



# COMPUTER VISION AND IMAGE PROCESSING - FUNDAMENTALS AND APPLICATIONS

## PROF. M.K. BHUYAN

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**PRE-REQUISITES :** Basic co-ordinate geometry, matrix algebra, linear algebra and random process.

**INTENDED AUDIENCE :** UG, PG and Ph.D students

**INDUSTRIES APPLICABLE TO :** The software industries that develop computer visions apps would be benefitted from this course.

## COURSE OUTLINE :

The intent of this course is to familiarize the students to explain the fundamental concepts/issues of Computer Vision and Image Processing, and major approaches that address them. This course provides an introduction to computer vision including image acquisition and image formation models, radiometric models of image formation, image formation in the camera, image processing concepts, concept of feature extraction and selection for pattern classification/recognition, and advanced concepts like motion estimation and tracking, image classification, scene understanding, object classification and tracking, image fusion, and image registration, etc.

This course will cover the fundamentals of Computer Vision. It is suited for mainly students who are interested in doing research in the area of Computer Vision. After completing the course, the students may expect to have the knowledge needed to read and understand more advanced topics and current research literature, and the ability to start working in industry or in academic research in the field of Computer Vision and Image Processing. They can also apply all these concepts for solving the real-world problems.

## ABOUT INSTRUCTOR :

Prof. Manas Kamal Bhuyan received a Ph.D. degree in electronics and communication engineering from the India Institute of Technology (IIT) Guwahati, India. He was with the School of Information Technology and Electrical Engineering, University of Queensland, St. Lucia, QLD, Australia, where he was involved in postdoctoral research. Subsequently, he was a Researcher with the SAFE Sensor Research Group, NICTA, Brisbane, QLD, Australia. He was an Assistant Professor with the Department of Electrical Engineering, IIT Roorkee, India and Jorhat Engineering College, Assam, India. In 2014, he was a Visiting Professor with Indiana University and Purdue University, Indiana, USA. Dr. Bhuyan was a recipient of the National Award for Best Applied Research/ Technological Innovation, which was presented by the Honorable President of India, the Prestigious Fulbright-Nehru Academic and Professional Excellence Fellowship, and the BOYSCAST Fellowship. He is an IEEE senior member. He is currently a Professor with the Department of Electronics and Electrical Engineering, IIT Guwahati, and Associate Dean of Infrastructure, Planning and Management, IIT Guwahati. His current research interests include image/video processing, computer vision, machine learning and human computer interactions (HCI), virtual reality and augmented reality. He has almost 25 years of industry, teaching, and research experience. He is the author of the book text book "Computer Vision and Image Processing: Fundamentals and Applications". For more details [www.iitg.ac.in/mkb](http://www.iitg.ac.in/mkb)

## COURSE PLAN :

**Week 1:** Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals of Computer Vision and Image Processing, Image Formation Concepts.

**Week 2:** Fundamental Concepts of Image Formation: Radiometry, Geometric Transformations, Geometric Camera Models.

**Week 3:** Fundamental Concepts of Image Formation: Camera Calibration, Image Formation in a Stereo Vision Setup, Image Reconstruction from a Series of Projections.

**Week 4:** Image Processing Concepts: Image Transforms.

**Week 5:** Image Processing Concepts: Image Transforms, Image Enhancement.

**Week 6:** Image Processing Concepts: Image Filtering, Colour Image Processing, Image Segmentation

**Week 7:** Image Descriptors and Features: Texture Descriptors, Colour Features, Edges/Boundaries.

**Week 8:** Image Descriptors and Features: Object Boundary and Shape Representations.

**Week 9:** Image Descriptors and Features: Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Speeded up Robust Features, Saliency

**Week 10:** Fundamentals of Machine Learning: Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Parameter Estimation, Clustering for Knowledge Representation, Dimension Reduction, Linear Discriminant Analysis.

**Week 11:** Applications of Computer Vision: Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Autoencoders.

**Week 12:** Applications of Computer Vision: Gesture Recognition, Motion Estimation and Object Tracking, Programming Assignments.