Expert and automatic strategies: subjective evaluation of production strategies

1. INTRODUCTION

Television sports production is a difficult task, and producing a remote sports event is arguably the most complicated to orchestrate. Many factors can adversely affect production, including weather, lighting conditions, and environmental noise. A successful production depends on extensive planning, from budgets, technology and location to the intricacies of the sport itself.

The key to quality sports productions is to assemble a crew skilled to predict what is to happen and where it is going to happen. It is important to build a crew that will work well together. The crew must understand how the event will unfold and how to best apply their television-related skills. Key to those predictive skills is the ability to plan for contingencies in case something goes wrong. [1]

It has previously been reported that if sports summaries are produced manually most probably new needs will arise, for instance, the need to limit time and effort. Having such new requirements leads to the need for devising automatic production strategies.

Our goal in this study is to assess the preferences from the final users on sports productions, and to this end we need to compare our method with those used by other authors. We are also set to examine the impact of different production strategies, one of which will be the autonomic strategy. This strategy will be compared with two other strategies put forward by different authors. In order to achieve this goal we must first conduct a subjective evaluation with final users.

Over the last years several new methods have appeared [1] but some of them are more interesting. For our study we have selected an autonomous production of basketball videos from multi-captured data with personalized viewpoints because it offers several advantages: 1) it deals with a multi-camera environment; 2) it enables adaptively selecting the viewpoint according to user preferences (e.g., display resolution or preferred cameras); and 3) it considers perceptual comfort as well as efficient integration of contextual information.

With the idea to analyse more fully this new (automatic) strategy we have carried out a second experiment in greater depth. Starting with the idea of both strategies being equally effective in producing sports content summaries, it is considered necessary to observe the influence of some relevant parameters on automatic strategies. Therefore; our second goal in this work is to compare the algorithms to produce automatic summaries with different parameters, and analyze subjective evaluations given by end users. In other words, we shall display contents summarized by the automatic strategy under different parameters: the type of resolution and the beta factor (this parameter is related to the way closeness and completeness are balanced), and observe if these parameters influence the preferences or subjective evaluations by end users.

After the initial literature review we have laid down different hypothesis to guide our research:

H1: The algorithms to produce automatic summaries should be as effective as expert generated summaries. If there are no differences among the strategies we could reduce the time allocated to sports summaries and human effort because the evaluation from users will be similar on all strategies.

H2: Additional parameters in the automatic strategy will influence the evaluation by end-users allowing us to delimit the content to certain parameters in order to improve our performance and get better evaluations. When resolution decreases we intuitively think that we should favour closer views, but we do not know how far we should go. Hence, for each resolution we have considered 3 different trade-offs, each of them favouring greater or lesser proximity. The objective of this test is to infer which trade-offs are preferred by users for a given resolution.

Clearly a new technology applied to the media does not only require new tools but it also requires studies on the acceptance and reactions from the final users. [2] For this reason it is important to perform user tests in various contexts and according to various parameters. However, there is no agreement over the most adequate methodology to be used in order to gather user feedback from these new types of production strategy. It is beyond the scope of this paper to provide an extensive review of the alternatives.

First we considered necessary to give our definition for subjective evaluations. Although all evaluations that take input from users could be considered in some way subjective, we are excluding from our definition those evaluations where the subjects are requested to perform a specific task and /or reply to set questions in connection with the task. Subjective evaluations cover a broad field of assessment [3, 4, 5 and 6] and can be divided among the following categories:

1. Psycho perceptual assessments. The goal from this type of assessment is to achieve a measure of the human perception on the output quality from a given system. Methods for the assessment of audiovisual communications are included in ITU-T Recommendations P.190 and P.920. In general these documents define two types of subjective assessment: a) those assessments establishing the performance of systems under optimum conditions, so called quality assessments, and b) those assessments establishing the ability of systems in preserving quality under non-optimum conditions in connection to transmissions or emissions, so called impairment assessments.
2. QoS assessment. This second type of assessment is not focused on the sensorial perception of quality but on the user subjective view over other system parameters, trying to evaluate the QoS of the output in a general sense. Among the numerous criteria that have been studied in this area (Bouch, & Sasse, 1999), the more frequent criteria include: Ease of use, Accessibility and Security.
3. Methods based on psychophysics. This innovative approach has been introduced for the first time by McCarthy, Sasse and Miras (2004) for multimedia technologies. These authors proposed this new methodology for comparing the effects of quantization vs. frame rate in streamed video. In their study they concluded that the rule “high motion = high frame rate” does not apply to small screens for sport content. They argued that a new method for eliciting continuous ratings of quality with minimal effort on the

users' part was needed. Therefore, they introduced a new methodology adapted from classical psychophysics to discover the functions relating physical quality to perceived quality. This method is based on gradually increasing and decreasing video quality within a single clip to identify the threshold level at which quality becomes acceptable or unacceptable to users.

Which approach does better match our research goals?

After reviewing the existing standards and the problems in applying these to reach our goals, we concluded we needed to create our own experimental design and session planning. We drew some guidelines from standards but only in regard to presentation methods, in order to make our experiment easily replicable by the scientific community.

