Guiding a tourist's gaze through urban space with 3D audio

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1 Introduction

Audio guides are a staple of tourist information, but the currently available systems merely provide content based on the location of the user ("Condition A"). The LAMETTA system[1] uses eye tracking to play audio only when a user focuses on areas of interests (AOIs) ("Condition B"). In our study, we investigated if adding 3D audio to LAMETTA (i.e., audio coming in the direction of the AOI) improves the overall performance of the system and the user experience ("Condition C").

2 Study overview

We adopted a between-subject design with 46 participants randomly assigned to one of the three experimental conditions. Their goal was to find predefined AOIs in a panorama view of Chicago while listening to the instructions and narration of the audio guide.

The experiment was conducted in the AudioVisual Lab with three large projection walls. During the study, the participants' eye gaze directions and electrodermal activities (EDA) were measured. Also, participants were asked to press the space bar in case they lost interest and felt bored in the process.

Fig. 1. Participant during the experiment

After the experiment, usability data was collected using questionnaires, including the User Experience Questionnaire (UEQ), System Usability Scale (SUS) and the NASA Task Load Index (NASA-TLX).

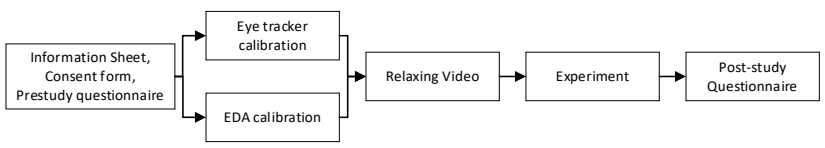

Fig. 2. The study procedure

3 Visualization

To support statistical findings and allow for an easy exploration of the data, a visualization tool was developed. The tool consists of different sections, displaying the data of a specified group of users.

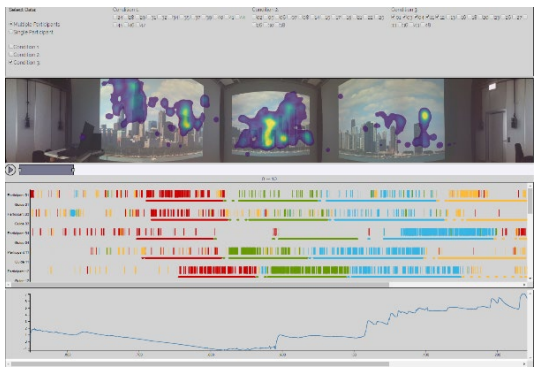

Fig. 3. Visualization Tool with user data displayed

4 Results and Discussion

RQ1. Does gaze guidance help participants identify and locate building?

For condition B and C, the results show:

- Shorter time to object identification (TTOI)[1,2] and higher success rate in hard-to-find building (Fig.4 and Tab.1).
- Higher "efficiency" in user experience questionnaire (UEQ) (Fig.6).

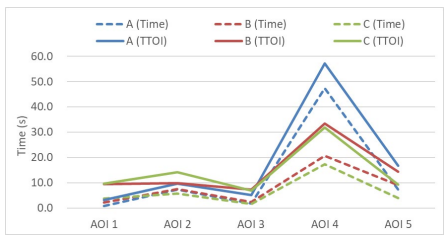

Fig. 4. Time to first fixation (Time) and TTOI in different conditions.

RQ2. Does 3D gaze guidance enhance system usability and reduce cognitive load?

For condition C, the results show:

- Lower cognitive load (NASA-TLX) (Fig.5).
- Higher system usability (SUS) (Fig.5).

	Condition A	Condition B	Condition C
AOI 1	100.0%	93.3%	93.8%
AOI 2	93.3%	93.3%	93.8%
AOI 3	100.0%	100.0%	100.0%
AOI 4	40.0%	80.0%	87.5%
AOI 5	100.0%	93.3%	100.0%

Tab. 1. Success rate of finding the AOIs in different conditions. The highlighted AOI is the hard-to-find building.

RQ3. Does 3D gaze guidance enhance user experience and reduce boringness?

For condition C, the results show:

- Higher "attractiveness", "perspicuity", "efficiency", "stimulation" and "novelty" in UEQ (Fig.6).
- Insufficient data of instant boringness assessment.

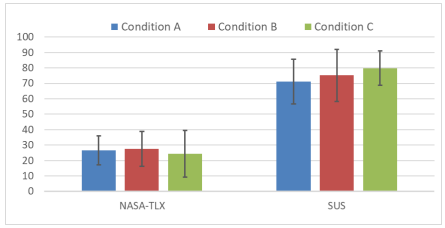

Fig. 5. NASA-TLX (↓ better) and SUS (↑ better) and scores in different conditions. Error bars indicate Standard Error.

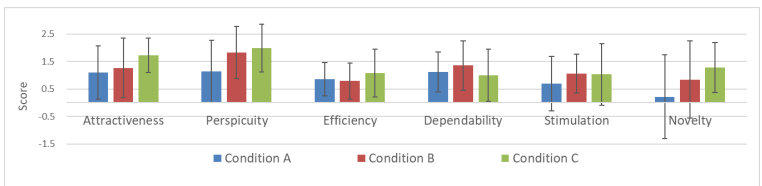

Fig. 6. Comparison of UEQ factors between different conditions. Error bars indicate Standard Error.

5 Conclusion and Outlook

We proposed a Gaze-Guided 3D audio guide, evaluated through a lab study with 46 participants and developed a visualization tool to analyze the results.

- Success rate of systems with gaze guidance were higher.
- 3D audio guidance enhances the system usability, user experience and reduces the cognitive load.
- The visualization gives an overview of the collected data in an understandable manner and underlines the findings of the study.

This study is only the first step towards the integration of 3D gaze guidance into real tourist assistance. In the future, the system should be tested in a real world scenario with a more diverse user group.

6 References

1. Kwok T C K, Kiefer P, Schinazi V R, et al. Gaze-Guided Narratives: Adapting Audio Guide Content to Gaze in Virtual and Real Environments[C]//Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems. ACM, 2019: 491.
2. Krejtz K, Duchowski A, Krejtz I, et al. Discerning ambient/focal attention with coefficient K[J]. ACM Transactions on Applied Perception (TAP), 2016, 13(3): 11.