Choose Your Own Perspective

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Prof. Marek Domański chairs the Department of Multimedia Telecommunications and Microelectronics at the Poznań University of Technology. He leads a team conducting research into the processing and compression techniques for video and other multimedia signals.

"Free-viewpoint video" technology, under development at the Poznań University of Technology, will enable viewers to watch video from varying points located on a virtual trajectory of their own selection

Thanks to ongoing advancements in technologies for recording, processing and transmitting high-resolution imagery, we are making ever-increasing use of recorded video (accessed via TV, the Internet, DVDs, Blue-Ray discs, etc.). Moving images now account for a rapidly growing share of the information transmitted across telecommunication networks. Such research into imaging techniques, striving to develop ways to transmit and display images more realistic than ever before, is a fascinating and fast-moving field.

Our team at the Department of Multimedia Telecommunications and Microelectronics, Poznań University of Technology, is involved in developing free-viewpoint video technology. Here the images are interactive - enabling viewers to "rotate" the scene without pausing the motion of objects or people. An early example of such techniques can be found in the scenes from "The Matrix" where one of the characters freezes mid-jump, then virtually spins around, with the whole scenery spinning together with them.

Our aim is to develop practical and low-cost systems able to generate new views of a dynamic scene from any 3D position chosen by viewer. The representation is first created from images generated by several cameras placed around the scene (Fig. 1). We should stress, however, that viewers are not limited to choosing from views taken by actual cameras, but most often see synthesized virtual images instead (Fig. 2), generated "on the fly" from recordings made with free-viewpoint technology.

Free-viewpoint video and television can be used to generate and transmit such sporting events as wrestling, judo, sumo and boxing matches, as well as dance competitions and theatre performances, and much more. For instance, parents will be able to enjoy recordings of children's performances, viewing them from their own child's perspective. There are also potential applications in training manuals, and even feature films and documentaries.

We are currently developing free-viewpoint television (FTV) systems which could be used online. The viewer will be able to watch on their computer, tablet, or smartphone, navigating around a scene using a touchscreen or pad.

The general layout of FTV is shown in Fig. 3. In this system, moving images are recorded by cameras placed around the scene and transmitted for further processing. The number of cameras is a balance between system cost/complexity and the quality of the virtual images that will be shown on user terminals. For most applications, using a dozen or so cameras results in virtual images of a sufficiently high quality. However, using even just ten cameras requires around forty cables,

