International Advance Journal of Engineering, Science and Management (IAJESM)
ISSN -2393-8048, July-December 2016, Submitted in December 2016, iajesm2014@gmail.com

An Evolution Study of Defense Strategies and Machine Learning Techniques

Vishal Soni, Research scholar, Department of Computer Science, Janardan Rai Nagar Rajasthan Vidyapeeth University, Udaipur (Rajasthan)
Dr. Manish kumar, Associate Professor, Janardan Rai Nagar Rajasthan Vidyapeeth University, Udaipur (Rajasthan)

ABSTRACT

The advancement in the field of AIA that will improve image retrieval performance. The suggested approach comprises three basic stages: segmentation, feature extraction and annotation. Shape images are segmented using edge detection techniques, whereas colour images are segmented using thresholding, region-based, and clustering-based techniques. K-means clustering on the brightness level of an image results in clusters creating image regions. Feature extraction is the process of transforming high-level features into low-level semantics. Shape characteristics that are rotation, scaling, and translation invariant are chosen. The fundamental RGB and L*u*v colour model is utilised for representation of images in colour characteristics. Mean oriented energy is calculated by extracting texture features with gabor filters. Annotation is performed utilising machine learning techniques such as artificial neural networks (ANN), hierarchies of ANN, rough sets, decision trees, k-nearest neighbour (KNN), and multiple instance learning (MIL) with K-NN. The text based search assesses retrieval performance which in turn measures annotation accuracy. During annotation the novelties are first introduction of new classifiers such rough sets used for tagging and second the creation of architectural framework of the classifiers.

Experiments are carried out using the Berkely segmentation dataset, the MPEG 7 Shape dataset, the Corel image dataset, and the Caltech256 dataset. The annotation performance for Corel picture dataset is increased using K-NN, notably for category viz. dinosaur and mountain. The misclassification of categories like buildings and beaches is improved with K-NN. MIL-based K-NN and RS improved dinosaur performance by 100%. ANN has also increased annotation accuracy for the category flowers.

INTRODUCTION

As the Internet expands and storage devices become more affordable, text, images, graphics, video, and music are increasingly being stored digitally. The form, texture, and color qualities of the query image, as well as images in the database, are commonly used to extract these attributes. Trade, education, criminal prevention, and biomedicine are just a few of the many possible applications for digital libraries and search engines.

Because vision is the most important sense for humans, images have always played an important part in our lives. A vast range of applications for image processing may be found as a consequence (medical, military, etc.). In today's world, photographs are more prevalent than ever before, and owing to advances in digital technology, anybody may produce a large number of photos. Standard image processing algorithms must cope with more difficult issues and their adaptation to human vision with such a large number of pictures. Adaptation in intelligent computer vision programs has necessitated the use of machine learning because of the intricacies of vision (e.g., face recognition). An increase in adaptability often comes with a rise in complexity, and any machine learning approach must be effectively regulated so that it can handle image processing challenges adequately. For one thing, it's difficult for most machine learning algorithms to deal with large amounts of data, often with high dimensions, which is the case when it comes to image processing. As a result, model selection processes must make use of interactions with image data and image priors.

LITERATURE SURVEY

Chris Kelliher (2016) Machine learning may be used to improve the methodologies that have already been introduced, and this is demonstrated in this paper. Starting with the fundamental distinctions between econometric and machine learning-based approaches to revealing a signal, we point out that cross-validation is a phase that is specific to machine learning. The differences between supervised and unsupervised machine learning algorithms are then discussed, with an emphasis on the most frequent algorithms for each type of method. On to the next step, which is the introduction of clustering techniques and demonstration of how they might be applied to finance in the context of clustering assets or market settings After that, we'll go through some of the most powerful categorization approaches that machine learning algorithms can use, such as Support Vector Machines and Logistic Regression. In the following section, we examine potential interpretability difficulties associated with particular machine learning methods and propose some techniques for creating models that are understandable. Finally, we cover alternative applications of machine learning in finance, such as in optimal execution or delta-hedging, as well as in credit risk modelling and simulation.

