Advanced Master's Degree
Robotics and Artificial Vision

tech global university

Advanced Master's Degree
Robotics and Artificial Vision

- Modality: **online**
- Duration: **2 years**
- Certificate: **TECH Global University**
- Credits: **120 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Website: **www.techtitute.com/us/engineering/advanced-master-degree/advanced-master-degree-robotics-artificial-vision**

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01

Introduction

In today's ever-evolving world, where Artificial Intelligence and Robotics are rapidly transforming many sectors, it is essential to specialize in areas such as Machine Vision. The increasing interaction between machines and humans and the need to process visual information effectively, generates a great demand for highly trained professionals in these emerging disciplines. Aware of this, we present this program, which provides advanced knowledge in Augmented Reality, Artificial Intelligence, industrial technologies and visual information processing in machines. Thanks to its 100% online methodology, engineering professionals will be able to adapt their study time to their personal and professional circumstances, assuring their study time to their personal and professional circumstances, ensuring a state-of-the-art learning state-of-the-art learning in a completely flexible environment.

Become an expert in Robotics and Computer Vision in 24 months with this TECH Global University Advanced Master's Degree. Enroll now"

The rise of Artificial Intelligence and Robotics is changing the technological, economic and social landscape globally. In this context, specialization
in areas such as Machine Vision is crucial to keep up to date in an environment of rapid advances and disruptive changes. The increasing interaction between humans and machines, and the need to process visual information efficiently, requires highly skilled professionals to lead innovation and address the challenges.

An ideal scenario for engineering professionals who want to advance an emerging sector. For this reason, TECH Global University has designed this Advanced Master's Degree in Robotics and Artificial Vision, which provides comprehensive training in these emerging disciplines, covering topics such as Augmented Reality, Artificial Intelligence and visual information processing in machines, among others.

A program that offers a theoretical-practical approach that allows graduates to apply their knowledge in real environments. All this, in addition, in a 100% online university degree, which allows students to adapt their learning to their personal and professional responsibilities. Thus, they will have access to high quality educational materials, such as videos, essential readings and detailed resources, providing them with a global vision of Robotics and Artificial Vision.

Likewise, thanks to the Relearning method, based on the continuous repetition of the most important contents, the student will reduce the hours of study and will consolidate the most important concepts in a simpler way.

A unique degree in the academic panorama that is also distinguished by the excellent team of specialists in this field, by the excellent team of specialists in this field. His excellent knowledge and experience and experience in the sector is evident in an advanced syllabus, which only TECH Global University.

This **Advanced Master's Degree in Robotics and Artificial Vision** contains the most complete and up-to-date program on the market. The most important features include:

- The development of case studies presented by IT experts
- 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 the self-assessment process can be carried out to improve learning
- Special emphasis on innovative methodologies in the development of Robots and Artificial Vision
- 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

Become an innovation leader and address ethical and safety challenges in creating innovative and effective solutions in different industry sectors"

"Take advantage of the opportunity to study in a 100% online program, adapting your study time to your personal and professional circumstances"

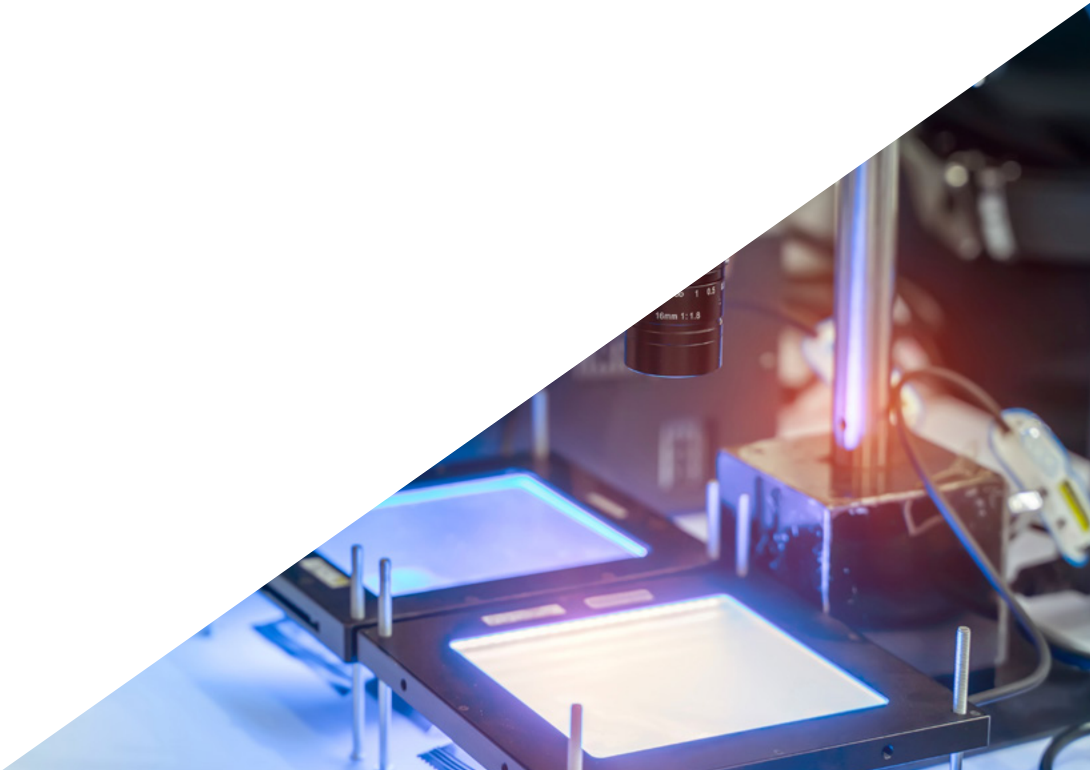
Analyze through the best didactic material how to carry out the tuning and parameterization of SLAM algorithms.

Delve whenever and wherever you want into the advances achieved in Deep learning.

Its teaching staff includes professionals from the field of Robotics, who bring to this program the experience of their work, as well as recognized specialists from reference 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 deliver an immersive learning experience, programmed to prepare in real situations.

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



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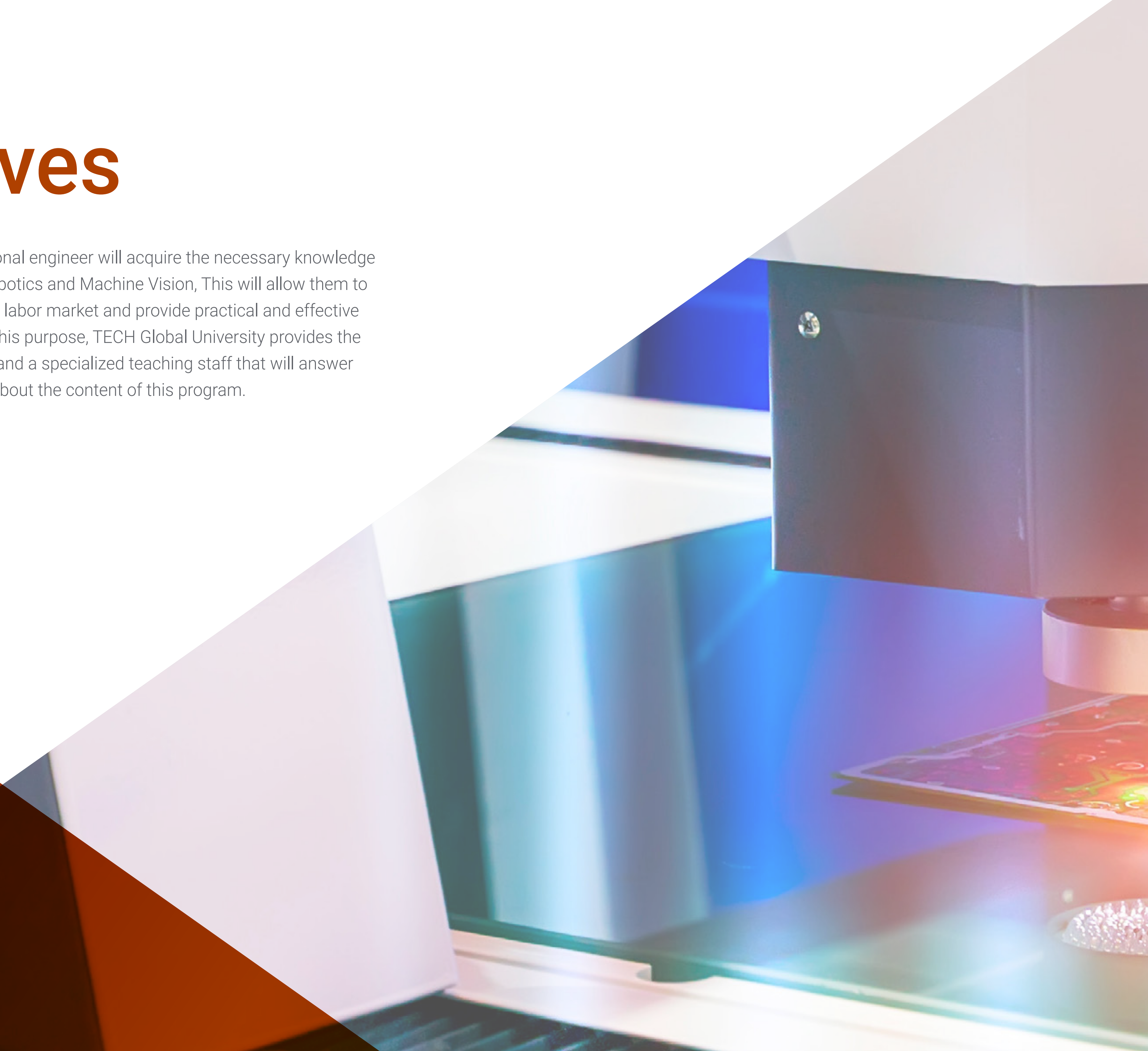
Objectives

