

# Deskewing of Underwater Images

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# Outline

- Why are underwater images deformed?
- How to remove the deformation, is it even possible?
- How to translate our problem into one that already has a solution?
- How to apply that solution to our transformed problem?
- How well does it work?
- Can we improve?

# Image Formation in Still Water

- How is an image formed when capturing a scene through a still water surface?

# Skew in UCW

- What if the water surface is dynamic?
- How does the image formation process change?

# Motion Blur in UCW

- What if the wave changes during camera exposure?

# Epiphany

- We have to remove both skew and motion blur, 2 variables
- Can we simplify this problem, 1 variable?

# Skew Removal

- What can we change about the image formation process to remove skew and leave only blurring?

# Image Blurring

- How is an image blurred?

# Deblurring

- How do we reverse the blurring process?

# Blind-Deblurring

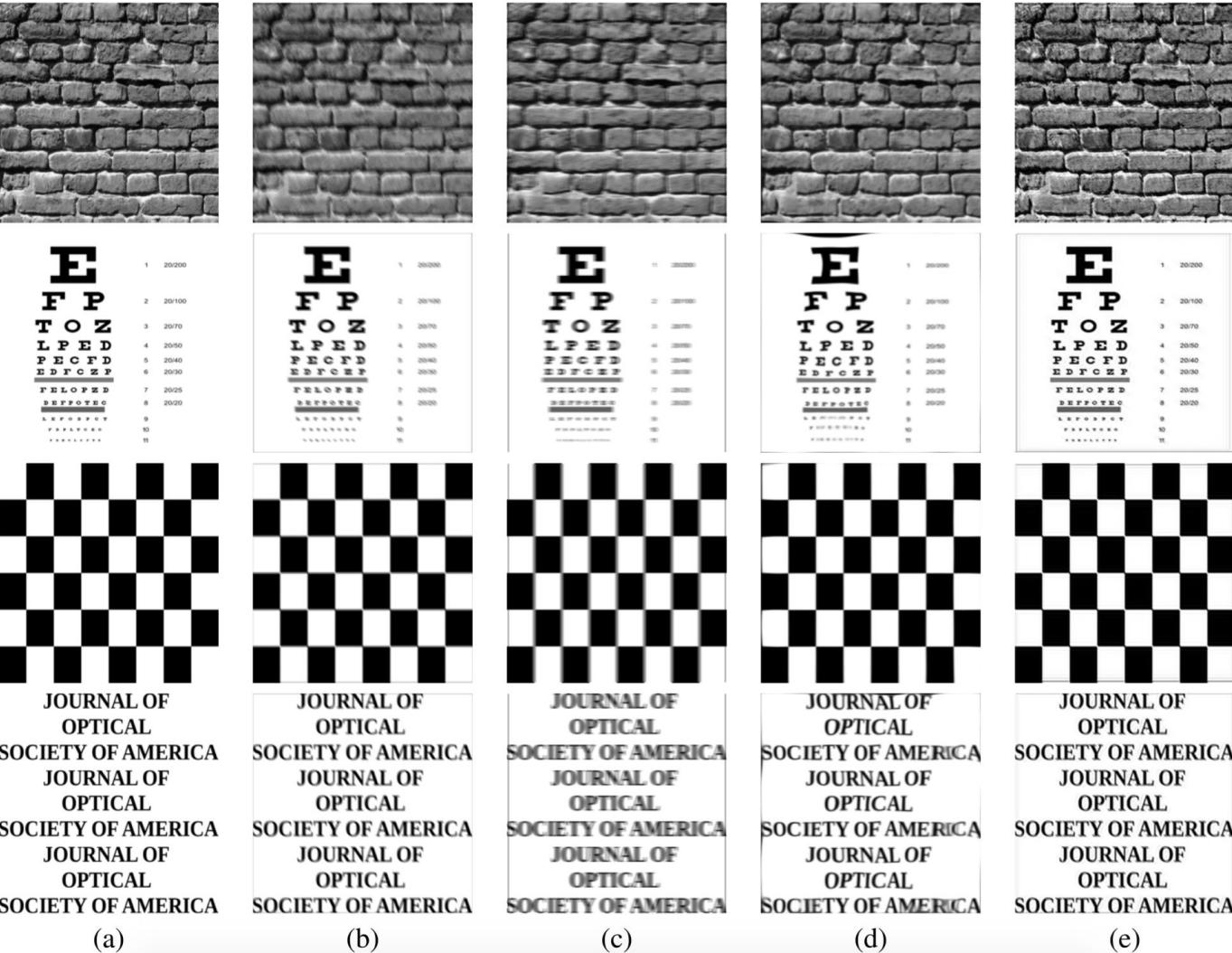
- What if we do not know how the image was blurred?

