物理信息神经场的基于稀疏数据的烟雾重建

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Title：Physics Informed Neural Fields for Smoke Reconstruction with Sparse Data

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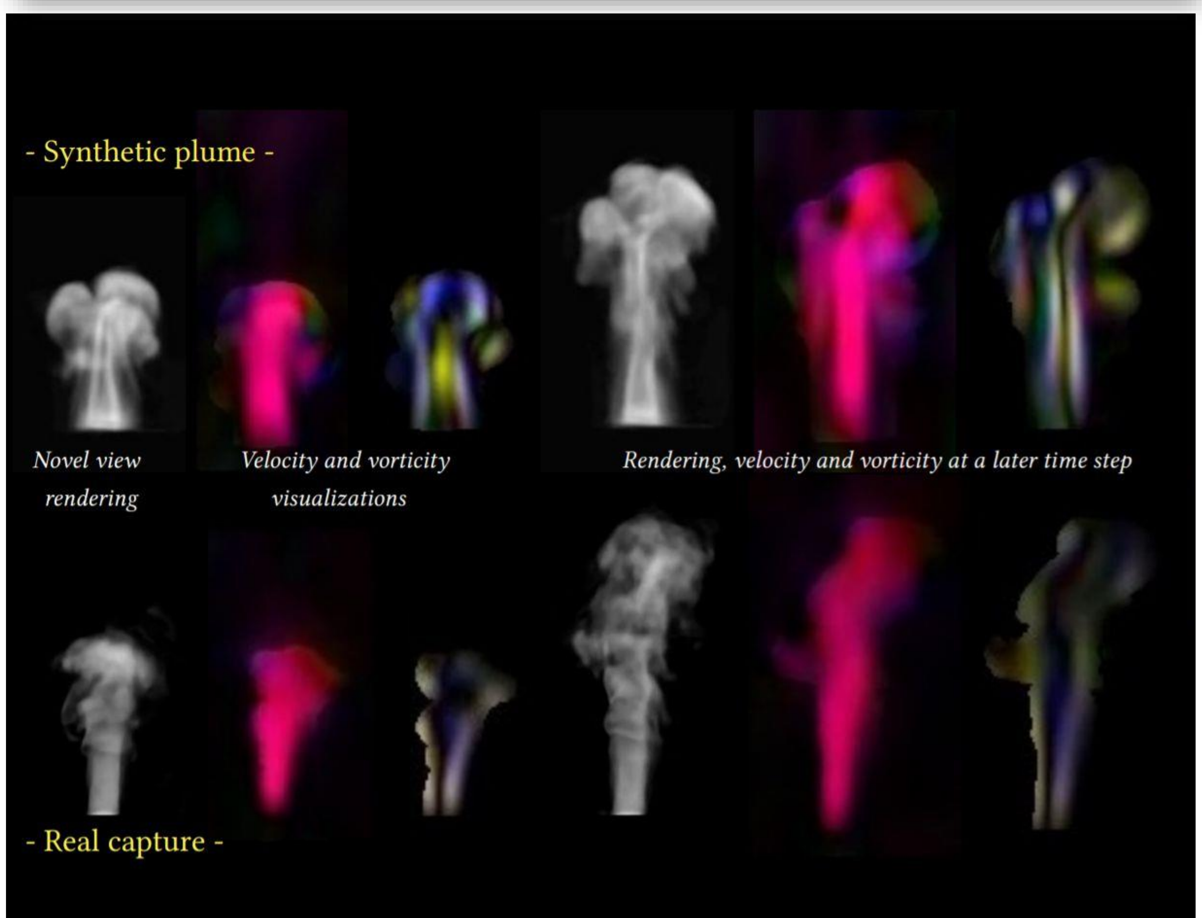
Background & Overview

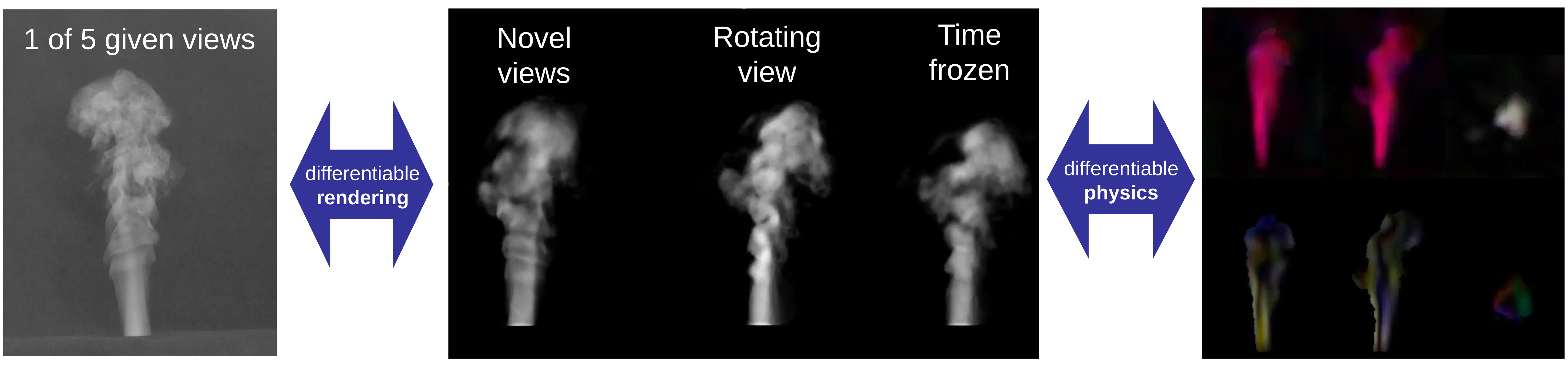
- Smoke is ubiquitous fluid phenomena
- Smoke density and motion capture previously entails special setups in Particle Image Velocimetry (PIV)
- We present a method to reconstruct continuous fluid fields from sparse RGB video frames with unknown lighting conditions by leveraging the underlying governing physics in an end-to-end optimization.



