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Image Processing Techniques for Feature Extraction and Analysis

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ABSTRACT: Feature plays a very important role in the area of image processing. Before getting features, various image pre-processing techniques like binarization, thresholding, resizing, normalization etc. are applied on the sampled image. After that, feature extraction techniques are applied to get features that will be useful in classifying and recognition of images. Feature extraction techniques are helpful in various image processing applications e.g. character recognition. As features define the behavior of an image, they show its place in terms of storage taken, efficiency in classification and obviously in time consumption also. Here in this paper, we are going to discuss various types of features, feature extraction techniques and explaining in what scenario, which features extraction technique, will be better. Hereby in this paper, we are going to refer features and feature extraction methods in case of character recognition application. While studying about images we come across various types of image features such as colour, shape, texture, etc. These image features are mainly used to illustrate the important features or properties of an image that can be used to classify and identify it. This paper provides a detailed study of various image features and its extraction techniques methods along with their mathematical function, real-life application and advantages of these features. Digital image processing is always an interesting field as it gives improved pictorial information for human interpretation and processing of image data for storage, transmission, and representation for machine perception.

KEYWORDS: Feature Extraction techniques, Image Processing, Optical Character Recognition (OCR), Pattern Recognition.

I. INTRODUCTION

Image Features contributes a very significant part in image processing and image analysis tasks. Image Features are characteristics or properties of an image that are mostly used in tasks such as object detection, image classification, picture recognition, etc. Features help us to know important information from an image and with the help of these features we can distinguish more than one object from each other. Before studying about features we need to perform image pre-processing on an image. Once the image pre-processing is done, we need to do feature extraction from an image to extract useful features. We will be studying about various image features such as colour, shape, corners, edges. The technique for extracting the feature from an image is of great use when we have tremendous amount of data and we need to decrease the size of data without losing any suitable information. At the end, we can set up the model with less machine effort as the input data is of less size which helps in increasing the performance and speed of learning a model. Feature extraction have an efficient role in determining the overall performance of the model. In image classification, the local features of the image are utilized to distinguish the different images. These features are categorised on the various key component of image data like color intensity, edges of the objects present in image, texture, etc. The efficiency of feature extraction method enhances the further processing of an image to a great extent. These features can be used in image matching, pattern recognition and retrieval. These applications require the compact and relevant information to achieve high degree of accuracy. An input image posses large complex and redundant information. The process of transferring this information to reduce set of feature is called the feature selection. Image Analysis is a process in which feature of the images are extracted and analyze for further processing. It is different from other image processing operations like restoration, coding and enhancement. Image analysis involves the detection, segmentation, extraction and classification techniques. Feature extraction technique is used to extract the features by keeping as much information as possible from large set of data of image. Efficiency and effectiveness of feature selection and extraction are severe challenge nowadays. Numerous methods are used to extract features like color, texture and shape as feature vector. Feature extraction methods are classified as the low level feature and high level feature extraction. Low level feature are small details of the image like point, line edge corner etc. Low level feature can be extracted automatically from the image without having knowledge of shape. High Level feature are built on top of low level features to detect objects and larger shapes in the image.

II. LITERATURE REVIEW

Nicolae Apostolescu (2024) The present paper aims to conduct an experiment that compares different methods of detecting objects in images. Programs were developed to evaluate the efficiency of SURF, BRISK, MSER, and ORB object detection methods. Four static gray images with sufficiently different histograms were used. The experiment also highlighted the need for image pre-processing to improve feature extraction and detection. Thus, a programmed method for adjusting pixel groups was developed. This method proved useful when one of the listed algorithms failed to detect the object in the original image, but succeeded after adjustment. The effectiveness of detection methods and the evaluation of their performance depend on the application, image preparation, algorithms used, and their implementation. Results of the detection methods were presented numerically (similarities, gradients, distances, etc.) and graphically.

Adel Hassan (2023) Feature extraction is the most vital step in image classification to produce high-quality and good content images for further analysis, image detection, segmentation, and object recognition. Using machine learning algorithms, profound learning like convolutional neural network CNN became necessary to train, classify, and recognize images and objects like humans. Combined feature extraction and machine learning classification to locate and identify objects on images can then be an input of automatic recognition systems ATR such as surveillance systems CCTV, to enhance these systems and reduce time and effort for object detection and recognition in images based on digital image processing techniques especially image segmentation that differentiate from computer vision approach. This article will use machine learning and deep learning algorithms to facilitate and achieve the study's objectives.

