

# Postgraduate Certificate

## Computer Vision Algorithms in Robotics: Image Processing and Analysis



## Postgraduate Certificate

### Computer Vision Algorithms in Robotics: Image Processing and Analysis

- » Modality: **online**
- » Duration: **12 weeks**
- » Certificate: **TECH Global University**
- » Credits: **12 ECTS**
- » Schedule: **at your own pace**
- » Exams: **online**

Acceso web: [www.techtute.com/us/engineering/postgraduate-certificate/computer-vision-algorithms-robotics-image-processing-analysis](http://www.techtute.com/us/engineering/postgraduate-certificate/computer-vision-algorithms-robotics-image-processing-analysis)

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# 01

# Introduction

Getting a robot to understand all the information around it and detect imperfections to know where it is is one of the most complex tasks today. That is why the robotic vision technique requires a deep knowledge of the most advanced tools to achieve an optimal result. This 100% online education offers the engineering professional a program in which he/she will be able to specialize in this field, thanks to the expert teaching team. With a theoretical-practical approach, students will be able to both broaden their knowledge and take a step further in their professional career in the Robotics industry.





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*A university degree in which you will progress in the robotics industry under the guidance of experts with long professional careers”*



The mobility and autonomy of robots depends largely on the technical ability to improve their artificial vision by making their movements much more precise and more human-like. A complex task that requires highly qualified engineering professionals. This Postgraduate Certificate, taught by a team of experts in Robotics, will delve over 12 weeks in the algorithms that allow image processing and analysis in robots.

An education in which students will acquire advanced and comprehensive knowledge about the efficient operation of mobile robots in complex environments, decision making and performing tasks without human intervention, i.e. everything that pertains to robotic navigation. A program with a theoretical approach, but with great practical application so that the professional can progress in a sector on the rise in recent years thanks to the improvement of techniques and the different advanced digital tools that allow the configuration of algorithms that affect artificial vision.

An excellent opportunity for the engineering professional who wishes to progress with a university degree taught entirely in 100% online mode. A teaching method that you can study comfortably and flexibly, since you only need a device with an internet connection to access all the multimedia content that makes up this Postgraduate Certificate, without fixed timetable sessions and with the complete content of the program from the first day. A method that will allow you to reconcile your personal responsibilities while acquiring an education that is at the forefront of the academic world.

This **Postgraduate Certificate in Computer Vision Algorithms in Robotics: Image Processing and Analysis** contains the most complete and up-to-date program on the market. The most important features include:

- ◆ Case studies presented by experts in robotic engineering
- ◆ The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- ◆ Practical exercises where self-assessment can be used to improve learning
- ◆ Its special emphasis on innovative methodologies
- ◆ Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- ◆ Content that is accessible from any fixed or portable device with an Internet connection



*A university program that brings you the most innovative multimedia content in the field of robotics and machine vision"*

“*The Relearning system of this 100% online teaching will facilitate your learning and reduce the long hours of study*”

The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

Its multimedia content, developed with the latest educational technology, will provide the professional with situated and contextual learning, i.e., a simulated environment that will provide an immersive education programmed to learn in real situations.

The design of this program focuses on Problem-Based Learning, by means of which the professional must try to solve the different professional practice situations that are presented throughout the academic course. For this purpose, the student will be assisted by an innovative interactive video system created by renowned experts.

*With this program, you can go deeper into Bayesian models and 3D segmentation with the most up-to-date tools.*

*Solve the main problems of Robot localization thanks to this Postgraduate Certificate. Enroll now.*



# 02

# Objectives

This Postgraduate Certificate has been created with the objective that the engineering professional advances in his career with an advanced and intensive education that will provide him with the essential knowledge to apply the latest tools in the processing used to provide visual information to robots, design algorithms for digital image processing or be able to develop current technologies in the cloud based on neural networks. All this with a specialized teaching team.







