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## **COMPUTER VISION ASSIGNMENT 1**

### **Introduction**

Computer vision is an aspect of artificial intelligence that gives the computer the ability to analyze and understand visual content. It mirrors the human vision, that means that computer vision works the same way that human vision works. A better understanding of how human vision work will help to understand how the computer vision works. While the human vision is a biological process which involves the eyes, optic nerves and the brain, computer vision relies on machine learning and deep learning to process images and videos. IBM defined computer vision as a field of artificial intelligence (AI) that uses machine learning and neural networks to teach computers and systems to drive meaningful information from digital images, videos and other visual inputs- and to make recommendations or take actions when they see defects or issues [1].

According to [2], the goal of the computer vision is to make useful decisions about real physical objects and scenes based on sensed images. Computer vision is that aspect of computer that does a similar function as of the human eyes. It helps to make the digital world look real that the users can interact with it. It does this by using deep learning to make sense of photos and videos captured to identify and classify objects or visual information. With the advancement of technology, there is a revolution in different industries because of the impact of computer vision. There is a daily emergence of more applications for computer vision underscoring the great potentials of computer vision. The

next decades will see computer vision revolutionizing most industries and fields. This perceived future of computer vision demands that people across all fields should start embracing computer vision.

### **Importance of Computer vision**

Computer vision is very important in many fields and there is huge impact of computer vision across different fields. Industries like manufacturing, healthcare, autonomous vehicles, security and surveillance, sport performance analysis, agriculture monitoring, species classification, self-driving cars, robotic automation, etc are experiencing this huge impact of computer vision technology. Computer vision has revolutionized these areas, increased efficiency and productivity, ensured better security, improved health outcome and even added support to humans. It has shown to be a technology with no end to their development. The potentials of computer vision and AI in general is not fully known, with more research, more capability of computer will be discovered. Every industry should look at ways computer vision will be applicable to them because with the evolution, computer vision will become applicable to most industries if not all as the world increasingly accept the virtual reality created by technology and largely made possible by computer vision. The computer vision is becoming extremely important to the world the same way human sight is important to humans. The machine having the ability to receive digital information, process it, analyze, interpret and make decisions based on that information is very important to the current state and future of the digital world and that is exactly what computer vision is all about.

The importance of computer vision in some fields will be highlighted below:

- **Robotics:** One area that robotics is making huge impact is in the automation industry. This has added great efficiency in the manufacturing and other areas where automation is applied. There is a massive growth in the application of robotics in operations and services. [3] reported of the massive boost in operations across industries in today's world due to the impact of computer vision. Computer vision enables robots to perform tasks like quality control, assembly line monitoring, and predictive maintenance, leading to increased efficiency and reduced labor costs. During the pandemic, CVS introduced DataRobot that helped in efficiently delivering testing and vaccines in the USA. Computer vision is also applied in X-ray imaging and precision surgery. Robotics are now used to perform domestic chores including baby sitting like the recently rolled out robots by Tesla. Robotics are used for some other human-related roles including partnership to humans and some level of customer service. The growth in the robotic technology is having huge impact on both the economy and the society, with increased efficiency as one of the major areas of improvement.
- **Healthcare:** Medical imaging analysis and surgical assistance are two areas that the impact of computer vision is felt in the healthcare industry. Computer vision algorithms assist in analyzing medical images like X-rays, MRIs, and CT scans, aiding in disease detection, diagnosis, and treatment planning [4]. Robotic-assisted surgeries often incorporate computer vision for precise instrument guidance and improved surgical outcomes [5]. The introduction of AI and particularly computer

vision in healthcare has improved operations, diagnosis and decision. Its important to note that this has caused an improved outcome in the healthcare system. As the computer vision technology improves, the healthcare outcome will continue to improve.

