Singing with an Angry-Birds-like Game

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***Abstract*—This paper presents a game system aimed towards promoting mental health, which implements singing as an input modality to control the bird-shots in an Angry-Birds-like game. Based on existing research, singing can act as a catalyst that medically reduces stress and thus can be used for rehabilitation. Our system works by analyzing singing by the player and adjusting the shooting performance based on the singing score. This paper focuses on how the system is developed and its functions.**

***Index Terms*—Singing game, Pitch detection, Serious games, Mental health**

I. Introduction

Mental disorders are one of the most common global issues. According to James et al. [1], it is estimated that around 264 million people are currently affected by it. Serious games are nowadays being considered as one of the solutions that impact positively towards reducing stress disorder-related symptoms.

Serious games are defined as games built for a purpose [2]. Science Birds, a clone of Angry Birds, is a game that has been recently used in serious-game research. Previously, Abdullah et al. [3] proposed a serious-game system for Science Birds, where Rube Goldberg Machine (RGM) mechanisms are used to generate a variety of levels with segments set in a way that creates a domino effect when a 'perfect shot' is conducted. A perfect shot is performed in a projectile trajectory that hits a TNT (explosion) whose position is known when its level is generated, resulting in clearing the level. [3]. On the other hand, a karaoke game system called UltraStar Play[1] enables users to sing and receive scores as they sing to the microphone in use.

This paper presents a game system in which a singing score through UltraStar Play is used as a trigger for the system to perform shooting by our proposed shooting mechanism in Science Birds. Here, the quality of a bird-shot is dependent on the player's singing accuracy similar to a karaoke-system. We expect this system to be beneficial for mental-health promotion, which we plan to conduct in the near future.

II. Existing Work

Singing has been claimed benefiting mental health in a systematic review conducted by Williams et al. [4]. Their study surveyed 13 articles out of 709 that were screened. In the review paper, data from 667 participants were reported where results indicate that group singing increases positive emotions, reduces anxiety, enhances feelings of belonging and self-confidence, and solidifies social bonding.

Our previous survey [5] explored applications and potentials of music therapy games. In that study, a couple of musical games were compared based on their play-styles and related experiments. According to the survey, we observed that most of the games discussed in the literature that use voice input or singing were not experimented for mental health. Therefore, in this paper we introduce a system that uses singing as an interaction tool and can be a platform for our up-coming research on mental health promotion.

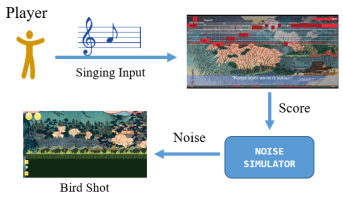

Fig. 1: An overview of the proposed game system

III. Proposed Game System

The proposed system (see a demo[2]) uses singing as a trigger to shoot birds. We merge two open-source game systems: Science Birds and a karaoke-like music game called UltraStar Play. UltraStar Play lets players sing to the connected microphone of the PC along with music; in our study, we adopt the single player mode of the system. A game flow diagram is shown in Fig. 1.

As the game plays a song, the lyrics and notes are shown on screen to allow the player to follow and sing accordingly. The game matches the notes, or their tempo and pitch, of the player's singing to the original and scores based on the correctness.

Figs. 2 and 3 show a singing scene, obtaining a score, and a domino effect due to RGM mechanisms. Here, as we merge the two systems, a score obtained from singing adds a noise

[1]https://github.com/UltraStar-Deluxe/Play

[2]https://tinyurl.com/ybtsnp57

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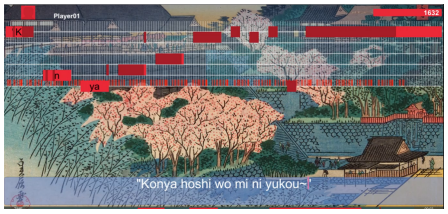

Fig. 2: Screenshot of the singing scene

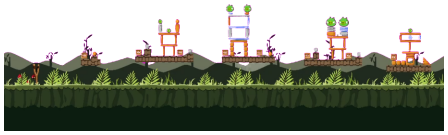

Fig. 3: A screenshot of the full structure

value to the shot and determines the shooting performance. There are three main aspects of the current system: 1) Pitch detection, 2) Scoring and, 3) Noise Calculation. Below we briefly describe each of these aspects.

A. Pitch Detection

The pitch detection technique that is used in UltraStar Play is Circular Average Magnitude Difference Function (CAMDF) which is a refined version of AMDF that picks up the correct and accurate pitch from the recordings with time efficiency. CAMDF is refined in the sense that it can get rid of the "falling tendency" error increasing the amount of accuracy. [6].

B. Scoring

The score is calculated based on pitch-matching that determines how many notes, golden notes and perfect lines are precisely matched and, thus, the player obtains a score out of 10000, as in UltraStar[3]. UltraStar has ratings pre-defined in its system associated with different ranges of total scores, e.g., ToneDeaf = 0, Amateur = 2000, Wannabe = 4000, Hopeful = 5000, RisingStar = 6000, LeadSinger = 7500, Superstar = 8500, and UltraStar = 9000. Thus, In this study, we empirically set the passing score to that greater than or equal to Wannabe = 4000.

(a) (b) (c)

Fig. 4: Screenshots of the bird-shot and RGM consequences

[3]https://tinyurl.com/y9qa7xjp

C. Noise Calculation

As the player finishes singing the current song, the score is recorded which is used to calculate the noise value. When the total score < 4000, we calculate:

$$A = 1 - \frac{TotalScore}{10000}, \tag{1}$$

where A is a noise scale factor with a range of [0.6, 1]. It is set to 0 when the total score ≥ 4000, which allows the system to perform a perfect shot to complete the level.

Let μ denote the optimal position of the bird after being dragged by the in-game slingshot. Note that such optimal positions can be directly determined by mechanisms proposed in Abdullah et al. [3]. The range of noises, R, is

$$R = [-As, As], \tag{2}$$

where s is a predetermined value that is set to 30 in this work based on our pilot studies with the aim to generate entertaining gameplay where the target is missed.

A noise value is uniformly sampled from the range of R and is added to the aforementioned optimal position μ, resulting in a noisy position $\tilde{x}$:

$$\tilde{x} = \mu + R \tag{3}$$

IV. Conclusions

We proposed a new system implementing singing as an input modality to control bird-shots in Science Birds. This system will be used as a platform to examine the effects of singing as an input for controlling game-play in regard to mental health promotion. We expect our system to reduce players' anxiety and enhance players' positive emotions. Our future goals include testing various noise generation algorithms associated with dynamic difficulty adjustment, and user evaluation to determine benefits in mental health promotion.

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