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A Survey on Computer Vision and Image Processing

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ABSTRACT: As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems. Sub-domains of computer vision include scene reconstruction, event detection, video tracking, object recognition, object pose estimation, learning, indexing, and image restoration. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g., in the forms of decisions. Understanding in this context means the transformation of visual images (the input of the retina) into descriptions of the world that can interface with other thought processes and elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory. In 1995 everyone in tech wanted a slice of the dot-com boom, but today, fields like artificial intelligence (AI), machine learning (ML) and big data drive the tech venture capital (VC) of the world to dig into their pockets. Computer vision is at the intersection of all these data-driven innovations. While uses for computer vision are well-known within the tech world, the term is still virtually unknown to the general public, even though many of them are already benefiting from it.

KEYWORDS: Artificial system, Video tracking, Digital images, Object recognition, artificial intelligence, machine learning .

I. INTRODUCTION

Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and in general, deal with the extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, *e.g.*, in the forms of decisions. Researchers in computer vision have been developing, in parallel, mathematical techniques for recovering the three-dimensional shape and appearance of objects in imagery. We now have reliable techniques for accurately computing a partial 3D model of an environment from thousands of partially overlapping photographs . Given a large enough set of views of a particular object or facade, we can create accurate dense 3D surface models using stereo matching . We can track a person moving against a complex background . We can even, with moderate success, attempt to find and name all of the people in a photograph using a combination of face, clothing, and hair detection and recognition . However, despite all of these advances, the dream of having a computer interpret an image at the same level as a two-year old (for example, counting all of the animals in a picture) remains elusive. Why is vision so difficult? In part, it is because vision is an inverse problem, in which we seek to recover some unknowns given insufficient information to fully specify the solution. We must therefore resort to physics-based and probabilistic models to disambiguate between potential solutions. However, modeling the visual world in all of its rich complexity is far more difficult than, say, modeling the vocal tract that produces spoken sounds.

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While traditional broadcast and consumer video systems operate at a rate of 30 frames per second, advances in digital signal processing and consumer graphics hardware has made high-speed image acquisition, processing, and display possible for real-time systems on the order of hundreds to thousands of frames per second. For applications in robotics, fast, real-time video systems are critically important and often can simplify the processing needed for certain algorithms. When combined with a high-speed projector, fast image acquisition allows 3D measurement and feature tracking to be realized.

