



Approved Innovative Course

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Course: *Digital Image Processing*

PEIMS Code:

Abbreviation:

Grade Level(s): 11-12

Number of Credits: 1.0

Course description:

This course introduces the topic of how images (pictures) are represented in a way that computers can store them in memory, manipulate their pixels, display them, and analyze their contents. Digital images are processed by programs written in scientific computing software environments. The following image processing operations will be studied: enhancement, filtering, reconstruction, compression, object detection, and classification.

Essential knowledge and skills:

(a) General requirements. This course is recommended for students in Grades 11-12. Recommended prerequisites: Algebra I, Geometry, and Algebra II. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.

(3) Digital image processing (DIP) is the field that is concerned with achieving the best representation of images for human visual analysis and for the storage, transmission, and representation of images in automated machine perception. It implies the processing of any two-dimensional (2-D) data by a digital computer.

(4) Students in DIP draw from mathematical theory for solving the problems of image



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capture, representation, storage, transmission, and interpretation. This course will use concepts and tools that students have learned in previous mathematics courses for solving problems.

(5) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(6) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

- (A) employ effective reading and writing skills,
- (B) employ effective verbal and nonverbal communication skills; and
- (C) employ effective engineering problem solving skills.

(2) The student computes mathematics to solve engineering problems. The student is expected to:

- (A) compute image resampling;
- (B) compute spatial domain transforms with single channel input images;
- (C) graphically plot the histogram of an image and compute histogram equalization to a given histogram;
- (D) compute edge detection by different gradient operators;
- (E) compute the 2-D convolution, window-filtering, and correlation of images;
- (F) compute the 2-D Fourier transform of images;
- (G) compute lowpass, highpass, and selective filtering of images in the Fourier domain;
- (H) compute enhancement performance measures to determine the quality of transform-based enhancement methods;
- (I) compute image degradation by linear noise;
- (J) compute image restoration through optimal linear windowed filtration;
- (K) compute the error resulting from optimal linear filtration for image restoration;
- (L) compute the main concepts of mathematical morphology for image processing;



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- (M) compute 2-D median-type filters for image restoration;
 - (N) calculate the projection of objects in an image for use in image reconstruction; and
 - (O) compute fast methods of image reconstruction by projections and fast paired transforms used in computerized tomography;
- (3) The student presents the processes and results of computer projects. The student is expected to:
- (A) organize oral, written, and graphic information for the reporting or projects.
- (4) The student understands how image processing requires working effectively in multidisciplinary teams. The student is expected to:
- (A) identify where image processing is being applied in industry and how the problems in image processing are often defined by people in other disciplines;
 - (B) establish lines of communication with industry experts and investigate multidisciplinary team environments that have been experienced by industry professionals; and
 - (C) propose a mock written proposal to government scientific agencies of how multidisciplinary efforts related to work and research involving image processing necessitate government funding.
- (5) The student understands the impact of engineering solutions in global and societal contexts. The student is expected to:
- (A) investigate a specific application of digital image processing and how the application has benefited mankind; and
 - (B) orally present the conducted research.
- (6) The student understands the need for continuing professional education in image processing. The student is expected to:
- (A) conduct an interview of a digital image processing professional, either in industry or academia, and write a report on the professional's continued education and the benefits received from it; and
 - (B) report how continuing education benefits industry professionals by providing them with new tools to work with.



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Description of specific student needs this course is designed to meet:

Exposure to currently in-demand fields of work and research are needed by our youth. A course in DIP serves this purpose. Basic and intermediate programming in scientific programming software serves to improve students' computer proficiency and build a skill set in computing that is transferable to multiple computer related industries. Critical thinking and analysis will strengthen the student's problem solving ability as they see current and past problems in imaging as well as their solutions. High levels of organization and attention to detail are required for image processing programming, and contributions will be made to the student in this area through the course.

Major resources and materials:

Each student will need access to:

- A computer during class time and outside of class to work on assignments.
- Scientific computing software such as Matlab®, Octave®, Python®, C®, or Java®. One textbook for digital image processing will be required. Textbooks are currently available for the subject, but our team at UTSA is developing a textbook specifically to be used for this high school image processing course, which will reduce the rigor, typically at the undergraduate or graduate level, to be readable by high school students.

Recommended course activities:

In class, programming of image processing algorithms will be required. Field trips to both university labs and industry settings where image processing is being applied in a way that is effective to demonstrate to high schools will be optional. Blackboard theoretical development will be provided and then programmed in scientific computing software. An optional special project will be given to address a student's individual interest in a specific area of DIP which will allow the student to investigate the area, produce a small result, and present the results in either in a written or oral report. A team project is an optional activity where the students will be grouped together in small groups (three or four students per group) and will work together to produce a new idea for the field of image processing. Each group will have the option to produce a new result or study and present a result that has already been discovered in the field. This will foster teamwork in computing and creativity in developing new results.

Suggested methods for evaluating student outcomes:

Evaluation methods will include in-class and homework assignments, and an in-class exam consisting of a programming section and a written analysis section. A final group project



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presentation will be optional.

Teacher qualifications:

The teacher will hold a valid Texas Teacher Certificate in one or more of the following subject areas.

- (1) Master Science Teacher (Grades 8-12).
- (2) Mathematics/Physical Science/Engineering: Grades 6-12.
- (3) Mathematics/Physical Science/Engineering: Grades 8-12.
- (4) Physical Science: Grades 6-12.
- (5) Physical Science: Grades 8-12.
- (6) Physics/Mathematics: Grades 7-12.
- (7) Physics/Mathematics: Grades 8-12.
- (8) Science: Grades 7-12.
- (9) Science: Grades 8-12.
- (10) Science, Technology, Engineering, and Mathematics: Grades 6-12.
- (11) Secondary Industrial Arts (Grades 6-12).
- (12) Secondary Industrial Technology (Grades 6-12).
- (13) Secondary Physics (Grades 6-12).
- (14) Secondary Science (Grades 6-12).
- (15) Secondary Science, Composite (Grades 6-12).
- (16) Technology Education: Grades 6-12.
- (17) Master Mathematics Teacher (Grades 8-12).
- (18) Mathematics: Grades 7-12.
- (19) Mathematics: Grades 8-12.
- (20) Secondary Mathematics: Grades 6-12

In addition, it is recommended a teacher have 1-3 years of experience processing images with scientific programming software. The Digital Image Processing for High School Instruction (DIPHI) training course is recommended.

Additional information: