

E1.216 COMPUTER VISION

LECTURE 01: INTRODUCTION

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Department of Electrical Engineering
Indian Institute of Science, Bengaluru

2024

No Cell Phones in Class



No ringing phones, no messaging!

El.216: Computer Vision (3:1)

<http://ee.iisc.ac.in/~venu>

Instructor:

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Teaching Assistant:

Lalit Manam

Email: lalitmanam@iisc.ac.in

Pre-requisites and logistics

- Familiarity with linear algebra and probability theory
- Signal and Image Processing
- Class Hours: Monday and Wednesday 2-4pm (B-306, EE)
- Make use of course webpage
- Undergraduates: need explicit permission

Grading Policy

- Homeworks, no submission (0%)
- Class Test 20%
- 4 surprise tests ($4 \times 10\%$)
- Final Exam 40%

Subject to minor changes

- Exam+test policy: no electronic devices
- **ZERO TOLERANCE FOR UNETHICAL BEHAVIOUR**

Motivation

Of all the human senses, vision is the richest in content and perhaps the hardest to formalise in a rigorous manner. As a discipline, Computer Vision covers a wide variety of methods for interpretation and analysis of visual data using a computer. In this course we will present a broad, introductory survey of the field. The objective of the course is to develop a familiarity with the approaches to modelling and solving problems in computer vision. Mathematical modelling and algorithmic solutions for vision tasks will be emphasised.

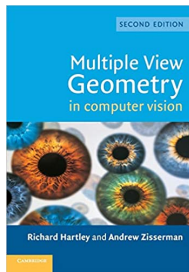
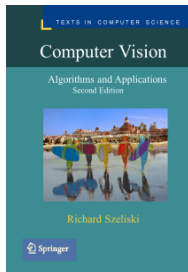
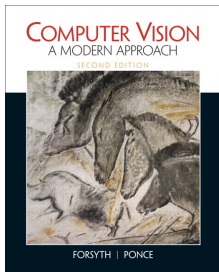
What is Computer Vision?

- Computer Vision \neq Image Processing
- Computer Vision \neq Deep Learning

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COMPUTER VISION



Objectives

- Images to understand physical world
- Functional replication of visual perception
- Develop suitable theory, models, algorithms
- Contexts
 - Image analysis in different domains
 - Recognition, scene interpretation, motion estimation, tracking, grouping etc.
 - 3D understanding of the world
- High-level reasoning is hard to define
- Low-level information processing is better understood
- Significant advances in understanding of geometry

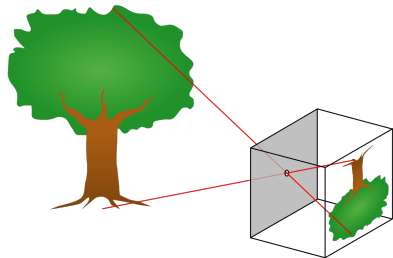
Contemporary scenario

- Massive volumes of data (cheap cameras, internet)
- Cheaper computational resources (GPUs)
- Statistical issues of increasing interest
- Huge advances in deep learning etc.
- Computer Vision goes mainstream
 - Real world impact
 - Developments + Hype
 - Serious social implications
 - Ethics, Fairness, Failures major considerations

- **Introduction**
- Camera Geometry
- Radiometry and Applications
- Image Features
- Robustness
- Geometric Transformations
- Image Segmentation
- Object Detection + Recognition
- Learning in Computer Vision
- Stereo and Depth Cameras
- Camera Calibration
- Geometry of Two Cameras
- The Shape of the World
- Optical Flow
- Ethics in Computer Vision

COMPUTER VISION

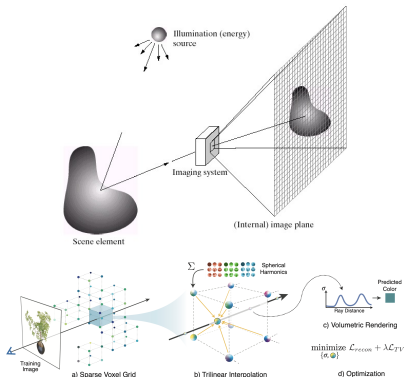
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wikipedia.org

