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Title **[MIV] Renderer-side edge processing for subjective quality improvement**

Source **PUT, ETRI**

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Abstract

The document presents a proposal of the renderer modification, which increases the subjective quality of the pose traces. The proposal is based on blurring of physical edges of objects, i.e., texture blurring in the surrounding of depth edges. The recommendation is to include proposed modification into TMIV16.

1 Proposal

The TMIV15 renderer does not include postprocessing methods increasing the subjective quality of rendered views, and the views are produced by simple reprojection. Such a reprojection results in generating sharp edges between different objects of the scene, which seem to be unnatural and distracting. We propose to blur such sharp, unnatural edges using a simple filter performed on rendered viewport, just before the final quantization:

```
// 7) Shading
computeShadingMap(sourceHelperList, targetHelper);

// 8) Output
for (size_t i = 0U; i < m_viewportColor.size(); i++) {
  if (isValidDepth(m_viewportVisibility[i])) {
    if (m_viewportColor[i].x() < 0.F) {
      m_viewportVisibility[i] = NAN;
      m_viewportColor[i] = Common::Vec3f{};
    } else {
      m_viewportVisibility[i] = std::clamp(1.F / m_viewportVisibility[i],
                                           cameraConfig.viewParams.dq.dq_norm_disp_low(),
                                           cameraConfig.viewParams.dq.dq_norm_disp_high());
    }
  }
}

// 8.5)
blurEdges();

// 9)

auto viewport = Common::RendererFrame{
    quantizeTexture(m_viewportColor, cameraConfig.bitDepthTexture),
    MivBitstream::DepthTransform{cameraConfig.viewParams.dq, cameraConfig.bitDepthGeometry}
        .quantizeNormDisp(m_viewportVisibility, 1)};
viewport.texture.fillInvalidWithNeutral(viewport.geometry);
return viewport;
```

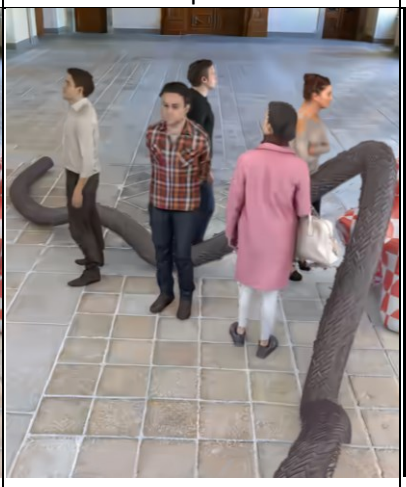
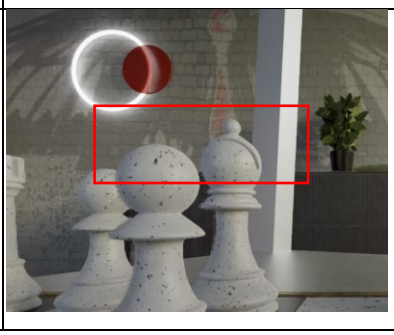
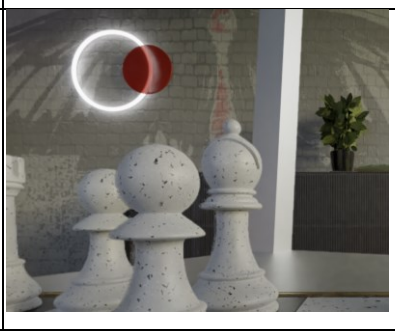
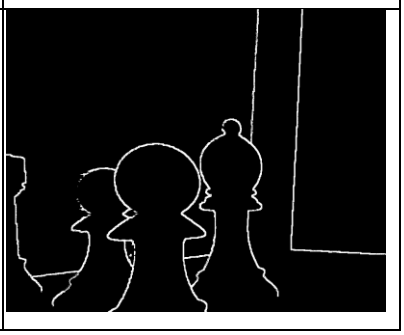
The filtration is based on weighted average of several (25) neighboring samples, i.e., the viewport is convolved with the signal:

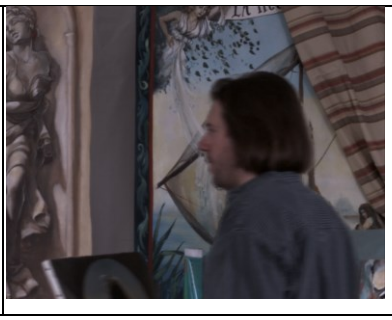
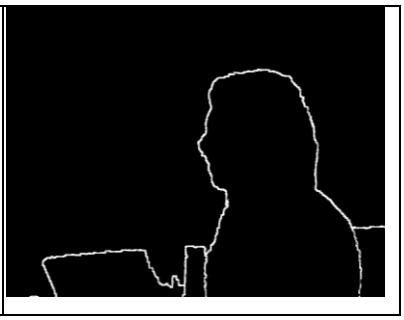
$$\begin{bmatrix} 1 & 2 & 3 & 2 & 1 \\ 2 & 3 & 4 & 3 & 2 \\ 3 & 4 & 5 & 4 & 3 \\ 2 & 3 & 4 & 3 & 2 \\ 1 & 2 & 3 & 2 & 1 \end{bmatrix} \cdot 1/65$$

However, only the samples placed on the geometry edges are processed. All the others are preserved. The decision, whether the sample should be filtered or not is based on calculation of minimum and maximum depth value within the 5x5 neighborhood. If the difference between these two values is higher than a threshold (4% of the dynamic range), it is supposed, that the sample is placed at the edge of the object. Otherwise, it is not filtered.

2 Results

The proposed approach was tested on mandatory content for both anchors, and the pose traces are available on the MPEG content server. No objective evaluation was performed, as the proposal do not influence the bitrate, and an impact on objective quality is far less important, than the subjective evaluation.

	TMIV15	Proposal	Difference
A65, W01, RP4			
A65, B02, RP1			

G65, D01, RP0			

Besides the more natural appearance, blurred edges are more temporally stable, additionally increasing the subjective quality of pose traces.

3 Recommendation

We recommend including the proposed modification into TMIV16.

4 Acknowledgement

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