P. Ajay et. al, (2016) Suppliers, distributors, manufacturers, and customers are all part of a chain of organisations known as the supply chain. It must be steadfast in its efforts to improve customer satisfaction. To share and integrate data, the organisations involved must work together to achieve consensus. The real world and the ideal world for supply chain networks, on the other hand, are worlds apart. This is due to the fact that the supply chain contains both well-known and obscure elements and concepts. As customer demand has grown exponentially, the way products have been used since the early 2000s and how they are being used today are two very different things. We need a supply chain strategy that works in order to satisfy the market's demand. As a result, Machine Learning became an important factor in analysing and providing the best solutions to this problem. An overview of machine learning and the interpretation of some models under it will be presented in this chapter, along with examples of its practical application in Supply Chain Management. With the aid of a case study and in-depth examination, we'll examine all of its various aspects and parameters. This will give an in-depth look at the benefits and drawbacks of using ML in SCM, as well as its future prospects.

N. Bharathi, B.S. Rishiikeshwer et. al, (2016) Data pre-cleansing is the first critical step. In order to extract insight or judgment, the pre-processed input must be fed to the appropriate Machine Learning (ML) model. The model's performance is entirely dependent on the characteristics that are included in the model. If you don't know how to choose features, it's impossible to design a great model. Choosing the right feature is essential to creating an accurate model. There are a wide variety of methods for extracting and selecting features in the literature. The model's performance might be seriously hampered and its complexity increased if it contains irrelevant elements. However, even if characteristics describe the record in an efficient manner, it is difficult to depict the record with less features using an ideal methodology for forecasting an unknown record accurately. Appropriate feature selection procedures are employed to deal with such difficulties. This chapter, therefore, focuses on several feature selection methods and their advantages and disadvantages. A python case study is used to bolster the argument. The model builder can use this chapter's plug-and-play technology to create an accurate model.

Abdulhamit Subasi (2016) Mathematical models are constructed using statistical theory, with the primary purpose of making conclusions from a small sample size. Model representation and algorithmic interpretation must be competent after they have been constructed. An algorithm's ability to classify data may be as important as its accuracy in some cases. Many domains, including forecasting, anomaly detection, and biomedical data analysis, rely on machine learning as a decision support tool. The goal of this chapter is to assist scientists in selecting an appropriate machine learning technique and guiding them using optimal strategies using real-time databases, as well as to familiarise readers with the fundamentals of machine learning before delving into solving real-world problems with machine learning techniques. Artificial intelligence, data mining, COMPUTER SCIENCE & ENGINEERING, data science, natural language processing, deep learning, mathematics, and statistics are just a few of the topics taught. Topics relating to various machine learning techniques, such as supervised, unsupervised, and reinforcement learning, will be investigated, and hence significant machine learning algorithms will be discussed in this chapter. As examples, suitable Python functions will be shown at the end of each section. The majority of the examples are adapted from the Python–scikit-learn framework and Tensor Flow.

Patrick Schneider, Fatos Xhafa (2015) Healthcare is entering a new era of sophisticated systems and enhanced human interactions. By enabling decision-making, streamlining processes, and liberating valuable human time, AI and machine learning technologies are changing the way people offer and receive health care. Decisions may be supported, procedures streamlined, and quality human time freed up through the use of AI and machine learning technologies A new wave of optimism has been ignited by the success and performance of AI-based expert-level diagnostic systems. However, ethical, safety, and equality concerns in the provision of healthcare are becoming more prominent in the public discourse. Artificial intelligence has been hindered by a lack of understanding of how it works and the resultant distrust, which has stifled its acceptance. All of the key AI learning topics are covered in depth in this chapter, including federated learning, which is an important part of the overall plan.

Khalid Ahmed Alafandy et. al, (2016) as well as issues and how they might be solved, are all included in this chapter's complete overview of machine learning. The open source libraries, which are also covered in this chapter, make it easier to write the code that is used to create any learning model with the help of machine learning.

Palekar V.R, Satish Kumar L (2015) Image data is being gathered at an unprecedented rate across a wide range of industries and social networking sites throughout the world. There are several uses for annotating photos, not just in image comprehension and analysis but also in some of the most pressing areas of concern, such as medical research and rural and urban management. AIA has been gaining popularity since the late 1990s, mostly because manual image annotation has several limitations that make it unsuitable for AIA applications. There is a thorough examination of the most recent stage of AIA techniques in this work, which incorporates 32 literatures over the previous few decades.

