# Computer Vision

1. **Course number and name:** 020TIMES4 Image Processing

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Instructor's or course coordinator's name:** Ahmad Audi

4. **Instructional materials:** Course handout, Powerpoint slides

   **References:**
   - Richard Szeliski, "Computer Vision: Algorithms and Applications".
   - by David Forsyth and Jean Ponce, "Computer Vision: A Modern Approach".
   - Rafael Gonzalez and Richard Wood, "Digital Image Processing".

5. **Specific course information**
   a. **Catalog description:**
   Introduction to digital images (acquisition and visualization, sampling, fundamental principles of digital images) - Basic image processing (notion of histogram and its uses, morphological operations, etc.) - Digital filtering of images and detection of points of interest and contours (median filter, bilateral filter, Sobel detector, Canny detector, FAST, SIFT, etc.) - Image segmentation using traditional techniques (thresholding methods, image region division, etc.) - Image denoising and restoration: methods based on statistical principles, deterministic methods, and machine learning - Computer vision/image processing with convolutional neural networks (image classification, object detection and localization, facial recognition, image segmentation, etc.).

   b. **Prerequisites:** 020THSES2 Signal Theory

   c. **Selected Elective** for CCE students

6. **Educational objective for the course**
   a. **Specific outcomes of instruction:**
   - Understand the fundamental concepts of digital images, including acquisition, visualization, and sampling.
   - Utilize basic image processing techniques such as histogram analysis and morphological operations proficiently.
   - Deploy various digital filtering methods for images to enhance image quality and reduce noise effective.
   - Develop skills in detecting points of interest and contours in images using techniques such as the Sobel and Canny detectors.
   - Partition images into meaningful regions using traditional techniques like thresholding and region division.
   - Use statistical, deterministic, and machine learning-based methods to denoise and restore images, improving their quality.

- Apply convolutional neural networks (CNNs) to various tasks in computer vision and image processing, including image classification, object detection, facial recognition, and image segmentation.
- Explain the main components of Angular and Google Firebase.

Gain hands-on experience using software tools and libraries commonly used in digital image processing to implement and experiment with different algorithms and techniques.

**b. PI addressed by the course:**

| **PI** | 1.3 | 2.1 | 2.2 | 2.4 | 2.5 | 5.2 | 6.3 | 6.4 | 7.2 |
|---|---|---|---|---|---|---|---|---|---|
| **Covered** | x | x | x | x | x | x | x | X | x |
| **Assessed** | | | | | | | | | |

## 7. Brief list of topics to be covered

- Introduction to digital images (acquisition and visualization, sampling, fundamental principles of digital images)
- Basic image processing (notion of histogram and its uses, morphological operations, etc.)
- Digital filtering of images (median filter, bilateral filter, etc.) and contour detection (Sobel detector, Canny detector, etc.)
- Detection of interest points and search for homologous points (matching) (SIFT detector, FAST, SURF, ORB descriptor, etc.)
- Image alignment and stitching (homography, panoramic image, etc.)
- Image segmentation using traditional techniques (thresholding methods, image region division, etc.)
- Image denoising and restoration: methods based on statistical principles, deterministic methods, and machine learning
- Stitching methods, homography, panorama creation
- Introduction to convolutional neural networks
- Classic networks for classification: History and evolution of networks: LeNet, AlexNet, VGG16, GoogleNet, ResNet, etc.
- Object detection and localization: Family of RCNN algorithms (RCNN, fast RCNN, faster RCNN, Mask RCNN)
- Semantic segmentation: Presentation of some algorithms for pixel-to-pixel segmentation (Enet, etc.)
- Some other applications: edge detection, colorization, style transfer, resolution enhancement, denoising, etc.
- 2 practical sessions on the classic part of image processing: Filtering, image segmentation, stitching, denoising, etc.
- 3 practical sessions on convolutional neural networks: use of pre-trained models to test different applications