



International Journal of Artificial Intelligence and Machine Learning

Publisher's Home Page: <https://www.svedbergopen.com/>



Research Paper

Open Access

Fundamental study of Computer Vision Through the Eye of Image Processing

Maulik Dhamecha¹, Urvi Dhamecha², Vijaykumar Vyas³, Dr. Nandan k Pandya⁴, Dr. Paresh kotak⁵, Ravindra Dudani⁶

¹ Department of Computer Engineering, V.V.P. Engineering College, Rajkot, Gujarat. E-mail: mvdhamecha@gmail.com

² Department of Computer Engineering, Marwadi University, Rajkot, Gujarat. E-mail: urvidarji17@gmail.com

³ Department of Information Technology, V.V.P. Engineering College, Rajkot, Gujarat. E-mail: er.vjay2009@gmail.com

⁴ Department of Computer Engineering, Faculty of Engineering Swaminarayan University, Kalol, Gandhinagar, Gujarat. E-mail: pandyanandan007@gmail.com

⁵ Department of Information Technology, V.V.P. Engineering College, Rajkot, Gujarat. E-mail: kotakp2003@gmail.com

⁶ Electronics and Communication Engineering Department, A. V. Parekh Technical Institute, Rajkot, Gujarat. E-mail: ravindradudani@gmail.com

Abstract

In this digital world, it is not wrong to say that tasks initially done by human eye is now done more efficiently by computer vision. This conveys that without human support computers can make assumptions about images. Computer Vision has been studied by varying aspects that includes techniques and ideas combining digital image processing, machine learning, computer graphics and pattern recognition using the unprocessed data records. This paper acknowledges us with the growth of Computer Vision which is focused on the Image Processing using various real-life applications in the theoretical perceptions and recent inventions. Computer Vision guides to gain the knowledge to the professionals about how to examine videos and images, understand those data and process required information. We relate the Computer Vision with Image Processing and provide brief explanations about the cutting-edge technologies.

Keywords: Computer Vision, Machine Learning, Convolutional Neural Network (CNN), Image Processing, Digital Image.

Introduction

Computer vision is a vast area that takes care of records of data for extracting patterns of images and interpretation of information [1]. It consists of an amalgamation of ideas, techniques, and concepts starting from utilizing digital images, pattern recognition, computing (AI), and graphics [2]. The majority of the functions in the Computer Vision system are related to the methodology of acquiring data about events or descriptions from the input fields, which is digital images and extraction. Various methods of solving problems in Computer Vision depend on the domain of the application and also the nature of the data under analysis.

Computer Vision essentially works through image processing and pattern recognition [2]. In other words, the understanding of the image is the result of the Computer Vision technique.

Computer Vision system has limited functionality and performance compared to the human eye. Although many experts have proposed a wide range of computer vision techniques to replicate the human eye, however, in many cases, there are limitations to the performance of a computer vision system. One of the biggest challenges in their strategy is the sensitivity of the parameters, the strength of the algorithm, and the accuracy of the results. It affects the complexity of the performance testing of computer vision systems. Typically, performance testing involves some measurement of the core behaviour of the algorithm to achieve accuracy, power, or to stretch control and monitor system performance [3].

Since the operation of the computer vision system depends on the design of the application system, there are extensive efforts proposed by many experts to amplify and separate computer vision in many areas and specific applications such as automated assembly line, remote hearing, robots, computer and human communication, tools of visually impaired, and others.

Related Work

It all began millions of years ago; the evolution of small organisms made them sensitive to light. Fast-forwarding today, there are plenty of life around the world with the same visual system [4][29]. It includes the eye for capturing light, after that the receptors located in the brain to access it, and finally, the visual cortex to process it. Over the past few years, we have not only expanded our 'viewing skills' for us but also on machines as well.

