자막의 구조적 특징을 이용한 축구 비디오 하이라이트 생성

허 문 행[†] · 신 성 윤[††] · 이 양 원[†††] · 류 근 호[††††]

요 약

디지털 비디오는 대용량의 저장 공간을 필요로 하는 시간적으로 매우 긴 데이터이다. 따라서 사용자들은 대용량의 긴 비디오를 시청하기 전에 사전에 제작된 요약된 비디오를 시청하고 싶어 한다. 특히, 스포츠 비디오 분야에서는 하이라이트 비디오를 시청하고자 한다. 결과적으로 하이라이트 비디오는 사용자들이 비디오를 시청하고자 할 경우 그 비디오가 시청할 가치가 있는지를 결정하는데 사용된다. 본 논문에서는 자막의 구조적 특징을 이용하여 축구 비디오 하이라이트를 생성하는 방법을 제시한다. 자막의 구조적 특징은 자막이 갖는 시간적 특징과 공간적 특징으로서 이러한 구조적 특징을 이용하여자막 프레임 구간과 자막 키 프레임을 추출한다. 그리고 하이라이트 비디오는 자막 키 프레임들에 대한 장면 재설정과 논리적 색인화 및 하이라이트 생성 규칙을 이용하여 생성한다. 마지막으로, 브라우저를 통한 사용자의 항목 선택에 의하여 하이라이트 비디오와 비디오 세그먼트에 대한 검색과 브라우징을 수행할 수 있다.

Creation of Soccer Video Highlight Using The Structural Features of Caption

Moon-Haeng Huh[†] · Seong Yoon Shin[††] · Yang Weon Lee[†††] · Keun Ho Ryu[††††]

ABSTRACT

A digital video is usually very long temporally, requiring large storage capacity. Therefore, users want to watch pre-summarized video before they watch a large long video. Especially in the field of sports video, they want to watch a highlight video. Consequently, highlight video is used that the viewers decide whether it is valuable for them to watch the video or not. This paper proposes how to create soccer video highlight using the structural features of the caption such as temporal and spatial features. Caption frame intervals and caption key frames are extracted by using those structural features. And then, highlight video is created by using scene relocation, logical indexing and highlight creation rule. Finally, retrieval and browsing of highlight and video segment is performed by selection of item on browser.

키워드 : 비디오 요약(Video Summarization), 하이라이트 비디오(Highlight Video), 자막의 구조적 특징(Structural Features of Caption), 검색과 브라우징(Retrieval and Brwosing), 자막 키 프레임(Caption Key Frame), 자막 프레임 구간(Caption Key Frame Interval)

1. Introduction

In video database, video contents are described by the structure of shots and scenes [1]. Shot is a valid unit for constructing video information and is a set of one or more continuous frames, showing continuous motions in the fixed time and space. Currently, many of researchers having interest in automatic and semiautomatic methods for video shot detection and characterization.

Video indexing can be performed efficiently using extraction and recognition of caption text. For example, there has been tremendous success in the automatic conversion of hard-copy documents via optical character recognition (OCR) technology [2-5] and the transcription of speech via voice recognition (VR) technology [6, 7]. In both case, although typically less than perfect, the output is an ASCII text representation that can be indexed with traditional information retrieval techniques. At this point, we can found that some information-rich video sources such as newscasts, commercials, movies and sports events that containing meaningful content in the form of voice, caption text and/or text in the image.

Video summaries are useful to decide whether it is valuable for video viewers to watch this video or not. Video summary was classified in two types as video summary sequence and video highlight. Video summary sequence is suitable for documentaries because it provide the significant abstract of whole video. Video highlight is suitable for video trailers or sports highlights because it contains only the interesting

† 종신회원 : 한국소프트웨어 진흥원(디지털 콘텐츠 사업단장)
†† 정 회 원 : 군산대학교 컴퓨터정보과학과 IT 교수
††† 종신회원 : 군산대학교 컴퓨터정보과학과 교수
†††† 종신회원 : 충북대학교 전기전자 및 컴퓨터공학부 교수
논문접수 : 2003년 3월 11일, 심사완료 : 2003년 4월 4일

segments of video [8].

