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Title Enhanced View Synthesis Reference Software (VSRS) for Free-viewpoint Television

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Introduction

At the 105th meeting in Vienna in July 2013 a new Ad hoc group on Free-viewpoint Television (FTV) has been founded.

One of the mandates of the new founded FTV group is to study available technologies for Free-viewpoint Television. During the recent years various formats for representation of 3D data have been developed. Currently the most popular option that has been investigated during the works on second phase of FTV, is MVD representation. Therefore, for the sake of evaluation of the future proposals for new data formats and their comparison with existing state-of-the art, a reference software for scene analysis and synthesis is desired.

During the works on compression technology for 3D video in the second phase of FTV, a software called View Synthesis Reference Software has been developed. The software has been initially proposed by Nagoya University and then improved jointly by the group, up to version 3.5. This software has been thoughtfully tested for dense linear arrangements of cameras, but not for other camera arrangements. A practical verification with new test sequences has shown that some required features are missing.

This paper presents a new version of View Synthesis Reference Software. It has been enhanced with extended support for arbitrary camera arrangement. The range of supported disparities has been extended to 16-bit. Previously used 8-bit depth representation allowed only for 256 different values of disparities, which in our research turned to be not enough for circular camera arrangement. Also, support for moving (changing in time) camera parameters has been added. The detailed description of introduced extensions and enhancement can be found below.

1. Introduced Extensions

1.1. Extended depth range/density - 16 bit depth maps

VSRS version 3.5 supports only 8 bit depth maps. This corresponds to 256 possible disparities which can be represented in an estimated depth map.

Z-near and Z-far normalization allows to use the software for any depth range but wider depth range results in more quantized depth maps. In previously used data sets (with linear camera arrangement) this was found to be satisfying as the number of considered disparity values (even with sub-pixel precision) not exceeded 256 much.

In a sparse or circular camera arrangement, number of disparity values that need to be represented can be much larger. Therefore, a new version of VSRS have been modified in order to support up to 65536 depth values (16 bit) with possibility of further easy enhancement if necessary.

Modification of bit-depth of used depth maps can be simply modified by usage of compilation flag in *version.h* file.

```
#define DEPTH_16BIT          //Enables 16 bit depth maps

#ifdef DEPTH_16BIT          //If 16bit depth is on define appropriate c++ types
    typedef unsigned short DepthType; //defines 16bit variable for storing disparity values
    typedef unsigned char ImageType;  //define 8bit variable for storing image samples
    #define MAX_DEPTH (256*256)      //Maximum disparity value
    #define MAX_LUMA 256             //Maximum luminance value
#else
    typedef unsigned char DepthType;
    typedef unsigned char ImageType;
    #define MAX_DEPTH 256
    #define MAX_LUMA 256
#endif
```

2. Example

Exemplary configuration file for enhanced View Synthesis Reference Software.

```
##### Input Parameters #####
DepthType                0                # 0...Depth from camera, 1...Depth from
the origin of 3D space
SourceWidth               480              # Input frame width
SourceHeight              270              # Input frame height
StartFrame                52              # Start frame for image data
StartFrameDepth           52              # Start frame for depth data
TotalNumberOfFrames      1                # Total number of input frames
LeftNearestDepthValue    -5.524340        # Nearest depth value of left image from
camera or the origin of 3D space
LeftFarthestDepthValue   -8.622723        # Farthest depth value of left image from
camera or the origin of 3D space
RightNearestDepthValue    -5.222178        # Nearest depth value of right image from
camera or the origin of 3D space
RightFarthestDepthValue  -8.695344        # Farthest depth value of right image from
camera or the origin of 3D space
CameraParameterFile      parametry1234.txt # Name of text file which includes real
and virtual camera parameters
LeftCameraName            param_cam2       # Name of real left camera
VirtualCameraName         param_camv2      # Name of virtual camera
RightCameraName           param_cam3       # Name of real right camera
LeftViewImageName        DEN_480x270_cam2.yuv # Name of left input video
RightViewImageName       DEN_480x270_cam3.yuv # Name of right input video
LeftDepthMapName         view2_480x270_depth_16bps_cf400.yuv # Name of left depth map
RightDepthMapName        view3_480x270_depth_16bps_cf400.yuv # Name of right depth map
OutputVirtualViewImageName viewV_480x270_synth.yuv # Name of output virtual view video

SynthesisMode            0                # 0...General, 1...1D parallel

ColorSpace                0                # 0...YUV, 1...RGB
Precision                 4                # 1...Integer-pel, 2...Half-pel, 4...Quater-pel
Filter                    1                # 0...(Bi)-linear, 1...(Bi)-Cubic, 2...MPEG-4 AVC

BoundaryNoiseRemoval      1                # Boundary Noise Removal: Updated By GIST

#---- General mode ----
```

ViewBlending
1...Not Blend

0

0...Blend left and right images,

StartFrameDepth

Unsigned Int, default: 0

Specifies the start frame number of the depth data. *StartFrameData* shall be a nonnegative.



Fig. 1. Exemplary 16 bit depth map for “Poznan_Game” sequence.

3. Software SVN

The software can be accessed from our SVN server:

<https://svn.multimedia.edu.pl/vsrs>

user: mpeg-ftv

pass: ftvftv

4. Conclusion

We presented an enhanced View Synthesis Reference Software that is natural extension of previously developed VSRS software. We propose to use it as a reference in further development and quality assessment of the new proposals of FTV formats.

5. References

- [1] M. Tanimoto, T. Fujii, and K. Suzuki, “Multi-View Depth Map of Rena and Akko & Kayo”, ISO/IEC JTC1/SC29/WG11, M14888, October 2007.

- [2] M. Tanimoto, T. Fujii and K. Suzuki, "Improvement of Depth Map Estimation and View Synthesis", ISO/IEC JTC1/SC29/WG11, M15090, January 2008.
- [3] M. Tanimoto, T. Fujii and K. Suzuki, "Reference Software of Depth Estimation and View Synthesis for FTV/3DV", ISO/IEC JTC1/SC29/WG11, M15836, October 2008.
- [4] http://opencv.jp/opencv-1.0.0_org/docs/index.htm .