Development of A Relaxation Support System Utilizing Stereophonic AR

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***Abstract*—Given the high prevalence of stress and anxiety in today's society, there is an urgent need to explore effective methods to help people manage stress. This research aims to develop a relaxation support system using stereophonic augmented reality (AR), designed to help alleviate stress by recreating relaxing environments with immersive stereo soundscapes, including stories created from generative AI and environmental sounds while users are going for a walk. This paper presents a preliminary evaluation of the effectiveness of the proposed relaxation support method.**

***Index Terms*—Augmented Reality, Spatial Audio, Generative AI, Mental Well-being**

I. INTRODUCTION

According to the Occupational Safety and Health Survey conducted by the Ministry of Health, Labour and Welfare in Japan in 2020 [1], nearly 54.3% of workers reported experiencing significant anxiety or stress related to their work. Similarly, the Japan National Life Standards Survey conducted in 2019 [2] indicated that 47.9% of individuals felt anxious or stressed in their daily lives. Furthermore, The World Health Organization reported that, in 2019, 970 million people worldwide were living with a mental disorder, with anxiety and depression being the most common. Such mental health conditions can impact all areas of life, including relationships and work and individuals with severe mental health conditions could even have a life expectancy that is 10 to 20 years shorter than the general population [3]. Given these findings, developing effective stress relief methods is crucial. Listening to natural sounds, such as flowing rivers, forests, or birdsongs, and viewing natural scenery, such as forests or seashores, have been shown to reduce stress [4]. In recent years, services, such as "Calm" were developed to offer "sleep stories", which are read aloud to help improve sleep quality for users.

In our research, we aim to develop a relaxation support system using stereophonic sound-based augmented reality (AR) to enhance relaxation and reduce stress by recreating relaxing environments with immersive stereo soundscapes during walks. This paper provides a preliminary evaluation of the effectiveness of such a proposed relaxation support method utilizing stereophonic AR.

II. RELATED WORK

Various approaches have been shown in previous research to be effective in promoting relaxation, such as introducing pleasant scents or playing calming music [5] [6]. Even simple activities such as reading picture books to college students have also been shown to help enhance positive emotions and reduce negative emotions for adults [7]. Moreover, activities such as enjoying beautiful scenery or taking a walk through forests and gardens are also recognized for their relaxing properties [8]. This had even led some researchers to even term the word "forest therapy" and a survey on such activities had revealed that sitting in a forest is significantly more comfortable, calming, and relaxing when compared to an urban environment [9]. The Stress Refreshment Survey indicated that carrying out seated meditation inside a forest was notably more refreshing than in urban settings, with the Profile of Mood States (POMS) results showing that post-meditation in forests provided significantly more energy, and provided a better reduction in negative emotions such as tension-anxiety, depression, anger-hostility, fatigue, and confusion when compared to urban environments.

While it is common for technology such as Virtual Reality to be used to simulate pleasant and calming virtual environments to facilitate relaxation and reduce stress [10], there have been relatively few studies exploring the use of augmented reality in this domain. For example, one study investigated how an AR system could be designed to support the meditation process by introducing an AR tree into the real environment which acts as a focus for the participant's visual attention during meditation. The branches and leaves on the tree were also programmed to sway based on the participant's exhalations [11]. Yet despite a key characteristic of AR in allowing users to engage with soothing digital elements without losing touch with their

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surrounding real-world environment, research exploring its application in enhancing the experience during relaxing walks or while resting in serene natural spaces remains limited. In particular, the potential of using stereophonic sound-based AR technologies specifically to reduce stress and enhance relaxation remains largely unexplored. As such, our research seeks to bridge this gap by conducting a preliminary evaluation of a stereophonic sound-based AR system designed to enhance the experience and stress reduction effects of walking through landscapes that naturally promote calmness.

