ATTENUATION-BASED LIGHT FIELD DISPLAYS

Bachelor Thesis

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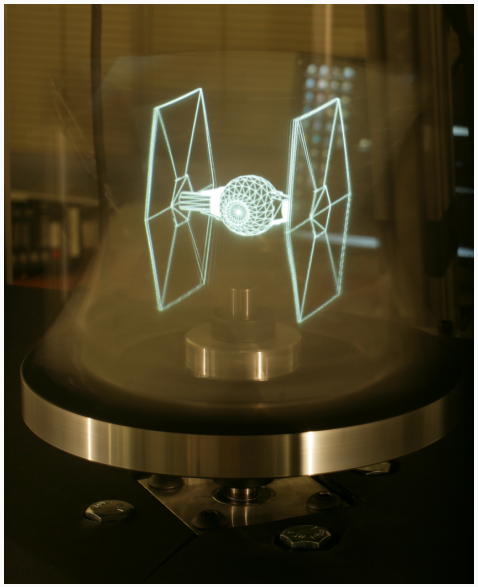
OUTLINE

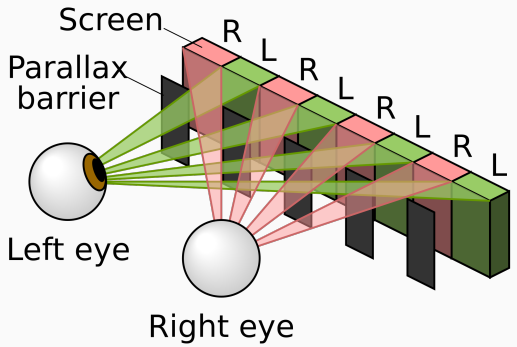
1. Motivation
2. Introduction to Light Fields
3. Problem Statement
4. Results
5. Assessment
6. Conclusion