This paper proposes a creation method of soccer video highlight using structural features of caption. The structural features are temporal appearing features and spatial position, size and color features. Caption frame intervals and caption key frames are extracted from input frames using those structural features of caption. And then caption key frames are indexed physically and logically. Soccer video highlight is created by pre-defined highlight creation rule. And also, easy retrieval and browsing method is provided for selection and watching of video fast and efficiently.

This paper is organized into five additional sections. Section 2 states related works. Section 3 presents structural features of caption. Section 4 presents extraction of the caption frame interval and key frame. Section 5 presents creation of soccer video highlight. Section 6 presents experimantal result, and finally, Section 7 concludes the work.

2. Related Work

Video Summarization is a field of study that many researchers have work continuously with a great interest. It was classified in two types as summary sequence and highlight. There are video skimming [9], scene transition graph [10], cluster validity analysis [11] and video manga [12] in creation of summary sequence, and movie trailer [13, 14] and event-based sports summarization [15] in creation of highlight.

Christal et.al. [9] proposed video skimming for summarizing documentaries or news videos. Video and transcription of video are aligned by the order of word, and the significant words are identified by linguistic analysis of transcription. Therefore, video clips are selected according to the priority of these words. Yeung et al. [10] proposed scene transition graph that was shot-based structure using the flow of story. Hanjalic et al.[11] extracted the key frame and set up the video shots. Then cluster validity analysis is used for creating of video summary sequence including those key frames. Uchihashi et al. [12] proposed a video summarization method of comic cartoon-like, called Video Manga. They used the measure of importance degree based on the scarcity and persistence of video segments.

Another type of video summarization is the extraction of highlight. Lienhart et al. [13] and Pfeiffer et al. [14] proposed the automatic creation method of movie trailer using the tracking of low-level visual and audio features, motion information and color information. They are used the heuristic features of the basic physical parameters for selecting of video clips with the important object, man, action, dialog, title text and title music. Babaguchi [15] proposed the summarization of sports video using the event-based video indexing. It is useful to video summarization but many important features for describing semantics are lost in the process.

3. Structural Features of Caption

3.1 Analysis of Caption Region

The caption appeared in soccer video is important element that gives the core contents of a soccer game. The caption region of soccer video is different from the region of drama and documentary, and it takes the following clear features.

① the position : the position of each caption region is fixed individually according to its type.
② the size : each caption region has its own size.
③ the existence : every caption region is appeared immediately (after the event). It remains some period of time and then disappeared.
④ the change : the position of text that can be changed is fixed in the caption region.
⑤ the color : each caption region has its own uniform colors.
⑥ the appearing point : the event caption region is appeared right after event occurrence.
⑦ the appearing sequence : the appearing sequence of the caption can be different each and every game.

Based on above features of caption, the caption key frame is extracted and the video segment is indexed. It plays an important role for the creation of the soccer video highlight.

3.2 Classification of Caption Scene

The caption of soccer video is appeared as a limited number of types. In this paper, caption scenes are classified in 13 limited types according to the meaning of contents, as follow.

① teams (*Ctem*) : the name of both teams (attached region and team name).
② grounds (*Cgnd*) : the name of grounds (sports ground and region).
③ broadcasting (*Cbct*) : the name of broadcaster (announcer and sportscaster).
④ referee (*Cref*) : the name of referee (a chief referee, sub-referees).
⑤ player list (*Clst*) : the player name list of both teams.

⑥ game beginning (*Cbgn*) : the beginning of game (the first/second half and team names).
⑦ score board (*Csco*) : the score of game (the first/second half, time, team names, and score).
⑧ bench (*Cbch*) : the bench of both teams (the name of manager, coach, and waiting player).
⑨ player (*Cplr*) : the name of the player who made shoot, assist, free kick, and light foul.
⑩ a change of players (*Cchg*) : the name of the player who changed in to and out from the field.
⑪ goal (*Cgol*) : the name of the player who made a goal.
⑫ foul (*Cfol*) : the name of the player who made the significant foul such as warning and foul-out.
⑬ game ending (*Cend*) : the ending of the game (team names and score).

