IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 7.301
Volume 3, Issue 2, March 2023

A Review Paper on Computer Vision

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Abstract: *Computer vision has been studied from many angles. From raw data acquisition to approaches and concepts that combine digital image processing, pattern recognition, machine learning and artificial intelligence. Many scholars were drawn to its widespread use across a wide range of disciplines and domains. This document provides an overview of the latest technologies and explanations of theoretical concepts. A major focus of computer vision research has been on image recognition. Processed by multiple aspects of field applications, computer scientists can use vision to evaluate photos and videos to get the information they need. Understanding information, event or descriptive information, and patterns is beautiful. We took advantage of the multi-region application mechanism and data-rich areas to analyze. This document complements the growth of computer vision and image processing reviews and related research.*

Keywords: Computer Vision, Pattern Recognition, Image Processing, Machine Learning, Deep Learning

I. INTRODUCTION

Various aspects of computer vision are studied. These range from simple data acquisition to methods and concepts that incorporate digital image processing, pattern recognition, machine learning and computer graphics. Its widespread use has attracted many researchers to understand wide range of subjects and disciplines. It provides theoretical concepts to explain the development of computer vision.

Computer Vision helps researchers extract key information from photos and videos, understand event information and descriptions, and create compelling models. It combines massive data analysis and multi-domain application domain technology. This work contributes to recent advances in computer vision, image processing, and related research. It divides most of computer vision into three categories: image processing, object recognition, and machine learning. It also provides a quick overview of the latest information about the strategy and how it works. The topic of computer vision has expanded to include everything from capturing raw data to extracting patterns from images to interpreting data. It includes the principles, techniques and ideas of digital image processing, pattern recognition, artificial intelligence and computer graphics.

Most computer vision tasks revolve around extracting information about events or descriptions from input scenes (digital photographs). The approach to solving computer vision problems depends on the application domain and the data being processed. Computer vision combines image processing and pattern recognition. Understanding images is the end result of the computer vision process.This area develops the ability of human vision to gather information by adapting to changes. Unlike computer graphics, computer vision involves extracting information from images. The basic methods of image recognition or enhancement overlap with image processing, and some authors use the terms interchangeably. Computer vision mainly involves creating patterns and extracting data and information from images while image processing involves applying computer modifications to images, such as sharpness and contrast. It has similar and sometimes overlapping meanings in human-computer interaction (HCI). On the other hand, computer vision cannot be expected to replicate the human eye perfectly. This is because computer vision systems behave differently than human eyes. Many researchers have proposed a variety of computer vision techniques that mimic the human eye, but the performance of computer vision systems is often limited. The sensitivity of the parameters, the strength of the algorithm and the accuracy of the results are all significant obstacles to their technique. This affects the complexity of evaluating the performance of computer vision systems.

II. COMPUTER VISION FUNDAMENTALS

Computer vision involves acquisition, processing and analysis of images and videos. First step in computer vision is image capture. This includes capturing images with cameras, sensors or other devices. The images are then processed to improve quality, reduce noise, and extract features for further analysis. These characteristics are based on the color, texture, shape or other characteristics of the image. The next step is image analysis. It involves extracting information from images using various techniques such as object detection, segmentation and recognition.

2.1 Object Detection

Object detection is the detection of objects in images or videos. This task is difficult because objects come in different shapes, sizes, colors and orientations. Several techniques have been developed to solve this problem, including feature-based deep learning techniques. Feature-based methods extract features such as edges, corners, and keypoints from images and associate these features with a database of known objects. One of the most popular feature-based methods is scale invariant feature transformation (SIFT). It extracts key points and descriptions from images and matches them to a database of known objects. Another popular approach is robust acceleration functions SURF, it is similar to SIFT, but it is faster and more robust to scale and orientation changes.

Convolutional neural networks (CNNs) are a type of neural network particularly suitable for object recognition tasks. A CNN consists of several layers, including convolutional layers that extract features from images and fusion layers that derive feature maps. The output of the CNN is then passed through one or more fully connected layers to produce a prediction or classification of the input image. The most famous example of deep learning-based object recognition methods is the ImageNet Large-Scale Visual Recognition Challenge (ILSVRC), a competition that uses deep learning methods to recognize objects in natural pictures.

