

Ergonomic Analysis of Hollywood 3D Films and the Representation Trends

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Abstract

In the field of stereoscopic (3D) images, there have been many initiatives from the viewpoint of 3D content creators. It has been pointed out that the establishment of know-how for creating 3D content in Hollywood is forward compared with the other countries. Here “know-how” means producing a depth sensation mainly by imposing a binocular disparity and it is closely related with various ergonomic issues. The authors have carried out multifaceted and continuous analysis of the disparity in well-known 3D films that were created in Hollywood and that have been highly evaluated throughout the world. The objective was to provide useful knowledge for creating 3D content in future, by quantitatively determining the characteristics and trends in the disparity in these movies. This paper introduces examples of the results for analysis of movies as a whole one and specific scenes.

Keywords: stereoscopic images, binocular disparity, content evaluation, Hollywood film, 3D representation

1. Introduction

In the field of 3D images, industry associations for hardware and software, consisting mainly of display manufacturers, have been established to undertake initiatives with the aim of promoting 3D images. Recently there have been many initiatives from the viewpoint of 3D content creators. The main example is the International 3D Society (I3DS)¹⁾ which was formed by Hollywood film makers and related companies and individuals, of which the Japanese committee (I3DS-J)²⁾ was established in 2011. The focus in I3DS-J is on how to produce and evaluate safe and comfort 3D content, and for the purpose ergonomic approaches are important.

The authors are associated with I3DS-J, and have carried out disparity analysis of Hollywood 3D films and investigated their 3D representations. This paper summarizes the activities and findings.

2. Disparity analysis of 3D films

It has been pointed out that the establishment of know-how for producing 3D content in Japan is backward compared with Hollywood. Here “know-how” means presenting depth sensation mainly by imposing binocular disparity. The authors have carried out multifaceted and continuous analysis of the disparity in well-known 3D films produced in Hollywood and highly evaluated throughout the world. The objective was to obtain useful knowledge for producing 3D content in future, by quantitatively determining the characteristics and trends in the disparity in these works.

This paper introduces examples of the results of analysis of works as a whole (macro analysis) and examples of specific scenes (scene analysis). In addition, disparity analysis is described for scenes

that are considered to express emotion within the works (emotion analysis). The extraction of disparity was carried out by image processing using stereo matching, by calculating the pixel disparity of the corresponding points between the left and right.

3. Analyzed 3D films

Disparity analysis was carried out for the following four 3D films.

- Avatar (20th Century Fox, 2009)
- Cloudy with a Chance of Meatballs (Sony Pictures, 2009)
- Tangled (Walt Disney Pictures, 2010)
- How to Train Your Dragon (Paramount, 2010)

In each case the pixel disparity was determined using the Blu-ray version that assumes viewing at home.

4. Results of macro analysis

First, stereo matching was carried out for one frame in each second for each of the content, and the pixel disparity was calculated for each frame.

The 90 percentile, 50 percentile, and 10 percentile pixel disparity for each frame was plotted in a time series as representative values of near, medium, and far in 3D space respectively. Positive values of pixel disparity mean the cross direction, and negative values mean uncross direction. If 3H (viewing distance of three times the screen height) with high-definition resolution (1080i) is assumed, then ± 55 pixels convert to a parallax angle of about ± 1.0 degree. Figure 1 and 2 shows the results of the macro analysis for "Avatar" and "Tangled". In order that the change in disparity throughout the whole works can be easily understood, each representative value was converted to a 10-second moving average. From these results it can be seen that the distribution of

representative values of disparity with time is not uniform in each work, but increases and decreases corresponding perhaps to the story telling within each work. Also, there are distinct differences between works. It can be found that in "Tangled" the proportion of uncross disparity is large compared with "Avatar". In addition it suggests that various

techniques are used in each work such as increasing or decreasing the disparity to present resting part for the viewers, from the point of view of designing the depth sensation. It was also confirmed that almost all of the representative values for near and far in the 3D films analyzed were within a parallax angle of ± 1.0 degree.

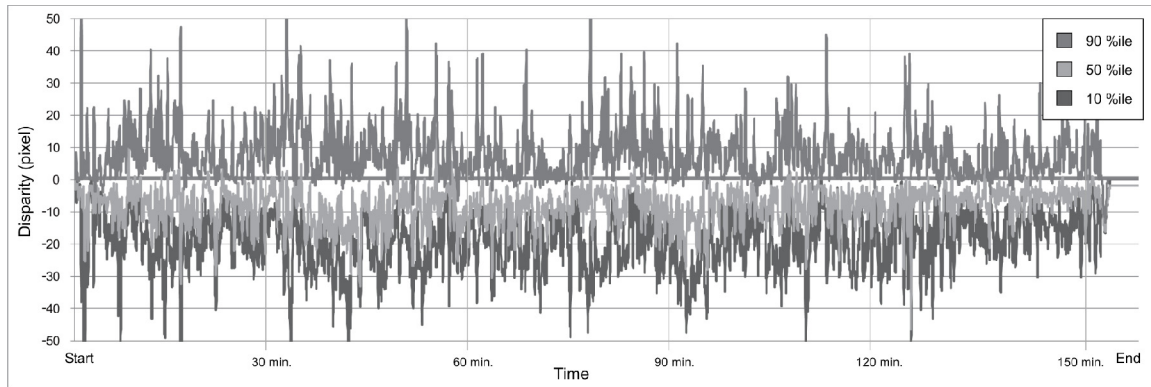


Figure 1 Results of macro analysis for "Avatar"