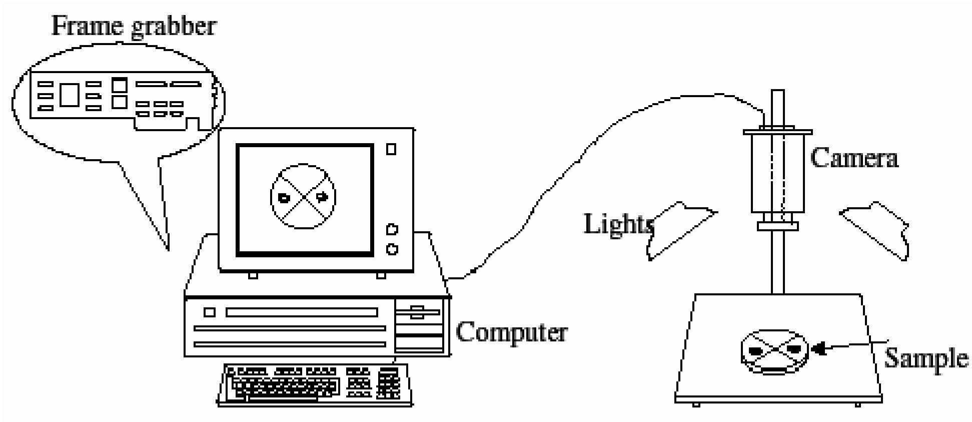

Fig1.Computer Vision System

Computer architecture for computer vision systems would be incomplete if only hardware were to be considered. The best hardware is only as good as the software running on it. One may argue that the long tradition in imaging of dedicated hardware has considerably hindered progress in software. Portable, modular, and reusable software is especially critical for computer vision tasks because they tend to include many different modules. As shown in (fig 1) there are many kinds of computer vision systems, nevertheless all of them contain these basic elements: a power source, at least one image acquisition device (i.e. camera, ccd camera etc.), a processor as well as control and communication cables or some kind of wireless interconnection mechanism. Also A frame grabber is present which is an electronic device that captures individual, digital still frames from an analog video signal or a digital video stream. It is usually employed as a component of a computer vision system, in which video frames are captured in digital form and then displayed, stored or transmitted. In addition, a practical vision system contains software, as well as a display in order to monitor the system. Vision systems for inner spaces, as most industrial ones, contain an illumination system and may be placed in a controlled environment.. Furthermore, a completed system includes many accessories like camera supports, cables and connectors.

II. HISTORY

In the late 1960s, computer vision began at universities that were pioneering artificial intelligence. It was meant to mimic the human visual system, as a stepping stone to endowing robots with intelligent behavior. In 1966, it was believed that this could be achieved through a summer project, by attaching a camera to a computer and having it "describe what it saw". Studies in the 1970s formed the early foundations for many of the computer vision algorithms that exist today, including extraction of edges from images, labeling of lines, non-polyhedral and polyhedral modeling, representation of objects as interconnections of smaller structures, optical flow, and motion estimation.

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III.RELATED FIELDS

Areas of artificial intelligence deal with autonomous planning or deliberation for robotical systems to navigate through an environment. Information about the environment could be provided by a computer vision system, acting as a vision sensor and providing high-level information about the environment and the robot. Artificial intelligence and computer vision share other topics such as pattern recognition and learning techniques. Consequently, computer vision is sometimes seen as a part of the artificial intelligence field or the computer science field in general.

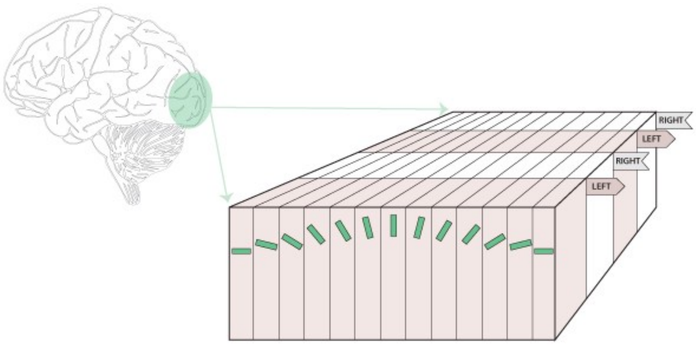

Fig 2.computer vision in neurobiology

A field which plays an important role is neurobiology, specifically the study of the biological vision system. Over the last century, there has been an extensive study of eyes, neurons, and the brain structures devoted to processing of visual stimuli in both humans and various animals. This has led to a coarse, yet complicated, description of how "real" vision systems operate in order to solve certain vision related tasks. These results have led to a subfield within computer vision where artificial systems are designed to mimic the processing and behavior of biological systems, at different levels of complexity. As shown in (Fig 2) the cells naturally maps for different angles, Each section of brain would contain a very specific set of neurons that mostly responded to bars of light with a specific angle. These cells reactions when combined were theorized to somehow be able to create a bottom-up image of the, natural world. That is to say, that by taking the response of many neurons responding to various bars of light, the human brain begins to draw a picture of the world around it.

IV.SYSTEM METHODS

The organization of a computer vision system is highly application dependent.

I. **Image acquisition** – A digital image is produced by one or several image sensors, which, besides various types of light-sensitive cameras, include range sensors, tomography devices, radar, ultra-sonic cameras, etc.
II. **Pre-processing** – Before a computer vision method can be applied to image data in order to extract some specific piece of information, it is usually necessary to process the data in order to assure that it satisfies certain assumptions implied by the method.
III. **Detection/segmentation –** At some point in the processing a decision is made about which image points or regions of the image are relevant for further processing.
IV. **Decision making:-**Making the final decision required for the application, for example:
   a) Pass/fail on automatic inspection applications.
   b) Match / no-match in recognition applications.

