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

**Television** 

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### Introduction

At the 105<sup>th</sup> 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 Freeviewpoint 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.

# 2. Example

Exemplary configuration file for enhanced View Synthesis Reference Software.

```
#============== Input Parameters ============================
DepthType
                                                                    # 0...Depth from camera, 1...Depth from
the origin of 3D space
SourceWidth
                                                                     # Input frame width
                                     270
52
52
                                                                     # Input frame height
SourceHeight
                                                                  # Start frame for image data
StartFrame
StartFrameDepth
                                                                  # Start frame for depth data
TotalNumberOfFrames
                                                                  # Total number of input frames
                                     -5.524340
                                                                  # Nearest depth value of left image from
LeftNearestDepthValue
camera or the origin of 3D space
                                     -8.622723
LeftFarthestDepthValue
                                                               # 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
                                    parametry1234.txt
                                                                     # Name of text file which includes real
CameraParameterFile
and virtual camera parameters
                                    param_cam2
param_camv2
                                                                     # Name of real left camera
LeftCameraName
VirtualCameraName
                                                                     # Name of virtual camera
                                    param_cam3
DEN_480x270_cam2.yuv
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
RightCameraName
                                                                    # Name of real right camera
SynthesisMode
                                                           # 0...General, 1...1D parallel
ColorSpace
                                                           # 0...YUV, 1...RGB
                                                          # 1...Integer-pel, 2...Half-pel, 4...Quater-pel
# 0...(Bi)-linear, 1...(Bi)-Cubic, 2...MPEG-4 AVC
Precision
                                      4
Filter
                                      1
BoundaryNoiseRemoval
                                                           # Boundary Noise Removal: Updated By GIST
#---- General mode -----
```

#### StartFrameDepth

Unsigned Int, default: 0

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

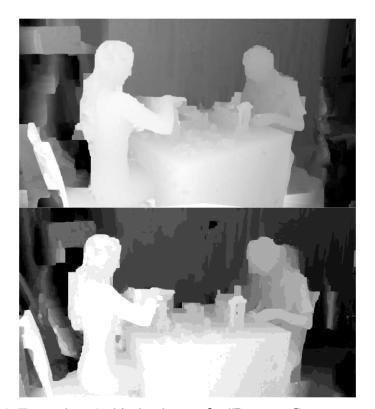


Fig. 1. Exemplary 16 bit depth map for "Poznan Game" sequence.

## 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 .