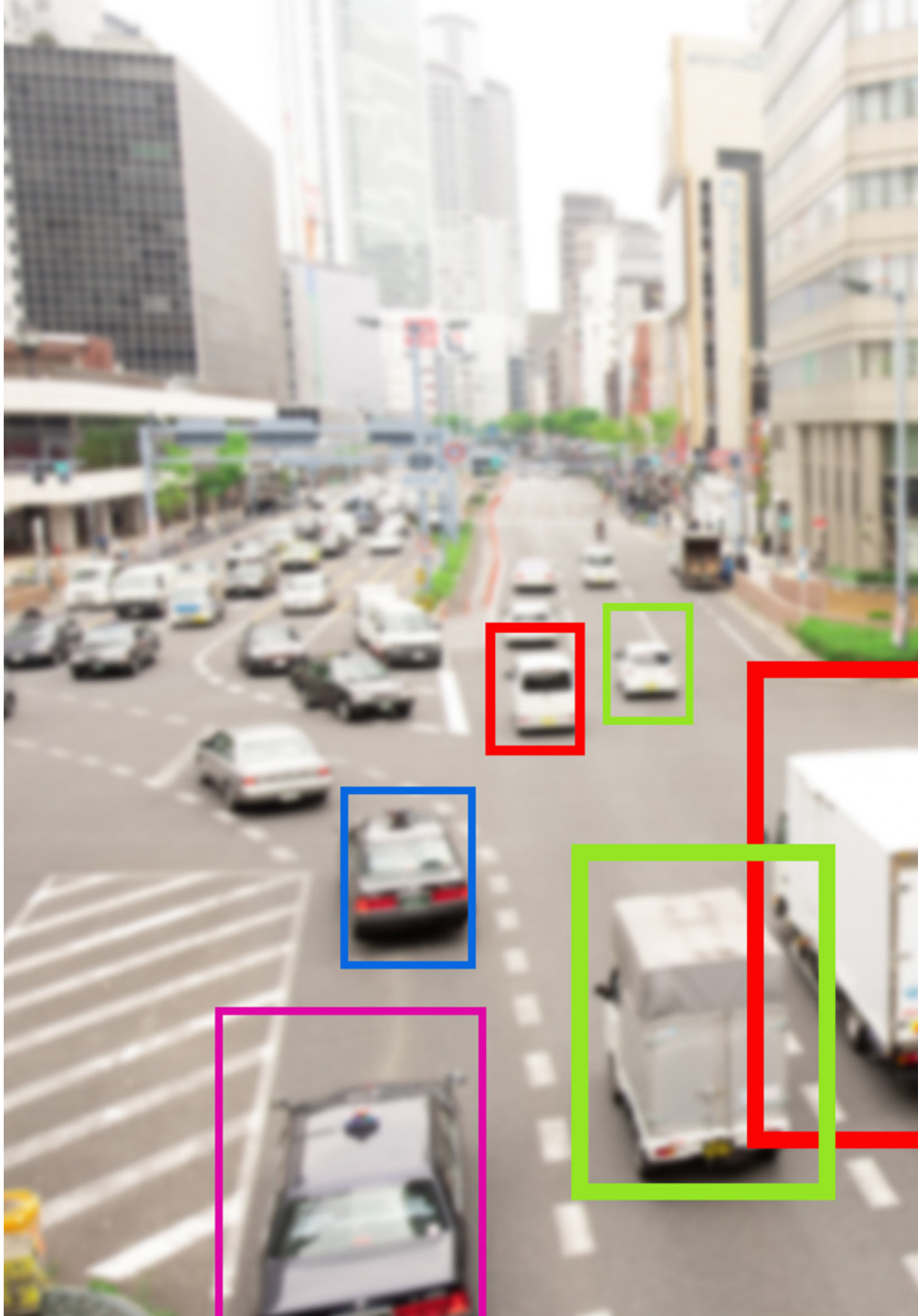
Thanks to this degree, the professional engineer will acquire the necessary knowledge to face challenges in the field of Robotics and Machine Vision, This will allow them to stand out in the constantly evolving labor market and provide practical and effective solutions in their field of work. For this purpose, TECH Global University provides the most innovative pedagogical tools and a specialized teaching staff that will answer any questions students may have about the content of this program.



The case studies of this university degree will give you an eminently practical approach to Robot Design and Modeling"

General Objectives

- 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
- Obtain an overview of the devices and hardware used in the computer vision world
- Analyze the different fields in which vision is applied
- Identify where the technological advances in vision are at the moment
- Assess what is being researched and what the next few years hold
- Establish a solid foundation in the understanding of digital image processing algorithms and techniques
- Assess fundamental computer vision techniques
- Analyze advanced image processing techniques
- Introducing the open 3D library
- Analyze the advantages and difficulties of working in 3D instead of 2D
- Introduce neural networks and examine how they work
- Analyze metrics for proper learning
- Analyze existing metrics and tools
- Examine the pipeline of an image classification network
- Analyze semantic segmentation neural networks and their metrics



Specific Objectives

Module 1. Robotic. Robot Design and Modeling

- Delve into the use of Gazebo Simulation Technology
- Master the use of the URDF Robot Modeling language
- Develop specialized knowledge in the use of Robot Operating System technology
- Model and Simulate Manipulator Robots, Land Mobile Robots, Air Mobile Robots and Model and Simulate Aquatic Mobile Robots

Module 2. Intelligent Agents. Applying 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 3. Deep Learning
- Analyze the families that make up the artificial intelligence world
- Compile the main Frameworks of *Deep Learning*
- Define neural networks
- Present the learning methods of neural networks
- Fundamentals of cost functions
- Establish the most important activation functions
- Examine regularization and normalization techniques
- Develop optimization methods
- Introduce initialization methods

Module 4. Robotics in the Automation of Industrial Processes
- Analyze the use, applications and limitations of industrial communication networks
- Establish machine safety standards for correct design
- Develop clean and efficient programming techniques in PLCs
- Propose new ways of organizing operations using state machines
- Demonstrate the implementation of control paradigms in real PLC applications
- Fundamentalize the design of pneumatic and hydraulic installations in automation
- Identify the main sensors and actuators in robotics and automation

Module 5. Automatic Control Systems in Robotics
- Generate specialized knowledge for the design of nonlinear controllers
- Analyze and study control problems
- Master control models
- Design nonlinear controllers for robotic systems
- Implement controllers and assess them in a simulator
- Determine the different existing control architectures
- Examine the fundamentals of vision control
- Develop state-of-the-art control techniques such as predictive control or machine learning based control

Module 6. Robot Planning Algorithms
- Establish the different types of planning algorithms
- Analyze the complexity of motion planning in robotics
- Develop techniques for environment modeling
- Examine the pros and cons of different planning techniques
- Analyze centralized and distributed algorithms for robot coordination
- Identify the different elements in decision theory
- Propose learning algorithms for solving decision problems

Module 7. Computer Vision
- Establish how the human vision system works and how an image is digitized
- Analyze the evolution of computer vision
- Evaluate image acquisition techniques
- Generate specialized knowledge about illumination systems as an important factor when processing an image
- Specify what optical systems exist and evaluate their use
- Examine the 3D vision systems and how these systems provide depth to images
- Develop the different existing systems outside the field visible to the human eye

Module 8. Applications and State-of-the-Art
- Analyze the use of computer vision in industrial applications
- Determine how vision is applied in the autonomous vehicle revolution
- Analyze images in content analysis

- Develop Deep Learning algorithms for medical analysis and Machine Learning algorithms for operating room assistance
- Analyze the use of vision in commercial applications
- Determine how robots have eyes thanks to computer vision and how it is applied in space travel
- Establish what augmented reality is and fields of use
- Analyze the Cloud Computing revolution
- Present the State of the Art and what the coming years have in store for us

Module 9. Computer 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 10. Robot Visual Perception Systems with Machine 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

Module 11. Visual SLAM. Robot Localization and Simultaneous Mapping Using Computer Vision Techniques

- Specify the basic structure of a Simultaneous Localization and Mapping (SLAM) system
- Identify the basic sensors used in Simultaneous Localization and Mapping (visual SLAM)
- Establish the boundaries and capabilities of visual SLAM
- Compile the basic notions of projective and epipolar geometry to understand imaging projection processes
- Identify the main visual SLAM technologies: Gaussian filtering, Optimization and loop closure detection
- Describe in detail the operation of the main visual SLAM algorithms visual SLAM algorithms
- Analyze how to carry out the tuning and parameterization of SLAM algorithms

Module 12. Application of Virtual and Augmented Reality Technologies to Robotics

- Determine the difference among the different types of realities
- Analyze the current standards for modeling virtual elements
- Examine the most commonly used peripherals in immersive environments
- Define geometric models of robots
- Assess physics engines for dynamic and kinematic modeling of robots
- Develop Virtual Reality and Augmented Reality projects

Module 13. Robot Communication and Interaction Systems

- Analyze current natural language processing strategies: heuristic, stochastic, neural network-based, reinforcement-based learning
- Assess the benefits and weaknesses of developing cross-cutting, or situation-focused, interaction systems
- Identify the environmental problems to be solved in order to achieve effective communication with the robot
- Establish the tools needed to manage the interaction and discern the type of dialogue initiative to be pursued
- Combine pattern recognition strategies to infer the intentions of the interlocutor and respond in the best way to them
- Determine the optimal expressiveness of the robot according to its functionality and environment, and apply emotional analysis techniques to adapt its response
- Propose hybrid strategies for interaction with the robot: vocal, tactile and visual

Module 14. Digital Image Processing

- Examine commercial and open-source digital image processing libraries
- Determine what a digital image is and evaluate the fundamental operations to be able to work with them
- Introduce image filters
- Analyze the importance and use of histograms
- Present tools to modify images pixel by pixel
- Propose image segmentation tools
- Analyze morphological operations and their applications
- Determine the methodology in image calibration
- Evaluate methods for segmenting images with conventional vision

Module 15. Advanced Digital Image Processing

- Examine advanced digital image processing filters
- Determine contour extraction and analysis tools
- Analyze object search algorithms
- Demonstrate how to work with calibrated images
- Analyze mathematical techniques for geometry analysis
- Evaluate different options in image compositing
- Develop user interface

Module 16. 3D Image Processing

- Examine a 3D image
- Analyze the software used for 3D data processing
- Developing open3D
- Determine the relevant data in a 3D image
- Demonstrate visualization tools
- Establish denoising filters
- Propose Geometric Calculation tools
- Analyze object detection methodologies
- Evaluate triangulation and scene reconstruction methods

Module 17. Convolutional Neural Networks and Image Classification

- Generate specialized knowledge on convolutional neural networks
- Establish evaluation metrics
- Analyze the performance of CNNs for image classification
- Evaluate Data Augmentation
- Propose techniques to avoid Overfitting
- Examine different architectures
- Compile inference methods

Module 18. Object Detection

- Analyze how object detection networks work
- Examine traditional methods
- Determine evaluation metrics
- Identify the main datasets used in the marketplace
- Propose architectures of the Two Stage Object Detector type
- Analyze Fine Tuning Methods
- Examine different Single Shoot architectures
- Establish object tracking algorithms
- Apply detection and tracking of people

Module 19. Image Segmentation with *Deep Learning*

- Analyze how semantic segmentation networks work
- Evaluate traditional methods
- Examine evaluation metrics and different architectures
- Examine video domains and cloud points
- Apply theoretical concepts through various examples

Module 20. Advanced Image Segmentation and Advanced Computer Vision Techniques

- Generate specialized knowledge on the handling of tools
- Examine Semantic Segmentation in medicine
- Identify the structure of a segmentation project
- Analyze Autoencoders
- Develop Adversarial Generative Networks

> *Design and develop advanced robotic systems that are efficient and collaborative, improving human-robot interaction and ensuring safety in diverse environments"*

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Skills

During the development of the Advanced Master's Degree in Robotics and Artificial Vision, students will have the opportunity to develop a wide range of skills that will allow them to excel in this field. Thus, the graduate will acquire essential skills in robot programming, embedded systems, navigation and localization, as well as in the implementation of machine learning algorithms. The program also focuses on solving complex problems in the design and control of robotic systems, addressing ethical and safety challenges in the creation of innovative and effective solutions in various industry sectors.

