

Immersive Panorama TV Service System

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Abstract—In this paper, we propose an immersive panorama TV service system. The proposed system provides real-time panorama videos and/or images for smart displays such as smart TVs, smart phones, and tablet PCs. Panorama videos and/or images are collected at sports events by panorama cameras. Collected contents are sent to servers, and then provide to smart devices with sports live videos. Users can select their view among panorama cameras, and can choose their view angle and zooming factor inside selected panorama camera. The proposed system provides immersive and realistic views of sports live events on users television.

I. INTRODUCTION

Various televisions have been developed to provide better experience to users, such as smart TVs, interactive TVs, IPTVs, social TVs and so on. However these do not provide enough immersive contents. Especially, for sports live events, users want more immersive images from their television. 3D TVs give more immersive and realistic images to users, but it is not convenient because additional glasses are needed or users can feel dizzy.

In this paper, an immersive panorama TV service system is proposed to provide immersive sports live contents on smart TVs. Panoramic videos and/or images from several panorama cameras at a sports stadium are provided to users by servers. Proposed system can make panoramic views of users moving left, right, up, and down and zooming in and out whenever users want. Using our TV service, users can feel that they are watching not only the sports game but also spectators and cheer leaders in the stadium whatever they want to watch.

II. RELATED WORK

The immersive panoramic video has been proposed for that the user experiences the video by wearing a head-tracked display [1]. The portion of the video in the direction of view is dynamically extracted and presented to the display in response to the user's head orientation. In the [2], high resolution panoramic views were proposed. This system supports UHD panoramic views with 3D environments. Reference [3] presents a unified approach to automatically build dynamic and multi-resolution 360° panoramic (DMP) representations from image sequence captured by hand-held cameras mainly undertaking rotation and zooming for natural scenes with

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moving targets. An adaptive strip compression for panorama video streaming has been proposed in [4]. For panorama video streaming, panorama images are fragmented vertically, and streamed for clients. However, low resolution panorama is considered, or real-time streaming or live broadcasting is not considered.

The ROI-based streaming has been proposed for peer-to-peer multicast live video streaming [5]. For distribution, the SPPM protocol is applied. A thumbnail overview and slices are used for panoramic image streaming. A video conferencing video on 3584 x 512 resolution is used for experiment. The panorama video coding based on multi-view video coding (MVC) is proposed [6]. In this approach, a MVC-coded panorama video stream and a down-sampled navigation video are applied for panorama video stream format. Furthermore, a panorama video player is proposed with consideration user interaction. However, since MVC is considered, it is not able to operate on live broadcasting environments.

III. IMMERSIVE PANORAMA TV ARCHITECTURE

The proposed system includes servers and clients. Servers in our system collect panoramic images using panorama cameras at sports stadium, provide streaming service to immersive panorama TV clients. Clients can be a smart TV, a smart phone, a tablet PC, a laptop, a PC and so on. Figure 1 show the architecture of immersive panorama TV service system.

Servers in the immersive panorama TV service consist of a post-processing module, an encoding module, and a streaming module. Each module can be individual server or a software module on one same server. The post-processing module receives panoramic images from panorama cameras, decodes images, and then adjusts contrasts, brightness, and colors of them. Since the playground of a stadium is brighter than the stand, the panoramic image of a sports stadium is hard to recognize objects, spectators, and players. Therefore, the post-processing is necessary.

The encoding module receives adjusted panorama images from the post-processing module, and then encodes them. As this point, the images are converted and encoded more than three kinds of resolutions to play on clients effectively and



Fig. 1. The architecture of immersive panorama TV service system.

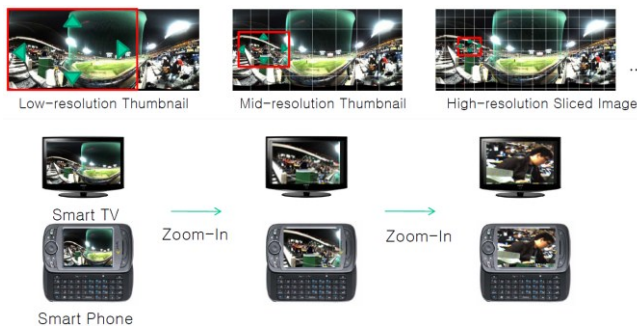


Fig. 2. Panorama images for streaming.

reduce network bandwidth consumption, as shown as Figure 2. The first one is a high-resolution image as same as the original panoramic image, another one is a low-resolution thumbnail image for full screen view, and the other one is a moderate kind of resolution thumbnail image. Since the actual viewing area of a high resolution image on the client display is a small part, a high resolution image is divided into small slices and encoded. Therefore, a network bandwidth consumption of server is reduced significantly, because clients receive some slices of a high resolution panoramic image instead of a whole image. The method of splitting into multiple slices of a high resolution panoramic image is shown in Figure 2. The streaming module provides panoramic sports live streams to clients according to users' requests. While the low resolution thumbnail image stream is provided to clients watching full screen view of whole panorama image, some high resolution sliced image stream is serviced to the client watching a small part of high resolution panoramic view.

Our client consists of a receiving module, a user interface module, and a display module. The receiving module manages buffers for three kinds of panoramic images, stores streams transmitted from servers, and sends them to the display module. When the display module requests images that are not in buffers, the receiving module sends request packets to servers to get requested images. The user interface module collects user's inputs for view change such as moving left, right, up and down, and zooming in and out, and sends view changing commands to the display module. The display module shows panoramic images according to received commands. The display module makes a virtual image space as big as original panoramic image using received low resolution image in the buffer of the receiving module, and shows user selected area of panoramic image.

IV. IMPLEMENTATION AND RESULTS

We implement the proposed service system and experiment it on real environments. The LadyBug3 of Point Grey is used for a panorama camera of our system. Server modules are implemented with C# based on .Net framework, C language, and LadyBug3 API. Smart TVs and portable smart devices (smart phones, tablet PCs and so on) are developed on the Android platform in Java language and C language with JNI technology. The PC type client is developed with MFC on Windows platform.



Fig. 3. Screenshots of smart TV(left) and smart phone(right).

For wireless network environments, we implement a panoramic image recovery method. If some high resolution slices are not able to find in buffer when a user moves his or her view with high resolution, this method in the display module requests them to servers, and creates panoramic view from low resolution thumbnail until when requested slices are arrived. Therefore users are able to navigate high resolution panoramic view, immediately.

We experimented with the implemented system using three panorama cameras on the last Korean Series game of Korean Baseball Organization at October 19, 2010. Figure 3 and Figure 4 show screenshots of the implemented immersive panorama TV service on a smart TV and a smart phone, respectively. Left upper pictures of each figure explain the direction of three panorama cameras at sports stadium. Each of cameras is located at stand of stadium on each direction. When users select camera among three locations, the panoramic stream of the selected camera is provided to smart TV or smart phone on real-time. The maximum resolution of panoramic image is 6000 x 3000 that is close to 6K UHD resolution. The serviced frame rate is one frame/sec, and the average transmission bit-rate is 250 Kbps.

V. CONCLUSION

In this paper, the immersive panorama TV service was proposed to provide immersive and realistic contents on TV platform. The proposed service was implemented for sports live broadcast. From the experiments, we confirmed that the implemented system provide immersive panoramic view for users. The implemented system supported immersive panoramic image of sport live event with 1 frame/sec, and responded from users' requests, immediately.

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