- **Autonomous vehicles:** There is a growing popularity of self-driving cars especially with the global promotion of electric cars. Self-driving cars rely heavily on computer vision for tasks such as object detection, lane keeping, and obstacle avoidance, promising to revolutionize transportation [6]. Tesla and Waymo are two of the leading makers of self-driving car. Though the self-driving car technology is still very young, but the importance can not be overstated because of its potential to reduce risk in human driving, reduction in operational cost when human driver is eliminated.
- **Security and Surveillance:** Facial recognition has improved the security systems. Computer vision enables facial recognition technology to be used for security purposes, such as access control, law enforcement, and surveillance systems [7]. Facial recognition is an important technology whose impact is already being felt in some places. It makes identification and apprehension of criminals easy leading to reduced crime rate. It has the potential of reducing the global crime because it makes it difficult for international criminals to hide.

### **History of Computer Vision**

Below is the summary of the main development in computer vision evolution

- **Pioneering Period (1950s-1960s):**

Though computer vision sounds like a new technology, scholars started the development of simple algorithms in the 1960s to process and analyze visual data. During that period Larry Roberts who is considered one of the pioneers of computer vision in his paper at MIT discussed the possibility of extracting 3D geometrical information from 2D perspective views of blocks [8]. This became a foundation for many in artificial intelligence across the world to study computer vision. Frank Rosenblatt developed the perceptron, an early artificial neural network for pattern recognition, laying the foundation for future developments [9]

- **Edge Detection and Feature Extraction (1970s-1980s):**

Edge detection is a technique that identifies edges in images. Feature extraction is a process that simplifies images into basic patterns. The focus of computer vision at this stage was on low-level vision, like edges, corners, and textures. Development of key algorithms for edge detection also took place [10]

- **Rise of Machine Learning (1990s-2000s):**

**Machine learning**, a subfield of artificial intelligence (AI) that focuses on algorithms that allow computers to learn from data without being explicitly programmed began to be applied [11]. The rise in computer and internet availability aided the growth

that computer vision experienced during this period. The first real-time face recognition video application was developed in 2001.

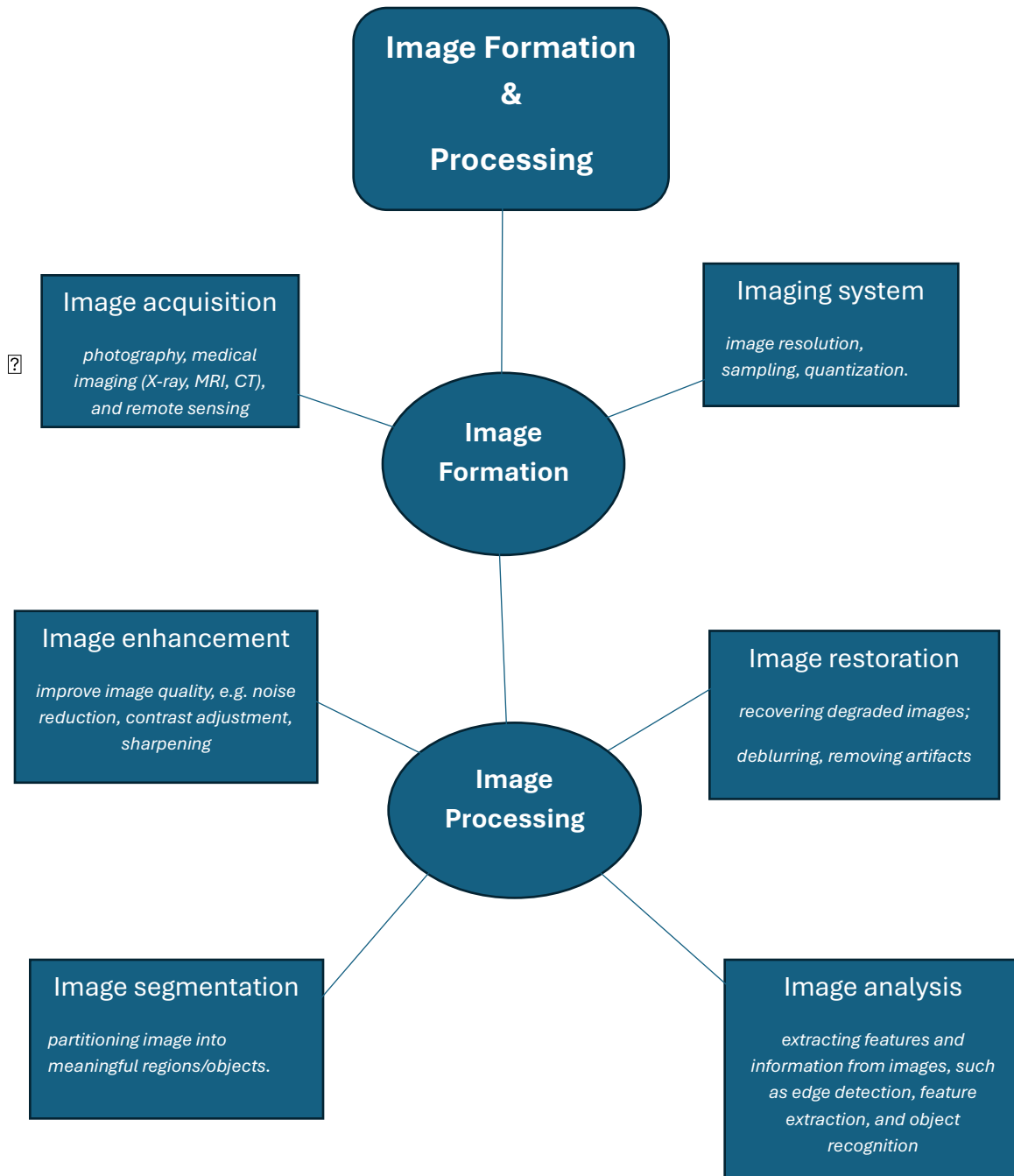
- **Deep Learning Revolution (2010s-Present):**

