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Development and Research on Innovative Vocational Education Skills

COMPUTER VISION IN PRACTICE

U3.E2. ANALYSIS AND EXPLORATION OF TYPICAL PROBLEMS OR TASKS PURSUED IN COMPUTER VISION

Computer Vision Expert

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LEARNING OBJECTIVES

The student is able to

CVE.U3.E2.PC1	Know the different application domains of computer vision.
CVE.U3.E2.PC2	Explore and analyse several examples and applications of computer vision.
CVE.U3.E2.PC3	Recognize the challenges surrounding computer vision approaches.
CVE.U3.E2.PC4	Identify and recognize computer vision intervention areas.

APPLICATION DOMAINS OF COMPUTER VISION

Healthcare

Retail

Manufacturing

Government

Insurance

APPLICATION DOMAINS OF COMPUTER VISION

Computer Vision has its applications across many domains. Some of these applications are:

- Defect detection
- Metrology
- Intruder Detection
- Assembly verification
- Screen reader
- Code and character reader (OCR)
- Computer Vision with robotics for bin picking

APPLICATIONS OF COMPUTER VISION: **RETAIL**

In recent years, it's been a technological trend, the use of computer vision in the retail sector. The most common uses cases are:

Behavioral tracking

To understand who their customers are and how they behave, retailers use computer vision algorithms in combination with store cameras. Also, they can use computer vision techniques to **track customers' movements** through stores. Algorithms are capable to recognize faces and **determine human characteristics**, like gender or age range.

Computer vision is an excellent tool for developing anti-theft mechanisms as well. Face recognition algorithms can be trained to spot known shoplifters or to find when someone is hiding an item in their backpack.

APPLICATIONS OF COMPUTER VISION: **RETAIL**

Inventory management, there are two main computer vision applications.

- Analyzing the security camera images, a computer vision algorithm can create a very accurate estimate of the items available in the store.
- Analyzing the use of shelf space to identify suboptimal configurations. Adding, to discovering lost space, an algorithm of this nature can recommend better item placement.

APPLICATIONS OF COMPUTER VISION: **MANUFACTURING**

The breaking of machines or the production of defective components are the main problems than can occur in this domain.

Computer vision algorithms are great in means of **predictive maintenance**.

Algorithms can identify potential problems before it happens by analyzing visual information.

Defect reduction applies the same idea, where the system can spot defects in components throughout the entire production line. This lets manufacturers take action in real-time and what has to be done to fix the issue.

APPLICATIONS OF COMPUTER VISION: **HEALTHCARE**

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There are a lot of applications in this domain.

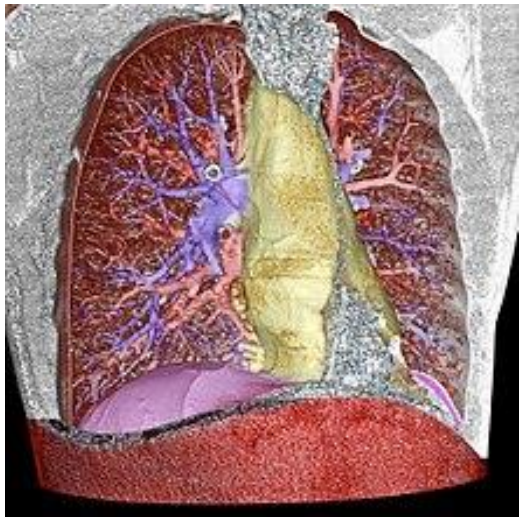
Medical image analysis is the best example because it helps to improve the medical diagnostic process. Images such as X-rays are analyzed to find anomalies like tumors or search for signs of neurological illnesses. This technique extracts the features from images to train a classifier in order to find anomalies.

Finer processing is required in some specific applications, for example, in the analysis of images from colonoscopies, it is necessary to segment the images to look for polyps and prevent colorectal cancer.

APPLICATIONS OF COMPUTER VISION: **HEALTHCARE**

The image above is a result of image segmentation used to visualize thoracic elements. The system segments and colours each important part. This type of technique is very used as techniques that estimate the amount of blood lost due to postpartum hemorrhages; quantify coronary artery calcium; and evaluate blood flow.

There are others area that computer vision play an important role.
Medical imaging is not the only area where computer vision can play an important role. For instance, there are setups that assist visually impaired people to navigate indoor environments safely. These systems provide a visual experience in real-time. Gaze tracking and eye area analysis can be used to find early cognitive impairments, such as autism or dyslexia in children, that correspond to unusual gaze behaviour.



APPLICATIONS OF COMPUTER VISION: **AUTONOMOUS VEHICLES**

Computer vision allows vehicles to perceive and understand the environment around them in order to operate correctly.

Object detection in images and videos is an exciting challenge in computer vision. This process requires locating a different number of objects and the ability to classify them, to distinguish if an object is a traffic light, a car, or a person.

