Promoting Emotions with Angry Birds-like Gameplay on Rube Goldberg Machine Levels

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***Abstract*—This paper proposes a method for generating Angry Birds-like game levels, and their gameplays, that promote spectator's emotions. Each of such levels features a domino effect generated based on Rube Goldberg Machine (RGM) mechanisms, allowing it to be completed by one perfect shot of a bird. We evaluate the effects on spectator's emotions by comparing two sets of gameplay videos; one with only perfect shots and the other with only imperfact shots (i.e., gameplays that were not successfully completed by one shot). We conducted an online survey using Positive and Negative Affect Schedule (PANAS) to evaluate the spectator's emotions before and after watching a video of interest. Our results show that perfect-shot videos lead to higher positive affect and lower negative affect of the spectator in the same series of generated RGM levels. In addition, the perfect-shot video has a stronger evidence in decreasing the negative affect of the spectator than the imperfect one.**

***Index Terms*—Angry Birds, Rube Goldberg Machine, well-being, spectator**

I. Introduction

Gameplay is enjoyed not only by players, but also spectators. Gameplay watched from a streaming platform such as Twitch has become a new kind of entertainment. Millions of spectators enjoy watching gameplay every month [1].

Our recent research was conducted to predict a TNT's placement to create a better explosion resulting in promoting the spectator's emotions [2]. However, this kind of research has not been conducted on real gameplay that allows a level to be cleared with different shooting behaviors; hence, there is still no evidence that a level played with different behaviors could lead to promoting the spectator's emotions. Our research hypothesis is that a video featuring a perfect shooting performs better in improving the spectator's emotions than those with an imperfect shooting.

II. Methodology

This study is conducted by extending our existing Angry Bird-like game [2], which was developed using a platform called Science Birds, a clone version of Angry Birds widely employed for academic research [3].

A. Rube Goldberg Machine (RGM) Mechanism

The RGM mechanism proposed in this research aims to build an interesting level as our previous research [2], which has found that a good TNT's placement contributes to the interestingness of Angry Birds video and help the spectators reduce their negative affect.

An RGM level is procedurally generated as a set of predesigned segments containing various objects. A segment has a specific object that needs to be destroyed to trigger the RGM mechanism resulting in the movement of another object as the output. Based on this idea, we generate an RGM level by connecting several segments to create a *domino effect* between them.

The generation process of a segment starts from the left side and is then chained to another direction until it reaches our desired amount or exceeds the boundary of a level (see Fig. 1). This mechanism allows a level to be completed with just one perfect shot of a bird by shooting it to the trigger on the first segment. Note that there are some cases that imperfect shots aimed at another object or location can also complete a level with one or more shots.

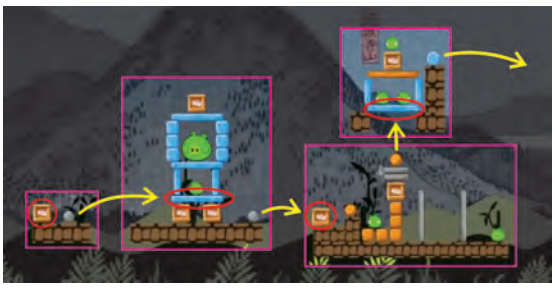

Fig. 1. A sample of a generated RGM level

B. Perfect Vs Imperfect Shots

The angle of a shot is calculated using simple physics projectile motion utilizing the bird's starting position, game's physics gravity, and target position. The perfect-shot behavior is created by shooting the first segment's trigger, resulting the level to be completed with just one shot of the bird. On the other hand, we add a noise value to the target position to create an imperfect-shot behavior. The noise equals six game distance units, which gives us approximately a 50% level completion rate according to our pilot study of 1000 shots on a selected level. One distance unit closely equals the width of the "PIG BIG" object (see Fig. 2)

C. Positive and Negative Affect Schedule (PANAS)

This research uses a self-reporting measure of positive and negative affect of participants developed by Watson et

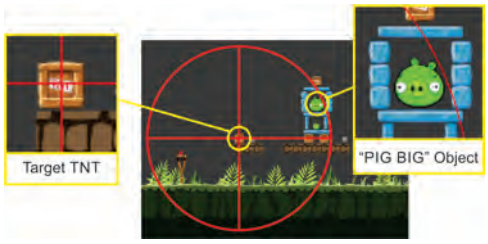

Fig. 2. The noise range from the target position (red circle)

al. [4] for system evaluation. This measure consists of 10 questions of positive affect (e.g. excited, alert, and proud) and 10 questions of negative affect (e.g. guilty, scared, and hostile). The questions are presented in a 5-point Likert scale from "Very Slightly or Not at All" to "Extremely." This research evaluates the summed value of the same affect type of positive affect and negative affect.

