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CODING OF MOVING PICTURES AND AUDIO

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1 Introduction

The PDR (Poznań Depth Refinement) method has been initially proposed in the Immersive Video CE-5 response [1]. The tool allows to enhance the inter-view consistency of the depth maps. In PDR, only depth maps are used (texture information is omitted).

In the first step, the cross-view synthesis is performed in order to project depth values from all N into each of N input depth maps. After this step, for all the points in each depth map there is a list of depth values, projected from various input depth maps.

In order to provide the inter-view consistency, each point is processed in the same way:

1. All the depth values are sorted in descending order.
2. If n smallest depth values are similar (difference smaller than a DepthBlendingThreshold) go to step 6; else go to 3.
3. Remove the first (smallest) depth value from the list.
4. If the number of the elements in the list is smaller than n, go to step 5; else go to step 2.
5. Restore all the removed values to the list, decrement n and go to step 2.
6. If $n > 2$, the new depth value for the analyzed point is an average value of these n values; if $n < 3$, the depth value of the analyzed point is temporally removed.

The initial value of n is equal to the number of input views.

The depth maps after described refinement contains holes – areas without any depth value. These areas are simply inpainted using 8-way, depth-based inpainting method (for each pixel of the hole the depth of the nearest non-hole pixel in each direction are compared; then the farthest depth is copied to the analyzed pixel).

In order to provide better consistency, all the described operations are performed twice. In the second iteration, the refined depth maps are treated as input ones.

2 Software manual

PDR tool requires a configuration file. Path to that file should be typed as a command line argument:

```
PDR   config.cfg
```

2.1 Configuration file

Two examples of a configuration file are attached to this manual.

2.1.1 Common parameters

```
NumberOfInputViews          # parameters for each input view should be included (see: 2.1.2)
NumberOfOutputViews         # parameters for each output view should be included (see: 2.1.3)

NumberOfFrames
StartFrame

DepthBlendingThreshold      # if difference between depth values is lower than this threshold,
                            # they are assumed to be the same; recommended: 40 for 10bps

RealCameraParameterFile:    # path to camera parameter file (see: section 2.2)
Width
Height
Format                      # Perspective or Omnidirectional

ZNear                       # may be overwritten for each input or output view
ZFar                        # may be overwritten for each input or output view
DepthChromaSubsampling      # 400 or 420, may be overwritten for each input or output view
DepthBitsPerSample          # 8 – 16, may be overwritten for each input or output view
```

2.1.2 Input view parameters

```
Input0 {
    CameraName              # the same as in camera parameters file
    Depth                   # path to input .yuv file
    ZNear                   # may be skipped if the same as in section 2.1.1
    ZFar                    # may be skipped if the same as in section 2.1.1
    DepthBitsPerSample      # may be skipped if the same as in section 2.1.1
    DepthChromaSubsampling  # may be skipped if the same as in section 2.1.1
}
Input1 {
    CameraName              # the same as in camera parameters file
    Depth                   # path to input .yuv file
}
```

…

2.1.3 Output view parameters

```
Output0 {
    CameraName                # the same as in camera parameters file
    Depth                     # path to output .yuv file
    ZNear                     # may be skipped if the same as in section 2.1.1
    ZFar                      # may be skipped if the same as in section 2.1.1
    DepthBitsPerSample        # may be skipped if the same as in section 2.1.1
    DepthChromaSubsampling    # may be skipped if the same as in section 2.1.1
}
Output1 {
    CameraName                # the same as in camera parameters file
    Depth                     # path to output .yuv file
}
…
```

2.2 Camera parameters

Current version of PDR tool requires camera parameters in VSRS-style format (intrinsic and extrinsic parameters matrix for each camera):

Camera_name

f_x	0	c_x	
0	f_y	c_y	
0	0	1	
0			
0			
r_{00}	r_{01}	r_{02}	t_0
r_{10}	r_{11}	r_{12}	t_1
r_{20}	r_{21}	r_{22}	t_2

3 Examples

1. Depth refinement of TechnicolorPainter sequence (configuration file attached):

```
PDR  SD.cfg
```

2. Depth refinement of IntelFrog sequence (configuration file attached):

```
PDR  SE.cfg
```

4 Software

MPEG Git Repository: http://mpegx.int-evry.fr/software/MPEG/Explorations/6DoF/PDR

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5 References

[1] A. Dziembowski, D. Mieloch, M. Domański, G. Lee, “PUT/ETRI Response to Immersive Video CE-5: Depth and color refinement”, ISO/IEC JTC1/SC29/WG11 MPEG/M48092, Jul. 2019, Göteborg, Sweden.