Neural Convolutional Surfaces (NCS)

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Motivation:
Common shape representation entangle geometric detail with overall shape structure. These descriptions include triangle meshes, neural implicit fields \cite{1,2} and neural atlases \cite{3}.
Neural Convolutional Surfaces distentsanges the two as show below.

![Structure + Detail = Shape](image)

Method:
Neural Convolutional Surfaces offers:
\begin{itemize}
\item unsupervised disentanglement
\item describes the global structure with an MLP
\item exploit weight sharing of CNN for surface detail
\end{itemize}

Split the mesh into patches and parametrize them as preprocessing.

An MLP defines the coarse surface: It maps point-wise 2D points (q) onto the surface (p), and gives us a Local Reference Frame (F) through auto-diff.

Repeating surface details are auto-decoded with CNN from a latent vector: the CNN upsample the patch latent vector, then through interpolation feature vector are decoded into displacements.

Results:
Examples of NCS reconstruction coarse and fine, for different models.

Place detail on the coarse structure: use the Local Reference Frame (F) to project the displacement on top of the coarse reconstruction.

The use of Local reference Frame (F) enables weight sharing between patches.
Optimize the network to reproduce the original geometry.

Summary/Conclusion:
Unsupervised disentanglement into coarse and fine.
Highly accurate reconstruction with low amount of parameters.
Enables editing through feature manipulation.

References:
\begin{itemize}
\item [1] Acorn - Martel et al. - SIGGRAPH 2021
\item [2] Neural Geometric Level of Detail - Takikawa et al. - CVPR 2021
\item [3] Neural Surface Maps - Morreale et al. - CVPR 2021
\item [4] IDF - Yifan et al. - ICLR 2022
\end{itemize}

Project Page:
(with paper & code)