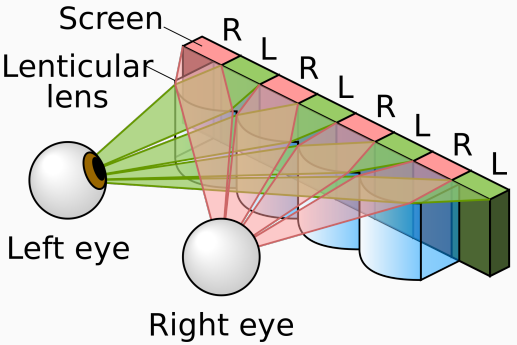
MOTIVATION

EXISTING 3D DISPLAYS



Add more images

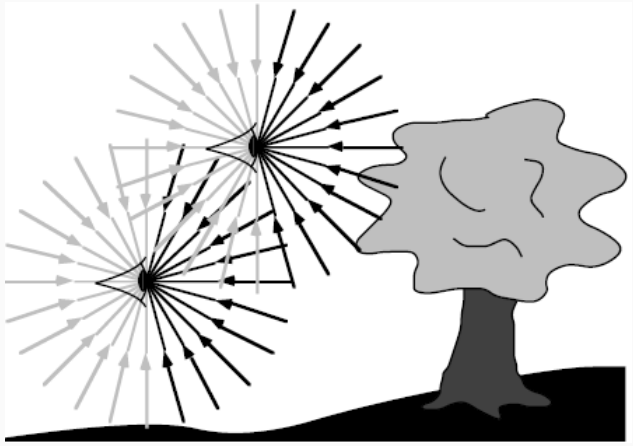




INTRODUCTION TO LIGHT FIELDS

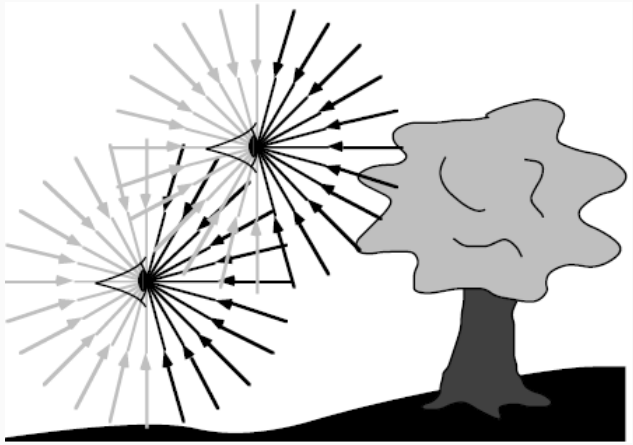
THE PLENOPTIC FUNCTION

- Measures light in the world



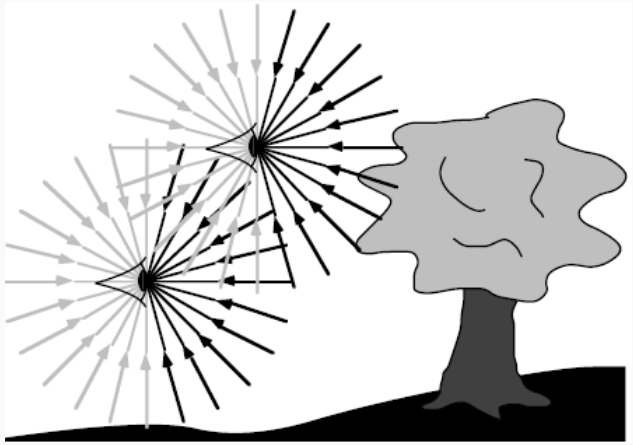
THE PLENOPTIC FUNCTION

- Measures light in the world
- $P(x, y, z, \theta, \phi, t, \lambda)$



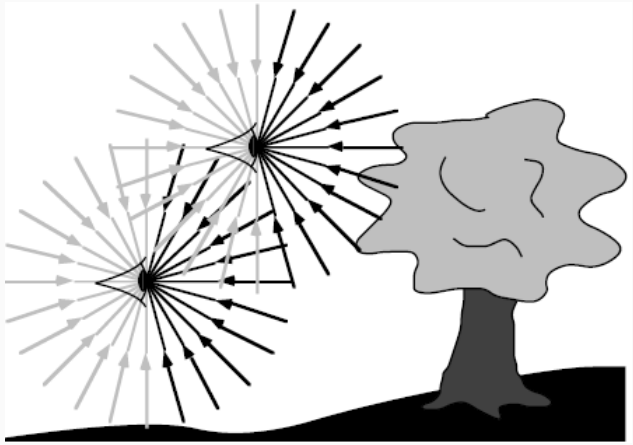
THE PLENOPTIC FUNCTION

- Measures light in the world
- $P(x, y, z, \theta, \phi, t, \lambda)$
- Position and viewing direction



THE PLENOPTIC FUNCTION

- Measures light in the world
- $P(x, y, z, \theta, \phi, t, \lambda)$
- Position and viewing direction
- Time, Wavelength



