**Research ethics clearance application to GTIIT**

**Section A: Applicant details**

Application Date: 2024/01/26

First name: Zehao

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Is this a generic research application?

Yes, it is.

Department: Mechanical Engineering and Robotics

Applying as: Recruiting human participants aging from 20 to 30 and collecting data on their walking around in the home environment and turning lights on and off.

Research project title: A Smart Home that Learns Inhabitant’s Habits and Achieve Automatic Light Control.

Undergone any other academic review or any similar applications?

No.

**Section B: Basic information**

Co-applications / collaborators:

Mingyi Liu, Zehao Kou, Zuojun Jiang

Proposed project duration:

1 week, 2024 January to February.

Does this study involve work with vulnerable participants, human tissue, social care research, participants lacking the capacity to consent or sensitive topics?

No.

Does this research involve work outside this institution?

Yes, the research will take place in LinYuYuan, which is a community 1km away from the campus.

Personnel involved:

Mingyi Liu, Zehao Kou, Zuojun Jiang, etc.

**Section C: Summary of research**

Aims and objectives.

The study aims to study the human habits of switching lights on and off in the home environment and automatically control the lights according to different user behaviors. Motion sensors will detect the position information of users while the participants moving in the home.

The study dataset aims to automatically annotate a more comprehensive range of user-environment interactions and includes user control data for actual lights, facilitating real control during the validation process. While participants moving in the home environment, the motion sensors can detect the location information and the algorithm will recognize the corresponding personalized light states.

Research proposal

For the study of real smart lighting systems, we will study the living habits of different groups such as young people, the elderly, children or workers, retirees, etc., and the special needs of the same people at different times, collect a variety of different data for in-depth research. Among them, our research focus will be placed on how to develop a system with strong adaptive ability and strong learning ability. To reduce the residents' relearning labor for smart lighting and improve the fast response ability of the algorithm, we will study the possibility of applying large models in intelligent lighting and the algorithm with strong adaptability such as reinforcement learning. In addition, we will pay attention to the occurrence of special cases in the data set. From the point of view of data, abnormal data needs to be removed or repaired, but abnormal data in the real world must be considered. For example, usually, users will work on weekdays, at this time the home does not need lighting, but if the user asks for leave on a certain day, although it still needs lighting on weekdays, for such "abnormal data", we will focus on the study. In other words, we should distinguish between the wrong data caused by noise and the special data generated by users' special needs, and correctly fit the special data and correct the wrong data, which is the main research object of this study. By building an experimental platform, collecting and analyzing data, building models and testing models, inviting volunteers to participate in the experiment, optimizing the experimental platform according to the volunteers' feedback, and collecting their data again, forming a cycle in which the model is iterated constantly, problems are found and solved, to realize the construction of smart lighting system. Our final goal is to detect less and less of the number of times volunteers manually turned the lights on and off.

For the actual smart lighting system construction, a series of sensors, including a brightness sensor, Passive Infrared (PIR) sensor, water sensor, temperature and humidity sensor, door and window sensor, and indoor positioning tool, are deployed in the apartment to comprehensively detect the physical parameters and changes caused by residents' activities. Subsequently, the lighting equipment is transformed, and the switch panel of hidden lights, spot lights, tinting lights, and ceiling lights are replaced with a switch panel with network functions and data transmission and reception capabilities. This makes it possible to monitor and control the lighting system in real-time through a network connection. Once the hardware is installed, we will initially set up some control light processes according to the daily lighting scene in real life, for example: when watching a movie, we will reduce the light, at this time only a few hidden lights are needed to provide illumination, when communicating with friends, turn on the ceiling light and get enough lighting environment, when exercising, use the tinting light to provide a passionate environment. After a series of tests, we will analyze the collected data and try to use machine learning, reinforcement learning, a large language model, and other ways to predict the user's lighting needs. After the accuracy has been improved, a group of volunteers will be invited to live in an apartment for the test. Volunteers will be free to control the lights according to their personal preferences.

**Section D: Methodology**

The participants need to walk around in the apartment and sit down for so while. All the behaviours are decided by them as well as switching on/off lights. For example, some people prefer to switch off the lights while after they leave a room while someone tends to keep the lights on. We need to use algorithms to learn they different behaviors and control the lights in the way they want. The motion sensors can detect the movement of people when they are in the detection range. They motion sensor data will be labelled with the states of the lights and trained in convolutional neural network (CNN) after processing. We will deploy a server in the apartment for training, communication and computing. Finally, it can achieve real-time control the states of lights according to the location of the participants.

**Section E: Elements of Research Methodology that Involve Human Participants (not more than 1/2 page)**

The participants need to randomly walk or sit and turn on/off lights according to their preferences in an apartment located in LinYuYuan near to our campus. They are asked to do this test for around 5 minutes and repeat it for another 9 rounds. The participants will have rests between each round and unnecessarily control the lights strictly in the same way in each round, but the path should be the same.

Personal safety – does this project raise any personal safety issues?

Participants only need to walk and sit in the apartment and using smart phones or switches to control the lights. They are asked to peacefully move in the apartment and take enough break between every test round. The whole process does not involve strenuous exercise or contact with hazardous electrical appliances.

**Section F: Risk Assessment – for New Data to be Collected from Human Participants**

Since the data is collected by motion sensor, which is installed on the celling of the apartment, the participants will not face any risk when new data is generated. They only need to access to cell phones and light switches, so it is very safe and insurance is not needed.

**Section G: Funding (Please specify the source of funding)**

Mingyi Liu’s start-up fund.

**Section H: Data Retention**

How long will the data containing personal identifiers be kept after publication of the first paper arising from the research project?

No longer.

How long will the anonymized data be kept after publication of the first paper arising from the research project?

Seven years.

**Section I: Declaration**

I declare that the information provided herein is accurate and representative of the experimental plan. I understand that any significant modification of this study methodology requires further ethical approval. This work may not be carried out until ethical approval is obtained by the University Ethics Committee.

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Signature of Applicant