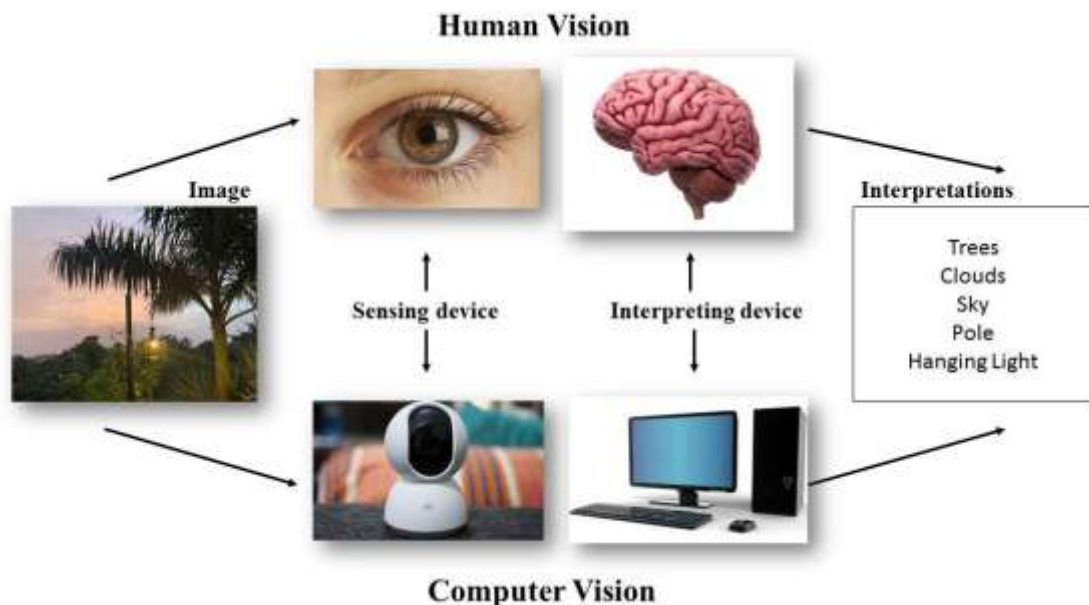


Fig.1. Understanding Human Vision and Computer Vision

The first type of photographic camera was invented in 1816 when a small box containing paper wrapped in silver chloride [5][8]. When the shutter was open, the silver chloride turned black at the time of exposed to light. Now, 200 years later, we have the most advanced versions of the program that can capture images to digital form. And thus, we will be able to imitate closely that how light and colour are captures by the human eye. The comprehension in the picture is very difficult. Think about this image.



Fig.2. Image of the Bird

By looking at this image in Fig.2, the human brain immediately identifies it as a Bird. But the computer does not understand easily.

Computer interprets the image as an algorithm which appears like this

```
[23, 43, 5, 67, 75, 25, 88, 65, 97, 86, 90,
 34, 56, 76, 23, 99, 56, 23, 99, 67, 53, 76,
 22, 72, 24, 73, 94, 38, 42, 95, 24, 75, 24,
 134, 75, 98, 24, 60, 52, 50, 31, 29, 62, 99
 53, 35, 77, 111, 112, 104, 56, 88, 90, 30, 78,
 33, 12, 90, 45, 89, 90, 112, 67, 78, 122, 132,
 54, 89, 105, 106, 207, 34, 44, 55, 21, 31, 42,
 87, 67, 45, 44, 27, 28, 117, 89, 91, 124, 94,
 109, 100, 180, 222, 245, 56, 66, 83, 63, 56, 40,
 113, 115, 17, 50, 54, 67, 75, 15, 31, 31, 18]
```

An array of integers represents the intensity of the colour scheme. There is no context here, it's just a huge amount of data. It turns out that the context is the basis for finding algorithms for understanding the content of images in the same way as the human mind [6][28]. And to do this work we use an algorithm that is very similar to how the human brain works through machine learning [9]. Machine learning allows us to

successfully train the context of data set so that the algorithm understands what all those numbers in a particular organization really represent

[23, 43, 5, 67, 75, 25, 88, 65, 97, 86, 90,
34, 56, 76, 23, 99, 56, 23, 99, 67, 53, 76,
22, 72, 24, 73, 94, 38, 42, 95, 24, 75, 24,
134, 75, 98, 24, 60, 52, 50, 31, 29, 62, 99
53, 35, 77, 111, 112, 104, 56, 88, 90, 30, 78,
33, 12, 90, 45, 89, 90, 112, 67, 78, 122, 132,
54, 89, 105, 106, 207, 34, 44, 55, 21, 31, 42,
87, 67, 45, 44, 27, 28, 117, 89, 91, 124, 94,
109, 100, 180, 222, 245, 56, 66, 83, 63, 56, 40,
113, 115, 17, 50, 54, 67, 75, 15, 31, 31, 18]

Fig.3. Computers Interpreting image object from pixel values

There are some images which are difficult for humans to recognise and so even it makes it difficult for machines to recognise through Machine Learning. Consider this example of Teddy Bear and Cavoodle and also Labradoodle Dog breed.



