A System for Automatic Replay Creation for Using Sports Relay and EEG

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Abstract

Videotaping is one of the most popular methods of recording daily events. We now often use PCs to watch or edit digital videos. Although making a home video has become quite popular recently, the quality of the produced video has not improved much. The purpose of our study was to develop a method to automatically convert amateur videos into more professional-looking ones. For this purpose, we looked closely at the re-play technique frequently used in sports relay broadcasting and came up with a way of generating re-play scenes automatically and inserting them into the original video. In this paper, we describe a program called MindStudio, which creates re-play scenes based on the analysis of the cameraman's EEG (electro encephalogram) and the use of techniques of sports relay broadcasting. This paper describes the design of the system and its performance evaluation.

1. Introduction

Forty per cent of households in Japan own a digital video camcorder. It has become quite popular to videotape daily life. The spread of video capture cards and video editing software has enabled amateur video editors to produce high-quality video. New networking services have made it possible to distribute video clips over the Internet. In the future, home video production will become even more popular. However, despite the fact that the quality of household video equipment has improved, the quality of video production has not improved much, primarily because amateur editors lack the necessary knowledge about video editing. We investigated automatic editing techniques to solve this problem, focusing in particular on techniques used in sports reply broadcasting. We were particularly interested in the use of a video replay technique, which is widely used in sports broadcasting. This technique is used to replay important scenes in sports games, for example in basketball or soccer games. We thought that replay scenes could also be inserted in amateur videos to make them more interesting to watch. For example, scenes of our children crossing the finish line in a race could be made more touching if a video replay effect were used in the video. We developed MindStudio using brain-wave information. Brain waves are electrical signals produced by the brain, which can be recorded and measured, and the EEG (electroe ncephalogram) measures brain waves of different frequencies in the brain [1]. MindStudio makes use of the EEG to automatically identify important scenes in a video, and it uses techniques from sports relay broadcasting to replay these scenes.

2. Background

2.1. The demand for editing tools for amateur video production

A survey conducted in Japan in 2002 has found that 58% of DV camcorder users use their camcorders to videotape their family and children, while 38% use

camcorders to videotape traveling sights and sports activities as a hobby [2]. Forty-five per cent of users use their camcorders once a month, while 40% of users use camcorders once a year. Among those who captured store their videos into a computer, 28% always edit them, 45% edit them only occasionally, and 30% never edit their videos. The reason why many users do not edit their videos is that editing videos is a time-consuming task for an amateur editor. However, the survey has also shown that 59% of users want to edit their videos. Therefore, it is important that video editing be made easy.

2.2 Problems in amateur video editing

The quality of any video is contingent on the editor's skills, and amateurs are likely to put video clips in chronological order due to a lack of necessary editing skills. As a result, video clips edited by amateurs tend to be boring, in stark contrast to videos created by professionals, who take advantage of the accumulated video grammar. It is difficult for amateurs to acquire such professional skills.

2.3 Related works

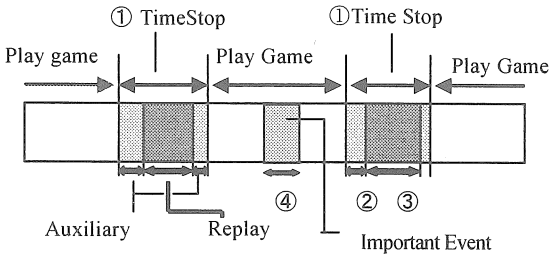
Because video editing requires a great deal of time, it is important to make the task more efficient. A number of techniques for automatic video editing have been created. These techniques use image characteristics such as color, motion, form, and texture or audio information such as frequency for video editing [3]-[7]. There is a video indexing method based on image recognition, which have been used to edit a cookery program [5]. This method is based on an idea that important scenes are connected with the speed of motion of the shown objects. The system detects important scenes with optical flow. Optical flow is the field of apparent velocities of objects in a sequence of images, which warps one image into another. We thought that it would be difficult to use this technique in amateur video editing. Girgensohn developed a tool called Hitchcock with which amateurs can edit home videos semi-automatically [6]. However, this system requires many manual operations, which makes it unsuitable for amateurs. In addition, the above methods are not meant for making unprofessional videos more attractive.

Techniques based on image and audio recognition cannot detect important scenes, because the importance of a scene is subjectively determined by each person based on their perceptions and emotions. It can be said that humans react unconsciously, when humans receive stimuli from the outside [8]. So we developed a system that automatically extracts important scenes from a video based on the cameraman's reactions.

3. Replay

3.1 Analysis of Videos of Basketball Games

We analyzed videos of NBA (National Basketball Association) games to determine how interesting scenes could be inserted and replayed. We thought we could apply professional skills to amateur video. In NBA programs, the clock is stopped for all fouls, out-of-bounds, and time-outs. This is similar to amateur videotaping in which video recording starts and stops. In our experiment, we found a video in which there were 15 cuts in a 20-min segment. In NBA programs, important scenes are replayed when the clock is stopped.