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*A 100% online program that will provide you with the techniques used in mobile robotics mapping"*



## General Objectives

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- ◆ Develop the theoretical and practical foundations necessary to carry out a robot design and modeling project
- ◆ Provide the graduates with an exhaustive knowledge of the automation of industrial processes that will allow them to develop their own strategies
- ◆ Acquire the professional skills of an expert in automatic control systems in Robotics



*A Postgraduate Certificate that gives you the opportunity to advance in a growing technological sector. Enroll now"*





## Specific Objectives

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- ◆ Analyze and understand the importance of vision systems in robotics
- ◆ Establish the characteristics of the different perception sensors in order to choose the most appropriate ones according to the application
- ◆ Determine the techniques for extracting information from sensor data
- ◆ Apply visual information processing tools
- ◆ Design digital image processing algorithms
- ◆ Analyze and predict the effect of parameter changes on algorithm performance
- ◆ Assess and validate the developed algorithms in terms of results
- ◆ Master the machine learning techniques most widely used today in academia and industry
- ◆ Delve into the architectures of neural networks to apply them effectively in real problems
- ◆ Reuse existing neural networks in new applications using transfer learning
- ◆ Identify new fields of application of generative neural networks
- ◆ Analyze the use of learning techniques in other fields of robotics such as localization and mapping
- ◆ Develop current technologies in the cloud to develop neural network-based technologies
- ◆ Examine the deployment of vision learning systems in real and embedded systems