# Deblurring for Circular Ripples

- Cannot apply space-invariant filter to image, need a space-varying filter
- How do we translate from space-varying to space-invariant?

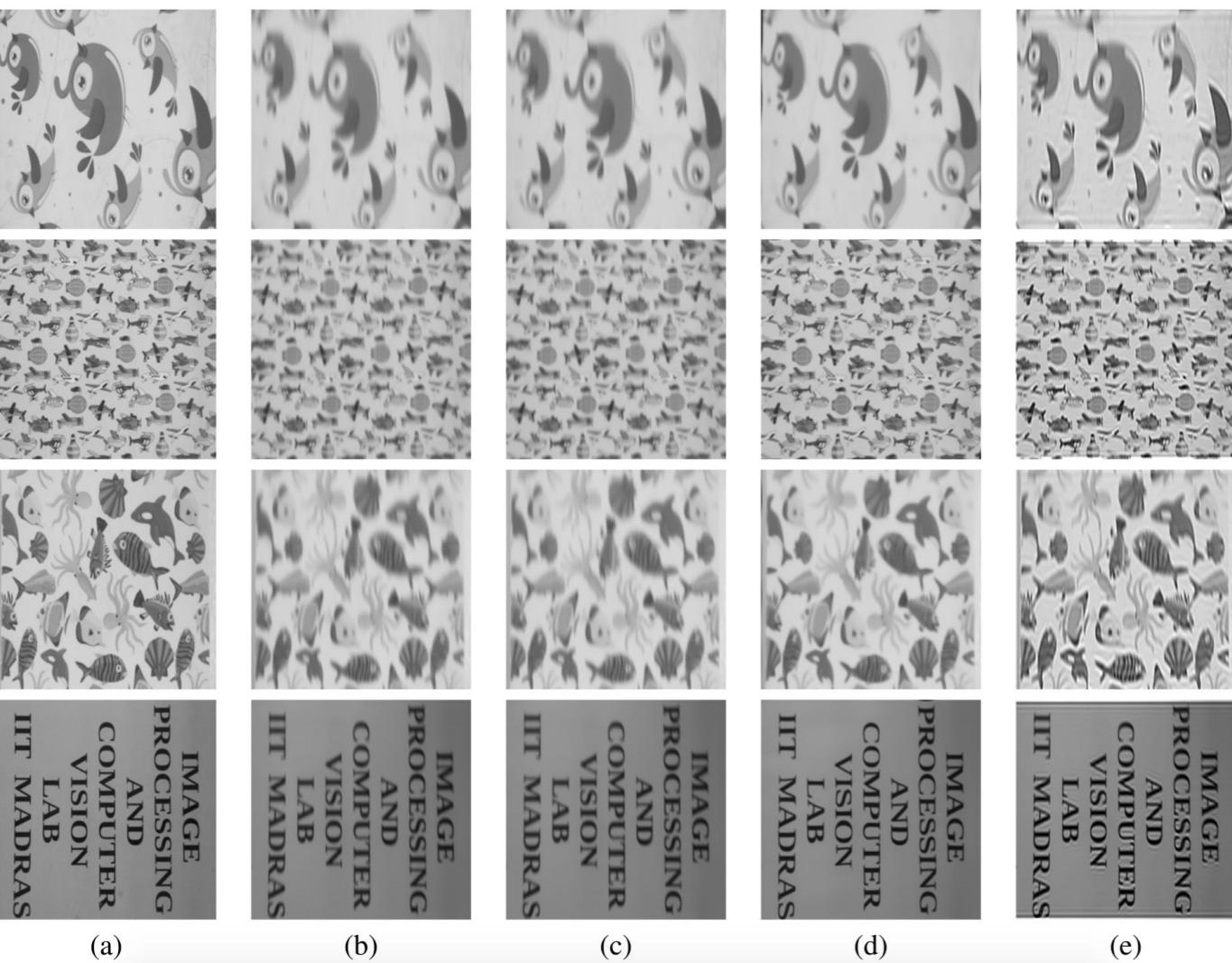
# Paper Results

Synthetic UCW



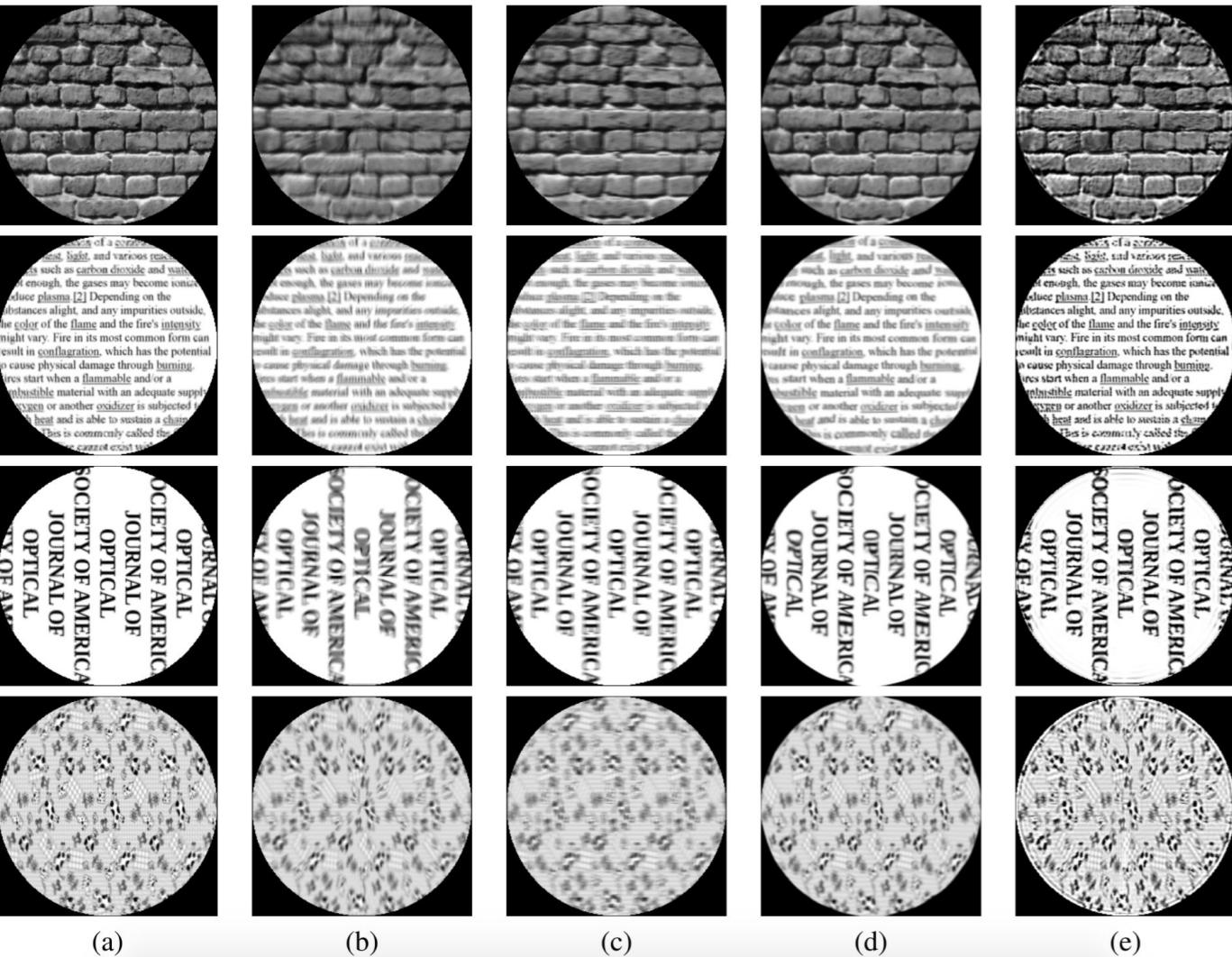
# Paper Results

Real UCW



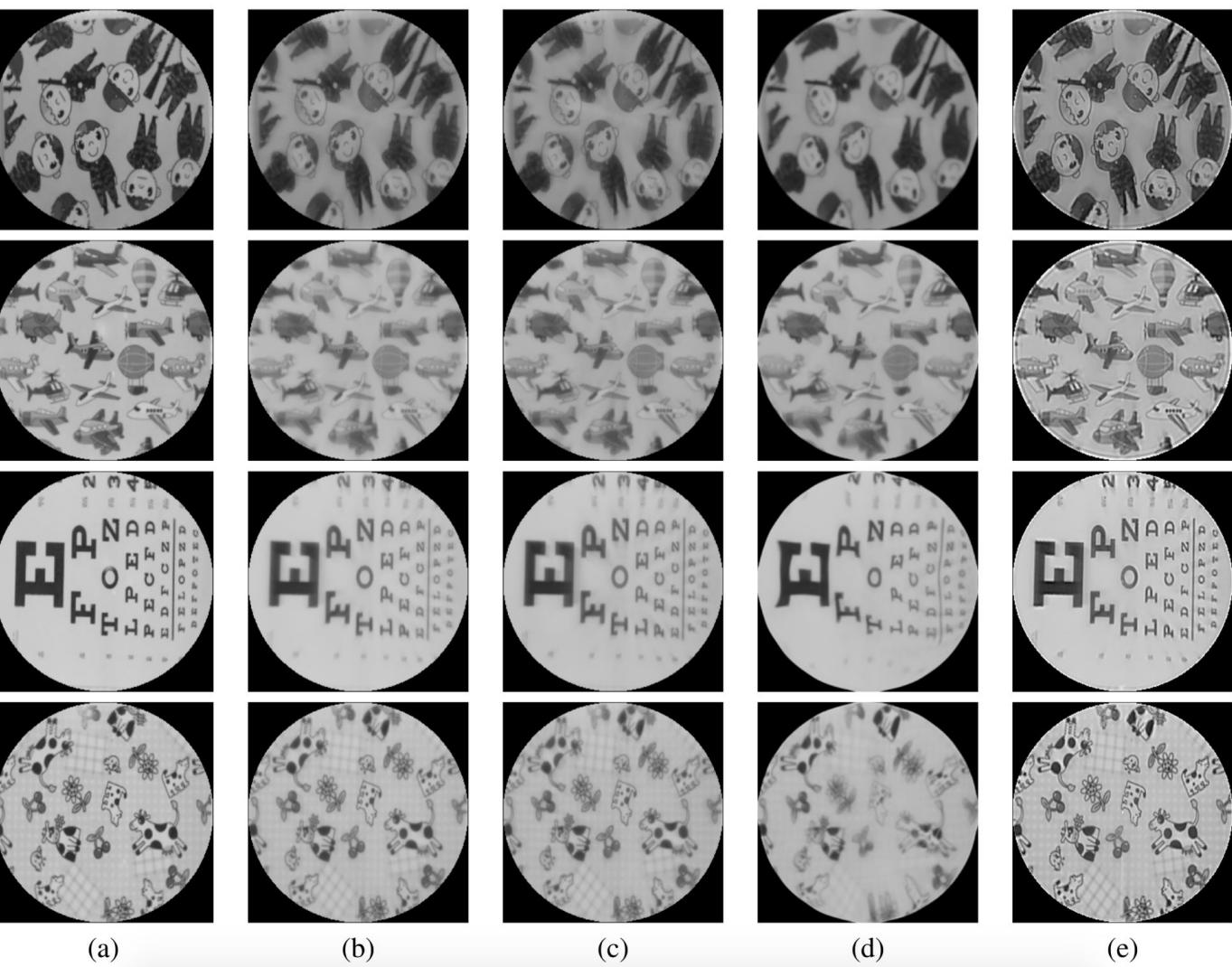