Fig.4. Images of Cavoodle and Labradoodle dog with Teddy Bear

Source:

(a) https://www.reddit.com/r/Eyebleach/comments/579r6d/cavoodle_pups_are_actually_the_cutest/

(b)

<https://www.newsstore99.top/Products.aspx?cid=30&cname=teddy+bear+labradoodle+puppies+for+sale>

(c) <https://www.pinterest.com/pin/542543086367636606/>

On seeing both these images, we cannot easily differentiate both as they look almost similar. With the help of Machine Learning model, a lot of teddy bear and dog images can be taken and as long as we feed them with enough detail [14]. This will eventually differentiate between both. Computer vision takes on increasingly challenging challenges and detects precision against people who perform similar image recognition tasks. But as humans, these species are imperfect. Sometimes they make mistakes. A neural network of such a type is called a convolutional neural network or CNN [11][19]. CNN essentially works by segmenting the image into smaller groups of pixels called a filter. Each filter is a pixel matrix, and the network performs a series of calculations on these comparisons and then contrasts the pixels with the specific pattern that the network requires [20][25]. In CNN's first layer, it can detect high-quality patterns, for instance, rough edges and curves. As the network generates more challenges, it can begin to recognize particular objects like faces and animals. The accuracy of the prediction done by CNN is through the large amount of labelled training data.

When CNN starts, all the filter values are set. As a result, its initial predictions are absurd. Each time CNN made a prediction against a labelled data, it uses an error function to compare how close its prediction was to the actual image label [24]. Based on the error or error function, CNN renews its filter

values and resumes the process. Ideally, each iteration operates with greater accuracy [23].

5. IMAGE PROCESSING

Image processing is analysing and manipulating a picture through code. Using math and computer science we can analyse, enhance and distort images for all kind of uses.

There are endless situations that require image processing done by software. Generally, they can be clustered into several groups, such as presence testing, object detection and localization, measurement, identification and verification etc [17].

In most cases, the acquired image from the cameras cannot be processed directly within the application, instead it is pre-processed, to enhance the image according to the specific task [26]. Here, in pre-processing, we can apply contrast enhancement, brightness adjustment, noise reduction and many more [30]. Some of the steps can be performed directly from the camera itself and thus keep the CPU load on the keeper side. The better the pre-processing the better the image quality and results of the image processing within your application [31].

Hence based on application images can be broadly classified as:

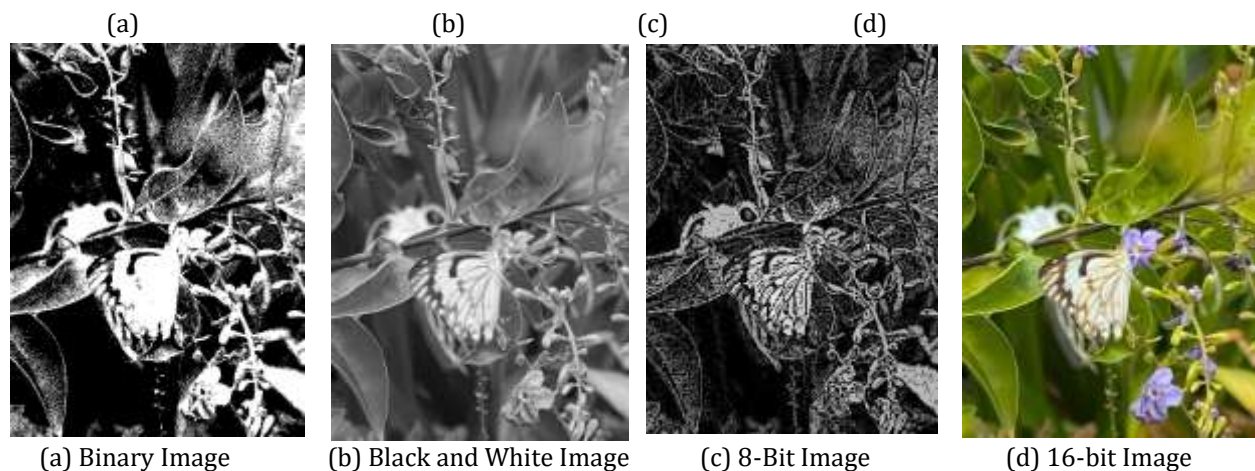


Fig.5. Types of Images

Binary Image: Binary images are images which consist of only two-pixel values, first one is 0 which is represented by black and second one is 1 which is represented by white. However, they are useful when all the information you need can be provided by the shape of an object and where you can easily find the shape of that object. Many a times the outcome of other image processing techniques is indicated in the form of a binary image. By thresholding the level of gray image [32]. binary images are acquired from those data. Pixels with a gray scale which are approximately 255, identified as above the threshold and set to 1 and remaining pixels which are below the threshold, are set to 0. Depending on the gray values correlated with the background and the object, this produces a black object on a light background or vice versa. Fig.5. (a). is an example of Binary Image.