Watson et al. [4] stated that a high value of the positive affect indicates participant's pleasurable engagement with the environment, while a low value of positive affect indicates the lack of such engagement which characterized by sadness and lethargy. On the other hand, a high value of the negative affect is correlated to general psychological distress, and a low value of it represents participant's calmness or composure. The summed value of the same affect type implies that a higher value of the positive affect or a lower value of the negative affect leads to better emotions.

III. Experiment

We prepared two videos of the perfect[1] and imperfect[2] shot gameplay played in the same series of generated RGM levels. The gameplay will proceed to the next level when either the current level is cleared or there are no more birds. In some cases, the imperfect-shot behavior took a longer time to pass a level because it needed to use more or all the available birds. Due to the fixed duration of the video, the imperfect-shot behavior had fewer levels played on the video than the perfect one.

We conducted an online PANAS survey in four languages: English, Japanese, Bahasa and Thai. All participants were required to answer the survey twice: before and after watching a video of the perfect or imperfect shot gameplay. There were 44 participants that randomly assigned to watch the perfect (22 participants) or imperfect (22 participants) shot video. We did not collect their personal data, and they give their answers anonymously.

IV. Results

Based on the experiment, the imperfect video has the average score of the positive affect increased by 1.27 and the negative affect decreased by 3.64. On the contrary, the perfect video has the average score of the positive affect increased by 2.0 and the negative affect decreased by 4.86 (see Fig. 3).

[1]https://youtu.be/_VjL6KdNTXQ
[2]https://youtu.be/byFPeCRZD3Q

We first analyzed the results by using Cronbach's α [5] and paired t-test (α=0.05). Our data showed excellent reliability (Cronbach's $\alpha \geq 0.9$) on the positive and negative affect of all PANAS questions for each video. We used t-test to evaluate the significant difference in the participants' affect values before and after watching the assigned video. Namely, it was applied to the positive affect (PA_I) and the negative affect (NA_I) of the imperfect video, and to the positive affect (PA_P) and negative affect (NA_P) of the perfect one. There was no statistically significant difference in PA_I (p=0.52) and PA_P (p=0.32). However, the result was statistically significant in NA_I ($p<0.05$) and NA_P ($p<0.01$).

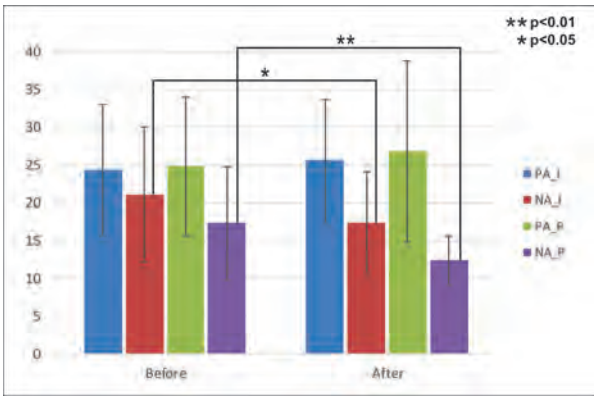

Fig. 3. Average positive and negative scores (ranged from 10 to 50)

V. Discussion and Future Work

Even though not statistically significant, a slight increase can be seen in both PA_I and PA_P (cf. Fig. 3). In comparison to the imperfect-shot video, the perfect-shot video performed better both in increasing the spectator's positive affect and decreasing the negative affect. The statistically significant decrease in both NA_P and NA_I shows that there is a high possibility that watching either video could decrease the spectator's negative affect, but with a stronger evidence in the perfect one. In future study, AI approaches can be employed to improve RGM level generation, to create more interesting shooting behaviors, and better promote the spectator's emotions.

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