# Paper Results

## Synthetic Circular



# Paper Results

Real Circular



# My Results

Ground Truth



# My Results

1/60 sec exposure time

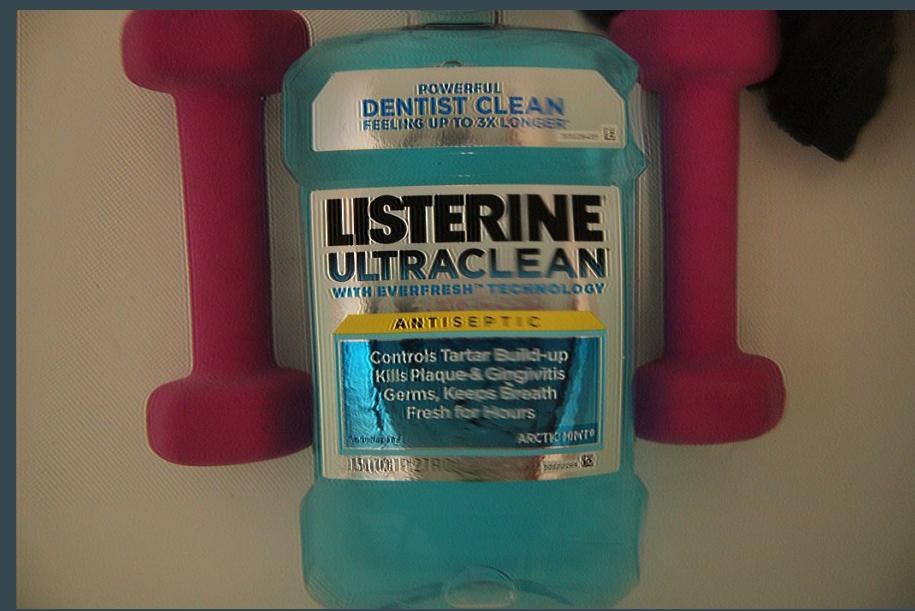
