Promoting Emotional Well-Being with Angry-Birds-like Gameplay on Pixel Image Levels

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***Abstract*—This paper describes the use of "Real Pixel Image Level Generator (RPILG)" along with a design of game control, called "enhancing play with smiling" to promote the players' emotion. Our study is conducted on Science Birds, an Angry-Birds-like game. RPILG is a procedural content generation method that generates game levels with the appearance of a pixel image of things, such as a pumpkin. We apply RPILG in Science Birds. A facial expression tool is used to recognize smiles in the player. And in our design, the black bird, a kind of shooting object in the game having the power to explode blocks, is modified such that its explosion power can be enhanced according to the degree of smiling. The idea behind this game design is to encourage smiling. An experiment is conducted with fourteen participants where two modes of gameplay "smiling for enhancing the birds" and "baseline play" are compared. An online survey using Positive and Negative Affect Schedule is used to evaluate the players' emotion after they have experienced both modes. Our experimental results provide an evidence that the former mode leads to statistically significantly higher positive affect and lower negative affect.**

***Index Terms*—Angry Birds, Mental Health Promotion, Game Design, Smile, Positive and Negative Affect Schedule**

I. Introduction

Negative emotion is nowadays all-too-common experiences. Many people have negative emotion beyond their coping abilities. Existing studies, in psychological science and related fields, reported that smiling is effective in relieving negative emotion [1]-[5]. Interestingly, a study by Kraft et al. [1] offers an evidence that even a forced smile can significantly relieve negative emotion like stress. In their work, smiling is forced by having participants hold chopsticks in their mouth.

We aim at investigating the effect of encouraging smiling in the context of video game playing. A game application used in this study is Science Birds[1], a well-known clone game of Angry Birds distributed for research purpose. A mechanism for encouraging players to smile is partly based on our previous work [6]. However, in the current work, we have changed the level generator to a new version which generates levels based on any given pixel images instead of on pre-designed models, removed fog which conceals the level, and only employ black birds for shooting in the game system. The black bird is a kind of bird that can explode and destroy other objects such as blocks and pigs. In addition, black birds' explosion power in this version can be enhanced at most 11 times according to the value of Joy which is emotion detected by a facial expression recognize tool in use. As a result, the higher value of Joy, the easier game clear becomes.

This paper has two contributions. The first contribution is the proposed gameplay mode that facilitates Angry-Birds-like gameplay with smiling while the second one is our finding that this kind of gameplay results in better players' emotion.

The first contribution is that we are the first group that adapts and applies "Real Pixel Image Level Generator (RPILG)," a type of procedural content generation that generates game levels by the real pixel images to the game world with a short description (i.e., image name), on an Angry-Birds-like game. In the following sections, we describe the game system which is followed by the descriptions on the experiment and results, discussions, and future work.

II. Game System

The proposed game system uses open-source game platform Science Birds, developed in Unity 3D by Ferreira et al. [7]. This section describes the whole system in two major parts. Figure 1 shows an overview of the system.

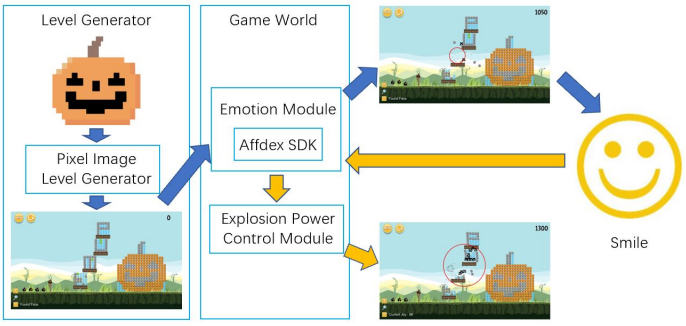

Fig. 1: System Overview

[1]https://github.com/lucasnfe/ScienceBirds

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Fig. 2: Example of a pixel image for generating a level

Fig. 3: Example of translation from the pixel image in Fig. 2 to marks

A. Real Pixel Image Level Generator (RPILG)

RPILG generates a level that looks like a pixel image. Science Birds has twelve types of blocks, each having three material types, that can be used to build a level, but RPILG only uses three block types: "SquareSmall," "RectSmall," and "SquareTiny." They are the types that we found suitable in terms of size and shape for generating pixel images. After a pixel image-like structure is generated, pigs and birds are added in respective order.

