

# 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: 6 weeks
- » Certificate: TECH Global University
- » Credits: 6 ECTS
- » Schedule: at your own pace
- » Exams: online

Website: [www.techtute.com/us/information-technology/postgraduate-certificate/computer-vision-algorithms-robotics-image-processing-analysis](http://www.techtute.com/us/information-technology/postgraduate-certificate/computer-vision-algorithms-robotics-image-processing-analysis)

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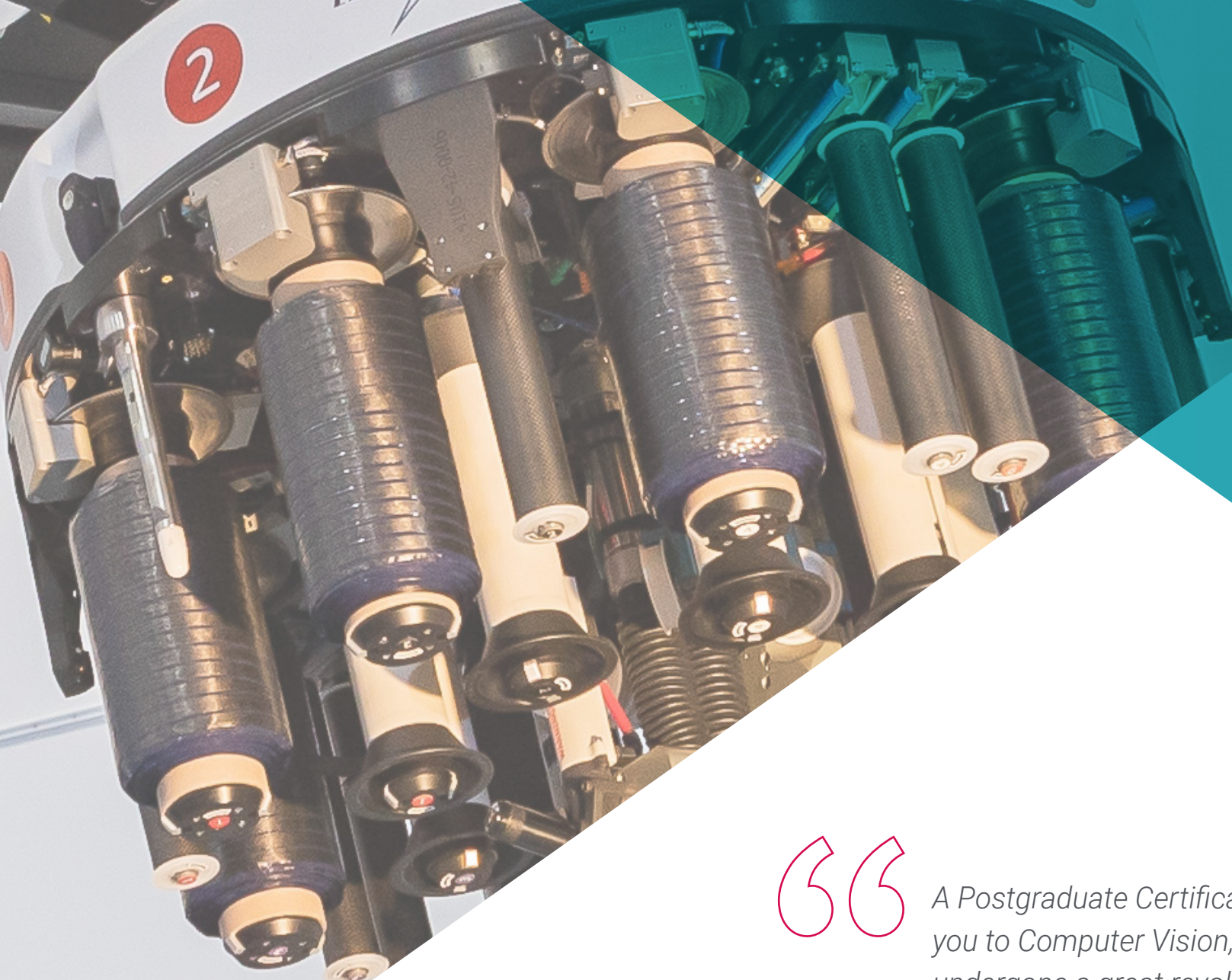
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# 01

# Introduction

Robot movement requires a great deal of knowledge of the surrounding environment. It is necessary that it detects imperfections and knows how to locate itself. This is not an easy task and its complexity requires advanced knowledge on the part of the IT professional. In a booming field and with an increasing demand for specialized profiles, it is essential to have an up-to-date and deep knowledge. This 100% online program delves into Computer Vision, offering a multimedia content at the forefront of educational teaching, provided by a specialized teaching team with experience in the field.





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*A Postgraduate Certificate that will lead you to Computer Vision, a field that has undergone a great revolution in recent years. Don't fall behind, enroll now"*

This Postgraduate Certificate, aimed at IT professionals, delves into Computer Vision in Robotics, with special emphasis on image processing and analysis. An advanced knowledge taught by an expert teaching team in Robotics, which will show students the importance of a correct work to improve the mobility and autonomy of a machine.

An online teaching that will focus on the complex world of robotic navigation. A learning where the students will be able to know perfectly the different techniques used by the scientific community in the area of Robotics to process the data that the machines collect, in order to obtain the most useful information for decision making of the robot itself. It will also delve into vision techniques based on Learning Systems, the use of Neural Networks, specifically Deep Neural Networks, which has revolutionized the way in which Computer Vision is used.

