DEPARTMENT OF INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Thesis type (Bachelor's Thesis in Informatics. . .)

Evaluation of Scene Representation Networks for Streamline Integration

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Evaluierung von Scene Representation Networks für Streamline Integration

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I confirm that this thesis type (bachelor's thesis in informatics. . .) is my own work and I have documented all sources and material used.

Munich, 15.02.2022 Alexander Fuchs

Acknowledgments

Abstract

Contents

1 Introduction

General Usage of SRNs reduce data, slightly decrease performance interpolation between frames (superresolution) => useful for vector fields requirements of flow fields: preserve not just individual points but the main defining stream features *cit Streamlines encapsulate the information to reconstruct a flow field Specific goal of the thesis: prior implementation of SRN exists: => good results already (lower data usage, decent quality) evaluate prior results on streamlines using l2, bof train a network on streamlines and see how it goes

2 Related Work

About related works on: SRNs in general: where have they been used? different approaches? vector fields: what are they generally used for Streamline Similarity: different options for streamline similarity (used for culling as well)

3 Streamline Integration

The approach to the generation of streamlines, plays an important role in achieving good results of the detected similarity between the reference and network representations. Different seeding strategies as well as integration methods, each come with their own advantages and disadvantages.

We chose to focus on different approaches for the creation and comparison of streamlines, as opposed to pathlines or streaklines. This means each sample taken during the generation of a streamline is taken from the same timestep. In contrast for a streakline each velocity sampled for the streamline would be on a timestep later than the previous. A comparison of streamlines, streaklines and pathlines can be seen in X.

3.1 General Methodology

The generation of streamlines is generally divided into two steps: Seeding and Integration During seeding, the initial points in space R3 and time R1 for the streamlines are generated. The seeding method affects coverage of the velocity field. An even coverage can be achieved using a uniform random/deterministic approach. Alternatively an approach using importance sampling can assist with highlighting more salient regions of the field.

The chosen integration method affects the accuracy of the streamlines according to the chosen step size. More advanced integration methods like rk45 will net a higher accuracy using the same step size in exchange for higher computational requirements. The used methods are highlighted in more detail in the following sections. Seed initial points: Generate next set of points repeat result is Tensor of Shape x

3.2 Seeding Strategy

The choice of seeding strategy can have a profound effect on streamline coverage and legibility. Choosing a good seeding strategy to cover large portions of the field, as well as in particular highlighting singularities and regions is an area of active research. Examples include. Since the purpose of our SRN is the visual representation of the original field, these considerations fit with our goal. The following methods focus on spatial distribution, as opposed to distribution among timesteps. The latter will be discussed in (later section/further research)

3.2.1 Uniform Random

The most naive approach to seeding is to use a uniform random distribution. By definition this approach has a very even distribution of seed points. An example of it can be seen in x. It does however lack any effect towards highlighting more salient regions especially during visualization. As such, a sparse field with regions of low interest might generate a significant number of streamlines with low movement.

3.2.2 Uniform Deterministic

During visualization the number of seed points has to be kept relatively low to keep visibility high. As such the actual distribution of streamlines when using a uniform random method might be less uniform than desired. A deterministic, evenly spaced distribution can be used in this case. An example of this distribution can be seen in. In general this approach is mostly useful for testing. In comparisons (especially if used during training) a random distribution is more desirable in order to reduce overfitting.

3.2.3 Importance Sampling using local Entropy

Our final approach to seeding is generating a local entropy field at each time step, which can then be applied in importance sampling. An entropy field can help highlight more salient regions in the field and increase the number of seed points generated in these areas.

The generation of the entropy field is a preprocessing step which has to be applied to each time step of the reference that we want to generate seeds on.

Generation of the Entropy field

How is Entropy calculated here?: Sphere of equal regions neighborhood size Use vector length or not? Rejection Sampling intensity min probability uneven coverage, focus on "important" regions

3.2.4 Comparison

On Speed and Accuracy

3.3 Integration Methods

3.3.1 Euler-Integration

procedure no additional samples needed

3.3.2 Runge-Kutta

some additional samples error is O()

3.3.3 Runge-Kutta-Fehlberg

adaptive stepsize more accurate requires higher number of samples individual? similarity might suffer under adaptive stepsize

4 Streamline Similarity

4.1 Prior Considerations

Masking, Time-relation (streamline vs pathline), adaptive stepsize

4.2 L2-Distance

Procedure, Limitations (stepsize, length, mask) decent since comparing streamlines with same start location

4.3 Bag-Of-Features

instead of distance generate a set of features for each point on the streamline compare these using clustered representative feature vectors

4.3.1 Choice of Features

4.3.2 Spatially Sensitive Bag-of-Features

4.4 Comparison

On Speed and Accuracy (Look up Error estimation)

5 Evaluation of the existing SRN

typically psnr or ssim we use streamline similarity show difference between the methods

5.1 Comparison of Network against

6 Results

6.1 Section

Citation test [Lam94].

6.1.1 Subsection

List of Figures

List of Tables

Bibliography

[Lam94] L. Lamport. *LaTeX : A Documentation Preparation System User's Guide and Reference Manual*. Addison-Wesley Professional, 1994.