Improving Subtitle Visibility in Low Budget Movies

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Introduction

Goal:
Develop a program in MATLAB that achieves visually pleasing viewing properties of a given subtitle and frame (picture) combination

Motivation:
Many foreign films may not have the budget to have individual people insert subtitles into the movie as this is a tedious task
What makes a subtitle have “poor” visibility?
Variables we consider

- Location
- Shadow
- Color

– What is the color of the subtitles will maximize discriminability between the text and the information on the frame below it?
Subtitle location

• Subtitle's left most location was calculated as:
  $x_{pos} = 0.9 \times im\_Length$

• Top most position was calculated as:
  $y_{pos} = \frac{im\_Width/2 - text\_Width/2}{2}$

• We selected this to replicate the style in most commercial subtitles
Subtitle location

**Challenges**

- Subtitle may be too long
- Image from movie unusually small

**Solutions**

- Inserted function to break up particularly long subtitles into two lines on the same frame
- Allow desired font size to be an input to the program, default 16
Subtitle shadow

Motivation

- Most commercial subtitles have outlines, shadow, and the option for a background box for the text
- Choices will affect readability

Implementation

- Made a black shadow around the text
- Darkened all the pixels in the box containing the caption
Subtitle color

• Program selects subtitle color that maximizes the average Delta E difference between text and other pixels in the textbox
• Motivation is that higher Delta E differences correspond to increased discriminability

Does increased discriminability = increased readability?
Subtitle color

**Challenges**
- Cannot meaningfully compare Delta E differences if using text of entirely different colors
- Computationally very intensive to select color shade that maximizes Delta E

**Solutions**
- Restricted ourselves to comparing Delta E differences using subtitles with shades of gray
- Luckily, nearly always, bright white text maximizes Delta E difference
Results

Color video

Black and white video

I was in the army.

I'm appointed to defend Tom Robinson.
Cases where brightest white is not optimal

1. White text with shadow
2. Optimal color with shadow
3. Optimal color without shadow
Cases where brightest white is not optimal
Text Luminance vs. Average Delta E difference between text and other pixels curve is not always linear
Black and white video case

Graph: Text Luminance vs. Average Delta E Difference Between Text and Other Pixels in the Textbox

Image: "I'm appointed to defend Tom Robinson."
Survey data on readability

Asked participants to rate on scale of 1-5 (5 as best) how visible the subtitles were:

- Average rating of 3.85, stdv of .75
- No statistically significant difference between five videos used (including black and white video)
Does increased discriminability = increased visibility?

Asked participants to rank the three images:
1) white subtitle (not optimal)
2) optimal color subtitle (with shadow)
3) optimal color subtitle (without shadow)
Let’s see the images again

1. White text with shadow
2. Optimal color with shadow
3. Optimal color without shadow
Conclusions

• Strong preference among participants in following order:
  – Optimal color subtitle without shadow
  – White subtitle with shadow
  – Optimal color subtitle without shadow
• Delta E is a valuable metric
• Subjective factors cannot be ignored
Possible extensions

• Optimize shadow as well
• Write program using faster language or using faster workstations to make program practical for longer clips
• Select position of subtitle that maximizes average Delta E difference
• Different shades of gray within the caption of a single frame as background varies within a given frame
References

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http://screenfont.ca/learn/
http://www.ofcom.org.uk/static/archive/itc/itc_publications/codes_guidance/standards_for_subtitling/subtitling_1.asp.html
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