In the light of the different methodologies and standards, and how to rate multimedia material, we decided to use a methodology that addresses our issues with standard methods while measuring both the quality of the video and the overall impression from the users over their capacity to understand the shown contents (sport summaries). Therefore, we decided to use a method based on psychophysics but adapted to the video material produced in APIDIS proyect. Our research goal was to understand the impact of resolution over the set of parameters that would produce an optimal video summary from the user's perspective.

After the present discussion on methodology we present section 2, containing the 1st experiment and the methodology used for introducing different production strategies over a quarter time of basketball. Paragraph 2.2 covers experiment 2, in which we intended to evaluate the perception over a sample of the same content displayed with different resolutions and beta factors.

In section 3 we include the obtained results and section 4 contains the conclusions drawn.

2. EXPERIMENTS

During our study we performed 2 different experiments with different content and using independent variables.

2.1. Experiment 1: EVALUATION OF PRODUCTION STRATEGIES (AUTOMATIC, EXPERT 1 AND EXPERT 2)

We used a uni-factorial within-subject design because we only used one independent variable.

Twenty four final users participated in this study (12 males and 12 females). The age of the users was distributed between 18 and 40 years. All of them had PC experience and liked basketball since we included this last condition as one of the selection criteria.

The 2 experiments were presented in random order so the users performed the tasks in different order. With this random mechanism we could prevent fatigue and other undesired effects.

Our goal with this experiment was to perform a subjective evaluation (perceptual evaluation) with final users. In this case we presented basket content with different production strategies.

2.1.1. Cognitive tasks/ experimental methodology

For this experiment we used an experimental setting for presenting the content designed by UCL (Université catholique de Louvain, Belgium). With this tool we can present to the users a complete basketball quarter divided in segments. We presented the quarter divided into different sequence segments for each move, and at the end of each segment the user had to evaluate how well they could follow the game, and pick the segments they liked the least, a little, much and the most. Each segment was produced with a different production strategy (in random order), and each segment was separately evaluated. In this experiment we tested 3 different video production strategies, two of them were prepared by 2 different expert editors and one was automatically produced with APIDIS's algorithms. To this end, we included an extra independent variable (type of strategy) with 3 different levels: automatic, expert 1 and expert 2.

The users from the sample were asked to judge visual quality, in this case, the quality of the image and the image capacity to offer a good view of the game, so we could obtain a subjective evaluation on the image based upon the production quality.

2.1.2. Eye tracking.

In addition to the above evaluation criteria, since we were interested in detecting which sequence parts were better attracting the users' attention and whether their attention changed with the different resolutions, we used an eye tracker device to follow the users' gaze.

With the aid of the eye tracker tool we recorded: 1) the fixation interval and the heat map for each segment, and 2) the users' eye pupil dilation while they watched the videos. Thanks to these data we could investigate the relationship between production strategies and attention or emotional reactions.

1) The fixation interval and the heat map for each segment (related to attention level) - when the fixation period is long the visual attention is greater, therefore the parts of the screen where the users fix their eyes for longer are the same zones they pay greater attention. This information is represented by the heat maps. [7] [8]
2) Eye pupil dilation (related to emotional reactions) - in this case the dilation of the eye pupil is related to the interest level and pleasure. The greater the pupil dilates the higher level of interest or pleasure felt by users. [9]

2.2. Experiment 2: IMPACT OF PRODUCTION PARAMETERS

For this second experiment we used a multi-factorial within-subject design because in this case we had 2 independent variables to consider (beta factor and resolution level). The sample of users is the same we used for experiment 1.

The goal for this second experiment was to investigate the subjective evaluation from users over the same content presented with different resolutions and beta factors; in other words we aimed to explore the different reactions to these factors.

2.2.1. Cognitive tasks/ experimental methodology

For this experiment we used a cognitive technique based on Signal Detection Theory [10] [11]. As explained in the introduction section, we intended to use a methodology such that addressed our interest issues with standard methods, while measuring both the video quality and the overall users' impression on their capability to understand the game (sport summaries). For this precise case we played the video material and the users had to stop the sequence whenever they perceived some improvement in video quality. When we speak of the video quality we mean the segments users felt easier to interpret and understand. Each video had one (1) minute duration and we randomly chose the beta factor but not the resolution. Consequently we presented a total of 18 videos, 6 of them with the lowest resolution and different beta factors at random, 6 similar videos but with different resolutions at random, and the remaining 6 videos with the highest resolution and different beta factors at random. The order of presentation for the diverse videos was also random.

For these video sequences we considered two independent variables:

1. Resolution:
    a. 160x120
    b. 320x240
    c. 640x480
2. Beta factor:
    a. Resolution a:
        i. Beta 0.25
        ii. Beta 0.5
        iii. Beta 1
    b. Resolution b:
        i. Beta 0.5
        ii. Beta 1
        iii. Beta 2
    c. Resolution c:
        i. Beta 1

ii. Beta 2
iii. Beta 4

2.2.2. Eye tracking

Following experiment 1, we used an eye tracking apparatus to evaluate the users' reactions. In this case we studied the fixation interval (related to attention) and the heat map for each video.

