A Theoretical Framework for Managing Suspense in Games

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***Abstract*—Suspense is one of the most important emotions for the enjoyment of games. Many techniques have been developed to generate and manage suspense in games, but a theoretical framework for this body of work is missing. In this paper, we present a framework that identifies the main components for suspense management in games. This framework includes both the cognitive model and computational model of suspense. For the computational model of suspense, we identify the affective loop between Player Suspense Model, Suspense Manager, and game content. This framework can help game designers better understand the various options and tools for creating and managing suspense and provides a road map for developing new techniques.**

***Index Terms*—Game AI, Suspense, Affective Games**

I. Introduction

Video games can be seen as mood managers [1]. Game designers have developed various methods to elicit and manage players' emotional experience [2]. This paper focuses on the creation and management of suspense, an important emotion for the enjoyment of games.

Suspense is a feeling of excitement or anxiety about an uncertain future [3], [4]. The words suspense and tension are often used interchangeably [3]. The appeal of many forms of media entertainment, such as film, music, literature, or sports, is closely related to their effectiveness in evoking suspense [3]–[5]. Studies have also shown that the feeling of suspense is one of the major factors that contribute to the enjoyment of games [6]–[9].

Many techniques have been developed to manipulate suspense in video games [10]–[17]. These techniques are based on a variety of cognitive models and manipulate different elements of games. A theoretical framework is needed to explain and classify this diverse set of techniques. However, such a framework does not currently exist. Recent reviews of affective games also did not pay enough attention to suspense in games. For example, in two systematic reviews of affective games [18] [19], suspense (or anxiety) was only briefly discussed, and many papers on game suspense were not included in the survey. Our work is an attempt to fill this gap.

In this paper, we propose a theoretical framework for managing suspense in games (Figure 1). This framework includes both the cognitive model and computational model of suspense. We identify three main components in computational models of suspense: player model, Suspense Manager, and the mapping of cognitive elements to game elements. We also identify the affective loop between Player Suspense Model, Suspense Manager, and game content. We divide game content into three emotional layers (story, gameplay, and artifact) and argue that suspense can be manipulated on these emotional layers simultaneously.

This framework can help game designers better understand the various options and tools for creating and managing suspense and provides a road map for developing new techniques.

In the following sections, we will first discuss why suspense is important for games. Then we will discuss different parts of our theoretical framework.

II. Why do we enjoy suspense?

Some studies suggested that the suspense a person experiences during an event might enhance the emotion evoked by the outcome of the event [3]. For example, a user study by Vachiratamporn, et al. [20] found "players were more likely to experience fear from a scary event when they were in a suspense state compared to when they were in a neutral state."

Menninghaus, et al. [21] [22] argued that negative emotions, such as fear and anxiety induced by suspense, are particularly powerful in securing attention, intense emotional involvement, and high memorability. The intensity of emotional involvement, regardless of being positive or negative, is by itself a prime factor of aesthetic enjoyment [22]. This idea can be tied to the concept of "flow" [23]. Because suspense can focus attention and intensify emotional involvement, it may help people getting into the state of "flow" [3].

Some studies show that people possess limited physiological, cognitive, and social resources to handle stress [24]. This limited capacity is referred to as a finite pool of worry. This implies that if a person is worried about what will happen in a game, it typically reduces concern about the risks in real life. Thus, suspense in games creates a temporary relief of real-life anxiety.

Studies in sports psychology indicated that many athletes benefit from elevated or even very high levels of anxiety [25]. Similarly, an elevated level of suspense in games may help improve some players' performance.

III. Overview

Figure 1 is an overview of the proposed theoretical framework of suspense management. We divide the computational model of suspense into two main components: Player Suspense Model and Suspense Manager. A cognitive model of suspense is the basis for both the Player Suspense Model and Suspense Manager. The cognitive elements in the cognitive model of suspense are mapped to game elements.

We divide game content into three layers: story, gameplay, and artifact. The Player Suspense Model retrieves the current state of the game from the three layers of game content. Some games also receive physiological signals from players. Based on these inputs, the Player Suspense Model estimates a player's current level of suspense. The Suspense Manager manipulates the game content to create a desirable level of suspense. The different layers of game content then elicit different types of suspense from the game player.