① An average of length time stop(27.9sec)
② An average of waiting the replay (9.8sec)
③ An average of length replay10.4sec)
④ An average of length the significant scene 15.1sec)
An average of frequency replay (41.2point/ game)
An average of frequency time stop 43.8point/ game)

Fig.1 The structure of NBA

4. EEG

4.1 The nature of the EEG

About 140 million nerve cells generate feeble electric signals, which are related to brain activity and environmental stimuli. The raw EEG has usually been described in terms of frequency bands: GAMMA waves come under greater than 30 Hz, and BETA waves in the range of 13-30 Hz, ALPHA waves come under in the range of 8-12 Hz, THETA waves come under in the range of 4-8 Hz, and DELTA waves come under less than 4 Hz. Beta waves with a frequency bandwidth of 14-30 Hz become prominent when people concentrate on something; this is called alpha attenuation [9]. It is difficult to determine one's mental condition from an EEG. However, it may be possible to roughly measure one's mental condition. Figure 2 shows an EEG sensor called MindForce. This device is small, light, and wireless, and people can easily use it because it can be easily taken off. This device is widely used to study relaxation and communication state. In our experiment, EEG waves were classified into four major categories as shown in Fig. 3. When a person's mental condition is normal, the EEG waves are equally distributed throughout the range of 7- 20 Hz, which is shown in Fig. 3(a). When a person concentrates on something, this results in alpha attenuation and a reduction in the intensity of all waves, which is shown in Fig. 3(b). Figure 3(c) shows the brain in a state of excitement, in which the intensity of beta waves above 20[Hz] are increased a moment enormously. When a person's eyeballs and face muscles move, the intensity of all waves increase significantly in an instant. This phenomenon is called EMG (electromyogram) as shown in Fig. 3(d). The noise in the signals must be removed when we measure an EEG.

4.2 An EEG-based experiment

We conducted an experiment to determine whether important scenes could be detected using an EEG, and we compared the scenes identified by the EEG as important with those that nine study subjects said were important to them. The subjects wore headphones so that they could not communicate from one another. The subjects faced a camera that videotaped their movements. This was done to ensure that the influence of the EMG was minimized. After the subjects finished watching a video, we asked them which scenes they paid attention to. The state of Figs. 3(b) and (c) was extracted as an important scene. These results are shown in Table 1.

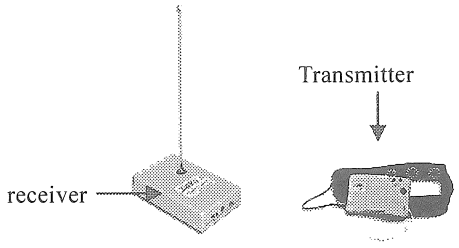


Fig.2 The instrument for measuring EEG (Mind Force)

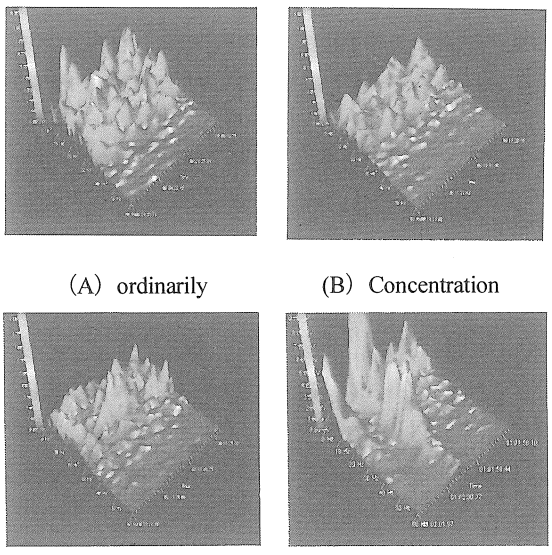


Fig.3 The nature of EEG

As shown in Table 1, 84% of all scenes that the subjects identified as impressive were successfully detected using the EEG. However, only 56% of all scenes corresponded to the scenes identified by the subjects, because the EEG identified many more scenes as important

than did the subjects. However, we found that it was possible to automatically extract scenes which the subjects felt were important. We then built a system to detect important scenes.

