Virtual Cinematography in Games

Investigating the Impact on Player Experience

Burelli, Paolo

Published in:
International Conference On The Foundations Of Digital Games

Publication date:
2013

Document Version
Early version, also known as pre-print

Virtual Cinematography in Games: Investigating the Impact on Player Experience

Paolo Burelli
Aalborg University Copenhagen
A.C. Meyers Vænge 15
2450 Copenhagen, Denmark
pabu@create.aau.dk

ABSTRACT

Cinematography is a key aspect in the development of modern computer games. The quality of the visuals depends, not only on the accuracy of the rendering, but on the way that the scene is presented to the player. Which element should be included in the frame, from which point of view and in which positions are all aspects that have been widely studied in classical cinematography. However, it is still unclear how the principles developed for the film medium are applicable to an interactive medium such as computer games. This article presents a study, which explores the interplay between cinematography and player experience. The results of the experiment demonstrate the existence of an impact of the cinematographic behaviour of camera on both player's affect and her in-game behaviour. Furthermore, this impact is dependent on the game mechanics highlighting once more the difference between classic cinematography and game cinematography.

1. INTRODUCTION

Virtual camera placement and animation play a vital role in 3D computer games and they deeply influence the way in which the player both perceives and interacts with the virtual world. This aspect becomes even more important in games that include elements of narrative and make use of visual elements to convey particular emotions or messages [2]. Similarly to films, in computer games, different camera parameters can make the viewer feel completely different emotions and drew completely different information out of the same scene. However, a camera control system for computer games has, not only to mediate the information flow between the virtual environment and the player, but also to support the player's ability to play [19].

Research and practice in virtual camera control have mainly addressed the problems of narrative and interaction separately, typically applying different principles and rules to interactive and non-interactive sessions within the same game. Cinematographic principles taken from film practice are widely applied in game replays and cut-scenes, while in most games, the interactive sessions rely on standard camera control paradigms such as first-person or third-person. The reasons for this are manifold. First, it is a challenging task to develop a real-time camera control system that supports control for the cinematographic behaviour. Moreover, the wide corpus of notions and rules which apply to classical cinematography and photography has an intuitive application on the visualisation of virtual stories, but there is an effective lack of a formalised knowledge about the impact of cinematography on interactive experiences — e.g. there is no taxonomy of shots for computer games such as the one that exists in film making.

In order to build such knowledge, it is necessary to investigate the relationship between cinematography and player experience in computer games beyond the boundaries of interactive narrative. Yannakakis et al. [27] analysed the impact of camera parameters, such as height or distance, on player psychophysiology for the purpose of developing an affect driven camera control system. We present an experiment that extends the aforementioned work by analysing the camera behaviour in terms of composition. Moreover, the game analysed in this experiment allows to extend the analysis across different genres with richer game mechanics. We have conducted an exploratory study in which the participants play a three-dimensional computer game with different viewpoint settings, each representing a different type of shot with different composition characteristics. Throughout the experiment, the players give feedback on their experience; this data is then compared to the shots features and analysed to identify the characteristics of relationship that exists between them. The results confirm some of the findings revealed by Yannakakis et al. [27], but there are evidences that the relationship between camera behaviour and player experience can be better explained by also analysing some cinematographic aspects of camera behaviour such as shot spacing or symmetry. Moreover, the results reveal that the task the player performs affects the relationship between experience and visualisation.

The remainder of the article is structured as follows: Section 2 presents and overview of the state-of-the-art in virtual cinematography and player experience modelling, Section 3 describes the experiment conducted, Section 4 presents and discusses the results of the experiment and Section 5 summarises the article and proposes a few future research directions.

2. RELATED WORK

Since the introduction of virtual reality, virtual camera control attracted the attention of a large number of researchers (refer to [10] for a comprehensive review). Early approaches focused on the mapping between the degrees of freedom (DOF) for input devices to 3D camera movement. Ware and Osbourne [23] proposed a set of mappings between the user inputs and the camera behaviour. While these metaphors are currently still common in many virtual reality applications, direct manipulation of the several degrees of freedom of the camera soon demonstrated to be problematic for the user, leading researchers to investigate how to simplify camera control [17, 11].

In parallel to the research on control metaphors, a number of researchers investigated the automation of the camera configuration process. The first example of an automatic camera control system was showcased in 1988 by Blinn [4]. Automatic camera control identifies the process of automatically configuring the camera in a virtual environment according to a set of requirements. A large volume of research studies on virtual cinematography is dedicated to the analysis of robust and time-efficient techniques to place and move the camera to satisfy a set of given requirements. Recently, different systems have reached levels of performance and expressiveness that allow the real-time generation of cinematographic views also in interactive and unpredictable virtual environments such as computer games [6, 15].

