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MOTION BLUR

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Motion Blur

- Common artefact caused due to relative motion between camera and scene.
- Can make images look artistic, but more often then not, motion blur is undesirable.

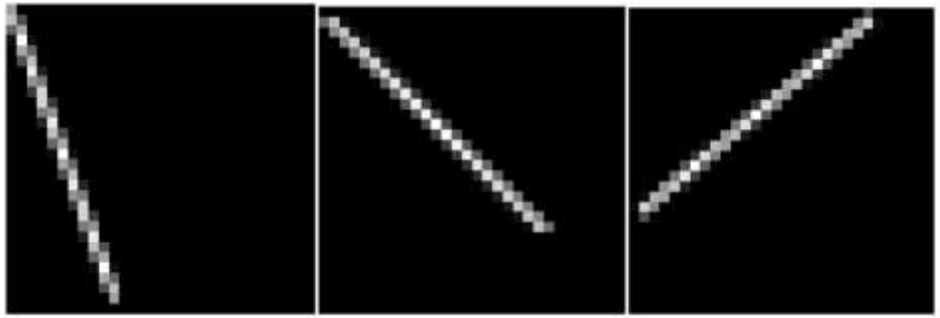
Removing Motion Blur

- Convolution- get blur image. Reverse convolution/deconvolution- get sharp image.
- Zero division and noise case in deconvolution like Inverse filter. Other algorithms to solve this- Lucy Richardson, Wiener filter, Regularised filter
- But PSF unknown most of the times/ deconvolution problem.

$$24 = 2 * 12$$
$$24 = 1 * 24$$
$$24 = 3 * 8$$
$$24 = 4 * 6$$

- Early research made prediction on PSF using prior statistical knowledge on image and kernel, but limited to use cases.
- Our research- linear motion blur. Parameters Length(L) and Angle(θ).

$$k(x,y) = \begin{cases} \frac{1}{L}, & \text{if } \frac{L}{2} \geq \sqrt{x^2+y^2} \text{ and } \theta = -\frac{x}{y} \\ 0, & \text{otherwise} \end{cases}$$



L=29, θ=110 L=26, θ=134 L=27, θ=41

- Our method finds PSF using the 2 dimensional Fourier transformation of blurred image.

$$F(u,v) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)e^{-j2\pi(ux+vy)}\,dx\,dy,$$
$$f(x,y) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} F(u,v)e^{j2\pi(ux+vy)}\,du\,dv$$

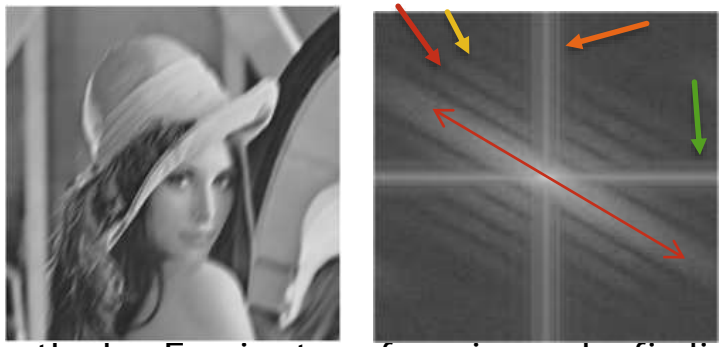
Proposed method

- Log spectrum or Log Fourier transformed image of blurred image. *V(x,y)* is FFT of blurred image.

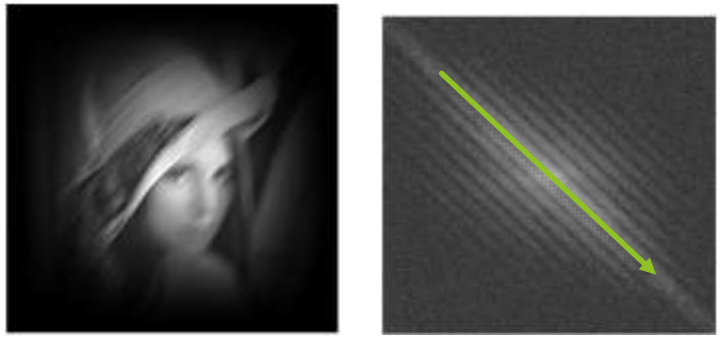
$$LS(x,y) = log(|V(x,y)|)$$

- Log FFT of sharp image

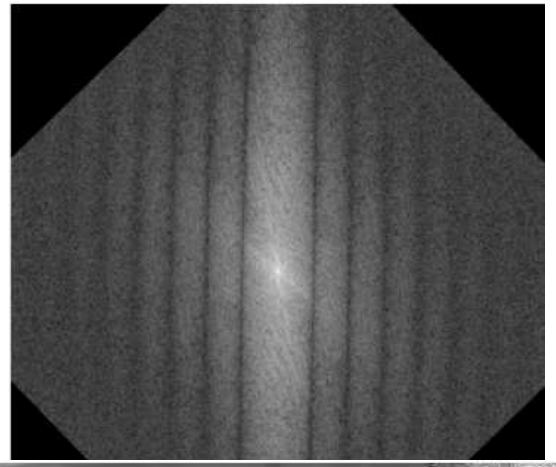
- Log FFT of blurred image

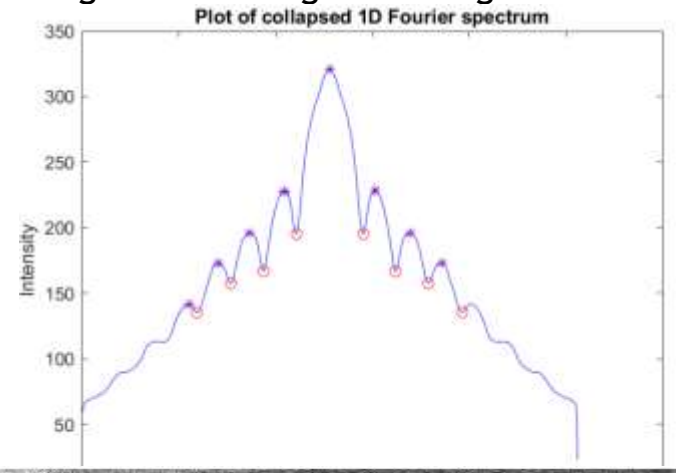


- Find angle parameter from the log Fourier transform image by finding the angle bright line makes with the vertical axis.



- Find length parameter after inversely rotating the log Fourier image with angle found.





Findings and Experiments

- Our method works even for low levels of blur unlike other studies based on linear motion blur.
- Average error in length prediction- 0.4 units, angle prediction- 1.1°.
- Additional experiments on deconvolution algorithm for motion blur case.

Algorithm	PSNR	SSIM	MSE
Lucy_Richardson	34.28	0.89	51.81
Regularisation	30.19	0.74	79.08
Blind	24.29	0.71	112.45
Wiener	11.2	0.06	2548.15

- Effect of errors in parameters calculation.

Error in predicted length	Percent change in PSNR value
15	-37.75
10	-32.81
7	-25.98
5	-17.53
3	-12.56
2	-6.94
1	-1.62

Error in predicted angle in degrees	Percent change in PSNR value
-70	-35.24
-50	-28.13
-30	-21.56
-20	-16.37
-10	-7.58
-5	-3.02
-3	-1.14
-2	-0.67
-1	-0.13

Conclusion

- Research ongoing on Deep Learning methods combined with traditional methods.
- Linear motion blur most common and our research interest.
- Our method estimates Length parameter accurately.
- Lucy Richardson algorithm best for motion blur deconvolution.
- Predicting exact length parameter important than predicting angle parameter for deconvolution.