Beside the above caption scene, the captions that were not very related current game, such as the caption of sports, game class, league, team rank, weather, other grounds and record, are appeared in the video. In this paper, those additional captions are except from the classification and extraction of the caption.

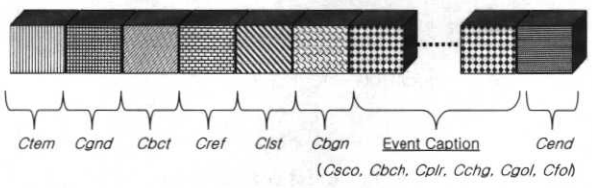
3.3 Temporal Features of Caption

The captions are classified as starting caption, event caption and ending caption in accordance with its appearing sequence, as <Table 1>. The captions have the temporal structure generally as (Figure 1).

〈Table 1〉 Temporal Classification of Caption

Temporal class	The component captions
Starting Caption	*Ctem, Cgnd, Cbct, Cref, Clst, Cbgn*
Event Caption	*Csco, Cbch, Cplr, Cchg, Cgol, Cfol*
Ending caption	*Cend*

Before the beginning of the substantial game, the most captions are appeared in order of *Ctem*, *Cgnd*, *Cbct*, *Cref*, *Clst* and *Cbgn*. This appearing sequence of the captions can be varied from each and every game. When the substantial game is beginning, event caption is appeared. And when it is ending, *Cend* caption is appeared.



(Figure 1) Temporal Flow of Caption

As shown in (Figure 1), event caption shows the event such as *Csco*, *Cbch*, *Cplr*, *Cchg*, *Cgol* and *Cfol*. It can be appeared irregular sequence and must be appeared right after the event.

At the last time, the result of game is showed by appearing of ending caption *Cend*.

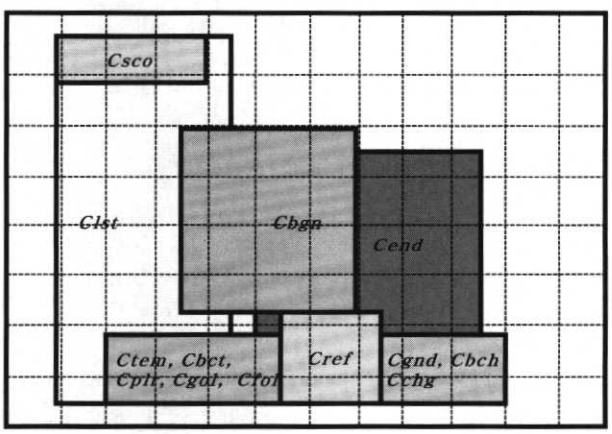
The appearing features of the caption is as <Table 2>.

〈Table 2〉 Appearing Features of Caption

Temporal class	Caption	Appearing features
Starting Caption	*Ctem, Cgnd, Cbct, Clst, Cref, Cbgn*	• getting the overview of game starting • appearing independently
Event Caption	*Csco*	• appearing short/long term through the overall game • appearing arbitrarily • appearing independently or overlapped with orthers
	Cbch, Cplr, Cgol, Cchg, Cfol	• appearing right after the event • appearing regardless of *Csco*
Ending Caption	*Cend*	• getting the results of game • ending broadcast

3.4 Spatial Features of Caption

The spatial feature of the caption is the information of the region that is the appearing position of the caption in the soccer video. The caption is appeared in 6 limited regions as (Figure 2).



(Figure 2) Spatial Structure of Caption

In (Figure 2), the regions of *Csco*, *Clst*, *Cbgn*, *Cend* and *Cref* are overlapped, but have it's own size that was different with one another. The captions of *Ctem*, *Cgnd*, *Cbct*, *Cbch*, *Cplr*, *Cgol*, *Cfol* and *Cchg* are hardly different from its size, and appeared at the center bottom of the frame.