However, the quality of the cinematics depends as much on the quality of the system which generates them, as on how the system is instructed — i.e. which type of shot is chosen, when and for how long. The problem of the definition of the inputs for an automatic camera control system was addressed for the first time by Christianson et al. [9]. They proposed a system that automatically schedules the sequence of shots to film one or more events in a virtual environment. In their work, they also defined a language (DCCL) that allows a designer to describe such sequences and to automatically relate them to events in the virtual world. Charles et al. [8] and Jhala and Young [13] investigated the automatic generation of shot plans from a story. El-Nasr [12] proposed an interactive narrative architecture that considers the visualisation of an interactive story as a whole coherent task including cameras, light and staging of the characters. Moreover, Jhala and Young [14] proposed an evaluation method for such task, based on the users' understanding of the story represented.

These approaches aim to create more expressive and intelligent tools for designers to define the camera behaviours. Other researchers, on the other hand, investigate the possibility to completely automatise the shot definition process. Tomlinson et al. [22] modelled the camera as an autonomous virtual agent, called CameraCreature, with an affective model and a set of motivations. The agent shots the most appropriate shot at every frame according to the events happening in the environment and its current internal state. Bares and Lester [3] investigated the idea of modelling the camera behaviour according to the user preferences to generate a personalised cinematographic experience. The user model construction required the user to specifically express some preferences on the style for the virtual camera movements. Based on the evidences of a relationship between visual attention, player in-game behaviour and virtual camera behaviour [18], Burelli and Yannakakis [7] extended the idea of user modelling of camera behaviour by implicitly building the models based on the player's visual attention. Trough these models, the camera controller detects in real-time what objects will the player desire to see and it can generate appropriate camera requirements to keep these objects on screen.

Between the top-down and the bottom-up approaches there is a big potential for a third direction in which the camera is driven to generate the cinematographic effect desired by the designer based on the player behaviour and feedback. The idea of affect driven camera control by Yannakakis et al. [27] is an example of such approach. This study investigated the impact of camera viewpoints on player experience and built a model to predict this impact. Such model can be used to instruct the camera controller to generate a certain affective state in the player.

A better understanding of the impact of the camera behaviour on player experience is important, not only to automatise virtual cinematography, but also to develop a knowledge which would allow game designers to make better informed decisions. We believe that such knowledge has the potential to help to develop a new theory of interactive virtual cinematography. However, in the study by Yannakakis et al. [27], the relationship is built on low level camera parameters and the findings give limited information about the visual features that are more relevant for the player. Therefore, in the light of these results and limitations, we conducted an investigation of the relationship between the camera cinematographic behaviour and player experience.

3. EXPERIMENT

Our hypothesis is that the relationship existing between camera movements and player experience goes beyond the direct camera properties and can be better explained through the analysis of the cinematographic characteristics of the visuals produced by the camera. Moreover, we are interested in expanding the scope of [27] by analysing how the relationship evolves across different game genres and mechanics. For this purpose, we conducted and experiment with 26 participants playing six pairs of short game sessions (maximum 30 seconds each) with different camera settings and with different tasks. Each participant is seated in front of a computer and is asked to hold an *Xbox 360* [1] game controller; after this, the participant is guided through the experiment by on-screen instructions. The participant plays initially three pairs of games, each pair features a different game task and the two games in the pair differ only by the way the camera behaves. During the second phase of the experiment, the participant plays the same initial three pairs, but the order of the camera settings is inverted to minimise the effect of the order of play. For each pair the player has to compare her experience between the two games on a set aspects — e.g. frustration or engagement. The tasks that the each player has to perform in the three games are the following:

- **Fight**: the player has to fight with an enemy and destroy it.
- **Collect**: the player has to collect a number of items.
- **Jump**: the player has to reach an area of the game level, which requires her to jump over several floating platforms.

[1] http://www.xbox.com/en-GB/xbox360/

(a) Bird's Eye

(b) Fixed

(c) Long Shot

(d) Mid Shot

(e) Over The Shoulder

(f) Point Of View

Figure 1: The six shot types evaluated in the experiment.

