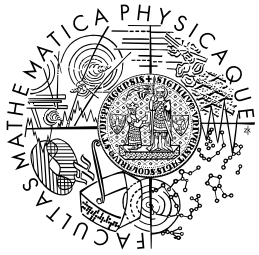

FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

MASTER THESIS

Bc. Lucia Tódová

Constrained Spectral Uplifting

Department of Software and Computer Science Education

Supervisor of the master thesis: doc. Alexander Wilkie, Dr.

Study programme: Computer Science

Study branch: Computer Graphics and Game Development

Prague 2020

I declare that I carried out this master thesis independently, and only with the cited sources, literature and other professional sources. It has not been used to obtain another or the same degree.

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In ..... date ....

Author's signature

Dedication.

Title: Constrained Spectral Uplifting

Author: Bc. Lucia Tódová

Department: Department of Software and Computer Science Education

Supervisor: doc. Alexander Wilkie, Dr., Department of Software and Computer Science Education

Abstract: Abstract.

Keywords: key words

Contents

Introduction

1. Color Science

Introduction to colors - what is a color, multiple ways of representing colors (tristimulus, spectral)

1.1 Spectral color representation

What a spectrum is from the POV of physics, wavelengths, sampling of spectra, visible wavelengths, human perception of spectrum, metamerism

Mention reflectance/emission spectra

1.2 Tristimulus representation

We want to represent color by fewer values (impossible to store the complete spectrum)

RGB, LAB, CIE XYZ spaces, focusing on the RGB representation, conversions, matching functions etc.

1.3 Rendering

RGB vs Spectral renderers, their pros&cons, examples

2. Spectral Uplifting

Spectrum to RGB conversion, mention the problems, inaccuracies - depending on the length of text, the intro to spectral uplifting (upsampling) can be regarded as a separate section

Also, probably here is a good time to mention that we are focusing on the reflectance spectra, however we will also talk about emission spectra in this section solely for research purposes

2.1 Available methods

Maybe separate them into subsections, or add a subsection for comparing the results

2.2 Trigonometric moment method

A review of the moment method (basically just a review of the paper)

2.2.1 Evaluation of various parameters

Add the results from the tests I ran back in April - which combination of number of moments, Warp/NonWarp and Mirror/NonMirror techniques is the most optimal. Also mention that we do not want to use complex moments as it doubles the space needed which will be unusable for the optimizer in the Implementation section.

2.2.2 Reconstruction results

Try the reconstruction on various spectrum values, also add the respective RGB values.

It might be nice to also add the ideal coefficients that we got from the borgtool by optimizing and comparing them to the coefficient that were originally computed (these are different mainly due to rounding errors during the algorithm).

3. Implementation

Mention that we use the trigonometric moment method to extend Borgtool, which is currently used for spectral uplifting. In addition to utilizing the moment method, we are also constraining the input - explain what the constraining means in two sentences.

3.1 Borgtool

Mention how it works, probably a few screenshots, mention the sigmoid method it was already using (reference the available methods subsection in Spectral uplifting). Mention that it was seeding the cube from the middle. Explain the cube "expansion" and that for all the other lattice points, a prior is used from their already fitted neighbor.

Also explain the threshold value - it is really important to set it properly and that it affects performance.

3.1.1 Optimizer

Maybe this doesn't need to be a subsection? Mention how it works, link the ceres optimizer and explain that until now we were using it to fit 3 coefficients.

3.1.2 Choice of parameters

Explain that because of the optimizer, we are actually using 9 moments. Link this to the spectral uplifting section. Emphasize that using complex moments isn't realistic and we need mirroring. Also, the default threshold is 0.1, going below is quite unrealistic - possible but would take a lot of time.

3.2 Cube constraints

We added the option to constraint the input. Explain the color atlases that might be provided, how the cube is seeded with them.

If not specified, the cube is seeded from the middle (use Munsell N5 that was pre-computed). Also explain the relationship of the size of the atlas with cube dimension.

3.3 Filling the cube

Just mention that we are basically doing what has already been done, however the cube is now growing in many directions (multi-threaded) and not only from the middle - would be nice to add progress images. Also, it might be nice to add progress images when seeding only from the middle.

Also emphasize that the optimizer is currently not working ideally and that there are a few issues - probably encounters some unresolved division by zero? - therefore sometimes, there are unexplained gaps. Explain that we are solving

this by trying out various different prior coefficients and that this is definitely an "ugly behavior".

4. Results

Not really sure about the subsections here (I still don't understand the texture options).

The idea that currently comes to mind: For each parameter setting, create a record containing the following:

- performance (time)
- average accuracy (targetRGB-latticeRGB)
- maxDifference (the important quantity)
- maybe other stuff (e.g. number of optimizer rounds)

Also mention that it is multi-threaded and performance is not really a priority - the cube has to be created only once and then can be reused as much as the artists need.

Compare these records with regard to:

4.0.1 Choice ot threshold

E.g. which threshold is still good enough for the moment method, the performance etc.

4.0.2 Sigmoid vs Moment method

Compare these two approaches (the texture option which I'm not sure about), choose the same threshold for both of them, maybe do this for more thresholds?

4.0.3 Constrained input

Compare maybe the performance of different atlases, or maybe atlas vs. seeding from the middle?

The Results chapter is just a sketch and it may be completely changed, depending on the results and which of them will be interesting.

Conclusion

Bibliography

J. Anděl. *Základy matematické statistiky.* Druhé opravené vydání. Matfyzpress, Praha, 2007. ISBN 80-7378-001-1.