

# Postgraduate Diploma Robot Visual Perception Systems with Machine Learning



## Postgraduate Diploma Robot Visual Perception Systems with Machine Learning

- » Modality: online
- » Duration: 6 months
- » Certificate: TECH Global University
- » Credits: 18 ECTS
- » Schedule: at your own pace
- » Exams: online

Website: [www.techtute.com/us/information-technology/postgraduate-diploma/postgraduate-diploma-robot-visual-perception-systems-machine-learning](http://www.techtute.com/us/information-technology/postgraduate-diploma/postgraduate-diploma-robot-visual-perception-systems-machine-learning)

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# 01

# Introduction

Artificial Intelligence, 30 years ago, could have been considered science fiction, but thanks to Turing and the group of scientists gathered at Dartmouth, all of them precursors of this technology, today AI is a reality based on extensive knowledge of the logical and mathematical foundations that have allowed the creation of robots capable of moving, of their control and of artificial vision. It is here where the Computer Science professionals finds an opportunity to progress in their career. For this reason, this 100% online program has been created with a team of experts specialized in Robotics, which will allow students to advance thanks to the multimedia and enriched content of this program.



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*Specialize in artificial vision applied to Robotics and progress in your professional career with this Postgraduate Diploma”*

Far from science fiction, this program aimed at Computer Science professionals is oriented to provide all the necessary knowledge for the student to be able to project any idea to be developed in Artificial Intelligence or to work in Robotics projects, especially in the field of visual perception systems.

In this way, the teaching team specialized in this area will guide the students through the algorithmic bases that support its operation, its applications, advantages and limitations. To do this, during the 6 months of this online postgraduate diploma, a theoretical-practical approach will be applied in which, through examples, the students will find environments with robots, but without losing sight of the relevance to understand the machine learning techniques to be used.

Although artificial vision is one of the most complex fields of Robotics, the multimedia material offered by this program will facilitate its learning. Thus, students will be able to acquire the main vision techniques based on learning systems, particularly the use of neural networks, which have revolutionized the way in which machine vision is used today. Likewise, in this program the student will learn the most advanced tools to be able to develop in the field of artificial vision for Robotics, both at a theoretical and practical level.

An excellent opportunity for graduates who wish to progress in their professional field under the guidance of the best specialists and with quality teaching, which allows access to all the content from the first day and a Relearning system, based on the reiteration of content, which in turn facilitates learning and knowledge consolidation.

This **Postgraduate Diploma in Robot Visual Perception Systems with Machine Learning** contains the most complete and up-to-date program on the market. The most important features include:

- ◆ Development of case studies presented by experts in robotic engineering
- ◆ The graphic, schematic, and practical contents which 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



*Join a 100% online program  
and apply advanced Artificial  
Intelligence techniques on  
Intelligent Agents in your projects”*



“

*Unleash your full potential in this Postgraduate Diploma and learn in a simple way to identify the new fields of application of generative neural networks”*

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 allow the professional a situated and contextual learning, that is, a simulated environment that will provide an immersive education programmed to prepare in real situations.

This program is designed around Problem-Based Learning, whereby the professionals must try to solve the different professional practice situations that arise throughout the program. This will be done with the help of an innovative system of interactive videos made by renowned experts.

