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A Study on Recent Trends in Multimedia Communication

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ABSTRACT

Nowadays image processing, computer vision and machine learning go hand in hand for many recognition tasks. These three fields are paving the way to a new future where robots can not only see everything around them with a clearer sense but can also understand how to interact with them. Through the use of highly sophisticated convolutional neural networks and advanced image processing techniques it is possible to scale technology to a new level.

Keywords: image processing, computer vision, machine learning, techniques

I. INTRODUCTION

The technique of image processing allows us to enhance images taken from cameras of sensors places on satellites or aircrafts and even any pictures taken from normal day to day life. These image processing systems have gained attraction since the availability of powerful personal computers with large memory and fast graphic software. Some of the most recent advances in technology are credited to computer vision. All the way from algorithms that detect skin cancer to self-driving cars, computer vision algorithms lay the foundation for all these feats. CV algorithms have been around since 1960's but only recently they progressed to more sophisticated levels. Machine learning is a field of artificial intelligence. In machine learning we try to learn a data model and fit new data to that model. Some new facial recognition technology has allowed for social media platforms to help users tag and share photos of friends. Recommendation engines, self-driving cars etc. are some of the examples of the power of machine learning.

II. IMAGE PROCESSING

An image is a 2D light intensity function f(x,y) where the (x,y) represents spatial coordinates and the value we get from f at any point (x,y) will be proportional to the brightness or the grey levels of the given image at that point. A digital image represents the function f(x,y) that has been discretised in both the spatial and brightness coordinates.

The elements of this digital array are called image elements or pixels.

1. A simple image model:

To be suitable for computer processing, an image f(x,y) must be digitalized both spatially and in amplitude. Digitization of the spatial coordinates (x,y) is called image sampling. Amplitude digitization is called grey-level quantization. The storage and processing requirements increase rapidly with the spatial resolution and the number of grey levels. Example: A 256 grey-level image of size 256x256 occupies 64K bytes of memory. Images of very low spatial resolution produce a checkerboard effect.

2. Basics of colour

(A) Light and spectra

Colour is the perceptual result of light in the visible region of the spectrum, having in the region of 400nm to 700nm, incident upon the retina. Visible Light is a form of electromagnetic energy consisting of a spectrum of frequencies having wavelengths range from about 400nm for violet light to about 700nm for red light. Most light we see is a combination of many wavelengths.

(B) Primaries

Any colour can be matched by proper proportions of three component colours called primaries. The most common primaries are red, blue and green. The following terms are used to define colour light:

1. Brightness or Luminance: This is the amount of light received by the eye regardless of colour.
2. Hue: This is the predominant spectral colour in the light.
3. Saturation: This indicates the spectral purity of the colour in the light.

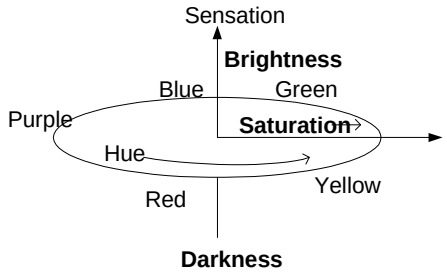

Figure 1. Saturation, Hue, Brightness Diagram

III. COMPUTER VISION

Computer Vision is a field of Artificial Intelligence and that aims at giving computers the ability to perceive objects of the world. There are three main methods involved in processing of components in computer vision as shown in Figure 2:

1. Image acquisition
2. Image processing
3. Image analysis and understanding

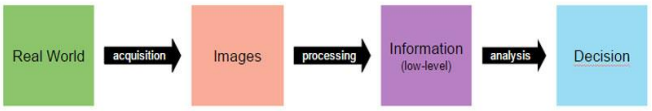

Figure 2. Steps in Computer Vision

1. Image acquisition

Image acquisition is the process of translating the analog images into binary data to get digital images. Different tools have been created to do this task as shown in Figure 3:

1. Webcams & embedded cameras
2. Digital compact cameras & DSLR
3. Consumer 3D cameras & laser range finders

Figure 3. Various Image acquisition devices

2. Image processing:

Next is the low level processing of images. In this step we apply some low level algorithms on parts of the image such as image edges, point features or segments etc. This second step usually involves advanced applied mathematics algorithms and techniques as shown in Fig-4. Low-level image processing algorithms include:

1. Edge detection
2. Segmentation
3. Classification
4. Feature detection and matching

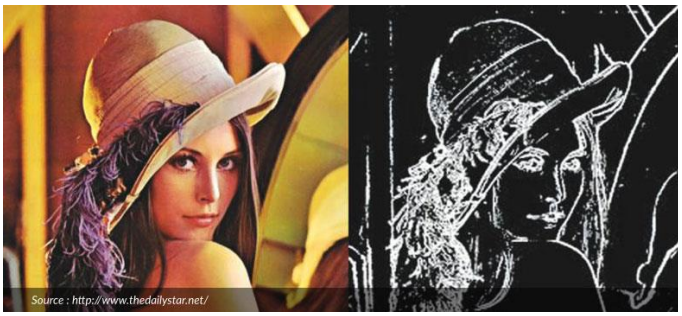

Figure 4. Edge Detection

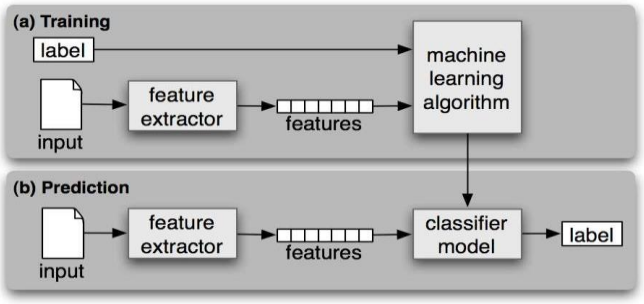

Figure 6. Steps in Machine Learning

3. Image analysis and understanding:

The last step is the actual analysis of the data, achieved using high-level algorithms, using both the image data and the low-level information computed in previous steps. Examples of high-level image analysis as shown in Fig-5 are:

1. 3D scene mapping
2. Object recognition
3. Object tracking

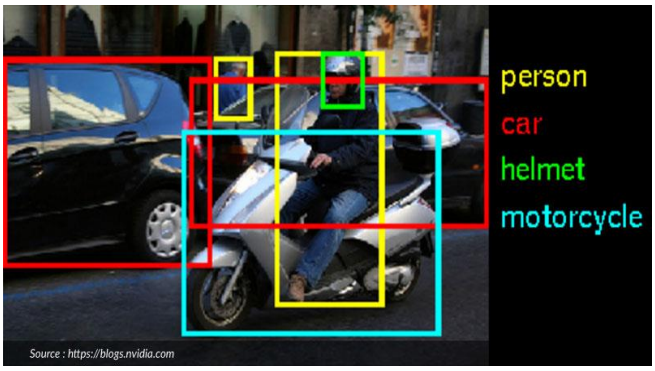

Figure 5. Object Detection

IV. MACHINE LEARNING

Machine learning is a field of computer science that gives computer systems the ability to "learn" with data, without being explicitly programmed. Figure 6 shows the steps in Machine Learning Algorithm.

Categories

The categories of machine learning are Supervised Learning, Unsupervised Learning, Semi-Supervised Learning and Reinforcement Learning.

1. Supervised Learning

The correct classes of the training data are known as shown in Figure 7.

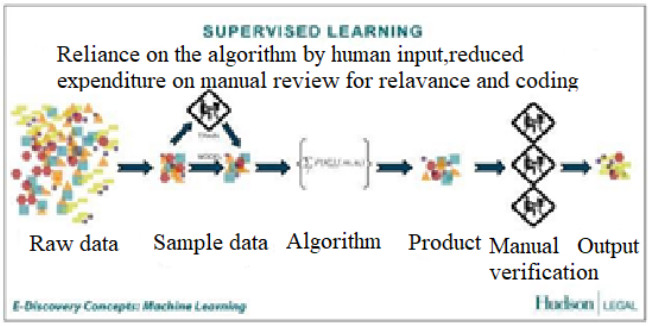

Figure 7. Supervised Learning

2. Unsupervised Learning

The correct classes of the training data are not known as shown in Figure 8.

