨

論文題目	Measuring the Readability of Electronic Devices: A Study of the Effects of Illuminance, Font Sizes, and Visual Acuity （電子情報機器の可読性の測定：照度、文字サイズ、視力の影響に関する研究）
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論 文 内 容 の 要 旨

At present, the commercial development of visual display terminals (VDTs) is moving at a rapid pace. The market is replete with many gadgets made for all ages. These devices require both visual and tactical manipulation and can affect a person in a variety of ways. Consumers of such products should not only be wary of price and quality but the safety of such devices. In this respect, safety refers to visual fatigue which is related to the performance of the reading device. While the International Organization for Standardization attempts to keep pace with the market changes, many of today's advances are moving ahead of the recommended standards for usage of such products. Thus, this dissertation focuses on the effects of illuminance, font size and visual acuity on the ability of people of all ages to read from such devices.

The field of ergonomics is concerned with understanding how humans interact with other systems (particularly mechanical) and as such has done much work in areas related to the impact of computer technology on the physical well-being of humans. Influences such as environmental lighting, contrast ratios, visual distance, font type and sizes as well as the condition of the individual eye are all of concern when studying the interaction between human beings and such technology. As such, this dissertation focuses on the effects of environmental illuminance, font sizes and visual acuity because they cover an environmental factor (lighting), a mechanical element (fonts) and elements of the human condition (aging and lens cataract cloudiness).

The study encompasses a look at some of the main VDTs available on the market today including the backlit type Liquid Crystal Display (LCD), e-ink with the front light type (Electronic Paper Display with an Integrated Light Unit), and the standard E-ink or E-reader (Electronic Paper Display without front light). Much of the literature has focused on the readability of LCDs and so the primary interest in this study is a comparison of these two different types display terminals.

This dissertation represents the combination of three different experiments that studied the readability of various electronic devices under different aspects of environmental conditions and visual performance. All three experiments included the participation of 95 or more subjects in measuring and evaluating the ease or difficulty of reading in English from various devices under different conditions. The main reason for using English was because of an interest in the development of globalized standardization with regard to the usage of electronic devices. Conventional paper text was used as a comparative reference because manufacturers of such products often claim that their innovations are close to paper.

In the first experiment, 110 participants took part in a study that evaluated the performance of an LCD, an Electronic Paper Display (EPD), and an EPD with an Integrated Light Unit (ILU-EPD) under 14 different levels illuminance. The experiment included both objective and subjective measures. First, the participants read aloud from a text block for each level illuminance, and the experimental team collected the correct number of responses. This procedure was done for each device including the paper text. Second, after reading from text block of words, the readers evaluated the readability of each device using a Visual Analysis Scale (VAS). The results indicated that all the devices were equally readable between 200-500 lx; however, the readers rated the LCD and ILU-EPD as easier to read at less than 200 lx compared to paper and the EPD with no additional lighting system.

The second experiment looked at the readability of the Courier font type and sizes on different visual display terminals. Courier is a monospaced font type that allows for ease of objective measurement in terms of evaluating the visual performance of electronic devices. In this test, 99 readers grouped according to age looked at and evaluated 8, 12, and 16 point sizes on an LCD and electronic device, with paper text as a reference. A two-way ANOVA was used to check for significance. The results from this experiment found that individuals under 65 years of age could read at the 8 point size while those over 65 years of age found it difficult.

The third experiment measured the effects of aging, visual acuity, and lens cataract cloudiness on the legibility of two fonts displayed on an e-paper device. The study compared the legibility of a serif font (Times New Roman) and sans serif type (Helvetica) as discrepancy exists in the literature as to which font type is best for screen terminals. The study included 133 participants who were measured according to their binocular near visual acuity for 50 cm. The results from this experiment indicated that the legibility of e-paper displays is influenced by age, cataract cloudiness, and 50 cm visual acuity.

The results of the above three evaluation experiments reported in this paper give useful knowledge on the readability of characters of various types of e-book terminals in order to standardize for the safety of users, and it contributes to the international standardization.