Dynamic Suspense Management Through Adaptive Gameplay

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Abstract. Suspense is an important emotion for the enjoyment of games. Various methods have been proposed to manage suspense in games. Most existing works focus on managing suspense via storytelling or artifacts, such as sound effects. However, little work has been done in studying how to use gameplay to manage suspense. In this paper, we present a study in which we developed a horror-adventure game with a built-in suspense manager based on adaptive gameplay. We conducted a small user study to evaluate the effect of dynamic suspense management on game players. Our results showed that gameplay could potentially be used to manage the level of suspense experienced by players, independent of the story and artifacts in the game. The work discussed in this paper will provide game designers with new tools for suspense management in non-narrative-based games.

Keywords: Affective computing · Game design · Suspense

1 Introduction

Suspense is a feeling of anxiety or excitement about an uncertain future. It is an important emotion for the enjoyment of different types of entertainment media, such as novels, films, TV, music, sports games, and video games [11,16,17,19,25]. In this paper, we focus on managing suspense in video games. Game designers often want to manage gameplayers' emotional experience during gameplay, and suspense is an important part of that emotional experience, especially for certain game genres, such as survival horror games.

In previous works, different methods have been proposed to manage suspense in games. Most of these methods focus on manipulating stories or game artifacts such as sound effects, perhaps because similar techniques have long been studied and used in other fields such as films and TV. However, little work has been done in studying how to adjust the gameplay to manage suspense. This is a new area that does not have much to borrow from other areas. Our work is an attempt to address this gap.

M. Wölfel et al. (Eds.): ArtsIT 2021, LNICST 422, pp. 94–104, 2022.
https://doi.org/10.1007/978-3-030-95531-1_7

In this paper, we present a study in which we developed a horror-adventure game with a built-in suspense manager based on adaptive gameplay. We conducted a small user study to evaluate the effect of dynamic suspense management on game players. Our results showed promising results that gameplay could be used to manage game suspense independent of the story and artifact layer. Our work provides more tools and evidence for game designers to manage gameplayers' emotional experience through adaptive gameplay.

2 Related Work

Zhu [31] proposed a theoretical framework for managing suspense in games. Based on this framework, suspense can be elicited on three different layers: story, gameplay, and artifact. Suspense is elicited through an affective loop [31]. First, a player suspense model needs to be developed to estimate a gameplayer's level of suspense. The estimation of a player's suspense can be based on the current state of the game and, in some cases, the player's physiological inputs. Then, the estimated player suspense is fed into a suspense manager to manipulate the story, gameplay, or artifacts, which in turn elicit suspense from the player. Our demonstration game is implemented largely based on this framework.

Many previous studies have focused on manipulating stories to manage suspense [4,5,9,10,13,22–24,27]. For example, Giannatos et al. [13] and Cheong and Young [5] used plan-based models to manipulate story structures in order to manipulate the reader's suspense. O'Neill and Riedl's computational model [23] generates plans for the protagonist to avoid an impending negative outcome. These computational models were largely based on the cognitive model proposed by Gerrig and Bernardo [12]. In Szilas and Richle's model [27], tension is generated by creating paradoxical narratives. Suspense in storytelling has long been studied in arts, psychology, and economy [1,11,12,15,17,19,21,26]. There is a rich set of cognitive theories for game designers to draw from.

Artifacts can also be used to manipulate the level of suspense. A number of studies have shown that sound effects can be used to manipulate anxiety and suspense [6,14,20,28–30]. Delatorre et al. [8] suggested decorative objects could also influence the perception of suspense.

Some researchers have attempted to manage suspense by dynamically adjusting gameplay. For example, Liu et al. [18] changed the level of difficulty in a game based on the anxiety level of players. In a game developed by Vachiratamporn et al. [30], a player's level of suspense affected the timing of scary events. Bailey and Zhu [2] managed suspense by dynamically adjusting gameplayers' uncertainty, fear, and hope. For example, uncertainty was controlled by withholding information from players. Fear was controlled by adjusting the speed of the enemies and the distance between the player and enemies. Given the wide variety of gameplays in video games, there is still a lack of research on the theory and practice of using gameplay to manage suspense. This is the primary motivation for our work.

3 Managing Suspense Through Adaptive Gameplay

3.1 Game Design Goals

Our goal was to study how adaptive gameplay can be used to manipulate suspense in a video game without a story and how effective this technique might be. We first began our design process by looking at various game genres to determine which would best fit our model for suspense. We quickly found that horror-adventure would suit our goal best. Our framework relies heavily on the fear, hope, and uncertainty model of suspense proposed by Ortony et al. [21]. While games of other genres certainly still include all three, we found that horror seemed to be the most saturated in this regard.

