2-D and 3-D Image Registration

A. Goshtasby, G. Stockman, and K. Rohr

(4 hours)

Description

Image registration is the process of establishing point-by-point correspondence between two images of a scene. This process is needed in various computer vision applications, such as stereo depth perception, motion analysis, change detection, object localization, object recognition, and image fusion. This course will cover the basics of image registration, including feature selection, feature correspondence, and transformation functions. Techniques for both 2-D and 3-D (volumetric) images will be covered and examples of rigid and nonrigid registration using remote sensing, medical, and industrial images will be given.

Outline

Following is the course outline:

1. Introduction (10 minutes)
   To start, a few examples of image registration are given and the terminologies used in this area are introduced.

2. Feature Extraction (50 minutes)
   First, a brief summary of methods for the extraction of point landmarks, lines/curves, and surfaces/regions in 2-D as well as 3-D images is given. Then, the detection and localization of point landmarks is covered in detail, comprising differential and parametric schemes.

3. Feature Correspondence (50 minutes)
   In this segment of the tutorial, similarity measures such as the sum of absolute differences, cross-correlation, invariant moments, Euclidean distance, and mutual information are described and methods for determining the correspondence between features in two images are given. These methods include random sample consensus (RANSAC), clustering, energy minimization methods, and Hausdorff distance. Among these methods, the clustering method is covered in detail.

   Break (15 minutes)

4. Transformation Functions (60 minutes)
   Here, various transformation functions for image registration are reviewed. This includes similarity transformation, projective transformation, thin-plate splines, piecewise linear and cubic functions, approximation methods, and piecewise approximation methods. Examples comparing various transformation functions in nonrigid image registration are provided.
5. **Validation Methods (15 minutes)**

   Determination of the reliability, accuracy, and speed of image registration methods are discussed and examples are given.

6. **Summary and References (10 minutes)**

   At the closing, the steps in image registration are reviewed and suggested reading in this area is given.

7. **Questions and Answers (20 minutes)**

   Finally, the speakers answer to questions from the audience.

**Biographies**

The course organizers are Drs. Ardeshir Goshtasby, George Stockman, and Karl Rohr. Dr. Goshtasby is a professor in the Department of Computer Science and Engineering at Wright State University. For nearly twenty years he has been working on various problems in image registration. With the collaboration of various colleagues in the area, he has edited two journal issues on image registration. He is currently writing a book on 2-D and 3-D image registration.

Dr. Stockman is a professor in the Department of Computer Science and Engineering at Michigan State University. He has done pioneering work in pose clustering for image registration and object recognition and is currently researching the use of the radial mass transform for selecting salient points in 3D volumes. He is coauthor of the text Computer Vision (Prentice-Hall, 2001) with Linda Shapiro and regularly teaches a computer vision course. He is an experienced lecturer and has worked on introduction of image computation in various undergraduate courses.

Dr. Rohr is a professor in the School of Information Technology, International University in Germany. Since about ten years he has been working in image registration. He not only has extensive publications in this field, but also made significant contributions on feature and landmark extraction from 2-D and 3-D images. He has written one book on Landmark-Based Image Analysis published by Kluwer Academic Publishers, which covers both landmark extraction and elastic image registration. For his research work he has been awarded several prizes.

**Contact**

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