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An Experimental Study on the Applicability of Fusion Display and Overlay Display of AR Smart City Data and Information

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ABSTRACT

The purpose of this research is to explore the applicability and differences of the Fusion display and Overlay display of AR smart city data information for smart city information acquisition. This experiment recruited 32 people who could read 12pt Arial regular characters without glasses for the experiment. Comparing the applicability of the two information display methods through the comprehensive data results of information acquisition cognition, information judgment cognition, fatigue test and usability research. Comprehensive analysis through eye tracker points and number map, heat map, saccade map, point analysis map and accuracy timetable. In terms of correctness data analysis, the Fusion display has a significantly lower correctness rate than the Overlay display and in terms of completion efficiency, the Fusion display is significantly slower than the Overlay display in recognition.

Keywords: Smart city information, AR, Fusion display, Overlay display, Eye tracking experiments

BACKGROUND

Smart digital twin cities digitally create virtual models of urban systems, it simulates the behavior of physical entities in a realistic environment with the help of data. And through virtual and real interactive feedback, data fusion analysis, decision iterative optimization and other means to design and build smart city platforms, thus adding or extending new capabilities to smart city management. On the new urban information carrier, the presentation of information has a certain impact on the speed and accuracy of information acquisition.

In conjunction with the trend towards AR glasses, paperless information design, i.e. visualization of information models, will be an important trend in the future, in demand for AR smart city related information reading, the right visualization can assist managers in their exploration of the city's data.

The key to AR information presentation is the presentation of the information, i.e., the way information is covered. Based on past research findings, there are two most conventional and operational ways to present, one is a

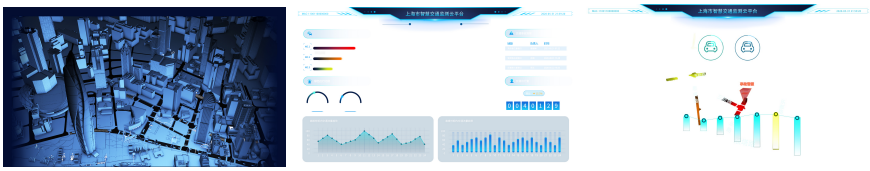

Figure 1: 3D model diagram (left) overlay infographic (middle) embedded infographic (right).

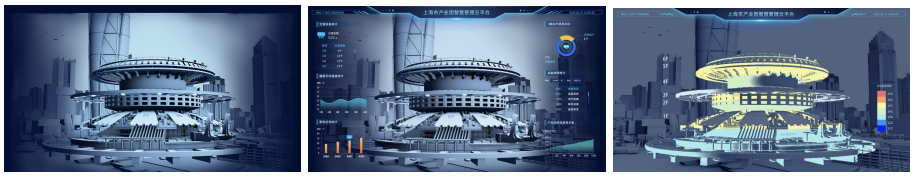

Figure 2: Overlay effect diagram.

fusion display that fuses real environmental scenes with virtual digital information, and searches for data in the scene (Susumu Nakajima et al. 2001). The other is that the scene information is superimposed on both sides of the picture in the form of information description (Shiaw-Tsyr Uang et al. 2019). The two types of visual effects are shown in Figures 1 and 2. However, which one to use as the mainstream form of display still needs to be experimentally explored.

Therefore, the purpose of this research is to explore the applicability and differences of the fusion description and superimposed description of AR smart city data information for smart city information acquisition. To judge which is more suitable as the mainstream display form. The research object is the eye movement data and information acquisition data in these two information display methods.

MATERIALS AND METHODS

Experimental Material Design

In order to investigate which is more suitable for smart city data overlay, Fusion display or Overlay display. This experiment used Rhino 3D modelling tools to build a 3D model of the city, the model contains three smart city operation scenarios: building equipment operation status, community power management system, and smart operation of business district.

The content of the message is consistent in each scenario, while it is expressed through both Fusion display and Overlay display. Twenty identical questions and answers were set up for each comparison group's information presentation.

Participants

The experiment will last for five weeks, and the number of recruits will be 32, Recruiters are divided into groups A and B, each with sixteen members. The experiment required the subject to be able to read 12pt Arial regular

characters without wearing glasses, Group A uses Fusion display, Group B uses Overlay display.

Procedures

For the AR city digital twin problem, superimposed and integrated visual expressions are designed to objectively test the performance of the subjects in visual search and logical thinking tasks and eye movement behaviors, perform statistical analysis on the data, and calculate the key points under different layouts. Data and key point search efficiency and assist in the verification of the questionnaire.

Information accuracy test session, this session is for the experimenter to wear the tobii eye-movement instrument and conduct a 2 question visualization test to ensure that the experimenter is familiar with the experimental process.