In this paper, the caption key frames are extracted from

13 caption scenes based on the features of the caption region. And then the key frames are indexed for the retrieval of the video segment according to the subject. Therefore, the caption region extraction and indexing play the important role in the construction of the soccer video database.

4. Extraction of The Caption Frame Interval and Key Frame

4.1 Extraction of Caption Frame Interval

Every caption of soccer video has its own features such as position, size and color. Caption frame intervals are extracted by similarity measure based on its features.

To extract caption frame intervals, the predefined structural features such as position, size, and color of captions are compared with those of input frames. If those are similar, an input frame becomes a candidate of caption frame. This similarity measure is performed continuously through whole frames. The consecutive frames that similarity is satisfied are becomes caption frame intervals. Similarity measures are performed as follow.

4.1.1 Similarity Measure of Caption Position

$$x_{f_i} - x_t < T_x \quad \text{and} \quad y_{f_i} - y_t < T_y \tag{1}$$

In equation (1), x_{fi} and y_{fi} is position of the input frame, x_t and y_t is the reference value obtained from the structural features. T_x and T_y is the position threshold.

4.1.2 Similarity Measure of Caption Size

$$\frac{A_{m_i}}{A_{f_i}} > T_A \quad \text{and} \quad \frac{A_{m_i}}{A_t} > T_A$$

where

$$A_{m_i} = area(\max(x_{f_i}, x_t),\ \max(y_{f_i}, y_t),\ \min(x_{f_i}, x_t),\ \min(y_{f_i}, y_t)) \tag{2}$$

In equation (2), A_{mi} is the area of the overlapping caption region between input and reference frame. A_{fi} and A_t each is the area of the caption region of input and reference frame. T_A is the size threshold.

4.1.3 Similarity Measure of Caption Color

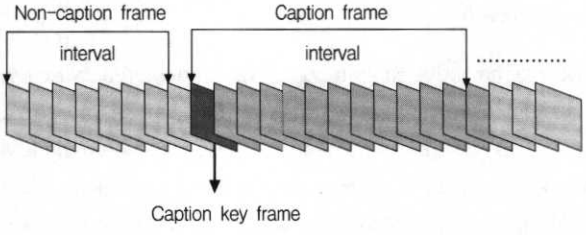
$$C_{f_i}^{R} - C_t^{R} < T_c \quad AND$$
$$C_{f_i}^{G} - C_t^{G} < T_c \quad AND \tag{3}$$
$$C_{f_i}^{B} - C_t^{B} < T_c$$

In equation (3), each C_{fi}^{RGB} and C_t^{RGB} is the maximum number of RGB pixel that is of the caption region of input and reference frame. T_c is the color threshold.

4.2 Extraction of Caption Key Frame

The extracted caption frame intervals indicate significant events, but all that frames can't be key frames. Therefore, one representative frame of caption frame interval is a caption key frame.

In this paper, as (Figure 3), caption key frame is the first frame of caption frame interval. Caption key frames play a significant role for video retrieval, browsing and highlight creation.



(Figure 3) Caption Key Frame Extraction

5. Creation of Highlight

5.1 Scene Relocation

5.1.1 The Need of Scene Relocation

Event captions such as *Cplr*, *Cchg*, *Cgol*, and *Cfol* are appeared right after event occurrence. Therefore, real events are existed in the preceding segments of caption key frame. Scene relocation reassigns event scenes for that they have the real events.

In soccer video, except for caption of starting, ending and intermittent score board, event captions are appeared right after event occurrence. Therefore, as <Table 3>, scene relocation is performed to relocation-needed scene.

