Sensitivity to Sound in Web-Based FPS Game

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Abstract— To train the hearing of individuals, both those with and without visual impairment, in a fun and effective way, the research methods used in this study include needs analysis, design, implementation, and testing. The result of this research is a web-based game that can be used to train an individual's hearing in a fun and effective way. The results of this study show that the developed web game can be used to train an individual's hearing in a fun and effective way. This game is equipped with various playing methods, each of which has several levels that can be accessed according to the level of difficulty, making it suitable for individuals with different levels of hearing ability.

Keywords— train the hearing, playing methods, game.

I. INTRODUCTION

In the gaming world, where sound is a crucial element, such as dialogue, music, and feedback sounds to create an immersive and interactive experience. In contrast to competitive gaming, sound is a vital piece of information to know the enemy's movements or other variables in the game, such as gunshot sounds, footsteps, and bomb defusing sounds. Examples of competitive games with these variables are typically found in First Person Shooter (FPS) games.

This prototype is designed to improve environmental hearing and can also assist individuals with visual impairment. As individuals who lack visual abilities, hearing becomes a more sensitive and critical sense to interact with their surroundings.

In addition to being intended for individuals with visual impairment, this prototype can also help non-visually impaired individuals distinguish the direction of sound sources. In this game, sounds will come from various directions, and players are expected to recognize the direction of the sound. By practicing sound source direction recognition in the game, both visually and non-visually impaired individuals can develop the same ability in their daily lives and navigate their surroundings more easily.

1. Problem Formulation:
   - How to design a game to train sound source localization?
   - How to create "EarLab" game to train sound source localization?
   - How is the acceptance of the visually impaired and non-visually impaired community towards "EarLab" game?

2. Research Objectives:
   - To create a game design that can enhance sound reaction ability.
   - To create a game that can train sound source localization.
   - To determine the acceptance of a game that can be well-received by visually impaired and non-visually impaired communities.

II. LITERATURE REVIEW

2.1 Sound

Sound is a mechanical energy of vibrating objects that travels through a solid-rarefaction-solid sequence in the medium it passes through.[1]

2.2 Decibel

The absolute loudness level that humans hear is determined by the intensity or pressure of the sound, and is generally expressed in decibels (dB), which is a unit of measurement for sound intensity. [2]

2.3 FPS Game

FPS games are a type of video game that places the player in a first-person perspective, providing a more immersive experience and generating greater emotional impact.[3]

2.4 Unity

Unity is a game engine that can process images, graphics, sounds, inputs, and others aimed at creating a 3D (Dimension) or 2D-based game. Unity is capable of being published as Standalone (.exe), web-based, Android, iOS iPhone, XBOX, and PS3.[4]

2.5 C#

C# is a combination of various different paradigms. As its name suggests, C# is a C-style language and primarily expressed using object-oriented paradigms.[5]

2.6 Simulation

Simulation is a genre of computer games. However, recently "simulation", which has traditionally been the domain of gamers, scientists, and the military, has emerged as a big buzzword in training.[6] Simulations can be done in various ways, either through software, hardware, or physical models. Examples of simulations include flight simulators, medical simulators, or business simulators.

2.7 Performance Expectancy

Performance Expectancy is the level at which the use of a particular system or technology is considered to improve individual job performance. [7] The use of Performance Expectancy in this study aims to measure the benefits of playing the "EarLab" game in introducing users to various sound effects.

2.8 Hedonic Motivation

Hedonic Motivation is often seen as the main motivator in consumer behavior, as people engage in activities and consume products to experience pleasure, enjoyment, and fun. [8] The use of Hedonic Motivation in this study aims to observe whether players have interest and enjoyment in playing the "EarLab" game.

2.9 Effort Expectancy

Effort Expectancy refers to the level of ease associated with the use of technology and is a primary factor in determining the overall acceptance and adoption of technology by individuals. [9] The use of Effort Expectancy in this study aims to observe whether players find it easy to play or even encounter difficulties in playing the "EarLab" game.

2.10 Behavioral Intention

Planned Behavioral Intention states that behavior is determined by an individual's intention to perform that behavior, which is influenced by their attitude, subjective norms, and observed behavioral control. [15] The use of Behavioral Intention in this study aims to observe whether players will continue to play the "EarLab" game.

II. METHOD

1. Data Sources
   - Primary Data Sources

The primary data sources will be collected and processed into two parts. The first part will come from questionnaires given to at least 50 non-visually impaired volunteers, and the second part will be structured interviews with at least 3 visually impaired individuals who have tried or completed the latest challenges in the media being tested.

This scientific activity test is conducted to test the prototype developed directly with respondents who have special needs or visually impaired individuals with the aim of training their hearing sensitivity and sensitivity to surrounding sounds. The scientific activity test will be conducted at the Semarang State Special School for the Visually Impaired located at Jl. Elang Raya No.2, Mangunharjo, Kec. Tembalang, Semarang City.

- Secondary Data Sources

Secondary data sources will be collected and processed from journals and articles related to sound intensity, noise, and human reflex reactions to sound.