If the task is not completed in 30 seconds, the experiment continues to the next game in the pair or to the next pair. These three tasks represent the basic mechanics of a 3D platform game and have been separated in order to collect a finer feedback about the effects of the different camera behaviours. The dependent variables that are measured during the experiment are the players' reported states and their in-game performance. The independent variables of this experiment are the game tasks and the camera behaviour; therefore, from the results of the experiment, we can evaluate the impact of camera behaviour and how this is mediated by the game mechanics; furthermore, the camera behaviours and the player experience questionnaires are designed so that the results are comparable to [27].

3.1 Camera Configurations

In all games used in this experiment, the virtual camera is controlled by CamOn [5], an automatic camera control system capable of animating the camera, driven by composition properties, such as objects size or position on screen. The camera control system is instructed to produce the following types of shot:

- **Bird's eye**: The camera follows the player's avatar from a high vantage point, the avatar stands at the centre of the screen (see Fig. 1(a)).
- **Fixed**: The camera shows the complete game level from a fixed position (see Fig. 1(b)).
- **Long Shot**: The camera follows the player's avatar from its back, the avatar's full figure is included in the frame and it is placed along the lower third section of the screen (see Fig. 1(c)).
- **Mid Shot**: The camera follows the player's avatar from its back, only the avatar's upper body is included in the frame and its centre is aligned along the lower third section of the screen (see Fig. 1(d)).
- **Over The Shoulder**: The camera stands above the left shoulder of the avatar looking forward and it keeps both the enemy in the avatar in the viewpoint (see Fig. 1(e)).
- **Point Of View**: The viewpoint is placed by the side of the head of the avatar (see Fig. 1(e)).

The shot types selected for the experiment represent only a small subset of the ones formalised in cinematography [1]; however, the set has been selected because it contains the cinematographic counterparts of the majority of camera configurations used in 3D computer games across different genres. Moreover, these six shots provide a wide coverage of some of the parameters evaluated by Yannakakis et al. [27] — e.g. distance and height — and by Swanson et al. [21] — e.g. symmetry and rule of the thirds —, allowing for a comparison of the results and, therefore, a better understanding of the overall role of virtual cinematography in computer games.

3.2 Player Experience

The features selected to describe the player experience are divided into two groups. The first group of features describe the player's cognitive and affective state; these features are measured using a forced choice response from the players. The second group of features describe the player's in-game behaviour; these features include statistics about the different actions performed by the player in each game session.

The six features belonging to the first group are *challenge*, *frustration*, *fun*, *anxiety*, *engagement* and *attention*. The first four have been included as a baseline for the comparison with previous works on affect and camera control [27]. The last two features are included as a connection to the author's previous study on attention based camera control [7]. The models of camera behaviour proposed in that earlier work are built on visual attention; therefore, understanding the impact of the viewpoint on attention and engagement could help designing an adaptation mechanism for such models. Furthermore, considering that engagement stands as a central aspect for interactive experiences [16], we believe that understanding the relationship between the camera behaviour and engagement is of vital importance to shed more light on the impact of virtual cinematography in games. Each state is expressed as a comparison between two games through 4-alternative forced choice (4-AFC) questionnaire scheme. As show in Fig 3.2, the preference questionnaire includes four alternative choices: Game A, Game B, Neither or Both Equally. This scheme has been chosen over a rating scheme for a number of advantages, including the absence of scaling, personality, and cultural biases as well as the lower order and inconsistency effects [25]. Moreover, a 4-AFC scheme, opposed to a 2-AFC scheme, accounts also for cases of non-preference.