The 4D light field

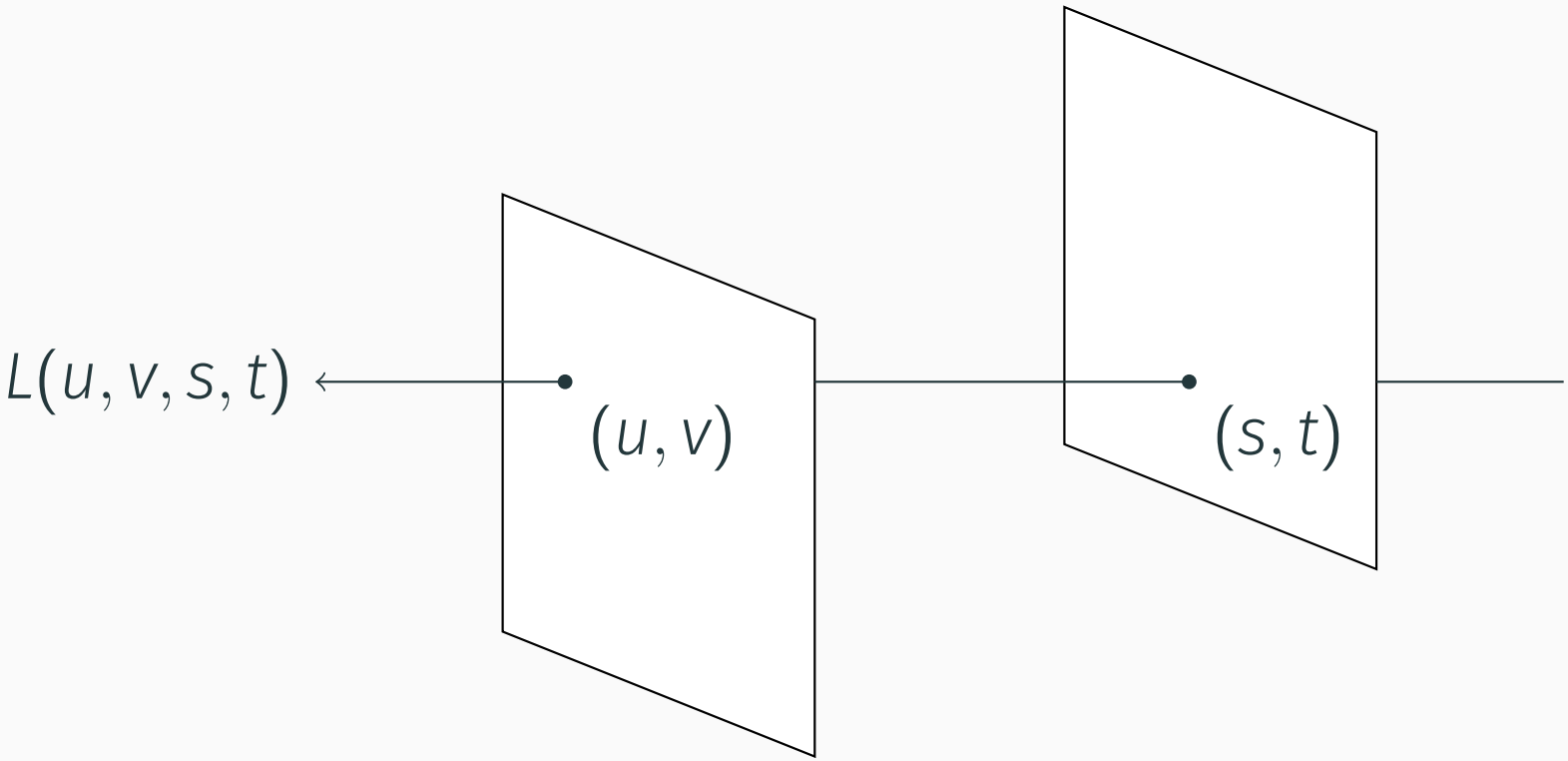
- Reduce dimensions of P

The 4D light field

- Reduce dimensions of P
- $L(u, v, s, t)$

The 4D light field

- Reduce dimensions of P
- $L(u, v, s, t)$
- Defined by two planes



LIGHT FIELD ACQUISITION

- Camera array

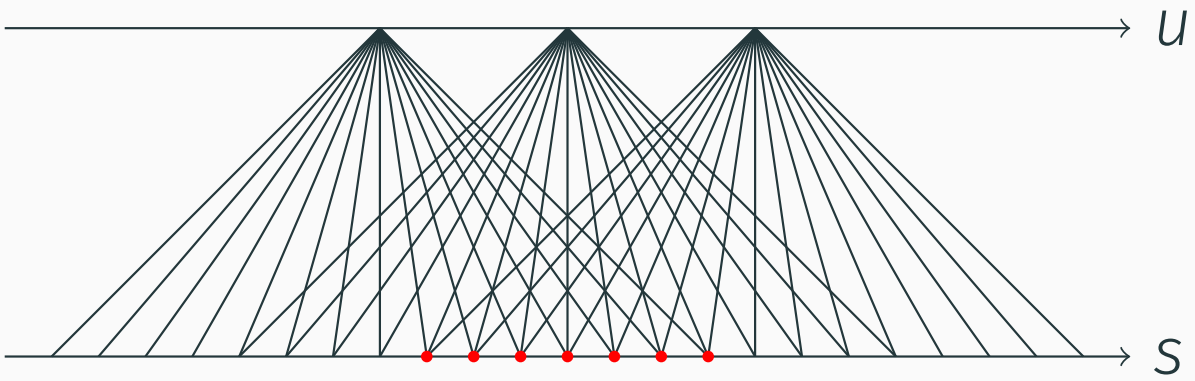
LIGHT FIELD ACQUISITION

- Camera array
- Gantry

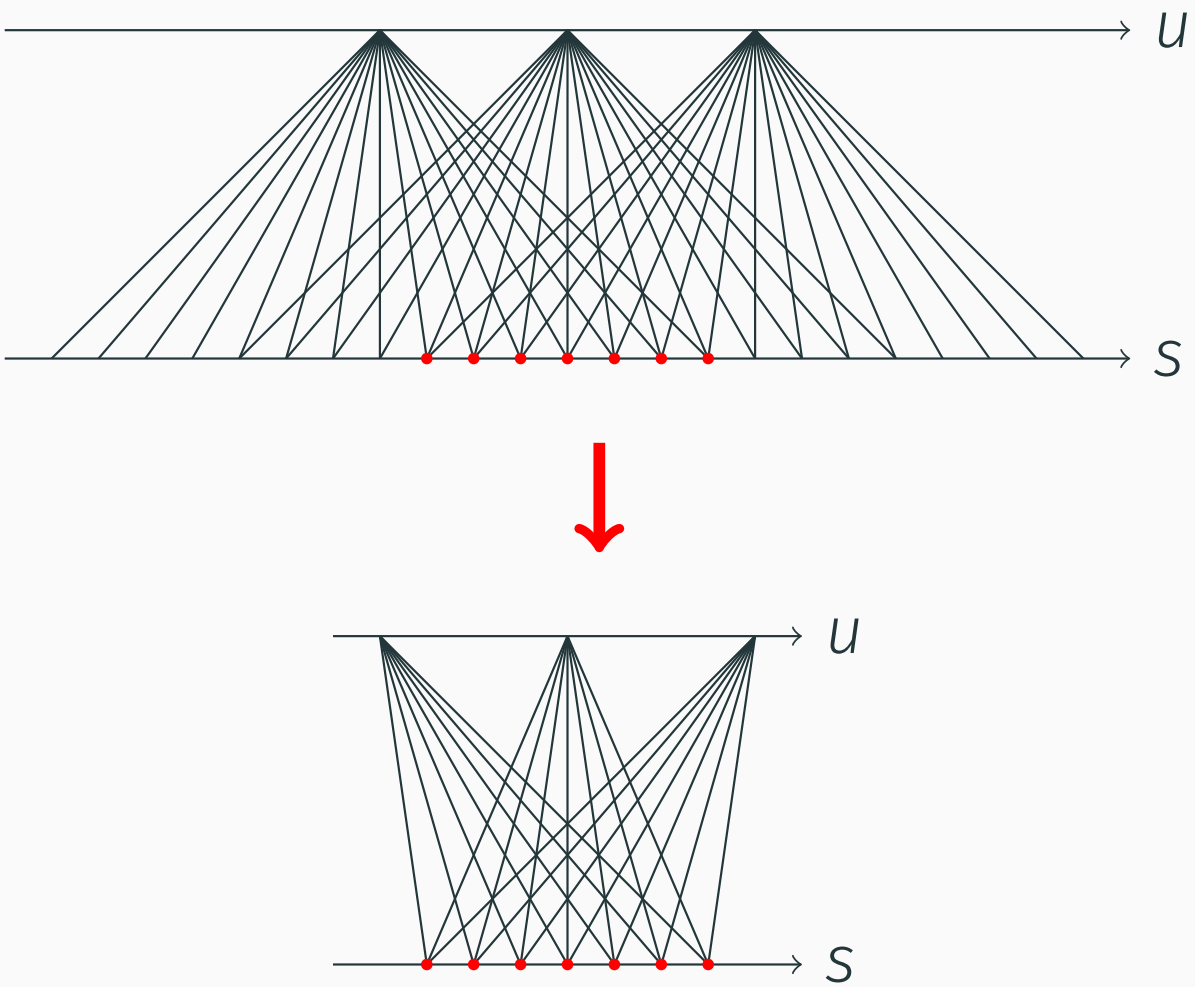
LIGHT FIELD ACQUISITION

- Camera array
- Gantry
- Plenoptic camera

PARAMETERIZATION



PARAMETERIZATION



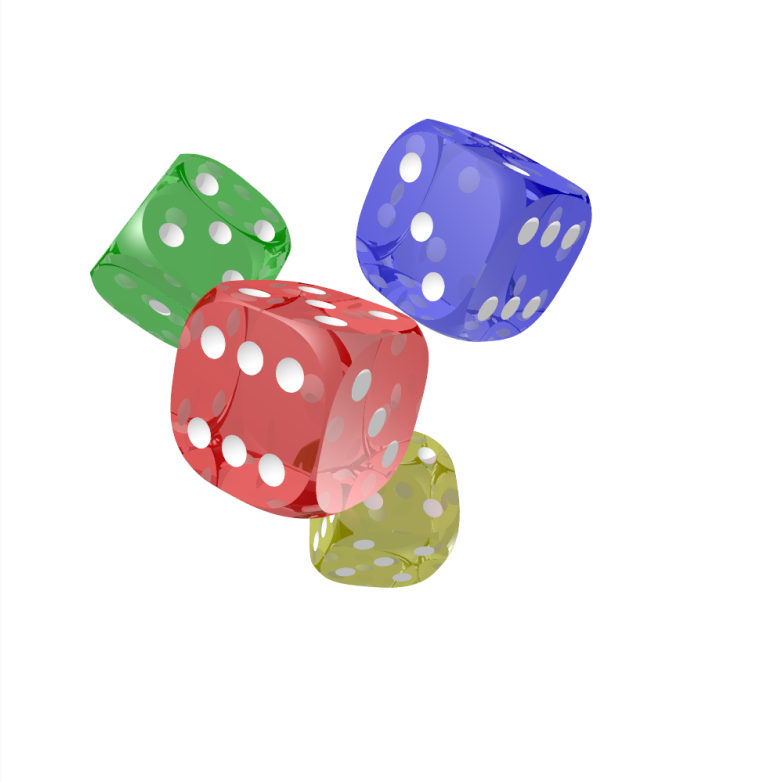
PARAMETERIZATION

Raw

Rectified

PARAMETERIZATION

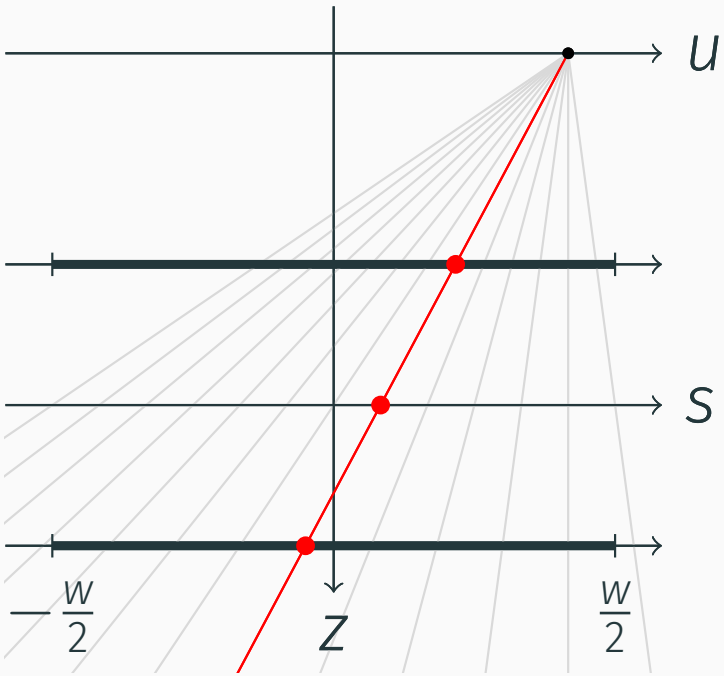
Raw



Rectified