To elaborate further on that subject, one of the issues we ran into early was giving false information to the player. Many games require that the player repeats certain mechanics over and over to become more proficient. Because our suspense manager seeks to actively change mechanics in real-time, we had to be careful when designing what our suspense manager would influence. Influencing the wrong mechanics could build a sort of mistrust in the player, who might end up feeling cheated out of learning the skills to succeed.

Another major design choice was the game's point of view. We considered virtual reality, first-person, and top-down 2D perspectives. We chose the top-down 2D perspective because it conveys more information to the player. It is easier to influence players with the mechanics worked on by the suspense manager. However, we later learned that the 2D perspective also has the significant drawback of hindering immersion and fear.

Our game, Photophobic, is a top-down 2D horror game set in a creepy apartment complex (Figs. 1, 2 and 3). The player has just woken up to find themselves alone. Now they must find the red keycard to get into the elevator and exit. In it, the player must make their way through a series of perilous rooms to find the correct keycards. Using only their fleeting flashlight, they must also eliminate and avoid the many dangers they face along the way.

An example run of a player might go as follows. After finding a blue keycard, the player moves into the blue door to enter. After moving in, noises hint that enemies may be lurking inside, so the player turns on their flashlight. Doing so will continuously drain their battery, but without the light, they will not be able to see the pair of enemies sneaking upon them. In doing so, the player stumbles upon a battery spawned in using the suspense manager. After eliminating the enemies using their light and finding a new key, the player heads out to explore another complex.

3.2 Player Suspense Model

Our suspense model creates an estimation of the player's level of suspense based on the idea that the player's level of suspense changes as they receive information from the game world. The level of suspense for the player can then be quantified based on the popularly accepted OCC suspense model [21]. In this model,

Fig. 1. Monster encounter

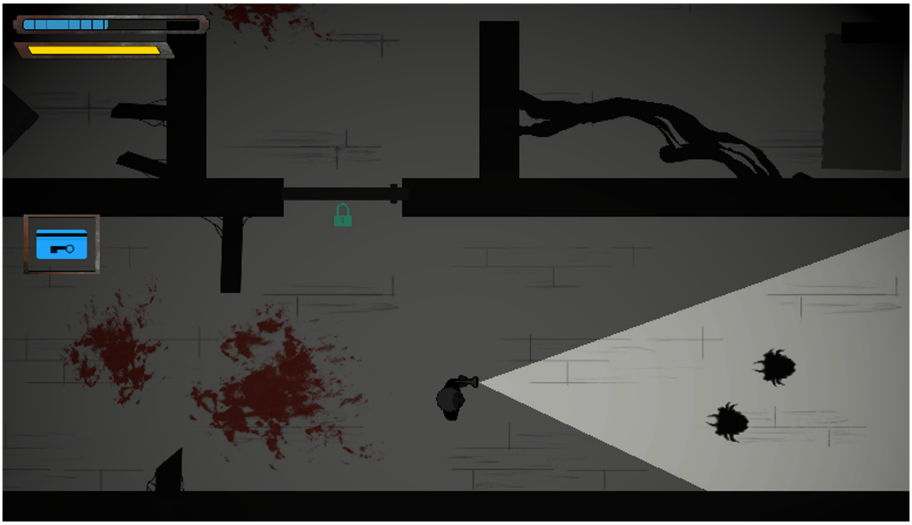

Fig. 2. Attacked in the hallway

suspense is generated by a combination of three factors: hope, fear, and uncertainty. We began breaking the various game mechanics into our three categories of hope, fear, and uncertainty and then assigned weights to each mechanic.

