Nirma University

Institute of Technology

Instrumentation & Control Engineering Department

Course Policy

B.Tech. Open Elective

Semester: VII, Academic Year: 2022-23,
Term: Odd

Course Code & Name	:	2ICOE02, Machine Vision
Credit Details	:	Lecture:3, Practical:0, Credit: 3
Course Co-ordinator	:	Prof. Harsh Kapadia
Contact No. & Email	:	9974415116, harsh.kapadia@nirmauni.ac.in
Office	:	Ext: 424
Course Faculty	:	Prof. Harsh Kapadia **Visiting Hours:** Monday-Friday – 09.00 a.m. to 4.00 p.m. Odd Saturdays: 09:00 p.m. to 04:45 p.m.
Course Blog	:	---

1. Introduction to Course

1.1 Importance of the course

The course focuses on the fundamentals of machine vision system. Images are everywhere and with that the applications of vision systems have increased exponentially. With the advancement in the technology, more and more machine vision applications are being deployed. The applications domain ranges from OCR/OCV, label inspection to measurement applications of complex objects

etc. The course offers students to understand the methods, algorithms, hardware and the integration aspects of machine vision applications.

1.2 Objective of the Course

By the end of the course, students will be familiar with the basics of image acquisition process, typical image processing methods and algorithms, pipeline of a machine vision application, design, analysis and optimization of machine vision etc. The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

1.3 Pre-requisite:

Students should have studied subject: Linear algebra, image processing basics, MATLAB basics, array operations, Python basics,

2. Course Learning Outcomes (CLO)

CLOs are clear statements of the expectations for student achievements in the course.

1 explain the basic concepts of machine vision techniques and domains of application
2 analyze and evaluate basic machine vision systems
3 select hardware components and processing algorithm for applications
4 design and build small scale machine vision systems for a variety of application domains

3. Syllabus

UNIT 1: Introduction to machine vision and its applications

Fundamentals of machine vision, components of a machine vision system, basic problem of vision: four approaches, brief history, application examples.

UNIT 2: Image Formation and Acquisition

Sampling and quantization of image signals, digital image formation, image format and types, image sensors, camera and its types, lenses and optics, lights and colour, pixels and image filters, image acquisition techniques, communication technologies.

UNIT 3: Algorithms for machine vision part 1

Basic image pre-processing operations, filters, intensity operations, threshold techniques, edge detection.

UNIT 4: Algorithms for machine vision part 2

Line fitting, circle detection, curve fitting, segmentation methods, hough transform, pattern matching algorithms, contour analysis, and neural networks.

UNIT 5: Vision system integration

Sensors, actuators, selection of vision system components, hardware software integration, mechanical assembly and mounting, rejection hardware, computing requirements.

UNIT 6: Applications

Surface defects detection, 1D/2D barcodes decoding and verification, optical character recognition and verification, label inspection, object presence detection, object recognition, location and position identification of objects and object dimensions measurement.

UNIT 7: Case studies and advances

Blister inspection system in pharmaceutical industry, surface defect detection in manufacturing industry, object sorting in production industry, foreign particle detection in food and beverages industry, advances in machine vision, 3-D machine vision, artificial intelligence in machine vision.

Topics/content for self-study are as listed below:

Basic image pre-processing operations, filters, intensity operations, sampling and quantization of image signals, digital image formation, image format and types

Students are expected to study above mentioned topics on their own. These topics will not be taught in the classroom. Students should refer to books available in the library for the same.

3.2. References

1 Davis, E. R. Machine Vision. San Diego, California: Academic Press.

2 Bruce G. Batchelor. Machine Vision Handbook. Springer.

3 Ramesh Jain, Rangachar Kasturi and Brain G. Schunck. Machine Vision. New York: McGraw-Hill, Inc.

4 Shapiro, L. G. and G. C. Stockman. Computer Vision. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Note: The latest edition of books should be referred.