III. PROPOSED METHOD

A. RELAXATION SUPPORT SYSTEM OVERVIEW

The relaxation support system developed in this study aims to promote relaxation by recommending locations where users can experience soothing sceneries. The system further enhances the relaxation experience by providing stories and calming environmental sounds tailored to each location which is delivered in an immersive manner through the use of stereophonic AR sound (see Figure 1). Upon activation, the system determines the user's current location through the smartphone's GPS sensors and suggests nearby relaxation spots such as parks and coastal areas. When users visit these locations, the system delivers a 3D audio experience featuring a story and environmental sounds that align with the spot's characteristics. This is done through the use of Unity[1] to build a stereophonic environment and geographical features are obtained from Mapbox[2] (See Figure 2). Since relaxation preferences and experiences vary among users, the system personalizes recommendations by analyzing the user's daily walking routes and content viewing history.

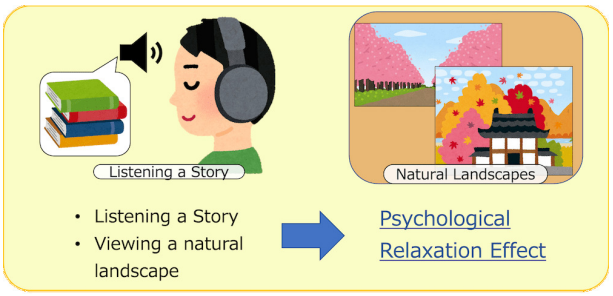

Fig. 1. Overview of the Relaxation Support System.

B. SYSTEM IMPLEMENTATION

To implement the system, the following issues will be addressed:

- **Acquisition of Relaxation Spots and Creation of Database**
  Identify and acquire relaxation spots in various areas, and extract keywords that describe the features of each spot to build a comprehensive database.

[1]https://unity.com/
[2]https://www.mapbox.com/

Fig. 2. On the map, sound sources are placed using Mapbox. The water feature depicted is Shobu Pond, surrounded by lush vegetation. The chosen ambient sounds of flowing water and the gentle rustling of swaying vegetation are fitting for this serene setting.

- **Collection and Databasing of Stories and Environmental Sounds**
  Gather stories and environmental sounds, primarily from free sources, and extract keywords that represent their characteristics to create a database.
- **Spot Recommendations Based on User's Current Location**
  Recommend nearby relaxation spots based on the user's interests and location data.
- **Matching stories and Ambient Sounds to Spots**
  Utilize feature keywords of each spot and the associated stories and ambient sounds to match them with each other.
- **Personalization Based on Analysis of Walking Areas and Viewing History**
  Analyze data on walking areas and content viewing history to offer personalized recommendations for spots and content.
- **Generating Stories Using RAG**
  The relaxation support system developed in this research collects information on spots visited by users from Google reviews and websites, and generates stories based on this spot data using RAG. By integrating the spot information into the story, the system aims to create a more immersive story.

IV. FEASIBILITY STUDY TO EXAMINE THE CHANGES IN EXPERIENCE AND EMOTION ASSOCIATED WITH ADDING ENVIRONMENTAL SOUNDS AND READINGS

A. OVERVIEW

To evaluate the feasibility of our proposed approach, we analyze the changes in emotions and experiences associated with the presence or absence of environmental sounds and voice readings during visits to a relaxation spot. Figure 3 provides an overview of this study.