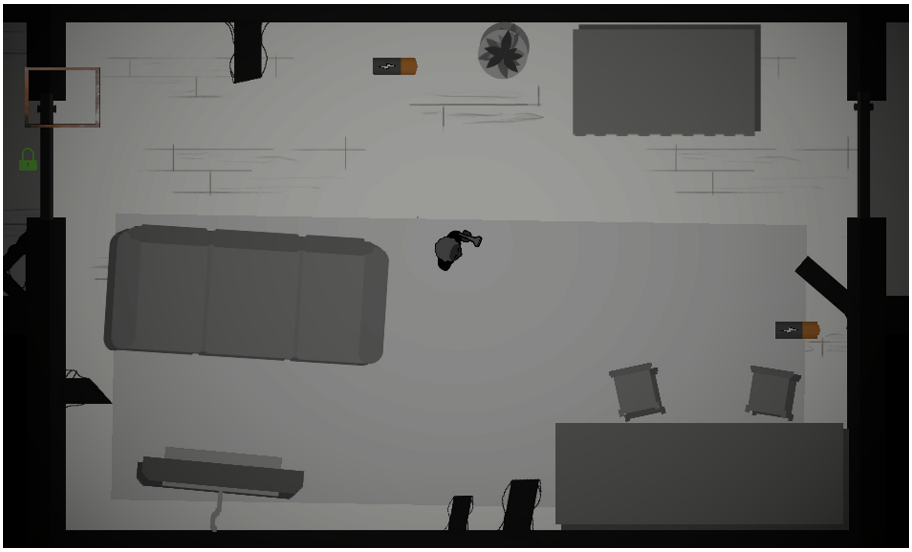

Fig. 3. The player in a saferoom

We used fuzzy logic [3] to determine the weight of each mechanic that affects each of the three categories. For example, the detection of an enemy NPC can have a high increase in fear. Not knowing the location of a battery pickup can lead to a low increase in uncertainty. Knowing the location and distance of a key or goal can have a moderate increase in hope. The specific details may vary from game to game and will be determined by game designers and developers. For our game, we had a breakdown that is shown in Fig. 4.

Once we defined each of the mechanics in terms of hope, fear, and uncertainty, we created equations to evaluate the game state and determine the player's level of suspense (see Fig. 5). We determine the value of the modifiers through the testing of our game. We specified weights based on designer expectations, and we have the system adjust those weights during play to ensure no mechanic overpowers the system. Finally, we had a value that represented the player's level of suspense during gameplay. The calculated level of suspense for the player was not necessarily the same suspense felt by the human player but served as a valid estimate of player suspense because it was based on the widely-accepted OCC cognitive model. This gave us a way to estimate the emotional experience of gameplay.

3.3 Suspense Manager

In order to run our suspense management system, we created a target suspense curve for our game based on MIT and McKinsey's work on emotional arcs [7]. The game will adjust the behavior of the game object based on the difference between the estimated suspense curve and the target suspense curve. The points

	Hope	Fear	Uncertainty
High	• Player Holding Key • Battery Amount	• Enemy location • Enemy following player • Light On/Off	• Enemy locations • Light On/Off
Med	• Player speed • Stamina Amount • Safe room proximity	• Enemy type • Battery Amount • Player Health	• Key location • Battery pickup location • Enemy status
Low	• Battery drain/recharge • Stamina drain/recharge	• Stamina Amount • Battery drain/recharge • Stamina drain/recharge • Sound effects	• Door location • Player knowledge of mechanics

Fig. 4. Breakdown of game mechanics and their mappings to hope, fear, and uncertainty. The weights are set using fuzzy logic.

$$\begin{aligned} hope = {} & holdingKey * highMod \\ & + (playerMoveSpeed + \frac{battery}{maxBattery} + \frac{Stamina}{maxStamina} + saferoomDistance) * medMod \\ & + (staminaChargeRates + batteryChargeRates) * lowMod \end{aligned}$$

$$\begin{aligned} fear = {} & (numEnemies + enemyDistance + enemyThreat + lightStatus) * highMod \\ & + (enemyTypes + \frac{maxBattery}{battery} + \frac{maxHealth}{health}) * medMod \\ & + (\frac{maxStamina}{stamina} + batteryChargeRates + staminaChargeRates + soundEffects) * lowMod \end{aligned}$$

$$\begin{aligned} uncertainty = {} & (\frac{enemiesSpotted}{TotalEnemies} + lightFlicker) * highMod \\ & + (\frac{batteriesFound}{TotalBatteries} + \frac{keysFound}{TotalKeys} + enemyMovementSet) * medMod \\ & + (\frac{doorsUnlocked}{TotalDoors} + timePlayed) * lowMod \end{aligned}$$

Fig. 5. Once broken down, we can turn the mechanics into our equations and assign the weights though testing.

of the curve were defined as specific values for suspense at key points in the level. As the player progressed through the level and reached key points, we would shift to the next stage of the curve, allowing the suspense manager to account for players progressing at wildly different paces. The manager was given control over various mechanics of the game to keep the estimated suspense level in line with the desired level. These mechanics included things such as:

– Changing battery and stamina charge and discharge rates
– Adjusting player and enemy max move speed
– Randomizing or altering enemy pathing
– Spawning or despawning enemies and battery pickups.