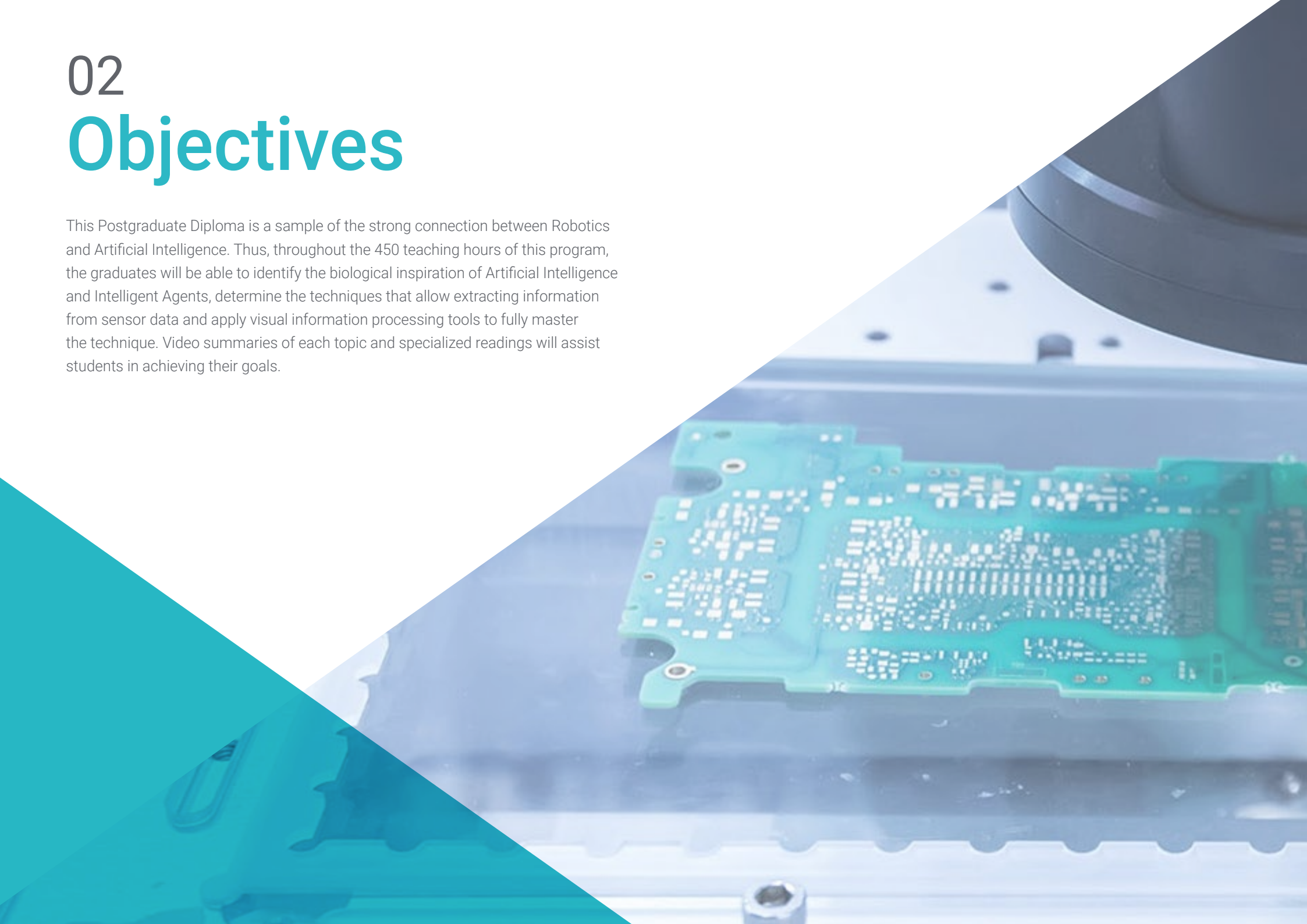
*This Postgraduate Diploma will allow you to reach a high level of mastery of the algorithms used in the creation of robots.*

*An excellent opportunity for you to implement your projects in the area of Robotics.*



# 02 Objectives

This Postgraduate Diploma is a sample of the strong connection between Robotics and Artificial Intelligence. Thus, throughout the 450 teaching hours of this program, the graduates will be able to identify the biological inspiration of Artificial Intelligence and Intelligent Agents, determine the techniques that allow extracting information from sensor data and apply visual information processing tools to fully master the technique. Video summaries of each topic and specialized readings will assist students in achieving their goals.





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*TECH's methodology allows you to distribute the teaching load according to your needs, adapting to your pace"*



## General Objectives

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- ◆ Understand the mathematical foundations for kinematic and dynamic modeling of robots
- ◆ Delve into the use of specific technologies for the creation of robot architectures, robot modeling and simulation
- ◆ Generate specialized knowledge on Artificial Intelligence
- ◆ Develop the technologies and devices most commonly used in industrial automation
- ◆ Identify the limits of current techniques to identify bottlenecks in robotic applications





## Specific Objectives

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### Module 1. Intelligent Agents. Application of Artificial Intelligence to Robots and Softbots