Develops competencies in Augmented Reality, Artificial Intelligence, industrial technologies and visual information processing in machines"

General Skills

- Master today's most widely used virtualization tools in use today
- Design virtual robotic environments
- Examine the techniques and algorithms underlying any AI algorithm
- Design, develop, implement and validate perceptual systems for robotics
- Develop the systems that are changing the world of vision and their functionalities
- Master the acquisition techniques to obtain the optimal image
- Develop tools that combine different computer vision techniques
- Establish problem analysis rules

Acquire essential skills in robot programming, embedded systems, navigation and localization, as well as in the implementation of machine learning algorithms"

Specific Skills

- Identify multimodal interaction systems and their integration with the rest of the robot components
- Implement own virtual and augmented reality projects
- Propose applications in real systems
- To examine, analyze and develop existing methods for path planning by a mobile robot and a manipulator
- Analyze and define strategies for the implementation and maintenance of perception systems
- Determine strategies for integrating a dialogue system as part of the basic robot behavior of the basic robot behavior
- Analyze programming and device configuration skills
- Examine control strategies used in different robotic systems
- Determine how a 3D image is formed and its characteristics
- Establish methods for the processing of 3D images
- Understanding the mathematics behind neural networks
- Propose inference methods
- Generate specialized knowledge about object detection neural networks and their metrics
- Identify the different architectures
- Examine tracking algorithms and their metrics
- Identify the most common architectures
- Apply correct cost function for learning
- Analyzing public data sources (datasets)
- Examine different labeling tools
- Develop the main phases of a segmentation-based project
- Examine filtering algorithms, morphology, pixel modification, etc
- Generate specialized knowledge about Deep Learning
- Develop convolutional neural networks

04

Course Management

The Advanced Master’s Degree in Robotics and Computer Vision has a highly qualified faculty, formed by experts in robotics, computer science and engineering with extensive experience in academic and professional fields. In addition, this outstanding faculty has experience in research and development of innovative robotic solutions, having worked on large-scale projects in a variety of industries. This work translates into a practical and distinctive approach and distinctive approach that is reflected throughout the content of the program, which will elevate the the students' competencies in Robotics and Artificial Vision.

Learn from a highly qualified faculty, composed of experts in robotics, computer science and engineering, with an outstanding academic and professional background"

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

Mr. Redondo Cabanillas, Sergio

- Specialist in Machine Vision Research and Development in BCN Vision
- Development and backoffice team leader. BCN Vision
- Project and development manager of machine vision solutions
- Sound Technician. Media Arts Studio
- Technical Engineering in Telecommunications. Specialization in Image and Sound at the Polytechnic University of Catalonia
- Graduate in Artificial Intelligence applied to Industry. Autonomous University of Barcelona
- Higher Level Training Cycle in Sound. CP Villar

Professors

Dr. Íñigo Blasco, Pablo

- Software Engineer at PlainConcepts
- Founder of Intelligent Behavior Robots
- Robotics Engineer at CATEC Advanced Center for Aerospace Technologies
- Developer and Consultant at Syderis
- PhD in Industrial Informatics Engineering at the University of Seville
- Degree in Computer Engineering at the University of Seville
- Master in Software Engineering and Technology

Mr. Campos Ortiz, Roberto

- Software Engineer Quasar Scence Resources
- Software Engineer at the European Space Agency (ESA-ESAC) for the mission Solar Orbiter
- 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 in Computer Science and Technology at Carlos III University

D. Rosado Junquera, Pablo J.

- Engineer Specialist in Robotics and Automatization
- R&D Automation and Control Engineer at Becton Dickinson & Company
- Amazon Logistic Control Systems Engineer at Dematic
- Automation and Control Engineer at Aries Ingeniería y Sistemas
- Graduate in Energy and Materials Engineering at Rey Juan Carlos University
- Master's Degree in Robotics and Automation at the Polytechnic University of Madrid
- Master's Degree in Industrial Engineering at the University of Alcalá

Dr. Jiménez Cano, Antonio Enrique

- Engineer at Aeronautical Data Fusion Engineer
- Researcher in European Projects (ARCAS, AEROARMS and AEROBI) at the University of Seville
- Researcher in Navigation Systems at CNRS-LAAS
- LAAS MBZIRC2020 System Developer
- Group of Robotics, Vision and Control (GRVC) of the University of Seville
- PhD in Automatics, Electronics and Telecommunications at the University of Seville
- Graduated in Automatic Engineering and Industrial Electronics at the University of Seville
- Degree in Technical Engineering in Computer Systems at the University of Seville

Dr. Alejo Teissière, David

- Telecommunications Engineer.with Specialization in Robotics
- Postdoctoral Researcher in the European projects SIAR and NIx ATEX at Pablo de Olavide University
- Systems Developer at Aertec
- PhD in Automation, Robotics and Telematics at the University of Seville
- Graduated in Telecommunication Engineering at the University of Seville
- Master's Degree in Automation, Robotics and Telematics from the 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
- Graduated in Telecommunications Engineering and Computer and Network Engineering from the University of Seville

Dr. Caballero Benítez, Fernando

- Researcher in the European projects COMETS, AWARE, ARCAS and SIAR
- Degree in Telecommunications Engineering from the University of Seville
- PhD in Telecommunications Engineering at the University of Seville
- Professor of the Systems Engineering and Automatics Area of the University of Seville
- Associate editor of the journal Robotics and Automation Letters

Dr. Lucas Cuesta, Juan Manuel

- Senior Software Engineer and Analyst at Indizen– Believe in Talent
- Senior Software Engineer and Analyst at Krell Consulting and IMAGiNA Artificial Intelligence
- Software Engineer at Intel Corporation
- Software Engineer at Intelligent Dialog Systems
- PhD's Degree in Electronic Systems Engineering for Intelligent Environments at the Polytechnic University of Madrid
- Graduate in Telecommunications Engineering at the Polytechnic University of Madrid
- Master's Degree in Electronic Systems Engineering for Intelligent Environments at the Polytechnic University of Madrid

Mr. Gutiérrez Olabarría, José Ángel

- Engineer specialized in artificial vision and sensors. Project management, software analysis and design
  of software and C programming of quality control and industrial informatics
- Market manager for the iron and steel sector, performing customer contact, sourcing, market plans and strategic accounts
- Computer Engineer. Deusto University
- Master in Robotics and Automation. ETSII/IT of Bilbao
- Diploma of Advanced Studies (DEA) of the PhD program in automatics and electronics. ETSII/IT of Bilbao

Mr. Enrich Llopart, Jordi

- Bcnvision's Chief Technology Officer - Machine vision
- Project and application engineer. Bcnvision - Machine vision
- Project and application engineer. PICVISA Machine Vision
- Graduated in Telecommunications Technical Engineering. Specialization in Image and Sound by the University School of Engineering of Terrassa (EET) / Universitat Politècnica of Catalonia (UPC)
- MPM - Master in Project Management. La Salle University - Ramon Llull University

Dr. Riera i Marín, Meritxell

- Deep Learning Systems Developer at Sycai Medical. Barcelona
- Researcher. National Center for Scientific Research (CNRS). Marseille, France
- Software engineer. Zhilabs. Barcelona
- IT Technician, Mobile World Congress
- Software engineer. Avanade, Barcelona
- Telecommunications Engineering at the UPC, Barcelona
- Master of Science: Signal, image, embedded systems and automation (SISEA) specialization
  at IMT Atlantique. Pays de la Loire - Brest, France
- Master's Degree in Telecommunications Engineering at UPC, Barcelona

Mr. González González, Diego Pedro

- Software Architect for Artificial Intelligence based systems
- Deep learning and machine learning application developer
- Software architect for embedded systems for railway applications safety and security
- Linux driver developer
- Systems engineer for railway track equipment
- Embedded Systems Engineer
- Deep Learning Engineer
- Official Master's Degree in Artificial Intelligence from the International University of La Rioja (Spain)
- Industrial Engineer by Miguel Hernández University

Mr. Higón Martínez, Felipe

- Electronics, telecommunications and computer engineer
- Validation and prototyping engineer
- Applications Engineer
- Support Engineer
- Master's Degree in Advanced and Applied Artificial Intelligence. IA3
- Technical Engineer in Telecommunications
- Degree in Electronic Engineering from the University of Valencia. García Moll, Clara
- Junior Visual Computer Engineer at LabLENI
- Computer Vision Engineer. Satellogic
- Full Stack Developer. Catfons Group
- Audiovisual Systems Engineering. Pompeu Fabra University (Barcelona)
- Master's Degree in Computer Vision. Autonomous University of Barcelona

Ms. García Moll, Clara

- Junior Visual Computer Engineer at LabLENI
- Computer Vision Engineer. Satellogic
- Full Stack Developer. Catfons Group
- Audiovisual Systems Engineering. Pompeu Fabra University (Barcelona)
- Master's Degree in Computer Vision. Autonomous University of Barcelona

Mr. Delgado Gonzalo, Guillem

- Computer Vision and Artificial Intelligence Researcher at Vicomtech
- Computer Vision and Artificial Intelligence Engineer at Gestoos
- Junior Engineer at Sogeti
- Graduated in Audiovisual Systems Engineering at the Universitat Politècnica de Catalunya
- MSc in Computer Vision at Universitat Autónoma de Barcelona
- Graduate in Computer Science at Aalto University
- Graduate in Audiovisual Systems. UPC - ETSETB Telecoms BCN

Mr. Bigata Casademunt, Antoni

- Perception Engineer in the Computer Vision Center (CVC)
- Machine Learning Engineer at Visium SA, Switzerland
- Degree in Microtechnology from the Ecole Polytechnique Fédérale de Lausanne (EPFL)
- Master's degree in Robotics from the Ecole Polytechnique Fédérale de Lausanne (EPFL)

Mr. Solé Gómez, Àlex

- Researcher at Vicomtech in the Intelligent Security Video Analytics department
- MSc in Telecommunications Engineering, mention in Audiovisual Systems by the Universitat Politécnica de Catalunya
- BSc in Telecommunications Technologies and Services Engineering, mention in Audiovisual Systems, Universitat Politécnica de Catalunya

05

Structure and Content

The Advanced Master's Degree in Robotics and Artificial Vision is presented as an excellent option for engineering professionals looking to specialize in this cutting-edge field. The program modules are developed in a progressive order, allowing students to acquire knowledge gradually and efficiently. It also offers the opportunity to learn about robot design, programming and control, as well as machine vision algorithms and machine learning techniques, essential skills for success in this constantly evolving field, and all this with a Virtual Library, accessible 24 hours a day from any digital device with an internet connection.