Deep learning is used in computer vision to teach machines how to see and understand the things around them. For object recognition, patterns and actions, Convolutional neural networks (CNNs) are a technique that processes images and videos [12]. The unveiling of AlexNet took place in the University of Toronto in 2012. AlexNet is a neural network that substantially reduced image recognition errors. Since then, the world has seen increase in many possibilities of computer vision and more are yet to be seen.

- **Image formation and processing**

Digital Image Processing is a book by [13] that provides a strong foundation in the principles of image formation and processing. It is understood that Image formation begins with the interaction of light with objects in the real world. When light is reflected, absorbed, or transmitted by objects, variations in intensity and color is created. This information is captured by an imaging sensor, which converts the analog light signal into a digital representation. This digital image is then processed using various techniques to enhance its quality, extract information, and perform higher-level tasks like object recognition.

The image formation and processing are summarized into.



## **Applications and challenges**

- Real-world applications of computer vision in the following areas below:

### **Facial recognition**

The application of computer vision in facial recognition has revolutionized the security system. The computer vision can spot suspicious activities and offenders through cameras in public and private places depending on the goal. This system can identify humans and give them access to restricted areas.

### **Medical imaging**

The medical imaging is another area artificial intelligence is greatly impacting through the computer vision application. Computer vision analyze medical imaging like CT scans, MRIs to help the medical personnels have a better understanding of the situation and give better diagnosis and treatment.

### **Virtual reality**

This is the interaction of a user with virtual objects through computer vision with the use of algorithms that analyzes the user's environment. In the real world, the virtual reality is applied to.



- Healthcare, precision incisions in surgery, mental health treatment (depression, anxiety, post-traumatic stress)
- In fashion where shoppers can virtually try on the wears.
- Applied in museum visits, visiting tourist places virtually

### **Augmented reality**

This involved the combination of digital information with the real world. In the real world, augmented reality is applied to surgery, furniture arrangement, product visualization.

### **Identify some challenges and ethical issues related to computer vision**

No doubt, computer vision is having a huge impact on the information technology industry especially in the virtual world however there are some challenges facing it. These include data quality, object scaling, lighting conditions, occlusion, accuracy, processing speed, and data labeling to name the few.

### **Ethical challenges facing computer vision**

**Fraud:** The use of deepfakes and masks by criminals poses a serious ethical issue

**Ethical consent violation:** the potential misuse of personal information and the use of personal information without consent is a of great concern.

**Bias:** using a bias data will obviously lead to a wrong outcome, bias result and this is of great ethical concern.

**Inaccuracy:** the quality of data used is very important to achieving the correct outcome.

**Legal consent violation:** it is important that the law is adhered to

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