



VisionTutor™ Module

Computer Vision Course for Aphelion™ Users An Interactive, Computer-Based Vision Training Program

SYLLABUS:

- Image Formation
- Image Enhancement
- Edge Detection
- Morphology
- Region Segmentation
- Feature Extraction
- Convolution
- Filtering
- Fourier Transform

Hypertext Lecture Material and Aphelion™ Macros for Laboratory Experiments

The VisionTutor™ computer vision course is a combined theoretical and laboratory package designed as an introductory course in Image Processing and Image Understanding. The format of the course makes it possible for colleges, universities, research labs, and in-house trainers to present computer vision techniques in a manner that will prepare students and end-users to both understand and apply the algorithms and techniques of this dynamic field. The format of this course is unique, as it consists of computer-based text, graphics, hyperlinks, and direct links to the Aphelion™ image processing software. All the exercises in the laboratory section are delivered as macro command code that can be run from the Aphelion™ Developer, a PC environment for Image Processing and Image Understanding research and application development.

Remember that in order to obtain a digital image from a continuous sample, there were three things we had to specify:

1. The spatial resolution of a quantized sample
2. The quantization function and number of discrete levels
3. The tessellation pattern of the image plane.

Ideally, we should choose a tessellation pattern that completely covers the image plane. There are many possible patterns that accomplish this, but only the regular ones are of interest here—these include the square, the triangle, and the hexagon.

The square pattern is the one most widely used, even though the actual scanning area is more elliptical in shape.

The triangular pattern is hardly ever used.

The hexagonal pattern has some interesting properties which will become apparent as we discuss digital geometry.

VisionTutor Laboratory Exercise: Photometry

Photometry is concerned with mechanisms for converting light energy into electrical energy. This exercise presents images that were taken from different types of sensor equipment.

To run this exercise

Run the macro Lab2_Photometry.apm.

The display windows show:

Galaxy image	taken from a satellite.
Colon image	recorded by an optical fiber camera.
MRI image	magnetic resonance imagery image of
Fruit image	taken by a color camera.
Feather image	microscopic image.
Tanks image	FLIR (forward looking infra-red) image.
Airport runway image	taken by a Landsat satellite.

Components

The VisionTutor™ course material includes lecture material and laboratory experiments as a mix of hypertext, graphics, and Aphelion™ macros. The lecture material is grouped into eight chapters, with an average of 80 pages per chapter. Each time a new concept is introduced, a laboratory exercise is made available via an on-page icon. Clicking the icon will automatically transition the user into the Aphelion™ environment and start the exercise as a macro file. The macro includes text, image display, and user interaction. At the completion of the exercise, the system will return to the lecture material. All of the macros are delivered as source code, allowing the student or the teacher to modify them.

Lecture Materials

The lecture materials are based on the Computer Vision course created by Professor Allen Hanson at the University of Massachusetts at Amherst. The lecture material allows students to interactively explore the concepts of computer vision, image processing, and image understanding, and gain a working knowledge of the algorithms.

Laboratory Materials

The laboratory section of the VisionTutor™ course uses the Aphelion™ Developer software environment. The VisionTutor™ Lab component is composed of a set of experiments implemented as Visual Basic® compatible macros that execute in the Aphelion™ Developer environment, plus instruction text. The experiments step students through the software environment providing self-paced learning of the Lab tools and computer vision concepts. The experiments enable the student to explore the nature of computer vision algorithms by interacting with operators and images, and observing processing results. In most cases, the students have the option of executing the experiment on their own image data.

Aphelion™ System

The Aphelion™ System is a general-purpose software development environment, available for Windows® environments, providing state of the art tools for Image Understanding methodologies. It is widely used for research and application development in the fields of medical, materials science, geology, quality control, military, and inspection imaging.

VisionTutor™ Course Syllabus

1. **Introduction** - The course starts with an overview and an introduction to computer vision concepts. The corresponding Lab material teaches basic Aphelion™ System interaction, such as using the Graphical User Interface, and running an Aphelion™ Visual Basic® compatible macro.
2. **Image Formation** - The Image Formation section explores the basic issues of digital imagery: geometry, radiometry, photometry and digitization. This section concentrates on the digitization process, particularly in terms of how an image can be viewed as a mapping of the actual scene.
3. **Image Enhancement** - This section explores linear and non-linear filtering, histogram equalization, and other image enhancement techniques.
4. **Edge and Line Extraction** - Various types of edge detection schemes, such as first and second derivative, Sobel, Prewitt and facet models, are covered in this section. Other related topics, such as edge thresholding and edge thinning, are also discussed.
5. **Morphology** - This section describes binary and gray scale morphology from the basic filtering techniques (open, close, tophat) up to the most advanced segmentation techniques (skeleton, watershed). Examples are used to show the theoretical nature of these operators, and how they are used in various applications.
6. **Image Segmentation** - The Image Segmentation section explores a variety of region segmentation algorithms, such as region split and merge techniques, region growing, histogram peak/valley analysis, and a number of thresholding methods.
7. **Convolution, Filtering, Fourier Transform** - This section explores the applications of these fundamental image processing techniques. Also covered is the important relationship between the spatial processing approach of convolution and the frequency processing approach of Fourier filtering.