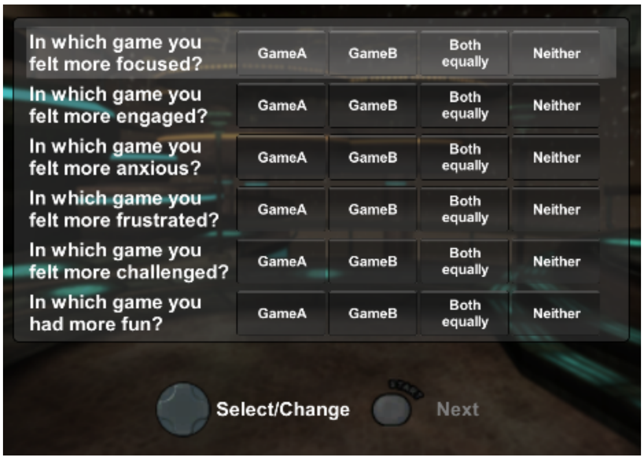


Figure 2: 4-AFC questionnaire on player experience

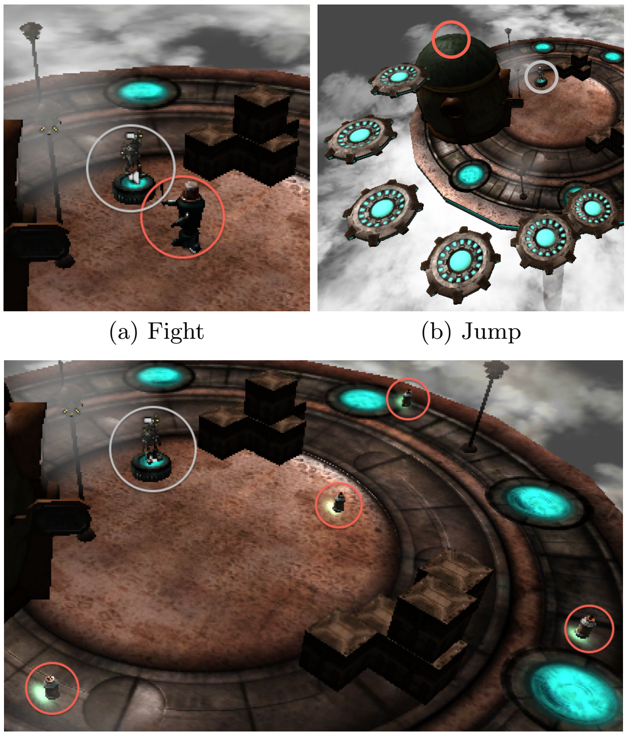
The second group of features contain statistics about the player behaviour; contrarily to the first group, these feature do not measure the experience directly; nonetheless, the player's in-game actions are linked to player experience [28]. Moreover, these features are important to understand the consequences of the different cinematographic choices on the player ability to play. These features are game dependent and, for this experiment, they contain the typical statistics of a platform game: *number of collected items*, *damage received*, *damage inflicted*, *number of jumps*, *umber of falls* and *time to complete the game*.

3.3 The Game

The game employed in this exploratory study is a three-dimensional platform game. It is a reduced version of Lerpz Escape, a tutorial game by Unity Technologies[2]. Similarly to the original game, it features an alien-like avatar trapped in a futuristic 3D environment made of floating platforms and containing collectible items and non-player characters. The game world is composed by one area in which each player has to complete the assigned task; the area contains different elements depending on the task to be performed. The game features three different tasks that must in turn be performed by the players to complete each game session. Each task has a name as described at the beginning of Sec. 3. In the task named *Fight*, the player has to kill an NPC; for this task, the game area contains only one NPC, which chases the avatar and pushes it out of the main platform (see Fig. 3(a)). The task named *Collect* requires the player to collect four items scattered around the area; for this task, the game area contains four floating collectible items (see Fig. 3(c)). In the task named *Jump*, the player has to jump over a series of floating platforms to reach a goal position; for this task the game area contains six platforms that allow to reach the goal area (see Fig. 3(b)).

The game designed for this experiment stands as a prototypical platform game, as it incorporates the typical aspects of the genre. According to the classification described by Wolf [24] the platform games are defined as *"games in which the primary objective requires movement through a series of levels, by way of running, climbing, jumping, and*

[2]http://www.unity3d.com



(a) Fight (b) Jump

(c) Collect

Figure 3: The three game tasks. The elements characterizing the game task are surrounded with a red circle, while the avatar is surrounded with a grey circle.

other means of locomotion"; moreover, according to Wolf, such games often *"involve the avoidance of dropped or falling objects, conflict with (or navigation around) computer controlled characters, and often some character, object, or reward at the top of the climb which provides narrative motivation"*.

Therefore, we can reasonably assume that the results obtained using the aforementioned game are generalizable to the whole *platform games* genre. Moreover, still according to Wolf's classification, it is possible to hypothesise that such results would, at least, partially, apply also to genres such as Adventure and Obstacle Course which have a very similar interaction scheme. Moreover, the game has been designed not only to maximise the applicability of the experiment results, but also to incorporate a highly interactive gameplay that minimises narrative. The reason for this choice is our desire for the evaluation of cinematography to focus on interaction rather than on story telling.