B. EXPERIMENTAL PROCEDURE

The feasibility experiment involved five male university students in their twenties. The experiment compared three

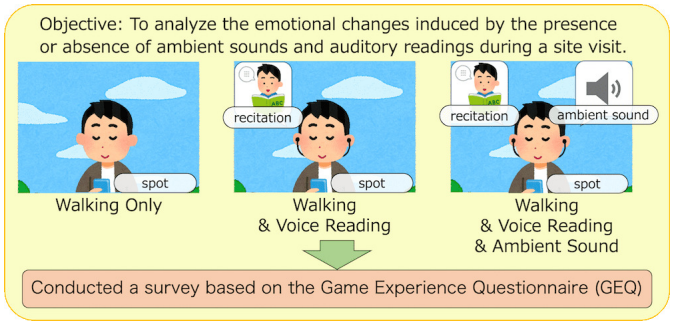

Fig. 3. An overview of our experiment to analyze changes induced by environmental sounds and story readings.

conditions: "walking only," "walking while listening to a reading," and "walking while listening to a reading with environmental sounds." Hereafter, these conditions will be referred to as "walking only," "reading only," and "reading with environmental sounds," respectively. Following each walking session, participants completed a questionnaire based on the Game Experience Questionnaire (GEQ) [12], which is used to measure their emotions and experiences.

C. EVALUATION MEASURES

To evaluate the emotions and user experiences, the core modules of the Game Experience Questionnaire (GEQ) were adopted, focusing on "positive affect, negative affect, immersion, and tension." The questionnaire was modified accordingly, as shown in Figure 4. The analysis involved calculating the total scores for each of these dimensions. The "walking only" condition was excluded from the analysis due to its lack of story content, which affects immersion.

D. RESULTS

Figure 5 presents the results of the GEQ analysis.

- Positive Affect
  Total positive affect scores were highest for "Walking & Voice Reading & Ambient Sound" followed by "Walking & Voice Reading" and "Walking only" with a notable difference between "Walking only" and the other two conditions. This indicates that both environmental sounds and reading significantly enhance positive affect.
- Negative Affect
  The total negative affect scores were lowest for "Walking & Voice Reading" followed by "Walking & Voice Reading & Ambient Sound" and "Walking only". This suggests that reading reduces negative affects more effectively than walking alone, though environmental sounds did not consistently reduce negative affect.
- Sensory & Imaginative Immersion
  Sensory & Imaginative Immersion was significantly greater in the "Walking & Voice Reading & Ambient Sound" condition compared to "Walking & Voice Reading" confirming that environmental sounds enhance immersion.
- Tension/Annoyance
  Tension/Annoyance scores were highest for "Walking & Voice Reading" followed by "walking only" and lowest for "Walking & Voice Reading & Ambient Sound" This demonstrates that environmental sounds are effective in reducing tension.

Components	questions
Positive Affect	I felt content
	I thought it was fun
	I felt happy
	I felt good
	I enjoyed it
Negative Affect	It gave me a bad mood
	I thought about other things
	I found it tiresome
	I felt bored
Sensory & Imaginative Immersion	I was interested in the app's story
	It was aesthetically pleasing
	I felt imaginative
	I felt that I could explore things
	I found it impressive
	It felt like a rich experience
Tension/Annoyance	I felt annoyed
	I felt irritable
	I felt frustrated

Fig. 4. Components and question items used in the evaluation experiment.

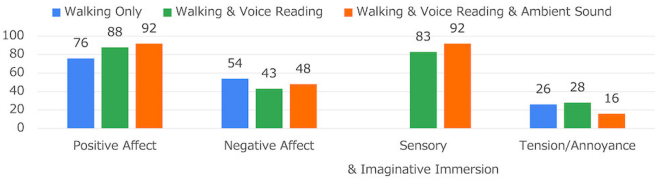

Fig. 5. GEQ Analysis Results.

The feasibility experiment results confirmed that adding environmental sounds and voice reading effectively enhanced positive affect. Additionally, the environmental sounds improved immersion and reduced tension. However, the presence of environmental sounds did not decrease negative affects.

V. FEASIBILITY STUDY TO EVALUATE THE EFFECTIVENESS OF STORIES AND VOICE READINGS GENERATED USING AI

A. OVERVIEW

In the next study, we examine the feasibility of using stories and voice readings generated using AI. Initially, we had intended to use LibriVox[3], which offers free audio readings of public domain books to implement the voice reading system. However, LibriVox has limitations, such as a lack of Japanese readings and variability in the length of readings across different books. To address these limitations, we instead explore the use of ChatGPT[4] to generate stories based on prompts that

[3]https://librivox.org/
[4]https://openai.com/chatgpt/

include the title, character dialogues, and other conditions, and VOICEVOX[5] to convert these stories into audio readings.