PROBLEM STATEMENT

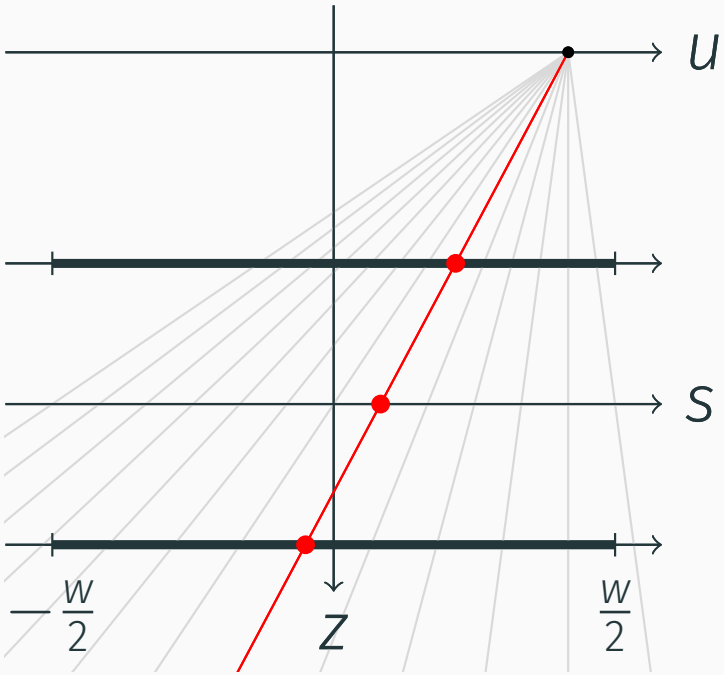
LIGHT TRANSMISSION



$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

L_m Color of ray m

LIGHT TRANSMISSION

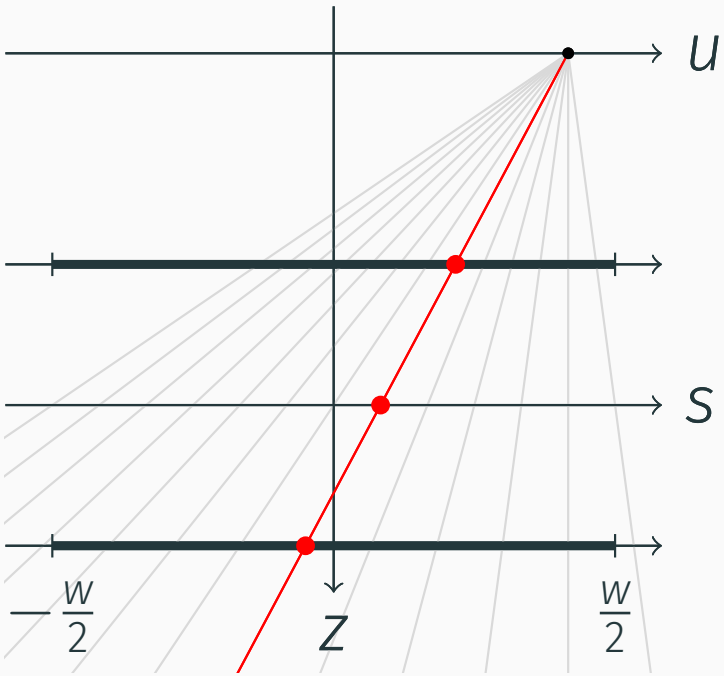


$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

L_m Color of ray m

t Transmission

LIGHT TRANSMISSION



$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

L_m Color of ray m

t Transmission

h Intersection

LIGHT TRANSMISSION

- Hard to solve directly

$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

LIGHT TRANSMISSION

- Hard to solve directly
- Transform to log-domain

$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

