# Postgraduate Certificate

## Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision

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# Postgraduate Certificate
## Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision

- Modality: **online**
- Duration: **6 weeks**
- Certificate: **TECH Global University**
- Credits: **6 ECTS**
- Schedule: **at your own pace**
- Exams: **online**

Website: www.techtitute.com/us/information-technology/postgraduate-certificate/visual-slam-robot-localization-simultaneous-mapping-using-computer-vision

# Index

01

# Introduction

Technological progress in recent decades has meant that Virtual Reality or Augmented Reality are no longer unknown concepts for the general population, and their application has also extended beyond entertainment, finding multiple sectors in which to grow. The great work done in Computer Vision has been the main cause of this progress, which, in turn, has led to the emergence of new professional profiles or the revaluation of the same. This program is a response to the demand for advanced and specialized knowledge that allows them to consolidate or advance in their careers. The expert teaching team in this field and the most up-to-date multimedia content will be the keys for students to achieve their goals.

*Enroll now in a Postgraduate Certificate designed to acquire advanced knowledge compatible with your professional responsibilities"*

This Postgraduate Certificate, aimed at IT professionals, through a specialized approach provides the necessary tools to analyze different theoretical frameworks, parameterizations and sensors that allow the development of Visual SLAM technology, which has allowed in recent years a growth and revolution in the field of Virtual and Augmented Reality, in the generation of synthetic maps or in the localization of systems in unknown environments.

A program taught by a highly qualified and experienced teaching team in the field of Robotics, which will take students during the 6 weeks of this course through the different techniques and applications of Gaussian Filters, Graphs and Optimization, which will allow students to develop those systems that best align with their knowledge. In addition, the IT professional will have the necessary tools to be able to determine how to apply a Visual SLAM according to different environments and circumstances. All this, with a didactic material that is at the forefront of academic teaching.

TECH offers with this Postgraduate Certificate an excellent opportunity to advance in a booming sector through an education that provides flexibility to students. As such, the IT professional will only need a laptop, tablet or cell phone with an Internet connection to access all the multimedia content available in its entirety from the first day. In this way, and without sessions with fixed schedules, students can conveniently access the Postgraduate Certificate whenever and wherever they wish.

This **Postgraduate Certificate in Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision** 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 with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- Practical exercises where self-assessment can be used to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with an Internet connection

*Get into an area that will allow you to configure drones or robots of great utility in sectors such as cartography or improve realistic scenarios in Virtual Reality"*

*Reduce the long hours of study with the teaching material and the Relearning system provided by TECH in all its programs"*

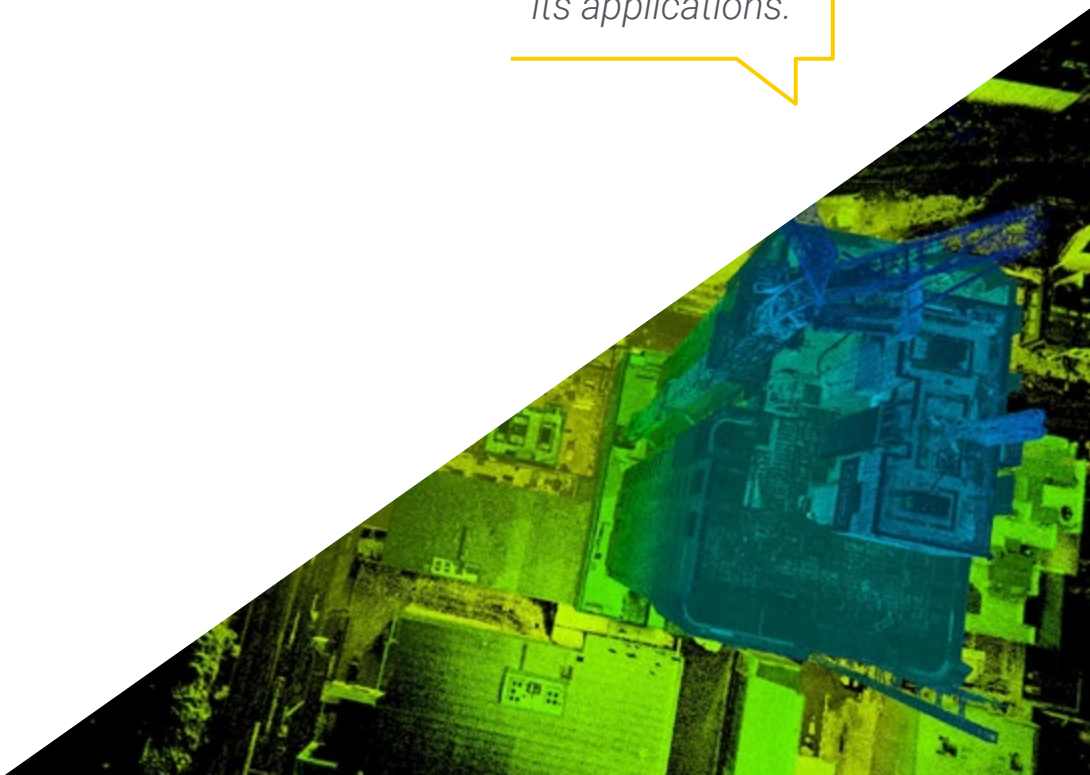
*A Postgraduate Certificate that provides you with real practical cases with great application in your daily work in the field of Robotics.*