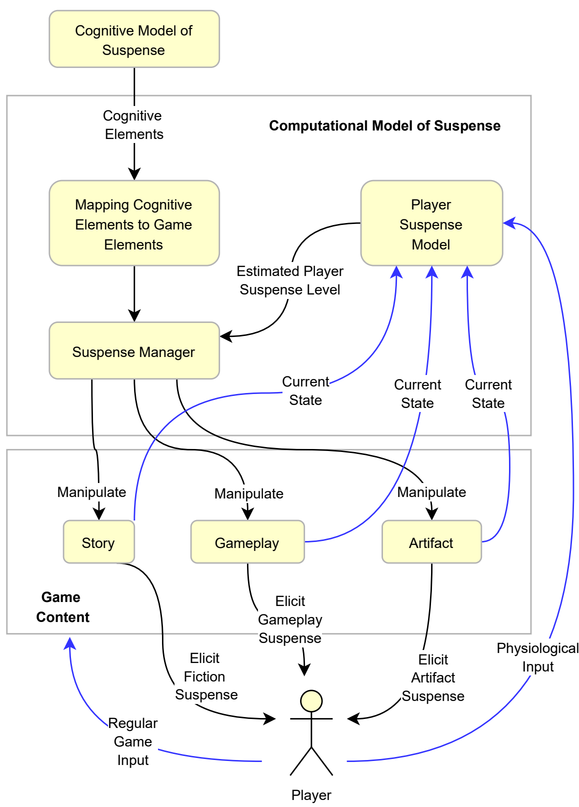

Fig. 1. Theoretical Model of Suspense Management in Games

IV. Cognitive models of suspense

Many computational models of suspense are based on cognitive models developed outside the field of computer games. In this section, we discuss some of the prominent cognitive models of suspense. Cognitive models of suspense try to answer two questions. What are the cognitive elements that generate suspense? How can we manipulate these cognitive elements to adjust the level of suspense?

In the widely accepted cognitive model proposed by Ortony, et al. [26], also known as the OCC model, suspense is generated by three elements: hope, fear, and uncertainty. Moulard, et al. [8] expanded the OCC model by adding probability change, effort, and possible emotional outcome.

Based on Brewer and Lichtenstein's structure-affect theory [27], suspense can be manipulated by adjusting the length between the initiating event and the outcome event, the discourse materials in between, and the significance of the outcome.

The psychological model of suspense proposed by Lehne and Koelsch [3] can be seen as an integration of Brewer and Lichtenstein's model and the OCC model. In this model, the initiating event creates uncertainty, and the events between the initiating event and the outcome event can be used to manipulate expectation, anticipation, and prediction, which are directly related to hope and fear.

Smuts [28] proposed the desire-frustration theory of suspense and argued that helplessness is a major factor for generating suspense. In other words, a spectator's inability to change the negative outcome for a character is the source of suspense. In video games, suspense can be managed by giving or removing options for a player.

Gerrig and Bernardo [29] suggested that readers' reports of suspense are moderated by their perceptions of the range of available solutions to a problem, and suspense was heightened when readers believed that the number of paths to a solution had been restricted. This model leads to a similar conclusion as the desire-frustration model that the way to manipulate suspense in a game is to change the number of options for a player.

Ely, et al. [4] defined suspense as the variance of the next period's beliefs. The greater the variance of the beliefs, the higher the suspense.

V. Three Layers of Game Content

We divide game content into three emotional layers: story, gameplay, and artifact. A computational model of suspense can manipulate suspense on multiple layers simultaneously. The three layers are based on the works by Perron [30] and Frome [31]. Perron [30] identified three layers of emotions in video games: fiction emotions (F emotions), gameplay emotions (G emotions), and artifact emotions (A emotions). Frome [31] identified four types of emotions for interactive play: ecological, narrative, game, and artifact. We followed Perron's model and believed that the ecological and artifact emotion could be merged into one layer. The artifact layer includes every visual and audio object in the game world but nothing outside the game world.

VI. Computational Model of Suspense

A. Mapping Cognitive Elements to Game Elements

A computational model of suspense is typically based on a particular cognitive model of suspense. For example, Suspenser [12], Dramatis [13], and the model by Giannatos, et al. [14] were all based on Gerrig and Bernardo's cognitive model [29]. Bailey and Zhu's model [17] was based on the

OCC model [26]. Doust and Piwek's model [32] was based on Brewer and Lichtenstein's theory [27].

A cognitive model of suspense provides a list of cognitive elements, such as fear, hope, uncertainty, player options, etc., that can be manipulated to adjust the level of suspense. Converting a cognitive model into a computational model of suspense requires mapping these cognitive elements to game elements. The mapping between cognitive elements and game elements is the basis for both Player Suspense Model and Suspense Manager.

For example, in Suspenser [12], the suspense was mapped to the number of plans that a player could choose to solve a problem. In Bailey and Zhu's model [17], fear was measured by the distance between the player and enemies. Hope is measured by the distance between a player and the goal.

B. Player Suspense Model

Player Suspense Models are used to estimate a player's level of suspense during gameplay. Every computational model of suspense includes such a Player Suspense Model, either implicitly or explicitly.

