MOTION-COMPENSATED COMPRESSION OF POINT CLOUD VIDEO

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Capture a point cloud of the person/object
  - List of occupied voxels: (x,y,z) (r,g,b)
- Transmit point cloud
- Immerse object into scene- render on Hololens
Second Real Time Voxelization
Holoportation
Color and geometry
Voxelized point cloud

- Voxelized point cloud (e.g. 512x512x512 grid)
- Voxels \( V_i = [x_i, y_i, z_i, R_i, G_i, B_i, A_i] \)
  - Geometry (position)
  - Color
  - Optional attributes

- Color (or attributes) encoded using RAHT
- Geometry encoded using Octtree
  - 2.5-3.3 bpv
Distortion metrics

Correspondence-based

\[ \delta_{Y+G} = \frac{1}{N_{\nu}} \left( \| E_c \|^2 + \beta \| E_g \|^2 \right) \]

Projections-based (image MSE/PSNR)
Motion estimation in between point clouds

Illustration from:
Motion compensation in DPC

Previous Frame

A voxel cube in current frame

\[
\begin{align*}
b_x N - M_x & \leq x_{i,t-1} < b_x N + N - M_x, \\
b_y N - M_y & \leq y_{i,t-1} < b_y N + N - M_y, \\
b_z N - M_z & \leq z_{i,t-1} < b_z N + N - M_z. \\
b_x N & \leq x_{it} < b_x N + N, \\
b_y N & \leq y_{it} < b_y N + N, \\
b_z N & \leq z_{it} < b_z N + N.
\end{align*}
\]
- Decision made for every occupied cube (size NxNxN voxels)

\[ R_{\text{intra}} = R_g^{\text{intra}} + R_c^{\text{intra}} \approx 2.5||\Omega|| + R_c^{\text{intra}} \]

\[ R_{\text{inter}} = R_g^{\text{inter}} + R_c^{\text{inter}} = R_{MV} \]

\[ D_{\text{intra}} = D_g^{\text{intra}} + \beta D_c^{\text{intra}} = \beta D_c^{\text{intra}} \]

\[ D_{\text{inter}} = D_g^{\text{inter}} + \beta D_c^{\text{inter}} = \delta, \]

- Choose intra coding if

\[ D_{\text{intra}} + \lambda R_{\text{intra}} < D_{\text{inter}} + \lambda R_{\text{inter}} \]

- If not just motion compensate (no residual)
In-loop filtering

- 3d extension of morphological closing applied to geometry
- “Deblocking” filter

\[ \hat{x}_i = \frac{\sum_{j, d_{ij} < \eta} x_j \rho^{d_{ij}}}{\sum_{j, d_{ij} < \eta} \rho^{d_{ij}}} \]
For distortion based on correspondence which is determined by Euclidean distance
RD curves - projections

For distortion based on projections (6 sided)
Man: Frame 58

Original

3.7 bpv
RD using a correspondence based distortion metric

3.7 bpv
RD using projection based Distortion metric

3.7 bpv
RAHT (all intra)
Results

4.4 bpv (original and decompressed)
Man frame 58

RAHT vs. MCIC
Ricardo frame 60
Conclusions

- Potential for “traditional” motion compensation in compression of point clouds to reduce the bit rate
- Geometry encoding is the largest hurdle now
- We still have very little about encoding residuals (which is what is done in regular motion compensated vídeo coders)
- Lots of work still to be done
Thank you