1. Cognitive experiment, the experimenter first read the questions carefully, after clarifying the questions, the experimenter picked up the tablet computer for AR overlay on the images, then the subject looked at the Centre of the screen, received the "start" command, clicked on the Centre of the screen and started reading to find information and complete the questions, a total of 5 groups of 20 questions, the experimenter recorded the time for each question.
2. Fatigue experiment, in this session, we ask the experimenter to test the fatigue of reading information in two types of visual information presentation: Fusion display and Overlay display,after the experimenter says "start", the experimenter will carry out a 10-minute information reading task of the same type of visual information presentation, read the information in the diagram The test is completed with multiple-choice questions. After reading the same type of visualization, a five-minute break is taken and another visualized reading task follows.
3. Interface usability questionnaires, in which the subjects are asked to evaluate the experimental interface according to their own circumstances, fill in an experimental research questionnaire and provide preferences and experimental suggestions.

Measurements and Analysis

In this experiment, eye movement data in visual search and logical thinking tasks were collected, recorded and analyzed using the TOBII eye movement instrument.

RESULTS

At the end of the experiment, questionnaires, question completion schedules (as shown in Figure 5), eye-tracking point charts (as shown on the right in Figure 3), thermograms (as shown on the left in Figure 3), eye-beat charts (as shown in Figure 4), and point analysis charts (as shown in Figure 4) were collected from the AB group, and conclusions were generated through statistical analysis of the experimental data, The results are as follows:

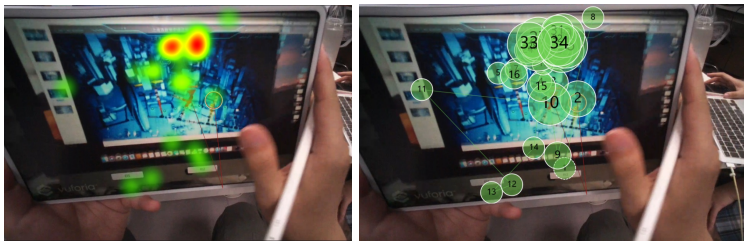

Figure 3: Point-and-figure plot (right) and heatmap (left) of eye movement data.

Figure 4: Saccade graph and point-and-figure graph of eye movement data.

Exeriment time	A	B	B	A	A	B
1	17.95	12.46	15.51	30.68	35.35	30.33
2	10.58	12.22	32.57	11.48	10.34	47.89
3	28.81	30.76	36.94	12.19	34.02	13.96
4	10.52	57.70	38.98	26.73	28.92	11.12
5	25.85	21.17	10.91	20.27	24.75	14.22
6	12.70	29.26	06.28	17.72	45.76	13.05
7	11.21	23.95	18.23	15.46	39.43	17.26
8	35.76	26.41	25.40	20.27	21.28	17.04
9	14.22	18.87	20.23	17.46	15.16	26.86
10	26.11	30.56	20.24	15.72	22.63	28.52
11	16.59	19.60	13.23	19.98	35.36	14.28
12	11.53	14.60	10.15	18.34	20.99	08.24
13	11.31	15.56	10.78	10.58	21.38	17.25
14	31.09	34.56	22.83	21.58	45.89	18.89
15	25.99	19.53	18.83	31.23	40.71	16.95
16	46.39	17.79	22.39	26.20	43.22	20.89
17	31.14	34.56	34.84	27.63	40.84	31.47
18	48.72	15.49	41.61	24.72	18.34	22.29
19	39.33	19.53	21.81	32.89	31.51	24.64
20	26.28	22.79	18.34	25.67	21分02	19.46

Figure 5: Timetable for Information Judgment.

1. In terms of correctness data analysis, the Fusion display has a significantly lower correctness rate than the Overlay display
2. In terms of completion efficiency, the Fusion display is significantly slower than the Overlay display in recognition

The biased conclusions are as follows:

1. Under the task-oriented experiment, users in the Fusion display were more focused on text.
2. Users who used the Fusion display f tended to search more in the central area.
3. The Overlay display were more effective in completing information tasks than fusion information displays

4. Users' subjective feedback shows that fusion displays are preferred because they are more technological in nature
5. Analysis of the gaze trajectory shows that the range of eye movements of the subjects in the Fusion display is wider, while in the Overlay display, the trajectory of the subjects' eye movements is concentrated on the layer information.
6. Analysis of the eye-movement heat map shows that the saturated colour module has a higher number of user attentions

CONCLUSIONS AND FUTURE WORK

In this study, a relatively simple experiment was carried out in a short period of time to generate relevant conclusions. Subsequent experiments will expand the sample size and use biased conclusions to adjust the experimental errors and optimize the stimuli.

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