- ◆ Analyze the biological inspiration of Artificial Intelligence and intelligent agents
- ◆ Assess the need for intelligent algorithms in today's society
- ◆ Determine the applications of advanced Artificial Intelligence techniques on Intelligent Agents
- ◆ Demonstrate the strong connection between Robotics and Artificial Intelligence
- ◆ Establish the needs and challenges presented by Robotics that can be solved with Intelligent Algorithms
- ◆ Develop concrete implementations of Artificial Intelligence Algorithms
- ◆ Identify Artificial Intelligence algorithms that are established in today's society and their impact on daily life

### Module 2. Artificial Vision Techniques in Robotics: Image Processing and Analysis

- ◆ 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

### Module 3. Robot Visual Perception Systems with Automatic Learning

- ◆ 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



*Follow the path from algorithms applied to robotics to Deep Learning with this Postgraduate Diploma"*

# 03

## Course Management

Teaching the complexity of Machine Vision requires a specialized team with extensive knowledge in the field of engineering, information technology and, ultimately, robotics. That is why TECH has incorporated to this program a teaching staff with a high education qualification and extensive professional experience, being also currently active in the field of Robotics. Thanks to this, you will gain knowledge that is very close to the reality of this technological industry.





“

*Your professional career can advance enormously in the field of Robotics thanks to the team of professionals who will reveal all their technical secrets”*



## 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
- ♦ Professional Master's Degree in Robotics, Automation and Telematics at the University of Seville