4. RESULTS AND DISCUSSION

The data collected during the experiment consists of 312 game sessions played by 26 players and 156 choices express for six features. The participants are 29 years old on average (std=5.98) and predominantly male (only 2 females). About 42% of the participants reported to have experience in playing platform games and almost 70% declared to play less than 2 hours per week. Based on these data, the reminder of the section presents initially a test to asses whether the order of play has an effect on the reported experience. The

	All				
Shot	Attention	Engagement	Anxiety	Frustration	Fun
BirdsEye	0.86	0.80	0.47	0.51	0.76
Fixed	0.49	0.61	0.83	0.32	0.61
LongShot	**0.00**	0.03	*1.00*	*1.28*	**0.00**
MidShot	0.20	**0.00**	0.52	1.07	0.13
OverTheShoulder	0.35	0.58	0.86	0.82	0.82
PointOfView	*1.12*	*1.12*	**0.00**	**0.00**	*1.27*

	Fight		Collect			
Shot	Frustration	Fun	Attention	Engagement	Frustration	Fun
BirdsEye	*1.33*	0.07	*3.06*	*2.40*	**0.00**	*1.87*
Fixed	**0.00**	0.67	**0.00**	0.07	1.44	0.10
LongShot	0.51	0.04	1.14	**0.00**	*1.63*	**0.00**
MidShot	1.07	**0.00**	1.14	0.48	1.22	0.02
OverTheShoulder	0.63	0.11	1.07	1.07	1.66	1.54
PointOfView	0.22	*1.78*	2.00	2.40	0.04	1.73

	Jump				
Shot	Attention	Engagement	Anxiety	Frustration	Fun
BirdsEye	1.47	**0.00**	0.78	0.78	1.44
Fixed	1.30	0.61	*1.78*	0.78	1.44
LongShot	**0.00**	0.04	1.66	*2.77*	**0.00**
MidShot	1.14	0.11	0.71	1.44	0.56
OverTheShoulder	0.94	0.88	1.74	0.89	1.33
PointOfView	*1.99*	*1.03*	**0.00**	**0.00**	*1.89*

Table 2: Shot types sorted for each reported state according to a Thurstone scales. Lower values indicate a positive relationship while — i.e. the shot has been often picked in the pairwise comparison. Higher values indicate the presence of no relationship or a negative one. This table contains only the reported state that showed a significant relationship in the chi-square test presented in table 1.

test is followed by an analysis of the impact of the different shot type on the experience both in terms of in-game behaviour and reported states. Finally, the relationship between the different aspects of the camera behaviour of the camera and the player experience is analysed to assess motivations of the aforementioned impact.

4.1 Order Effect

The experiment uses preferences to assess player experience and the testing scheme is within subject; therefore, as a first step of the analysis, it is important to assess if the order of play has any impact on the reported states. To asses such impact, we follow the testing procedure described in [26] and

	Fight	Collect	Jump	Overall
Attention	0.09	**0.00**	**0.00**	**0.00**
Engagement	0.10	**0.00**	**0.05**	**0.00**
Anxiety	0.46	0.07	**0.01**	**0.00**
Frustration	**0.05**	**0.00**	**0.00**	**0.00**
Challenge	0.25	0.55	0.09	0.17
Fun	**0.01**	**0.01**	**0.03**	**0.00**

Table 1: P values of a Pearson's chi-square test of independence between type of shot (as a six valued categorical variable) and each reported state. A value lower than 0.05 indicates the presence of a relationship between the shot types and a certain reported state. The same test is conducted over the whole dataset and for each specific game task.

we calculate the correlation r_o as follows:

$$r_o = \frac{K - J}{N} \tag{1}$$

where K is the number of times the users expresses a preference for the first game session in both pairs, J is the number of times the users expresses a preference for the second game session in both pairs and N is the number of game pairs in which a preference is expressed. The statistical test shows that no significant order effect emerges for none of the reported states.

4.2 Type of Shot

In order to asses the existence of a relationship between camera behaviour and player experience, we first consider camera behaviour as a categorical variable having 6 states corresponding to the 6 types of shots used in the experiment. By doing this, we are able to estimate which states are affected and how the different types of shot impact the different states.