Black and White Image: Black and white imagery combines the extremes of light and dark in a continuum of gray tones. A black-and-white image can be pursued as an image from which all color information has been removed, either by digital processing or through selective film development. In the modern computer age, the phrase "black and white" is sometimes used to mean a binary image that features only pure black and pure white pixels; in that context, the term commonly reserved for a grayscale image describes the outcome in terms of the range of grey rather than true colour [16]. Fig.5. (b). is a Black and White Image.

8-bit colour format: 8-bit color is used to store image statistics into the memory of computer or image files of the storage. In this format, one 8-bit is represented by each pixel. It has a range of 0-255 colours, of which 0 is used for black, 255 white and 127 for gray. The 8-bit color format which is generated is also identified as the gray image. Initially, it was used by the UNIX application [17]. Fig.5. (c). is an example of 8-bit colour format Image.

16-bit colour format: It is a colour image format. It has 65,536 different colours and is also known as High Colour Format. In this format the colour distribution is not the same as the gray image. The 16-bit format is actually split into three other formats namely Red, Green and Blue. That's a popular RGB format [18]. Fig.5. (d). is an example of 16-bit colour format Image.

There are different stages of the image processing wherein the foremost is the

Acquisition: Image acquisition in image processing can be broadly defined as the act of retrieving an image from another source, sources that are usually the source of Hardware, so it can be transferred to any processes that need to take place thereafter. Its working mainly concerns with scaling and colour conversion either RGB to Gray or Gray to RGB [21].

Image Enhancement: Image enhancement refers to the method of highlighting particular details of an image, along with reducing or deleting any unnecessary details depending on the specific needs. Generally, we use it to extract some hidden statistics from the image, this will be the simplest and most interesting in the field of Image Processing areas [22].

Image Restoration: The process of capturing a noisy or corrupt image and re-producing a clean as original image is known as Image restoration. Corruption can occur in many ways such as blurred motion, noise and improper camera focus. Image retrieval is done by reversing the blurred image process and by doing a point source and using a point source image, called Point Transfer Function (PSF) to retrieve lost image details in the blurring process [23].

Image Compression: without reducing the image quality when we reduce the size of the graphics file to an acceptable level is known as image compression. Decreasing file size allows more images to be saved with a certain amount of disk space or memory. Hence it mostly engages with image size or resolution [24].

Morphological Processing: Morphological imaging is the collection of nonlinear processes that relate to the structure or morphology of image properties. Morphological processing depends exclusively upon the relative ordering of pixel values and not upon their absolute numerical values; it therefore finds the most suitable application in binary image processing. For this reason, morphological operations are also applicable to gray-tone images whose light-transmission properties may be unknown so that the absolute values are either missing or less important [25].

Segmentation Procedure: Image segmentation is a branch of image processing, in which image is classified into different parts regarding its features and structures. The main purpose of image classification is to make the image easier so that it can be easily analyzed. According to image segmentation you divide the image into different parts with similar attributes. Those parts in which image divides are called Image Objects [27].

Representation and Description: Image representation and description are essential for successful acquisition and recognition of objects in the scene. Thereafter the image is segmented into background region areas and objects, one intends to represent and define them into characteristics properties of the computer processing during pattern recognition or with the correct measurement codes for structured storage during image compression [26].

Object Recognition and Detection: Object recognition refers to the identification of an object contained within images or videos. It intends to provide machines with the capacity to understand image content in a way that is similar to humans. Object detection algorithms bring together image stratification and object localization by taking as input an image and returning one or more bounding boxes, each with a corresponding class label. These object detection algorithms are able to carry out both multi-class classification and localization, and they are also able to manage objects related to recurring events. [28].

6. RELATION BETWEEN COMPUTER VISION AND IMAGE PROCESSING

Image processing is a small set of computer vision. To perform visual simulations and experiment of vision, the computer vision uses image processing algorithms on a human scale. For example, if the purpose is to enlarge the image for later use, then this can be called image processing. And if the purpose is to recognize objects, an automatic driving disability, then it can be called a computer vision [33].