*An online teaching that will allow you to delve into projective geometry and its applications.*

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

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

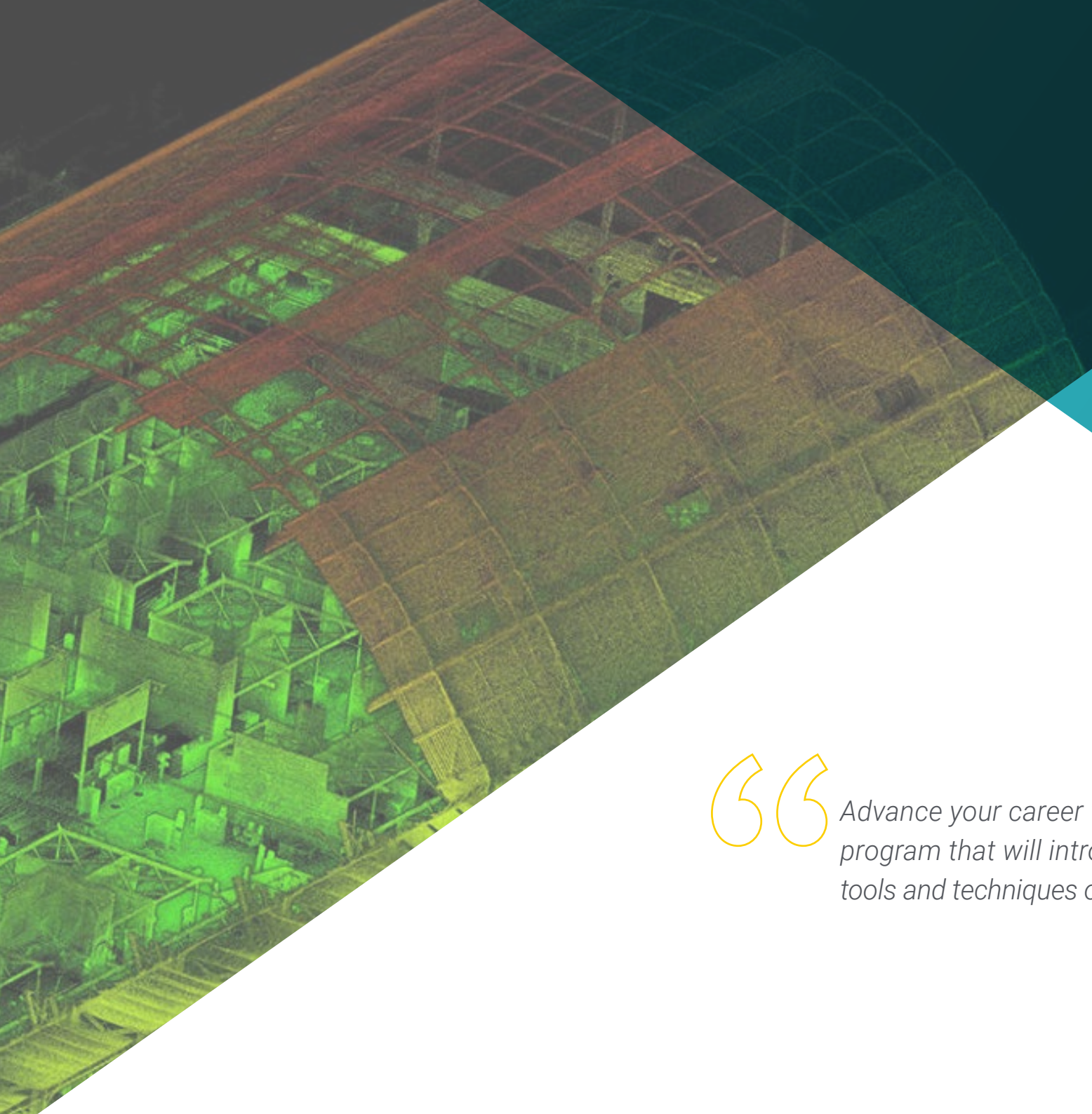
This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise during the academic year For this purpose, the students will be assisted by an innovative interactive video system created by renowned and experienced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



02

# Objectives

At the end of the 180 teaching hours of this Postgraduate Certificate, the students of this program will have acquired a deeper and up-to-date knowledge in the field of Robotics, especially in the Visual SLAM and its most recent applications. In detail, the Computer Science professional will acquire a solid knowledge on the main algorithms used, on projective and epipolar geometry or the main technologies used. The teaching staff specialized in this field will guide the students through this program so that they can achieve their goals in an agile and simple way.