$$\downarrow \quad t = e^{-a}$$

$$\bar{L}_m = \bar{L}_0 - \sum_{n=1}^{N} a^{(n)}(h(m,n))$$

LIGHT TRANSMISSION

- Hard to solve directly
- Transform to log-domain
- Solve for absorbance

$$L_m = L_0 \prod_{n=1}^{N} t^{(n)}(h(m,n))$$

$$\downarrow \quad t = e^{-a}$$

$$\bar{L}_m = \bar{L}_0 - \sum_{n=1}^{N} a^{(n)}(h(m,n))$$

LIGHT ABSORBANCE

$$\bar{L}_m = \bar{L}_0 - \sum_{n=1}^{N} a^{(n)}(h(m,n))$$

LIGHT ABSORBANCE

$$\bar{L}_m = \bar{L}_0 - \sum_{n=1}^{N} a^{(n)}(h(m,n))$$

$$\downarrow \quad L_0 = 1$$

$$\bar{L}_m = -\sum_{n=1}^{N} a^{(n)}(h(m,n))$$

RAY CASTING

- One linear constraint per ray

$$\bar{L}_m = -\sum_{n=1}^{N} a^{(n)}(h(m,n))$$

RAY CASTING

- One linear constraint per ray
- Create a big matrix P

$$\bar{L}_m = -\sum_{n=1}^{N} a^{(n)}(h(m,n))$$

RAY CASTING

- One linear constraint per ray
- Create a big matrix P
- Matrix encodes intersections

$$\bar{L}_m = -\sum_{n=1}^{N} a^{(n)}(h(m,n))$$

RAY CASTING

$$
P = \begin{array}{c} \\ \bar{L}_1 \\ \bar{L}_2 \\ \bar{L}_3 \\ \bar{L}_4 \\ \bar{L}_5 \\ \bar{L}_6 \\ \bar{L}_7 \\ \bar{L}_8 \\ \bar{L}_9 \\ \bar{L}_{10} \\ \bar{L}_{11} \\ \bar{L}_{12} \end{array}
\begin{array}{c}
\begin{array}{cccccccccc}
\alpha_1 & \alpha_2 & \alpha_3 & \alpha_4 & \alpha_5 & \alpha_6 & \alpha_7 & \alpha_8 & \alpha_9 & \alpha_{10}
\end{array} \\
\left(\begin{array}{cccccc|cccc}
 & & 1 & & & 1 & & & & \\
 & & & 1 & & 1 & & & & \\
1 & & & & & & 1 & & & \\
 & 1 & & & & & & & 1 & \\
\hline
 & & & & 1 & & & & 1 & \\
 & & 1 & & & 1 & & & & \\
1 & & & & & & & & 1 & \\
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 & 1 & & & & & 1 & & & \\
 & & & 1 & & & & 1 & & \\
 & & 1 & & & & & & 1 & \\
 & 1 & & & & & & & 1 &
\end{array}\right)
\end{array}
$$

OPTIMIZATION PROBLEM

$$\begin{aligned} \underset{\alpha}{\text{argmin}} \quad & \left\| P\alpha + \bar{L} \right\|^2 \\ \text{subject to} \quad & \alpha \geq 0. \end{aligned}$$

RESULTS

ASSESSMENT

CONCLUSION

MTHEME

The *mtheme* is a Beamer theme with minimal visual noise inspired by the HSRM Beamer Theme by Benjamin Weiss.