3. RESULTS

3.1. Experiment 1: EVALUATION OF PRODUCTION STRATEGIES (AUTOMATIC, EXPERT 2 AND EXPERT 1)

During this task the users had to perform a subjective evaluation of some video segments with different production strategies. In this case we applied three types of production strategies (automatic, expert 2 and expert 1) and the users had to assess the quality of these strategies and choose the segment they liked the least, a little, not much, a lot or the most.

3.1.1. E-prime data:

Automatic Strategy

The repeated measure ANOVA used to analyze the data revealed significant differences among the users' evaluations, although most users rated with low evaluations the majority of the automatically produced videos (see Table 1 and Figure 1).

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
AUTOMATIC STRATEGY COMPARISON	Pillai Trace	,671	11,575(a)	3,000	17,000	,000
	Wilks Lamba	,329	11,575(a)	3,000	17,000	,000
	Hotelling Trace	2,043	11,575(a)	3,000	17,000	,000
	Roy's Root	2,043	11,575(a)	3,000	17,000	,000

Table 1

QUALITY COMPARISON FOR AUTOMATIC STRATEGY

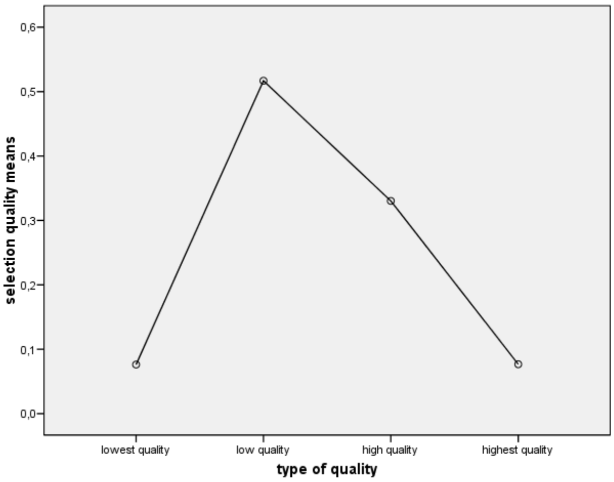


Figure 1 Estimated margined mean values from ratings on automatic strategy videos.

Expert 2 strategy

In this case we can again observe significant differences among user evaluations. Most videos (expert 2 videos) were rated as low quality, similar to the case for automatic production videos (see Table 2 and Figure 2).

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
EXPERT 2 STRATEGY COMPARISON	Pillai Trace	,986	410,682(a)	3,000	17,000	,000
	Wilks Lamba	,014	410,682(a)	3,000	17,000	,000
	Hotelling Trace	72,473	410,682(a)	3,000	17,000	,000
	Roy's Root	72,473	410,682(a)	3,000	17,000	,000

Table 2

QUALITY COMPARISON FOR EXPERT 2 STRATEGY

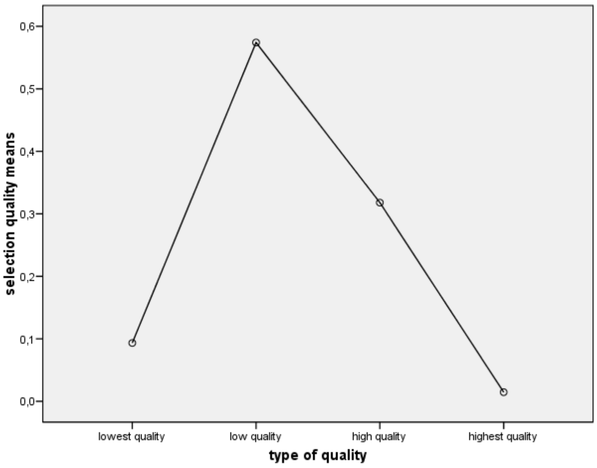


Figure 2 Estimated margined mean values from ratings on expert 2 strategy videos.

Expert 1 strategy

We can again observe from the data significant differences among user evaluations. Once more most videos were rated as low quality (see Table 3 and Figure 3).

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
EXPERT 1 STRATEGY COMPARISON	Pillai Trace	,992	717,275(a)	3,000	17,000	,000
	Wilks Lamba	,008	717,275(a)	3,000	17,000	,000
	Hotelling Trace	126,578	717,275(a)	3,000	17,000	,000
	Roy's Root	126,578	717,275(a)	3,000	17,000	,000

Table 3

QUALITY COMPARISON FOR EXPERT 1 STRATEGY

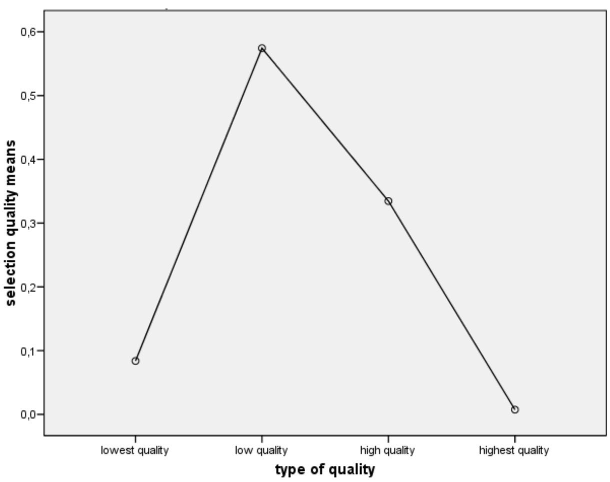


Figure 3 Estimated margined mean values from ratings on expert 1 strategy videos.

