Mobile Sports Video with Total Users Control

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INTRODUCTION

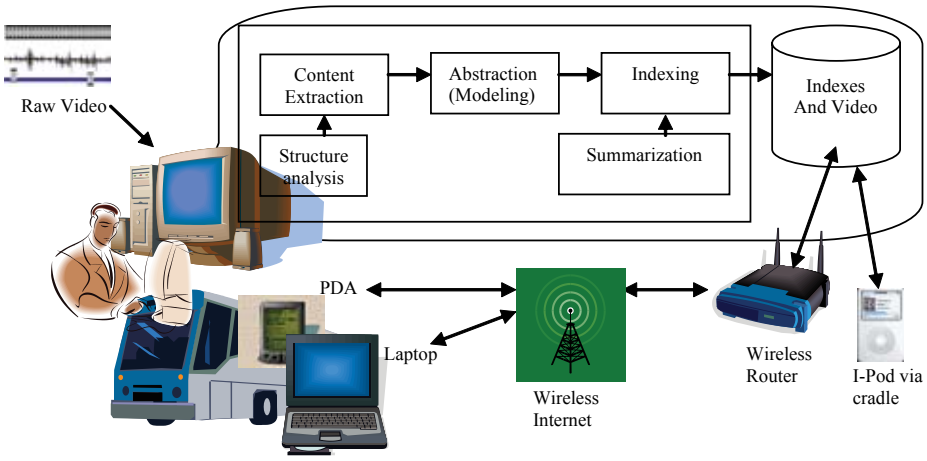
Sports video is very popular thanks to its in-progress (live) information and entertainment values. Many users are motivated to access sports video using mobile devices, since they often cannot watch the game on their sofa due to a busy life and inability to cope with lengthy games. The current generation of mobile video services has only focused on supporting the when and where consumers can watch their favorite sports matches. Since total control over playback and content is neglected, users often have to settle with low-quality videos and static content, which have been pre-processed. This limitation slows down the progress towards an era in which users are comfortable using their mobile devices to enjoy sports broadcasts while gaining total control over what they can watch at their most convenient time and place. In this article, we will describe a mobile video system which offers users full support over the when, where and how they want to watch sports video. The main new features offered are: (1) non-linear navigation within single and/or multiple documents; (2) customizable and personalized summaries; (3) multimodal access and video representation.

BACKGROUND

With the ongoing growth of mobile and hand-held video-enabled devices such as PDAs, smartphones, and iPods, users are increasingly able to afford video on-demand at their most convenience. Sports video is particularly popular for mobile consumption, thanks to its in-progress information (live) and entertainment values. Consumers are at the most convenient level if they have total control over the "when, where and how" they can access the video. The following will describe two scenarios that show how users can benefit from total control over mobile sports video. Figure 1 gives an overview of the descriptions.

- **Scenario 1:** A soccer fan does not want to miss two important live matches, one in the morning (7 a.m.), and another one in the evening (7 p.m.). Thus, he schedules the recording of both broadcasts on his home PC with TV tuner. While the video is being recorded, he wants to watch it on his laptop during a one-hour trip to work. Unfortunately, the bus is full and he has to stand with noisy and squeezed passengers. Thus, he uses his PDA that is connected via wireless network to listen to the audio and occasionally look at the live images. As soon as he arrives at work, he has to attend meetings and finish many tasks, which are due on that day. During this time (8 hours), his PC has finished the match recording and indexing process. At 6:30 p.m. he finishes work, and during his bus-trip from work he must watch the first match while skipping many boring tracks (i.e., those without any interesting events), so that he can watch the first 30 minutes of

Figure 1. Mobile sports video architecture



the second match live on his laptop (by using wireless broadband to access his PC via remote desktop). As soon as he arrives at home, he must cook dinner, thus he uses his PDA in his pocket to listen to the match. During dinner, he cannot watch the game since it is a special time for his family, hence he settles with audio commentaries being turned on only when there is a goal scored. At 8:30 p.m., he can relax and watch the rest of the live match using the media center in his living room. In this scenario, we assume that all devices are connected with a wireless network and all have access to broadband Internet. This setup allows each device to inform the server (in this case the home PC) the current time-stamp in which the user stops each playback.