This section reports on the results of our feasibility study to evaluate the effectiveness of stories and reading voices generated using AI which would be used in our relaxation support system. We compared the effectiveness of stories generated by ChatGPT with those from public domain books and assessed the ease of listening to the voice readings. Themes for the evaluation included "cherry blossoms," "apple fields," and "mountains and fields." (themes that could be commonly found in the areas where the experiment was conducted). For public domain books, scenes featuring these themes were extracted from full-length stories for comparative analysis.

B. PARTICIPANT

The experiment involved 12 participants: 7 undergraduate students (4 males and 3 females) and 5 male graduate students from a University in Japan in their 20s.

C. EVALUATION MEASURES

The evaluation used a 7-point Likert scale. For story comparisons, four items were assessed: "appropriateness as a story," "suitability for the theme," "interest," and "ease of understanding." For reading voice comparisons, only "ease of understanding" was evaluated. The average values for each evaluation item were used for analysis.

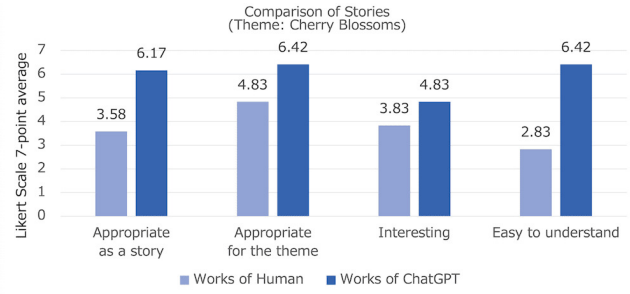

Fig. 6. Comparative Results of Stories (Theme: Cherry Blossoms).

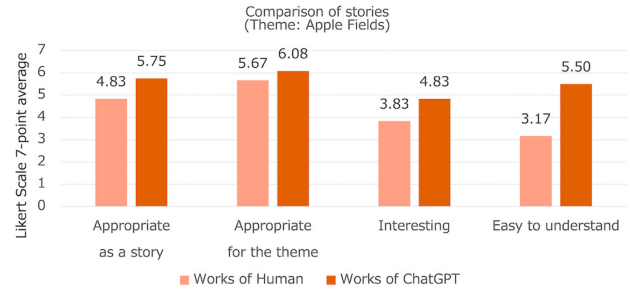

Fig. 7. Comparative Results of Stories (Theme: Apple Fields).

[5]https://voicevox.hiroshiba.jp/

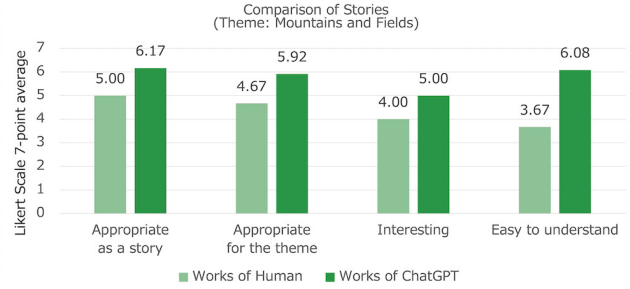

Fig. 8. Comparative Results of Stories (Theme: Mountains and Fields).