To conduct an in-depth study on the evaluation of image quality and general assessment of the summary sequences we performed a second analysis. For this second analysis our goal was to detect **differences among subjective evaluations for all strategies.** We did not observe differences among user evaluations for the different segments produced with either the automatic or expert strategies. Different production strategies were evaluated by the users with similar ratings. Therefore, it can be concluded that there are no perceptual differences for the different types of strategy. Since the videos were evaluated with very close results by end users we can propose the automatic strategy for creating automatic summaries, thus saving time and effort on the production of sports summaries.

To view the data in greater detail see Tables 4, 5, 6 and 7, and Figures 4, 5, 6, and 7.

RATING GIVEN BY THE USERS: LOWEST QUALITY

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
LOWEST QUALITY RATING	Pillai Trace	,016	,145(a)	2,000	18,000	,866
	Wilks Lamba	,984	,145(a)	2,000	18,000	,866
	Hotelling Trace	,016	,145(a)	2,000	18,000	,866
	Roy's Root	,016	,145(a)	2,000	18,000	,866

Table 4

RATING AS LOWEST QUALITY

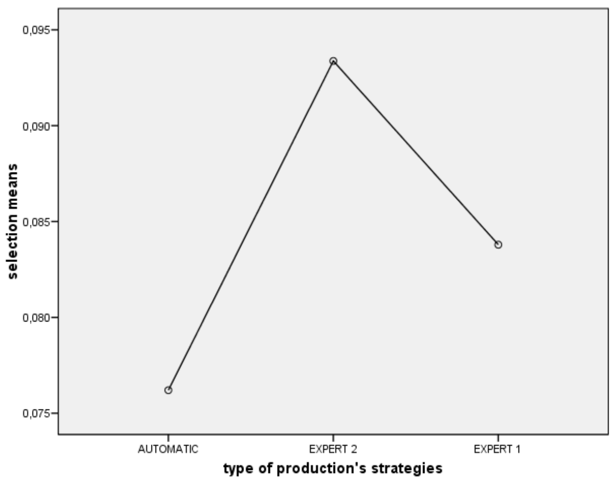


Figure 4 Estimated margined mean values for lowest quality rating on all production strategies (automatic, expert 2 and expert 1).

As Figure 4 illustrates, Expert 2 is the production strategy most rated as "lowest" quality.

RATING GIVEN BY THE USERS: LOW QUALITY

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
LOW QUALITY RATING	Pillai Trace	,064	,620(a)	2,000	18,000	,549
	Wilks Lamba	,936	,620(a)	2,000	18,000	,549
	Hotelling Trace	,069	,620(a)	2,000	18,000	,549
	Roy's Root	,069	,620(a)	2,000	18,000	,549

Table 5

RATING AS LOW QUALITY

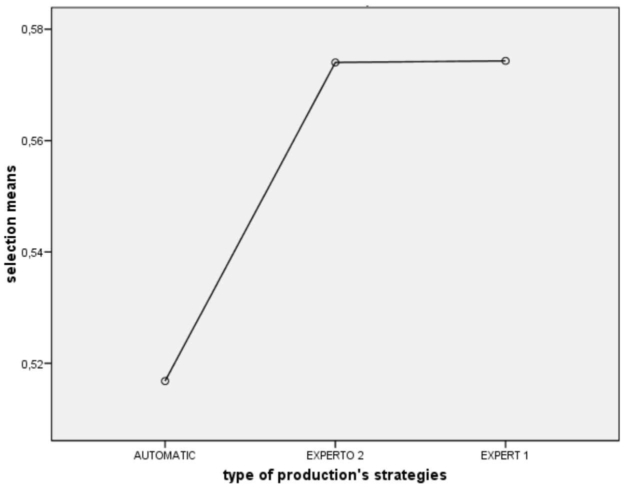


Figure 5 Estimated margined mean values for low quality ratings on all production strategies (automatic, expert 2 and expert 1)

Expert 2 and 1 are the production strategies most often rated as low quality.