2.2 Object Segmentation

Object segmentation is division of an image into regions corresponding to objects. This task is difficult because the objects have complex shapes and can overlap. Various techniques have been developed to solve this problem, such as area-based and perimeter-based methods. Region-based methods involve dividing an image into appropriate regions.

Computer vision works by stimulating humans to visualize and extract relevant information from objects using algorithms and optical sensors. Computer vision has developed into the field of artificial intelligence and simulated human visualization, which is very different from traditional methods which are time-consuming and require extensive laboratory research. It can be used in conjunction with an illumination system to simplify image acquisition and processing. Image analysis can be divided into the following steps:

1. Image segmentation to identify object images in the International Journal of Computer Science
2. Image preprocessing to improve image quality in order to improve image detail.

2.3 Pattern Recognition

Pattern recognition is a subset of computer vision that focuses on the process of recognizing objects by transforming images for better image quality and interpretation. This method tries to extract data from images collected by sensors to make decisions. In other words, computer vision aims to create machines that see.

Image acquisition, preprocessing, feature extraction, recognition/segmentation, advanced processing, and decision making are among the most widely used frameworks in computer vision. 3D morphological analysis and pixel optimization are two key categories of computer vision frameworks. Pixel optimization refers to the structural analysis and characterization of pixel morphology, including internal components, for better image processing and pattern recognition. Image processing and pattern recognition, checking three-dimensional morphology has become the standard theory of computer image processing and pattern recognition. In addition, the method must be applied to fairly large datasets containing a large number of geometric synthesis layers.

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Comprehensive understanding of complex color clusters requires efficient and accurate computational algorithms to extract important quantitative information. Computer algorithms can improve performance by combining morphological analysis with certain artificial intelligence techniques. Examples of computer algorithms include fuzzy logic, artificial neural networks, and genetic algorithms.

There are many research papers dealing with noise reduction strategies such as, Gaussian-based linear filtering. Algorithms can be used to remove certain types of grain noise from photos. Local fluctuations caused by particles are reduced because each pixel is adjusted to the average value of its environment. Probably is one of the most influential publications in 2012 on the application of deep learning to computer vision. In the popular ImageNet computer vision, a neural network with more than 60 million parameters greatly outperformed the previous state-of-the-art image recognition method. The boom started with improved architectures of convolutional neural networks and ConvNets.

Accuracy of image classification is a challenge, sometimes surpassing that of the human eye. The main difference between deep learning methods and computer vision is the concept of end-to-end learning. You no longer need to define features and perform feature engineering, neuron does it for you. For example, if you want to train a deep neural network to recognize cats, don't tell it to look for whiskers, ears, fur, and eyes. Give it thousands of pictures of cats. If you continue to misclassify foxes as cats, don't rewrite your code. The need for massive amounts of training data and massive computing power has taken the computer vision field by storm with this amazing tool! A field of research concerned with making data interpretable, analyzable and understandable.

III. USES OF COMPUTER VISION

1. **Object recognition:** Computer vision algorithms can identify and classify objects in images and video, automating tasks such as inventory control, safety monitoring, and quality control in manufacturing.
2. **Facial Recognition:** Computer vision technology can identify and authenticate people based on their facial characteristics, which is useful in security applications such as access control and surveillance.
3. **Medical Imaging:** Computer vision is widely used in medical imaging such as x-rays, CT scans and MRIs. This enables doctors to detect and diagnose diseases more accurately and efficiently, and to plan and manage surgical procedures.
4. **Self-driving cars:** Computer vision is a key component of self-driving cars, allowing them to navigate and avoid obstacles in real time.
5. **Augmented and Virtual Reality:** Computer vision techniques are used in augmented and virtual reality applications to detect and respond to user movements and interactions.
6. **Robotics:** Computer vision is essential for robots to navigate their environment, perceive and manipulate objects, and interact with humans in a variety of environments.
7. **Agriculture:** Computer vision technology can be used to analyze and monitor crop growth, soil quality and crop health, allowing farmers to optimize yields and reduce waste.
8. **Sports Analytics:** Using computer vision technology to analyze sports footage to provide coaches and players with insight into performance, tactics and strategies.
9. **Artificial Intelligence:** Computer vision is central to many artificial intelligence applications, such as natural language processing, voice recognition, and autonomous decision making.