V. APPLICATION

The computer vision and machine vision fields have significant overlap. Computer vision covers the core technology of automated image analysis which is used in many fields. Machine vision usually refers to a process of combining

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automated image analysis with other methods and technologies to provide automated inspection and robot guidance in industrial applications. In many computer vision applications, the computers are pre-programmed to solve a particular task, but methods based on learning are now becoming increasingly common. Examples of applications of computer vision include systems for:

- Automatic inspection, *e.g.*, in manufacturing applications;
- Assisting humans in identification tasks, e.g., a species identification system;[17]
- Controlling processes, *e.g.*, an industrial robot;
- Detecting events, *e.g.*, for visual surveillance or people counting;
- Interaction, *e.g.*, as the input to a device for computer-human interaction.

Also, Computer vision provides direct benefits to the user by cutting down on development times and creating an end-product that meshes with what the user wants and needs to do. Rather than functionalities being determined behind closed doors among a small group of developers and C-level executives, features are evolving based on natural usage. This is a boon for both developers, who can rely on AI and ML to identify major patterns for them, and for users, who end up with a more tailored user-friendly product.

VI. FUTURE WORK

One of the most complex and high profile ways computer vision is being used is in the advancement of autonomous cars. Driverless vehicles depend on advanced AI computer vision, with deep machine learning woven throughout for guidance. Since data is the gas that fuels AI and ML advancement, it's no surprise that Google owns the most advanced driverless technology on the market. Similar techniques are being used to develop computer vision security cameras, to conduct marketing research (by analyzing the pupils of testers as they try different products and watch different ads), create health care scanners that help technicians, and even build smarter green buildings that react to daily usage. Computer vision is the future, and it's a massive step toward creating truly invisible technology that adapts to users' needs instantly and predicts their future needs with uncanny accuracy.

Fig 3: Waymo, Google's self-driving car project

Waymo,(Fig 3) Google's name for its self-driving car project, is growing its computer vision through testing on public streets. By gathering data from real-world scenarios and recording variables that can occur during daily driving. This project will increase scope and necessity of computer vision in future.

VII. SURVEY RESULTS OF COMPUTER VISION AND IMAGE PROCESSING EDUCATION

The survey shows that, in addition to classic survey courses in Computer vision and image processing, there are many focused and multidisciplinary courses being taught that reportedly improve both student and faculty interest in the topic. It also demonstrates that students can successfully undertake a variety of complex lab assignments. In addition, this paper includes a comparative review of current textbooks and supplemental texts appropriate for computer vision

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image processing courses. Ten years ago, an undergraduate computer vision course was not a common feature of many engineering or computer science curricula. A digital image processing course was more common, but generally as an application of signal processing techniques within an EE/CompE program. Today, however, a larger number of institutions offer computer vision courses at the undergraduate level. In some cases the computer vision courses are offered as a complement or continuation of an IP course, in other cases as a standalone elective.

The text resources available for computer vision educators are improving. In addition to two high quality main textbooks, there are now a number of useful supplemental texts that should enable educators to fine-tune their reading list. In addition, the web resources available to educators are growing. Lab assignments, syllabi, reading lists, and lectures notes posted on the web create a wealth of inspiration and ideas when trying to decide what labs or readings to use during the upcoming semester. Even if you don't actually use anything you find, looking over the variety that exists will help you to come up with tasks that are both fun and challenging for students.

VIII. CONCLUSION

Therefore, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. . Understanding in this context means the transformation of visual images (the input of the retina) into descriptions of the world that can interface with other thought processes and elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory. The scientific approach builds upon a basic understanding of physical principles. In the case of computer vision, this includes the physics of man-made and natural structures, image formation, including lighting and atmospheric effects, optics, and noisy sensors. The task is to then invert this formation using stable and efficient algorithms to obtain reliable descriptions of the scene and other quantities of interest. The scientific approach also encourages us to formulate and test hypotheses, which is similar to the extensive testing and evaluation inherent in engineering disciplines.

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