RATING GIVEN BY THE USERS: HIGH QUALITY

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
HIGH QUALITY RATING	Pillai Trace	,009	,082(a)	2,000	18,000	,921
	Wilks Lamba	,991	,082(a)	2,000	18,000	,921
	Hotelling Trace	,009	,082(a)	2,000	18,000	,921
	Roy's Root	,009	,082(a)	2,000	18,000	,921

Table 6

RATING AS HIGH QUALITY

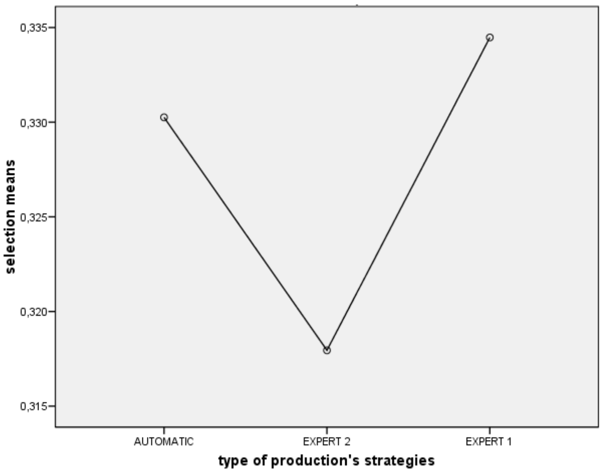


Figure 6 Estimated margined mean values for high quality ratings on all production strategies (automatic, expert 2 and expert 1)

Expert 1 and Automatic were the production strategies most often given a high quality rating.
➔ Consequently, the automatic strategy obtained less “low” and more “high” ratings.

RATING GIVEN BY THE USERS: HIGHEST QUALITY

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
HIGHEST QUALITY RATING	Pillai Trace	,125	1,280(a)	2,000	18,000	,302
	Wilks Lamba	,875	1,280(a)	2,000	18,000	,302
	Hotelling Trace	,142	1,280(a)	2,000	18,000	,302
	Roy’s Root	,142	1,280(a)	2,000	18,000	,302

Table 7

RATING AS HIGHEST QUALITY

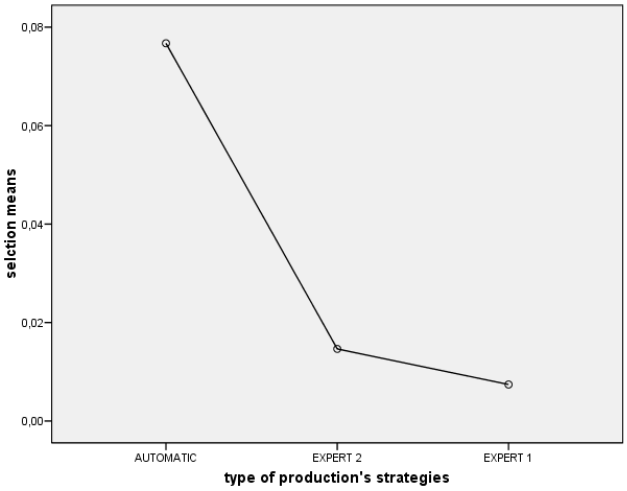


Figure 7 Estimated margined mean values for the highest quality ratings on all production strategies (automatic, expert 2 and expert 1)

The automatic production strategy was most often rated with the highest quality. ➔ Consequently, the automatic strategy obtained less "low" and more "high" ratings.

Despite the fact that there seems to be no significant difference between the ratings, Figure 7 shows a tendency to prefer the automatic strategy videos.

3.1.2. Eye tracking data

General data on fixation

Fixation interval:

We have not detected significant differences between the three types of production strategy but we found a trend towards longer fixation with **Expert 2** strategy videos. See Table 8 and Figure 8 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
FIXATION vs. STRATEGIES	Pillai Trace	,036	,282(a)	2,000	15,000	,758
	Wilks Lamba	,964	,282(a)	2,000	15,000	,758
	Hotelling Trace	,038	,282(a)	2,000	15,000	,758
	Roy's Root	,038	,282(a)	2,000	15,000	,758

Table 8

FIXATION INTERVAL

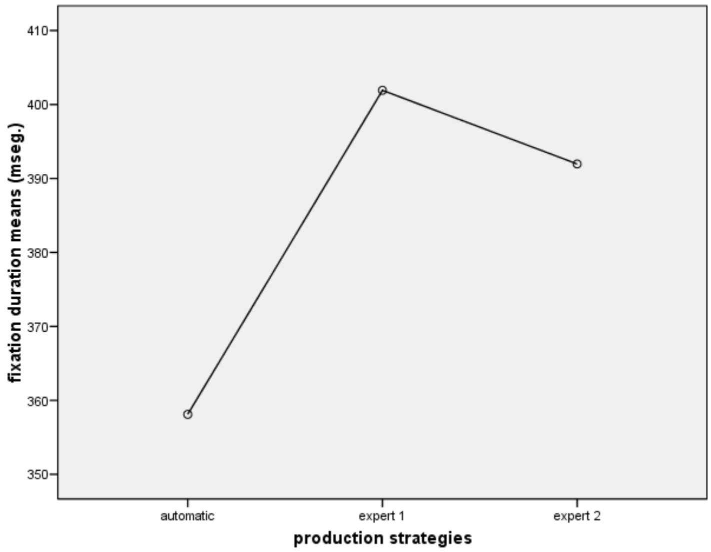


Figure 8 Estimated margined mean values from fixation intervals for the 3 studied strategies: automatic, expert 1 and expert 2.

In this last figure we can observe the differences in fixation interval data between the three production strategies.

HEAT MAPS:

The following heat maps are the result of aggregating all fixations from all the users for a whole quarter with a particular strategy. We have superimposed one frame/image to establish a reference with the game, but each image works only as a frame of reference. We can obtain the specific heat map for each particular second over the game duration.

