

Basque Conference on Cyber Physical Systems and Artificial Intelligence
(18-19/May/2022)
European project cybSpeed

Computer Vision and Artificial intelligence Applications in Industry 4.0



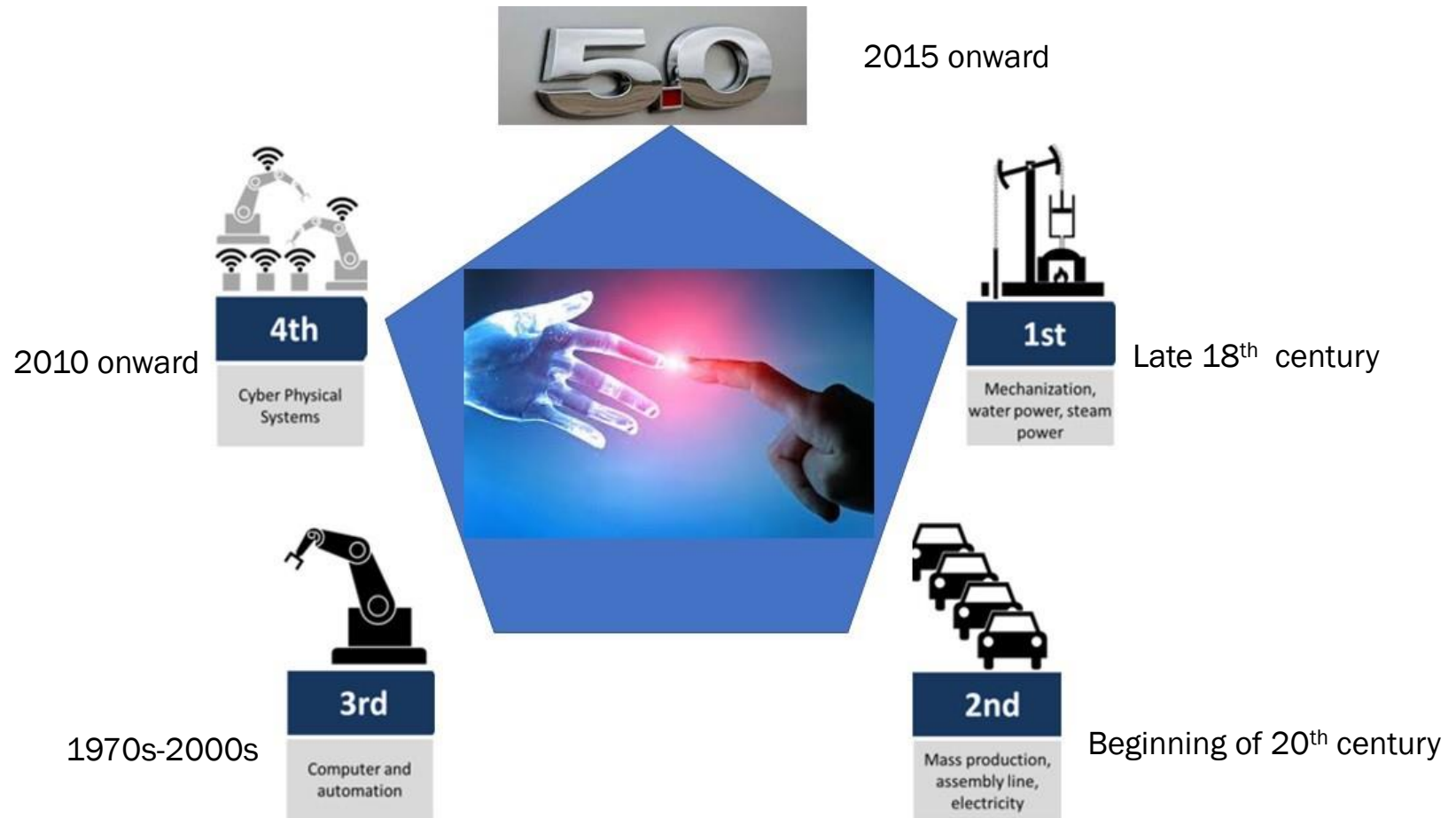
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Overview

- I. Background and motivation
- II. State of the Art
- III. Computer Vision Trends
- IV. Applications of Computer Vision

Industry 5.0 - “Valuate life standard, creativity and high-quality custom-made products”:

To change processes directing towards closer cooperation between man and machine, and systematic prevention of waste and wasting including INDUSTRIAL UPCYCLING



Industry 4.0 - “Smart Factory”:

Cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions, cooperate with each other and with humans in real time, both internal and cross-organizational services are offered and used by participants of the “value chain”.

Background and Motivations

1

Growing need to interact with CV and AI applications/systems, with exponential growth in the last 2 decades.

2

Applications in virtually all areas of knowledge: medical image analysis, agriculture, cultural heritage, robotics, crime surveillance, autonomous cars, industry, among others.

3

New challenges for universities: it is needed an update of curriculum / courses concerning CV/AI, focused on novel/emerging techniques and hardware.