Pixel images are stored in a database. PILG starts by randomly selecting a pixel image (Fig. 2) and representing it using at most 16 and at least 3 kinds of "marks" such as "!" and "?" shown in Fig. 3. Marks are then grouped, each group being assigned the same block and material types; the positions of blocks and their material types forming a pixel-image-like structure are obtained and saved into $List\_Mark$. Next, PILG finds the locations to place pigs on the top of each column in the structure and then saves the data into $List\_Pig$. Then, the number of birds is heuristically set to one more than that of pigs. In our previous work, bird types were selected based on predefined selection probabilities, but in this work, as mentioned earlier, only black birds are used. The bird data are saved into $List\_Bird$. Finally, a level is generated based on the information from the aforementioned three lists. During this, some randomness is also added to promote the variety of game levels. A Science Birds AI agent developed by Ma et al. [8] is employed to test beforehand whether levels generated by PILG can be cleared.

B. Enhancing the Explosion Power by Smiling

We now describe how the explosion power is controlled by smiling in three parts. The first describes how Joy is detected. The second describes how this emotion is used to control the explosion power in the game. The last describes real-time feedback to the player.

1) Emotion Detection: The game detects the emotion of the player through an embedded Affdex Emotion SDK [9]. This SDK is a cross-platform real-time facial expression detection tool, which can track a variety of emotion states and facial expressions. However, since in our application, the goal is to encourage smiling, the system only focuses on Joy whose value is increased when the player smiles and decreased when the player's brow is raised or furrowed.

2) Explosion Power Control: The explosion power of black birds is controlled by the parameter value of Joy obtained from the aforementioned SDK. This parameter is denoted as $currentJoy$ in Algorithm 1, and its value ranges from 0 to 100. Its explosion power is immediately enhanced as the player smiles based on the value of Joy, up to 11 times of its default value (Figs. 4-5). In case the player stops smiling before the bird explodes, it will explode with the default explosion power. This design is based on our specification that the player should keep smiling long enough during each gameplay. The explosion power of the birds, denoted as $ExplosionPower$ in Algorithm 1, is initialized to 2 based on the original setting in the game, and its maximum value is set to 11 times because this explosion power should be able to destroy most objects in a given level.

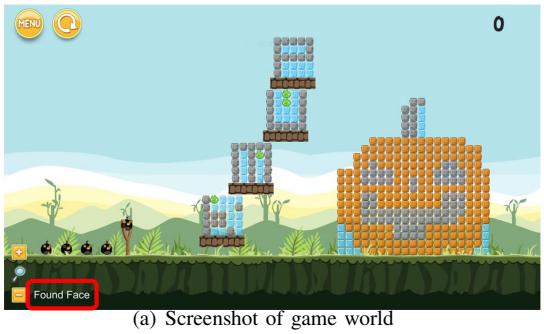
Algorithm 1 Algorithm of ExplosionPower control

```
ExplosionPower = 2
repeat every second
  currentJoy ← Emotion SDK
  if currentJoy ! = 0
    i = currentJoy/10
    ExplosionPower = (i + 1)ExplosionPower
  else
    break
  end if
until Game ends
```

3) Feedback to the Payer: When a game level starts, the system will simultaneously find the player's face. If the face is found, the lower left corner of the game screen will display "Found face" (Fig. 4). When the player smiles, the display will be changed to "Current Joy : x," where x is the value of *currentJoy* and the explosion power will be increased immediately, helping the player clear the level easily (Fig. 5). From Figs. 5 a and b the difference in explosion power can be seen. In case the player's face cannot be detected by the system, the lower left corner will display "Lost Face" (Fig. 6).

III. Experiment

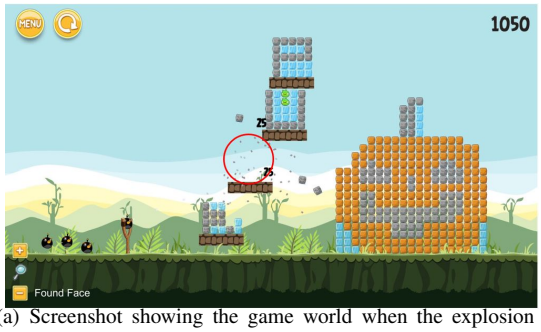
An experiment was conducted to compare two modes for playing the game. One is "Smiling for enhancing the explosion power" previously mentioned. The other, which is a baseline, is "normal playing with no enhancement of the explosion power", where the built-in camera is disabled. There were