HEAT MAP FOR AUTOMATIC STRATEGY VIDEOS

HEAT MAP FOR EXPERT 1 STRATEGY VIDEOS

HEAT MAP FOR EXPERT 2 STRATEGY VIDEOS

The images show similar areas of fixation for the three strategies, although it can be observed that this area of fixation is slightly larger for the automatic strategy. However, all of the fixation areas are located in the center of the screen regardless of the different evaluations (e-prime data).

Eye pupil dilation data

In progress.

3.2. Experiment 2: IMPACT OF PRODUCTION PARAMETERS

For this experiment the users were asked to do a subjective evaluation by stopping the video sequence when they perceived some improvement in quality. This video quality rating is associated to the degree in which users perceive and understand the sport summary sequence.

With this task we tried to explore if a different beta factor has any influence upon user evaluation for the same resolution, and whether significant differences can be detected for different beta values.

3.2.1. E-prime data

In order to study the data from the continued user ratings we conducted an ANOVA analysis with 2 independent variables: the parameter BETA (with 3 values), and the video resolution (also in 3 different levels).

DATA FROM 160X120 RESOLUTION

Though we found no significant differences when varying the beta factor we detected a certain preference for the sequences with a 0.5 beta. See Table 9 and Figure 9 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
LOW RESOLUTION COMPARISON	Pillai Trace	,094	,207(a)	2,000	4,000	,822
	Wilks Lamba	,906	,207(a)	2,000	4,000	,822
	Hotelling Trace	,103	,207(a)	2,000	4,000	,822
	Roy's Root	,103	,207(a)	2,000	4,000	,822

Table 9

LOW RESOLUTION (160X120): INFLUENCE OF BETA FACTOR

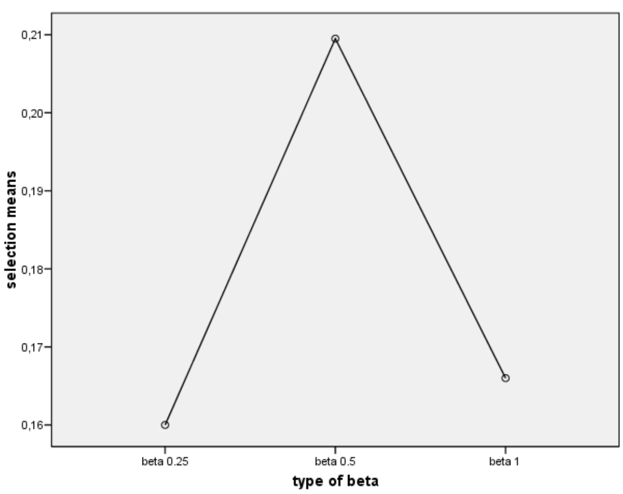


Figure 9 Average ratings for different BETA presented in low resolution

DATA FROM 320X240 RESOLUTION

Results obtained with the medium resolution were similar to those for the low resolution. We found no significant differences from varying the beta factor but there was a tendency to again prefer the sequences with 0.5 beta. See Table 10 and Figure 10 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
MEDIUM RESOLUTION COMPARISON	Pillai Trace	,456	1,677(a)	2,000	4,000	,296
	Wilks Lamba	,544	1,677(a)	2,000	4,000	,296
	Hotelling Trace	,838	1,677(a)	2,000	4,000	,296
	Roy's Root	,838	1,677(a)	2,000	4,000	,296

Table 10

MEDIUM RESOLUTION (320X240): INFLUENCE OF BETA FACTOR

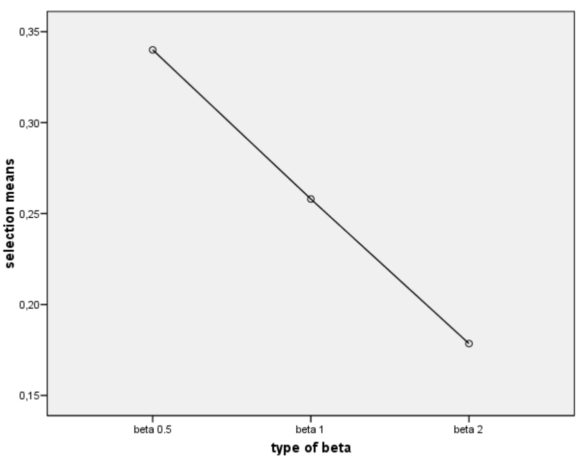


Figure 10 Average ratings for different BETA presented in medium resolution

DATA FROM 640X480 RESOLUTION

The data analysis again showed no significant differences from the three different betas. See Table 11 and Figure 11 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
HIGH RESOLUTION COMPARISON	Pillai Trace	,326	,966(a)	2,000	4,000	,455
	Wilks Lamba	,674	,966(a)	2,000	4,000	,455
	Hotelling Trace	,483	,966(a)	2,000	4,000	,455
	Roy's Root	,483	,966(a)	2,000	4,000	,455