For this purpose, we conduct a Person's chi-square test of independence between the preferences expressed and camera behaviour; for each state the preference is expressed as a binary variable, while the camera behaviour has 6 possible categories. The chi-square test of independence allows to identify whether there is a dependence between two categorical variables. The test is conducted on a set containing all the recorded games and on three sets containing the games sorted by task. Table 1 shows the results of the test, a p-value lower than 0.05 indicates that a significant relationship exists. Overall, most of the reported states exhibit a significant dependence to the type of shot, hinting that different

Gameplay	Feature	B.Eye	Fixed	L.Shot	M.Shot	O.T.Shoulder	P.O.V.	p
Fight	Falls	0.05	0.06	0.33	0.06	0.29	0.06	0.02
Fight	Damage Inflicted	2.82	2.39	2.22	2.94	1.79	2.44	0.03
Collect	Falls	0.05	0.06	0.33	0.06	0.29	0.06	0.02
Jump	Falls	0.00	0.81	0.30	0.31	0.35	0.50	0.01

Table 3: Impact of the camera configuration on the gameplay sorted by feature and gameplay type. Only the features, which have a significantly different average between the different types of shots, have been included in the table for space reasons. The significance is tested through an ANOVA test.

cinematographic behaviours can be used to affect the player experience also in platform games.

However, it is worth noticing that reported challenge does not appear to be significantly affected by the type to shot, this result apparently contradicts the results reported by Yannakakis et al. [28]; however, the differences in terms of level design between the two games used in the experiments is most likely the reason for this contradiction. The platform game employed in this experiment features an open space with no major obstacle, while the game used in the previous experiment featured narrow corridors with high walls making some camera configurations potentially more challenge as they could partially or completely hide the avatar.

Another reported state that partially contradicts the findings by Yannakakis et al. is anxiety. This state appears to be significantly influenced by the type of shot in the games that require the player to Jump. In addition, the results reported in table 3 show that the number of falls is reported as significantly different among the games played with different shot types. This could explain how the significant effect on anxiety is probably motivated by the fact that certain shots make jumping more difficult than others. Similarly to challenge, the difference between this result and one by Yannakakis' et al. depends on the differences between the games employed in the two experiments, since jumping between platforms is not a mechanic of the pac-man like game used in their study.

Even though, the chi-square test reveals the existence of a relationship between cinematography and player experience; to estimate the characteristics of this relationship, it is necessary to sort the preference results and understand how each type of shot affects the different states. Table 2 shows each shot type sorted according to a Thurstone Case V scale. Sorting the data using this scale permits to understand which shot, among the ones considered, has the strongest positive influence on each state. The scale is sorted from the smallest to the biggest value; thus, the shot with value equal to 0 is the one which is most often reported as inducing more a certain state on the player. Another interesting characteristic of the scale is the distribution of the values: the more they are far apart, the higher are the differences in terms of impact among the shots.

One interesting fact that emerges from this analysis is that either the *Mid Shot* or the *Long Shot* is always reported to be most fun in all experimental conditions. This is probably due to the familiarity of these types of shots, since 3D platform games commonly adopt this type of camera. The impact of the other reported states vary according to the game task and it is interesting how certain emotions, such as *frustration*, are induced by completely different shots depending on the task that has to be performed.

4.3 Camera Behaviour Characteristics

In order to understand the motivations of the impacts disclosed in the previous section, we need to analyse how the characteristics of the camera behaviour are related to the user reported states. By analysing the cinematographic experiences in terms of what the players see while playing the games, we can isolate which visual features of the shots contributed on their impact on player experience. The characteristics that we extracted in the game are the following:

- *Distance and height*: average distance and height of the camera relative to the avatar.
- *Rule Of Thirds*: average level of satisfaction of the rule of the thirds.
- *Spacing*: average percentage of the screen not covered by any object.
- *Symmetry*: average level of symmetry of the objects positions on screen.

The first two characteristics describe directly the behaviour of the camera, while the last three describe it from a cine-

Gameplay	Experience	Camera	c(z)	p
All	Attention	Spacing	0.27	0.00
	Engagement	Spacing	0.37	0.00
	Engagement	Symmetry	0.17	0.05
	Anxiety	Distance	-0.23	0.01
	Frustration	Spacing	-0.30	0.00
	Fun	Distance	0.22	0.02
	Fun	Spacing	0.29	0.00
Fight	Engagement	Spacing	0.29	0.04
	Frustration	Symmetry	-0.45	0.00
	Fun	Symmetry	0.41	0.01
Collect	Attention	Symmetry	-0.42	0.00
	Engagement	Rule Of The T.	0.31	0.04
	Engagement	Spacing	0.51	0.00
	Frustration	Spacing	-0.38	0.03
	Fun	Distance	0.32	0.05
	Fun	Spacing	0.38	0.01
Jump	Attention	Spacing	0.36	0.01
	Engagement	Symmetry	0.44	0.00
	Frustration	Spacing	-0.48	0.00
	Challenge	Symmetry	-0.44	0.01
	Fun	Spacing	0.37	0.01

Table 4: Correlations between the characteristics of the shots and the reported states. Only the significant correlations have been included.

matographic perspective in terms of composition of the generated images. These characteristics are calculated only on the objects which are considered relevant for the gameplay — i.e. platforms, collectable items and enemies — and which are present on screen. The values are calculated using the formulas proposed by Swanson at al. [21].