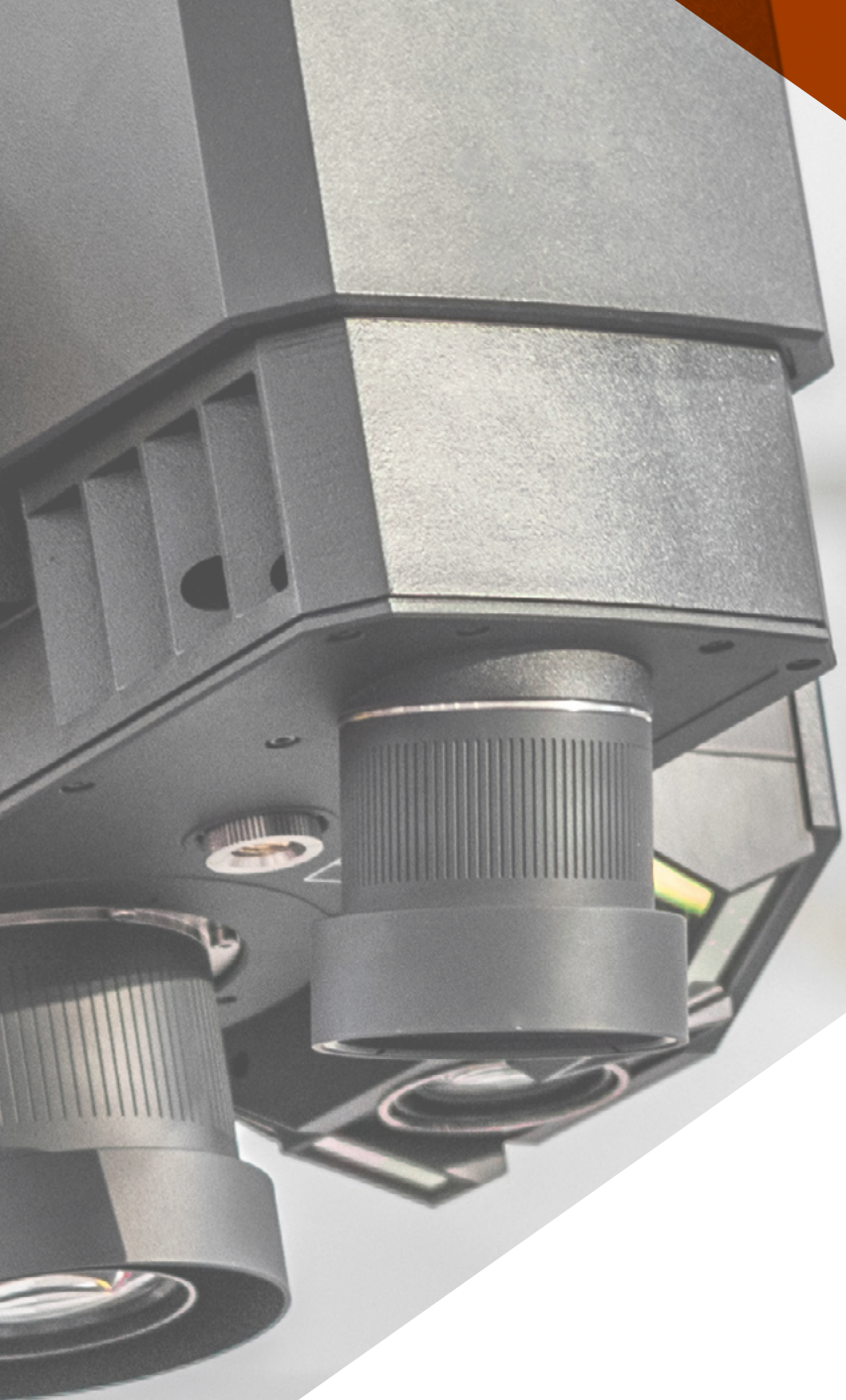


# 03

# Course Management

TECH Technological University selects the most specialized teaching staff with a high educational level in all its degrees in order to offer students a quality education. Thus, the engineering professional who takes this online program will have at his disposal a faculty with extensive experience in the field of robotics, especially focused on the field of machine vision. His experience will be key for students who wish to learn about the most applied tools and techniques in the sector.





“

*A team of experienced teachers and leaders in robotics projects will guide you to reach your goals in this sector”*



## Management



### Dr. Ramón Fabresse, Felipe

- ◆ Senior Software Engineer at Acurable
- ◆ NLP Software Engineer at Intel Corporation
- ◆ Software Engineer in CATEC, Indisys
- ◆ Researcher in Aerial Robotics at the University of Seville
- ◆ PhD Cum Laude in Robotics, Autonomous Systems and Telerobotics at the University of Seville
- ◆ Degree in Computer Engineering at the University of Seville
- ◆ Master's Degree in Robotics, Automation and Telematics at the University of Seville

## Professors

### Dr. Martín Ramos, Jorge

- ◆ Head of the Perception and Software Unit at CATEC
- ◆ R&D Project Manager at CATEC
- ◆ z R&D Project Engineer at CATEC
- ◆ Associate Professor at the University of Cadiz
- ◆ Associate Professor at the University International of Andalucia
- ◆ Researcher in the Robotics and Perception group at the University of Zurich
- ◆ Researcher at the Australian Centre for Field Robotics at the University of Sydney
- ◆ PhD in Robotics and Autonomous Systems from the University of Seville
- ◆ Graduate in Telecommunications Engineering and Computer and Network Engineering from the University of Seville





# 04

## Structure and Content

This Postgraduate Certificate consists of a syllabus that has been developed by a teaching team specialized in the field of Robotics, which will allow the engineering professional to deepen during 300 teaching hours in Machine Vision. Thus, students will acquire a thorough knowledge of computer vision, optical sensors, mathematical tools and the different vision learning methods used. The video summaries, the specialized readings and the real cases provided by the teaching staff will serve to acquire a comprehensive and agile learning process.





“

*The real cases presented in this course will facilitate the creation of Neural Networks in robots”*

## Module 1. Computer Vision Techniques in Robotics: Image Processing and Analysis

- 1.1. Computer Vision
  - 1.1.1. Computer Vision
  - 1.1.2. Elements of a Computer Vision System
  - 1.1.3. Mathematical Tools
- 1.2. Optical Sensors for Robotics
  - 1.2.1. Passive Optical Sensors
  - 1.2.2. Active Optical Sensors
  - 1.2.3. Non-Optical Sensors
- 1.3. Image Acquisition
  - 1.3.1. Image Representation
  - 1.3.2. Color Space
  - 1.3.3. Digitizing Process
- 1.4. Image Geometry
  - 1.4.1. Lens Models
  - 1.4.2. Camera Models
  - 1.4.3. Camera Calibration
- 1.5. Mathematical Tools
  - 1.5.1. Histogram of an Image
  - 1.5.2. Convolution
  - 1.5.3. Fourier Transform
- 1.6. Image Preprocessing
  - 1.6.1. Noise Analysis
  - 1.6.2. Image Smoothing
  - 1.6.3. Image Enhancement
- 1.7. Image Segmentation
  - 1.7.1. Contour-Based Techniques
  - 1.7.3. Histogram-Based Techniques
  - 1.7.4. Morphological Operations