Get a global view on Robotics and Machine Vision, thanks to access to high quality educational materials"

Module 1. Robotic. Robot Design and Modeling

1.1. Robotics and Industry 4.0
 1.1.1. Robotics and Industry 4.0
 1.1.2. Application Fields and Use Cases
 1.1.3. Sub-Areas of Specialization in Robotics
1.2. Robot Hardware and Software Architectures
 1.2.1. Hardware Architectures and Real-Time
 1.2.2. Robot Software Architectures
 1.2.3. Communication Models and Middleware Technologies
 1.2.4. Robot Operating System (ROS) Software Integration
1.3. Mathematical Modeling of Robots
 1.3.1. Mathematical Representation of Rigid Solids
 1.3.2. Rotations and Translations
 1.3.3. Hierarchical State Representation
 1.3.4. Distributed Representation of the State in ROS (TF Library)
1.4. Robot Kinematics and Dynamics
 1.4.1. Kinematics
 1.4.2. Dynamics
 1.4.3. Underactuated Robots
 1.4.4. Redundant Robots
1.5. Robot Modeling and Simulation
 1.5.1. Robot Modeling Technologies
 1.5.2. Robot Modeling with URDF
 1.5.3. Robot Simulation
 1.5.4. Modeling with Gazebo Simulator
1.6. Robot Manipulators
 1.6.1. Types of Manipulator Robots
 1.6.2. Kinematics
 1.6.3. Dynamics
 1.6.4. Simulation
1.7. Terrestrial Mobile Robots
 1.7.1. Types of Terrestrial Mobile Robots
 1.7.2. Kinematics
 1.7.3. Dynamics
 1.7.4. Simulation
1.8. Aerial Mobile Robots
 1.8.1. Types of Aerial Mobile Robots
 1.8.2. Kinematics
 1.8.3. Dynamics
 1.8.4. Simulation
1.9. Aquatic Mobile Robots
 1.9.1. Types of Aquatic Mobile Robots
 1.9.2. Kinematics
 1.9.3. Dynamics
 1.9.4. Simulation
1.10. Bioinspired Robots
 1.10.1. Humanoids
 1.10.2. Robots with Four or More Legs
 1.10.3. Modular Robots
 1.10.4. Robots with flexible parts (Soft-Robotics)

Module 2. Intelligent Agents. Application of Artificial Intelligence to robots and softbots

2.1. Intelligent Agents and Artificial Intelligence
 2.1.1. Intelligent Robots. Artificial Intelligence
 2.1.2. Intelligent Agents
  2.1.2.1. Hardware Agents. Robots
  2.1.2.2. Software Agents. Softbots
 2.1.3. Robotics Applications

Module 3. *Deep Learning*

3.4. Activation Functions
- 3.4.1. Activation Function
- 3.4.2. Linear Functions
- 3.4.3. Non-Linear Functions
- 3.4.4. Output vs. Hidden Layer Activation Functions

3.5. Regularization and Normalization
- 3.5.1. Regularization and Normalization
- 3.5.2. Overfitting and Data Augmentation
- 3.5.3. Regularization Methods: L1, L2 and Dropout
- 3.5.4. Normalization Methods: Batch, Weight, Layer

3.6. Optimization
- 3.6.1. Gradient Descent
- 3.6.2. Stochastic Gradient Descent
- 3.6.3. Mini Batch Gradient Descent
- 3.6.4. Momentum
- 3.6.5. Adam

3.7. Hyperparameter Tuning and Weights
- 3.7.1. Hyperparameters
- 3.7.2. Batch Size vs. Learning Rate Vs. Step Decay
- 3.7.3. Weights

3.8. Evaluation Metrics of a Neural Network
- 3.8.1. Accuracy
- 3.8.2. Dice Coefficient
- 3.8.3. Sensitivity Vs. Specificity/Recall vs. Precision
- 3.8.4. ROC Curve (AUC)
- 3.8.5. F1-Score
- 3.8.6. Matrix Confusion
- 3.8.7. Cross-Validation

3.9. Frameworks and Hardware
- 3.9.1. Tensor Flow
- 3.9.2. Pytorch
- 3.9.3. Caffe
- 3.9.4. Keras
- 3.9.5. Hardware for the Learning Phase

3.10. Creation of a Neural Network-Training and Validation
- 3.10.1. Dataset
- 3.10.2. Network Construction
- 3.10.3. Education
- 3.10.4. Visualization of Results

Module 4. Robotics in the Automation of Industrial Processes

4.1. Design of Automated Systems
- 4.1.1. Hardware Architectures
- 4.1.2. Programmable Logic Controllers
- 4.1.3. Industrial Communication Networks

4.2. Advanced Electrical Design I: Automation
- 4.2.1. Design of Electrical Panels and Symbology
- 4.2.2. Power and Control Circuits Harmonics
- 4.2.3. Protection and Grounding Elements

4.3. Advanced Electrical Design II: Determinism and Safety
- 4.3.1. Machine Safety and Redundancy
- 4.3.2. Safety Relays and Triggers
- 4.3.3. Safety PLCs
- 4.3.4. Safe Networks

4.4. Electrical Actuation
- 4.4.1. Motors and Servomotors
- 4.4.2. Frequency Inverters and Controllers
- 4.4.3. Electrically Actuated Industrial Robotics

4.5. Hydraulic and Pneumatic Actuation
- 4.5.1. Hydraulic Design and Symbology
- 4.5.2. Pneumatic Design and Symbology
- 4.5.3. ATEX Environments in Automation

4.6. Transducers in Robotics and Automation
- 4.6.1. Position and Velocity Measurement
- 4.6.2. Force and Temperature Measurement
- 4.6.3. Presence Measurement
- 4.6.4. Vision Sensors

4.7. Programming and Configuration of Programmable Logic Controllers PLCs
 4.7.1. PLC Programming: LD
 4.7.2. PLC Programming: ST
 4.7.3. PLC Programming: FBD and CFC
 4.7.4. PLC Programming: SFC
4.8. Programming and Configuration of Equipment in Industrial Plants
 4.8.1. Programming of Drives and Controllers
 4.8.2. HMI Programming
 4.8.3. Programming of Manipulator Robots
4.9. Programming and Configuration of Industrial Computer Equipment
 4.9.1. Programming of Vision Systems
 4.9.2. SCADA/Software Programming
 4.9.3. Network Configuration
4.10. Automation Implementation
 4.10.1. State Machine Design
 4.10.2. Implementation of State Machines in PLCs
 4.10.3. Implementation of Analog PID Control Systems in PLCs
 4.10.4. Automation Maintenance and Code Hygiene
 4.10.5. Automation and Plant Simulation

Module 5. Automatic Control Systems in Robotics

5.1. Analysis and Design of Nonlinear Systems
 5.1.1. Analysis and Modeling of Nonlinear Systems
 5.1.2. Feedback Control
 5.1.3. Linearization by Feedback
5.2. Design of Control Techniques for Advanced Non-linear Systems
 5.2.1. Sliding Mode control
 5.2.2. Lyapunov and Backstepping Control
 5.2.3. Control Based on Passivity
5.3. Control Architectures
 5.3.1. The Robotics Paradigm
 5.3.2. Control Architectures
 5.3.3. Applications and Examples of Control Architectures
5.4. Motion Control for Robotic Arms
 5.4.1. Kinematic and Dynamic Modeling
 5.4.2. Control in Joint Space
 5.4.3. Control in Operational Space
5.5. Actuator Force Control
 5.5.1. Force Control
 5.5.2. Impedance Control
 5.5.3. Hybrid Control
5.6. Terrestrial Mobile Robots
 5.6.1. Equations of Motion
 5.6.2. Control Techniques for Terrestrial Robots
 5.6.3. Mobile Manipulators
5.7. Aerial Mobile Robots
 5.7.1. Equations of Motion
 5.7.2. Control Techniques in Aerial Robots
 5.7.3. Aerial Manipulation
5.8. Control Based on Machine Learning Techniques
 5.8.1. Control Using Supervised Learning
 5.8.2. Control Using Reinforced Learning
 5.8.3. Control Using Non-Supervised Learning
5.9. Vision-Based Control
 5.9.1. Position-Based Visual Servoing
 5.9.2. Image-Based Visual Servoing
 5.9.3. Hybrid Visual Servoing
5.10. Predictive Control
 5.10.1. Models and State Estimation
 5.10.2. MPC Applied to Mobile Robots
 5.10.3. MPC Applied to UAVs

Module 6. Planning Algorithms in Robots

6.1. Classical Planning Algorithms
- 6.1.1. Discrete Planning: State Space
- 6.1.2. Planning Problems in Robotics. Robotic Systems Models
- 6.1.3. Classification of Planners

6.2. The Trajectory Planning Problem in Mobile Robots
- 6.2.1. Forms of Environment Representation: Graphs
- 6.2.2. Search Algorithms in Graphs
- 6.2.3. Introduction of Costs in Networks
- 6.2.4. Search Algorithms in Heavy Networks
- 6.2.5. Algorithms with any Angle Approach

6.3. Planning in High Dimensional Robotic Systems
- 6.3.1. High Dimensionality Robotics Problems: Manipulators
- 6.3.2. Direct/Inverse Kinematic Model
- 6.3.3. Sampling Planning Algorithms PRM and RRT
- 6.3.4. Planning Under Dynamic Constraints

6.4. Optimal Sampling Planning
- 6.4.1. Problem of Sampling-Based Planners
- 6.4.2. RRT* Probabilistic Optimality Concept
- 6.4.3. Reconnection Step: Dynamic Constraints
- 6.4.4. CForest. Parallelizing Planning

6.5. Real Implementation of a Motion Planning System
- 6.5.1. Global Planning Problem. Dynamic Environments
- 6.5.2. Cycle of Action, Sensorization. Acquisition of Information from the Environment
- 6.5.3. Local and Global Planning

6.6. Coordination in Multi-Robot Systems I: Centralized System
- 6.6.1. Multirobot Coordination Problem
- 6.6.2. Collision Detection and Resolution: Trajectory Modification with Genetic Algorithms
- 6.6.3. Other Bio-Inspired Algorithms: Particle Swarm and Fireworks
- 6.6.4. Collision Avoidance by Choice of Maneuver Algorithm

6.7. Coordination in Multi-Robot Systems II: Distributed Approaches I
- 6.7.1. Use of Complex Objective Functions
- 6.7.2. Pareto Front
- 6.7.3. Multi-Objective Evolutionary Algorithms

6.8. Coordination in Multi-Robot Systems III: Distributed Approaches II
- 6.8.1. Order 1 Planning Systems
- 6.8.2. ORCA Algorithm
- 6.8.3. Addition of Kinematic and Dynamic Constraints in ORCA

6.9. Decision Planning Theory
- 6.9.1. Decision Theory
- 6.9.2. Sequential Decision Systems
- 6.9.3. Sensors and Information Spaces
- 6.9.4. Planning for Uncertainty in Sensing and Actuation

6.10. Reinforcement Learning Planning Systems
- 6.10.1. Obtaining the Expected Reward of a System
- 6.10.2. Mean Reward Learning Techniques
- 6.10.3. Inverse Reinforcement Learning

Module 7. Computer Vision

7.1. Human Perception
- 7.1.1. Human Visual System
- 7.1.2. Color
- 7.1.3. Visible and Non-Visible Frequencies

7.2. Chronicle of the Computer Vision
- 7.2.1. Principles
- 7.2.2. Evolution
- 7.2.3. The Importance of Computer Vision

7.3. Digital Image Composition
 7.3.1. The Digital Image
 7.3.2. Types of Images
 7.3.3. Color Spaces
 7.3.4. RGB
 7.3.5. HSV and HSL
 7.3.6. CMY-CMYK
 7.3.7. YCbCr
 7.3.8. Indexed Image
7.4. Image Acquisition Systems
 7.4.1. Operation of a Digital Camera
 7.4.2. The Correct Exposure for Each Situation
 7.4.3. Depth of Field
 7.4.4. Resolution
 7.4.5. Image Formats
 7.4.6. HDR Mode
 7.4.7. High Resolution Cameras
 7.4.8. High-Speed Cameras
7.5. Optical Systems
 7.5.1. Optical Principles
 7.5.2. Conventional Lenses
 7.5.3. Telecentric Lenses
 7.5.4. Types of Autofocus Lenses
 7.5.5. Focal Length
 7.5.6. Depth of Field
 7.5.7. Optical Distortion
 7.5.8. Calibration of an Image
7.6. Illumination Systems
 7.6.1. Importance of Illumination
 7.6.2. Frequency Response
 7.6.3. LED Illumination
 7.6.4. Outdoor Lighting
 7.6.5. Types of Lighting for Industrial Applications. Effects
7.7. 3D Acquisition Systems
 7.7.1. Stereo Vision
 7.7.2. Triangulation
 7.7.3. Structured Light
 7.7.4. Time of Flight
 7.7.5. Lidar
7.8. Multispectrum
 7.8.1. Multispectral Cameras
 7.8.2. Hyperspectral Cameras
7.9. Non-Visible Near Spectrum
 7.9.1. IR Cameras
 7.9.2. UV Cameras
 7.9.3. Converting From Non-Visible to Visible by Illumination
7.10. Other Band Spectrums
 7.10.1. X-Ray
 7.10.2. terahertz

