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Computer Vision

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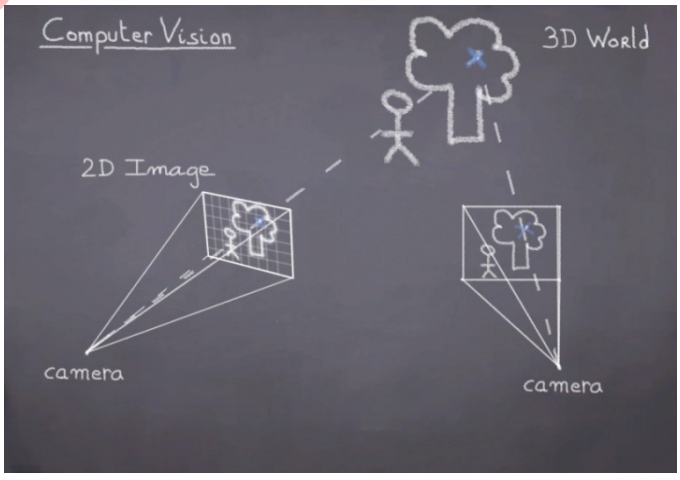
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Abstract: ***Computer vision is the science of endowing computers or other machines with vision, or the ability to see. The ultimate goal of computer vision is to model and replicate human vision using computer software and hardware at different levels .It combines knowledge in computer science ,electrical engineering ,mathematics , physiology , biology , and cognitive science . It needs knowledge from all these fields in order to understand and simulate the operation of the human vision system.The objective of studying computer vision is segmentation, reconstruction the 3D world, recognition and control. Related topics: image processing, computer graphics, pattern recognition, perception , robotics and AI. Some Applications for computer vision are medical computer vision or medical image processing,machine vision, Military applications, autonomous vehicles. There are many Typical tasks of computer vision such as Recognition,Motion analysis , Scene reconstruction , Image restoration.The organization of a computer vision system is highly application dependent. Some systems are stand-alone applications which solve a specific measurement or detection problem, while others constitute a sub-system of a larger design which, for example, also contains sub-systems for control of mechanical actuators, planning, information databases, man-machine interfaces, etc. Typical functions which are found in many computer vision systems are Image acquisition,pre-processing, feature extraction, direction/segmentation, high level processing , decision making.There are manykind of computer vision systems, nevertheless all of them contains these basic elements: power source, at least one image acquisition device (i.e. camera, ccd, etc), processor as well as control and communication cables or some kind of wireless interconnection mechanism. In addition a practicalvision system contains software for application and develop as well as display in order to monitor what the system does. Vision system for inner spaces, as most industrial ones, contains in addition an illumination system and in most cases a controlled environment, specially on external lighting. Furthermore, a completed system includes many accessories like camera supports, cables and connectors.***

Keywords: Replicate human vision, Cognitive science, robotics, motion analysis, mechanical actuators, feature extraction, segmentation.

1. INTRODUCTION

Computer vision (image understanding) is a discipline that studies how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of properties of the structures present in the scene.Computer vision has also been described as the enterprise of automating and integrating a wide range of processes and representations for vision perception. 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. The field of computer vision has evolved under the central theme of achieving human-level capability in the extraction of information from image data. There are many and diverse applications of computer vision since much of human experience is associated with images and with visual information processing.



Computer vision is the construction of explicit, meaningful descriptions of physical objects from their images. The output ofcomputer vision are a description or an interpretation or

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somequantitative measurements of the structuresin the3 D scene. Imageprocessing and pattern recognition area among many techniquescomputer vision employs to achieveitsgoals .