2. Data Collection Techniques

- Structured Interview

This technique is a data collection method in research that involves predetermined questions organized in a questionnaire or list of questions. The advantage is that the resulting data can be measured and analyzed quantitatively, and ensures that each research subject is interviewed in the same way.

- Questionnaire

This technique is a method of collecting information from respondents using a questionnaire or list of questions. This method can be done by providing an online questionnaire using a link that will be forwarded to a Google Form site containing statements with a Likert rating scale of 1 (strongly disagree) to 5 (strongly agree).

To obtain valid and proven data, the developer will summarize the data obtained by testers through questionnaires distributed through links containing quizzes that want to be recorded and also links to the web games that want to be tested.

III. RESULTS AND DISCUSSION

"EarLab" implements a feature called Spatial Audio. Spatial Audio refers to the representation of sound in three dimensions, making the listening experience more immersive[6]. This feature aims not only to make "EarLab" more immersive but also to help players identify specific directions in their surrounding environment, such as sounds from the front, back, top, bottom, left, or right.

The game "EarLab" pursues simplicity, minimalism, lightness, and ease of access. Therefore, graphic options will not be a significant aspect for now, as smooth performance and detailed audio are the top priority. The gameplay itself is based on feedback and references given by individuals, groups, and other simulation games as a guide to ensure the game does not deviate in the wrong direction.

2.1 Sound Spatial

For sound design implementation, the developer uses the Steam Audio plugin developed by Valve Software.

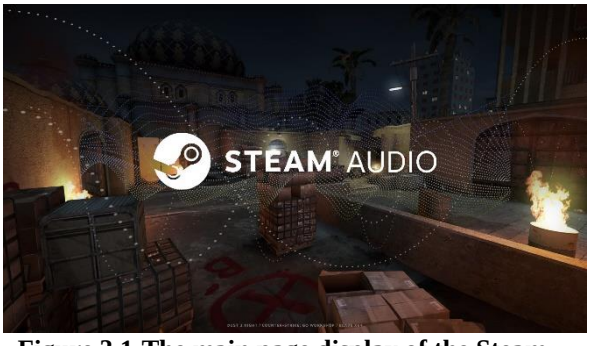

Figure 3.1 The main page display of the Steam Audio web page developed by Valve Software.

Steam Audio is a plugin for processing sound design to make it more immersive, providing features where audio can interact with the surrounding environment, and

providing a realistic simulation of how sound will be heard by players. This plugin is available not only for Unity, but also for Unreal, FMOD, standalone C programming, and other applications.

The implementation method is very easy and simple because this plugin is designed as a unity package or plugin that can be used directly after installation. Not only that, Steam Audio also has complete documentation on how to apply and implement it on their official website. Developers only need to activate the Steam Audio plugin by changing the Spatializer Plugin and Ambisonic Decoder Plugin to "Steam Audio" in the project settings on Unity, and activate Spatialize on the Audio Source as shown in the following images.

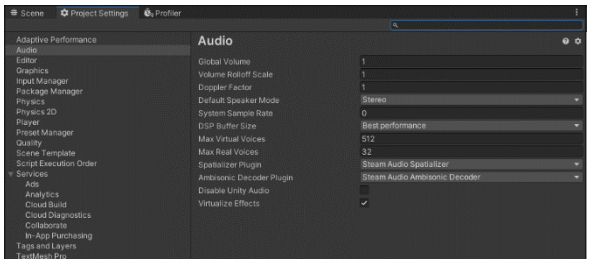

Figure 3.2 The Audio tab display on the Project Settings.

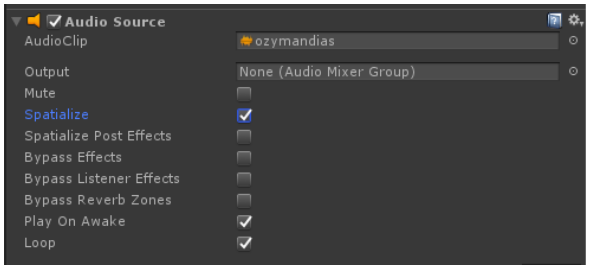

Figure 3.3 Audio Source added to the Game Object.

2.2 Enemy Interaction

The implementation of interaction uses calculations from a circular radius around the player. If an enemy is within the predetermined radius circle, the player can interact with the enemy by pressing the "F" button and earn points. Here is an example script:

```
1 reference
private void FindVisibleTargets() {

    // clear the target while not collide to targeMask
    visibleTargets.Clear();
    Collider[] targetsInViewRadius = Physics.OverlapSphere(transform.position, viewRadius, targetMask);
```

Figure 3.5 Implementation of player and enemy interaction radius.