Module 8. Applications and State-of-the-Art

8.1. Industrial Applications
 8.1.1. Machine Vision Libraries
 8.1.2. Compact Cameras
 8.1.3. PC-Based Systems
 8.1.4. Industrial Robotics
 8.1.5. Pick and place 2D
 8.1.6. Bin Picking
 8.1.7. Quality Control
 8.1.8. Presence Absence of Components
 8.1.9. Dimensional Control
 8.1.10. Labeling Control
 8.1.11. Traceability

8.2. Autonomous Vehicles
- 8.2.1. Driver Assistance
- 8.2.2. Autonomous Driving

8.3. Artificial Vision for Content Analysis
- 8.3.1. Filtering by Content
- 8.3.2. Visual Content Moderation
- 8.3.3. Tracking Systems
- 8.3.4. Brand and Logo Identification
- 8.3.5. Video Labeling and Classification
- 8.3.6. Scene Change Detection
- 8.3.7. Text or Credits Extraction

8.4. Medical Application
- 8.4.1. Disease Detection and Localization
- 8.4.2. Cancer and X-Ray Analysis
- 8.4.3. Advances in Artificial Vision Due to Covid-19
- 8.4.4. Assistance in the Operating Room

8.5. Spatial Applications
- 8.5.1. Satellite Image Analysis
- 8.5.2. Computer Vision for the Study of Space
- 8.5.3. Mission to Mars

8.6. Commercial Applications
- 8.6.1. Stock Control
- 8.6.2. Video Surveillance, Home Security
- 8.6.3. Parking Cameras
- 8.6.4. Population Control Cameras
- 8.6.5. Speed Cameras

8.7. Vision Applied to Robotics
- 8.7.1. Drones
- 8.7.2. AGV
- 8.7.3. Vision in Collaborative Robots
- 8.7.4. The Eyes of the Robots

8.8. Augmented Reality
 8.8.1. Operation
 8.8.2. Devices
 8.8.3. Applications in the Industry
 8.8.4. Commercial Applications
8.9. Cloud Computing
 8.9.1. Cloud Computing Platforms
 8.9.2. From cloud computing to production
8.10. Research and State-of-the-Art
 8.10.1. Commercial Applications
 8.10.2. What's Cooking?
 8.10.3. The Future of Computer Vision

Module 9. Artificial Vision Techniques in Robotics: Image Processing and Analysis

9.1. Computer Vision
 9.1.1. Computer Vision
 9.1.2. Elements of a Computer Vision System
 9.1.3. Mathematical Tools
9.2. Optical Sensors for Robotics
 9.2.1. Passive Optical Sensors
 9.2.2. Active Optical Sensors
 9.2.3. Non-Optical Sensors
9.3. Image Acquisition
 9.3.1. Image Representation
 9.3.2. Color Space
 9.3.3. Digitizing Process
9.4. Image Geometry
 9.4.1. Lens Models
 9.4.2. Camera Models
 9.4.3. Camera Calibration
9.5. Mathematical Tools
 9.5.1. Histogram of an Image
 9.5.2. Convolution
 9.5.3. Fourier Transform
9.6. Image Preprocessing
 9.6.1. Noise Analysis
 9.6.2. Image Smoothing
 9.6.3. Image Enhancement
9.7. Image Segmentation
 9.7.1. Contour-Based Techniques
 9.7.3. Histogram-Based Techniques
 9.7.4. Morphological Operations
9.8. Image Feature Detection
 9.8.1. Point of Interest Detection
 9.8.2. Feature Descriptors
 9.8.3. Feature Matching
9.9. 3D Vision Systems
 9.9.1. 3D Perception
 9.9.2. Feature Matching between Images
 9.9.3. Multiple View Geometry
9.10. Computer Vision based Localization
 9.10.1. The Robot Localization Problem
 9.10.2. Visual Odometry
 9.10.3. Sensory Fusion

Module 10. Robot Visual Perception Systems with Automatic Learning

10.1. Unsupervised Learning Methods applied to Computer Vision
- 10.1.1. Clustering
- 10.1.2. PCA
- 10.1.3. Nearest Neighbors
- 10.1.4. Similarity and Matrix Decomposition

10.2. Supervised Learning Methods Applied to Computer Vision
- 10.2.1. Concept “Bag of words”
- 10.2.2. Support Vector Machine
- 10.2.3. Latent Dirichlet Allocation
- 10.2.4. Neural Networks

10.3. Deep Neural Networks:: Structures, Backbones and Transfer Learning
- 10.3.1. Feature Generating Layers
  - 10.3.3.1. VGG
  - 10.3.3.2. Densenet
  - 10.3.3.3. ResNet
  - 10.3.3.4. Inception
  - 10.3.3.5. GoogLeNet
- 10.3.2. Transfer Learning
- 10.3.3. The Data Preparation for Training

10.4. Computer Vision with Deep Learning I: Detection and Segmentation
- 10.4.1. YOLO and SSD Differences and Similarities
- 10.4.2. Unet
- 10.4.3. Other Structures

10.5. Computer Vision with Deep Learning II: Generative Adversarial Networks
- 10.5.1. Image Super-Resolution Using GAN
- 10.5.2. Creation of Realistic Images
- 10.5.3. Scene Understanding

10.6. Learning Techniques for Localization and Mapping in Mobile Robotics
- 10.6.1. Loop Closure Detection and Relocation
- 10.6.2. Magic Leap. Super Point and Super Glue
- 10.6.3. Depth from Monocular

10.7. Bayesian Inference and 3D Modeling
- 10.7.1. Bayesian Models and "Classical" Learning
- 10.7.2. Implicit Surfaces with Gaussian Processes (GPIS)
- 10.7.3. 3D Segmentation Using GPIS
- 10.7.4. Neural Networks for 3D Surface Modeling

10.8. End-to-End Applications of Deep Neural Networks
- 10.8.1. End-to-End System. Example of Person Identification
- 10.8.2. Object Manipulation with Visual Sensors
- 10.8.3. Motion Generation and Planning with Visual Sensors

10.9. Cloud Technologies to Accelerate the Development of Deep Learning Algorithms
- 10.9.1. Use of GPUs for Deep Learning
- 10.9.2. Agile development with Google IColab
- 10.9.3. Remote GPUs, Google Cloud and AWS

10.10. Deployment of Neural Networks in Real Applications
- 10.10.1. Embedded Systems
- 10.10.2. Deployment of Neural Networks. Use
- 10.10.3. Network Optimizations in Deployment, Example with TensorRT

Module 11. Visual SLAM. Robot Localization and Simultaneous Mapping by Computer Vision Techniques

11.1. Simultaneous Localization and Mapping (SLAM)
- 11.1.1. Simultaneous Localization and Mapping. SLAM
- 11.1.2. SLAM Applications
- 11.1.3. SLAM Operation

11.2. Projective Geometry
- 11.2.1. Pin-Hole Model
- 11.2.2. Estimation of Intrinsic Parameters of a Chamber
- 11.2.3. Homography, Basic Principles and Estimation
- 11.2.4. Fundamental Matrix, Principles and Estimation

11.3. Gaussian Filters
- 11.3.1. Kalman Filter
- 11.3.2. Information Filter
- 11.3.3. Adjustment and Parameterization of Gaussian Filters

11.4. Stereo EKF-SLAM
- 11.4.1. Stereo Camera Geometry
- 11.4.2. Feature Extraction and Search
- 11.4.3. Kalman Filter for Stereo SLAM
- 11.4.4. Stereo EKF-SLAM Parameter Setting

11.5. Monocular EKF-SLAM
- 11.5.1. EKF-SLAM Landmark Parameterization
- 11.5.2. Kalman Filter for Monocular SLAM
- 11.5.3. Monocular EKF-SLAM Parameter Tuning

11.6. Loop Closure Detection
- 11.6.1. Brute Force Algorithm
- 11.6.2. FABMAP
- 11.6.3. Abstraction Using GIST and HOG
- 11.6.4. Deep Learning Detection

11.7. Graph-SLAM
- 11.7.1. Graph-SLAM
- 11.7.2. RGBD-SLAM
- 11.7.3. ORB-SLAM

11.8. Direct Visual SLAM
- 11.8.1. Analysis of the Direct Visual SLAM algorithm
- 11.8.2. LSD-SLAM
- 11.8.3. SVO

11.9. Visual Inertial SLAM
- 11.9.1. Integration of Inertial Measurements
- 11.9.2. Low Coupling: SOFT-SLAM
- 11.9.3. High Coupling: Vins-Mono

11.10. Other SLAM Technologies
- 11.10.1. Applications Beyond Visual SLAM
- 11.10.2. Lidar-SLAM
- 11.10.3. Range-only SLAM

Module 12. Application of Virtual and Augmented Reality Technologies to Robotics

12.1. Immersive Technologies in Robotics
- 12.1.1. Virtual Reality in Robotics
- 12.1.2. Augmented Reality in Robotics
- 12.1.3. Mixed Reality in Robotics
- 12.1.4. Difference between Realities

12.2. Construction of Virtual Environments
- 12.2.1. Materials and Textures
- 12.2.2. Lighting
- 12.2.3. Virtual Sound and Smell

12.3. Robot Modeling in Virtual Environments
- 12.3.1. Geometric Modeling
- 12.3.2. Physical Modeling
- 12.3.3. Model Standardization

12.4. Modeling of Robot Dynamics and Kinematics Virtual Physical Engines
- 12.4.1. Physical Motors. Typology
- 12.4.2. Configuration of a Physical Engine
- 12.4.3. Physical Motors in the Industry

12.5. Platforms, Peripherals and Tools Most Commonly Used in Virtual Reality
- 12.5.1. Virtual Reality Viewers
- 12.5.2. Interaction Peripherals
- 12.5.3. Virtual Sensors

12.6. Augmented Reality Systems
- 12.6.1. Insertion of Virtual Elements into Reality
- 12.6.2. Types of Visual Markers
- 12.6.3. Augmented Reality Technologies

12.7. Metaverse: Virtual Environments of Intelligent Agents and People
- 12.7.1. Avatar Creation
- 12.7.2. Intelligent Agents in Virtual Environments
- 12.7.3. Construction of Multi-User Environments for VR/AR

12.8. Creation of Virtual Reality Projects for Robotics
- 12.8.1. Phases of Development of a Virtual Reality Project
- 12.8.2. Deployment of Virtual Reality Systems
- 12.8.3. Virtual Reality Resources

12.9. Creating Augmented Reality Projects for Robotics
- 12.9.1. Phases of Development of an Augmented Reality Project
- 12.9.2. Deployment of Augmented Reality Projects
- 12.9.3. Augmented Reality Resources

12.10. Robot Teleoperation with Mobile Devices
- 12.10.1. Mixed Reality on Mobile Devices
- 12.10.2. Immersive Systems using Mobile Device Sensors
- 12.10.3. Examples of Mobile Projects

Module 13. Robot Communication and Interaction Systems

13.1. Speech Recognition: Stochastic Systems
- 13.1.1. Acoustic Speech Modeling
- 13.1.2. Hidden Markov Models
- 13.1.3. Linguistic Speech Modeling: N-Grams, BNF Grammars