- 1.8. Image Feature Detection
  - 1.8.1. Point of Interest Detection
  - 1.8.2. Feature Descriptors
  - 1.8.3. Feature Matching
- 1.9. 3D Vision Systems
  - 1.9.1. 3D Perception
  - 1.9.2. Feature Matching between Images
  - 1.9.3. Multiple View Geometry
- 1.10. Computer Vision based Localization
  - 1.10.1. The Robot Localization Problem
  - 1.10.2. Visual Odometry
  - 1.10.3. Sensory Fusion

## Module 2. Robot Visual Perception Systems with Machine Learning

- 2.1. Unsupervised Learning Methods applied to Computer Vision
  - 2.1.1. Clustering
  - 2.1.2. PCA
  - 2.1.3. Nearest Neighbors
  - 2.1.4. Similarity and Matrix Decomposition
- 2.2. Supervised Learning Methods Applied to Computer Vision
  - 2.2.1. "Bag of words" Concept
  - 2.2.2. Support Vector Machine
  - 2.2.3. Latent Dirichlet Allocation
  - 2.2.4. Neural Networks
- 2.3. Deep Neural Networks: Structures, Backbones and Transfer Learning
  - 2.3.1. Feature Generating Layers
    - 2.3.3.1. VGG
    - 2.3.3.2. Densenet
    - 2.3.3.3. ResNet
    - 2.3.3.4. Inception
    - 2.3.3.5. GoogLeNet
  - 2.3.2. Transfer Learning
  - 2.3.3. The Data Preparation for Training





- 2.4. Computer Vision with Deep Learning I: Detection and Segmentation
  - 2.4.1. YOLO and SSD Differences and Similarities
  - 2.4.2. Unet
  - 2.4.3. Other Structures
- 2.5. Computer Vision with Deep Learning II: Generative Adversarial Networks
  - 2.5.1. Image Super-Resolution Using GAN
  - 2.5.2. Creation of Realistic Images
  - 2.5.3. Scene Understanding
- 2.6. Learning Techniques for Localization and Mapping in Mobile Robotics
  - 2.6.1. Loop Closure Detection and Relocation
  - 2.6.2. Magic Leap, Super Point and Super Glue
  - 2.6.3. Depth from Monocular
- 2.7. Bayesian Inference and 3D Modeling
  - 2.7.1. Bayesian Models and "Classical" Learning
  - 2.7.2. Implicit Surfaces with Gaussian Processes (GPIS)
  - 2.7.3. 3D Segmentation Using GPIS
  - 2.7.4. Neural Networks for 3D Surface Modeling
- 2.8. End-to-End Applications of Deep Neural Networks
  - 2.8.1. End-to-End System. Example of Person Identification
  - 2.8.2. Object Manipulation with Visual Sensors
  - 2.8.3. Motion Generation and Planning with Visual Sensors
- 2.9. Cloud Technologies to Accelerate the Development of Deep Learning Algorithms
  - 2.9.1. Use of GPUs for Deep Learning
  - 2.9.2. Agile Development with Google IColab
  - 2.9.3. Remote GPUs, Google Cloud and AWS
- 2.10. Deployment of Neural Networks in Real Applications
  - 2.10.1. Embedded Systems
  - 2.10.2. Deployment of Neural Networks. Use
  - 2.10.3. Network Optimizations in Deployment, Example with TensorRT

05

# Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning**.

This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.







“

*Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"*

## Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

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*At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world”*



*You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.*



*The student will learn to solve complex situations in real business environments through collaborative activities and real cases.*

### A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

“*Our program prepares you to face new challenges in uncertain environments and achieve success in your career”*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.