All player suspense models take input from the current state of the game, such as the locations of the avatar, enemies, and NPCs in the game world. Some games also used physiological signals to measure a player's level of anxiety, which is an indicator of the level of suspense. According to Robinson, et al. [18], the most commonly used physiological signals are heart rate, facial expression, breathing activity, EDA, and temperature. For example, Liu, et al. [10] used a variety of physiological signals, including ICG, ECG, BPV, EMG, skin conductance, temperature, and heart sound, to measure player anxiety. Vachiratamporn, et al. [11] measured anxiety through heart rate and brainwaves and used them as inputs into their games. Another example is the work by Chanel, et al. [33].

Many games [12]–[17] did not take physiological signals from players but tried to estimate player's level of suspense based on the current state of the game. The basic assumption is this. Since a set of cognitive elements from a cognitive model are mapped to a set of game elements, we can estimate the intensity of these cognitive elements by measuring specific values of the corresponding game elements. And a player's level of suspense can be estimated by heuristic equations [12], [15], [17] based on the intensity of the cognitive elements.

C. Suspense Manager

The goal of the Suspense Manager is to manipulate a player's estimated suspense level by manipulating game content. A game designer may want to achieve a specific level of suspense or steer game players along a predefined emotional arc. Such manipulations may happen on three different layers simultaneously: story, gameplay, and artifact.

D. Suspense management in the story layer

Many computational models of suspense focused on story manipulation [12]–[16], [32], [34], [35], perhaps because most of the cognitive models of suspense were developed from and for storytelling.

For example, Giannatos, et al. [14] proposed a computational model that used a planner to generate solutions to the planning problem imposed by a set of predefined and procedurally generated plan operators. A fitness function would evaluate the solutions based on the model proposed by Gerrig and Bernardo [29]. Similarly, Cheong and Young [12] also proposed a plan-based model of narrative comprehension to determine the final content of the story in order to manipulate the reader's suspense. Also based on Gerrig and Bernardo's theory [29], O'Neill and Riedl's computational model [13] generated plans for the protagonist to avoid an impending negative outcome and measures the suspense level by determining its perceived likelihood of success. In Szilas and Richle's model [35], the suspense was generated by creating paradoxical narratives.

E. Suspense management in the gameplay layer

There is relatively little research on suspense management in the gameplay layer, perhaps because the mapping between cognitive elements of suspense and game mechanics is not always obvious. But previous work showed that it is also possible to manipulate non-narrative gameplay to manipulate a player's level of suspense. For example, Liu, et al. [10] dynamically changed the level of difficulty in a game based on the anxiety level of players estimated from physiological inputs. In the affective survival horror game developed by Vachiratamporn, et al. [11], the timing of the scary events was affected by the player's level of suspense, which was estimated from the physiological inputs. In Bailey and Zhu's work [17], uncertainty was manipulated by controlling how much a player knew the whereabouts of the enemies. Fear was controlled by adjusting the speed of the enemies and the distance between the player and enemies. Given the rich set of gameplay in most games, there are many opportunities to map cognitive elements of suspense to different gameplay or different combinations of gameplay. More research work is needed in this area.

F. Suspense management in the artifact layer

Previous work has shown that it is possible to use audio and visual effects to evoke suspense from players [11], [36], [37]. For example, Toprac and Abdel-Meguid [36] showed that high volume sound effects that were well-timed with the accompanying visual element were the best sound design for causing fear. Untimed and acousmatic sound effects could evoke suspense. Vachiratamporn, et al. [11] used static noise and stomping sound, along with scary events, to create suspense when a player was in a neutral state for a relatively long period of time. The user study by Graja, et al. [37] suggested the sound facet events were the most effective in stimulating stress/anxiety/tension.

G. Desirable level of suspense

The goal of a Suspense Manager is to manipulate game content to elicit a desirable level of suspense from players. However, it seems difficult to clearly specify what a desirable level of suspense is and how to adjust it throughout a game.

Szilas and Richle [35] proposed a computational model that follows the dramatic curve. Similarly, the model proposed by Bailey and Zhu [17] tried to steer a player towards a desirable emotional arc. In other cases, the goal seems to be maintaining a relatively steady level of suspense [12] or trigger suspense at regular intervals [11]. Overall, most existing work on computational models of suspense did not address this issue sufficiently. It is a difficult problem because a desirable level of suspense may differ for different games, designers, and players. But more specific guidelines can help game designers and developers implement computational models of suspense.

VII. Conclusion and Future Work

We have proposed a theoretical framework for managing suspense in games. In this framework, we identify the major components for managing game suspense and the relationship among these components. This framework can help understand and classify existing works. It also provides a road map for developing new computational models of suspense. We are expanding this work to produce a comprehensive review of suspense management in games. We also plan to conduct user studies to validate this framework, particularly how different layers can be coordinated to influence player suspense.

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