13.2. Speech Recognition Deep Learning
- 13.2.1. Deep Neural Networks
- 13.2.2. Recurrent Neural Networks
- 13.2.3. LSTM Cells

13.3. Speech Recognition: Prosody and Environmental Effects
- 13.3.1. Ambient Noise
- 13.3.2. Multi-Speaker Recognition
- 13.3.3. Speech Pathologies

13.4. Natural Language Understanding: Heuristic and Probabilistic Systems
- 13.4.1. Syntactic-Semantic Analysis: Linguistic Rules
- 13.4.2. Comprehension Based on Heuristic Rules
- 13.4.3. Probabilistic Systems: Logistic Regression and SVM
- 13.4.4. Understanding Based on Neural Networks

13.5. Dialog Management: Heuristic/Probabilistic Strategies
- 13.5.1. Interlocutor's Intention
- 13.5.2. Template-Based Dialog
- 13.5.3. Stochastic Dialog Management: Bayesian Networks

13.6. Dialog Management: Advanced Strategies
- 13.6.1. Reinforcement-Based Learning Systems
- 13.6.2. Neural Network-Based Systems
- 13.6.3. From Speech to Intention in a Single Network

13.7. Response Generation and Speech Synthesis
- 13.7.1. Response Generation: From Idea to Coherent Text
- 13.7.2. Speech Synthesis by Concatenation
- 13.7.3. Stochastic Speech Synthesis

13.8. Dialogue Adaptation and Contextualization
- 13.8.1. Dialogue Initiative
- 13.8.2. Adaptation to the Speaker
- 13.8.3. Adaptation to the Context of the Dialogue

13.9. Robots and Social Interactions:Emotion Recognition, Synthesis and Expression
- 13.9.1. Artificial Voice Paradigms: Robotic Voice and Natural Voice
- 13.9.2. Emotion Recognition and Sentiment Analysis
- 13.9.3. Emotional Voice Synthesis

13.10. Robots and Social Interactions: Advanced Multimodal Interfaces
- 13.10.1. Combination of Vocal and Tactile Interfaces
- 13.10.2. Sign Language Recognition and Translation
- 13.10.3. Visual Avatars: Voice to Sign Language Translation

Module 14. Digital Image Processing

14.1. Computer Vision Development Environment
- 14.1.1. Computer Vision Libraries
- 14.1.2. Programming Environment
- 14.1.3. Visualization Tools

14.2. Digital image Processing
- 14.2.1. Pixel Relationships
- 14.2.2. Image Operations
- 14.2.3. Geometric Transformations

Module 15. Advanced Digital Image Processing

15.5. Facial Recognition
- 15.5.1. Facial Landmark Detection
- 15.5.2. Applications
- 15.5.3. Facial Recognition
- 15.5.4. Emotion Recognition

15.6. Panoramic and Alignment
- 15.6.1. Stitching
- 15.6.2. Image Composition
- 15.6.3. Photomontage

15.7. High Dynamic Range (HDR) and Photometric Stereo
- 15.7.1. Increasing the Dynamic Range
- 15.7.2. Image Compositing for Contour Enhancement
- 15.7.3. Techniques for the Use of Dynamic Applications

15.8. Image Compression
- 15.8.1. Image Compression
- 15.8.2. Types of Compressors
- 15.8.3. Image Compression Techniques

15.9. Video Processing
- 15.9.1. Image Sequences
- 15.9.2. Video Formats and Codecs
- 15.9.3. Reading a Video
- 15.9.4. Frame Processing

15.10. Real Application of Image Processing
- 15.10.1. Problem Analysis
- 15.10.2. Image Processing
- 15.10.3. Feature Extraction
- 15.10.4. Final Results

Module 16. 3D Image Processing

16.1. 3D Imaging
- 16.1.1. 3D Imaging
- 16.1.2. 3D Image Processing Software and Visualizations
- 16.1.3. Metrology Software

16.2. Open 3D
- 16.2.1. Library for 3D Data Processing
- 16.2.2. Features
- 16.2.3. Installation and Use

16.3. The Data
- 16.3.1. Depth Maps in 2D Image
- 16.3.2. Pointclouds
- 16.3.3. Normal
- 16.3.4. Surfaces

16.4. Visualization
- 16.4.1. Data Visualization
- 16.4.2. Controls
- 16.4.3. Web Display

16.5. Filters
- 16.5.1. Distance Between Points, Eliminate Outliers
- 16.5.2. High Pass Filter
- 16.5.3. Downsampling

16.6. Geometry and Feature Extraction
- 16.6.1. Extraction of a Profile
- 16.6.2. Depth Measurement
- 16.6.3. Volume
- 16.6.4. 3D Geometric Shapes
- 16.6.5. Shots
- 16.6.6. Projection of a Point
- 16.6.7. Geometric Distances
- 16.6.8. Kd Tree
- 16.6.9. Features 3D

16.7. Registration and Meshing
- 16.7.1. Concatenation
- 16.7.2. ICP
- 16.7.3. Ransac 3D

16.8. 3D Object Recognition
- 16.8.1. Searching for an Object in the 3D Scene
- 16.8.2. Segmentation
- 16.8.3. Bin Picking

16.9. Surface Analysis
- 16.9.1. Smoothing
- 16.9.2. Orientable Surfaces
- 16.9.3. Octree

16.10. Triangulation
- 16.10.1. From Mesh to Point Cloud
- 16.10.2. Depth Map Triangulation
- 16.10.3. Triangulation of unordered PointClouds

Module 17. Convolutional Neural Networks and Image Classification

17.1. Convolutional Neural Networks
- 17.1.1. Introduction
- 17.1.2. Convolution
- 17.1.3. CNN Building Blocks

17.2. Types of CNN Layers
- 17.2.1. Convolutional
- 17.2.2. Activation
- 17.2.3. Batch Normalization
- 17.2.4. Polling
- 17.2.5. Fully Connected

17.3. Metrics
- 17.3.1. Matrix Confusion
- 17.3.2. Accuracy
- 17.3.3. Precision
- 17.3.4. Recall
- 17.3.5. F1 Score
- 17.3.6. ROC Curve
- 17.3.7. AUC

17.4. Main Architectures
- 17.4.1. AlexNet
- 17.4.2. VGG
- 17.4.3. Resnet
- 17.4.4. GoogleLeNet

17.5. Image Classification
- 17.5.1. Introduction
- 17.5.2. Analysis of Data
- 17.5.3. Data Preparation
- 17.5.4. Model Training
- 17.5.5. Model Validation

17.6. Practical Considerations for CNN Training
- 17.6.1. Optimizer Selection
- 17.6.2. Learning Rate Scheduler
- 17.6.3. Check Training Pipeline
- 17.6.4. Training with Regularization

17.7. Best Practices in Deep Learning
- 17.7.1. Transfer Learning
- 17.7.2. Fine Tuning
- 17.7.3. Data Augmentation

17.8. Statistical Data Evaluation
- 17.8.1. Number of datasets
- 17.8.2. Number of Labels
- 17.8.3. Number of Images
- 17.8.4. Data Balancing

17.9. Deployment
- 17.9.1. Saving and Loading Models
- 17.9.2. Onnx
- 17.9.3. Inference

17.10. Case Study: Image Classification
- 17.10.1. Data Analysis and Preparation
- 17.10.2. Testing the Training Pipeline
- 17.10.3. Model Training
- 17.10.4. Model Validation

Module 18. Object Detection

18.1. Object Detection and Tracking
- 18.1.1. Object Detection
- 18.1.2. Case Uses
- 18.1.3. Object Tracking
- 18.1.4. Case Uses
- 18.1.5. Occlusions, Rigid and Non-Rigid Poses

18.2. Evaluation Metrics
- 18.2.1. IOU - Intersection Over Union
- 18.2.2. Confidence Score
- 18.2.3. Recall
- 18.2.4. Precision
- 18.2.5. Recall–Precision Curve
- 18.2.6. Mean Average Precision (mAP)

18.3. Traditional Methods
- 18.3.1. Sliding Window
- 18.3.2. Viola Detector
- 18.3.3. HOG
- 18.3.4. Non Maximal Supresion (NMS)

18.4. Datasets
- 18.4.1. Pascal VC
- 18.4.2. MS Coco
- 18.4.3. ImageNet (2014)
- 18.4.4. MOTA Challenge

18.5. Two Shot Object Detector
- 18.5.1. R-CNN
- 18.5.2. Fast R-CNN
- 18.5.3. Faster R-CNN
- 18.5.4. Mask R-CNN

18.6. Single Shot Object Detector
- 18.6.1. SSD
- 18.6.2. YOLO
- 18.6.3. RetinaNet
- 18.6.4. CenterNet
- 18.6.5. EfficientDet

18.7. Backbones
- 18.7.1. VGG
- 18.7.2. ResNet
- 18.7.3. Mobilenet
- 18.7.4. Shufflenet
- 18.7.5. Darknet

18.8. Object Tracking
- 18.8.1. Classical Approaches
- 18.8.2. Particulate Filters
- 18.8.3. Kalman
- 18.8.4. Sorttracker
- 18.8.5. Deep Sort

18.9. Deployment
- 18.9.1. Computing Platform
- 18.9.2. Choice of Backbone
- 18.9.3. Choice of Framework
- 18.9.4. Model Optimization
- 18.9.5. Model Versioning

18.10. Study: detection and tracking of people
- 18.10.1. Detection of People
- 18.10.2. Monitoring of People
- 18.10.3. Re-Identification
- 18.10.4. Counting People in Crowds

Module 19. Image Segmentation with *Deep Learning*

19.1. Object Detection and Segmentation
- 19.1.1. Semantic Segmentation
  - 19.1.1.1. Semantic Segmentation Use Cases
- 19.1.2. Instantiated Segmentation
  - 19.1.2.1. Instantiated Segmentation Use Cases

19.2. Evaluation Metrics
- 19.2.1. Similarities with Other Methods
- 19.2.2. Pixel Accuracy
- 19.2.3. Dice Coefficient (F1 Score)

19.3. Cost Functions
- 19.3.1. Dice Loss
- 19.3.2. Focal Loss
- 19.3.3. Tversky Loss
- 19.3.4. Other Functions

19.4. Traditional Segmentation Methods
- 19.4.1. Threshold Application with Otsu and Riddlen
- 19.4.2. Self-Organized Maps
- 19.4.3. GMM-EM Algorithm

19.5. Semantic Segmentation Applying Deep Learning: FCN
- 19.5.1. FCN
- 19.5.2. Architecture
- 19.5.3. FCN Applications

19.6. Semantic Segmentation Applying Deep Learning: U-NET
- 19.6.1. U-NET
- 19.6.2. Architecture
- 19.6.3. U-NET Application

19.7. Semantic Segmentation Applying Deep Learning: Deep Lab
- 19.7.1. Deep Lab
- 19.7.2. Architecture
- 19.7.3. Deep Lab Application

19.8. Instantiated segmentation applying Deep Learning: Mask RCNN
- 19.8.1. Mask RCNN
- 19.8.2. Architecture
- 19.8.3. Application of a Mask RCNN

19.9. Video Segmentation
- 19.9.1. STFCN
- 19.9.2. Semantic Video CNNs
- 19.9.3. Clockwork Convnets
- 19.9.4. Low-Latency