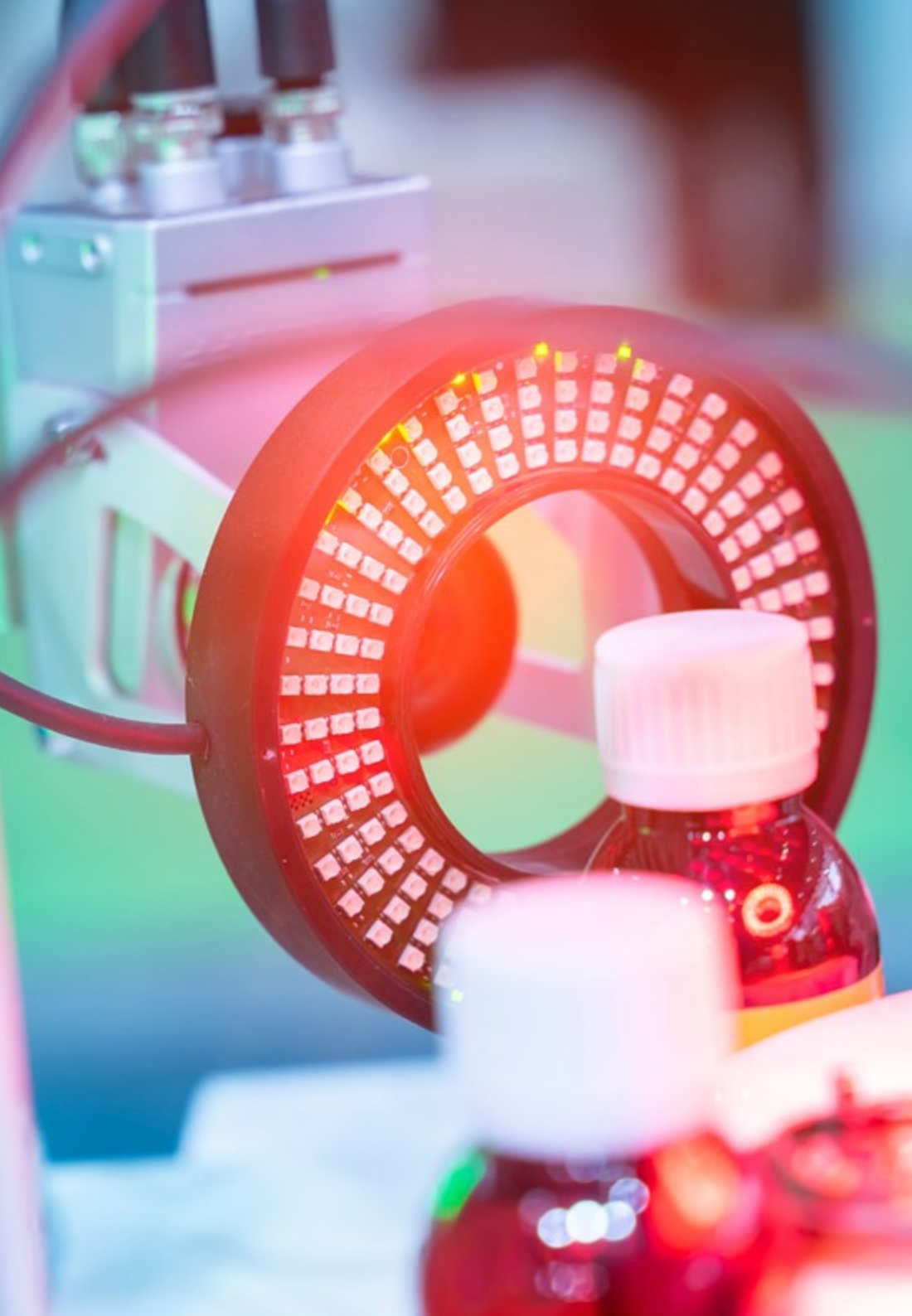
## Professors

### Mr. Campos Ortiz, Roberto

- ♦ Software Engineer Quasar Science Resources
- ♦ Software Engineer at the European Space Agency (ESA-ESAC) for the Solar Orbiter mission
- ♦ Content creator and Artificial Intelligence expert in the course: "Artificial Intelligence: The technology of the present-future" for the Andalusian Regional Government. Euroformac Group
- ♦ Quantum Computing Scientist Zapata Computing Inc
- ♦ Graduated in Computer Engineering at Carlos III University
- ♦ Master's Degree in Computer Science and Technology at Carlos III University

### Dr. Ramon Soria, Pablo

- ♦ Computational Vision Engineer at Meta
- ♦ Applied Science Team Leader and Senior Software Engineer at Vertical Engineering Solutions
- ♦ CEO and founder of Democracy
- ♦ ACFR Researcher (Australia)
- ♦ Researcher in the GRIFFIN and HYFLIERS projects at the University of Seville
- ♦ PhD in Computational Vision for Robotics at the University of Seville
- ♦ Graduated in Industrial Engineer, Robotics and Automatization from University of Seville