This technology, united with the analysis of data from other sources, such as sensors and/or radars, is what allows a car to “see”.

APPLICATIONS OF COMPUTER VISION: **INSURANCE**

The use of computer vision in this domain has a great impact, particularly in claims processing.

The application of computer vision can guide clients through the process of **visually documenting a claim**.

It can analyze images and send them to the appropriate agents, in real time, Also, at the same time, it can estimate and adjust repair costs, determine if the insurance covers them, and even check for possible fraud. This results in a better client experience.

Computer vision is a huge help in **avoiding accidents. T**here are applications for preventing collisions, integrated into industrial machinery, cars, and drones.

APPLICATIONS OF COMPUTER VISION: **AGRICULTURE**

The area of precision agriculture is an area where computer vision is having a enormous impact.

Various applications have been developed in **grain production.** Computer vision algorithms can now detect, or predict, diseases or pest and insect infestations. Early diagnosis let farmers to take appropriate measures quickly, reducing losses and ensuring production quality.

Another challenge is **weed control**, considering that weeds have become resistant to herbicides over time and represent significant losses for farmers. There are robots with integrated computer vision technology that monitor an entire farm and spray herbicides precisely. This saves enormous volumes of pesticides, that is a benefit for the planet and in terms of production costs.

APPLICATIONS OF COMPUTER VISION: **AGRICULTURE**

Soil quality is another main factor. Through images taken by mobile phones, some applications can recognize potential defects and nutritional deficiencies in soils. After analyzing the images sent, these applications propose soil restoration techniques and possible solutions to the problems detected.

Computer vision can be used in **sorting** as well. There are algorithms for sorting fruits, vegetables, and even flowers, by recognizing their main properties (e.g. size, quality, weight, color, texture). These algorithms are also, capable of spotting defects and estimating which items will last longer and which should be sent to local markets.

APPLICATIONS OF COMPUTER VISION: **DEFENSE AND SECURITY**

Like in **Retail**, companies like banks or casinos, can benefit from computer vision applications that allow them to **identify customers** based on analyzing images from security cameras.

In terms of **homeland security tasks,** computer vision is a powerful ally. It can be used to improve cargo inspection at ports or for surveillance of sensitive places like embassies, power plants, hospitals, railroads, and stadiums.

Computer vision is used extensively in **defense tasks** such as reconnaissance of enemy terrain, automatic identification of enemies in images, automating vehicle and machine movements, and search and rescue.

CHALLENGES OF COMPUTER VISION

- **Reasoning Issue:** Modern neural network-based algorithms are complex system whose functionings are often obscure. The lack of reasoning creates a real challenge for computer vision experts who try to define any attribute in an image or video.
- **Privacy and Ethics**: Vision powered surveillance is a worrisome threat to privacy in various countries. Face recognition and detection is prohibited in some countries because it exposes people to unauthorized use of data.
- **Fake Content:** like other technologies, computer vision in the wrong hands can lead to dangerous problems. By accessing powerful data centres, anyone is capable of creating fake images, videos or text content.
- **Adversarial Attacks**: optical illusions for the computer, when an attacker creates a faulty machine learning model, they mean the machine using it to fail. These flawed models are difficult to identify and can cause severe damage to any system.

Visual Search Engines

A visual search engine is able to retrieve images that meet certain content criteria. Searching for keywords is a usual use case, but sometimes we can present a source image and ask that similar images be found. In some cases, it is possible to specify more detailed search criteria, like images of beaches, taken during the summer, containing at least ten people.

Face recognition at Facebook

One of the principal objectives was the possibility of protecting strangers from using photos in that a user appears or informing people with a visual impairment who appears in a photo or video.

Amazon Go

The concept is simple: customers enter the store, choose the products, and leave the store with them, without having to queue up to pay at the checkstand or self-check kiosk.

Tesla Autopilot

Tesla's Autopilot technology provides autonomous driving features. Tesla's Autopilot technology is another extraordinary example of the impact that computer vision has had on our most common daily activities.

Microsoft's InnerEye

In the healthcare sector, InnerEye by Microsoft is a tool that assists radiologists, oncologists, and surgeons who work with radiology-based images. The main goal of the tool is to accurately identify tumors among healthy anatomy in 3D images of cancerous growths. Based on computer vision and machine learning techniques, the technology produces detailed 3D modelings of tumors.

SUMMARY

- Some of the applications of computer vision are: Defect detection, Metrology, Intruder Detection, Assembly verification, Screen reader, Code and character reader (OCR), and Computer Vision with robotics for bin picking.
- Some uses cases are: Microsoft's InnerEye, Tesla Autopilot, Amazon Go, Face recognition at Facebook and Visual Search Engines.
- In the retail sector, the most common uses cases are: Behavioral tracking and inventory management.

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The aim of the Blueprint is **to support an overall sectoral strategy and to develop concrete actions to address short and medium term skills needs.**

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