UCW



# My Results

1/60 sec exposure time

UCW



# My Results

1 sec exposure time

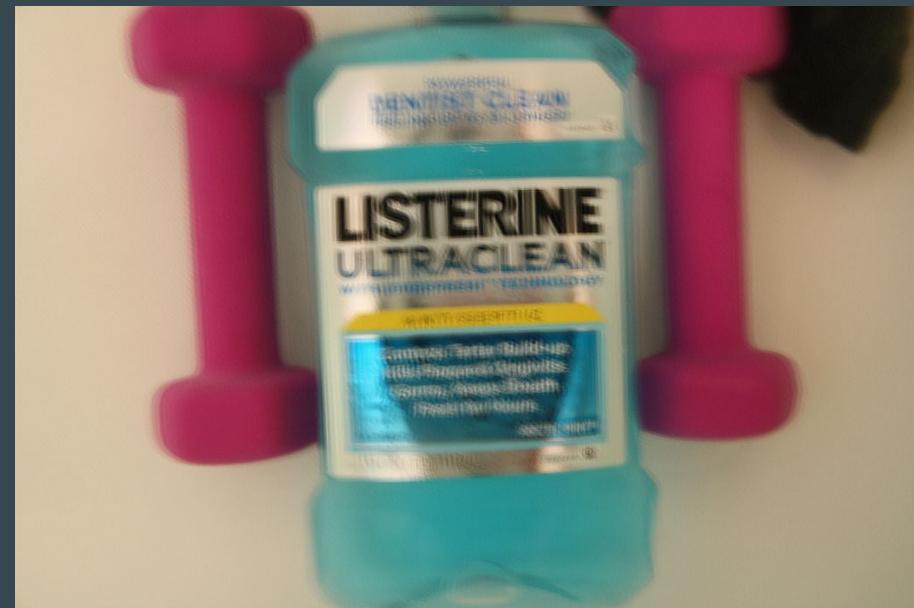
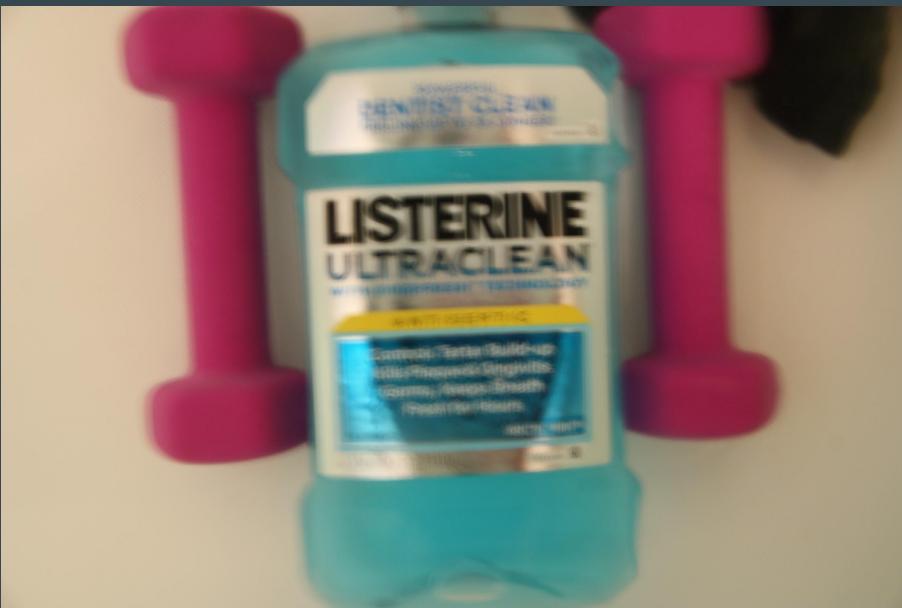
UCW