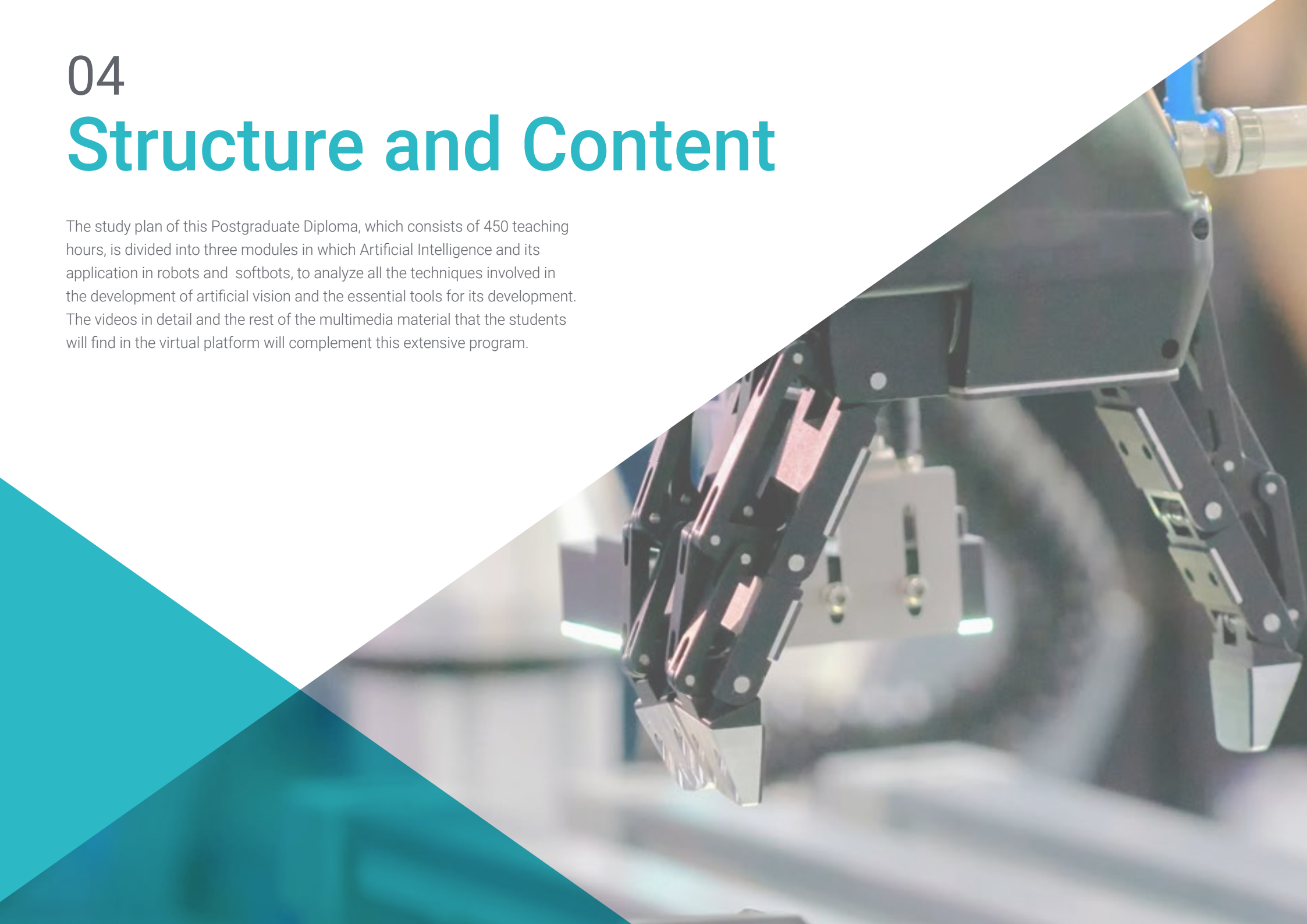
**Dr. Pérez Grau, Francisco Javier**

- ◆ 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

The study plan of this Postgraduate Diploma, which consists of 450 teaching hours, is divided into three modules in which Artificial Intelligence and its application in robots and softbots, to analyze all the techniques involved in the development of artificial vision and the essential tools for its development. The videos in detail and the rest of the multimedia material that the students will find in the virtual platform will complement this extensive program.