Table 4 shows the significant correlations found between the shots characteristics and the different reported states. Correlation coefficients $c(z)$ are calculated according to the following equation:

$$c(z) = \sum_{i=0}^{N_p} \frac{z_i}{N_p} \tag{2}$$

where N_p is the total number of games where subjects expressed a clear preference, $z_i = 1$, if the subject prefers the game with the larger value of the examined feature and z_i = -1, if the subject chooses the other game.

Among the two direct features analysed, only distance appears to have significant correlations respectively negative with reported anxiety and positive with reported fun. When comparing this data with the respective Thurstone scales we see that very close shots are very rarely picked as fun and distant shots are rarely picked as anxious. However, it is also clear, that only distance is unable to account for the dependences observed in the previous sections. The relationship become clearer when the composition features (spacing, symmetry and rule of the thirds) are also taken into account. Fun, for instance, is positively correlated to both distance and spacing and this helps understanding why *mid shot* and *long shot* are considered the most fun: these shots offer a view of the largely empty horizon generating shots with high spacing value even if the camera is relatively close to the avatar. At the same time, shots that offer on average little spacing, such as *bird's eye* and *fixed* have less influence on fun, despite their high distance values.

One interesting observation is that the *rule of the thirds* feature does not appear to be significantly correlated to any reported state beside engagement in the games featuring the collection task. This features is commonly considered very important for image aesthetics and it has been reported to be also perceived as such by user observing digital images [21]. A possible explanation for this lack of significance might be that, in general in platform games and specifically in the jumping and fighting sessions, the gameplay is too fast for the player to perceive the aesthetics of the shot as an important factor. This would also explain why, during the item collection sessions that have a slower gameplay, the *rule of the thirds* feature appear significantly and positively correlated to engagement.

5. CONCLUSIONS

The article presented a study of the impact of cinematographic camera control on player experience in a platform game. The aim of the study is to identify whether this impact is statistically significant, on which aspects of player experience is the impact significant, how do different types of shot affect player experience and which characteristics of the camera behaviour are responsible for the impact. For this purpose, an experiment was conducted with 26 participants playing a series of short games with different mechanics and different camera configurations. During the experiment, players' in-game statistics and reported affective and cognitive states have been collected.

The results revealed the existence of an impact of cinematography on all reported states but challenge. Moreover, it emerged the different types of shot affect aspects such a frustration or attention differently depending on the task performed. This finding further highlights the difference between film cinematography and game cinematography, since it demonstrates how the impact on the player experience is mediated by her interaction. Another fact that emerged from the comparison of the results presented in this paper with previous works on affect and camera control is that some aspects of the player experience appear to be affected by the viewpoint independently of the game characteristics. On other aspects of player experience, the effect changes depending on the game mechanics and the level design.

The primary limitation of this study is the composition of the sample that participated the experiment. The vast majority of male participants and the fact that most participants were engineering graduate students limit the generalisability of the results. A further limitation is the number of shots evaluated and the lack an analysis on the movements of the camera. To overcome these limitations, we believe that several similar experiment should be run with different participants and on different games, for the purpose of developing a data driven ontology of shot types for computer games and their effects on player experience. Such an ontology could be a valuable tool to design better interactive cinematographic experiences.

6. REFERENCES

[1] D. Arijon. *Grammar of the Film Language.* Silman-James Press LA, 1991.

[2] R. Aylett, S. Louchart, J. Dias, A. Paiva, and M. Vala. FearNot!âĂŞan experiment in emergent narrative. In *International Working Conference on Intelligent Virtual Agents*, 2005.

[3] W. H. Bares and J. C. Lester. Cinematographic User Models for Automated Realtime Camera Control in Dynamic 3D Environments. In *International Conference on User Modeling*, pages 215–226. Springer-Verlag, 1997.

[4] J. Blinn. Where Am I? What Am I Looking At? *IEEE Computer Graphics and Applications*, 8(4):76–81, 1988.

[5] P. Burelli. *Interactive Virtual Cinematography.* PhD thesis, IT University Of Copenhagen, 2012.