Artificial Intelligence

Thinking Humanly

“The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense.” (Haugeland, 1985)

“[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . .” (Bellman, 1978)

Thinking Rationally

“The study of mental faculties through the use of computational models.”
(Charniak and McDermott, 1985)

“The study of the computations that make it possible to perceive, reason, and act.”
(Winston, 1992)

Acting Humanly

“The art of creating machines that perform functions that require intelligence when performed by people.” (Kurzweil, 1990)

“The study of how to make computers do things at which, at the moment, people are better.” (Rich and Knight, 1991)

Acting Rationally

“Computational Intelligence is the study of the design of intelligent agents.” (Poole *et al.*, 1998)

“AI . . . is concerned with intelligent behavior in artifacts.” (Nilsson, 1998)

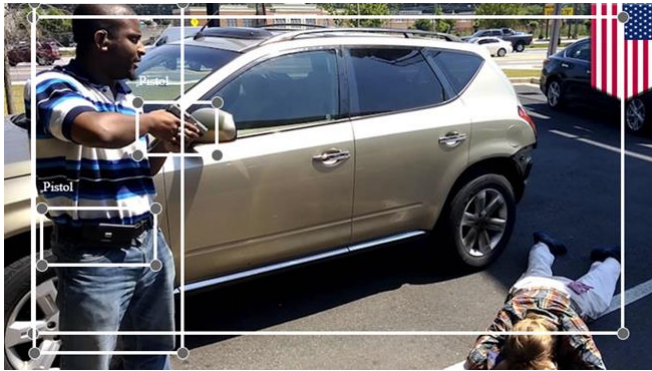
Computer Vision

- *“Computer Vision, image understanding, or scene analysis is that combination of image processing, pattern recognition, and artificial intelligence technologies which focuses on the computer analysis of the one or more images, taken with a simple/multiband sensor or taken in time sequence. The analysis recognizes, locates the position and orientation, and provides a sufficiently detailed symbolic description or recognition of those imaged objects deemed to be of interest in the three-dimensional environment ...”*

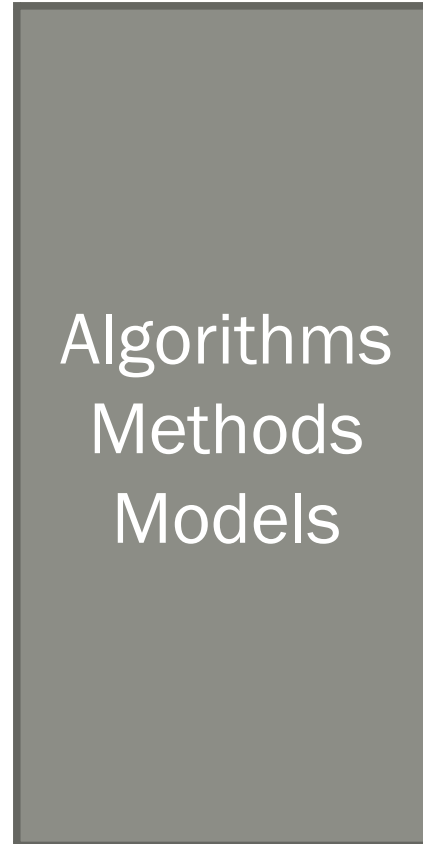
Robert M. Haralick, Linda G. Shapiro. (1991) **“Glossary of computer vision terms.”**
Pattern Recognition Volume 24, Issue 1 1991, Pages 69-93

Computer Vision Workflow

Input

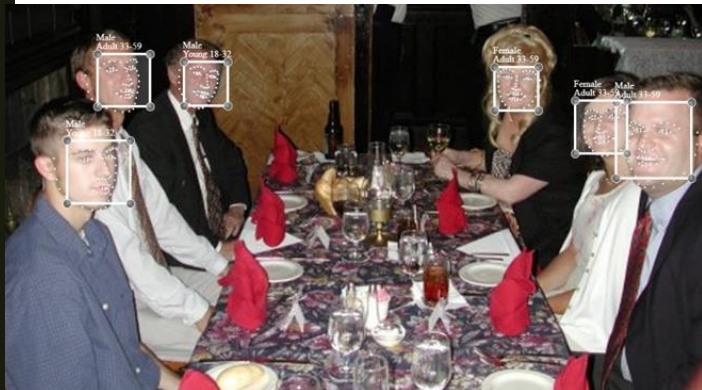


Program



Output

Identified a possible carjacking action...



Identified 6 person, 4 men and two women

Computer Vision and Artificial Intelligence

- AI refers to the ability of machines to process and understand data of any kind.
- CV deals primarily with visual data. CV is one of many components of AI-based products, e.g., Autonomous Cars, Medical Image Analysis, Machine Vision.
- CV is an interdisciplinary field of science that enables computers or other machines to identify and process images and videos, just as the human eye does.
- CV involves several tasks, including signal processing, image enhancement, object detection and classification, motion analysis, and 3D image reconstruction, semantic image understanding.