Enable the theme by loading

```
\documentclass{beamer}
\usetheme{m}
```

Note, that you have to have Mozilla's *Fira Sans* font and XeTeX installed to enjoy this wonderful typography.

SECTIONS

Sections group slides of the same topic

```
\section{Elements}
```

for which the *mtheme* provides a nice progress indicator

...

TYPOGRAPHY

```
The theme provides sensible defaults to \emph{empha
text, \alert{accent} parts or show \textbf{bold} re
```

becomes

The theme provides sensible defaults to *emphasis* text, accent parts or show **bold** results.

LISTS

Items

- Milk
- Eggs
- Potatos

Enumerations

1. First,
2. Second and
3. Last.

DESCRIPTIONS

PowerPoint Meeh.

Beamer Yeeeha.

ANIMATION

- This is important

ANIMATION

- This is important
- Now this

ANIMATION

- This is important
- Now this
- And now this

ANIMATION

- This is really important
- Now this
- And now this

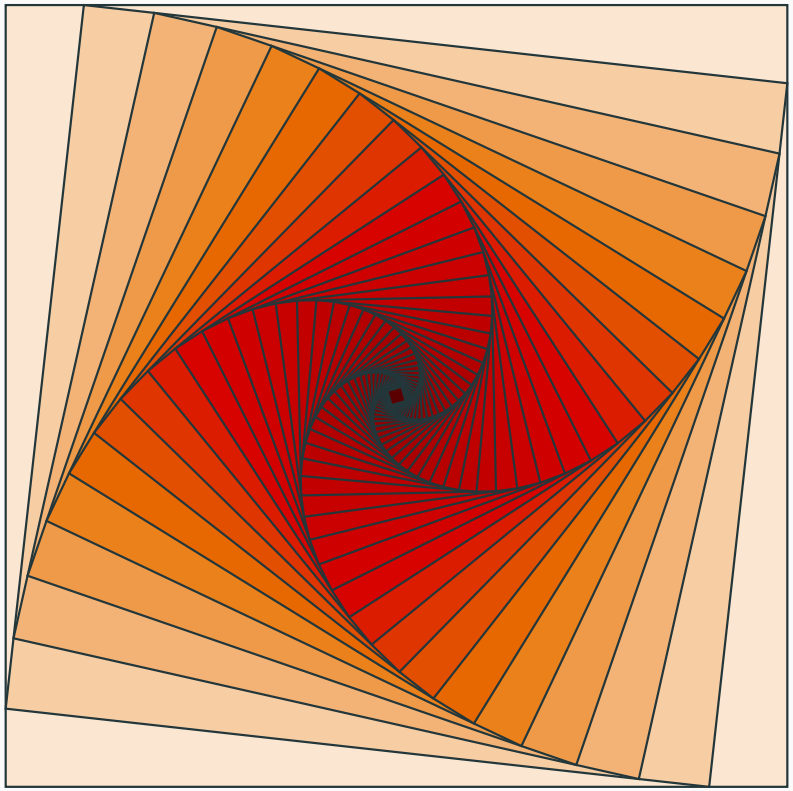

Figure: Rotated square from texample.net.

TABLES

Table: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

BLOCKS

This is a block title

This is soothing.

MATH

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

QUOTES

Veni, Vidi, Vici

plainDark background

SUMMARY

Get the source of this theme and the demo presentation from

`github.com/matze/mtheme`

plainQuestions?