Project Summary: Affective Buildings

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This project investigated the feasibility of inferring discomfort glare in occupants using facial action unit (FAU) measurements and wearable technology. The more broader aim of this project was to work towards the development of an occupant-centered automated control strategy for façades in office buildings.

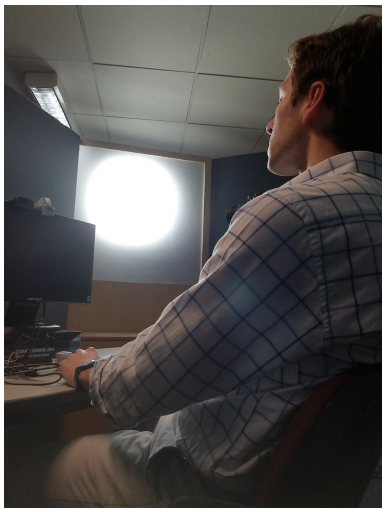

Figure 1: Glare from sunlight negatively affects productivity and comfort in buildings

The investigation was carried out using an experimental approach. Firstly, novel methodologies to capture the occupant response to glare were developed, consisting of: i) Novel wearable technology to measure the levels of vertical illuminance on occupants; ii) Novel Facial Action Unit sensor to detect discomfort glare in occupants. These novel methodologies were then tested in an experimental setup. Volunteer participants were given tasks to perform on a computer, during which glare was induced using a diffused LED light source.

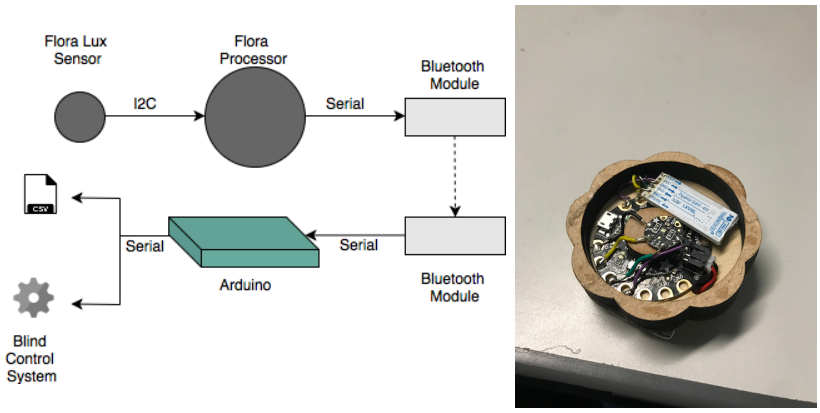

Figure 2: Wearable Light Sensor Developed As Part Of The Project

Figure 3: Setup of Experiment

The facial action units related to occupant discomfort glare were then selected based on findings of previous research, as well as preliminary experimental results. Analysis of the FAU were then correlated with the light measurements from the wearable technology. Initial findings showed that participants exhibited identifiable and repeated responses, which corresponded to the introduction of the glare source. These responses can be used reliably in an automated facade shading strategy.

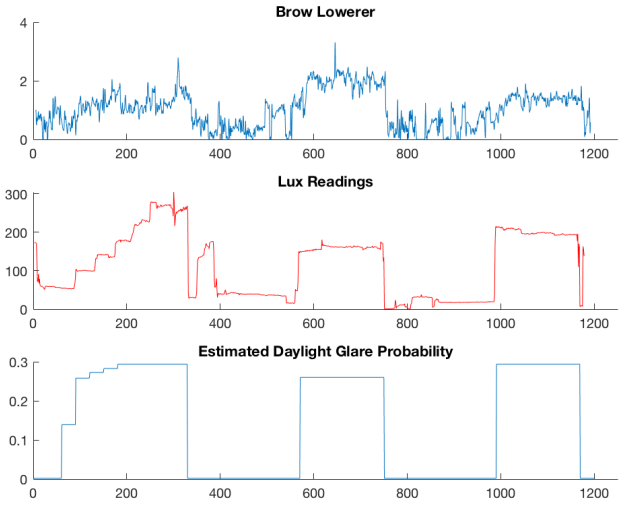

Figure 4: Sample results from one participant

Further non-experimental analysis looked into possible methods of controlling an adaptive facade using these measurements, and identified certain calculations which could be done to improve reliability. Suggested methods mainly involved computing the deviation from an expected reading based on historical values. Smoothing and making selective choices about which readings should contribute to the expected reading were found to be important for reliability.

Finally, a survey was conducted to investigate occupant acceptability of this novel occupant-centred methodology in order to address concerns about the reliance of the proposed method on a video stream of the user's face. Respondents showed a likelihood of accepting a final product which fulfilled proposed privacy features including device isolation, limited memory and recording only when in use. Further suggestions from participants imply a requirement to be able to manually turn off and on the device.