Average Salary (CV /ML)

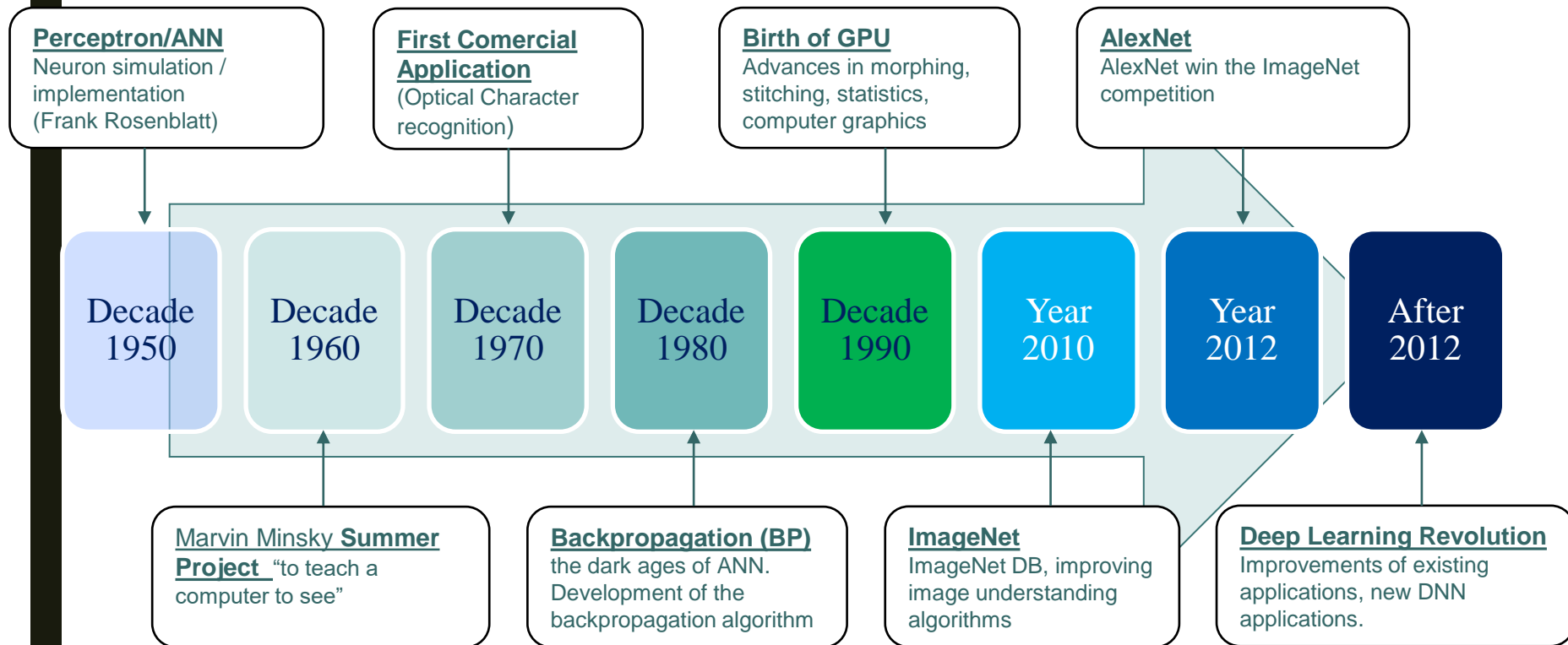
- **The average salary for a Computer Vision Engineer is \$104219.00 per year in the USA.**

Salary estimates are based on 131 salaries submitted anonymously to Indeed by Computer Vision Engineer employees, users, updated at May 10, 2022. (Accessed at: May 18, 2022). (<https://www.indeed.com/salaries/computer-vision-engineer-salaries>).

- **The average salary for a Machine Learning Engineer is \$125604.00 per year in the USA.**

Salary estimates are based on 833 salaries submitted anonymously to Indeed by Computer Vision Engineer employees, users, updated at May 13, 2022. (Accessed at: May 18, 2022). (https://www.indeed.com/career/machine-learning-engineer/salaries?from=top_sb)

State of the Art / Evolution



Trends in Computer Vision

- Ensure Safety in the workplace and people
- Automatic Anomaly Detections for ensuring Quality
- Thermal Imaging Analysis
- Real-time Application of Edge Computing
- Helping hands through Sensor Data
- Leveraging Closed Loop Solutions, mainly to industrial use cases
- More training on Auto-annotation (automated data augmentation)
- Explain of AI solutions
- Explainable AI
- Agriculture 4.0
- Retail and e-Commerce
- Banking solutions
- Healthcare
- Sports and Wellness Industry
- Robotic Process Automation