*Advance your career with a university program that will introduce you to the tools and techniques of robot localization"*

## General Objectives

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

*Access with this online program to the most up-to-date knowledge about the algorithms used in Visual SLAM technology"*



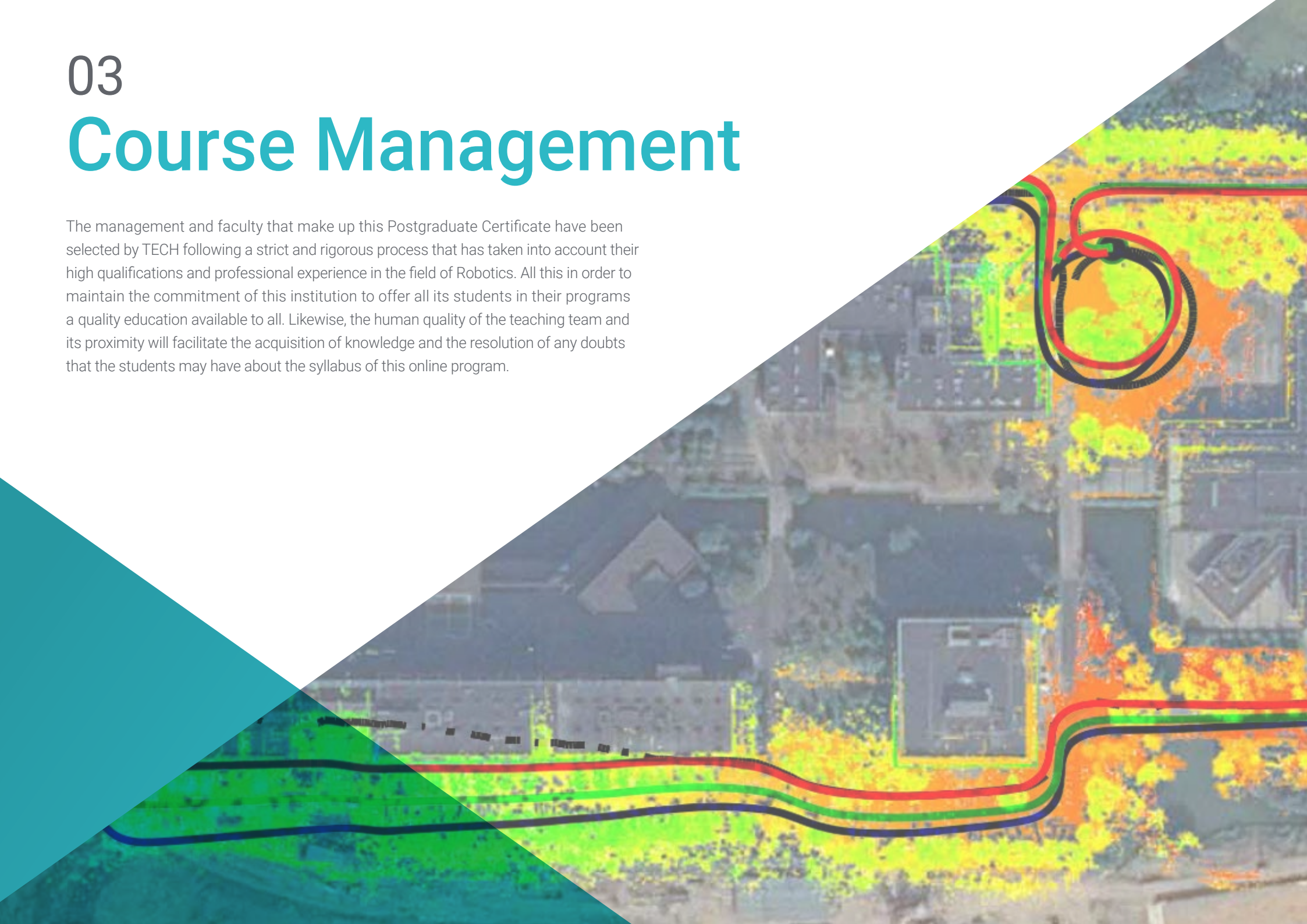
## Specific Objectives

- 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 Filters, Optimization and Loop Closure Detection
- Describe in detail the operation of the main visual SLAM algorithms
- Analyze how to carry out the tuning and parameterization of SLAM algorithms

03

# Course Management

The management and faculty that make up this Postgraduate Certificate have been selected by TECH following a strict and rigorous process that has taken into account their high qualifications and professional experience in the field of Robotics. All this in order to maintain the commitment of this institution to offer all its students in their programs a quality education available to all. Likewise, the human quality of the teaching team and its proximity will facilitate the acquisition of knowledge and the resolution of any doubts that the students may have about the syllabus of this online program.