Table 11

HIGH RESOLUTION (640X480): INFLUENCE OF BETA FACTOR

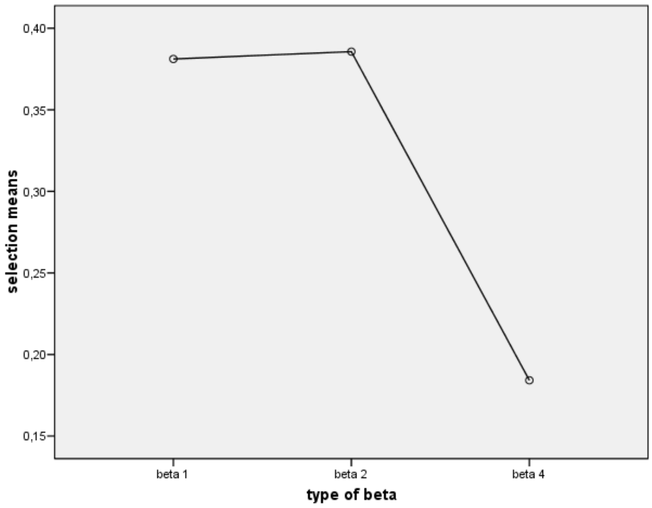


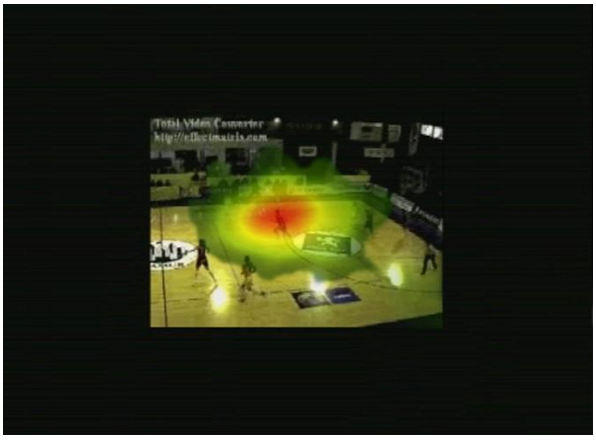
Figure 11 Average ratings for different BETA presented in high resolution

3.2.2. Eye tracking data

Following the previous analyses we have also studied the data from the eye tracking system, which produced clear patterns of the focus of attention for each user. The patterns were very similar for all three resolutions presented. In all cases the focus of attention covered approximately the same area as the player carrying the ball, so this shows the focus of attention remains on the basketball player with the ball. Below, we include an example of the heat maps for the same video sequences presented in 3 resolutions (low, medium and high).

LOW RESOLUTION (160X120)

MEDIUM RESOLUTION (320X240)



HIGH RESOLUTION (640X480)

Data on fixation intervals

Next we present the data on of fixation intervals for each of the video sequences shown to the users. We have performed an ANOVA analysis on the fixation intervals for the different resolutions aggregating all the videos presented with a set resolution.

From the gathered data we can see significant differences in length of fixation interval between resolutions. The results show that users pay more attention at the lowest resolution (160x120) in comparison with the other two. See Table 12 and Figure 12 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
DURATION OF FIXATION FOR DIFFERENT RESOLUTIONS	Pillai Trace	,326	5,806(a)	2,000	24,000	,009
	Wilks Lamba	,674	5,806(a)	2,000	24,000	,009
	Hotelling Trace	,484	5,806(a)	2,000	24,000	,009
	Roy's Root	,484	5,806(a)	2,000	24,000	,009

Table 12

FIXATION INTERVAL

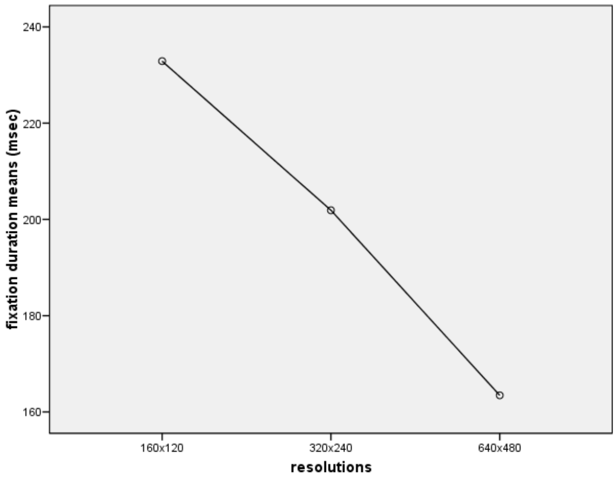


Figure 12 Estimated margined mean values of the fixation interval for three video resolutions

To conduct an in-depth study on the quality and evaluation on the videos general perception we performed a second analysis where we considered all beta values with all resolutions. This analysis showed no significant influence from the beta factor values. See Table 13 and Figure 13 next.

Effect		Value	F	Gl hypothesis	Gl error	P (Level of Significance)
BETA FACTOR	Pillai Trace	,346	,265(a)	4,000	2,000	,880
	Wilks Lamba	,654	,265(a)	4,000	2,000	,880
	Hotelling Trace	,530	,265(a)	4,000	2,000	,880
	Roy's Root	,530	,265(a)	4,000	2,000	,880

Table 13

We can observe on the following graphic a tendency of preference by the users for the 0.5 beta, but nonetheless the difference is not very significant.