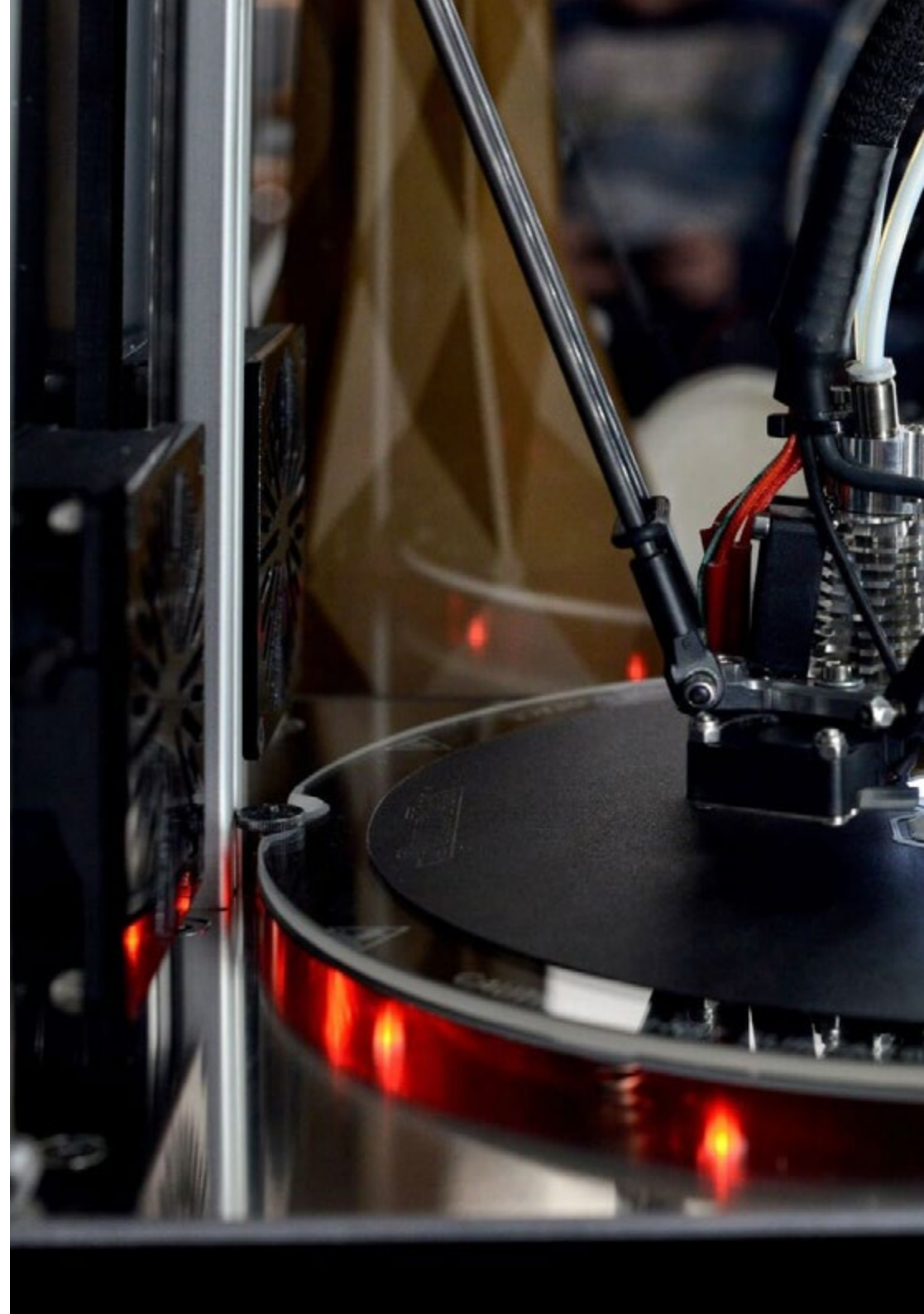
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*Enroll in this Postgraduate Diploma and acquire advanced learning in Deep Learning through tools such as Google IColab”*



## Module 1. Intelligent Agents. Application of Artificial Intelligence to Robots and Softbots

- 1.1. Intelligent Agents and Artificial Intelligence
  - 1.1.1. Intelligent Robots. Artificial Intelligence
  - 1.1.2. Intelligent Agents
    - 1.1.2.1. Hardware Agents. Robots
    - 1.1.2.2. Software Agents. Softbots
  - 1.1.3. Robotics Applications
- 1.2. Brain-Algorithm Connection
  - 1.2.1. Biological Inspiration of Artificial Intelligence
  - 1.2.2. Reasoning Implemented in Algorithms. Typology
  - 1.2.3. Explainability of Results in Artificial Intelligence Algorithms
  - 1.2.4. Evolution of Algorithms up to Deep Learning
- 1.3. Search Algorithms in the Solution Space
  - 1.3.1. Elements in Solution Space Searches
  - 1.3.2. Solution Search Algorithms in Artificial Intelligence Problems
  - 1.3.3. Applications of Search and Optimization Algorithms
  - 1.3.4. Search Algorithms Applied to Machine Learning
- 1.4. Machine Learning
  - 1.4.1. Machine Learning
  - 1.4.2. Supervised Learning Algorithms
  - 1.4.3. Unsupervised Learning Algorithms
  - 1.4.4. Reinforcement Learning Algorithms
- 1.5. Supervised Learning
  - 1.5.1. Supervised Learning Methods
  - 1.5.2. Decision Trees for Classification
  - 1.5.3. Support Vector Machines
  - 1.5.4. Artificial Neural Networks
  - 1.5.5. Applications of Supervised Learning