*You will have at your disposal a close teaching team that will help you achieve your goals. Advance in the field of Robotics"*

## Management

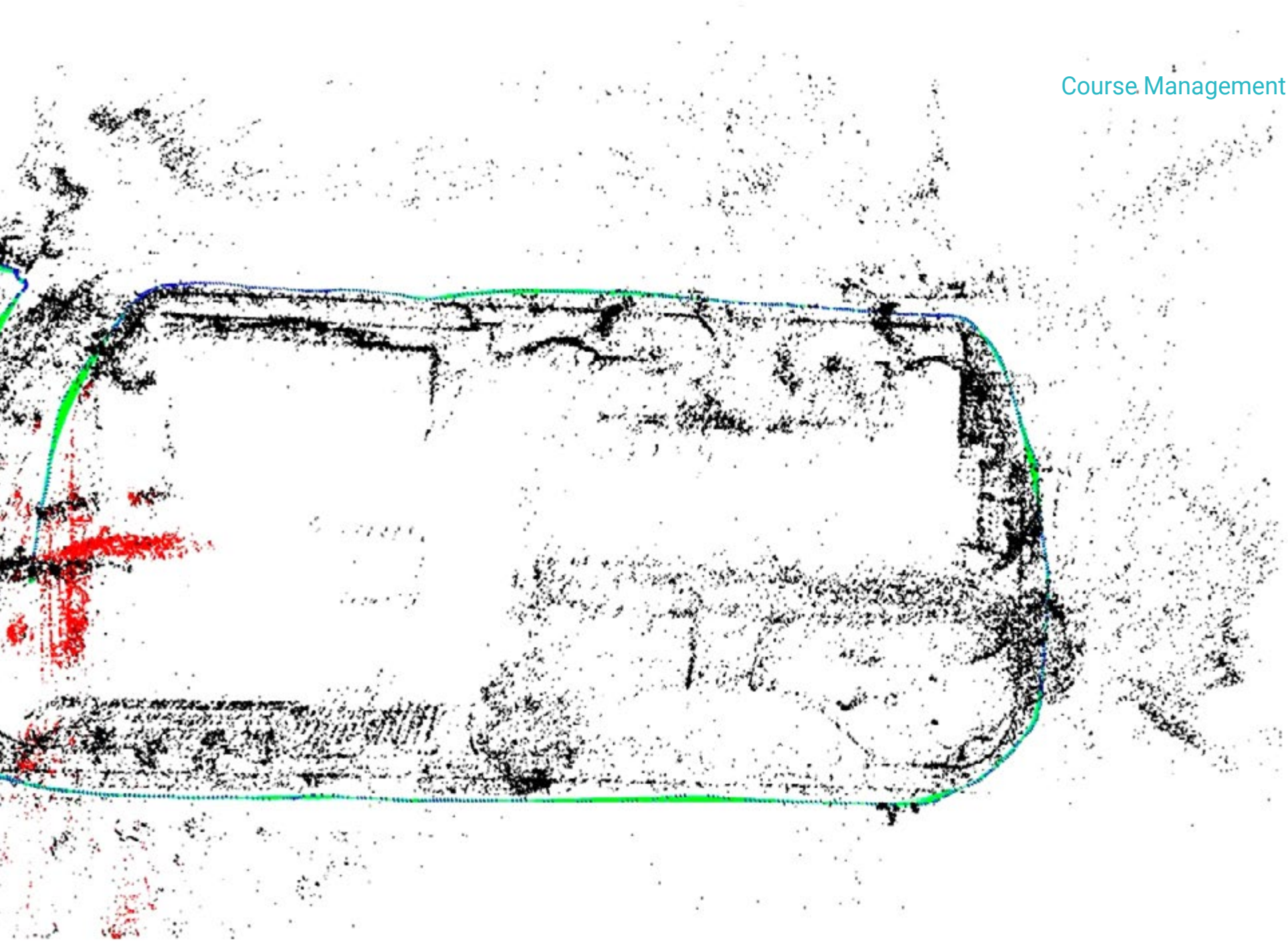
### Dr. Ramón Fabresse, Felipe

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

## Professors

### Dr. 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
- Full Professor of Systems Engineering and Automatics at the University of Seville
- Associate editor of the journal Robotics and Automation Letters



04

# Structure and Content

The syllabus of this Postgraduate Certificate has been developed following the strict guidelines of the teaching team that makes up this program, so that students reach the most comprehensive and up-to-date knowledge on Visual SLAM. To this end, the IT professional will have at his disposal video summaries, specialized readings and real case studies that will facilitate learning in the field of localization and simultaneous mapping, the most used techniques and the most recent applications of Visual SLAM. The Relearning system, applied by TECH in all its programs, will allow students to learn in a more natural and progressive way.