4. Laboratory details

The course does not have laboratory component. However, various software which are conventionally used to develop machine vision applications will be demonstrated in the lecture sessions. Also, different applications will be discussed in details with software demonstration.

6. Assessment Policy

6.1 Component wise Continuous Evaluation (CE), Laboratory and Project Work (LPW) & Semester End Examination (SEE) weightage

Assessment scheme	***CE***				***LPW***		***SEE***
Component weightage	*0.6*				*--*		*0.4*
	Class Test/ Quiz 1 15%	*Sessional examination 40%*	*Class Test/Quiz 2 15%*	*Term Paper/ Innovative Assignment 30%*	*--*	*--*	*Semester end examination 100%*

6.2 Assessment Policy for Continuous Evaluation (CE)

Assessment of Continuous Evaluation comprises of three components.

1. Class Test /Quiz 1 will be conducted as per academic calendar. It will be conducted online/ offline for the duration of 15 minutes and will be of 15 marks.

2. Class test /Quiz 2 will be conducted as per academic calendar. It will be conducted offline for the duration of 15 minutes and will be of 15 marks.
3. Student require to submit term paper/software simulation/research paper review based special assignment in group of two. The topics of the assignment will be conveyed after class test. Marks will be given out of 30 for the submitted work.

6.3 Assessment Policy for Laboratory and Project Work (LPW)

Not applicable as the course doesn't have laboratory component.

6.4 Assessment Policy for Semester End Examination (SEE)

A written examination of 3 hour duration will be conducted for the course as per academic calendar. It will carry 100 marks and marks obtained out of 100 will be converted as per weightage assigned.

7. Lesson Plan

Session No.	Topics	Mapped CLO
1	Overview of the course, Discussion on Course Policy, Course Website and Blog, Importance of the course, Evaluation, Linkages of the course with other course/'s and Professional relevance	-
2	Fundamentals of machine vision, components of a machine vision system	1
3	Basic problem of vision: four approaches, brief history, application examples	1
4	Sampling and quantization of image signals, digital image formation, image format and types	1,2
5	Sampling and quantization of image signals, digital image formation, image format and types	1,2
6	Image sensors, camera and its types	1,2
7	Image sensors, camera and its types	1,2
8	Lenses and optics	1,2
9	Lenses and optics	1,2
10	Lights and colour	1,2
11	Pixels and image filters	1,2

12	Image acquisition techniques, communication technologies	1,2
13	Basic image pre-processing operations	2,3
14	Basic image pre-processing operations	2,3
15	Filters, intensity operations	2,3
16	Filters, intensity operations	2,3
17	Threshold techniques, edge detection	2,3
18	Threshold techniques, edge detection	2,3
19	Line fitting, circle detection	2,3
20	Curve fitting	2,3
21	Segmentation methods	2,3
22	Hough transform	2,3
23	Pattern matching algorithms	2,3
24	Pattern matching algorithms	2,3
25	Contour analysis	2,3
26	Neural networks	2,3
27	Sensors, actuators, selection of vision system components	2,3
28	Sensors, actuators, selection of vision system components	2,3
29	Hardware software integration	2,3
30	Mechanical assembly and mounting	2,3
31	Rejection hardware, computing requirements	2,3
32	Surface defects detection	4
33	1D/2D barcodes decoding and verification	4
34	Optical character recognition and verification	4
35	Label inspection	4
36	Object presence detection	4
37	object recognition	4
38	Location and position identification of objects and object dimensions measurement	4
39	Blister inspection system in pharmaceutical industry	4
40	Surface defect detection in manufacturing industry	4
41	Object sorting in production industry	4
42	Foreign particle detection in food and beverages industry	4
43	Advances in machine vision, 3-D machine vision	4
44	Artificial intelligence in machine vision	4