- 1.6. Unsupervised Learning
  - 1.6.1. Unsupervised Learning
  - 1.6.2. Kohonen Networks
  - 1.6.3. Self-Organizing Maps
  - 1.6.4. K-Means Algorithm
- 1.7. Reinforcement Learning
  - 1.7.1. Reinforcement Learning
  - 1.7.2. Agents Based on Markov Processes
  - 1.7.3. Reinforcement Learning Algorithms
  - 1.7.4. Reinforcement Learning Applied to Robotics
- 1.8. Artificial Neural Networks and Deep Learning
  - 1.8.1. Artificial Neural Networks. Typology
  - 1.8.2. Applications of Neural Networks
  - 1.8.3. Transformation from Machine Learning to Deep Learning
  - 1.8.4. Deep Learning Applications
- 1.9. Probabilistic Inference
  - 1.9.1. Probabilistic Inference
  - 1.9.2. Types of Inference and Method Definition
  - 1.9.3. Bayesian Inference as a Case Study
  - 1.9.4. Nonparametric Inference Techniques
  - 1.9.5. Gaussian Filters
- 1.10. From Theory to Practice: Developing an Intelligent Robotic Agent
  - 1.10.1. Inclusion of Supervised Learning Modules in a Robotic Agent
  - 1.10.2. Inclusion of Reinforcement Learning Modules in a Robotic Agent
  - 1.10.3. Architecture of a Robotic Agent Controlled by Artificial Intelligence
  - 1.10.4. Professional Tools for the Implementation of the Intelligent Agent
  - 1.10.5. Phases of the Implementation of AI Algorithms in Robotic Agents


## Module 2. Artificial Vision Techniques in Robotics: Image Processing and Analysis

- 2.1. Computer Vision
  - 2.1.1. Computer Vision
  - 2.1.2. Elements of a Computer Vision System
  - 2.1.3. Mathematical Tools
- 2.2. Optical Sensors for Robotics
  - 2.2.1. Passive Optical Sensors
  - 2.2.2. Active Optical Sensors
  - 2.2.3. Non-Optical Sensors
- 2.3. Image Acquisition
  - 2.3.1. Image Representation
  - 2.3.2. Color Space
  - 2.3.3. Digitizing Process
- 2.4. Image Geometry
  - 2.4.1. Lens Models
  - 2.4.2. Camera Models
  - 2.4.3. Camera Calibration
- 2.5. Mathematical Tools
  - 2.5.1. Histogram of an Image
  - 2.5.2. Convolution
  - 2.5.3. Fourier Transform
- 2.6. Image Preprocessing
  - 2.6.1. Noise Analysis
  - 2.6.2. Image Smoothing
  - 2.6.3. Image Enhancement
- 2.7. Image Segmentation
  - 2.7.1. Contour-Based Techniques
  - 2.7.3. Histogram-Based Techniques
  - 2.7.4. Morphological Operations
- 2.8. Image Feature Detection
  - 2.8.1. Point of Interest Detection
  - 2.8.2. Feature Descriptors
  - 2.8.3. Feature Matching

- 2.9. 3D Vision Systems
  - 2.9.1. 3D Perception
  - 2.9.2. Feature Matching between Images
  - 2.9.3. Multiple View Geometry
- 2.10. Computer Vision based Localization
  - 2.10.1. The Robot Localization Problem
  - 2.10.2. Visual Odometry
  - 2.10.3. Sensory Fusion

## Module 3. Robot Visual Perception Systems with Automatic Learning

- 3.1. Unsupervised Learning Methods applied to Computer Vision
  - 3.1.1. Clustering
  - 3.1.2. PCA
  - 3.1.3. Nearest Neighbors
  - 3.1.4. Similarity and Matrix Decomposition
- 3.2. Supervised Learning Methods Applied to Computer Vision
  - 3.2.1. "Bag of Words" Concept
  - 3.2.2. Support Vector Machine
  - 3.2.3. Latent Dirichlet Allocation
  - 3.2.4. Neural Networks
- 3.3. Deep Neural Networks: Structures, Backbones and Transfer Learning
  - 3.3.1. Feature Generating Layers
    - 3.3.3.1. VGG
    - 3.3.3.2. DenseNet
    - 3.3.3.3. ResNet
    - 3.3.3.4. Inception
    - 3.3.3.5. GoogleNet
  - 3.3.2. Transfer Learning
  - 3.3.3. Data. Preparation for Training
- 3.4. Computer Vision with Deep Learning I: Detection and Segmentation
  - 3.4.1. YOLO and SSD Differences and Similarities
  - 3.4.2. Unet
  - 3.4.3. Other Structures

