Algorithm Development for Film Rating using Human Bio-Feedback Data toward Content

Exploratory study of EEG and eye-tracking data equation

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***Abstract*—Most countries adopt film rating system for protect their children from bad content. But there are often disagree with the rating results because of subjective judging system. This study tried to develop evaluation algorithm for film rating using human response data like EEG and eye movement. Eye-tracking movement data suggest possibilities of making meaningful scale using sex and age differences. But EEG data suggest inconsistent result with brain hemisphere, position, and brain wave types. Further human subject's response data and DB needed to use EEG data for making film classification equation.**

Keywords-EEG; eye-tracking; film rating

I. INTRODUCTION

Film rating system was introduced to protect young children from violent and sexual content. But many countries experience controversy about rating results including South Korea. The main reason of dispute was caused by subjectivity of rating committee member. Most countries adopt human judge system to classify film and video content. Deciding by majority can't draw full consent.

Classification systems are not consistent for films. Different ratings can be given for a film in a different country [1]. Age-based ratings are commonly used but content-based ratings are also required [2]. The Korea Media Rating Board (KMRB) is an independent non-governmental organization for classification of film, video, and music video. KMRB classified 1,002 movies and 4,478 videos in 2012 [3].

KMRB also adopt age based classification system. Five classifications (All, 12+, 15+, 18+, and R) exist for films in Korea. R (restricted) rated movies only can be played at a restricted places. Seven standards are considered to rate films which are theme, sexuality, violence, language, horror, drug use, and imitable behavior in Korea. But these criteria can be very arbitrary because some scenes may seem sexual depending on the person's preconception or tendency.

Current rating system needs to be developed with a more objective method. This study tried to verify classification scale using EEG measurement system to detect human arousal responses to the film content. We used EEG detecting machines to measure human subject's responses to sexual and violent content. Further to our measurement, we suggested classification algorithm or equation using the EEG response data to determine film grades.

II. METHOD

Six Korean films were used for the experiment and 10 seconds stimuli clips were captured from each film (Table 1).

Three clips were representative scenes of violence and other three clips were sample scenes of sexuality. And each clip has different rating results from KMRB. Fourteen high school students (7 male and 7 female) and fourteen university students (7 male and 7 female) participated in EEG and eye movement tracking experiment. The age of high school students ranged from 15 to 18 and the ages of the university students ranged from 20 to 29. All subjects reported knowing the rating system for films.

The experiment was designed as a 2 x 3 mixed factorial design to examine the effects of age (18- and 18+) and rating (12+, 15+, and 18+). The between subject factor was age and the within factor was film rating. One dependent factor was EEG responses. The component variables are EEG signal of frontal lobes, temporal lobes, and occipital lobes. The other dependent factor was eye movement responses.

We recorded 10 different EEG waves; Left Frontal Alpha (LFA) Left Frontal Beta (LFB) Right Frontal Alpha (RFA) Right Frontal Beta (RFB) Left Temporal Alpha (LTA) Left Temporal Beta (LTB) Right Temporal Alpha (RTA) Right Temporal Beta (RTB) Occipital Alpha (OA) Occipital Beta (OB), Left Occipital Gamma (LOG), Right Occipital Gamma (ROG). And we recorded 4 different eye movement responses; fixation count (FC), fixation duration (FD), visiting count (VC), and visiting duration (VD).

Participants watched six film clips (10 seconds each) in random order. Subjects were fully explained about the experiment before they participate in, and for high school students, their parents agreed with the informed consent. EEG and eye movement data were acquired at the usability test laboratory of school of digital media, in Kyungsung University to minimize external noise and block other obstacles. Subjects were tested individually in a brightly lit,

electrically-shielded and sound-attenuated room appropriate for watching content.

TABLE I. STIMULUS FILM CLIPS

Content	Description			
	Title	***Rating***	***Year***	***Scene***
Violence	I'ma Cyborg, but that's OK	12+	2006	Shooting a gun at a doctor
	Gold eyes	15+	2013	Killing a person with a fountain pen
	Countdown	18+	2011	Gangster's fighting scene
Sexuality	Be my pet	12+	2011	Actor takes off his pants
	S Diary	15+	2004	Man and woman lying in a bathtub
	Sex is zero 2	18+	2007	Side view of upper body naked man and woman

32 channel EEG acquisition unit (Laxtha, Inc.) and Tobii eye-tracker (Tobii Inc.) were used with personal computer running EEG and eye-tracker software. EEG data were digitized at 512 samples per second during acquisition. Laxtha software performed an FFT (Fast Fourier Transformation) of raw data for each epoch. High and low pass filters were set at 8 Hz and 30 Hz, respectively. The reference electrode was attached on the left earlobe.