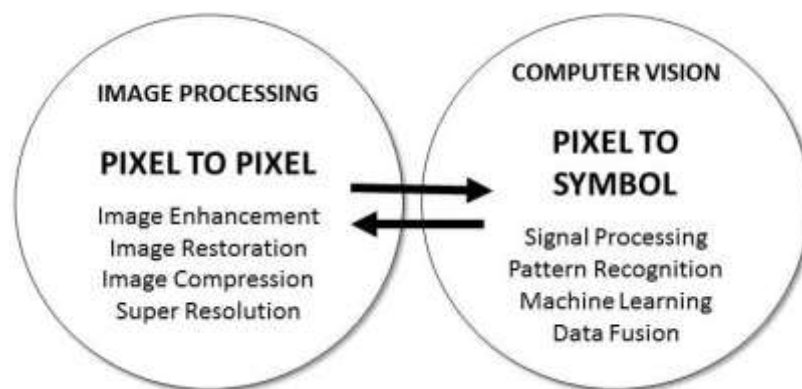


Fig.6. Relation between Image Processing and Computer Vision

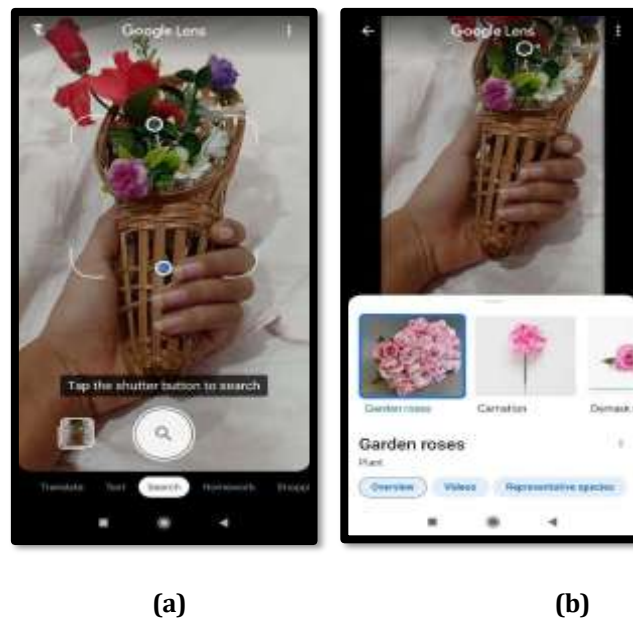
The above Fig.6. shows the correlation of the fields that is computer vision and image processing.

Image processing is technique that deals with processing image where input is taken as raw image and output received is enhanced image, hence following pixel to pixel values conversion of the image [34]. And in Computer vision sets of enhanced images are taken as input and pixel values are represented in

the form of symbols to teach computers to identify objects like humans using machine learning techniques.

7. Real world applications of Computer Vision and Image Processing correlating the relation among both the technologies

Visual Search: Using Image Recognition Technology, one can shop or search for visual products or information with one's own mobile camera. In Visual Search, simply searchers can scan the objects in their surrounding environment and submit an image to the search engine instead of typing the search query and the search engine shows all the similar images as result to the given input image [35]. It is a new concept and considered as a growing and powerful tool for e-commerce products and forums. Visual Search integrates a number of search engines and social media platforms, including Pinterest, Bing, Amazon, and Google.



(a) Before Searching (b) After Searching
Fig.7. Images of Visual Search in Google Lens

Figure 6: As would be the case when an image of an object is captured, here with Google Lens, the object in the image is detected by the software and relevant information and search results are provided to the user [36]. Computer vision allows machines to not just see what is present but understand what they see and then decide what to do based on what has been understood. Essentially, computer vision as a technology has a very long history; however, its practical application regarding visual search became possible only with the development of electronic technology [37]. In essence, machine learning provides a level of detail for a computer to understand the content of an image. For example, Google Lens returns with technical information identifying cues and entities detected within the Google Knowledge Graph. Besides that, some platforms use other software in order to enable image recognition capabilities.

Human Pose Estimation: Human pose estimation is one of the interesting applications in the field of Computer Vision. In a nutshell, pose estimations are a computer vision method to deduce the image of a person or object present in a photo / video [38].