A program with a theoretical-practical approach with the most updated multimedia content for students to acquire a learning that will allow them to progress in their professional career in a field that has grown in recent years and whose future prospects are positive. It is, therefore, an excellent opportunity to acquire a quality and flexible education. Students only need an electronic device with internet connection to access the entire syllabus at any time of the day, without fixed schedules, and with the ease of distributing the teaching load according to their needs.

This **Postgraduate Certificate in Computer Vision Algorithms in Robotics: Processing and Images 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



*You have at your disposal 24 hours a day the most up-to-date multimedia content in Robotics, so you can access it whenever and wherever you want"*

“

*Acquire advanced knowledge in learning techniques for Localization and Mapping in Mobile Robotics with this Postgraduate Certificate”*

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.

The 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 immersive education programmed to learn in real situations.

This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise during the academic year. For this purpose, students will be assisted by an innovative, interactive video system created by renowned and experienced experts.

*During 6 weeks you will learn the most used techniques and tools for 3D segmentation.*

*You will gain advanced knowledge in Deep Neural Networks and their application in Industry 4.0.*



# 02 Objectives

This Postgraduate Certificate has been created with the aim that students upon completion of the 6-week program will be able to understand Computer Vision in Robotics and acquire a broad knowledge in the different techniques used for the extraction of information, digital image processing or develop current technologies in the cloud to develop technology based on neural networks. All this thanks to the didactic material provided by the team of experts that integrates this program.





“

*A 100% online program with real cases that will allow you to put you in situation before the main problems that you may face in the field of Computer Vision”*



## General Objectives

- ◆ 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 field. 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

The IT professionals who take this online program will have at their disposal a faculty with extensive experience in the field of Robotics technology and engineering, especially in field of computer vision. The involvement of the teaching team in projects in this field will be very useful for the students, who will have the most up-to-date knowledge in this field. Likewise, the IT professionals who take this program will be able to solve any doubts that may arise throughout this program, thanks to the proximity of the teaching staff of this program.





“

*An expert teaching team will help you advance in the field of Robotics. The industry demands more and more specialized profiles. Click and enroll”*

## 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. Pérez Grau, Francisco Javier

- ◆ Head of the Perception and Software Unit at CATEC
- ◆ R&D Project Manager at CATEC
- ◆ 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 180 teaching hours where students can delve into the field of Computer Vision in Robotics with an up-to-date syllabus consisting of video summaries, specialized readings and real cases. All this will allow you to delve into the processing and analysis of images, learn the main techniques used to establish optical sensors, 3D vision systems, localization in robots or the different methods of learning the environment. The *Relearning* system, which TECH applies in each of its programs, will favor the foundation of knowledge in a more natural and progressive way.







“

*The Relearning learning system, which TECH applies in its programs will allow you to reduce the long hours of study”.*

## Module 1. 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.

“

*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.*



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

The case method has been the most widely used learning system among the world's leading Information Technology schools for as long as they have existed. 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 course, students 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 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: Processing and Images 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 qualification without having to travel or fill out laborious paperwork”*

This program will allow you to obtain your **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.

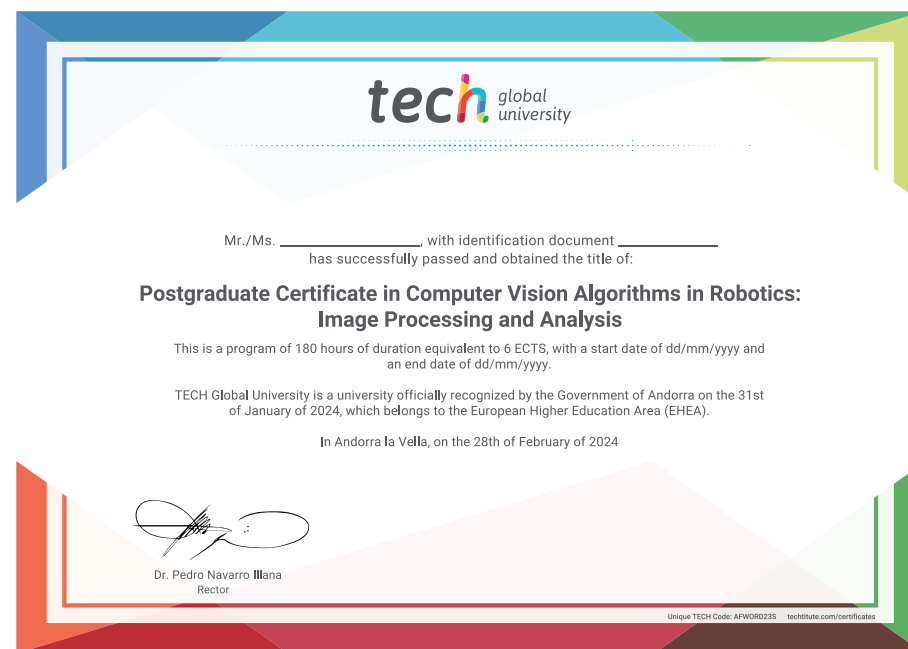
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

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

Modality: **online**

Duration: **6 weeks**

Accreditation: **6 ECTS**



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

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institutions technology learning

community commitment

**tech** global university

personalized service innovation

knowledge presentation

online training

development languages

virtual classroom

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

- » Modality: online
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