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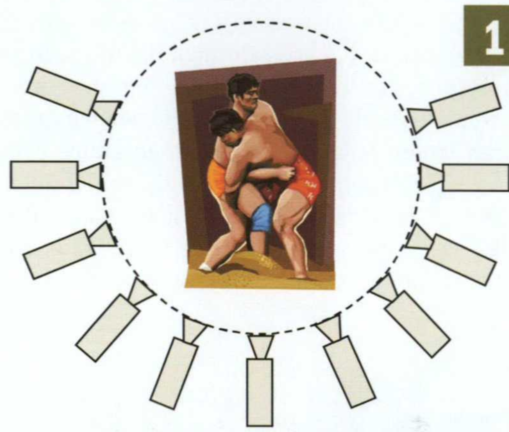
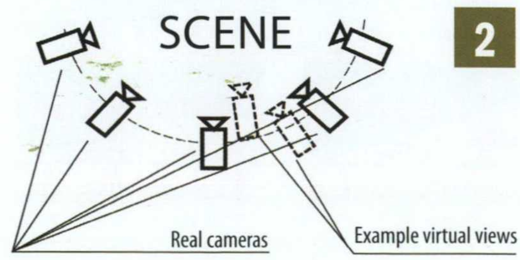
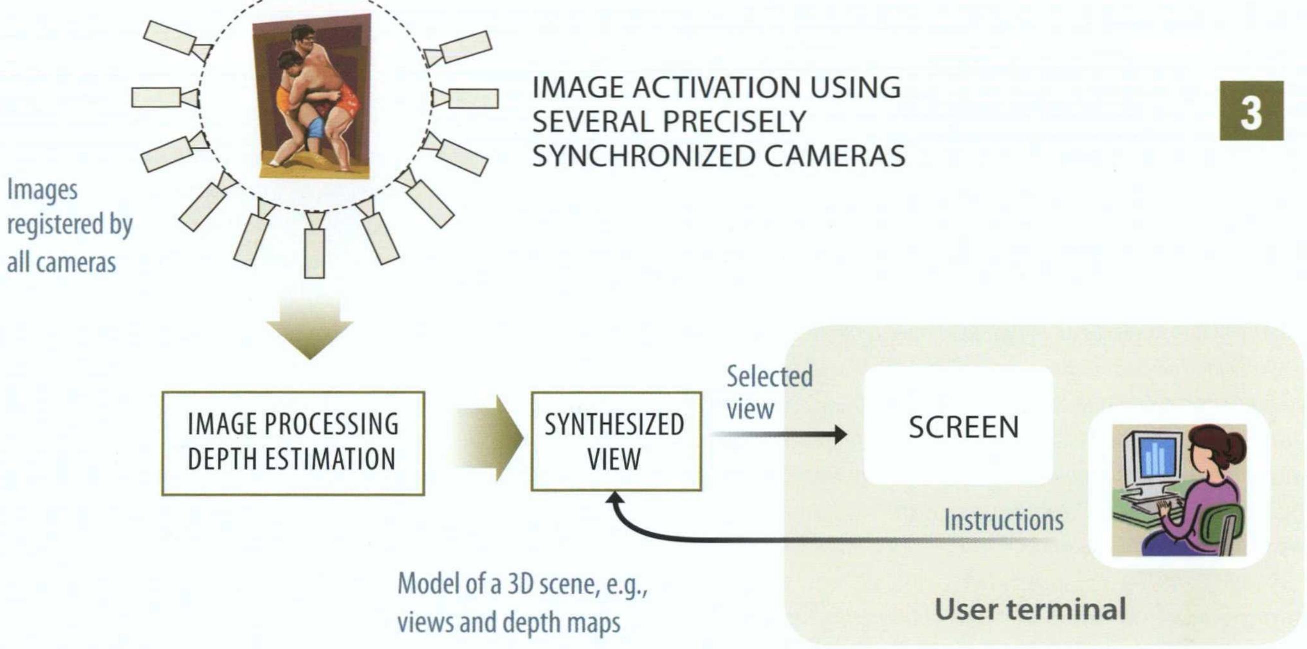


Cameras placed around the scene record moving images from different viewpoints

2



Real views registered with real cameras, plus virtual views generated by image synthesis software



Simplified schematic view of a free-viewpoint TV system

which can impractical or impossible for health and safety reasons in many sports and arts events. To solve this problem, our team has developed novel wireless camera modules placed on tripods (Fig. 4). This makes it possible to operate the cameras remotely from a single point; they can also be synchronized with an accuracy of approx. 2 microseconds. We have developed a practical system of synchronizing images recorded by several cameras simultaneously.

The most important research in the area, however, focuses on developing algorithms for processing several moving images simultaneously. This includes methods of pinpointing camera location down to the nearest few micrometers, and compensating for optical system errors, differences in color sensitivity parameters across cameras (even cameras of the same model can show certain variation), and differences in lighting level between individual camera viewpoints. Depth perception is especially difficult, estimating how far away from the imaging plane objects corresponding to specific points on the image lie. Such algorithms have been published for simpler cases, but developing methods appropriate for cameras placed arbitrarily around a scene is a major problem our team is currently trying to solve.

Systems comprising several cameras generate vast volumes of data, which means that new compression methods are needed. We achieved a major success in 2011 when we developed an original method of simultaneous compression of moving images originating from several cameras placed relatively close together. Testing done at foreign laboratories concluded that our compression method is one of best two compression techniques currently available, and it is significantly better than those developed by major research teams at companies such as Sony, LG, Samsung and Ericsson. As a result, our method has been used in the development of a new compression standard known as 3D-HEVC.

Unfortunately, neither our method nor those developed by other teams is effective in compressing moving images generated by several cameras placed more sparsely around the scene. We are currently working on compression methods to combat this problem, which is a major research challenge. Effective compression is highly complex; for example, the method developed by our team previously used software around 100,000 lines of code long.

We hope to be able to continue our work, since it opens new areas of fascinating applications for technologies providing interactive visual content. ■

Author's archives

4 **Wireless camera modules mounted on tripods, for recording scenes outdoors**