- **Scenario 2:** A casual sports viewer does not usually watch live broadcasts since she likes to follow various sports and has a very busy life. However, she does not want to wait and follow static summaries from TV and Internet. Instead, she prefers to be able to watch the personalized summary of each sport video every day or at least three times in a week during her trip from-and-to work. She likes the contents to be pre-recorded on her home PC, indexed, and prepared according to her personal preferences so that she can store them in her iPod. For swimming and other racing sports, she likes to watch every race in real-time while skipping the interviews. For soccer, basketball, and other score-based games, she only wants to see all key events (i.e., goal and goal attempts), as well as any interesting segments in which her favorite players appear. For tennis, badminton and other set-point based games, she wants to see only the key events, such as long rally and service ace, as well as the last portion of play just before each set is won by the player. Due to the unpredictability of public transport (e.g., lighting, crowd, etc.), she needs each segment to be available in multimodal forms so that she can listen or see the key audio or images. Moreover, when she has too many videos to be watched, she needs the video segments to be presented in key frames in order to choose which clips she wants to play.

The two scenarios demonstrate that mobile video interaction increases the necessity for more effective content-based retrieval. Mobile devices have limited capabilities in supporting users watching the full contents of a sports video due to their small screen size and restricted battery life. Since local storage in mobile devices is relatively small, costs of downloading streaming content is also a major issue. Thus, users need to selectively watch particular segments they want to watch to reduce the time and costs of downloading full-video content. Current solutions for streaming video content have not fully exploited the power of content-based indexing to enhance users' experiences. For example, UEFA.com via RealPlayer 10 only allows users to watch a fixed set of soccer video segments which are compiled as a 15 minute highlight. To improve the flexibility of content access, the system must more adaptive to a user's requirements. A study on users' requirements on mobile TV content has found that viewing was most likely to be transient and low commitment, as people are worried about getting too absorbed and are distracted with other tasks (Knoche & McCarthy, 2005). One of the biggest challenges in mobile sports video streaming is how to repurpose TV-quality videos for mobile devices to meet the tolerable downloading time, color depth, and available network bandwidth (Lum & Lau, 2002). Traditional approaches have simply sacrificed the video quality and produce distorted pictures and audio, which are not necessarily acceptable for small screen and speakers. Hence, users should be able to select which key segments (highlights) to watch, thus content-based analysis of sports video is needed to extract the important content automatically. Automatic sports video highlights extraction has been a major issue, which has been addressed by researchers world-wide (Babaguchi, Ohara, & Ogura, 2003; Duan, Xu, Chua, Qi, & Xu, 2003; Ekin & Tekalp, 2003; Rui, Gupta, & Acero, 2000); therefore it will not be the focus of this article.

The scenarios also show the importance of context awareness as an integral feature in mobile computing, which means that applications should react according to the circumstances in which they operate (Wikipedia, 2006). Almost any information available at the time of an interaction can be seen as context information (Korkea-aho, 2000), thus its long list can be categorized into: user-, physical-, computing- and time- contexts (Chen & Kotz, 2000).

Based on these discussions, Table 1 summarizes the requirements for sports video viewing on mobile devices. In this article, we will propose a content-based video indexing and retrieval that supports a total control over the video accessing (i.e., M1-M4) and how it can meet all the other requirements (i.e., T1-T4, and S1-S4). To demonstrate the look-and-feel of the system, we have implemented a Web-based video retrieval system that can be accessed by desktop and mobile devices; thus supporting multi-platform access (S1). Figure 2 depicts the system's interface.

TOTAL CONTROL ON PLAY-BACK

It should be noted that all video playback tools, such as Windows Media Player and Apple QuickTime, support total control over: *play*, *pause*, and *rewind* during live streaming video (T1). Fast forward is only available when the future content is already available; for example, play-back is delayed after the video is recorded (T2). While play and pause are very straight forward operations, fast forward and rewind should be achieved in a more elegant manner, rather than