# My Results

1 sec exposure time

UCW



# My Results

2 sec exposure time

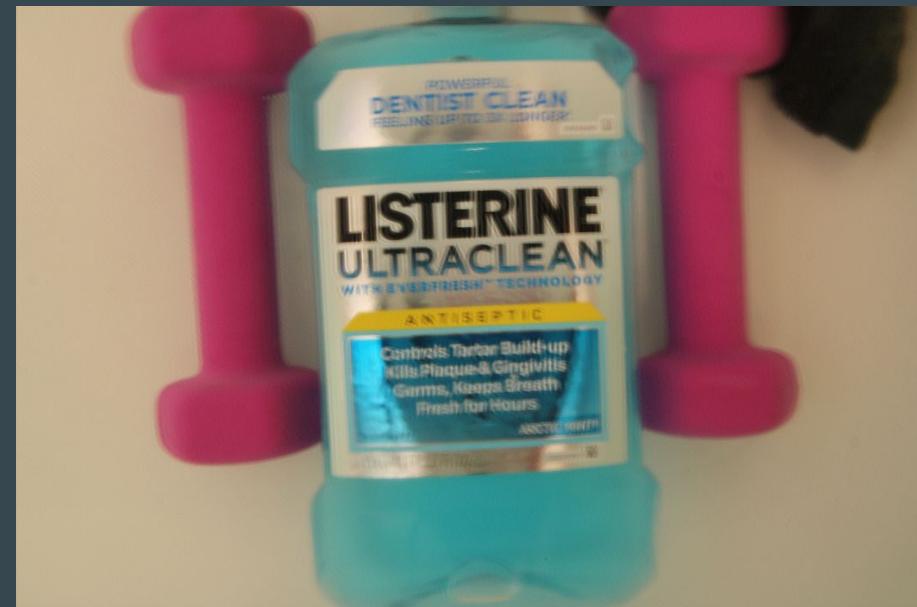
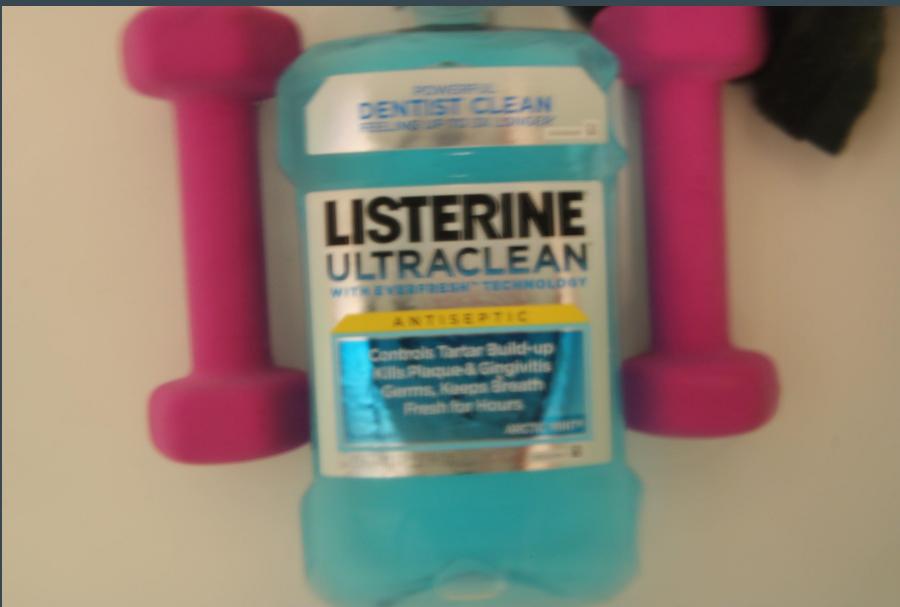
UCW