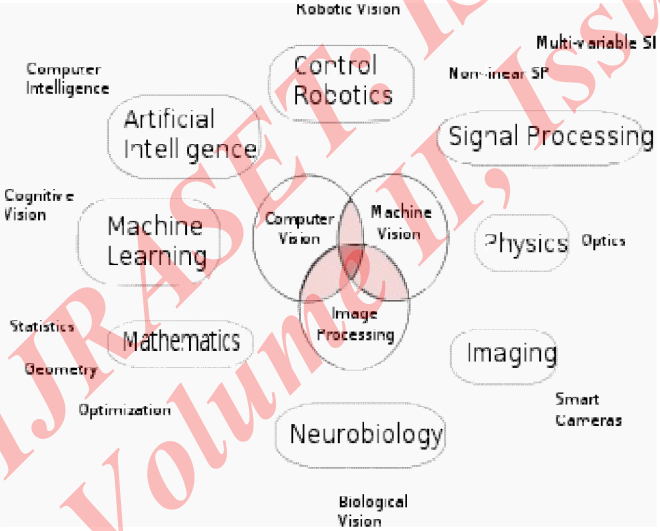
2. RELATED FIELDS

2.1 Artificial Intelligence

Artificial intelligence (AI) is the intelligence exhibited by machines or software, and the branch of computer science that develops machines and software with human-like intelligence. Major AI researchers and textbooks define the field as "the study and design of intelligent agents",where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1955,defines it as "the science and engineering of making intelligent machines". 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.

2.2 Neuro Science

Neuroscience is the scientific study of the nervous 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.



2.3 Signal Processing

Signal processing is an area of Systems Engineering, Electrical Engineering and applied mathematics that deals with operations on or analysis of analog as well as digitized signals, representing time-varying or spatially varying physical quantities.
Signal processing manipulates a signal to change it's characteristics or extract information. It is performed by computers, special purpose integrated circuits and analog electrical circuits.

2.4 Image Processing

Image processing and image analysis tend to focus on 2D images, how to transform one image to another, e.g., by pixel-wise operations such as contrast enhancement, local operations such as edge extraction or noise removal, or geometrical transformations such as rotating the image.

2.5 Machine Vision

Machine vision (MV) is the technology and methods used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance in industry. The primary uses for machine vision are automatic inspection and industrial robot guidance. Common machine vision applications include quality assurance, sorting, material handling, robot guidance, and optical gauging.

2.6 Pattern Recognition

Pattern recognition is a field which uses various methods to extract information from signals in general, mainly based on statistical approaches and artificial neural networks. A significant part of this field is devoted to applying these methods to image data.

III. APPLICATIONSOF COMPUTER VISION

3.1 Face Recognition

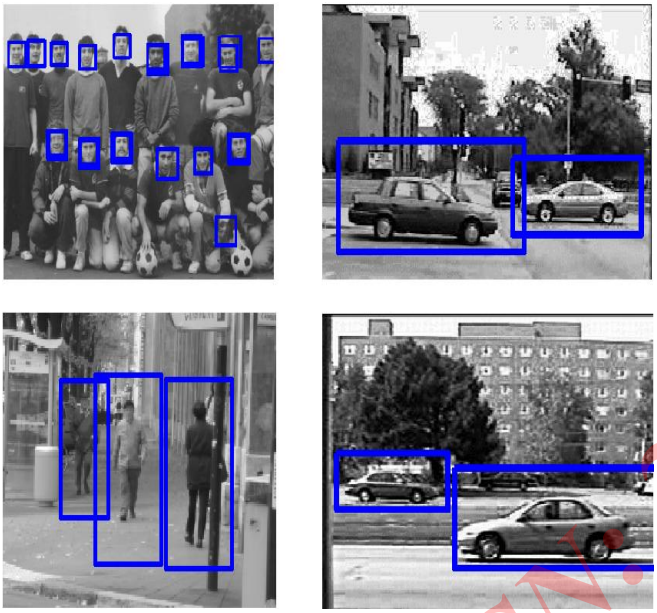
A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from avideo source. One of the ways to do this is by comparing selected facial features from the image and a facial database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems.

3.2 Object Recognition

Object recognition - in computer vision is the task of finding and identifying objects in an image or video sequence. Humans recognize a multitude of objects in images with little

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effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes / scale or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems. Many approaches to the task have been implemented over multiple decades.



3.3 Video Surveillance

Closed-circuit television (CCTV) is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point (P2P), point to multipoint, or mesh wireless links. Though almost all video cameras fit this definition, the term is most often applied to those used for surveillance in areas that may need monitoring such as banks, casinos, airports, military installations, and convenience stores.

3.4 Remote Sensing

Remote sensing is the acquiring of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation). It may be split into active remote sensing, when a signal is first emitted from aircraft or satellites)[1][2] or passive (e.g. sunlight) when information is merely recorded.