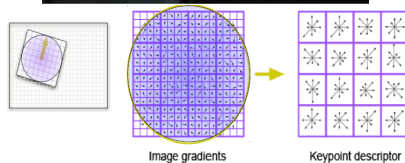
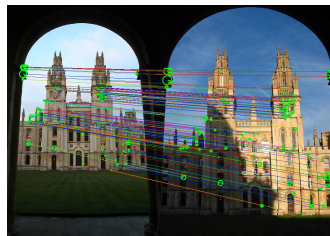
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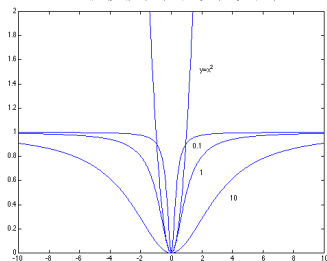
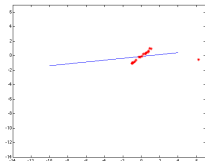
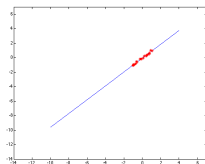
Alexei Efros; Plenoxels

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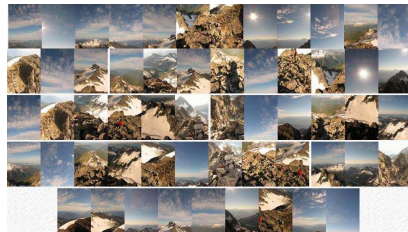
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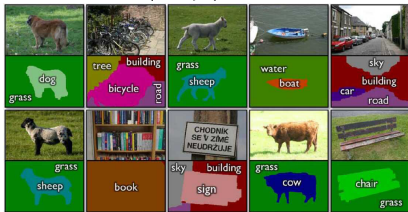
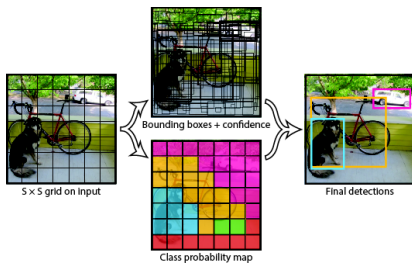
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Szeliski 1st and 2nd Editions

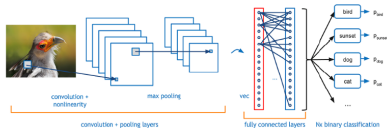
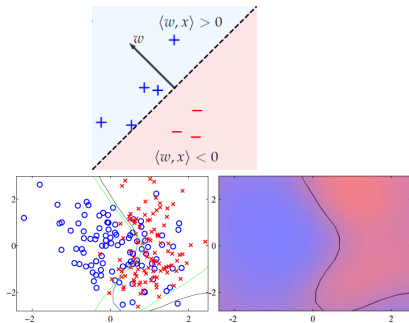
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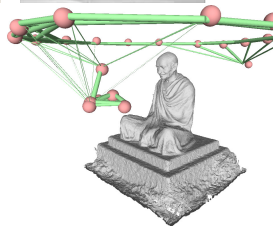
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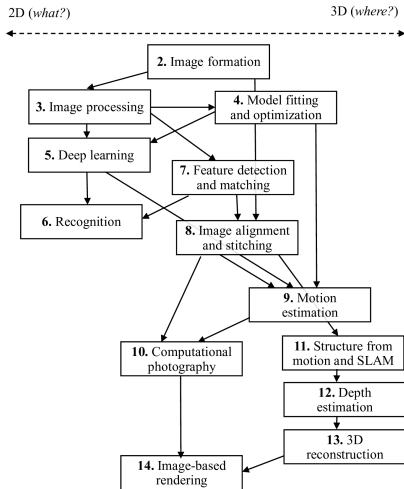
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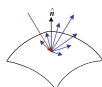
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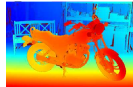
2. Image formation



