Human Color and Visual Information Processing Investigated by Psychophysical Approaches and Development of Applications with Computational Model Simulation

Project Leader

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1. Objective

Color and visual information play crucial roles, being the central medium of human related information processing. In information systems, which process all forms of information involving humans, color and visual information are the primary means of information presentation. In particular, color is used extensively in information systems and technologies. However, scientific and applicability aspects of human visual information processing and human behavior have not been well investigated. In addition, many studies in visual perception have not mentioned potential and practical applications of their findings, and many of the applicable studies in visual information processing, such as image analysis and image retrieval, have ignored how the human brain works to process images. Therefore, within the context of knowledge of human perception and recognition, this project aims to deepen our understanding of color and illumination control, shape and color recognition, and visual information processing in behavioral tasks. Subsequently, algorithms for applications will be developed that focus on computational model simulation methodology.

2. Project Outline

This project has three research areas, as follows.

(a) Age-related Changes in Visual Perception:

Human vision senescently changes because of anatomical and physiological age-related deteriorations. Specifically, increment of lens density and decrement of cone sensitivities with age should cause extensive changes in visual perception. However, these changes affect little in many aspects of visual performance. For example, color appearance is relatively stable throughout a person's life span. In this research area, age-related change in visual performance will be measured, and estimate these changes by means of empirical models. [See refs 2, 6, 11 and 12]

(b) Color Perception and Color Processing Models:

Some people have dichromatism in color vision, in which only two independent colors rather than three colors are required to match a certain color. Red-green dichromatism is a typical dichromatism; it causes reduced appearance of both redness and greenness. However, dichromatic people can accurately identify color names of standard color chips, even they cannot discriminate red and green in color tests. In this area, further investigation will be made to clarify this unexpected conflict. [See refs 1, 2 and 6]

(c) Impulse response functions (IRFs) of Human Visual System:

Impulse response function (IRF) is defined as perceptual and/or cognitive response of entire human visual processing system to a flashlight as a function of time. Regardless of the uncountable number of neurons concerning to the information process, the human system can control and synchronize divided information in the brain and can make a certain perception (and/or cognition). Thus, measurement of IRFs with sophisticated stimulus can be a good tool to investigate and analyze subsystems of the human visual processes, such as color and shape. [See refs. 4,6, and 11]

In sub-projects in these research areas, the basic procedure will be: firstly human observers' visual performance will be measured and analyzed to find factors that influence performance. Secondly, a computational model will be made based on those factors using model simulation of the human visual performance. Thirdly,

accuracy of computational model simulation will be evaluated by comparison with real visual performance.

3. Expected Performance

In this project, the successful candidate would be expected to:

(a) Make good proposals regarding a project including experiments, especially for a Ph.D. (SSP) project. (This part will be initially evaluated by the research proposal in SSP application documents)
(b) Contributing to supervisor's projects to learn protocols and procedures for high quality research.
(c) Working independently in experimental preparation, work and data analysis.
(d) Assisting the senior members (most likely masters students) in the lab in all aspects of research activities.
(e) Share routine work in terms of managing the laboratory.

4. Required Skills and Knowledge

The successful candidate for this project will have the following knowledge and skills:

(a) Some background in vision, brain and/or psychological research is strongly preferred.
(b) Ability to communicate effectively in English, including writing research papers in English.
(c) Ability to adapt quickly to new research areas.
(d) Ability to collect, analyze and report to English research publications.
(e) High motivation to conduct foundation research on human factors.
(f) Programming skill (MATLAB), and strong ability in mathematics are preferred.

SSP status is restricted to a three-year period; all SSP students have to write at least two excellent research papers for established English language journals within three years. Thus, it is strongly recommended that the accepted candidate will join the supervisor's project immediately and soon establish one project in the four research areas as the core of his/her Ph.D. thesis. Additionally, the candidate's proposals for new, creative, and interesting research subprojects are welcome.

References (Underlined authors are SSP graduates of this laboratory)

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