19.10. Point Cloud Segmentation
- 19.10.1. The Point Cloud
- 19.10.2. PointNet
- 19.10.3. A-CNN

Module 20. Advanced image segmentation and advanced computer vision techniques

20.1. Database for General Segmentation Problems
- 20.1.1. *Pascal Context*
- 20.1.2. *CelebAMask-HQ*
- 20.1.3. *Cityscapes Dataset*
- 20.1.4. *CCP Dataset*

20.2. Semantic segmentation in medicine
- 20.2.1. Semantic segmentation in medicine
- 20.2.2. Datasets for medical problems
- 20.2.3. Practical Applications

20.3. Annotation Tools
- 20.3.1. *Computer Vision Annotation Tool*
- 20.3.2. *LabelMe*
- 20.3.3. Other Tools

20.4. Segmentation tools using different Frameworks
- 20.4.1. Keras
- 20.4.2. Tensorflow v2
- 20.4.3. *Pytorch*
- 20.4.4. Others

20.5. Semantic Segmentation Project. The Data, Phase 1
- 20.5.1. Problem Analysis
- 20.5.2. Input Source for Data
- 20.5.3. Data Analysis
- 20.5.4. Data Preparation

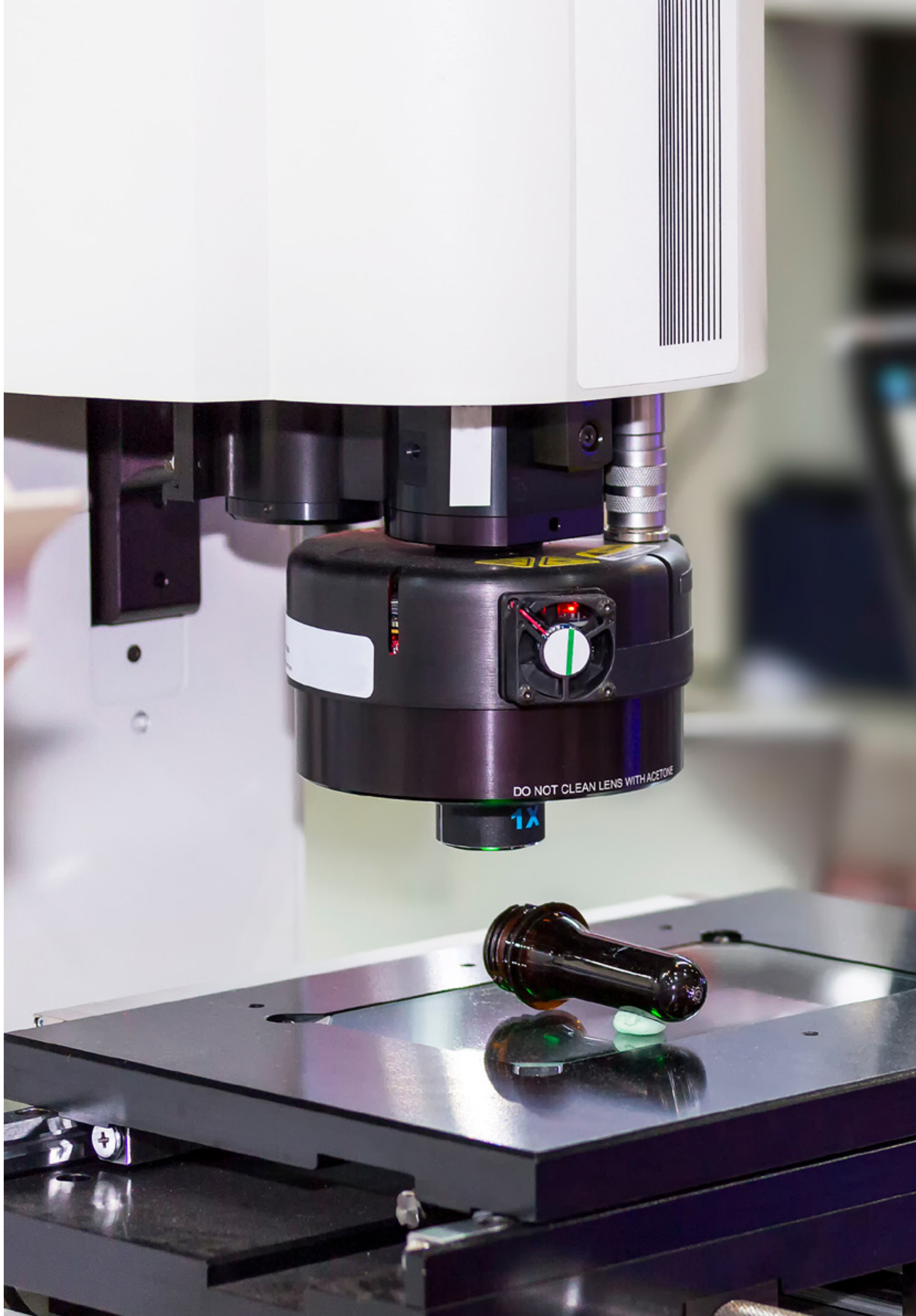
20.6. Semantic Segmentation Project. Training, Phase 2
- 20.6.1. Algorithm Selection
- 20.6.2. Education
- 20.6.3. Assessment

20.7. Semantic Segmentation Project. Results, Phase 3
- 20.7.1. Fine Tuning
- 20.7.2. Presentation of The Solution
- 20.7.3. Conclusions

20.8. Autoencoders
- 20.8.1. Autoencoders
- 20.8.2. Architecture of an Autoencoder
- 20.8.3. Noise Removal Autoencoders
- 20.8.4. Automatic Coloring Autoencoder

20.9. Generative Adversarial Networks (GANs)
- 20.9.1. Generative Adversarial Networks (GANs)
- 20.9.2. DCGAN Architecture
- 20.9.3. Conditional GAN Architecture

20.10. Enhanced Generative Adversarial Networks
- 20.10.1. Overview of the Problem
- 20.10.2. WGAN
- 20.10.3. LSGAN
- 20.10.4. ACGAN



Differentiate yourself from the rest of your competitors by acquiring specialized skills in a field with great growth potential"

06

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 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

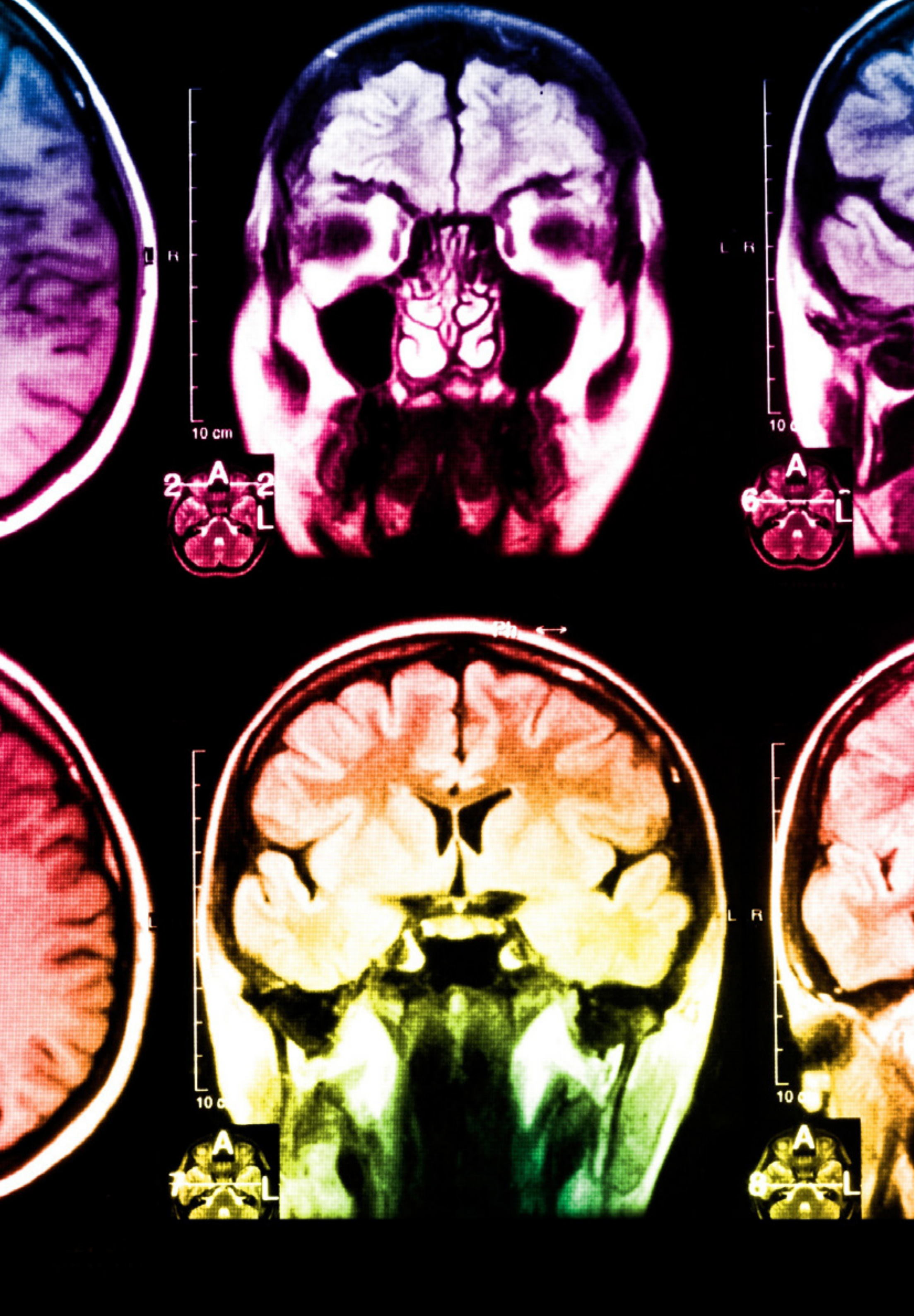
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

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.