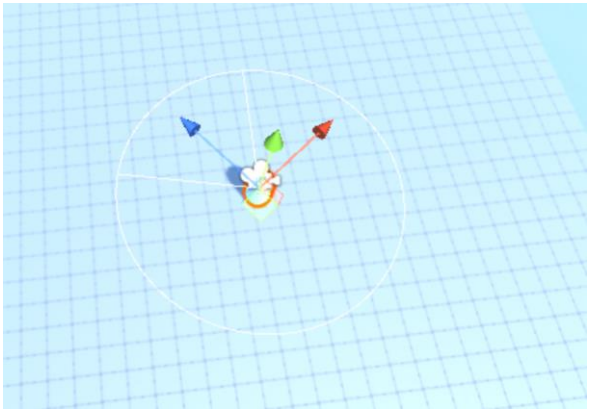

Figure 3.6 Visualization of the radius for the player to interact with the enemy target.

2.3 Scoring

The implementation of scoring uses calculations based on how long the enemy has been alive and how close the player is to the enemy. For each defeated enemy, the player will get 5 points, and they will get a bonus point multiplier if they interact with the enemy within a certain time frame after it appears. Here is an example script used to calculate the score.

```
// inputs
if(Input.GetKeyUp("f")) {

    StartCoroutine(DelayedDestroyGameObject());
    StartCoroutine(ActionCooldown());
    _OSM.DecreaseAudio();

    // if the distance between player and object is less than 3f, it's near object. Vice versa
    // Calculate player's gain point it
    // if NearPoint : if object is found before 5 seconds add 1.5 score multipler else 1.0
    // if FarPoint : if object is found before 5 seconds add 1.2 score multipler else 1.0
    // final point will be the dst * near/far multipler

    // note if the point are more than difficulty threshold then decrease object volume

    if(_OLT.touched) return;

    _OLT.touched = true;

    if(dstToTarget <= 3f) {

        Debug.Log("NearObj " + "Distance : " + dstToTarget);

        Points = Points + (5f * _OLT.nearMultipler);
    } else if(dstToTarget >= 3f) {

        Debug.Log("FarObj " + "Distance : " + dstToTarget);

        Points = Points + (5f * _OLT.farMultipler);
    }

    isAllowed = false;

    _GM.Score = Points;
    Debug.Log("Current Score is : " + _GM.Score);
}
```

Figure 3.7 Score calculation.

2.4 Unlocking Stage

Each level has a "Next Stage" button when the time runs out and the player meets the score requirement for that level. The following is an example.

Figure 3.8 Stage 1 display when the time runs out and the player meets the score requirement for that level.

As can be seen in Figure 3.8, the "Next Stage" button will appear if the player has met the level score requirement with a score of 20. When the player presses the "Next Stage" button, a script like the example below will be executed.

```
0 references
private void UnlockLevel() {

    numberOfUnlockedLevels = PlayerPrefs.GetInt("levelUnlocked_M1");

    if (numberOfUnlockedLevels <= levelToUnlock) {

        PlayerPrefs.SetInt("levelUnlocked_M1", numberOfUnlockedLevels + 1);
    }
}
```

Figure 3.9 Example script used to unlock the next level.

As can be seen in Figure 3.9, if this script is executed, it will take an integer with the keyword "levelUnlocked_M1", and if the number of integers is the same as the level integer, add 1 to the integer value. For example, in this case, the player can only play level 1, so the "levelToUnlock" integer value is 1, and if the player completes that level, the value will be increased by 1. If the player plays level 2, the "levelToUnlock" integer value is 2.

2.5 Test of Correlation

If the results of the correlation test show a star sign, it indicates a strong relationship between the variables. In this case, the average of the variables PE, EE, HM, and BI are converted to RPE, REE, RHM, and RBI so it can be concluded that there is a strong relationship between these variables.

Correlations

		RPE	REE	RHM	RBI
RPE	Pearson Correlation	1	,780**	,693**	,623**
	Sig. (2-tailed)		,000	,000	,000
	N	59	59	59	59
REE	Pearson Correlation	,780**	1	,747**	,509**
	Sig. (2-tailed)	,000		,000	,000
	N	59	59	59	59
RHM	Pearson Correlation	,693**	,747**	1	,626**
	Sig. (2-tailed)	,000	,000		,000
	N	59	59	59	59
RBI	Pearson Correlation	,623**	,509**	,626**	1
	Sig. (2-tailed)	,000	,000	,000	
	N	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 4.47 Table of correlation test between related variables.

IV. CONCLUSION

- "EarLab" is a simulation game designed to train hearing, especially in training users to distinguish the direction of sound sources. "EarLab" has a minimalist design that makes it lightweight and easy to navigate. "EarLab" uses a web platform where users can easily access and run the game using the internet and a web browser. "EarLab" has 3 varied modes that will keep players entertained while playing this game.

- "EarLab" uses a feature/tool/plugin called "Steam Audio" which provides additional properties to audio objects in Unity, these properties are "Spatial Audio" which can make sound sources appear 3D based on the player's viewing direction in playing this game. This tool also provides other features that can make audio seem realistic by utilizing physics calculations and absorption with different fields.

- "EarLab" has been well received by both blind and sighted communities.

This can be seen from interviews with the blind and with good, valid, and reliable correlation data on non-blind questionnaire results.

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