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- 3.5. Computer Vision with Deep Learning II: Generative Adversarial Networks
    - 3.5.1. Image Super-Resolution Using GAN
    - 3.5.2. Creation of Realistic Images
    - 3.5.3. Scene Understanding
  - 3.6. Learning Techniques for Localization and Mapping in Mobile Robotics
    - 3.6.1. Loop Closure Detection and Relocation
    - 3.6.2. Magic Leap, Super Point and Super Glue
    - 3.6.3. Depth from Monocular
  - 3.7. Bayesian Inference and 3D Modeling
    - 3.7.1. Bayesian Models and "Classical" Learning
    - 3.7.2. Implicit Surfaces with Gaussian Processes (GPIS)
    - 3.7.3. 3D Segmentation Using GPIS
    - 3.7.4. Neural Networks for 3D Surface Modeling
  - 3.8. End-to-End Applications of Deep Neural Networks
    - 3.8.1. End-to-End System. Example of Person Identification
    - 3.8.2. Object Manipulation with Visual Sensors
    - 3.8.3. Motion Generation and Planning with Visual Sensors
  - 3.9. Cloud Technologies to Accelerate the Development of Deep Learning Algorithms
    - 3.9.1. Use of GPUs for Deep Learning
    - 3.9.2. Agile Development with Google IColab
    - 3.9.3. Remote GPUs, Google Cloud and AWS
  - 3.10. Deployment of Neural Networks in Real Applications
    - 3.10.1. Embedded Systems
    - 3.10.2. Deployment of Neural Networks. Use
    - 3.10.3. Network Optimizations in Deployment, Example with TensorR



# 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.*



*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 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 Diploma in Robot Visual Perception Systems with Machine Learning guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Diploma issued by TECH Global University.



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



This program will allow you to obtain your **Postgraduate Diploma in Robot Visual Perception Systems with Machine Learning** 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.

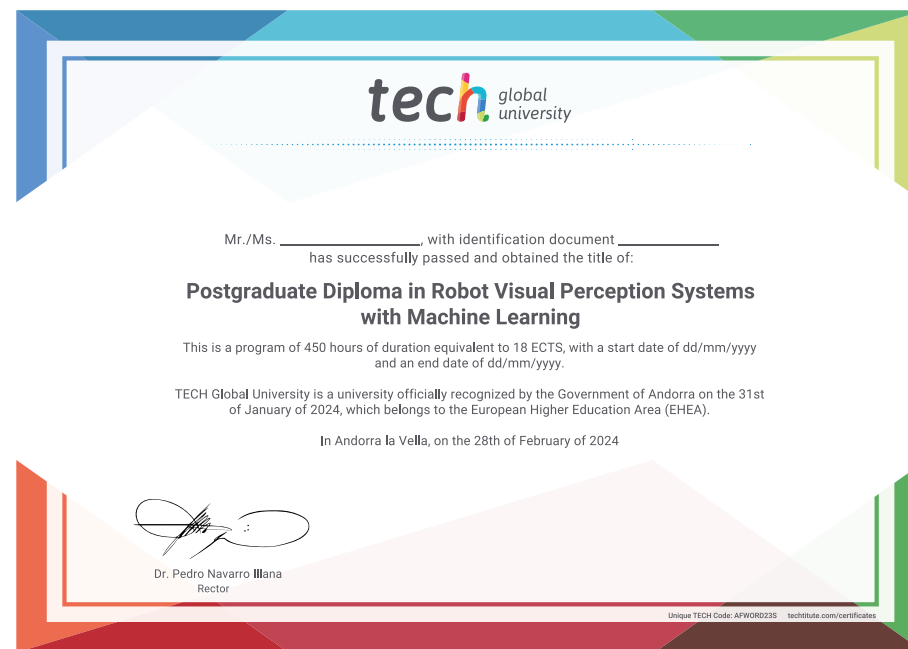
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Postgraduate Diploma in Robot Visual Perception Systems with Machine Learning**

Modality: **online**

Duration: **6 months**

Accreditation: **18 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 course  
development language  
virtual classroom



## Postgraduate Diploma Robot Visual Perception Systems with Machine Learning

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- » Credits: **18 ECTS**
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