〈Table 3〉 Classification of Scene Relocation

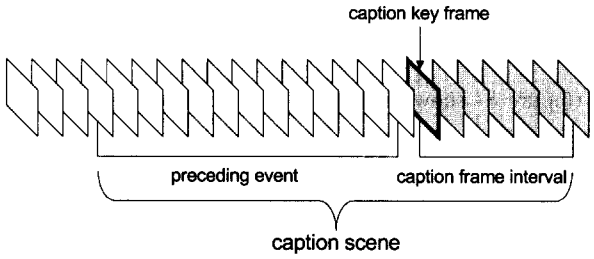
Classification	Scene Details
Relocation-no-need scene	*Ctem*, *Cgnd*, *Cbct*, *Cref*, *Clst*, *Cbgn*, *Csco*, *Cbch*, *Cend*
Relocation-need scene	*Cplr*, *Cchg*, *Cgol*, *Cfol*

In <Table 3>, relocation-no-needed scenes are not performed scene relocation and leave as it is.

5.1.2 The Technique of Scene Relocation

Relocation-need scenes must contain its caption frame intervals and preceding events. (Figure 4) shows the technique

of scene relocation of relocation-need scenes. Caption key frame interval contains all frames that including its own captions. Preceding events must be sufficient for presenting significant events.



(Figure 4) Scene Relocation

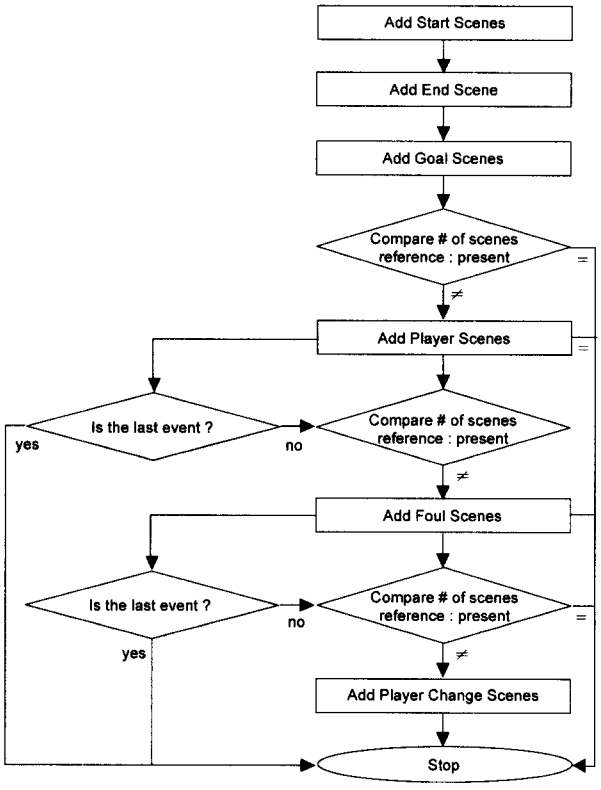
In general, a sufficient presenting time of preceding event is from 10 to 20 seconds. Therefore, in this paper, preceding event time has 20 second. It shows that preceding event has 600 frames in according to standard as 30 frames per second. Therefore, caption scene consist of preceding event (20sec, 600frame) and caption frame interval.

5.2 Creation of Highlight

First of all, the reference number of highlight scenes must be determined for creating of soccer video highlight. In soccer video, the most significant event is the goal. Therefore, the reference number of highlight scenes is determined flexibly after due consideration of the number of goals. Highlight creation rule is as follow.

- The basic element of highlight consist of *Ctem*, *Cgnd*, *Cbct*, *Cref*, *Clst*, *Cbgn*, *Cplr*, *Cchg*, *Cgol*, *Cfol*, and *Cend*. The rule details are as following :
  - starting scene
    ① The first scene consists of *Ctem*.
    ② The next scenes consist of *Cgnd-Cbct* or *Cbct-Cgnd* according to original video sequence.
    ③ The next scenes consist of *Cref-Clst* or *Clst-Cref* according to original video sequence.
    ④ The last scene consists of *Cbgn*.
  - ending scene
    ① The ending scene is the last scene of the game. It consists of *Cend*.
  - event scene
    Event scenes are included in highlight according to the following event priority. In each step, the total number of the created highlight scenes is compared with the reference number of the highlight scenes until both numbers are same or the last events are included in highlight.
    ① The first event consists of *Cgols* according to original video sequence.
    ② The second event consists of *Cplrs* according to original video sequence.
    ③ The third event consists of *Cfols* according to original video sequence.
    ④ The last event consists of *Cchgs* according to original video sequence.
- Up to now, if the total number of the created highlight scenes is less than the reference number of the scene, the final highlight video keep the present highlight.