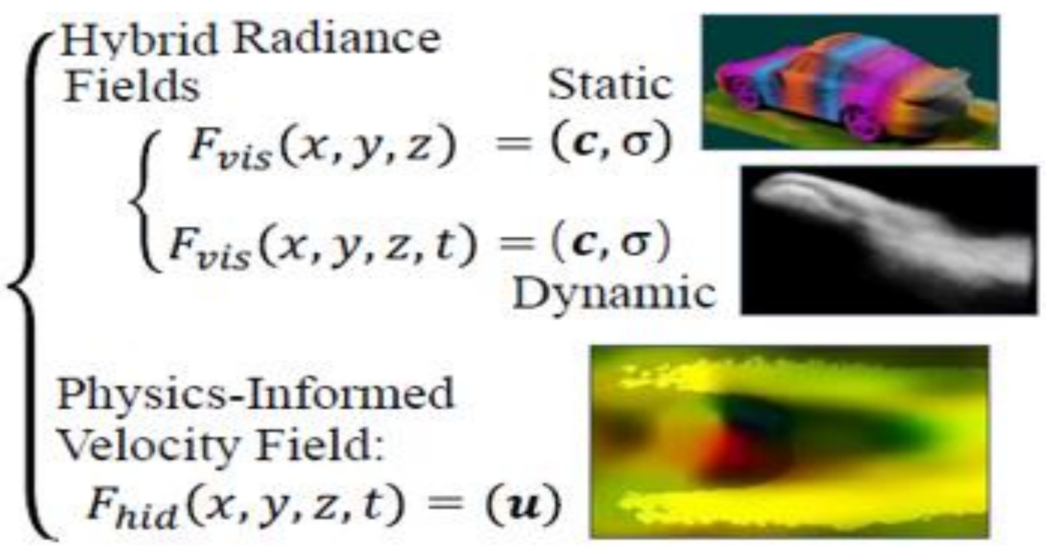
Reconstruct smoke from synthetic or real plume

Method

Input Sparse RGB Videos | **Radiance Representation** $f(x,y,z,t) = (d,c)$ | **Velocity Representation** $f(x,y,z,t) = \mathbf{u}$



➢ Hybrid Architecture



➢ Comprehensive Supervisions

- Image Space Priors (l2 loss, VGG loss, ghost density regularization)
- Data Priors (a pre-trained fluid model)
- Physics Priors （transport equation and Navier-Stokes equations)

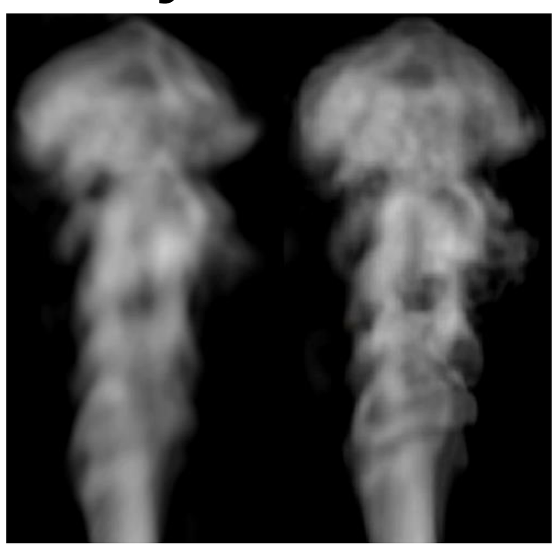
$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u}\cdot\nabla\mathbf{u} = -\frac{1}{\rho}\nabla p + \nu\nabla\cdot\nabla\mathbf{u} + f$$

