

Graduate School of Science and Technology Master's Thesis Abstract

Laboratory name (Supervisor)	Ubiquitous Computing System (Keiichi Yasumoto (Professor))		
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Thesis title	Human-Centric-Lighting System to Induce Better Emotion		
Abstract			
<p>Smart home includes home automation as its main function, and it is an inevitable trend in the development of modern society. As the name implies, some automated systems are used to control the home environment, including temperature and humidity, lighting, windows, and even home security systems, gate control, various alarms, etc., to provide a safer, more comfortable and convenient home environment. The purpose of smart home is to improve people's quality of life (QoL). A good quality of life is very important for maintaining people's physical and mental wellbeing. Therefore, how to use smart home technology to provide an optimized environment for individuals will be an important topic to make people live more enjoyably and comfortably. There are many environmental factors that affect people, such as humidity, temperature, sound, lighting, etc. Among them, the focus of this thesis is the lighting color. Many studies have pointed out that the color has a significant impact on human emotions, however, the preferences and effects of lighting color are different from person to person, and also from situation to situation. Therefore, in this thesis, we propose a human-centric-lighting (HCL) control system with adopting the reinforcement learning to find a personally and situationally optimized lighting. The goal of this thesis is to provide users in different situations (e.g., working, cooking, eating, relaxing, etc.) with a more suitable lighting color, and bring users a better emotional state.</p> <p>The proposed approach is to train a reinforcement learning model for each user and each situation. The reinforcement model we used is Deep-Deterministic-Policy-Gradient which is an improvement from Deep-Q-Network and Q-learning. To find the optimized lighting color for user, it needs to be trained with many repeated episodes (e.g., thirty episodes) where each episode includes actuating bulbs with a proposed color and obtaining emotional feedback from user but it will be a heavy burden for users. To solve this problem, we propose a novel method which applies to a new user a model pre-trained with sufficient number of episodes for fine-tuning, so that the number of episodes for training is reduced to a great extent. Besides, we have implemented a prototype of the proposed human-centric lighting system. The system consists of smart bulbs which can set one of 360 different colors through Wi-Fi and a PC which runs the reinforcement learning model we developed. To validate the proposed system, we conducted a usability test with five participants at a living room of NAIST smart home where six bulbs were deployed. First, the original model was trained by a person not included in the participants with 30 episodes. Then, the original model was fine-tuned by each participant with 10 episodes during each task.</p> <p>Two tasks were set for reproducing two situations for each participant: working with PC and relaxing by watching TV. After each task, each participant was asked to fill out a subjective questionnaire (preference for the resulting color, improvement of emotional state, etc.). The result of questionnaires showed that all users agreed that the final-adjusted lighting color is positive to their emotion. In addition, 90 percent of the answers indicated that users agreed that the final-adjusted lighting color matches their preferences and they have high willingness to install this lighting control system at home.</p>			