(Figure 5) shows the flow of highlight creation.



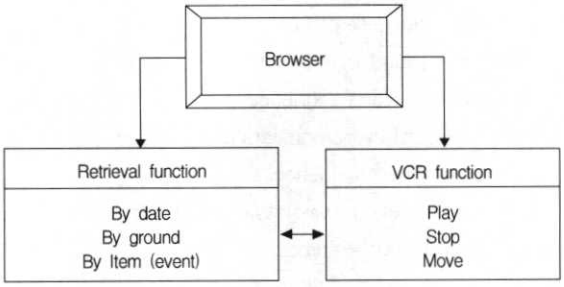
(Figure 5) The Flow of Highlight Creation

In 2001 pro soccer game, the number of goals made from 0 to 6 goals for each game. Therefore, there can have no goals or maximum 6 goals in highlight. Another scenes are included in highlight according to highlight creation rule.

5.3 Retrieval and Browsing

Indexed video and highlight video must be easily browsed by user who want retrieve the video segment. Therefore, as (Figure 6), video browser has the function of retrieval

and VCR together.



(Figure 6) The Function of Browser

It is desirable that retrieval function is performed by selection of user. As in (Figure 6), users can select date, play ground and event for retrieve the video segment what they want watch, then result is displayed in window. Also VCR function can play, stop and move the selected video segment.

6. Experimental Results

In this paper, experiment is implemented using Visual C++ 6.0 under the circumstances of Pentium Ⅳ 1.3GHz and Windows 2000 Server. Experimental video data is the first half of four games from Posco League Pro Soccer. It is used as normalized form of AVI file format and 320×240 size.

(Figure 7) Window of Caption Key Frame Extraction

(Figure 7) shows the extraction of the caption key frames through the extraction of the caption regions and caption frame intervals. In (Figure 7), the left part plays the selected video, and right part displays the extracted caption key-frames. And the lower part is simple operator for select, play and stop video segments.

The extracted caption key frames are significant elements for the creation of soccer video highlight. <Table 4> shows result of caption key frame extraction.

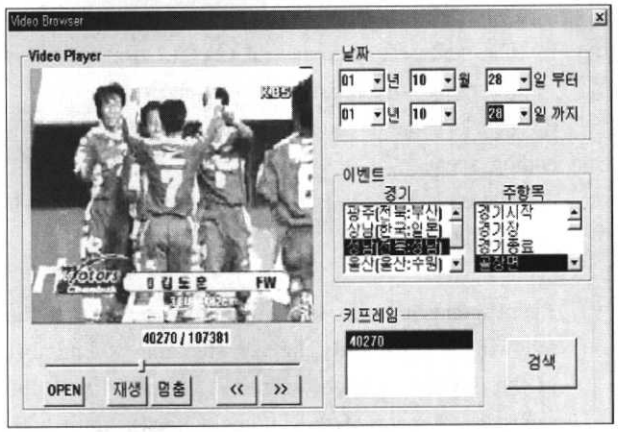
〈Table 4〉 Result of Caption Key Frame Extraction

Games	The number of caption key frame
Video A	62
Video B	54
Video C	67
Video D	58

(Figure 8) shows creation of the highlight according to the highlight creation rule in soccer video. The upper part shows video player, simple operator and frame indicator. And the lower part shows caption key frames of the created highlight.

(Figure 8) Window of Highlight Creation

In highlight creation, we set the reference number of highlight scenes as 20. Therefore, a highlight video was composed of 20 caption scenes. The average playing time of input video is 58.3 minutes, and the average playing time of highlight video is 6.7 minutes. Video viewers can watch and understand whole video contents in 6.7 minute without viewing whole video.