We chose these mechanics for the suspense manager in an effort to remain within our design goal of ensuring the player does not feel cheated by the system.

Each of these mechanics is outside of the player's ability to notice when making small adjustments and, therefore, will go unnoticed. While the adjustments themselves may not be noticed, how they interact and the cascading effects will be noticed. For example, a player may not notice their flashlight draining 1% per second vs. 1.5% per second, but they will notice when their battery charge is low, which will occur faster. Enemies that the player could easily run away from before could still escape but will remain much closer to the player and have a higher chance of catching them if the player makes a mistake. Through these changes, we can measure and affect the level of suspense a player is feeling.

We then used the established mechanics to create an AI that performs these changes in real-time based on the current and desired suspense levels. We divided the mechanics into high and low impact changes. Low impact changes are small adjustments made to the values the player cannot see, such as adjusting the rate of battery drain, which allow a fine adjustment of the suspense and can easily be reversed. High impact changes are more dramatic actions like the spawning of items or enemies, which are very noticeable and not easy to undo. Our suspense manager uses the high and low impact changes to evaluate, analyze, and adjust the estimated level of suspense in our game in order to match it to the target suspense curve.

4 User Study

We conducted a user study after finishing the game development using Unity. We had five volunteers participate in our study, undergraduate students ranging from the ages of 18 to 21. Each participant was set up with an Apple Watch in order to measure the participant's resting heart rate and their heart rate throughout the game. After finishing the game, each participant was also set up with a recording of their playthrough. Following the same time between heart rate checks, every 30 s, we also asked them to roughly estimate their levels of suspense from 0–10. This way, we would be able to analyze the difference in suspense from the tester's heart rate, personal estimation, and the estimated suspense values from our in-game player suspense model.

The results of our testing can be seen in Figs. 6, 7, and 8. In Fig. 6, each blue line shows a player's level of suspense estimated by the game AI. Each red line shows a player's heart rate. The sample size is too small to conduct meaningful statistical analysis. While there are no clear correlations between the estimated suspense and heart rate for Tester 1 and Tester 4. There are some similarities between the patterns in the estimated suspense level and the heart rate for Tester 2 and 3. Whether heart rate is a reliable measurement of suspense is still debatable, especially for low-level suspense. Our preliminary research into this area is inconclusive, and we hope that further work will yield more data for analysis.

Figures 7 and 8 show the self-rated suspense level by players and the desired suspense curve from two gameplay sessions. Here the rise and fall of the two curves show some similarities. In Fig. 7, although the desired climax (red line) is