III. VALIDITY OF EEG AND EYETRACKING DATA

Eye-tracking data suggest possibility of making meaningful scale using sex and age differences. Statistic says that eye gaze data about violent content had different distribution order like university students> male high school students > female high school students. And interaction effects of age and gender showed meaningful results. In other words, each group has different eye gaze pattern. Sexual contents also suggest similar results.

Four eye-tracking variables appeared to have effective discrimination capacity. (Table 2) Therefore, we can setup an equation to predict age group if we know time and count numbers of user's eye movement toward sexual and violent content.

But EEG data suggest inconsistent result depending on brain hemisphere, position, and brain wave types. Such as past research results, brain waves demonstrate irregular pattern. This means brain wave data has individual variations, thus it is not easy to standardize. Stimulus clip which contain violent content targeting age over 12 (12+) and stimulus which has violent content targeting age over 18 (18+) show no significant difference in alpha and beta waves at every part of lobes. But stimulus clip which contain violent scene targeting age over 15 (15+) produced significant differences between groups at frontal lobe. Violent stimulus age over 18 (18+) represents also significant differences between groups in gamma wave at occipital lobe. Male high school student group recorded strongest responses and female high school students group, female university students, and male university student group follows. Past researches explain that strong beta responses mean high attention or feeling. Our results show that weak or too strong violent scene can't affect to subjects and intermediate stimulus aiming proper age can touch subject's mind.

Sexual stimulus (15+) also represents significant differences between groups in gamma wave at occipital lobe. Male high school student group recorded highest wave responses and male university student group followed the last. But stimulus which has most sexual content targeting age over 18 (18+) showed no significant difference in alpha, beta, and gamma waves at every part of lobes. Nevertheless, alpha and beta waves of all subjects recorded statistically significant differences in 12+ content.

TABLE II. SCALE CONSTRUCTION ELEMENTS AND VALIDKTY

Scale	***Variables***	***Validity***
Eye-tracking Data (X1)	Fixation Count(FC)	○
	Fixation Duration(FD)	○
	Visiting Count(VC)	○
	Visiting Duration(VD)	○
EEG Data (X2)	Left Front Alpha(LFA)	○
	Left Front Beta(LFB)	○
	Right Front Alpha(RFA)	○
	Right Front Beta(RFB)	○
	Left Temporal Alpha(LTA)	×
	Left Temporal Beta(LTB)	×
	Right Temporal Alpah(RTA)	×
	Right Temporal Beta(RTB)	×
	Occipital Alpha(OA)	△
	Occipital Beta(OB)	△
Discrminant Variable (Y)	Age	
	Gender	

a. ○=high validity, △=need consideration, ×=invalid

Only four from ten EEG variables appeared to have effective discrimination capacity and other variables have limited or invalid capacity. (Table 2) Therefore, it is desirable to use temporal and occipital brain wave data as reference variables.

IV. EQUATION SUGGESTION & CONCLUSION

A. Equations

The main goal of film rating is to predict proper age group for the content. So we can set age variable(Y) as a key dependent variable. EEG and Eye-tracking data variables can be set as independent variables. If we adopt the experiment results, regression equations can be;

$$Y\ (Age) = aX1\ (FC, FD, VC, VD) + bX2\ (LFA, LFB, RFA, RFB) + residuals \quad (1)$$

If discriminant variables are nominal scale, discriminant function can be as follows;

Y (group) =Discriminant Z score< datum point=0 or > datum point

Discriminant Z score= aX1 (FC, FD, VC, VD) + bX2 (LFA, LFB, RFA, RFB) +constants (2)

B. Conclusion

Eye-tracking data was proved to have meaningful distinction ability to assort proper age groups. But EEG responses toward sexual and violent content lack coherence depending on part of brain and type of brain waves. This corresponds with past researches that EEG has individual difference whereupon it is hard to standardize.

We used very limited but meaningful data to equate whole brain and eye responses toward content. And our data used limited human samples. But this equation is an explorative sample to measure human responses to visual stimulus. If we use large sample and every part of brain activity data, we can draw more elaborate equations to predict film ratings. The significance of this experiment is suggestion of objective tool rather than subjective method for evaluate proper age ratings for films.

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