(Figure 9) Browsing Window

〈Table 5〉 Comparison of Video Summarization Methods

Methods		Features	Advantage	Problem(difficulty)
Summary Sequence	Video Skimming	• color/caption • audio keyword • keyword frequency	• event indexing	• linguistic analysis • object/caption recognition
	Scene Transition Graph	• story flow • time window	• simple and fast	• time window setting • story overlapping
	Cluster Validity Analysis	• clustering • cluster distance	• various structuring	• cluster formation • validity criterion
	Video Manga	• comic cartoon • segment scarcity • segment persistent	• useful to cartoon- like	• high overhead • matching criterion • inaccurate extraction
Highlight	Movie Trailer	• low level physical features • heuristic parameters	• ease of feature extraction • various parameters	• accumulation and application of heuristic • semantics matching • change of heuristic
	Event-based Sports Highlight	• event-based indexing • closed caption • time window	• event definition and description	• event extraction • difference of time point
Proposed Method		• event-caption-based • structural features (temporal, spatial) • creation rule	• event definition and description • event priority • logical indexing	• limited domain • focus on caption

(Figure 9) shows video browser that can be easily select and retrieve video segment by user who want to watch it.

Users can select a date or the period that they want to see, and then the events that are satisfied it are listed below. At this time, users can select the events that they want, and can make narrow the scope of retrieval. Also key frames of the selected event are listed below, then the users can select the key frames and watch the selected shot.

<Table 5> shows the comparison between the proposed and the existing video summarization methods. The proposed method is more efficiently create the highlight using the structural features than another.

7. Conclusion

This paper proposed the efficient creation method of soccer video highlight using the structural features of caption such as temporal and spatial features. The structural features of caption are extracted by analysis of caption information, and caption frame intervals and caption key frames are extracted using those features. Also an efficient highlight creation rule is used for highlight creation. Users can watch and understand, fast and easily, the videos that they want to watch it. In experiment, the average playing time of input video is 58.3 minutes, and the average playing time of highlight video is 6.7 minutes. Therefore, video viewers can watch and understand whole video contents in 6.7 minute without viewing whole video. And it gives the wide range of video selection and reduce the time and cost. Video browser is designed for efficient and easy retrieval too. This paper provides the foundation for implementation of the enhanced sports video management system.

In future, we are of the opinion that the continuous study of automatic active caption detection and semantic event extraction must be performed by many researchers.

References

[1] G. Davenport, T. Smith and N. Pincever, "Cinematic Primitives for Multimedia," Computers and Graphics, Vol.15, pp. 67-74, 1991.

[2] I. Guyon, "Applications of Neural Networks to Character Recognition," International Journal of Pattern Recognition and Artificial Intelligence, Vol.5, pp.353-382, 1991.

[3] S. Harmalkar and R. M. K. Sinha, "Integrating Word Level Knowledge in Test Recognition," In Proc. of ICPR, pp.758-760, 1990.

[4] F. Li and S. S. Yu, "Handprinted Chinese Character recognition Using Probability Distribution Feature," International Journal of Pattern Recognition and Artificial Intelligence, Vol.8, pp.1241-1258, 1994.

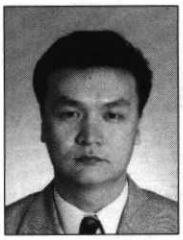
[5] M. A. O'Hair and M. Kabrisky, "Recognizing Whole Words as Single Symbols," In Proc. of ICDAR, pp.350-358, 1991.

[6] J. Hernando, "Voice Signal Processing and Representation Techniques for Speech Recognition in Noisy Environmen-