$$\nabla\cdot\mathbf{u} = 0$$

$$\frac{\partial\sigma}{\partial t} + \mathbf{u}\cdot\nabla\sigma = 0$$

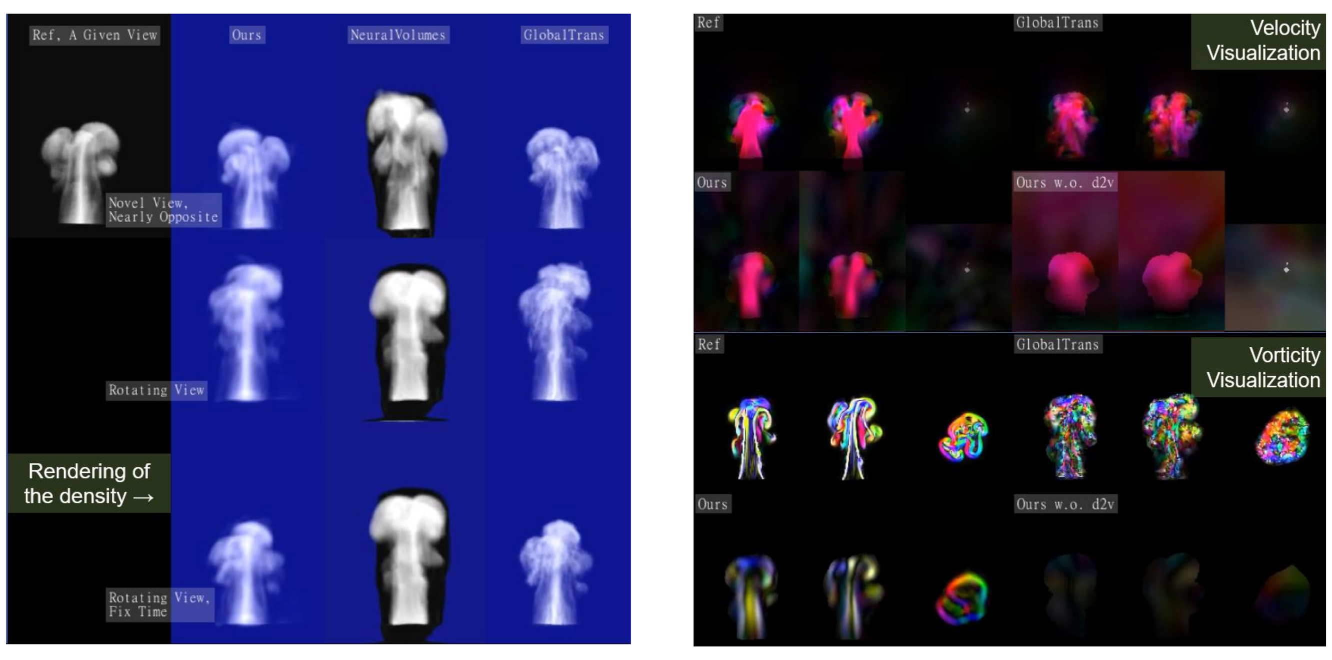
Results

Analysis



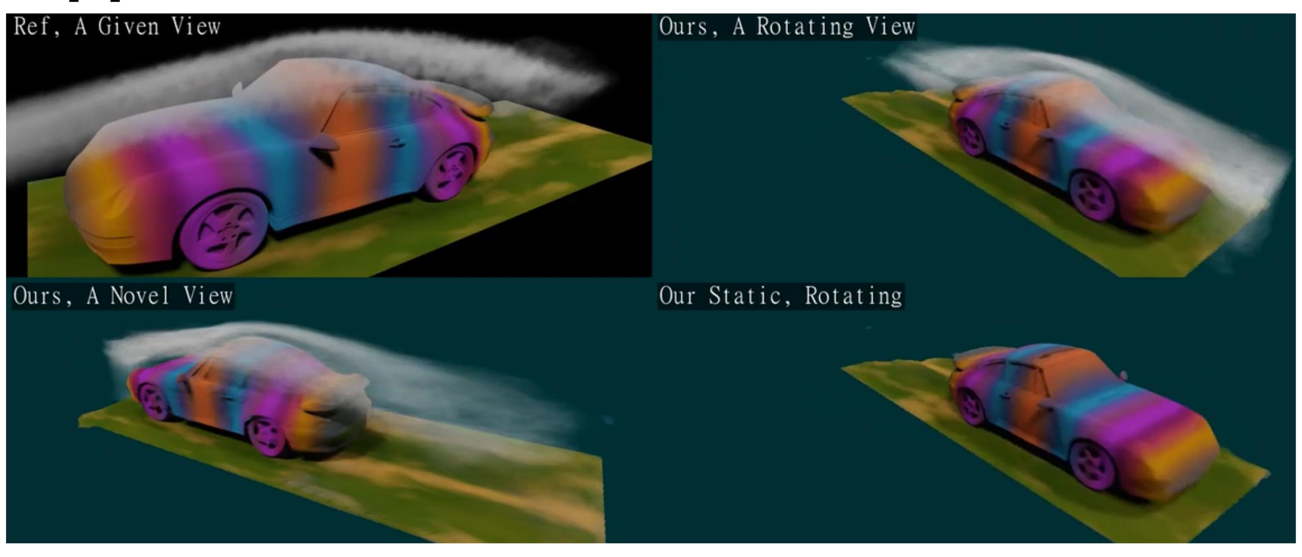
w.o. / w. VGG loss

w.o. / w. density regularization



Comparisons on the captured *ScalarFlow* Scene

Applications



Hybrid scene with smoke and a car

Hybrid scene with smoke and static monsters