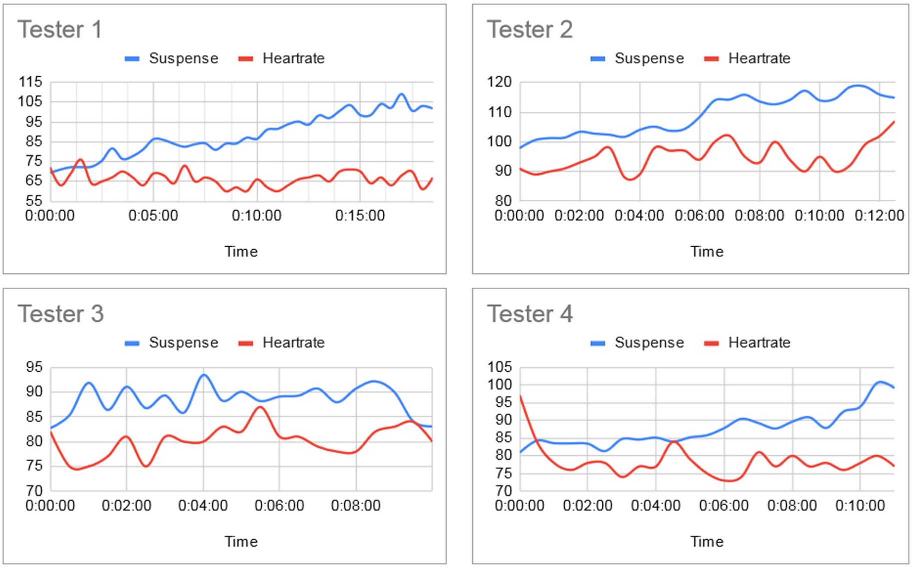

Fig. 6. Players' heart rate and estimated suspense values

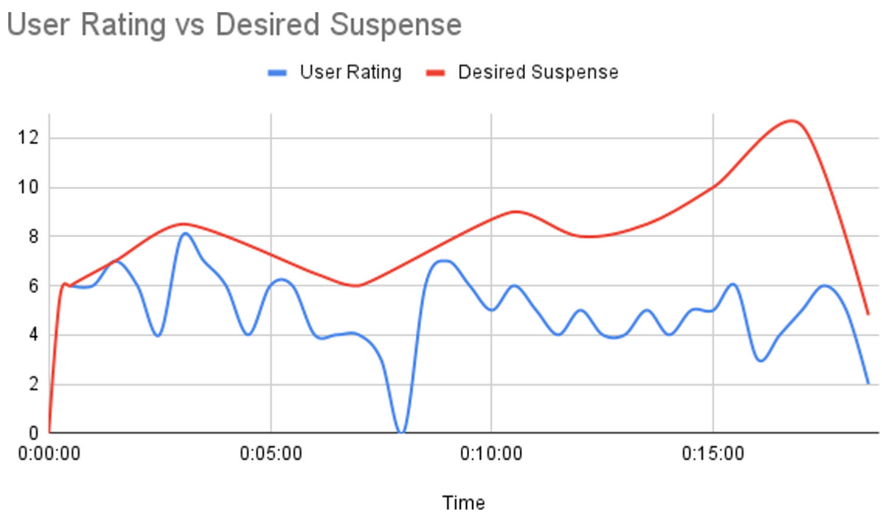

Fig. 7. Self-rated suspense levels (from 0 to 10) by players vs. desired suspense curve (Color figure online)

not manifested in the self-rated suspense curve (blue line), the "rise and fall and rise" pattern in the first half of the red line is present in the blue line. Similarly, in Fig. 8, the rise and fall patterns in the desired suspense curve (blue line) are largely present in the self-rated suspense curve (red line).

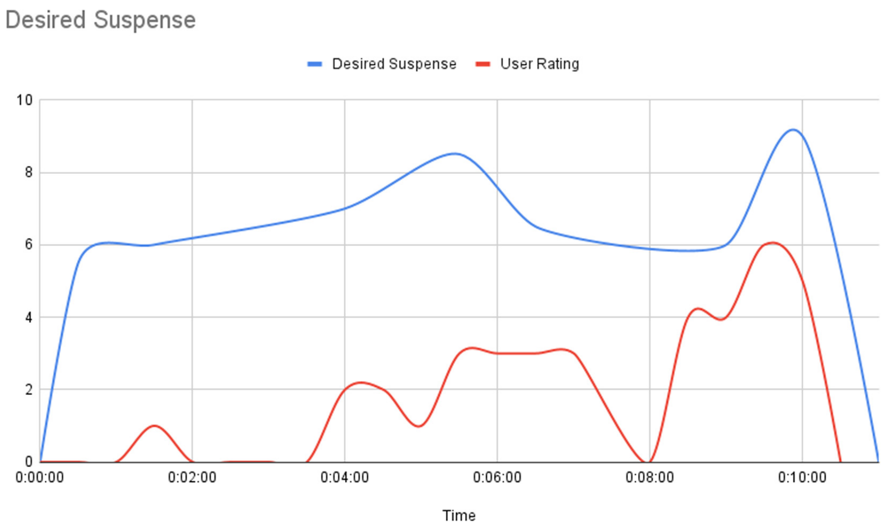

Fig. 8. Self-rated suspense levels by players vs. desired suspense curve (Color figure online)

These preliminary results demonstrate the potential of our suspense model and management system. With more user data and tweaking, the suspense curves could become more accurate estimations of suspense and anxiety. For example, the curve did not account for the drops in suspense that occur when the player ends up lost for extended periods of time. These factors could result in players experiencing different levels of anxiety than we anticipated at particular moments.

5 Conclusion and Future Work

We have presented our study in which we tested a computational model of suspense for non-narrative gameplay. Using this model, we generate and manage the user suspense using only gameplay, without the intervention from narrative and artifacts. Our small user study showed some potential, but more experiments are needed. This model can be used for non-narrative-driven games or to supplement narrative-based computational models of suspense in story-driven games. The results from our experiments show that there could be a viable solution. Using what we learned from the development process, there is an opportunity for other game developers to create a game with our framework integrated as a core feature. In the future, we plan to do more user studies and collect more user data to improve our player suspense model and collect enough data to draw meaningful conclusions about the correlation between our system and player experience.

Acknowledgement. This work was supported in part by NSF Award #1852516.

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