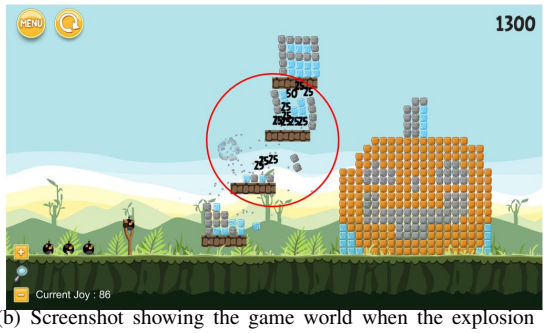
(a) Screenshot of game world

(b) Player's facial expression

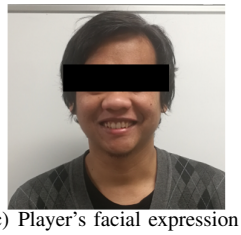
Fig. 4: Example of a game level before the player smiles. The bottom left of the level indicates that the player's face is found.



(a) Screenshot showing the game world when the explosion power is not enhanced

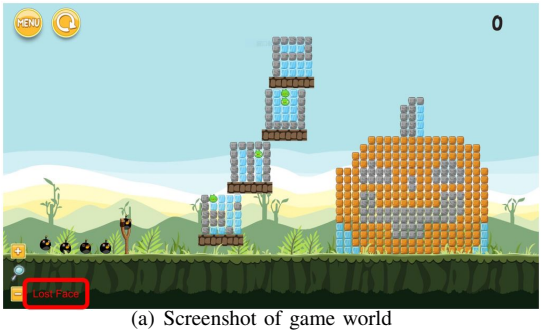


(b) Screenshot showing the game world when the explosion power is enhanced (the bottom left of the level shows the value of Joy)



(c) Player's facial expression

Fig. 5: The game level in Fig. 4 after a shot black bird hits a structure.



(a) Screenshot of game world

(b) Player's facial expression

Fig. 6: Example of a situation when the system cannot detect the player's face

fourteen healthy participants (13 males, 1 female) who were randomly divided into two groups. All of them are university students who were reported to have no chronic disease from health examination.

There were two experimental conditions, individually corresponding to one of the two modes (Condition 1: "Smiling for enhancing the birds' explosion power" and Condition 0 : "Baseline play"). The participants from the two groups engaged in both conditions but in a different order.

Here is the procedure of the experiment:

Step 1: Practice playing the game with both modes, 1 minute each. Then take a rest for 2 minutes.

Step 2: Do either Condition 1 or 0 for 3 minutes. After the game is done, answer a Positive and Negative Affect Schedule (PANAS) questionnaire and rest for 2 minutes.

Step 3: Do the other condition for 3 minutes. Then, do another PANAS questionnaire.

For further details, PANAS is a self-reporting survey developed by Watson et al. [9] for measuring the positive and negative affect of participants. It consists of two 10-item scales: one for the positive affect and the other for the negative affect. For system evaluation, these twenty items were translated into five languages: English, Japanese, Thai, Bahasa Indonesia, and Chinese. Each item is rated on a 5-point scale of 1 (Very Slightly or Not at All) to 5 (Extremely). From the summed value of the same affect type, it can be said that a higher value of the positive affect or a lower value of the negative affect leads to better emotion [4].

IV. Statistical Analysis and Results

After finishing the experiment, the values of 10 respective component items were summed up to the positive and the negative affect scores. All participants' scores can be seen in Fig. 7 to Fig. 10. The average score of the positive affect is

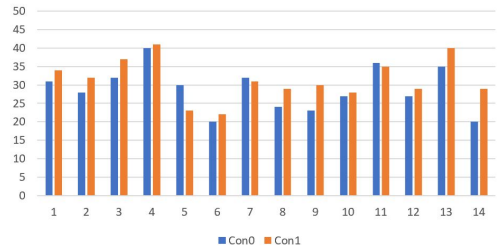


Fig. 7: Positive affect scores from 14 participants in both conditions.

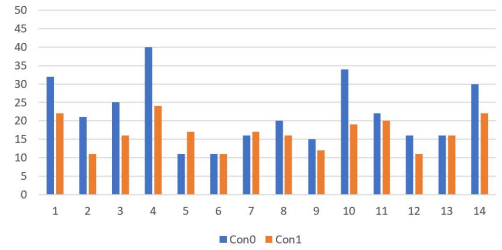


Fig. 8: Negative affect scores from 14 participants in both conditions.