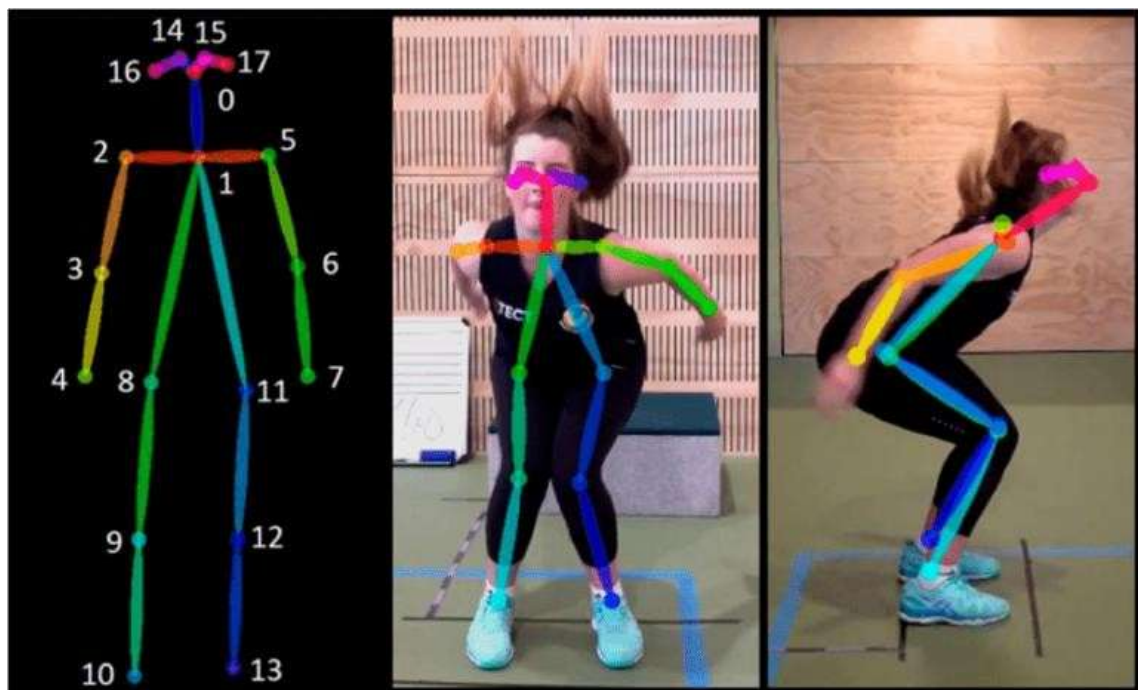


Fig.7. Human Pose Skeleton

source: https://www.researchgate.net/publication/338905462_The_'DEEP'_Landing_Error_Scoring_System
Human Pose Skeleton set of key points or coordinates that defines the human poses. Furthermore, pose estimation deals with recognising, locating and tracking the key points of Human Pose Skeleton in an image/video [39]. Activity recognition for real-time sports analysis or surveillance system, For Augmented reality experiences, in training Robots, Animation and gaming are various applications of Human Pose Estimation.

8. Conclusion

Computer vision shares a relationship with image processing and machine learning. The notion of computation, defined as a general scheme of instructions, has much to do with image editing operations. Image processing, in turn, has lent benefits across varied technological areas, especially in the analysis of images for deriving the necessary information. As the technological hubs began adopting a computer-oriented approach, the arena has expanded to other engineering fields like remote sensing, robotics, computer-human interfaces, healthcare, and satellite communications. The researchers in the field of computer vision can use information retrieved from image and video analysis for event prediction by extracting custom features. Since the development of computer vision is closely related to image processing and machine learning, such developments can also be utilized in a wide variety of fields to predict or identify objects, human activities, and events related to the environment.

References

- [1] Krishna Kumar, A. Kar, S. N. Jha, and M. A. Khan. "Machine vision system: a tool for quality inspection of food and agricultural products." *Journal of food science and technology* 49, no. 2 (2012): 123-141. doi: 10.1007/s13197-011-0321-4
- [2] Goral Godhani, Maulik Dhamecha, "A Study on Movie Recommendation System Using Parallel MapReduce Technology," Vol.5, Issue 1, page no.375-378, *IJEDR* - 2017. <https://rjwave.org/IJEDR/papers/IJEDR1701058.pdf>.
- [3] Maulik Dhamecha, Amit Ganatra, and C. K. Bhensadadiya, "Comprehensive Study of Hierarchical Clustering Algorithm and Comparison with Different Clustering Algorithms," *CiiT Int. J.*, 2011.
- [4] Cosido, Oscar, Andres Iglesias, Akemi Galvez, Raffaele Catuogno, Massimiliano Campi, Leticia Terán, and Esteban Sainz. "Hybridization of Convergent Photogrammetry, Computer Vision, and Artificial Intelligence for Digital Documentation of Cultural Heritage-A Case Study: The Magdalena Palace." In *Cyberworlds (CW), 2014 International Conference on*, pp. 369-376. IEEE, 2014. DOI: 10.1109/CW.2014.58
- [5] Dhaval Chandarana, Maulik Dhamecha, "A Survey for Different Approaches of Outlier Detection in Data Mining," in *Proc. IEEE*, 2015. doi: 10.1109/EESCO.2015.7253811