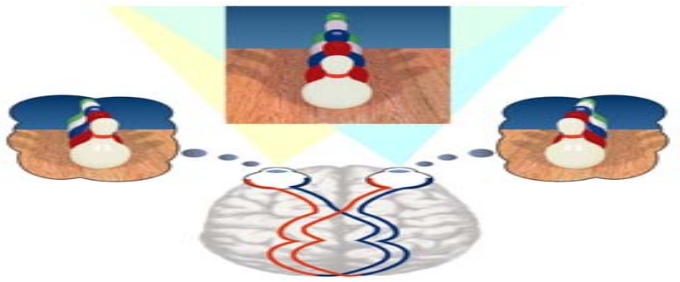


3.5 Robotics

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots,[1] as well as computer systems for their control, sensory feedback, and information processing. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and/or cognition.

3.6 Computer Stereo Vision

Computer stereo vision is the extraction of 3D information from digital images, such as obtained by a CCD camera. By comparing information about a scene from two vantage points, 3D information can be extracted by examination of the relative positions of objects in the two panels. This is similar to the biological process Stereopsis. With stereo vision, we can see Where objects are in relation to our own bodies with much greater precision--especially when those objects are moving toward or away from us in the depth dimension. We can see a little bit around solid objects without moving our heads and we can even perceive and measure "empty" space with our eyes and brains.



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IV. TYPICAL TASKS OF COMPUTER VISION

4.1 Recognition

The classical problem in computer vision, image processing, and machine vision is that of determining whether or not the image data contains some specific object, feature, or activity. This task can normally be solved robustly and without effort by a human, but is still not satisfactorily solved in computer vision for the general case – arbitrary objects in arbitrary situations. The existing methods for dealing with this problem can at best solve it only for specific objects, such as simple geometric objects (e.g., polyhedra), human faces, printed or hand-written characters, or vehicles, and in specific situations, typically described in terms of well-defined illumination, background, and pose of the object relative to the camera.

OBJECT RECOGNITION - In computer vision it is the task of finding and identifying objects in an image or video sequence. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes / scale or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. Google Goggles provides a stand-alone program illustration of this function

IDENTIFICATION – An individual instance of an object is recognized. Examples include identification of a specific person's face or fingerprint, identification of handwritten digits, or identification of a specific vehicle.

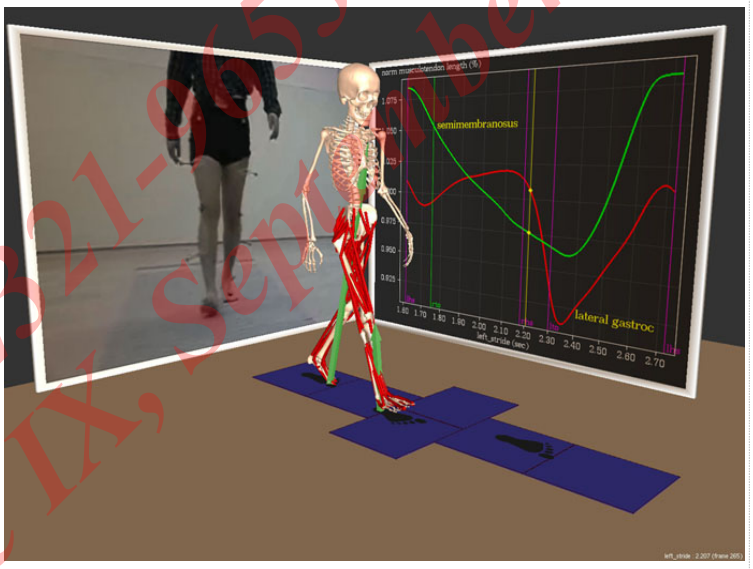
Content-based image retrieval – finding all images in a larger set of images which have a specific content. The content can be specified in different ways, for example in terms of similarity relative a target image (give me all images similar to image X), or in terms of high-level search criteria given as text input.

Pose estimation – estimating the position or orientation of a specific object relative to the camera. In computer vision and in robotics, a typical task is to identify specific objects in an image and to determine each object's position and orientation relative to some coordinate system. This information can then be used, for example, to allow a robot to manipulate an object or to avoid moving into the object.

Optical character recognition (OCR - is the mechanical or electronic conversion of scanned or photographed images of typewritten or printed text into machine-encoded/computer-readable text. It is widely used as a form of data entry from some sort of original paper data source, whether passport documents, invoices, bank statement, receipts, business card, mail, or any number of printed records.

