

# MA3113: Topics in Mathematical Image Processing I

## Syllabus and Introduction



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# Syllabus

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- **Instructor:** Prof. Suh-Yuh Yang (楊肅煜)  
Office: M315, Hong-Jing Hall  
Phone: 03-4227151 ext. 65130
- **Office hours:** Tuesday 10:00 ~ 12:00 am or by appointment.
- **No teaching assistant**
- **Prerequisites:** MA3111 and some knowledge of MATLAB:  
<https://portal.ncu.edu.tw/>
- **Grading policy:** *oral presentations (20%) × 3, poster of project results (20%), and others (20%).*

## Course objective

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This is a companion course of the “MA3111: Mathematical Image Processing.”

- (1) We will continue to introduce advanced mathematical techniques for image processing.
- (2) This course emphasizes practical implementation and computer simulations.
- (3) In addition, every student must complete a research project on image processing and make several presentations.

## References

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No textbook, but we will provide some slides and journal papers.  
Below are some references:

- (1) [AK2002] G. Aubert and P. Kornprobst, *Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations, Second Edition*, Springer Verlag, New York, 2002.
- (2) [CS2005] T. F. Chan and J. Shen, *Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods*, Society for Industrial and Applied Mathematics, Philadelphia, 2005.
- (3) [TUM2019] D. Cremers, *Computer Vision I: Variational Methods, Online Resources*, Departments of Informatics & Mathematics, Technical University of Munich, Germany, 2019/2020.  
<https://vision.in.tum.de/teaching/online/cvwm>
- (4) [GW2018] R. C. Gonzalez and R. E. Woods, *Digital Image Processing, Fourth Edition*, Pearson Education Limited, New York, 2018.

## Important dates

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- The period for adding and dropping a course: 2/20-3/10, 2026
- The period for withdrawing a course: 4/7-5/15, 2026
- 1st oral presentation: March 24-25, 2026 (5th week)
- 2nd oral presentation: May 5-6, 2026 (11th week)
- 3rd oral presentation: June 9-10, 2026 (16th week)
- Turn in the poster of the project result: June 17, 2026 (17th week)

## This course will cover the following topics

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- (1) Advanced PDE and variational methods for image processing
- (2) Advanced optimization methods for image processing
- (3) Principal component pursuit theory with applications to image processing

Below, we glance at some topics we have learned (or not yet) in  
“MA3111: Mathematical Image Processing.”

# Image denoising

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original



noisy



ROF model



adaptive

## Image deblurring

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original



blurry



blurry & noisy



deblurring

# Image fusion

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source1



source2



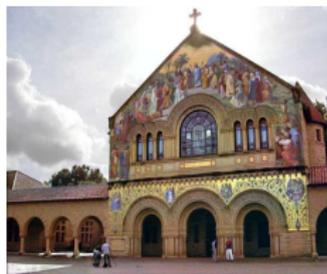
LSDGF1



LSDGF2

# Image contrast enhancement

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low-light images

contrast enhanced

# Image inpainting

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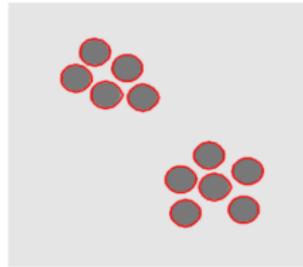


corrupted

inpainted

## Image segmentation (level set function)

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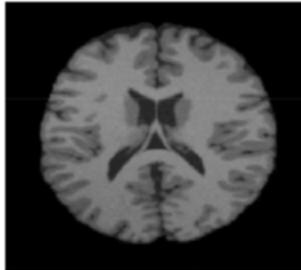
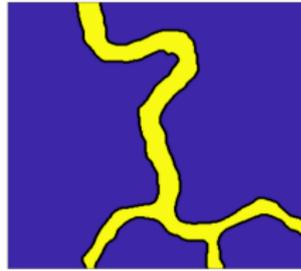
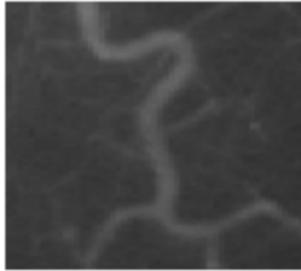


input

segmented

# Medical image segmentation (characteristic function)

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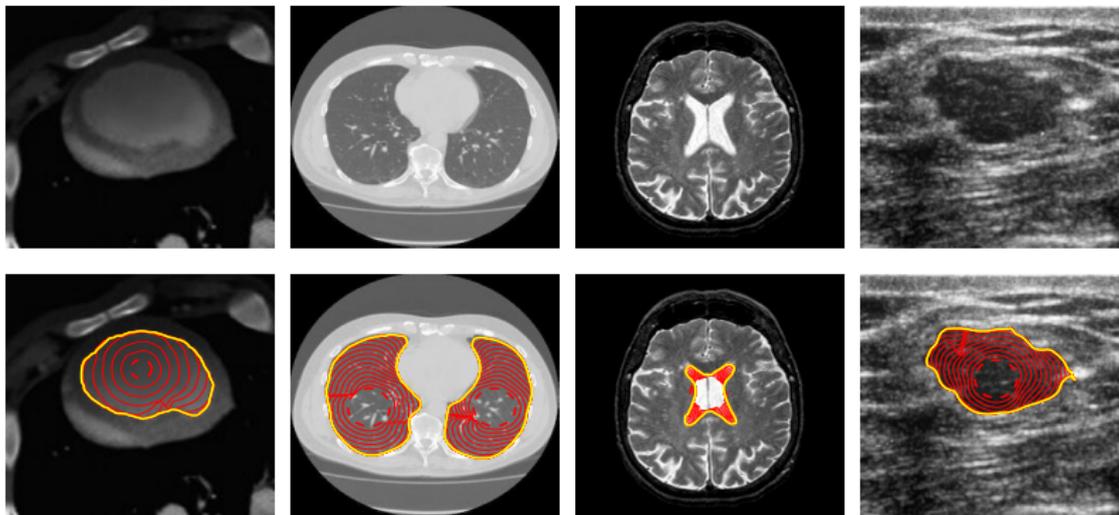


input

segmented

## Medical image segmentation (snake method)

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(1st row) Human's cardiac CT, human's lung CT, brain CT, and ultrasound images

(2nd row) Deformation processes by AeGVF

# Image dehazing

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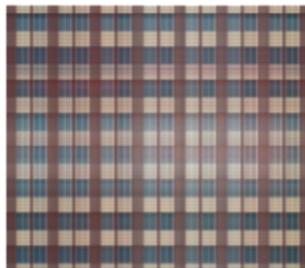


input

dehazed

# Background recovering (principal component pursuit)

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input

recovered