Jun Miura (2022) This paper describes an image enhancement method for reliable image feature matching. Image features such as SIFT and SURF have been widely used in various computer vision tasks such as image registration and object recognition. However, the reliable extraction of such features is difficult in poorly illuminated scenes. One promising approach is to apply an image enhancement method before feature extraction, which preserves the original characteristics of the scene. We thus propose to use the Multi-Scale Retinex algorithm, which is aimed to emulate the human visual system and it provides more information of a poorly illuminated scene. We experimentally assessed various combinations of image enhancement (MSR, Gamma correction, Histogram Equalization and Sharpening) and feature extraction methods (SIFT, SURF, ORB, AKAZE) using images of a large variety of scenes, demonstrating that the combination of the Multi-Scale Retinex and SIFT provides the best results in terms of the number of reliable feature matches.

Latha D U (2022) In the image downloading process, image processing method, data mining method, and computer scanning technique, feature removal is an important step. The process of extracting logical data from original data is known as feature extraction. However, many FE methods still struggle with the difficulty of extracting relevant features that can accurately capture the basic content of a piece of data or database. We provide a survey of existing methods of extracting features used in recent years in this work. Brightness, homogeneity, entropy, meaning, and strength were shown to be the most of the distinctive features that could be obtained when using global learning and development community features extraction method in the images in the study. In addition, it was found that the extraction methods are not specific to the application and can be used in a variety of situations.

Tianming Song (2021) Medical image technology is becoming more and more important in the medical field. It not only provides important information about internal organs of the body for clinical analysis and medical treatment but also assists doctors in diagnosing and treating various diseases. However, in the process of medical image feature extraction, there are some problems, such as inconspicuous feature extraction and low feature preparation rate. Combined with the learning idea of convolution neural network, the image multi feature vectors are quantized in a deeper level, which makes the image features further abstract and not only makes up for the one-sidedness of single feature description but also improves the robustness of feature descriptors. this paper presents a medical image processing method based on multi feature fusion, which has high feature extraction effect on medical images of chest, lung, brain and liver, and can better express the feature relationship of medical images. Experimental results show that the accuracy of the proposed method is more than 5% higher than that of other methods, which shows that the performance of the proposed method is better.

Image Processing

Image processing is one of the ways of doing tasks using image. It is done to obtain certain information that is important to it. Image processing complete. It is a type of the signal processing where the input used is image and the output obtained can be in that image form or in its features form. Image processing is one of the fastest-growing technologies today. It is also an important research field in engineering and computer science. Analog and the digital image processing are two types of image processing methods which is used. Solid copies, such as prints and photographs, can benefit from analogue image processing. When using these visual aids, image analysts use a variety of translation bases. Digital image processing techniques allow computer-assisted conversion of digital images. Pre-processing, scaling, and presentation, and extracting information, are the three most common processes all data types must go through when using digital techniques. Medical research has made extensive use of image processing, which has led to more effective and more effective treatment methods. For example, it can be used in breast screening to detect breast cancer early using a sophisticated lump screening algorithm. Because medical applications require highly processed image processors, these applications require extensive development and testing before they can be approved for us.

Shape-Based Feature Extraction Methods

Visual features of objects are called the shape characteristics or visual features. For example, circular object or triangular objects or other shapes, perimeter boundary of the object, the diameter of the border and so on. The visual features showed intuitively are all belongs to shape features. Shape features can be divided into two categories, one is based on the characteristics of the border, and the other is based on regional characteristics. Accordingly, the methods of image shape feature extraction are also divided into boundary-based feature extraction methods and region-based feature extraction methods. As the intuitiveness and understand ability of shape features, targets in images can be identified very well. However, this approach lacks a sound mathematical model. When target is out of shape, the result is not reliable. The demand for calculation consumption and store consumption is high when the target is describing comprehensively. The target shape information reflected from many of the objectives is not exactly the same as human intuition. The accuracy of the shape feature extraction result depends on the pre-segmentation effect.

Feature Extraction Techniques

Using the image features obtained from the corresponding images taken from different viewpoints, image stitching is achieved. Block matching and feature-point matching are the two basic ways to identify the matching region from the input images. Block matching algorithms calculate the correlation between regular-sized blocks generated in sequential images. Such methods include either Normalized Cross-Correlation or phase correlation using an Fast Fourier Transform. Such methods involve a series of complex calculation and also very sensitive to the slight distinction between images. Feature based methods extract distinctive features from each image and matches these features to establish a global correspondence.