Some Applications

Urban Probe

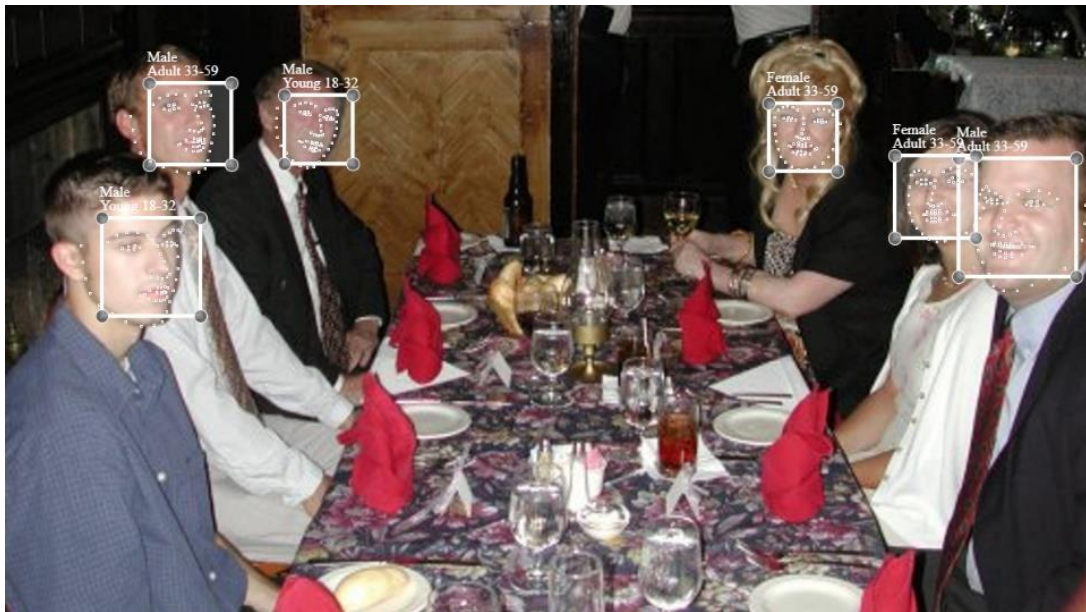
Object (person/car/space) detection and tracking



AGATHA

- A tool, aimed at criminal investigation police and intelligence services, to facilitate the collection of evidence of criminal practices.

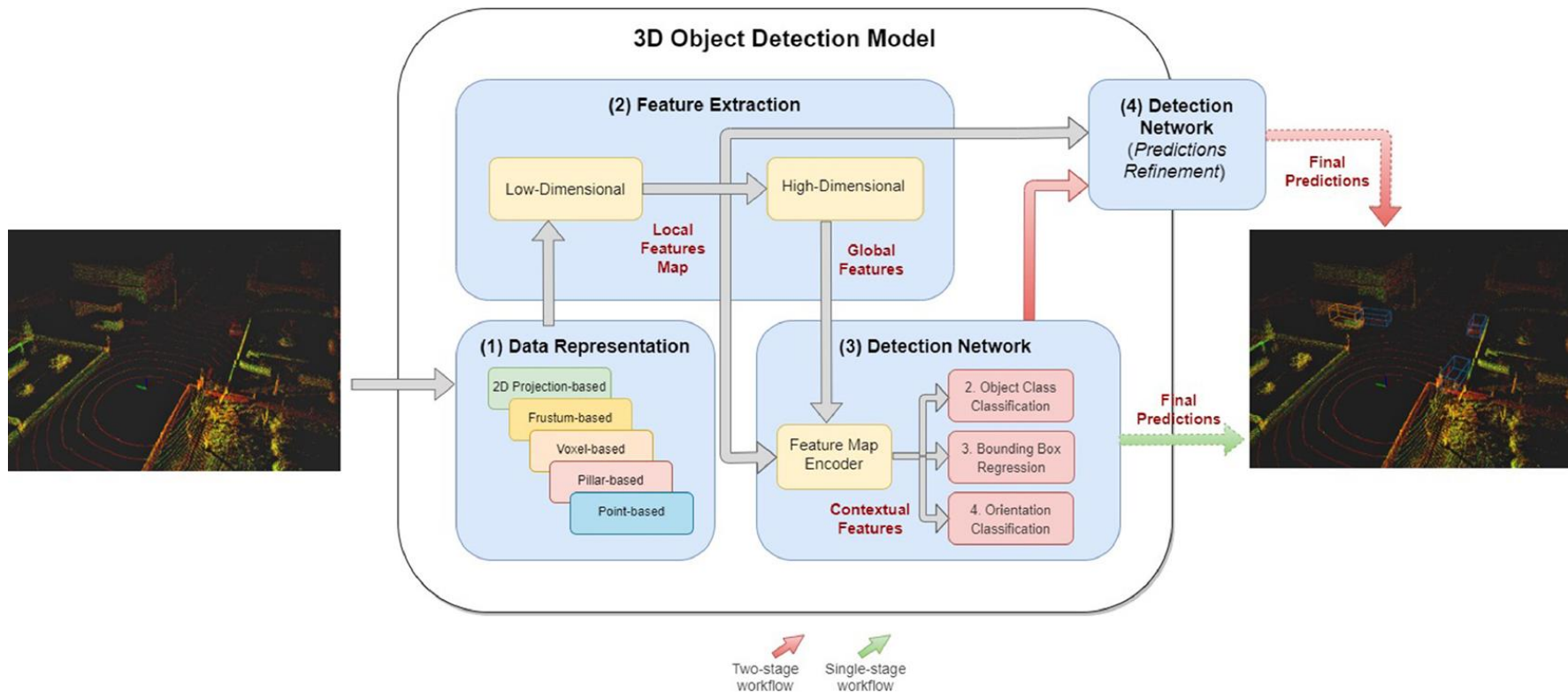
- Automatic analysis of information available from open sources. Ex: social networks, forums, images, blogosphere information, radio and TV.



Brito, P., ..Guevara Lopez, M.A.: *AGATHA: Face Benchmarking Dataset for Exploring Criminal Surveillance Methods on Open Source Data*. in *2018 International Conference on Graphics and Interaction (ICGI)*. 2018.