*Learn more about Localization and Simultaneous Mapping in a simpler and more agile way thanks to the Relearning system of this Postgraduate Certificate"*

## Module 1. Visual SLAM. Robot Localization and Simultaneous Mapping by Computer Vision Techniques

1.1. Simultaneous Localization and Mapping (SLAM)
- 1.1.1. Simultaneous Localization and Mapping. SLAM
- 1.1.2. SLAM Applications
- 1.1.3. SLAM Operation

1.2. Projective Geometry
- 1.2.1. Pin-Hole Model
- 1.2.2. Estimation of Intrinsic Parameters of a Chamber
- 1.2.3. Homography, Basic Principles and Estimation
- 1.2.4. Fundamental Matrix, Principles and Estimation

1.3. Gaussian Filters
- 1.3.1. Kalman Filter
- 1.3.2. Information Filter
- 1.3.3. Adjustment and Parameterization of Gaussian Filters

1.4. Stereo EKF-SLAM
- 1.4.1. Stereo Camera Geometry
- 1.4.2. Feature Extraction and Search
- 1.4.3. Kalman Filter for Stereo SLAM
- 1.4.4. Stereo EKF-SLAM Parameter Setting

1.5. Monocular EKF-SLAM
- 1.5.1. EKF-SLAM Landmark Parameterization
- 1.5.2. Kalman Filter for Monocular SLAM
- 1.5.3. Monocular EKF-SLAM Parameter Tuning

1.6. Loop Closure Detection
- 1.6.1. Brute Force Algorithm
- 1.6.2. FABMAP
- 1.6.3. Abstraction Using GIST and HOG
- 1.6.4. Deep Learning Detection



1.7. Graph-SLAM
- 1.7.1. Graph-SLAM
- 1.7.2. RGBD-SLAM
- 1.7.3. ORB-SLAM

1.8. Direct Visual SLAM
- 1.8.1. Analysis of the Direct Visual SLAM Algorithm
- 1.8.2. LSD-SLAM
- 1.8.3. SVO

1.9. Visual Inertial SLAM
- 1.9.1. Integration of Inertial Measurements
- 1.9.2. Low Coupling: SOFT-SLAM
- 1.9.3. High Coupling: Vins-Mono

1.10. Other SLAM Technologies
- 1.10.1. Applications Beyond Visual SLAM
- 1.10.2. Lidar-SLAM
- 1.10.2. Range-only SLAMM

*A Postgraduate Certificate that will allow you to open your field of vision and learn the different applications of Visual SLAM"*

05

# Methodology

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

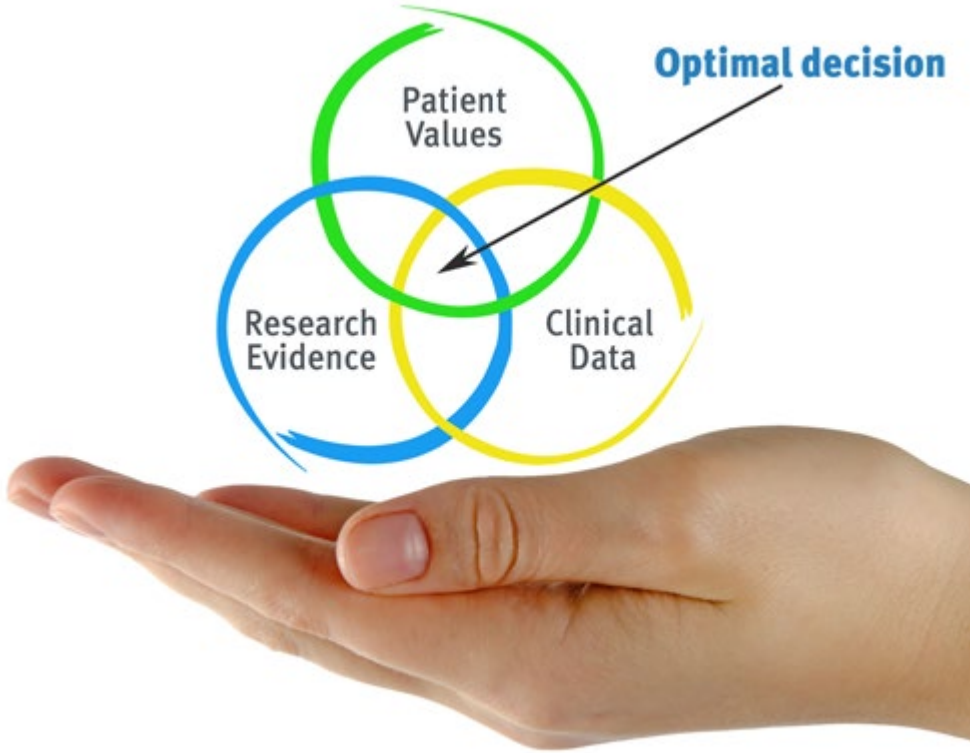
This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