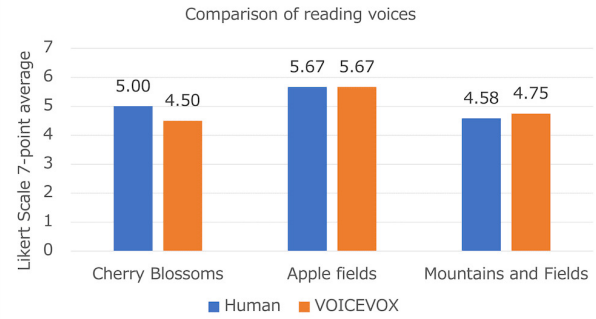

Fig. 9. Comparison results of the audibility of the reading voice.

D. RESULTS AND DISCUSSION

The results of the story evaluations are presented in Figures 6, 7, and 8, while the results for the audibility of the reading voice are shown in Figure 9.

The comparison revealed that ChatGPT-generated stories received higher average scores across all four evaluation items compared to public domain books, with a particularly significant difference in "ease of understanding." This suggests that ChatGPT-generated stories were easier to comprehend, likely due to their simpler language and phrasing. Additionally, there was no significant difference in the ease of listening between human voices and VOICEVOX-generated voices. Thus, the VOICEVOX-generated readings were deemed as comfortable to listen to as human-read ones. In conclusion, both ChatGPT-generated stories and VOICEVOX-generated reading voices was considered effective enough for our study.

VI. PROPOSED EXPERIMENT DESIGN TO EVALUATE THE EFFECTIVE OF OUR RELAXATION SUPPORT SYSTEM

A. OVERVIEW

This section outlines the proposed experiment design to evaluate the effectiveness of our relaxation support system developed using stereophonic AR. The effectiveness of our system will be analyzed based on how stress levels change among participants after the relaxation system is used.

B. PARTICIPANTS

In this study, we plan to include 20 university students divided into two groups: one group will use the system, and the other will walk as usual.

C. ANALYTICAL METHOD

Stress levels will be assessed using the STAI [13] and VAS based stress questionnaires [14]. The STAI, developed by Spielberger, evaluates both State Anxiety (current stress) and Trait Anxiety (general predisposition to stress). The VAS, a psychometric response scale, will be used by asking participants to mark their current stress level on a 10 cm line, labeled from "not at all stressed" to "very stressed".

D. STRESS INDUCTION

Prior to the experiment, stress will be induced in the participants prior to utilizing the system (or going for a walk). Stress will be induced through oral problem-solving tasks, including mathematical and general knowledge problems adapted from Almazrouei et al. [15]. Participants will be informed of a time constraint (2 minutes for written calculations and 30 seconds for simple and general knowledge questions) and that they may only answer each question once, with the expectation of correctly answering more than half the questions.

E. EVALUATION PROCEDURE

Participants will initially complete the STAI and VAS to assess their pre-experiment stress levels. Following stress induction, participants will again complete the STAI and VAS to measure stress levels. Subsequently, they will engage in relaxation: those in the system group will experience ambient sounds and voice readings in stereophonic sound through earphones while viewing the scenery, whereas those in the control group will simply view or walk through the scenery. Post-relaxation, participants will complete the GEQ (as detailed in Section IV), the STAI and VAS questionnaires.

VII. CONCLUSION

In this paper, we aim to develop a relaxation support system which utilizes Stereophonic AR. Feasibility studies were conducted to evaluate the effectiveness of adding environmental sounds and voice readings during a site visit as well as the effectiveness of ChatGPT-generated stories and VOICEVOX-generated reading voices. Afterward, we aim to conduct an experiment to assess the proposed system's efficacy, where 20 university students will be divided into two groups: one using the system and one walking as usual. Participants will be assessed on their stress and anxiety levels using STAI and VAS before and after stress induction, and GEQ will be used to evaluate their emotions and experiences post-relaxation. Future work will involve increasing the number of participants in follow-up experiments and conducting them with more diverse experimental designs in terms of age, gender, and occupation to improve the reliability and generalizability of the results. Additionally, other systems from related research will be investigated to compare the relaxation support system proposed in this study with other relaxation systems.

VIII. ACKNOWLEDGMENTS

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