Table1. The result of the EEG experiment

Subject:	A	B	C	D
Claim	8	10	7	5
EEG	13	14	11	8
Agreement	7	8	6	4
Recall(%)	86	80	86	80
precision(%)	54	57	55	50

Subject:	E	F	G	H	I
Claim	10	11	8	7	5
EEG	11	14	13	13	10
Agreement	9	9	7	6	4
Recall(%)	90	82	86	86	80
precision(%)	82	64	54	46	40

	Bs	Sp
Detection	11.9	7.9
Agreement	—	6.7

recall	precision
84%	56%

$$pricision = \frac{agreement(Bs, Sp)}{Sp} \quad recall = \frac{agreement(Bs, Sp)}{Bs}$$

Bs : The number of scene detected by system
Sp : The number of scene which subject claimed

5. System implementation and evaluation

We developed MindStudio based on the EEG analysis of the experimental results described in the previous section. The basic functions of MindStudio are these.

<Basic functions>

・A cameraman's EEG is measured while he is videotaping. The video is transferred to a PC. The measured EEG is transmitted to the system through radio waves, and it is analyzed in real time.

・Information about the date and time of the recording is recorded on the digital videotape in the ISO/IEC 61834 format and can be extracted automatically. The video files are stored in a database with the recording date and time information.

・The beginning of cameraman's concentration and the length of concentration are analyzed based on the measured EEG. The system determines the importance of each scene, and it cuts the video using the recording date information.

5.1 Evaluation of MindStudio

We conducted an experiment using MindStudio. Three subjects watched a 15-min sports video on TV. We asked them which scenes they paid attention to and compared these scenes with those identified by the system as important. The subjects wore headphones so that they could not communicate with one another.

5.2 Experimental results and discussion

The results of the experiment are shown in Table 2. Unfortunately, the system could not detect scenes that the subjects found impressive, and these scenes were not replayed. However, one of the scenes which each of the subjects paid attention to could be replayed. We therefore would like to suggest that it may be possible to automatically replay scenes that viewers are concentrating on or excited by find interesting. We believe that there was error in the prototype system, because the importance of extracted scenes was determined based solely on the variation in the brain waves. It is important to investigate the source of this error to eliminate it.

5.3 The relationship between replay scenes and time stop unclear

We analyzed which important scenes should be selected for replay scenes from NBA games. Fig.4 shows that the scenes that were shown just before the clock was stopped were more likely to be selected for replay. It is important to add the result of analysis of NBA program as the parameter which decides score of importance of the significant scenes. Based on the results, we

built another prototype system.

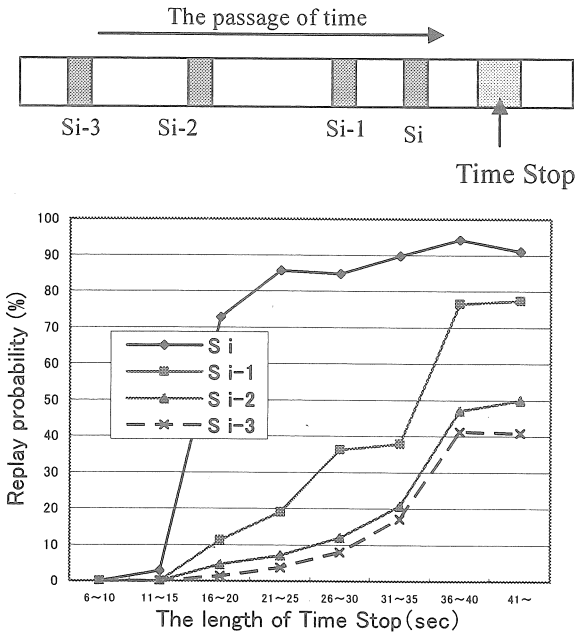


Fig.4 The relation of the important scene to Time Stop

Table 2 shows the results of an experiment with the second prototype. As shown in the table, the new system could replay important scenes for subject B. All the subjects said that they found attractive the video that the system generated automatically.

Table.2 The result of the experiment by the system

	Time claimed.(begin、end)	Time detected (begin、 end)
Subject A	(0:07:15, 0:07:23)	(0:06:37,0:06:50)
Subject B	(0:07:10, 0:07:21)	(0:07:01,0:07:17)
Subject C	(0:07:13, 0:07:22)	(0:06:35,0:06:50)

	time difference of begin [sec]	time difference of end [sec]
Subject A	38	32
Subject B	9	4
Subject C	38	33

6. Conclusion

The purpose of our research is to develop a method for improving the quality of amateur video automatically. In this paper, we described a system that uses a replay technique, which is widely used in sports relay broadcasting, to improve the quality of amateur video. Our system could extract important scenes from amateur's video for replay by analyzing cameraman's brain waves and the structure of NBA games. The system could detect scenes that subjects thought were important. We believe that our system can be used to automatically replay scenes that users find interesting.

DVD recorders have become quite popular. With the chasing playback function, we no longer have to wait until the recording is finished to watch the show. It is possible to play a video from the beginning while it is still being recorded. However, users must manually search for important scenes and rewind the video. For some people, this may be a troublesome task. Our system makes the process automatic. Also, the ability to share scenes that different people find interesting can make watching TV a more enjoyable experience.

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