## Relearning Methodology

TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

*In 2019, we obtained the best learning results of all online universities in the world.*

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically.

This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

*Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.*

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.



This program offers the best educational material, prepared with professionals in mind:



### Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.



### Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.



### Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.



### Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.





#### Case Studies

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.



#### Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".



#### Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.





06

# Certificate

The Postgraduate Certificate in Computer Vision Algorithms in Robotics: Image Processing and Analysis guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate issued by TECH Global University.





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*Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork”*

This private qualification will allow you to obtain a **Postgraduate Certificate in Computer Vision Algorithms in Robotics: Image Processing and Analysis** endorsed by **TECH Global University**, the world's largest online university.

**TECH Global University** is an official European University publicly recognized by the Government of Andorra ([official bulletin](#)). Andorra is part of the European Higher Education Area (EHEA) since 2003. The EHEA is an initiative promoted by the European Union that aims to organize the international training framework and harmonize the higher education systems of the member countries of this space. The project promotes common values, the implementation of collaborative tools and strengthening its quality assurance mechanisms to enhance collaboration and mobility among students, researchers and academics.

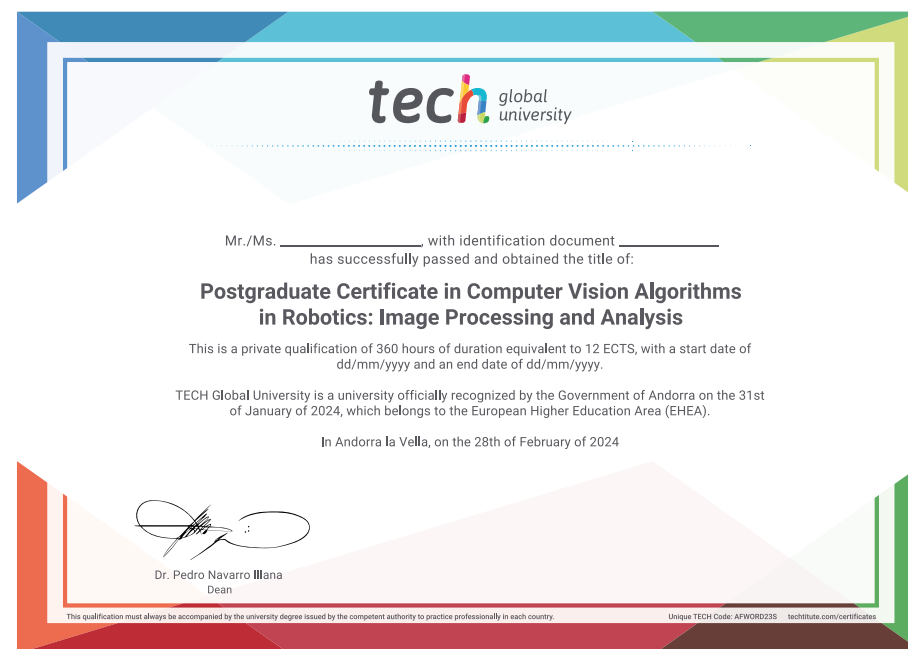
This **TECH Global University** private qualification is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Postgraduate Certificate in Computer Vision Algorithms in Robotics: Image Processing and Analysis**

Modality: **online**

Duration: **12 weeks**

Accreditation: **12 ECTS**



\*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH Global University will make the necessary arrangements to obtain it, at an additional cost..

future  
health confidence people  
education information tutors  
guarantee accreditation teaching  
institutions technology learning  
community commitment  
personalized service innovation  
knowledge present  
online training  
development language  
classroom



## Postgraduate Certificate Artificial Vision Algorithms in Robotics: Image Processing and Analysis

- » Modality: online
- » Duration: 12 weeks
- » Certificate: TECH Global University
- » Credits: 12 ECTS
- » Schedule: at your own pace
- » Exams: online

# Postgraduate Certificate

## Computer Vision Algorithms in Robotics: Image Processing and Analysis