CALIFORNIA STATE UNIVERSITY CHANNEL ISLANDS

NEW COURSE PROPOSAL

PROGRAM AREA ___ MATH AND COMPUTER SCIENCE, BIOLOGICAL AND PHYSICAL SCIENCES

1. **Catalog Description of the Course.** *[Include the course prefix, number, full title, and units. Provide a course narrative including prerequisites and corequisites. If any of the following apply, include in the description: Repeatability (May be repeated to a maximum of ___ units); time distribution (Lecture ___ hours, laboratory ___ hours); non-traditional grading system (Graded CR/NC, ABC/NC). Follow accepted catalog format.]*

PHYS 445. IMAGE ANALYSIS AND PATTERN RECOGNITION (3)
Three hours of lecture in the lab per week.
Prerequisite: PHYS/COMP/MATH 345 or consent of instructor.
The course addresses the issue of analyzing the pattern content within an image. Pattern recognition consists of image segmentation, feature extraction and classification. The principles and concepts underpinning pattern recognition, and the evolution, utility and limitations of various techniques (including neural networks) will be studied.
Programming exercises will be used to implement examples and applications of pattern recognition processes, and their performance on a variety of diverse synthetic and real images will be studied.
Same as COMP 445, MATH 445
GenEd: B1, B4 and Interdisciplinary

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2. **Mode of Instruction.**

	Units	**Hours per Unit**	**Benchmark Enrollment**
Lecture	____3____	___1_____	___20_____
Seminar	_____	_____	_____
Laboratory	_____	_____	_____
Activity	_____	_____	_____

3. **Justification and Learning Objectives for the Course.** (Indicate whether required or elective, and whether it meets University Writing, and/or Language requirements) *[Use as much space as necessary]*

Pattern recognition is a very active area of study and research, which has seen many advances in recent years. New and emerging applications - such as data mining, web searching, multimedia data retrieval, face recognition, and cursive handwriting recognition -

require robust and efficient pattern recognition techniques. Statistical decision making and estimation are regarded as fundamental to the study of pattern recognition.
This course would become an elective for Computer Science and Math majors, and will be part of a proposed emphasis in Mathematics.

Through this course, students will be able to
- explain the principles and basic concepts of pattern recognition
- demonstate the limitations in extracting and quantifying pattern content
- apply image segmentation methods to partition an image into disjoint, connected sets of pixels
- store the segmented image as a membership map, as a boundary chain code, or by line segment encoding
- use appropriate methods to store object size, shape and texture and use surface fitting to extract an object of interest
- use features for classification that are discriminative, reliable, independent and few in number
- establish representative and unbiased classifier parameters for a training set
- apply critical reasoning skills in the application of physical principles and choice of appropriate technique
- explain the architecture, processing, operation and performance of neural networks
- remove the bias from a proportion estimate

Programming exercises will be used to implement the various processes, and their performance on synthetic and real images will be studied.
This course is not designed to satisfy the University Writing or Language requirements, although it will include substantial components of writing and oral presentation. A project report on particular image recognition strategies, consisting of both in-class writing and outside writing of revised prose on a topic, will be completed by each student and their report will be discussed in the class.

4. Is this a General Education Course **YES** **NO**
If Yes, indicate GE category:

A (English Language, Communication, Critical Thinking)	
B (Mathematics & Sciences)	**X**
C (Fine Arts, Literature, Languages & Cultures)	
D (Social Perspectives)	
E (Human Psychological and Physiological Perspectives)	

5. Course Content in Outline Form. *[Be as brief as possible, but use as much space as necessary]*

Introduction: types of pattern, quantifying pattern, concepts of pattern recognition, limitations and historical background. and an individual project report will be completed.

Morphological image processing: binary image connectivity, hit or miss transforms, thinning and skeletonization, dilation and erosion, open and closing, gray scale operations.
Image segmentation: thresholding, gradient-based methods, edge-detection and linking, region growing, binary image processing, segmented image structure.
Object measurement: size measurements, shape analysis – topological attributes, spatial moments, orientation and Fourier descriptors; texture analysis, curve and space fitting.
Classification and estimation: feature selection, classifier design and training, measurement of performance. Statistical classification, a priori probabilities, Bayes' rule. Statistical decision procedures. Operations upon random vectors.Feature extraction and nonlinear mapping. Quadratic and linear classifiers. Parameter estimation -maximum likelihood estimation, Bayesian estimation, non-parametric estimation. Supervised and unsupervised training.
Neural networks: architecture, processing, operation, performance.
Design considerations. Proportion estimation.
Image detection and registration: template matching, matched filters.
Summary: choice of appropriate technique.

6. References. *[Provide 3 - 5 references on which this course is based and/or support it.]*

- Kenneth R. Castleman, **Digital Image Processing,** Prentice-Hall, 1996 (ISBN 0-13-211467-4)
- Charles W. Therrien, **Decision Estimation and Classification**, John Wiley, 1989.
- R. O. Duda and P. E. Hart, **Pattern Classification and Scene Analysis,** John Wiley and Sons, New York, 1973.

- W. K. Pratt, **Digital Image Processing**, 3rd ed. John Wiley, 2001 (ISBN 0-471-37407-5)
- Rafael C. Gonzalez and Paul Wintz, **Digital Image Processing,** Addison Wesley, 1992
- GA Baxes, **Digital Image Processing: Principles and Applications.** John Wiley, 1994
- JC Russ, **The Image Processing Handbook.** CRC Press, 1995.
- Anil K. Jain, **Fundamentals of Image Processing,** Prentice Hall, 1990.

7. List Faculty Qualified to Teach This Course.

Dr. Geoff Dougherty
Dr. Bill Wolfe

8. Frequency.

a. Projected semesters to be offered: Fall _____ Spring __X___ Summer _____

9. New Resources Required.

No new resources

a. Library needs

One copy each of the books listed in para.6.

c. Facility/space needs

10. Consultation.

Attach consultation sheet from all program areas, Library, and others (if necessary)

11. If this new course will alter any degree, credential, certificate, or minor in your program, attach a program modification.

_____Geoff Dougherty_____1/8/03_____
Proposer of Course Date