Applications Of Feature Extraction

Bag of words is the most used technique for natural language processing. In this process they extract the words or the features from a sentence, document, website, etc. and then they classify them into the frequency of use. Feature extraction plays an important role in image processing. This technique is used to detect features in digital images such as edges, shapes, or motion. Once these are identified, the data can be processed to perform various tasks related to analyzing an image. Auto encoders are a form of unsupervised learning designed to reduce the noise present in data. In auto encoding, input data is compressed, encoded, and reconstructed as an output. This process leverages feature extraction to reduce the dimensionality of data, making it easier to focus on only the most important parts of the input.

III. METHODOLOGY

A description of how the different parts/stages of the Proposed system are implemented. As shown in the flowchart of how the other parts of the system interrelate First Stage is feature extraction, divided into two parts one is the training part and the second is the evaluation part. Both parts will divide the images into two groups, one for good & bad quality images and one for good & bad content, then send the suitable images to the second classification stage, which is the evaluation part. The first stage is the feature selection stage, which will select and pickup required features of existing objects in images using different algorithms Many methods exist for feature extraction, and this paper will focus on three methods: HOG, DCT, and CNN. The best results of these methods will be chosen to move forward to the next

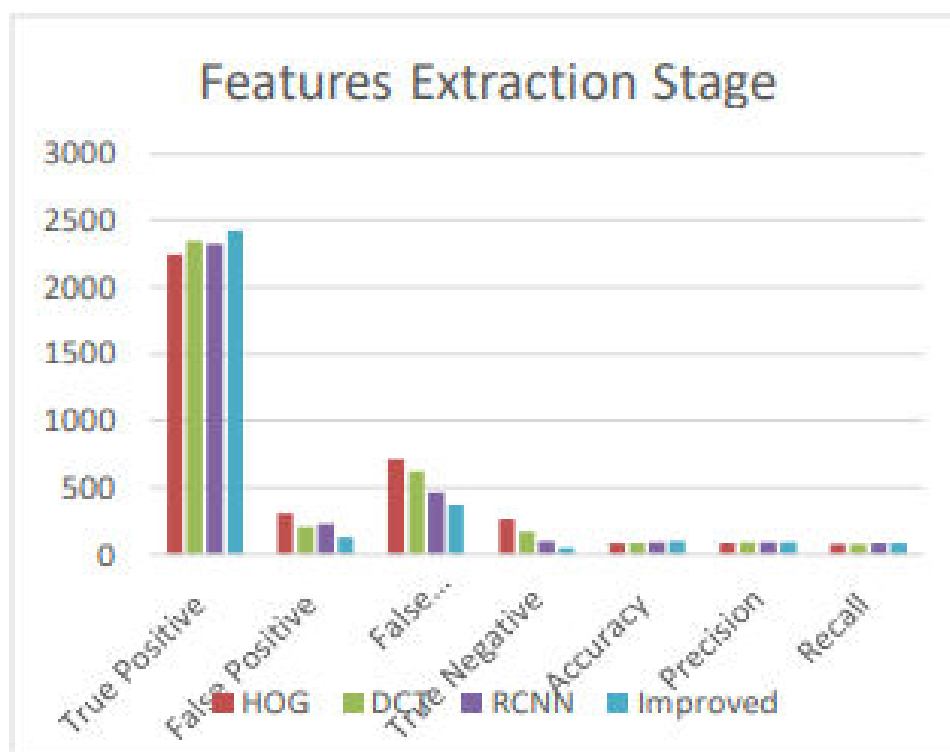
stage. HOG mainly uses gradients to provide information about the image's content, especially for edges and corners, which are morefit for object detection. DCT is mainly used to convert spatial information to frequency information that provides more information about images' quality and divides images based on their frequency parameters. CNN is mainly used for image classification. It is suitable for feature image extraction since it reduces the required number of parameters without affecting the image quality with hgh accuracy. Network layers are trained for a massive set of images suitable for other tasks, especially object recognition

IV. RESULTS AND DISCUSSIONS

The simulation of the proposed system was built using different tools: MATLAB, R Studio, and Golab, including computer vision and neural networks and machine learning packages like TensorFlow and Kiras. The primary goal of this paper is to create a model that provides the best results for detecting and recognizing an object in images with minimum time and less computational resources than used in an automatic recognition system which in this paper will be a CCTV system. - Experiments were performed on a single node laptop, four cores, Microsoft Windows 10, Core i7 processor, 1.8GHz speed, 16 GB memory, and 500 GB HDD and google lab "Golab." Different data sets and algorithms are used to build the model. The data sets used are COCO and VCC16, which contains many images; we chose a sample of "3000 images," including a specific object such as flowers and animal "Cat & Dogs," to experiment. The algorithms are HOG, DCT, R-CNN, SVM, RF, LBP, Learners, and Mask R-CNN. As shown in Table 1-2, the results using separated algorithms compared to our proposed model provide the best results.