Sensible Cars

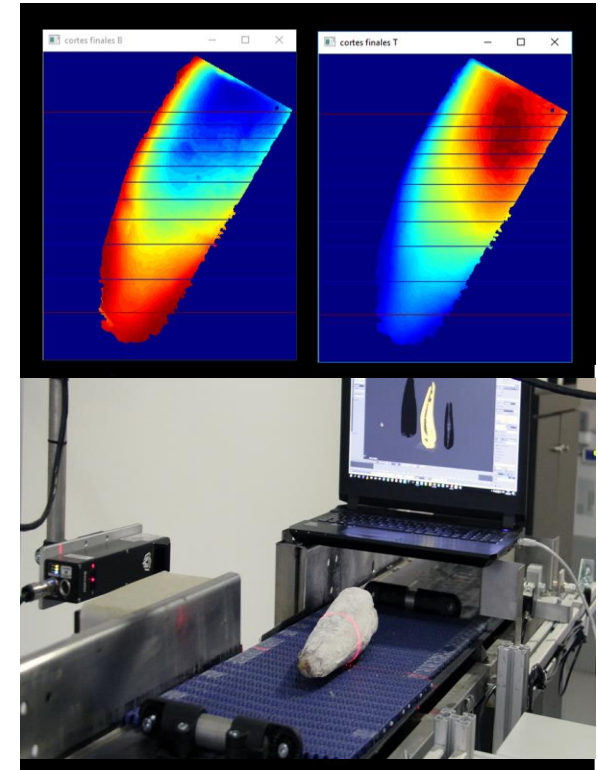
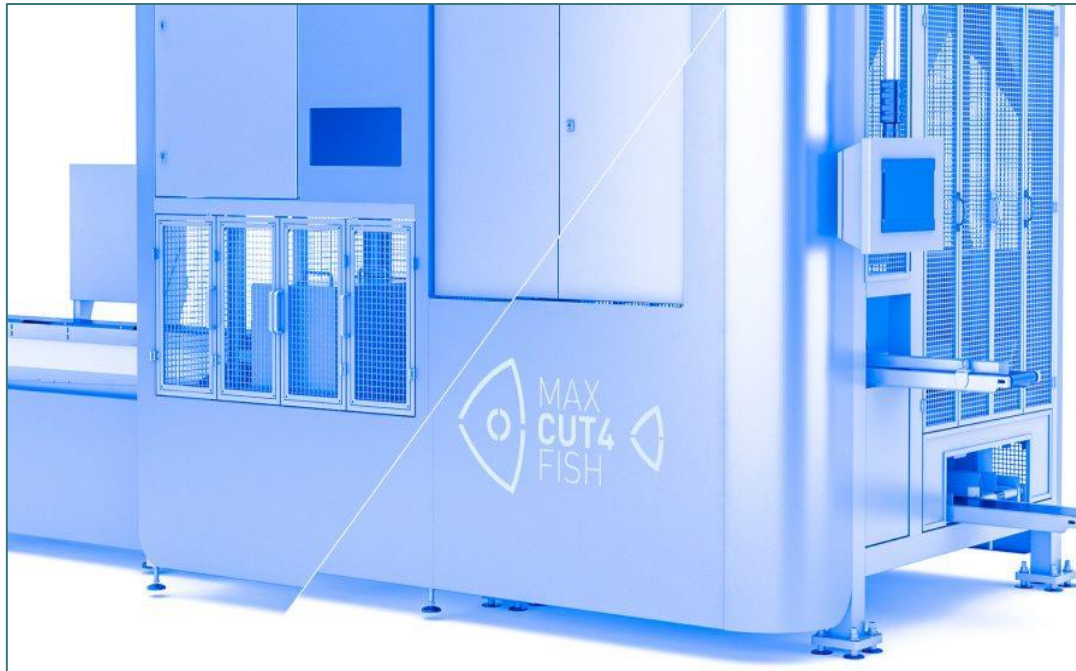
Tool for autonomous cars: real-time object detection and identification, 3D mapping of the vehicle's surroundings.



Fernandes, D., et al., Point-cloud based 3D object detection and classification methods for self-driving applications: A survey and taxonomy. Information Fusion, 2021. 68: p. 161-191.