4.2 MOTION ANALYSIS

The motion analysis processing can in the simplest case be to detect motion, i.e., find the points in the image where something is moving. More complex types of processing can be to track a specific object in the image spatial and over timetemporal, to group points that belong to the same rigid object that is moving in the scene, or to determine the magnitude and direction of the motion of every point in the image.



Examples of such tasks are:

Egomotion - Egomotion is defined as the 3D motion of a camera within an environment. An example of egomotion estimation would be estimating a car's moving position relative to lines on the road or street signs as observed from the car itself.

Tracking - tracking is the process of locating a moving object (or multiple objects) over time using a camera. It has a variety of uses, some of which are: human-computer interaction, security and surveillance, video communication and compression, augmented reality, traffic control, medical imaging[1] and video editing.

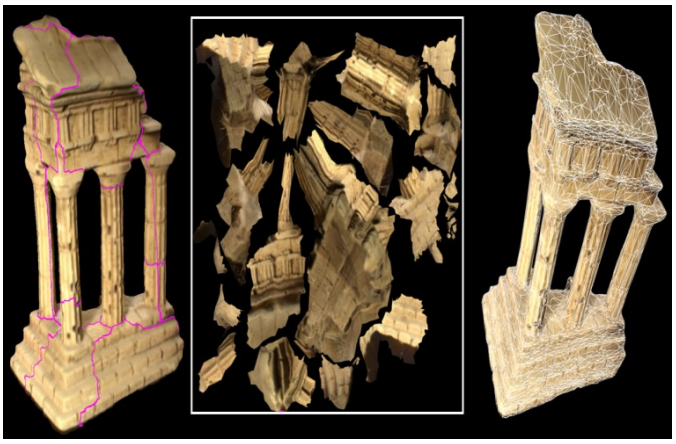
4.3 Scene Reconstruction

Given one or (typically) more images of a scene, or a video, scene reconstruction aims at computing a 3D model of the scene. In the simplest case the model can be a set of 3D points. More sophisticated methods produce a complete 3D

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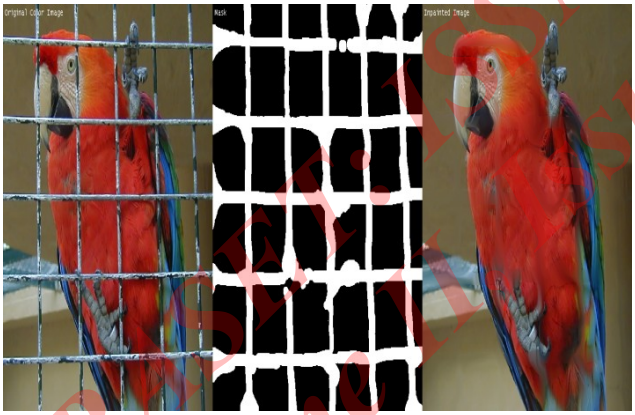
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surface model. The advent of 3D imaging not requiring motion or scanning, and related processing algorithms is enabling rapid advances in this field. Grid-based 3D sensing can be used to acquire 3D images from multiple angles.



4.4 Image Restoration

The aim of image restoration is the removal of noise (sensor noise, motion blur, etc.) from images. By first analysing the image data in terms of the local image structures, such as lines or edges, and then controlling the filtering based on local information from the analysis step, a better level of noise removal is usually obtained compared to the simpler approaches. An example in this field is the inpainting.



V. COMPUTER VISION SYSTEM METHOD

The organization of a computer vision system is highly application dependent. Some systems are stand-alone applications which solve a specific measurement or detection problem, while others constitute a sub-system of a larger design. Many functions are unique to the application.

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. The pixel values typically correspond to light intensity in one or several spectral bands (gray images or colour images), but can also be related to various physical measures, such as depth, absorption or reflectance.

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.

1. Re-sampling in order to assure that the image coordinate system is correct.
2. Noise reduction in order to assure that sensor noise does not introduce false information.
3. Contrast enhancement to assure that relevant information can be detected.

