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A Comprehensive Study of Computer Vision and its importance in higher studies

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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. The scope of this paper concerns both the developments in the field of computer vision and applications related to computer vision such as vision for the robots of the next century. It also describes the importance of Computer Vision in higher studies to integrate some of the advanced ideas into coherent development system.

Keywords: Artificial intelligence, Computer Vision, analysis, Navigation, Vision.

Introduction

Computer vision is an interdisciplinary field that deals with how computers can be made for gaining 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

Areas of artificial intelligence deal with autonomous planning or deliberation for robotical systems to navigate through an environment. A detailed understanding of these environments is required to navigate through them. 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.

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".

What distinguished computer vision from the prevalent field of digital image processing at that time was a desire to extract three-dimensional structure from images with the goal of achieving full scene understanding. 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 and representation of objects as interconnections of smaller structures, optical flow, and motion estimation.

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.

Therefore computer vision studies what world information vision systems can retrieve from visual sensory input, under what circumstances, and how.

Computer Vision and Graphics

It has often been said that computer vision and computer graphics are closely related, being inverses of the same problem. Computer graphics can be considered image synthesis in that it takes a mathematical description of a scene and produces a 2D array of numbers, which is an image. Computer vision can be considered a form of image analysis, taking a 2D image and converting it into a mathematical description. The next decade saw studies based on more rigorous mathematical analysis and quantitative aspects of computer vision. These include the concept of scale-space, the inference of shape from various cues such as shading, texture and focus, and contour models known as snakes.

Researchers also realized that many of these mathematical concepts could be treated within the same optimization framework as regularization and Markov random fields. By the 1990s, some of the previous research topics became more active than the others.

Research in projective 3-D reconstructions led to better understanding of camera calibration. With the advent of optimization methods for camera calibration, it was realized that a lot of the ideas were already explored in bundle adjustment theory from the field of photogrammetry. This led to methods for sparse 3-D reconstructions of scenes from multiple images. Progress was made on the dense stereo correspondence problem and further multi-view stereo techniques. At the same time, variations of graph cut were used to solve image segmentation.