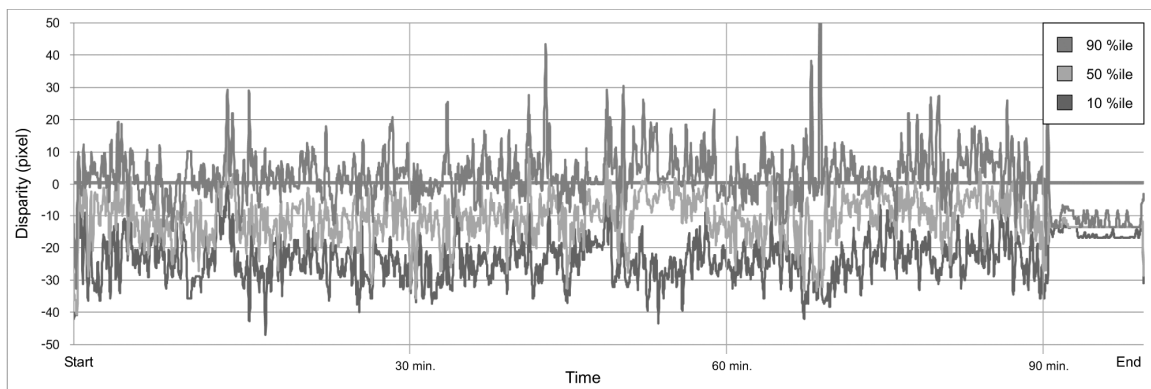


Figure 2 Results of macro analysis for "Tangled"

5. Results of scene analysis

Specific scenes within each work were selected and analyzed from the viewpoint of presenting depth sensation. Figure 3 shows the results of disparity analysis of scenes extracted from the first half of "How to Train Your Dragon". This is considered to be characteristic from the point of view of corresponding to the psychological tension of the main characters. Specifically, it can be seen that in producing the effect of depth, there is a trend in the distribution of representative values for near and far that after there has been a change in the expansion direction, suddenly there is a reduction, which is maintained for fixed period. It is speculated that this control of the disparity corresponds to the psychological change or calmness of the characters in the scene, which is deliberately reflected in the presentation of depth sensation. In the other works

also, characteristic scenes where disparity is controlled can be seen here and there, so it is considered necessary to carry out more detailed analysis of this deliberate effect.

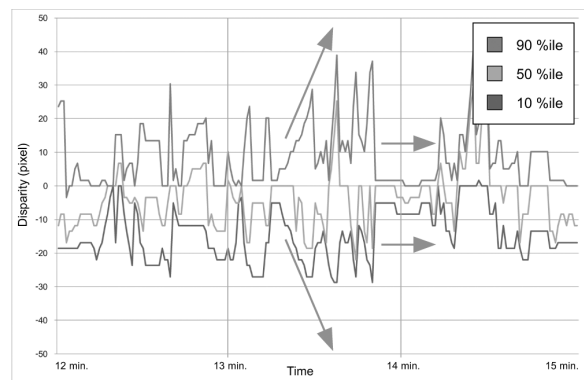


Figure 3 Example of scene analysis

6. Classification of basic emotions

Ekman asserts that there are ordinary emotion categories that are not dependent on culture, and that there are six types of emotion that can be classified extremely accurately from the shape and changes in the forehead, eyebrows, eyelids, cheeks, nose, lips, and chin⁴). The six types of emotion are anger, dislike, fear, happiness, sadness, and surprise. The authors classified the emotional scenes within these works in accordance with the basic emotions of Ekman. Specifically, by identifying and classifying emotional scenes in the works, and comparing them with the basic controls of depth sensation (Figure 4), the aim was to obtain basic knowledge regarding the trends in production of specific emotional expressions.

7. Classification of emotional scenes

Within the 3D films referred to above, 109 scenes were identified and classified as "emotional". Identification was carried out by the three of authors, having normal stereoscopic vision, acting as coders, viewing all the works several times, and selecting candidate scenes. Then the selected scenes were evaluated using Ekman's basic emotions as the criterion, and for those scenes where the judgments of the coders agreed, those scenes were given that basic emotion. Table 1 shows the results of classification of these identified 109 scenes into the basic emotions, and the percentage of each of the basic emotions in the classified scenes.