MaxCut4Fish

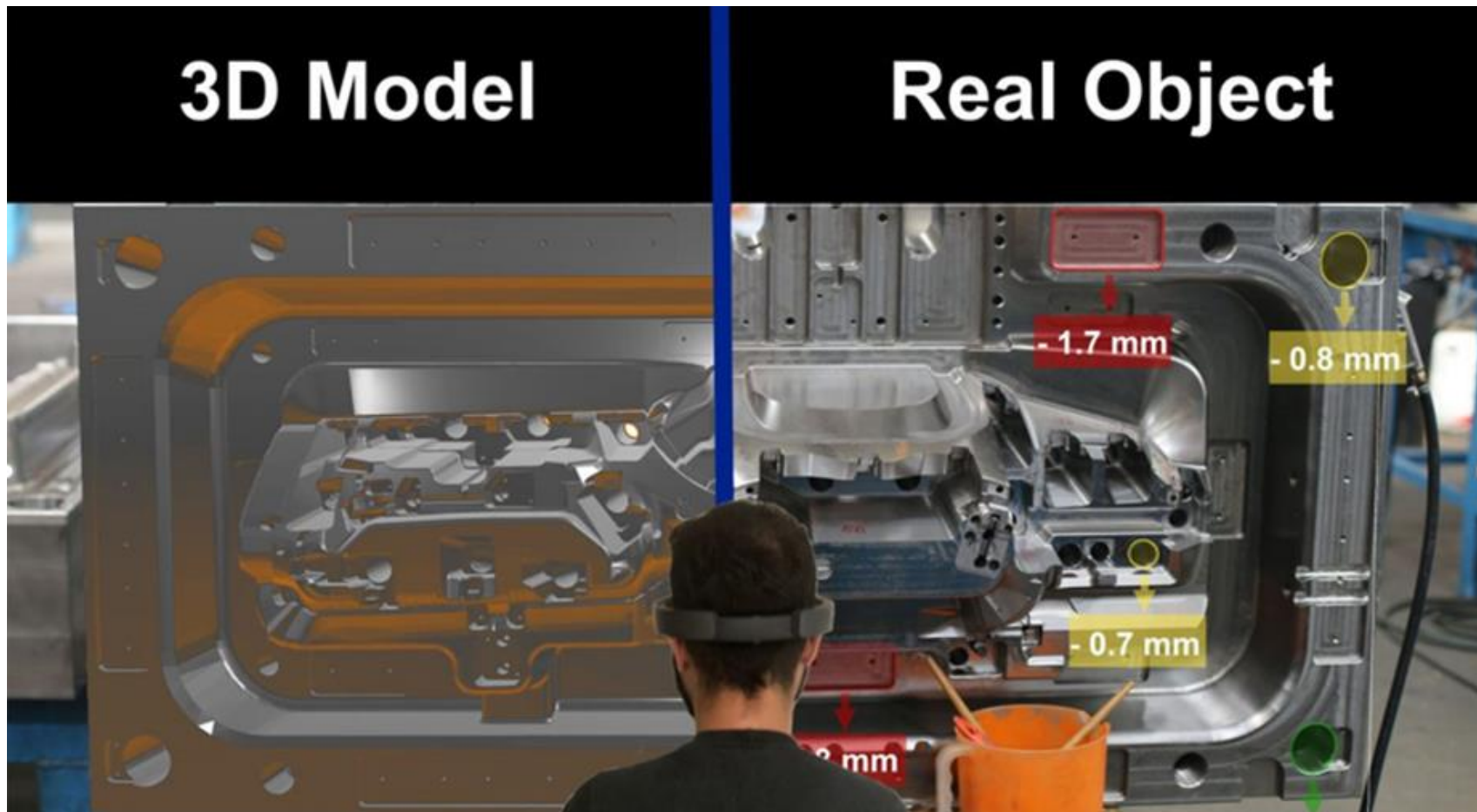
Intelligent system for automatic cutting of frozen fish to optimize the pieces to be cut, time, reliability and consistency of the cut, quality of the final cuts and minimum need for human intervention



Gonzalez D., Alves N., Figueiredo R., Maia P. and Guevara Lopez M.A. (2019). Automated Vision System for Cutting Fixed-weight or Fixed-length Frozen Fish Portions. Proceedings of the 8th International Conference on Pattern Recognition Applications and Methods - Volume 1: ICPRAM, ISBN 978-989-758-351-3, pages 707-714. DOI: 10.5220/0007482407070714