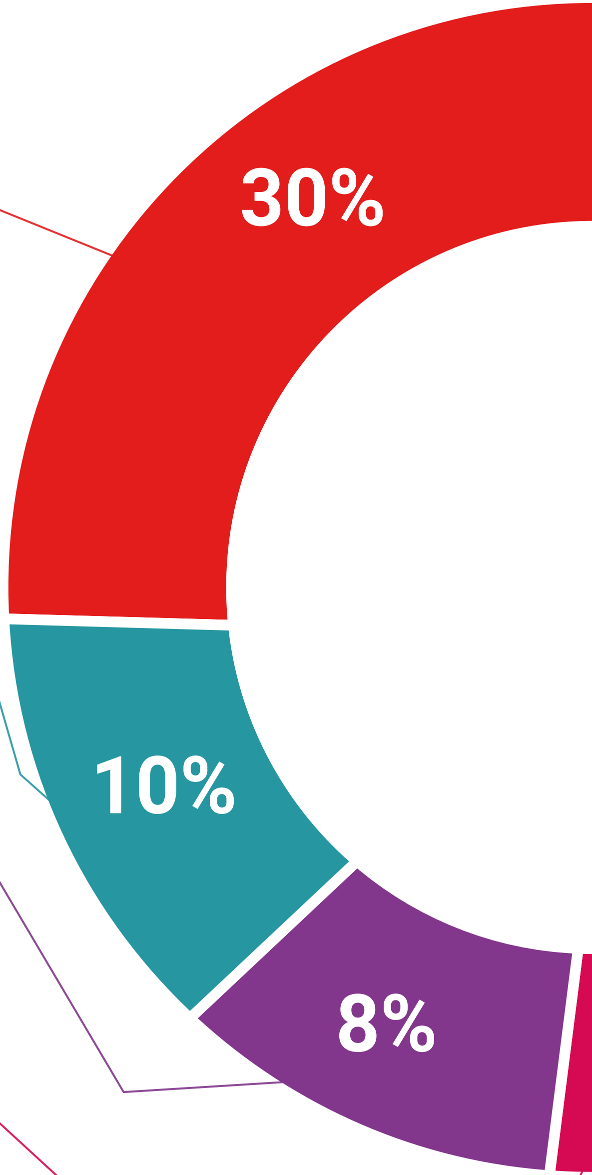
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

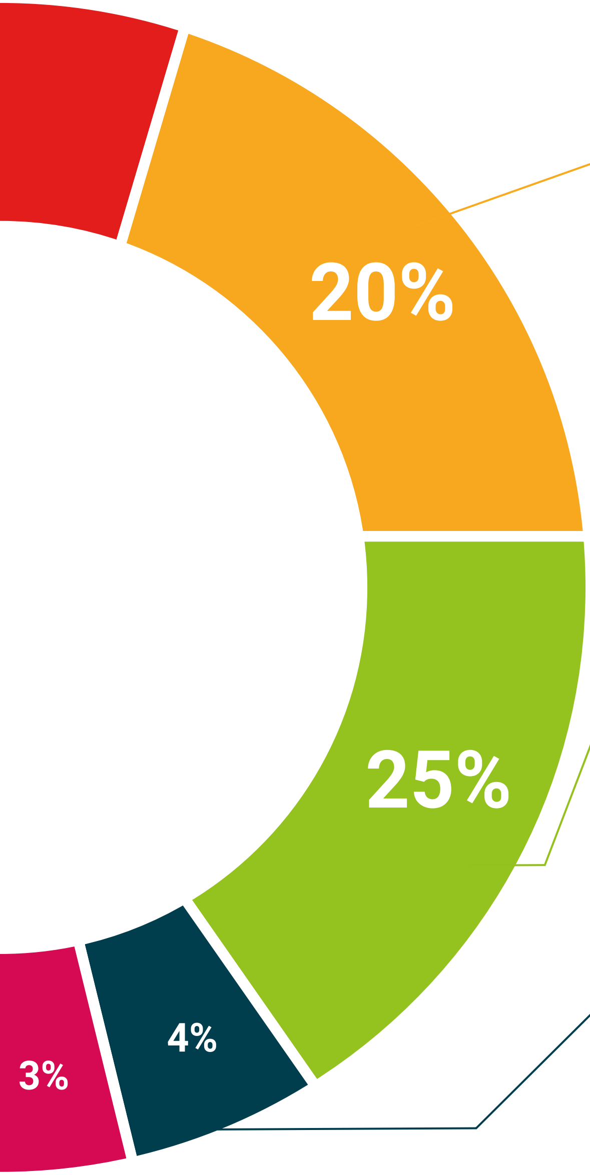
Practising Skills and Abilities

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.

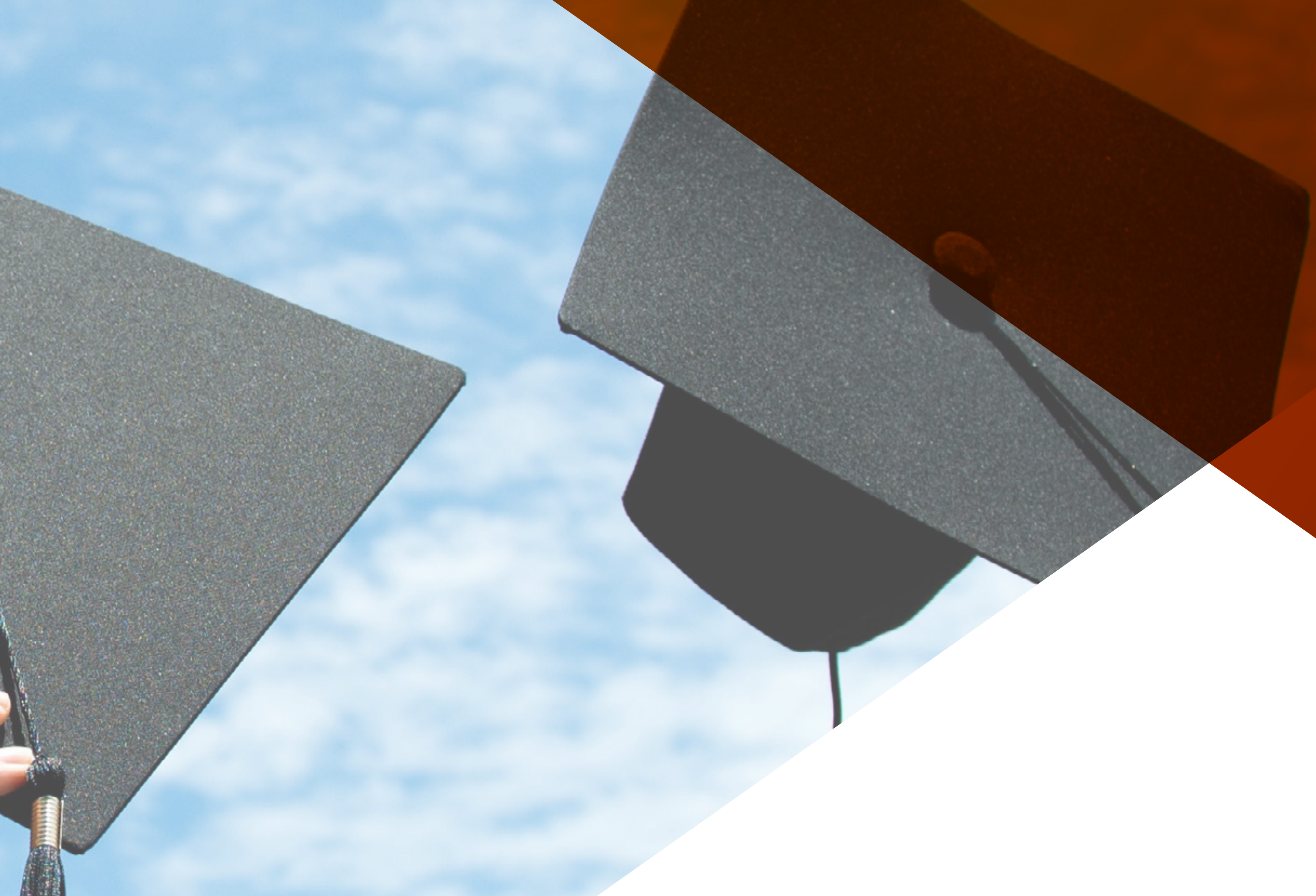
This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

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.

07
Certificate

The Advanced Master's Degree in Robotics and Artificial Vision guarantees students, in addition to the most rigorous and up to date education, access to an Advanced Master's Degree issued by TECH Global University.



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

This program will allow you to obtain your **Advanced Master's Degree diploma in Robotics and Artificial Vision** 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.

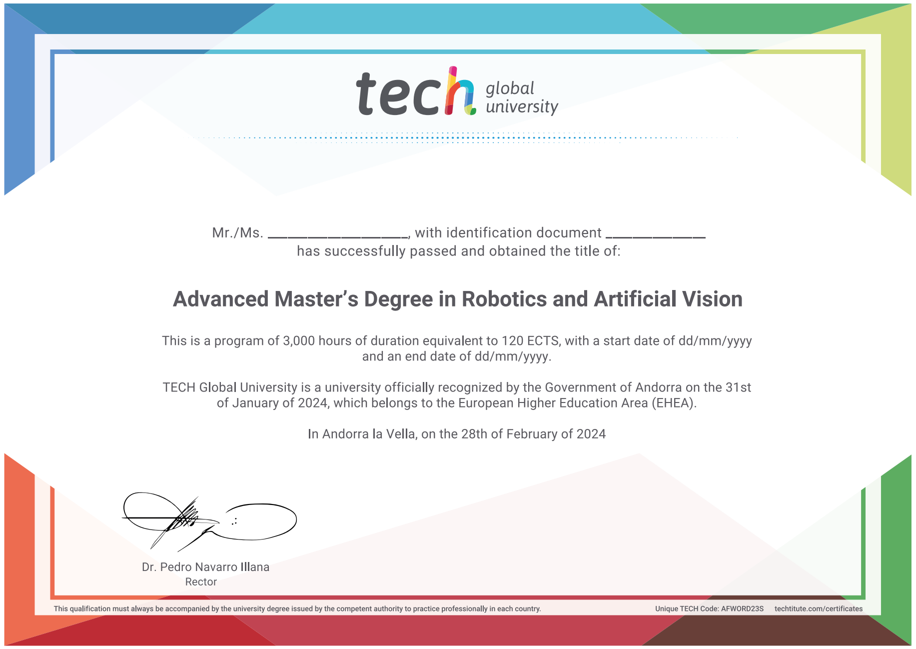
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Advanced Master's Degree in Robotics and Artificial Vision**

Modality: **online**

Duration: **2 years**

Accreditation: **120 ECTS**


tech global university

Mr./Ms. _________________, with identification document ____________
has successfully passed and obtained the title of:

Advanced Master's Degree in Robotics and Artificial Vision

This is a program of 3,000 hours of duration equivalent to 120 ECTS, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH Global University is a university officially recognized by the Government of Andorra on the 31st of January of 2024, which belongs to the European Higher Education Area (EHEA).

In Andorra la Vella, on the 28th of February of 2024

Dr. Pedro Navarro Illana
Rector

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country. Unique TECH Code: AFWORD23S techtitute.com/certificates


Advanced Master's Degree in Robotics and Artificial Vision

General Structure of the Syllabus

Year	Subject	ECTS	Type
1º	Robotic. Robot Design and Modeling	6	CO
1º	Intelligent Agents. Application of Artificial Intelligence to robots and softbots	6	CO
1º	Deep Learning	6	CO
1º	Robotics in the Automation of Industrial Processes	6	CO
1º	Automatic Control Systems in Robotics	6	CO
1º	Planning Algorithms in Robots	6	CO
1º	Computer Vision	6	CO
1º	Applications and State-of-the-Art	6	CO
1º	Artificial Vision Techniques in Robotics: Image Processing and Analysis	6	CO
1º	Robot Visual Perception Systems with Automatic Learning	6	CO

Year	Subject	ECTS	Type
2º	Visual SLAM. Robot Localization and Simultaneous Mapping by Computer Vision Techniques	6	CO
2º	Application of Virtual and Augmented Reality Technologies to Robotics	6	CO
2º	Robot Communication and Interaction Systems	6	CO
2º	Digital Image Processing	6	CO
2º	Advanced Digital Image Processing	6	CO
2º	3D Image Processing	6	CO
2º	Convolutional Neural Networks and Image	6	CO
2º	Classification Object Detection	6	CO
2º	Image Segmentation with Deep Learningl	6	CO
2º	Advanced image segmentation and advanced computervision techniques	6	CO

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*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.

Advanced Master's Degree
Robotics and Artificial Vision

- Modality: **online**
- Duration: **2 years**
- Certificate: **TECH Global University**
- Credits: **120 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Advanced Master's Degree
Robotics and Artificial Vision

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