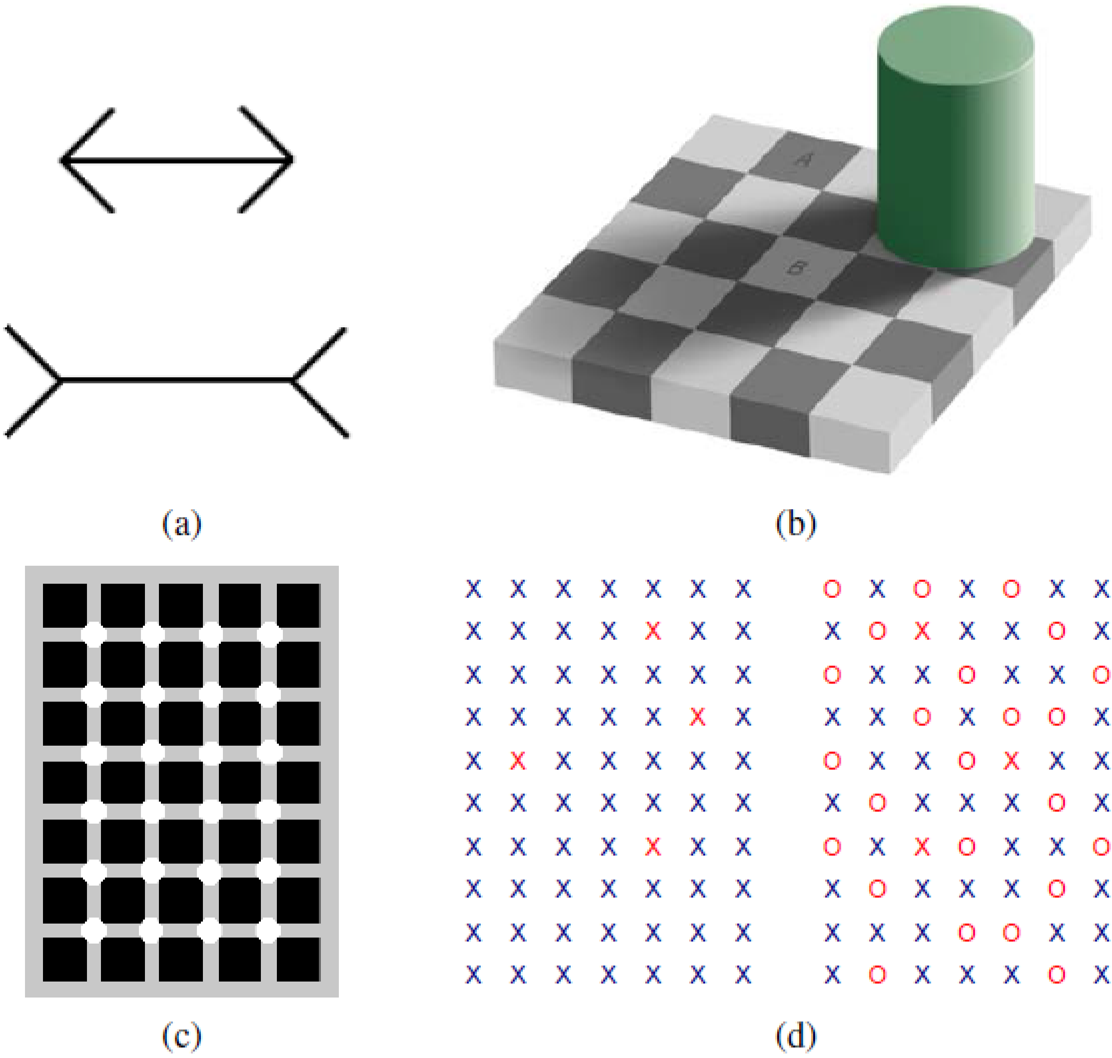

Fig. 1: Some common optical illusions which tells about the visual system

The mapping of the image processing and computer vision algorithms into computer graphics hardware explicitly and practically exposes the relationship between these operations. For instance, it has been shown that the process of image registration using an algebraic projective geometry is isomorphic to the process of projecting a texture mapped polygon under perspective projection in computer graphics.

In the same fashion, modern graphics requires a number of operations to be performed on an incoming fragment generated from a mathematical representation of a desired scene. These are operations such as geometric transformations, lighting, reflection, texture mapping and so on which are done in order to generate a final output pixel value. Similarly, for computer vision, a low-level algorithm will perform a number of operations on an input pixel value.

After the processing is done, a final output is produced which characterizes the input image as a mathematical construct of some significance. Despite the inverse nature, these processes are both characterized by a high degree of local processing which must occur per pixel (or in a small region, achieved perhaps by filtering.

APPLICATIONS & IMPORTANCE OF COMPUTER VISION

Computer Vision is being used today in a wide variety of real-world applications, which include:

- **Optical character recognition (OCR):** reading handwritten postal codes on letters and automatic number plate recognition (ANPR);
- **Machine inspection:** rapid parts inspection for quality assurance using stereo vision with specialized illumination to measure tolerances on aircraft wings or auto body parts or looking for defects in steel castings using X-ray vision
- **Retail:** object recognition for automated checkout lanes;
- **3D model building (photogrammetry):** fully automated construction of 3D models from aerial photographs used in systems such as Bing Maps;
- **Medical imaging:** registering pre-operative and intra-operative imagery or performing long-term studies of people's brain morphology as they age;
- **Automotive safety:** detecting unexpected obstacles such as pedestrians on the street, under conditions where active vision techniques such as radar or lidar do not work well
- **Match move:** merging computer-generated imagery (CGI) with live action footage by tracking feature points in the source video to estimate the 3D camera motion and shape of the environment. Such techniques are widely used in Hollywood.

Computer Vision in Industries

A second application area in computer vision is in industry, sometimes called machine vision, where information is extracted for the purpose of supporting a manufacturing process. One example is quality control where details or final products are being automatically inspected in order to find defects. Another example is measurement of position and orientation of details to be picked up by a robot arm. Machine vision is also heavily used in agricultural process to remove undesirable food stuff from bulk material, a process called optical sorting [8].

Military applications are also one of the largest areas for computer vision. The obvious examples are detection of enemy soldiers or vehicles and missile guidance. More advanced systems for missile guidance send the missile to an area rather than a specific target, and target selection is made when the missile reaches the area based on locally acquired image data. Modern military concepts, such as "battlefield awareness", imply that various sensors, including image sensors, provide a rich set of information about a combat scene which can be used to support strategic decisions. In this case, automatic processing of the data is used to reduce complexity and to fuse information from multiple sensors to increase reliability [9].

Fig. 2: Cost pressures and consumer handheld technology increasingly drive rugged wearable computer designs for war fighter application.

CONCLUSION

Computer graphics and computer vision are truly complementary disciplines quickly approaching convergence. As noted, the broad study of computer-based imagery extends beyond these two fields to include the areas of HCI, visualization, and image processing. Ongoing research and development will continue to forge this bond, and we'll begin to see real-world products emerge from these efforts. Then we will see the fruits of this convergence.

The field of virtual reality has driven much progress in immersive computing experiences, but a whole field of inspiration comes from the area of interface gadgets beyond the monitor, keyboard, and mouse. Science fiction has long dreamed of the ultimate computer interface that will "wet-wire" directly to our brains.

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