IV. THE FUTURE SCOPE OF COMPUTER VISION

Cognitive advances in artificial intelligence have allowed computer vision to surpass human intelligence. Today, computer vision services permeate critical business processes such as marketing, advertising, and customer service, delivering impactful information and experiences. Therefore, capturing the light of computer vision is essential for startups to achieve advanced business intelligence. Object recognition in brand monitors and advances tagging. Artificial intelligence development services create greater business value while improving security. Today, businesses are extending the benefits of computer vision technology to areas as diverse as brand awareness, marketing, and advertising. Here's how computer vision is changing in the world of digital business,

1. **Massive data inputs:** Computer vision systems can now detect more objects per frame with increased accuracy and precision. Visual Question Answering(VQA) as a part of deep learning, allows systems to power image recognition and natural language processing (NLP) techniques.
2. **Binary classification:** answer queries about the placement of objects in images.
3. **Tally:** count the number of a specific subject or object.
4. **Open problem:** Infer spatial and contextual information of objects.

Computer vision in E-commerce is booming all over the world. One of the applications of e-commerce is automatic product classification. When a new product is added to an e-commerce store, its attributes are automatically extracted using a computer vision system without human intervention. It automates the labeling process for each new item a store wants to add, so products can get to virtual shelves and into consumers hands faster.

Majority of banks use computer vision to implement their know-your-customer (KYC) processes. It allows customers to open accounts with selfies and short video calls. Computer vision technology is also being used to identify customer sentiment and provide actionable insights to personalize banking services across multiple channels. Increased customer satisfaction and ease of account creation have a direct impact on a bank's bottom line.

The future scope of computer vision is enormous as the field is constantly evolving and advancing with the latest technologies. Here are some key areas where we can expect major developments in the coming years:

1. **Deep Learning:** Deep learning algorithms have shown great potential for enabling machines to learn from large amounts of data, and we can expect to see in the future more advanced deep learning techniques being applied to computer vision problems.
2. **3D Vision:** The ability to perceive depth and create 3D representations of objects is an area of growing interest in computer vision where we can expect to see significant advances, which may have applications in areas such as Augmented and Virtual Reality, Robots and Autonomous Cars.
3. **Real-Time Processing:** As the need for real-time processing of visual data continues to grow, we can expect to see advancements in computer vision hardware such as GPUs and TPUs for processing faster and more efficient.
4. **Edge Computing:** With the rise of the Internet of Things (IoT), there is a growing need for computer vision applications that can run on low-power devices such as wireless cameras and sensors, rely on cloud-based processing. Edge computing solutions using machine learning techniques may become more common in the future.
5. **Ethics and Privacy:** As computer vision technologies become more widespread, there will be an increasing need to address ethical and privacy issues, such as biases in algorithms, facial recognition and surveillance.
6. **Multimodal Sensing:** Combining multiple sources of sensing data such as vision, sound, and touch is a growing area of interest in computer vision, and we can expect to see more applications using multimodal sensing, to improve human- interaction and computer perception.

Overall, the future of computer vision is vast, and we can expect to see major breakthroughs in this field in the coming years, which could have a profound impact on a wide range of industries.Computer vision is a growing area of research that involves the processing, analysis, and interpretation of images and video. This literature review article provides an overview of state-of-the-art techniques used in computer vision, including object recognition, segmentation and tracking, as well as recent developments in deep learning and its applications in vision by computer. It began with an introduction to the fundamentals of computer vision, including image acquisition, processing, and analysis. Next, we discussed various object detection, segmentation, and recognition techniques, including feature-based and in-depth learning techniques. Finally, we discussed future directions in the field, including robotics, autonomous vehicles, and computer vision applications in healthcare.

V. CONCLUSION

Image processing and machine learning are both related to computer vision. The multidisciplinary field of computer vision has been closely linked to image processing. Image processing benefits many technical fields, especially in extracting important information in image analysis. Computer vision has developed as a technical field that evolved into many different technical fields, such as geographic remote sensing, robotics, human-computer communication, healthcare, and satellite communications. Researchers interested in computer vision examine photos and videos and extract information so that new knowledge can be used to predict certain events. Advances in computer vision are so intertwined with image processing and machine learning that the two can be combined. It can be applied to a wide range of investigations, such as predicting or detecting an object's behavior, characteristics, etc. The object's color palette changes to black and white. Examples of an element that differs from its original size due to scaling and translucent objects or color combinations

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