*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

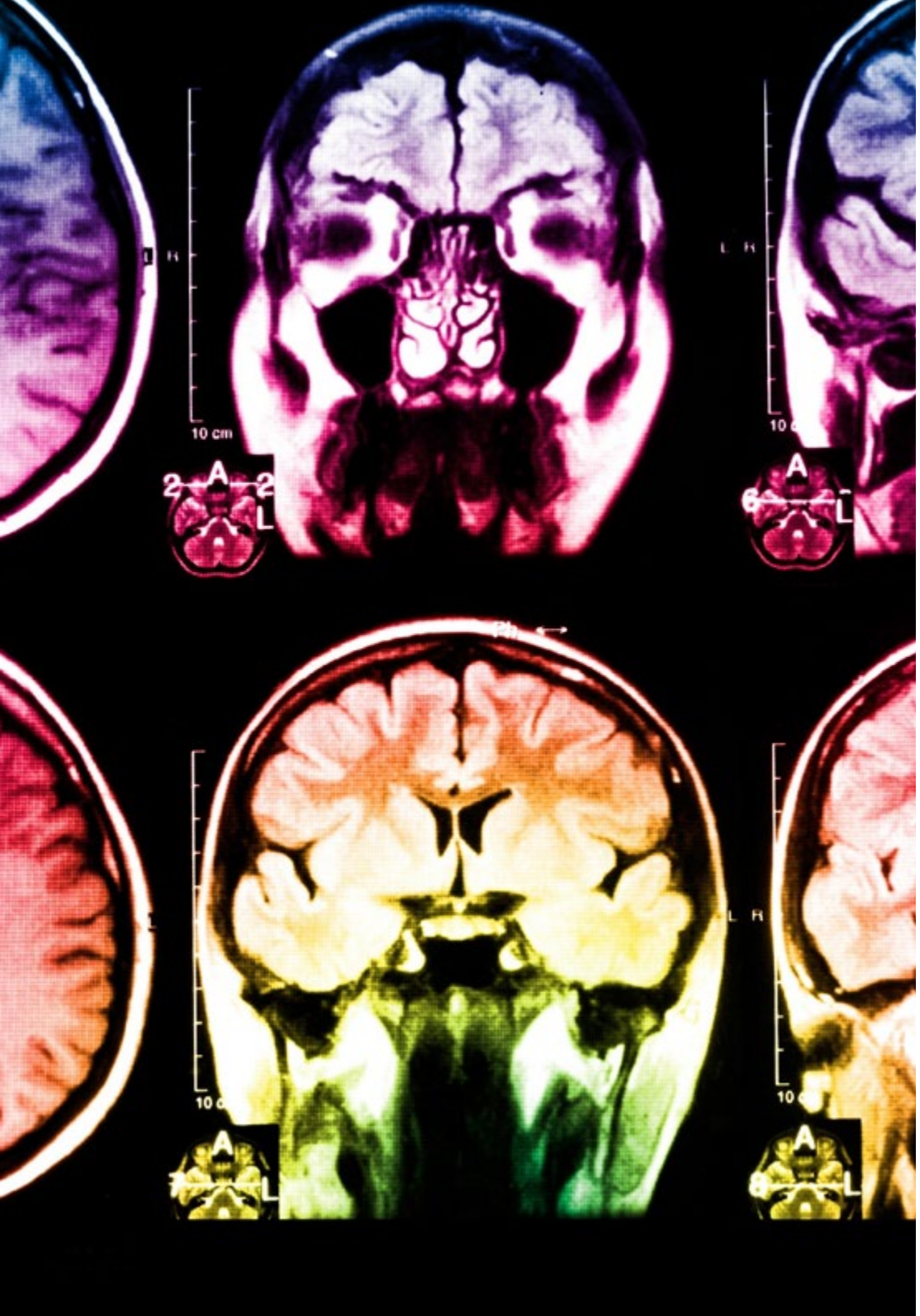
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines different teaching elements in each lesson.

