FlumeNet: A neural network model for generating videos of flume experiments

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Abstract

In geophysics research, flow experiments are used to study patterns of landscape evolution, and to understand the physical processes by which these patterns are created on the surface of Earth. Understanding these processes is important for assessing risk of environmental disasters (e.g., floods in urban areas) and for modeling natural processes such as oil and gas production. Although various numerical models were proposed in the literature for simulating flow and sediment transport on land, these experiments are limited in their ability to model long-term phenomena, such as erosion and sediment transport, which are important for understanding the evolution of landscapes.

In this work, neural network models are proposed for generating new videos of the flume. These models are able to generate new videos that are similar to the original videos, but with new patterns of erosion and sediment transport. The proposed models are trained on a dataset of images from experiments and are able to generate new videos that are consistent with the original videos and with new patterns of erosion and sediment transport.

Background

Our previous work on simulating the landscapes of our planet with the help of machine learning algorithms has shown promising results. By training the models on a large dataset of images, we were able to generate new videos that are similar to the original videos, but with new patterns of erosion and sediment transport. The proposed models are trained on a dataset of images from experiments and are able to generate new videos that are consistent with the original videos and with new patterns of erosion and sediment transport.

Methodology (contd.)

Video frames directly, three networks are trained to predict optical flow that is then used to synthesize new videos.

- TuricciNet

- Velocity module

- Acceleration module

- Regression problem:

- Output layer:

- SpiralNet

- VortexNet

- Velocity module

- Acceleration module

- Regression problem:

- Output layer:

Methodology (contd.)

In an attempt to capture very small changes in flow patterns, a recursive neural network model is proposed. This 2D convolutional model of the flume is trained to infer the difference between every two consecutive video frames using different GTEC sizes. Then, another set of GTEC sizes is used to fill in the gaps between the produced frames as illustrated in Fig. 3.

Results

- SliceNet

- Bramble's masks of the GTEC sizes are used here to show how the model works with high-frequency variations, and it is clear that the model is capable of accurately reproducing the patterns.

- VortexNet

- SpiralNet

Conclusions

- This work modelled and generated videos of experiments on a simple 2D vortical flow, which is a useful tool for visualizing the flow patterns.

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References


