Computer and Machine Vision

Lecture Week 13
Part-2
Exam #2 - Review
Outline of Week 13

- Dense Motion Analysis
  - Review of Scalar / Tensor View of Images
  - Pixel Motion Vectors
  - Motion Vectors
  - Optical Flow

- Exam #2 Review
Exam #2 Review

Ch. 5 to 8 in CV
Ch. 9, 11 & 12 in Learning
OpenCV
CMV Supplemental Materials
CV Ch. 5

Segmentation

- Beyond Edge Finding, Determines Pixels Belonging to Distinct Objects in Scenes
  - E.g. Eye – Sclera, Iris, Pupil Boundaries
  - Skeletonization (Supplemental Material, not CV)

- Bounding Edges Can Define (Ignore Snakes), But Closed Circuits on Edges Define

- 3 Methods We Considered
  - Region Splitting (Foreground / Background)
  - Watershed
  - K-means Clustering
CV Ch. 6

Feature Alignment

- Stitching Images Together – Panorama or Mosaic
- RANSAC and Hough Lines
- Chessboard Calibration Methods for Distortions
- Vanishing Points
CV Ch. 7

Structure from Motion

- Concepts Only
- Point Cloud Concepts
- Computer Tomography Concepts
- Comparison to Depth Mappers – Passive and Active
Dense Motion Estimation

- Video Stabilization Concepts
- Motion Vectors – Frame to Frame Motion of Pixels, Macroblocks, Features
- Optical Flow – Relative Motion of Objects (Segmented) Between Observer and Scene
- Motion Blur Cause and Concept (Adds Camera Realism to Animation)
- Motion Compensation
E.R. Davies Supplemental Material on Machine Vision

Computer and Machine Vision
Blackboard Supplemental Postings
Connectedness Concepts
- 8-Connected Definition
- 4-Connected Definition

Object Labeling (p. 232-233)
- Original “A” space and Label “P” Space
  - Scan to Find and Object
  - Propagation to Label an Object
  - Resume Scan
- Algorithm in Table 9.1
- Complexity of Simple Scan Algorithm
- Concept of Single Scan and Co-Exist to Improve Efficiency

Distance Functions (Distance of Pixel from Background “0”)
- Ramp Scan Concept (p. 241 to 242) – recall 3x3 indexes on p. 26
- Horizontal and Vertical Ramp Scan
- Concept of Distance Image as Data Compression
Recall Binary Image Conventions

Definition of “Chi” – 9.2

– Basic Concept of Counting number of 0-to-1 transitions in Neighborhood
– Understand all Cases of Pixel Neighborhood and Identification of a Boundary Point
– Special Cases for Skeletal Points
– Modified to Handle Special Cases, Remove any Point with \( \text{Chi} = 2 \), \( \text{Chi} > 2 \) or \( \text{Chi} = 0 \) means point is skeletal
– Sigma is the sum of 8 neighbors and if \( \text{Sigma} = 1 \), point is skeletal
– See Chi on p. 248, 9.12
Centroidal Profile Shape Function
- Find Centroid (X-bar, Y-bar) with Scan of FG, BG
- Plot Distance of Each Boundary Pixel from Centroid in R, Theta Plot
- R, Theta Function is a Unique Signature for Shape
  - Useful for Defect Detection (Out of Expected Shape)
  - Useful for Sorting into Shape Classes

Occlusion Problems – Basic Concepts and Problems

S, Phi Alternative – Tangent Angle Phi as a Function of Boundary Distance S
- Sources of Error in this Method (e.g. estimation of S)
Learning OpenCV

Programming Concepts

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Learning OpenCV – Ch. 9

- Background Subtraction
- Watershed Algorithm
- Delaunay Triangulation and Voronoi Tessellation – Subdividing Images into Triangular Groups (Concepts Only)
Camera Calibration

- Focus on Concepts
- Need Transformation from Servo to Pixel Coordinates and Vice Versa
  - Characterize by Tilt/Pan of Field of View to Extremes of Total Scene FOV
  - Measure Target Pixel translation X, Y of ONE pixel if possible for small Tilt/Pan servo increment at Distance “d”
  - Compile LUT (Look-Up Table) of Transforms at each Distance “d” measured for 3D LUT
  - Use Linear Interpolation Between Locations
  - At a distance “d”, use LUT for tilt and for pan with interpolation
  - Can Use Bi-Linear or Tri-Linear Interpolation for tilt, pan, and distance

Radial Distortions

- Fish Eye (Barrel) – where bulge is in the middle
- Hour Glass (Pincushion) – where corners are over-extended
- Normally a Function of distance from camera to target of interest
- Non-linear curve fit or LUT to correct
Learning OpenCV – Ch. 12

- Stereo Imaging
- Structure from Motion