Dynamic Frame Rate: A Study on Viewer Perception of Changes in Frame Rate Within an Animated Movie Sequence

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1 Introduction

Dynamic Frame Rate (DFR) is the change in frame rate of a movie sequence in real time as the sequence is playing. Throughout the majority of the past century and after the introduction of sound in films, frame rates used in films have been kept at a standardization of 24 frame per second despite technological advancement [Salmon et. Al 2011]. In the past decade, spatial resolution has been increasing in display systems while the temporal resolution, the frame rate, has not been changed. Because of this, researchers and filmmakers stress that motion judders and blurriness are much more apparent and they propose that high frame rates will solve the issue [Emoto et. Al 2014] [Turnock 2013]. Some industry experts and critics, however, oppose the use of high frame rates [Wilcox 2015]. Despite all the research and attempts in using high frame rate, the idea of using dynamic frame rate in digital cinema has not been explored in depth. As such, there is very limited information on how people perceive DFR and how it actually works. By understanding DFR and how viewers perceive the changes in frame rate, it will help us adapt new techniques in the creation of cinema. We can utilize high frame rate in sequences that could benefit from high frame rate while keeping the rest of the sequences at standard frame rate. This thesis aims to understand the basics of DFR, how different implementations of DFR changes viewer perception and how people perceive a change of frame rate in an animated movie sequence displayed.

2 Our Approach

Given that dynamic frame rate is the change in frame rate in real time as a movie sequence is playing, the first step toward understanding how it works is to explore the different methods of creation. The methods that are chosen for the purpose of this research are instantaneous cut, crossfade and linear change. Instantaneous cut refers to changing directly from a lower frame rate to a high frame rate. For example, changing from 30 fps to 120 fps instantly. Crossfade refers to using frame-blending and fading techniques to change in-between frame content over a period of time. This will create the illusion that the frame rate is changing. Linear change refers to a linear increase or decrease in the change in frame rate over a time frame.

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A test concept is created for this research to understand and collect data on viewer perception of DFR. The test is split into three groups, Simple, Normal, and Complex. Different variables are considered for the animation test for each group. Each group has 10 subjects. The subjects will view five experimental conditions each composed of 10 trials for 50 total experimental trials. Additionally, there are two control conditions consisting of 25 trials for each condition, and bringing the total number of trials to 100. The five experimental test conditions are five different implementations of DFR: instantaneous cut, crossfade over one second, crossfade over three seconds, linear change over one second, and linear change over three seconds. The two control conditions are constant 30 fps and 120 fps. The trials are randomized and subjects are asked to press on a button whenever they notice a change in frame rate. The data collected is analyzed with Signal Detection Theory to understand the viewer's noticeability and perception on different DFR implementations.

The expected result for this research is that participants will notice the DFR regardless of the implementation being viewed. However, the type of change and the time it takes to change, can affect the amount of noticeability. The perception of DFR can be affected by the speed of object movement and the amount of motion blur. To minimize the effect, changing the frame rate when objects move at a slower speed or at a stand still will help lower the detection of a change in frame rate.

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