USER PREFERENCE

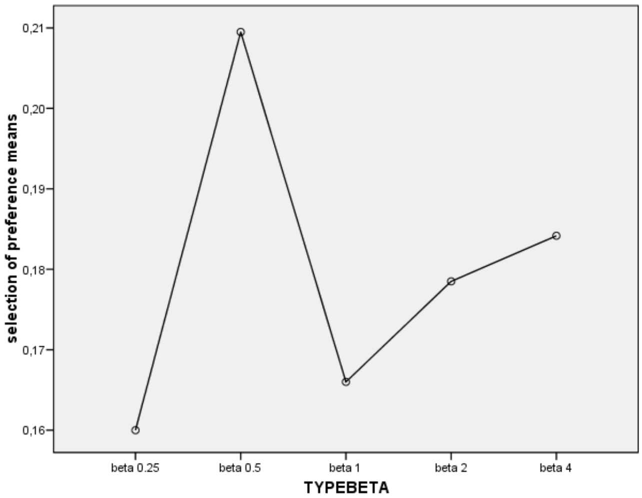


Figure 13 Average selection ratings for the all BETA values presented across all resolutions

4. CONCLUSIONS.

4.1 Experiment 1: EVALUATION OF PRODUCTION STRATEGIES (AUTOMATIC, EXPERT 2 AND EXPERT 1)

1. We found no differences between the users' ratings for the different video segments in terms of the automatic or expert production strategies. Different production strategies were evaluated in a similar way by end users who seemed to judge the different strategies as equally good. Therefore, we conclude that there are no perceptual differences between the tested strategies. Since the three strategies were ranked at a similar quality level by end users we suggest the automatic strategy be used to produce automated sports summaries, thus saving save time and effort.
2. Although we found no significant differences on eye fixation as a result of changing the production strategy, we detected a certain tendency for longer fixation intervals for summaries produced with the expert 2 strategy (See Fig. 4).
3. No major differences were detected for the users' focus of attention, and therefore the heat maps for the different production strategies turned out very similar (See Fig. 5).
4. We have not detected significant differences for eye pupil dilation as a result of varying production strategies.

We plan to continue this line of research and gather further data that will allow us to ascertain whether the data presented in this document were overall influenced by a too low quality from the presented videos.

4.2. Experiment 2: IMPACT OF PRODUCTION PARAMETERS

In the light of the obtained results we have found no clear set of parameters that would be best suited for a given resolution. In general terms, we recommend the use of a 0.5 beta for the tested image resolutions.

With regard to the fixation intervals, the data show significant differences in duration of fixation for different resolutions. The results show that users pay more attention to scenes with lower resolution (160x120) in comparison to others.

The eye tracker results show a clear pattern of what users focus their attention on. For all three resolution levels the focus of attention was the same size: the area occupied by the player with the basketball, so the focus of attention was the player.

5. REFERENCES

6. [1] OWENS J., "Television sports production, 4th Edition," Focal Press, 2007

[2] Tariq Bhatti, PhD Exploring Factors Influencing the Adoption of Mobile Commerce *Journal of Internet Banking and Commerce, December 2007, vol. 12, no.3*

[3] [ITU BS. 1387] ITU-T: "Method for objective measurements of perceived audio quality (PEAQ)", ITU Rec. BS. 1387, 1998-2001.

[4] [ITU P. 862] ITU-T: "Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs", ITU Rec. P.862, 2001.

[5] "Methodology for the Subjective Assessment of the Quality of Television Pictures," ITU-R Rec. BT.500-10, Geneva, Switzerland, 2000.

[6] Bouch, A., and Sasse, M.A. "It ain't what you charge it's the way that you do it: A user perspective of network QoS and pricing.", Proceedings of IM'99 (Boston MA, May 1999).

[7] [VIWR99] Viollet, J.-P., Isart, F., Wanderley, M., and Rodet, X.. "On the Choice of Transducer Technologies for Specific Musical Functions. A Study on Gestural Control Applied to Sound Synthesis." *Int. Report*. Ircam – C. Pompidou. Author, 1999

[8] Hoffman, J. E. (1998). Visual attention and eye movements. In H. Pashler (ed.), Attention (pp. 119-154). Hove, UK: Psychology Press.

[9]. Deubel, H. & Schneider, W.X. (1996) Saccade target selection and object recognition: Evidence for a common attentional mechanism. Vision Research, 36, 1827-1837.

[10]. (http://www.rotuaari.net/downloads/publication-43.pdf Marika T., Väinämö S., Vanninen V., Isomursu M., (2004) "Catching Emotions Elicited by Mobile Services"

[11]. (Tanner Jr., Wilson P.; John A. Swets (1954-11). "A decision-making theory of visual detection.". *Psychological Review.* **61** (6): 401-409. http://psycnet.apa.org/journals/rev/61/6/401/. Retrieved on 2009-06-24. ;

[12]. Coren, S., Ward, L.M., Enns, J. T. (1994) *Sensation and Perception*. (4th Ed.) Toronto: Harcourt Brace.