45	Review of the course, Feedback related to the course, Linkages with advanced courses in succeeding years	-

8. Mapping of Session Learning Outcomes (SLO) with Course Learning Outcomes (CLO)

Session No.	Session Learning Outcomes: After successful completion of the session, student will be able to	CLO
1	Overview of the course, Discussion on Course Policy, Course Website and Blog, Importance of the course, Evaluation, Linkages of the course with other course/'s and Professional relevance	-
2	Fundamentals of machine vision, components of a machine vision system	1
3	Basic problem of vision: four approaches, brief history, application examples	1
4	Sampling and quantization of image signals, digital image formation, image format and types	1,2
5	Sampling and quantization of image signals, digital image formation, image format and types	1,2
6	Image sensors, camera and its types	1,2
7	Image sensors, camera and its types	1,2
8	Lenses and optics	1,2
9	Lenses and optics	1,2
10	Lights and colour	1,2
11	Pixels and image filters	1,2
12	Image acquisition techniques, communication technologies	1,2
13	Basic image pre-processing operations	2,3
14	Basic image pre-processing operations	2,3
15	Filters, intensity operations	2,3
16	Filters, intensity operations	2,3
17	Threshold techniques, edge detection	2,3
18	Threshold techniques, edge detection	2,3
19	Line fitting, circle detection	2,3
20	Curve fitting	2,3
21	Segmentation methods	2,3
22	Hough transform	2,3
23	Pattern matching algorithms	2,3
24	Pattern matching algorithms	2,3
25	Contour analysis	2,3
26	Neural networks	2,3
27	Sensors, actuators, selection of vision system components	2,3
28	Sensors, actuators, selection of vision system components	2,3

29	Hardware software integration	2,3
30	Mechanical assembly and mounting	2,3
31	Rejection hardware, computing requirements	2,3
32	Surface defects detection	4
33	1D/2D barcodes decoding and verification	4
34	Optical character recognition and verification	4
35	Label inspection	4
36	Object presence detection	4
37	object recognition	4
38	Location and position identification of objects and object dimensions measurement	4
39	Blister inspection system in pharmaceutical industry	4
40	Surface defect detection in manufacturing industry	4
41	Object sorting in production industry	4
42	Foreign particle detection in food and beverages industry	4
43	Advances in machine vision, 3-D machine vision	4
44	Artificial intelligence in machine vision	4
45	Review of the course, Feedback related to the course, Linkages with advanced courses in succeeding years	-

9. Teaching-learning methodology

1. Lectures: Primarily Chalk and Black board will be used to conduct the course. However, where required, Power Point Presentations (PPTs), Video Lectures, Simulations / Animations etc. will be used to enhance the teaching-learning process.
2. Laboratory: Explanation of Experiment to be performed along with co-relation with theory will be given. At the end of each session assessment will be carried out based on parameters like completion of lab work that includes observations, calculations, graphs and conclusions, individuality and involvement of the student, regularity, discipline etc. Students will be quizzed to check their understanding of the experiment/exercise conducted.

10. Active learning techniques

Active learning is a method of learning in which students are actively or experientially involved in the learning process. Following active learning techniques will be adopted for the course.

- One Minute Paper: On the half sheet of paper write down what you think are two important points presented so far.
- Muddiest Points: Write down an idea that was presented that seems unclear to you right now.

- Real-life examples

11. Course Material

Following course material is uploaded on the course website:

- Course Policy
- Lecture Notes
- Books / Reference Books / NPTEL video lectures
- Assignments, Tutorials, Lab Manuals
- Question bank
- Web-links, Blogs, Video Lectures, Journals
- Animations /Simulations, Software
- Advanced topics

12. Course Learning Outcome Attainment

Following means will be used to assess attainment of course learning outcomes.

- Use of formal evaluation components of continuous evaluation, tutorials, laboratory work, semester end examination
- Informal feedback during course conduction

13. Academic Integrity Statement

Students are expected to carry out assigned work under Continuous Evaluation (CE) component and LPW component independently. Copying in any form is not acceptable and will invite strict disciplinary action. Evaluation of corresponding component will be affected proportionately in such cases. Turnitin software will be used to check plagiarism wherever applicable. Academic integrity is expected from students in all components of course assessment.