ts," Signal Processing, Vol.36, No.3, p.393, 1994.
[7] Y. Pan, J. Wu, S. Tamura and K. Okazaki, "Neural Network Vowel-Recognition jointly Using Voice Features and Mouth Shape Image," Pattern Recognition, Vol.24, pp.921-927, 1991.
[8] K. Hang-Bong, "Generation of Video Highlights Using Video Context and Perception," *Proc. of SPIE, Storage and Retrieval for Media Databases 2001*, Vol.4315, pp.320-399, 2001.
[9] M. Christal, M. Smith, C. Taylor and D. Winkler, "Evolving Video Skims into Useful Multimedia Abstractions," *Proc. CHI '98*, pp.171-178, 1998.
[10] M. Yeung, B. Yeo and B. Liu, "Segmentation of Video by Clustering and Graph Analysis," *Computer Vision and Image Understanding*, Vol.71, No.1, pp.94-109, 1998.
[11] A. Hanjalic and H. Zhang, "An Integrated Scheme for Automated Video Abstraction Based on Unsupervised Cluster-Validity Analysis," *IEEE Taans. Cir. & Sys. for Video Tech.*, Vol.9, No.8, pp.1280-1289, Dec., 1999.
[12] S. Uchihashi, J. Foote, A. Girgenshon and J. Boreczky, "Video Manga : Generating Semantically Meaningful Video Summaries," *Proc. ACM MM '99*, 1999.
[13] R. Lienhart, S. Pfeiffer, and W. Effelsberg, "Video Abstracting," *Communications of the ACM*, Vol.40, No.12, pp.54-62, 1997.
[14] S. Pfeiffer, R. Lienhart, S. Fisher and Effelsberg, "Abstracting Digital Movies Automatically," *Int. Jour. Visual Communication and Image Representation*, Vol.7, No.4, pp.345-353, 1996.
[15] N. Babaguchi, "Towards Abstracting Sports Video by Highlights," *Proc. IEEE Int. Conf. Multimedia and Expo (III)*, pp.1519-1522, Aug., 2000.

허 문 행

e-mail : moonh@software.or.kr
1979년 숭실대학교 전산학과
1998년 연세대학교 공학대학원(공학석사)
2003년 충북대학교 대학원 전자계산전공 (이학박사)
1980년 한국전자통신연구원 선임 연구원
1984년 한국통신 연구개발원(책임연구원)
2001~현재 한국소프트웨어 진흥원(디지털 콘텐츠 사업단장)
관심분야 : 디지털콘텐츠, 멀티미디어, 개발방법론, 산업정책

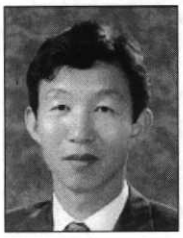


신 성 윤

e-mail : syshin@cs.kunsan.ac.kr
1994년 군산대학교 전산학과
1997년 군산대학교 대학원 정보통신공학과 (공학석사)
2003년 군산대학교 대학원 컴퓨터과학과 (이학박사)
1998년~2002년 군장대학 컴퓨터응용학부 겸임교수
1999년~2002년 (주)네트플러스 동영상연구팀 연구원
2003년~현재 군산대학교 컴퓨터정보과학과 IT 교수
관심분야 : 컴퓨터비전, 패턴인식, 인공지능, 멀티미디어

이 양 원

e-mail : ywrhee@kunsan.ac.kr
1979년 숭실대학교 전산학과 졸업
1983년 연세대학교 산업대학원 전자계산학과(공학석사)
1994년 숭실대학교 대학원 전자계산학과 (공학박사)
1979년~1986년 한국국방연구원 정보관리 위원회 연구원
1986년~현재 군산대학교 컴퓨터정보과학과 교수
관심분야 : 멀티미디어, 컴퓨터비전, 가상현실, 인공지능



류 근 호

e-mail : khryu@dblab.chungbuk.ac.kr
1976년 숭실대학교 전산학과(공학사)
1980년 연세대학교 공학대학원 전산전공 (공학석사)
1988년 연세대학교 대학원 전산전공 (공학박사)
1976년~1986년 육군군수지원사전산실(ROTC 장교), 한국전자통신연구소(연구원), 한국방송통신대 전산학과(조교수) 근무
1989년~1991년 Univ. of Arizona Research Staff(TempIS 연구원, Temporal DB)
1986년~현재 충북대학교 전기전자 및 컴퓨터공학부 교수
관심분야 : 시간 데이터베이스, 시공간 데이터베이스, Temporal GIS, 객체 및 지식베이스 시스템, 지식기반 정보검색 시스템, 데이터마이닝, 데이터베이스 보안 및 Bio-Informatics 등