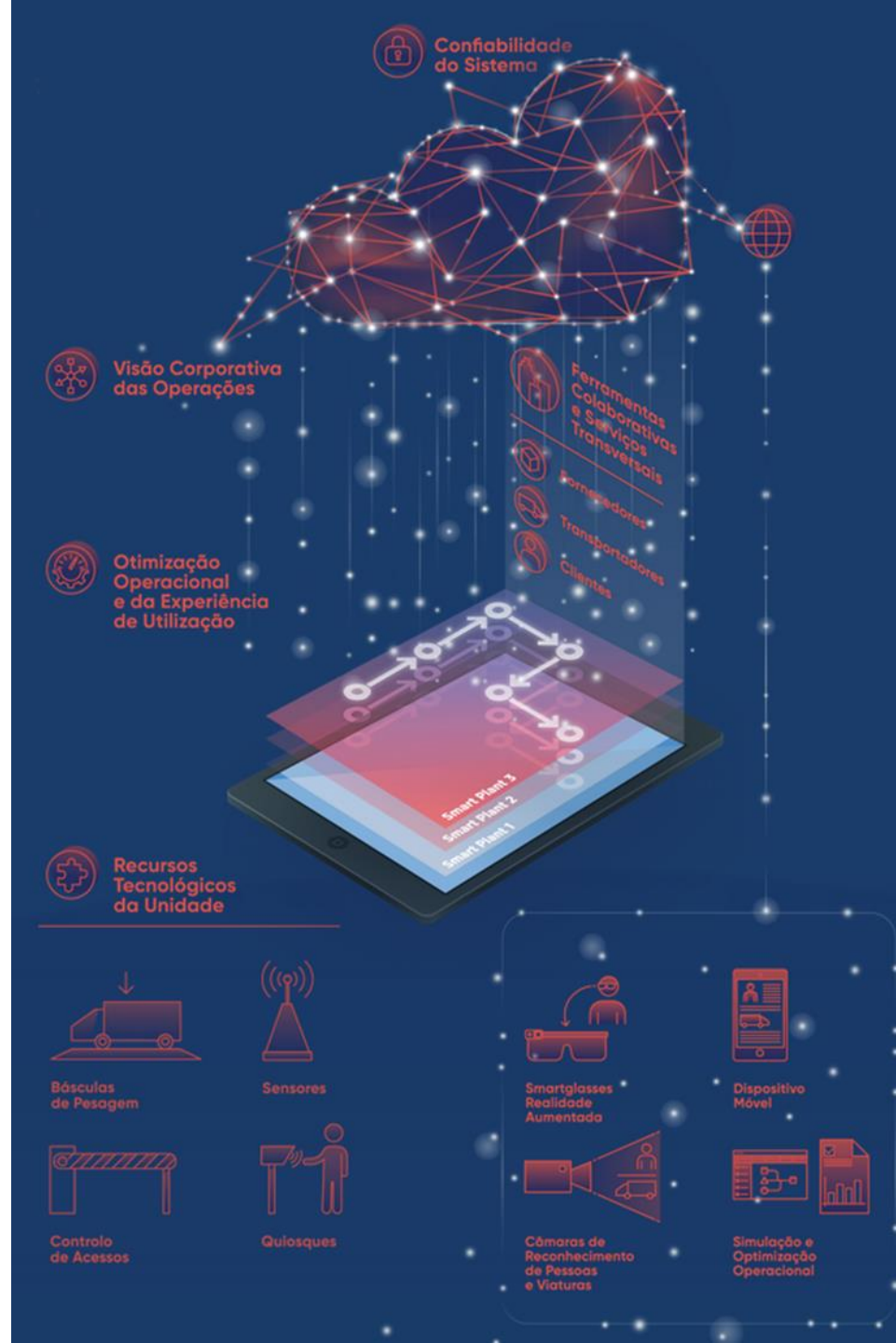
Intelligent4DMoulds

A tool for improving quality control tasks in the mould's industry, combining CV, AR and AI.



Unified Hub 4 Smart Plan

- ✓ Software architecture oriented to services and technological solutions, incorporating the paradigm of IoT and Industry 4.0.
- ✓ Corporate and aggregate vision of operations of industrial units dispersed by several geographies.



Fashion Awareness Customer Profiling

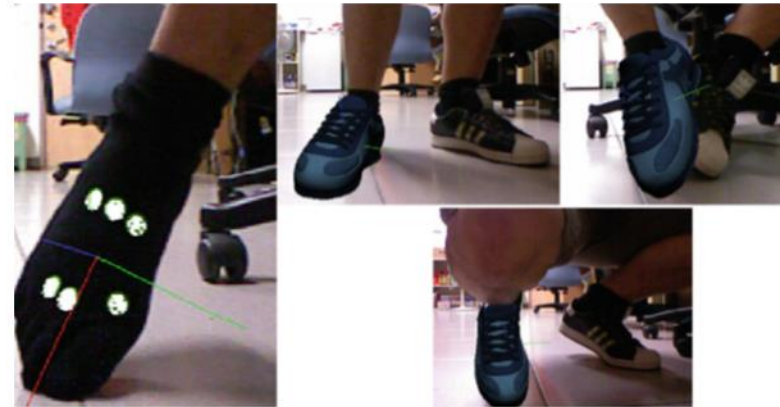
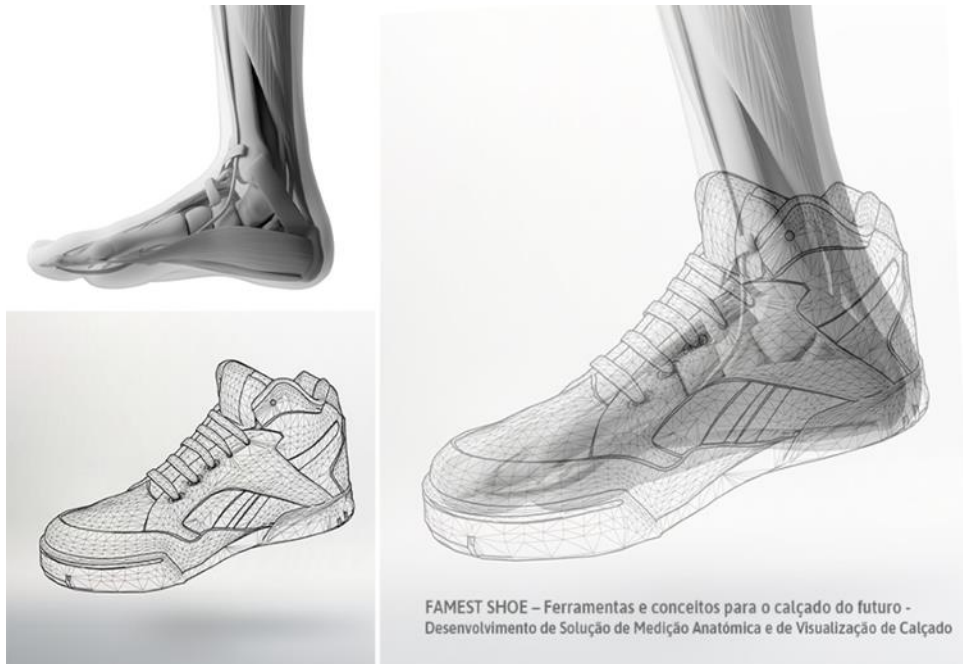
FACPROF:

A tool to manage the stocks in the retail of fashion articles, based on a characterization of the visitors and their consumption, in response to the real needs of the consumers



Footwear, Advanced materials, Equipments and Software Technologies

Tools and concepts for the footwear of the future, development of Anatomical Measurement and Footwear Visualization Solution.

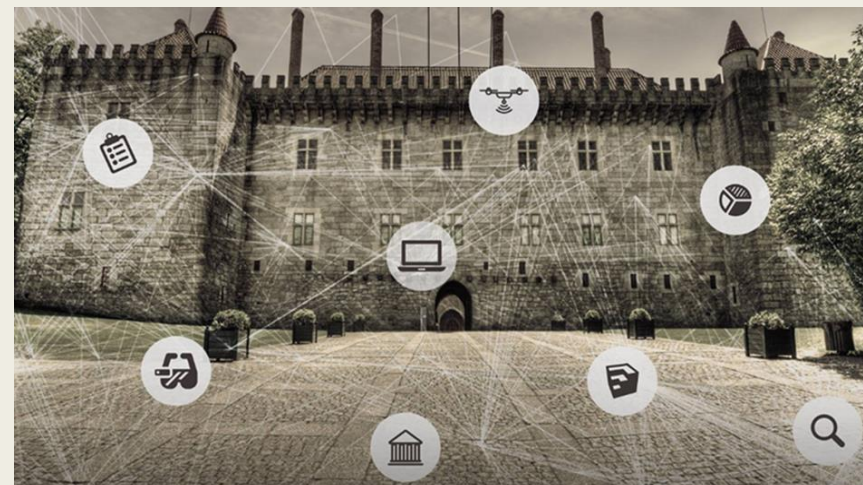
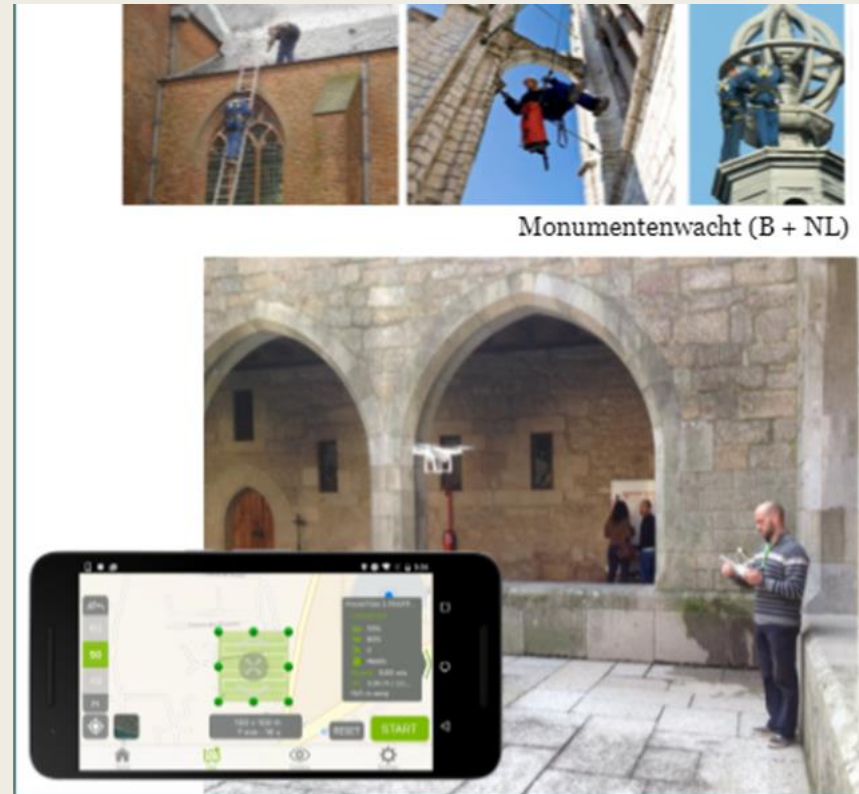


HeritageCARE

(SUDOE project)

Integrated monitoring system to assess the current and future state of a historic building, contributing to the preventive conservation of heritage with historical and cultural value in Southwest Europe.

Fonnet, A., et al. (2017). *Heritage BIM integration with mixed reality for building preventive maintenance*. 2017 24º Encontro Português de Computação Gráfica e Interação (EPCGI).



Senior Inclusive

Application and device composed of a tablet + wristband, adapted to the level of hardware, for the needs of the elderly, supporting the provision of home care.



Magalhães, L., et al. A three-staged approach to medicine box recognition. in 2017 24º Encontro Português de Computação Gráfica e Interação (EPCGI). 2017.

Many thanks