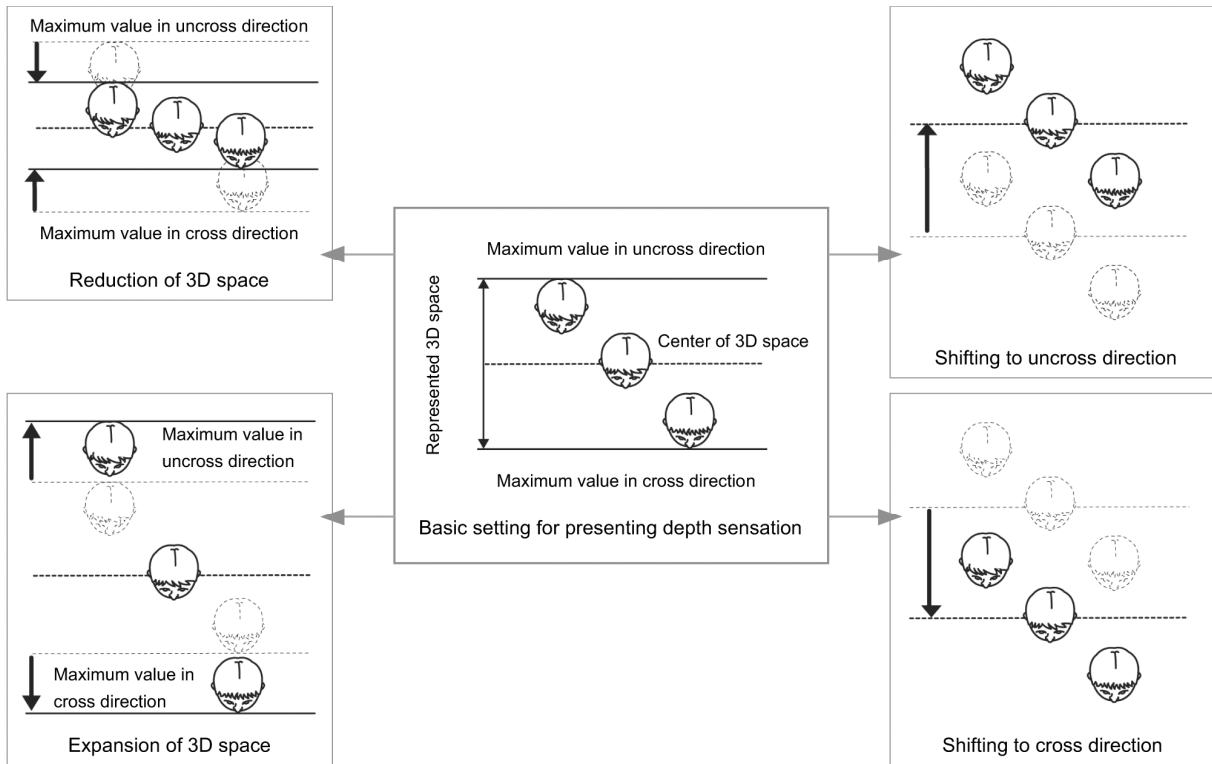


Figure 4 Basic controls of depth sensation

Table 1 Results of classification of emotional scene

	Anger	Dislike	Fear	Happiness	Sadness	Surprise
Num. of scenes	8	5	23	31	15	27
Rate (%)	7.3	4.6	21.1	28.4	13.8	24.8

8. Analysis of emotional scenes

Quantification of emotional scenes was carried out using the results of disparity analysis of the classified scenes, by calculating the difference between the first frame and the maximum value within the scene as a

representative value of the center and the range of the represented 3D space. The objective of this quantification was to find some characteristics or trends in the presentation of depth sensation in the classified scenes that express the specific emotions.

9. Results of emotion analysis

For each of the basic emotions, the representative values for the range of the represented 3D space increased, but their trends differed depending on the type of emotion. On the other hand, the direction of the center of the 3D space varied depending on the type of emotion. Specifically, in scenes classified as dislike or surprise, the center of the 3D space changed in the direction nearer to the viewer, but in scenes classified as fear a change in the direction

farer was seen.

Depending on the viewer, changes in the center and the range of the 3D space are experienced as changes in the distance to the object or the depth. Although the analysis in this paper did not go so far as to confirm the intentions of the creators, it is considered that the possibility of a dramatic association between control of the depth sensation and the expression of specific emotions is suggested.



Figure 5 Results of emotion analysis

10. Conclusions

This paper describes the extraction and analysis of disparity in well-known 3D Hollywood films. Future tasks of this study include the following three points.

- Increasing the number of works, and utilizing the obtained knowledge for guidelines, etc.
- Detailed analysis of characteristic scenes, and construction of new methods of expression
- Development of disparity control to express specific emotions and examination of their effectiveness

Acknowledgements

Many people cooperated in promoting this study. The authors would like to express their gratitude to those members of I3DS and I3DS-J involved in this work, and the following stereographers who were in charge of the production of the 3D films analyzed in this paper and gave important suggestions for the authors;

Mr. Chuck Comisky, Mr. Rob Engle, Mr. Buzz Hays, Mr. Phil McNally and Mr. Robert Newman.

This research was partially supported by the Japan Society for the Promotion of Science, Grant-in-Aid for Challenging Exploratory Research 2011 – 2012 (23650054, Takashi Kawai).

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