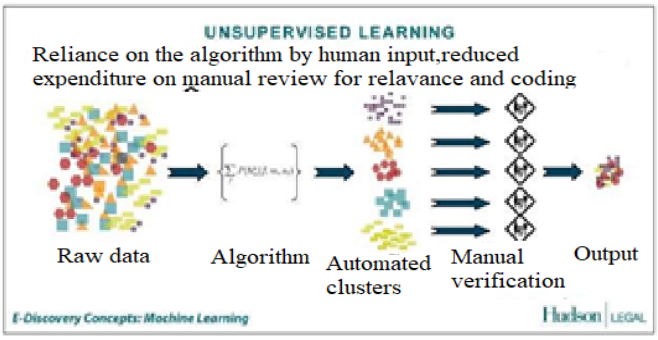

Figure 8. Unsupervised Learning

3. Semi-Supervised Learning

A Mix of Supervised and Unsupervised learning as shown in Figure 9

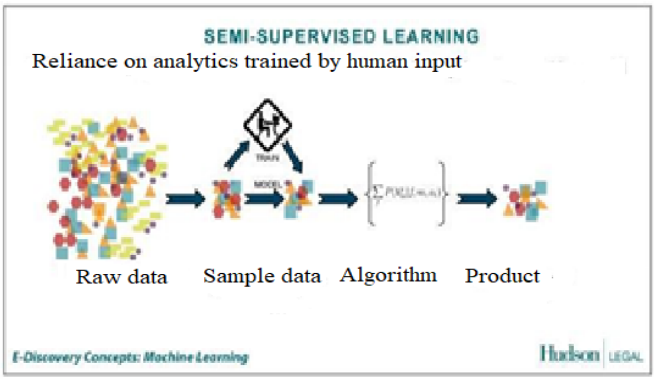

Figure 9. Semi-Supervised Learning

4. Reinforcement Learning

Allows the machine or software agent to learn its behaviour based on feedback from the environment as shown in Figure 10.

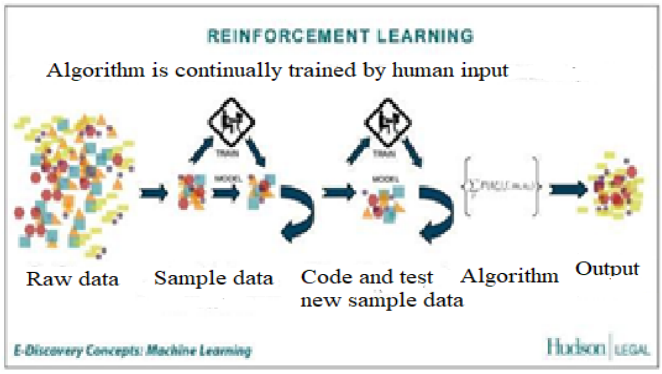

Figure 10. Reinforcement Learning

V. APPLICATIONS

1. Applications of image processing:

Digital image processing has two main application areas i.e. Improvement of pictorial information for human interpretation and Processing of scene data for autonomous machine perception. In this second area we focus on extracting information from the image that is suitable for processing. Examples include automatic character recognition, industrial machine vision for product assembly and inspection, military recognizance, automatic processing of fingerprints etc.

2. Applications of computer vision:

Few applications of computer vision are Motion recognition, Augmented reality, Autonomous cars, Domestic/service robots and Image restoration such as denoising,

3. Applications of machine learning:

Few application areas of machine learning are Spam Email Detection, Machine Translation (Language Translation), Clustering (KMeans) used in Amazon Recommendations, Classification used in Google News, Rating a Review/Comment as used in Yelp, Fraud detection used in Credit card Providers, Decision Making used in Bank/Insurance sector, Sentiment Analysis and Speech Understanding as used in iPhone with Siri.

VI. CONCLUSION

Image processing, computer vision and machine learning are nowadays concepts that are implemented in most of the technology we use today. Through advances in these fields we have been able to make breakthroughs in science and engineering to enable us all to move towards a brighter future.

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