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.

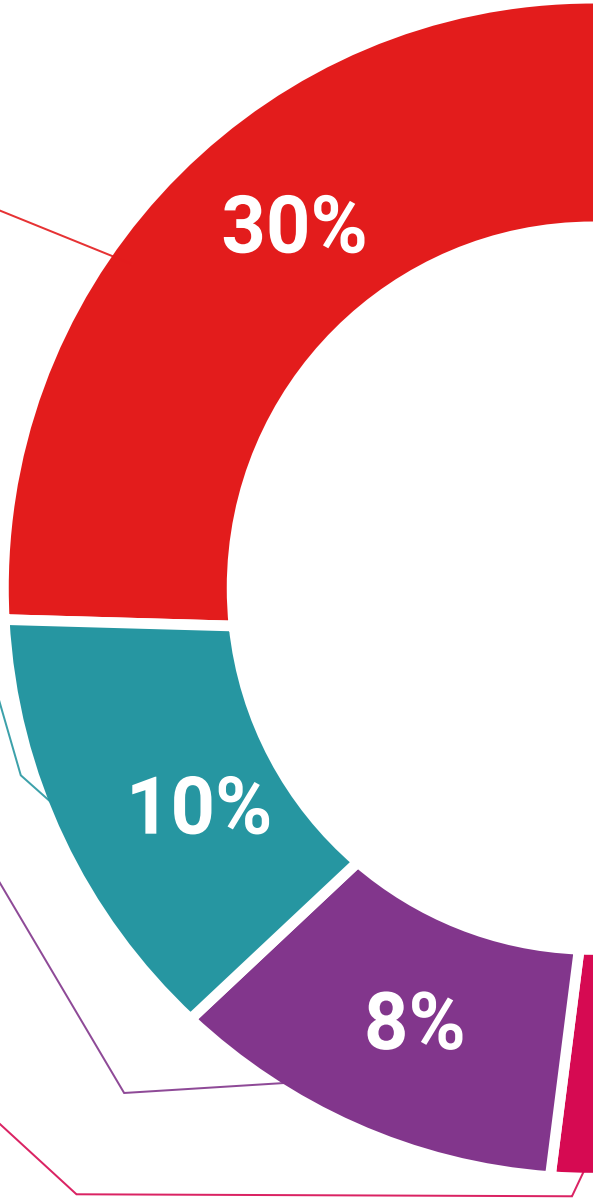
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

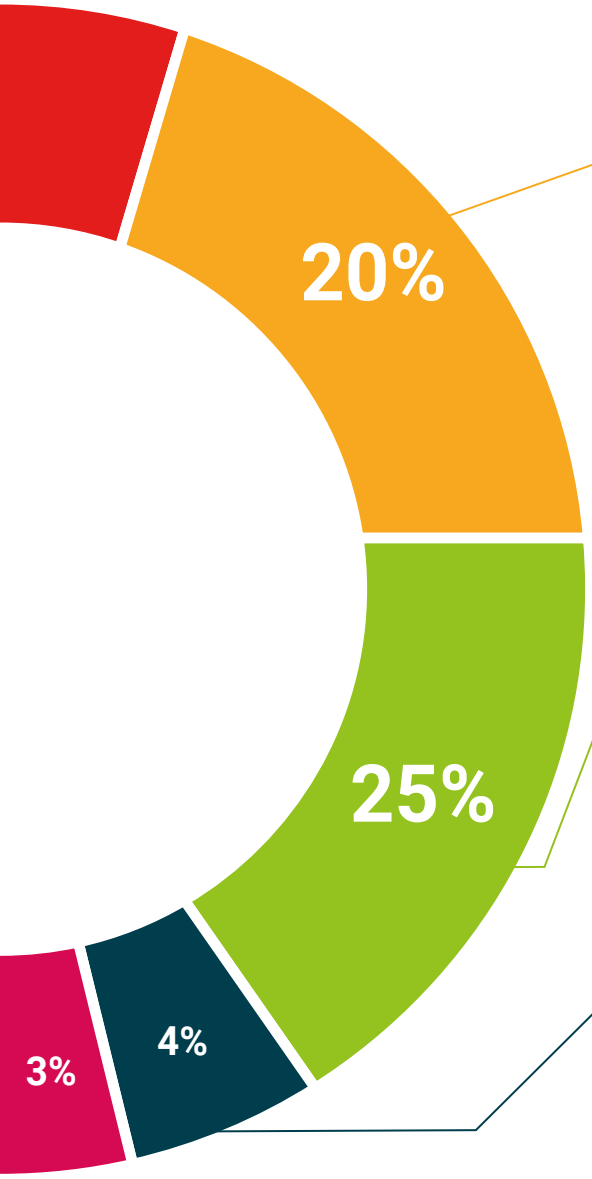
### Practising Skills and Abilities

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 Certificate in Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate 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 **Postgraduate Certificate in Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer 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: **Postgraduate Certificate in Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision**

