The Social Impact of Computer Vision

Antensteiner, D.
doris.antensteiner.fl@ait.ac.at

Austrian Institute of Technology, Seibersdorf

Abstract

Computer vision has been around for over half a century, it is used today in various fields and influences our everyday life. Surveillance systems are improving security and managing traffic situations, medicine is enhanced with vision algorithms to support surgeons, doctors and patients in their tasks, industry is relying on computer vision for product inspection tasks and assistive systems are helping our impaired and elderly people throughout the day. These applications are improving our well-being and capabilities, save lives and manage tedious jobs. In this essay we discuss the social impact, history and applications of computer vision today.

1 Introduction

In this day and age computer vision impacts the life of everyone in our society. It developed to become more powerful and present in various fields. In this essay we describe computer vision influences in those fields and their social impact. Focused on assistive computer vision we show the rapid development in recent years and their various effects. Furthermore, we will talk about future developments.

Robots help to produce the products we use, visual surveillance is taking place on our streets, fingerprint sensors are used for security on our mobile devices, vision algorithms are omnipresent in medicine to help diagnose patients, industrial inspection tasks are carried out with imaging systems, and assistive computer vision systems are supporting some of us in our everyday life. Assistive computer vision tools are used in various fields in order to overcome limitations and improve the everyday life of disabled and elderly people, patients and healthy people who have use of support. Fields of applications include rehabilitation, home healthcare, life-logging, mobility aids, personalized monitoring and support for visual impairments.

2 Presence and impact of computer vision

Computer vision has a profound impact in society. It plays a role in a plethora of fields and applications, reaching from assistive systems over medical applications and surveillance systems to visual industrial inspections and production.

Some of the first computer vision attempts aimed to simulate the human visual apparatus, which started with the perceptron of Rosenblatt 1957 [1] to automatically detect objects in images, which back then showed a poor performance on real images. Then, lots of statistical methods and algorithms emerged to solve image processing tasks. By 1990 algorithms existed for face recognition, object detection, image segmentation and classification tasks. Soon reliable feature detectors and descriptors developed, such as SIFT [2](1999) and the faster SURF [3] (2006), which both allow better feature comparisons, and bag-of-words, where features are connected as visual words.

At the same time, learning approaches gained further attention. Cortes and Vapnik presented a soft margin Support Vector Machine (SVM) approach [4] in 1995, which then was heavily used mostly for binary classification tasks. LeCun et.al. introduced 1998 a new convolutional neural network [5], which was based on the early perceptrons, and was used for character classification. Still, it wasn't until the 2010's before more difficult tasks could be solved using neural networks, due to strong processing units and storage capacities. By today, in many learning tasks, algorithms can reach the accuracy of human, mostly using deep convolutional neural networks [6].

Fast and reliable computer vision systems of today allow the application in wide-spread areas. In the following sections we will discuss some of the highest influential sectors.

2.1 Assistive Systems

Computer vision can be a powerful tool in the field of assistive systems, which aim to improve the life of elderly or impaired people, as well as of patients and to assist healthy people with everyday tasks.

Robots are developed as assistance at home or in nursing homes, today they can help people bathe, lift them, improve their mobility, and monitor them for safety and health-care. Robots consist of several sensors, motoric parts and computational units. The data from visual sensors is analyzed on computational units to gain information about tasks and the environment. Thereby, computer vision models the robots' visual system. Examples are Pearl [7] and the assistive robot introduced in [8], which remind people of routine tasks and guides them through environments, perform tracking and detection tasks.

Several projects work on the assistance of visually impaired people, one example is the start-up Aipoly [9], which uses smartphones and implemented a neural network algorithm, that understands scenes, keeps learning, identifies objects and colors. Other examples detected groceries from a training data set [10] and texts while walking around [11].

2.2 Medicine

In medicine computer vision is used intensively to support doctors in diagnosing and treating their patients.

The most common applications are image analysis and 2D/3D reconstruction from scanners, including magnetic resonance imaging (MRI), positron emission tomography (PET), single-photon emission computed tomography (SPECT), ultrasound and x-rays.

Computer assisted surgery and surgical navigation systems support the planning of surgeries and guide when surgical interventions have to be performed. The algorithms analyze the generated models from the patients, which underlying data was captured through scanners. The surgeon can manipulate the model and plan the surgery more precisely. Surgical navigation deals with navigating surgical instruments during the procedure, in relation to the patients position. This showed to be very useful especially when parts of the instrument can't be seen by the surgeon. In robotic surgery, the instrument is partly or fully controlled by a surgical robot.

Several start-ups emerged in the field of medical computer vision. An example is the company Ai-Cure [12], it aims to bring medical help to people all around the world, with using a smartphone, its' camera, big data and machine learning algorithms. The application reminds patients to take their medication and checks, if the correct medication and dose was applied. The start-up CellScope [13] uses computer vision algorithms for diagnosing ear and skin infections at home with an otoscope or a dermatoscope.

2.3 Surveillance

Well-established surveillance tasks for computer vision are detection and tracking of people, vehicles and objects, and behavioral analysis (speed of vehicles, direction of people, traffic jam). These algorithms are commonly used in airports to detect people, unusual events and the length of waiting lines, as well as on streets, to detect the vehicle-types, speeds of vehicles, highway marks, read license plates, locate accidents and the traffic intensity.

More recently, drones came into application for surveillance tasks. They can capture and analyse information about environments, even when they are difficult to access for humans. One example is the start-up Skydio [14], which uses a camera on a drone to autonomously maneuver and avoid obstacles, without using GPS. Another example is the start-up BetterView [15], who are focusing on aerial imagery for analysis tasks of insurance, construction and real estate companies to enable them to make better decisions with additional insights.

2.4 Inspection

Computer vision is used for security inspection tasks for biometrical data and security features, as well as for industrial inspections.

Biometrical inspection includes fingerprint and iris scanning to identify people. This is common on border checks to verify that the persons' identity confirms with the identity on the passport, or to initiate a first identification and store the biometrical features for future recognition. Today biometrical features are also commonly used to access buildings or computers and to operate devices, such as printers or specific industrial machines.

Security features are checked for example on banknotes and passports to detect counterfeiting, this is applied in banks, stores and border controls.

Industrial inspection ensures the quality of the product, by checking for cuts or irregularities in the surface and controlling defined features, as color, print, consistency or position of the product. Robots are commonly used for computer vision based automation of inspection tasks.

Today computer vision inspection algorithms are expanding and can be used with mobile devices. One example is the AIT mobile border control [16] for land border crossing points, including controls of biometrical and passport data. Another example is the start-up tractable [17], which is using artificial intelligence to provide expert visual analysis for automated analysis of insurance issues and other customized automated and mobile inspection tasks.

3 Summary

With our computers gaining high processing capabilities, computer vision grew into a widely used tool with a plethora of applications that influence our everyday life. We showed the major applications in assistive systems, medicine, surveillance and inspection. Computer vision systems can significantly improve security and safety, assist us in image search and processing and help improve health by guiding operations or supporting patients. As of now, many inventions and start-ups in the field of computer vision are emerging due to strong algorithms and recent machine learning advances. For the future, we expect computer vision to spread further and exploit its capabilities. The computer vision community is still facing difficult problems in developing powerful algorithms, improving existing applications and in gaining a deeper understanding of popular machine learning techniques.

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