# My Results

2 sec exposure time

UCW



# My Results

1/60 sec exposure time

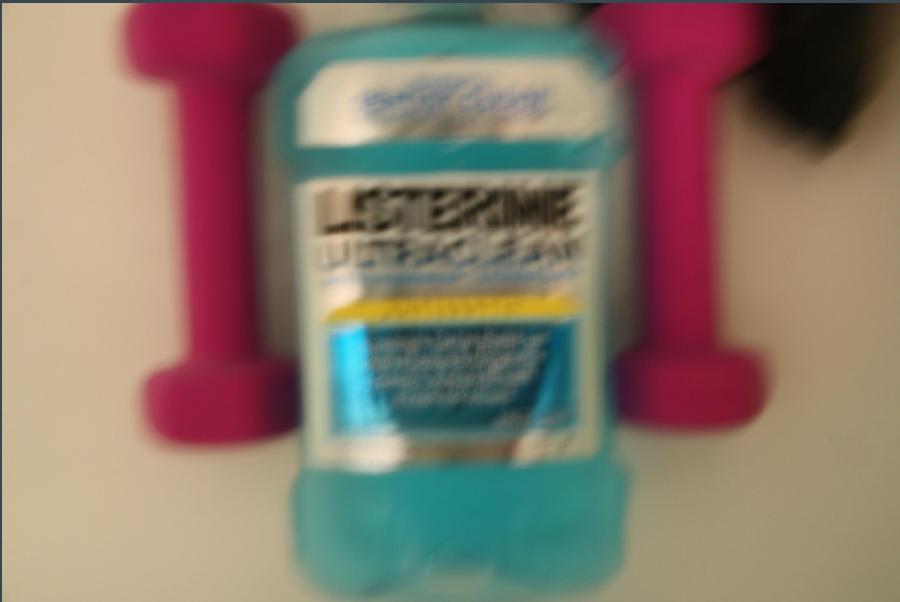
Circular Ripples



# My Results

2 sec exposure time

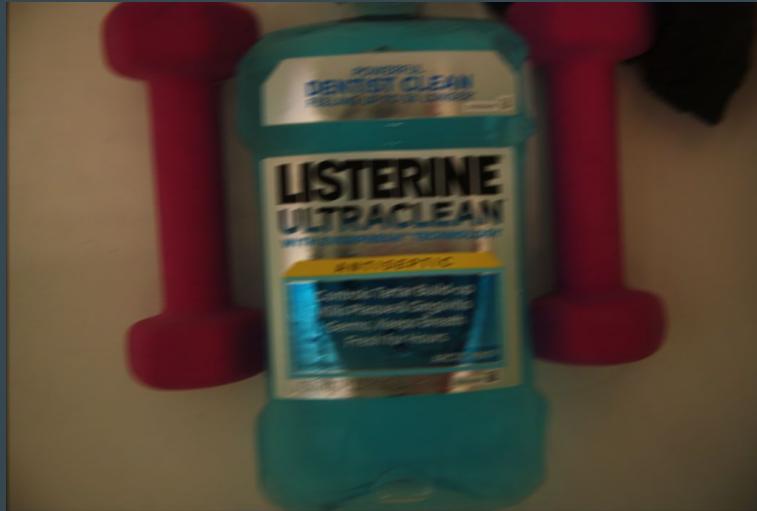
Circular Ripples



(a)



(b)



(c)



(a) Ground Truth

(b) Synthetic Motion Blur

(c) Deblurring

# My Results

- Why didn't it work?

# Modifications

- How can we improve on their solution?

# Conclusion

- Thank You