Table 1: Features Extraction Stage

Type	Total Images	HOG	DCT	RCNN
True Positive	3000	2245	2345	2323
False Positive	3000	304	203	225
False Negative	3000	710	620	462
True Negative	3000	259	168	100
Accuracy	100	83	84	93
Precision	100	88	90	91
Recall	100	76	79	83

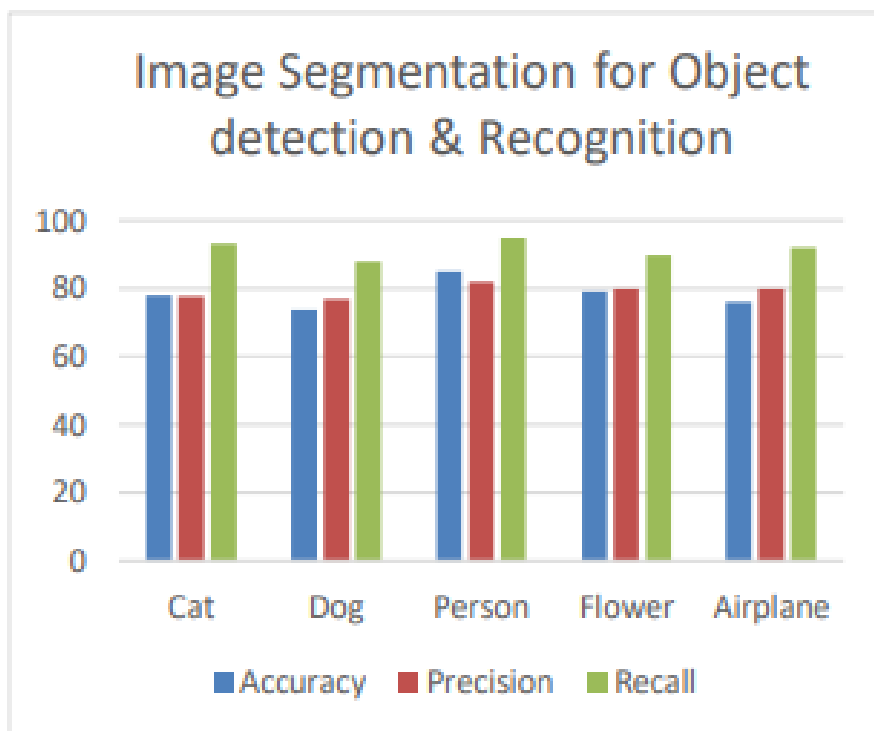


Graph. 1: Feature Extraction Stage Results

As shown in Table 1, describe the results of stage one in the proposed model. The R-CNN model provides the best accuracy for identifying the required features at 93 % compared to DCT with 84% and HOG at 83%, respectively. So, based on our adopted methodology will choose the output of R-CNN images that will move forward to the next stage.

Table 2: Image Segmentation for Object detection & recognition

Object	Accuracy	Precision	Recall
Cat	78	77.8	93
Dog	74	77	88
Person	82	82	95
Flower	79	80	90
Airplane	76	80	92



Graph. 2: Image Segmentation Stage Results

As shown in Table 2 describe the results of stage one in the proposed model. Image segmentation-based artificial intelligence techniques using Mask R-CNN provide the best accuracy results for most objects from sample data set images ranging between 74 – 82 %. So, based on our adopted methodology will choose the output of the model images that will move forward to the next stage.

V. CONCLUSION

A detailed study about the features is discussed that may be useful in pattern recognition system. Usefulness of features, types of features in image processing system is explained. As patterns may have different orientation, styles etc., various image pre-processing techniques are applied firstly. Then based on features, some recognition technique can be applied. For extracting features, many feature extraction techniques have been developed and are discussed in this paper in detail. Using this paper, a quick overview of feature extraction techniques may be taken and it can be decided that which feature extraction technique will be better for the work to be done based on complexity, type of image. Feature extraction is one of the commonly utilised method. It is an efficient strategy in a range of applications as well as academic subjects. This study looked into the methodology, types, and applications of feature extraction. The types of features to be extracted are determined by the applications of feature extraction. The accuracy of the extraction and the performance of extraction methodologies are more significant elements to consider when performing feature extraction. This report has examined various stages of image processing techniques. An overview of all related image processing methods such as pre-processing, segmentation, feature extraction and classification techniques have been presented in this paper. Recent research in image processing techniques is also presented in this literature review.

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