- [6] Krishna Parmar, Nivid Limbasiya, Maulik Dhamecha, "Feature-based Composite Approach for Sarcasm Detection Using MapReduce," in Proc. IEEE, 2018. DOI: 10.1109/ICCMC.2018.8488096
- [7] Mark S. Nixon, Alberto S. Aguado. "Feature Extraction and Image Processing for Computer Vision", Fourth Edition, 2002
- [8] Maulik Dhamecha, "Improve K-Mean Clustering Algorithm in Large-Scale Data for Accuracy Improvement," AISC, 2021. https://doi.org/10.1007/978-981-15-9516-5_5
- [9] Vijay Vyas, Maulik Dhamecha, Urvi Dhamecha, "Performance Evaluation of Hashgraph Algorithm in IoT: Execution Time and CPU Usage in DLT Systems" Advances in Nonlinear Variational Inequalities, vol. 27, no. 4, pp. 606–617, 2024, doi: <https://doi.org/10.52783/anvi.v27.6397>.
- [10] Prof. Shilpa Hiremath, Dr. A Shobha Rani. "A Concise Report on Image Types, Image File Format and Noise Model for Image Preprocessing", Volume: 07 Issue: 08 | Aug 2020, 2020, pp. 4991-4993.
- [11] Vijay Vyas, Maulik Dhamecha, Urvi Dhamecha, "Cognitive Storage Techniques Using Popularity Heuristics in Big Data Frameworks" Communications on Applied Nonlinear Analysis, vol. 31, no. 8, pp. 1262–1276, 2024, doi: <https://doi.org/10.52783/cana.v31.6392>.
- [12] Rafael C. Gonzalez, Richard E. Woods. "Digital Image Processing". Third Edition, University of Tennessee, NledData Interactive. Pearson International Edition, 2008.
- [13] Bhavesh Kathiriya, Vijay Vyas, Maulik Dhamecha, "Optimizing Fuzzy Decision Systems with the Jaya Algorithm for Enhanced Data Transfer in Multi-Hop CRNs" Franklin Open, Elsevier, vol. 16, 2026, doi: <https://doi.org/10.1016/j.fraope.2026.100722>.
- [14] Victor Wiley, Thomas Lucas. "Computer Vision and Image Processing: A Paper Review". International Journal Of Artificial Intelligence Research, Vol 2, No 1, June 2018.
- [15] Maulik Dhamecha, Urvi Dhamecha, Aswathy R Nair, Hansa Vaghela, Ravi J. Khimani, Shyam Kotecha, "Survey of Allaying Vulnerabilities for Cloud based Security in Zero Trust Architecture" International Journal of Computer Information Systems and Industrial Management Applications, vol. 18, pp. 1046–1055, 2026, doi: <https://doi.org/10.70917/ijcisim-2026-3695>.
- [16] Wolfe, J. M. (2015). Visual search. In J. M. Fawcett, E. F. Risko, & A. Kingstone (Eds.), The handbook of attention (pp. 27–56). Boston Review.
- [17] Dr. Suhas Shirol, Dr. Rajeev Kumar Singh, Dr. Sunil Gagare, Dr. Jitendra Bakliwal, Maulik Dhamecha, Dr. Navnath Narawade, "A Detailed Examination of Artificial Intelligence Techniques Across Diverse Industries Applications, Advantages, And Obstacles" International Journal of Computer Information Systems and Industrial Management Applications, vol. 18(23), pp. 301–314, 2026, doi: <https://doi.org/10.70917/ijcisim-2026-5575>.
- [18] Maulik Dhamecha, Urvi Dhamecha, Aswathy R Nair, Hansa Vaghela, Ravi J. Khimani, Shyam Kotecha, "A Comprehensive Review of Architecture, Technologies, Characteristics, And Applications of Internet of Things" International Journal of Artificial Intelligence and Machine Learning, vol. 6, pp. 710–721, 2026, <https://doi.org/10.51483/IJAIML.6.7s.2026.710-721>.
- [19] Ms Rashmi Raghavenda Patil, Prof Sushma V Chaugule, Dr. V S Malemath, "Pose Estimation For Skeleton Detection", International Journal of Engineering Applied Sciences and Technology, 2019, Vol. 4, Issue 4, August 2019, pp. 192-196
- [20] Maulik Dhamecha, "An Efficient Comparison between Structured Analysis and Object-Oriented Analysis," IJSRCSEIT, 2021. <https://doi.org/10.32628/CSEIT217369>
- [21] Maulik Dhamecha, "Plant Recommendation System with the Use of Weather Forecasting," CEUR Workshop Proc., 2021.
- [22] D. Laney, "3D data management: Controlling data volume, velocity and variety," META Group Research Note, 2001.
- [23] Maulik Dhamecha, "Optimize Ant Colony Algorithm with Relation of Efficiency and Performance for the Traveling Salesman Problem," GRADIVA, 2021.
- [24] Maulik Dhamecha, "Fundamentals of ANN and Basic Algorithm of Neural Network in Data Analytics," MOENIA, 2021.
- [25] Maulik Dhamecha, "Study of Search Engines with the Paradigm of Machine Learning," SAMRIDDHI – J. Phys. Sci. Eng. Technol., 2022.
- [26] Urvi Darji, Shruti Oza, Kruti P. Thakor "Design Of PFD With Charge Pump For DPLL In 0.18µm CMOS Technology", NCAET (2012)
- [27] M. I. Jordan and T. M. Mitchell, "Machine learning: Trends, perspectives, and prospects," Science, vol. 349, no. 6245, pp. 255–260, Jul. 2015, doi: 10.1126/science.aaa8415.
- [28] Maulik Dhamecha, "Literature Survey of Basic Methodologies in Cloud Computing," SAMRIDDHI – J. Phys. Sci. Eng. Technol., 2022.
- [29] Maulik Dhamecha, "Fundamental Study of Chatbot with the Use of Artificial Intelligence," SODHASAMHITA, 2022.
- [30] Urvi Darji, Shruti Oza, Kruti P. Thakor "Low power and low jitter phase frequency detector for dpll using 0.18µm cmos technology", ICIKR-ETS (2012)
- [31] T. M. Mitchell, Machine Learning. New York, NY, USA: McGraw-Hill, 1997.

