

# EE 367 Project Proposal

Kathleen Feng, Daniel Stanley

12 February 2020

For the final project, we want to combine two established techniques of text deblurring and flutter shutter to enhance images of text.

## 1 Motivation

The following scene from *National Treasure: Book of Secrets*, in which Nicholas Cage uses a traffic cam to take an image of a wooden plank with secret writing, shows the need for high quality motion deblurring of text: [https://youtu.be/PbaKSNN0G\\_w?t=112](https://youtu.be/PbaKSNN0G_w?t=112).

Additionally, motion blur is common in handheld cellphone photos, especially if they are taken from moving vehicles, like trains and subways. People often take pictures of signs and maps containing text, both for their own keepsake and for applications like text-to-speech for the visually impaired. Being able to extract clear photos of text are helpful for relaying information to all.

## 2 Related Work

Flutter shutter [1] is a technique for deblurring images due to motion. Instead of being open for the entire exposure image, the shutter “flutters” nonuniformly between open and closed, resulting in an image with a “coded blur.” From there, the point spread function can be used to deblur the image using traditional methods, such as deconvolution and linear methods. Further work [2] extends flutter-shutter to include super-resolution and enhances the image size using linear methods, showing that other imaging techniques can be combined with flutter-shutter.

Much work has been done to achieve high-resolution text images from low-resolution or blurry inputs. Mancas-Thillou and Mirmehdi [3] give an overview of existing techniques focusing on superresolution. Many of the discussion points on deblurring algorithms (Maximum Likelihood, IBP, POCS, MAP) and the use of priors (Tikhonov, TV) are relevant to flutter shutter tasks as well as superresolution. More advanced priors exist as well, such as a Markov Random Field informed by example images [4]. Even without the Markov model the idea of searching a set of generated blurred/sharp image pairs for matching shapes is applicable to flutter shutter images with a complicated point-spread function.

## 3 Project Overview

We want to combine two established techniques of text deblurring and flutter shutter to enhance images of text. Focusing on text allows us to use a very specific prior since we know the region is broken into regions of solid color with well-defined boundaries. Both techniques are impressive separately, and we are curious to see how much improvement we can get by combining them. We

particularly interested in seeing whether flutter shutter gives a significant increase in image quality and text readability, given that text presents a simpler scene than typical real-world scenes.

## 4 Milestones: Timelines and Goals

1. Read papers to decide on which priors to use for text deblurring
2. Acquire or simulate flutter shuttered images (we would like recommendations on the best approach for this)
3. Implement text deblurring with priors using motion-blurred images
4. Implement flutter shutter motion deblurring with no text-specific priors
5. Combine flutter shutter deblurring with text priors
6. Compare text clarity of 4 approaches:
  - (a) Regular deconvolution
  - (b) With flutter shutter deblur, without text prior
  - (c) Without flutter shutter deblur, with text prior
  - (d) With flutter shutter deblur, with text prior
7. Bonus: capture flutter shuttered images using a real camera

## References

- [1] R. Raskar, A. Agrawal, and J. Tumblin, “Coded exposure photography: Motion deblurring using fluttered shutter,” *ACM Trans. Graph.*, vol. 25, p. 795–804, July 2006.
- [2] A. Agrawal and R. Raskar, “Resolving objects at higher resolution from a single motion-blurred image,” in *2007 IEEE Conference on Computer Vision and Pattern Recognition*, pp. 1–8, June 2007.
- [3] C. Mancas-Thillou and M. Mirmehdi, *An Introduction to Super-Resolution Text*, pp. 305–327. London: Springer London, 2007.
- [4] Jangkyun Park, Younghee Kwon, and Jin Hyung Kim, “An example-based prior model for text image super-resolution,” in *Eighth International Conference on Document Analysis and Recognition (ICDAR’05)*, pp. 374–378 Vol. 1, Aug 2005.