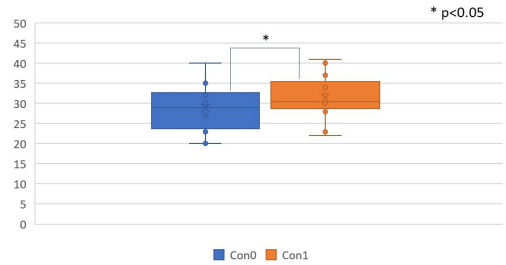


Fig. 9: Boxplot of positive affect scores from all participants, separated by condition.

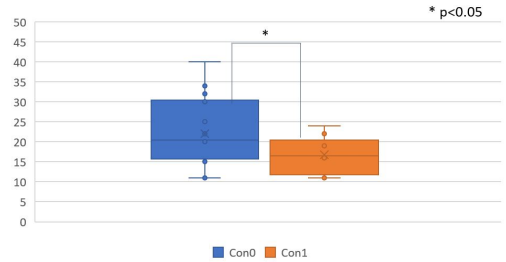


Fig. 10: Boxplot of negative affect scores from all participants, separated by condition.

28.93 and 31.43 for condition 0 and condition 1, respectively. The average score of the negative one is 22.07 and 16.71 for conditions 0 and 1, respectively. In other words, in comparison to the baseline gameplay, enhancing the explosion power by smiling can increase the positive affect score by 2.5 while this mode can decrease the negative affect score by 5.36.

The Wilcoxon Signed-Rank test was used to evaluate the statistical significant difference in the participants' affect scores between the two conditions. Each affect scores are significantly different between conditions 0 and 1 at a confident interval of 95% (p = 0.0278 for positive, and p = 0.0121 for negative). From these results, the proposed play mode was found more promising in encouraging the positive affect and discouraging the negative one.

V. Discussions and Future Work

Our results from the conducted experiment indicated that enhancing the explosion power of the black birds by smiling could not only increase the positive affect, but also decrease the negative one, both with a statistical significance. Consequently, the game system we proposed can promote players' emotion.

Future work includes validation of our concept with larger and/or different groups of participants. We also plan to test the system with patients with specific disorders through clinical colleagues. Applying the concept of smiling for promoting the health of game players to other game applications is also a promising direction.

Acknowledgement

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References

[1] T. L. Kraft, S. D. Pressman, "Grin and Bear It: The Influence of Manipulated Facial Expression on the Stress Response," Psychological Science, 23(11), pp. 1372-1378, 2012.

[2] M. B. Lewis, P. J. Bowler, "Botulinum toxin cosmetic therapy correlates with a more positive mood," Journal of Cosmetic Dermatology, 8(1), pp. 24-26, 2009.

[3] WY Lin, J. Hu, YF Gong, YF, "Is it helpful for individuals with minor depression to keep smiling? An event-related potentials analysis," Social Behavior and Personality, 43(3), pp. 383-396, 2015.

[4] A. L. Jones, C. Batres, A. Porcheron, J. R. Sweda, F. Morizot, R. Russell, "Positive facial affect looks healthy," Visual Cognition, 26(1), pp. 1-12, 2018.

[5] N. Tagalidou, V. Loderer, E. Distlberger, AR. Laireiter, "Feasibility of a Humor Training to Promote Humor and Decrease Stress in a Subclinical Sample: A Single-Arm Pilot Study," Frontiers in Psychology, 9(577), 2018.

[6] J. Xu, C. Yang, Y. Okido, P. Paliyawan, R. Thawonmas, T. Harada, "An Angry Birds-like Game System for Promoting Players Emotion," Proc. of the 2018 IEEE 7th Global Conference on Consumer Electronics (GCCE), Nara, Japan, pp.159-160, 2018.

[7] L. N. Ferreira, C. F. M. Toledo, "Tanager: A Generator of Feasible and Engaging Levels for Angry Birds," IEEE Transactions on Games, 10(3), pp. 304-316, 2018.

[8] Y. Ma, Y. Takano, E. Zhang, T. Harada, and R. Thawonmas, "Playing Angry Birds with a Neural Network and Tree Search," 2018 Angry Birds AI Symposium, Stockholm, Sweden, 7 pages, Jul. 17, 2018.

[9] D. McDuff, A. Mahmoud, M. Mavadati, M. Amr, J. Turcot, R. E. Kaliouby, "AFFDEX SDK: a cross-platform real-time multi-face expression recognition toolkit," Proc. of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. ACM, pp. 3723-3726, 2016.

[10] D. Watson, A C Lee, A. Tellegen. "Development and validation of brief measures of positive and negative affect: the PANAS scales," Journal of personality and social psychology 54, no. 6, pp. 1063-1070, 1988.