[6] P. Burelli and G. N. Yannakakis. Combining Local and Global Optimisation for Virtual Camera Control. In *IEEE Conference on Computational Intelligence and Games*, page 403, 2010.

[7] P. Burelli and G. N. Yannakakis. Towards Adaptive Virtual Camera Control In Computer Games. In *International symposium on Smart Graphics*, 2011.

[8] F. Charles, J.-l. Lugrin, M. Cavazza, and S. J. Mead. Real-time camera control for interactive storytelling. In *International Conference for Intelligent Games and Simulations*, pages 1–4, London, 2002.

[9] D. Christianson, S. Anderson, L.-w. He, D. H. Salesin, D. Weld, and M. F. Cohen. Declarative Camera Control for Automatic Cinematography. In *AAAI*, pages 148–155. AAI, 1996.

[10] M. Christie, P. Olivier, and J.-M. Normand. Camera

Control in Computer Graphics. In *Computer Graphics Forum*, volume 27, pages 2197–2218, 2008.

[11] S. M. Drucker and D. Zeltzer. Intelligent camera control in a virtual environment. In *Graphics Interface*, pages 190–199, 1994.

[12] M. S. El-Nasr. An Interactive Narrative Architecture based on Filmmaking Theory. *International Journal on Intelligent Games and Simulations*, (March), 2004.

[13] A. Jhala and R. M. Young. A discourse planning approach to cinematic camera control for narratives in virtual environments. In *AAAI*, number July, pages 307–312, Pittsburgh, Pennsylvania, USA, 2005. AAAI Press.

[14] A. Jhala and R. M. Young. Cinematic Visual Discourse: Representation, Generation, and Evaluation. *IEEE Transactions on Computational Intelligence and AI in Games*, 2(2):69–81, June 2010.

[15] C. Lino, M. Christie, F. Lamarche, G. Schofield, and P. Olivier. A Real-time Cinematography System for Interactive 3D Environments. In *Eurographics/ACM SIGGRAPH Symposium on Computer Animation*, pages 139–148, 2010.

[16] H. L. O'Brien and E. G. Toms. What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology*, 59(6):938–955, Apr. 2008.

[17] C. B. Phillips, N. I. Badler, and J. Granieri. Automatic viewing control for 3D direct manipulation. In *ACM SIGGRAPH Symposium on Interactive 3D graphics*, pages 71–74, Cambridge, Massachusetts, USA, 1992. ACM Press.

[18] A. Picardi, P. Burelli, and G. N. Yannakakis. Modelling Virtual Camera Behaviour Through Player Gaze. In *International Conference On The Foundations Of Digital Games*, 2011.

[19] D. Pinelle and N. Wong. Heuristic evaluation for games. In *CHI*, CHI '08, page 1453, New York, New York, USA, 2008. ACM Press.

[20] C. Soanes and A. Stevenson. *Oxford Dictionary of English*. Oxford University Press, 2005.

[21] R. Swanson, D. Escoffery, and A. Jhala. Learning Visual Composition Preferences from an Annotated Corpus Generated through Gameplay. In *IEEE Conference on Computational Intelligence and Games*, pages 363–370, 2012.

[22] B. Tomlinson, B. Blumberg, and D. Nain. Expressive autonomous cinematography for interactive virtual environments. In *International Conference on Autonomous Agents*, page 317, 2000.

[23] C. Ware and S. Osborne. Exploration and virtual camera control in virtual three dimensional environments. *ACM SIGGRAPH*, 24(2):175–183, 1990.

[24] M. J. P. Wolf. Genre and the video game. In M. J. P. Wolf, editor, *The medium of the video game*, chapter 6, pages 113–134. University of Texas Press, 2001.

[25] G. N. Yannakakis and J. Hallam. Rating vs. Preference: A comparative study of self-reporting. In *Affective Computing and Intelligent Interaction Conference*. Springer-Verlag, 2011.

[26] G. N. Yannakakis, J. Hallam, and H. H. Lund. Entertainment capture through heart rate activity in physical interactive playgrounds. *User Modeling and User-Adapted Interaction*, 18(1-2):207–243, Sept. 2008.

[27] G. N. Yannakakis, H. P. Martinez, and A. Jhala. Towards Affective Camera Control in Games. *User Modeling and User-Adapted Interaction*, 2010.

[28] G. N. Yannakakis and J. Togelius. Experience-driven procedural content generation. *IEEE Transactions on Affective Computing*, pages 1–16, 2011.