Modality: **online**

Duration: **6 weeks**

Accreditation: **6 ECTS**


tech global university

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

**Postgraduate Certificate in Visual SLAM: Robot Localization and Simultaneous Mapping Using Computer Vision**

This is a program of 180 hours of duration equivalent to 6 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

Unique TECH Code: AFWORD23S techtitute.com/certificates

*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.

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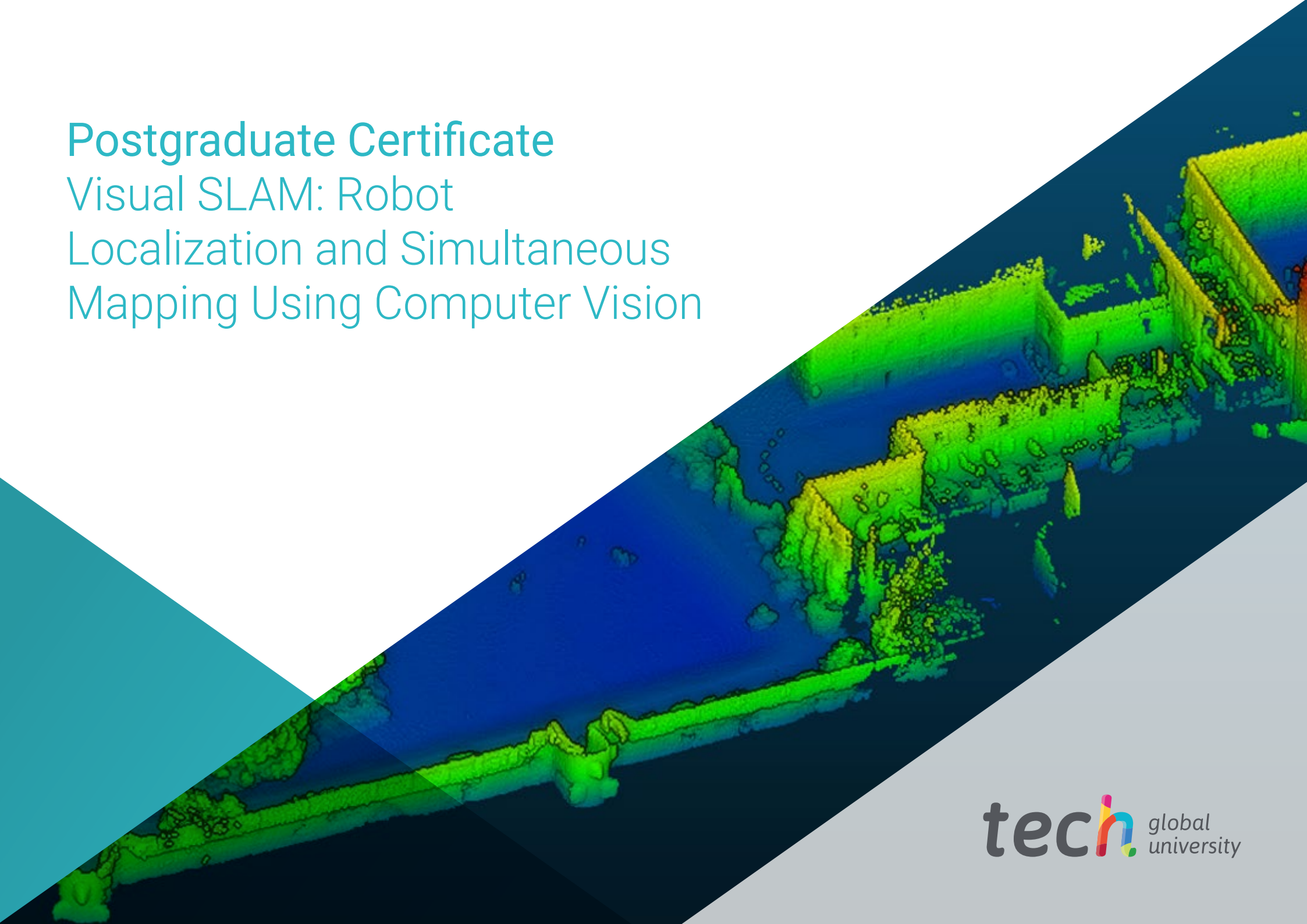

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