5. Deep learning



9. Motion estimation



12. Depth estimation



3. Image processing



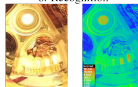
6. Recognition



4. Optimization



7-8. Features & alignment



10. Computational Photography



11. Structure from motion



13. 3D reconstruction



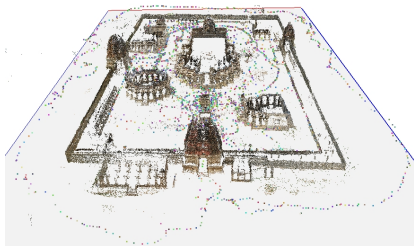
14. Image-based Rendering

Szeliski Second Edition

3D Reconstruction from Images

- Take lots of pictures
- We took around 2500 of them!
- Solve the *structure-from-motion* problem (invert image formation)
- And the result is . . .

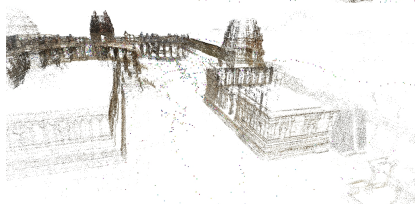
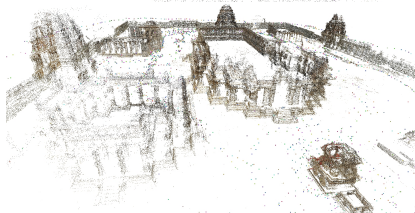
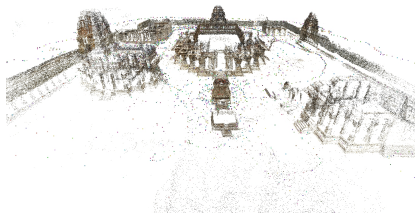
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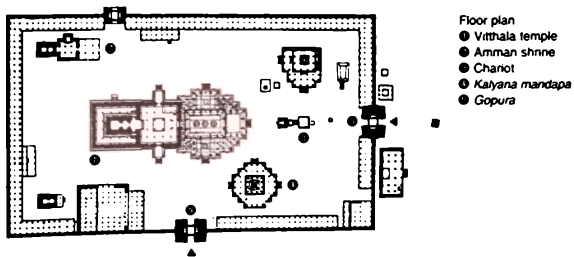
Vitthala Temple, Hampi

Rendering of our 3D model

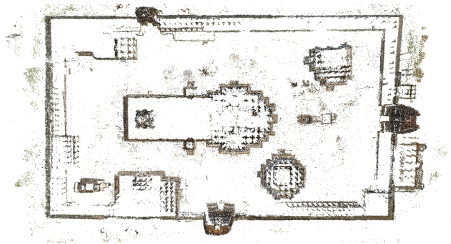


Vitthala Temple, Hampi

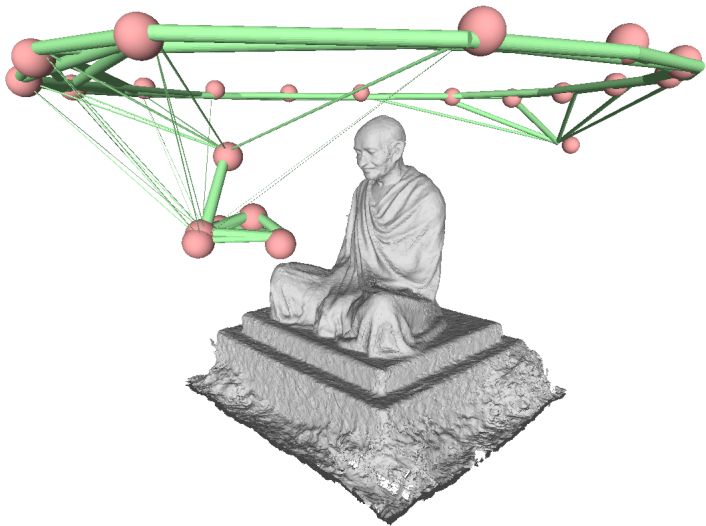
Comparison of Reconstruction



(a) Architectural Drawing



(b) Reconstruction



Mahatma Gandhi Statue @ Sabarmati Ashram