- [32] J. Schmidhuber, "Deep learning in neural networks: An overview," *Neural Networks*, vol. 61, pp. 85–117, Jan. 2015, doi: 10.1016/j.neunet.2014.09.003.
- [33] Maulik Dhamecha, "Literature Survey for Outlier Detection Methods in Data Analytics," *TANZ Res. J.*, vol. 9, no. 12, pp. 139–142, 2023, doi: 10.6084/doi.23.9.11.TANZ21837.
- [34] D. Shen, G. Wu, and H. Suk, "Deep learning in medical image analysis," *Annual Review of Biomedical Engineering*, vol. 19, pp. 221–248, Jun. 2017, doi: 10.1146/annurev-bioeng-071516-044442.
- [35] Maulik Dhamecha, Urvi Dhamecha, "Prediction of Air Quality Index Affected by Vehicle Emissions Using Machine Learning," *Int. J. Environ. Sci.*, vol. 11, no. 21, pp. 1566–1571, 2025, doi: 10.64252/r2d6a722.
- [36] Maulik Dhamecha, Urvi Dhamecha, "Behavioural Detection of Ransomware and a Comprehensive Approach to Ransomware Prevention," *IEEE Commun. Standards Mag.*, vol. 11, no. 21, pp. 1–7, 2025, doi: 10.1109/MCOMSTD.2025.3616108.
- [37] Y. Tian, M. Mirzabagheri, S. M. H. Bamakan, and H. Qu, "Improving security using SVM-based anomaly detection," *Soft Computing*, vol. 25, no. 2, pp. 841–851, Jan. 2021, doi: 10.1007/s00500-020-05373-x.
- [38] Vijaykumar Vyas and Ashwin Raiyani Determine a Performance Parameter by Using the IOTA Distributed Ledger Technology Method. Volume 48 Issue 4 (November 2024).
- [39] Vijaykumar Vyas and Ashwin Raiyani Enhancement of IOTA implementation in IoT: Comparison and analysis. *AIP Conf Proc [Internet]*. 2023 Nov 14; 2963(1): 20016.