Feature extraction – Image features at various levels of complexity are extracted from the image data. Typical examples of such features are:

1. Lines, edges and ridges.
2. Localized interest points such as corners, blobs or points.

Decision making - Making the final decision required for the application,[11] for example:

1. Pass/fail on automatic inspection applications
2. Match / no-match in recognition applications
3. Flag for further human review in medical, military, security and recognition applications

VI. CONCLUSION

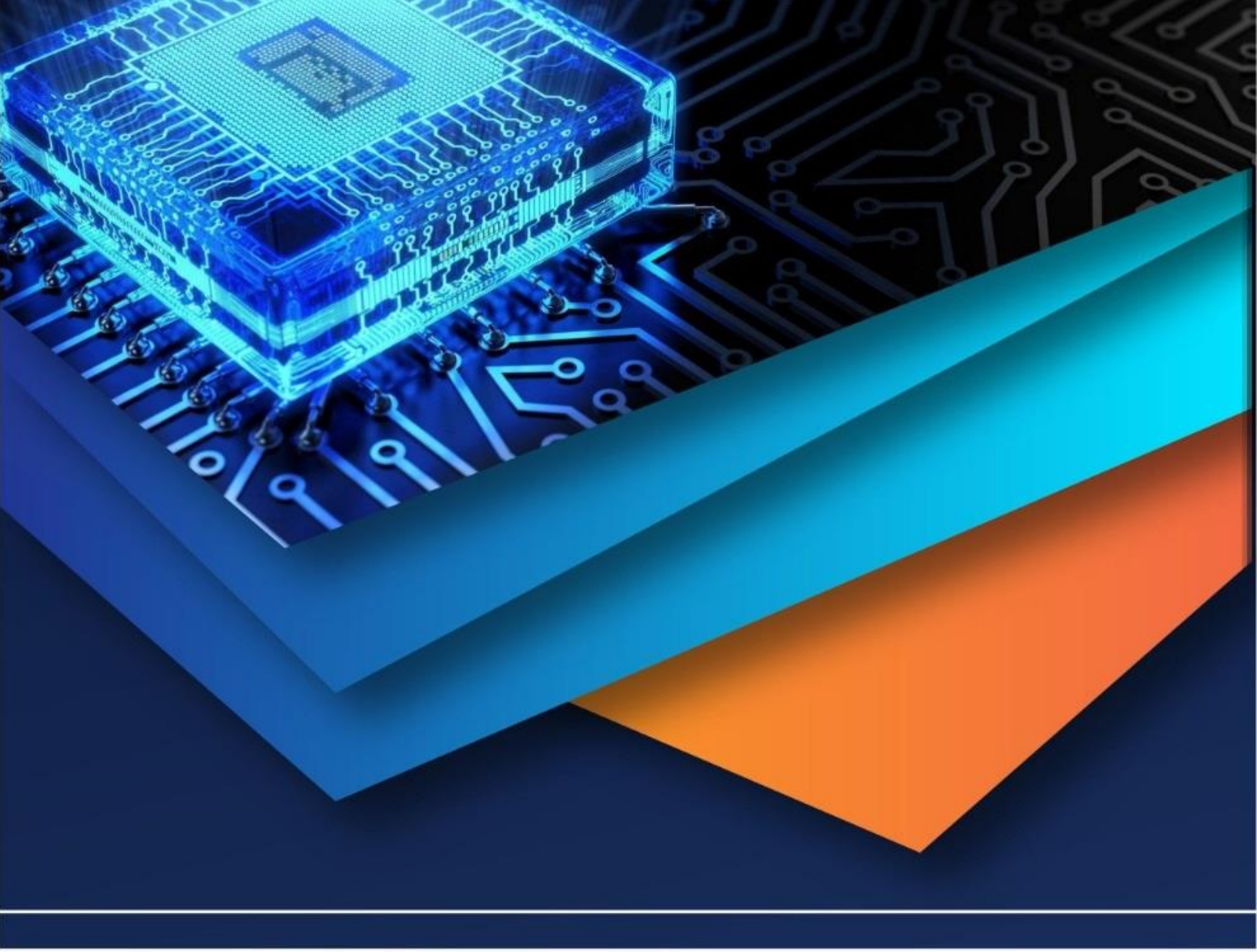
From the above Research we can conclude that Computer Vision is one of the major trend in Future Development. The applications of computer vision like object recognition, motion analysis, remote sensing etc. can help us to eliminate the faults. Computer vision techniques are recently used in many places like remote sensing in UAVs(Unmanned Aerial Vehicles) , video surveillance in security purposes and robot vision in UGVs(Unmanned Ground Vehicles) like Google cars.Recently there is a new computer system introduced that identifies better facial expressions than humans. There are many questions and problems related to this field but still computer vision is on of the biggest inventions in human history.

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