Hakan Koyuncu, Manish Dixit et. al, (2015) Since big picture databases are being used more and more frequently in multimedia systems, working with digital images has become increasingly common among these systems. As a result, obtaining photos from these databases has never been easier than using Content-Based Image Retrieval (CBIR). When a user requests a picture, a big database of images is used to search for that picture depending on the user's request. This is the core focus of this study. Aside from the fact that it is faster than the other ways, this is the most commonly utilized strategy since it is effective at automatically obtaining photos. It has a lot going for it as a viable alternative to more traditional approaches. For this study, we analyzed and contrasted 38 publications from the CBIR.

PROPOSED FRAMEWORK

The un-annotated image is used as the input in the second phase, and it is segmented to give regions. The next activity is feature extraction, which generates visual characteristics of the contents to be applied to the annotation model that was trained in the previous phase. The model created in the preceding phase will apply appropriate semantic labels to the image based on its contents. As a result, the output will be an annotated image.

The photographs from the annotation phase are used as data stores in the third phase. A textual query will be issued, and the system will return a list of relevant photos. Because the annotation is content-based, image retrieval will be more efficient and accurate.

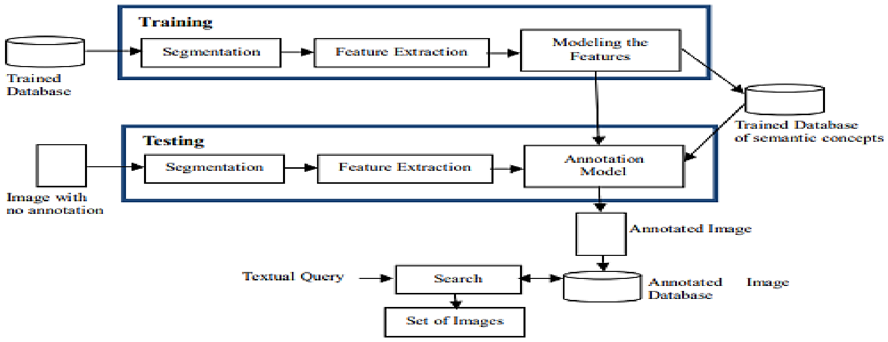

Figure Architecture of Proposed System

CONTENT-BASED IMAGE RETRIEVAL

In contrast to traditional information retrieval, CBIR relies on unstructured image databases since digital pictures are nothing more than a collection of pixel intensities. Prior to any sort of reasoning about a picture's content, it is necessary for image processing to extract useful information from raw data (such as determining whether or not a given form or texture is present).

It's distinct from these other areas since it focuses on locating specific pictures within a big collection that meet certain criteria. Among the many things that go under the umbrella term "picture processing" are things like improving images, compressing and transmitting them, as well as interpreting them. For the most part, the line between conventional image analysis and CBIR is well-defined, however there are rare exceptions. This can be better understood if we look at an example. Automatic facial recognition technology is already in use by several police agencies. There are two ways to make advantage of these systems. Initial identification can be made by cross-referencing the image captured by the camera with an individual's data record in an online database. The following are some of the most important:

- Comprehending picture consumers' demands and information-seeking behaviour;
- Identifying appropriate ways of describing image content
- Obtaining such features from raw photos; and
- Storing big image databases in a compact manner.
- Using human evaluations of similarity to match query and stored photos.
- Offering accessible user interfaces to CBIR systems
- Quickly accessing stored images by content

The following are some of the most important research issues in video retrieval:

- Methods for merging video, text, and sound for retrieval
- Effective user presentation of search results
- Automatic shot and scene detection

AUTOMATIC IMAGE ANNOTATION (AIA)

In recent years, the availability of contemporary and affordable image capture technologies has increased the use of digital photos. Despite substantial study in this topic, proper image retrieval from big collections remains a difficult task. This is because transferring the semantic information of the image as viewed by people is difficult. To provide photos with meaningful text descriptions based on the contents of their images, we use a process known as "automatic picture annotation" (AIA). Multimedia modeling, particularly the semantic gap between low-level visual elements and high-level semantic ideas, has become an important subject because of the rising volume of visual digital material. The use of AIA in image databases and social media platforms is becoming in importance. Each image is manually tagged with relevant keywords in the previous technique, which allows for faster searching and retrieval of photos. It is a time-consuming and labor-intensive process that requires a significant amount of resources and time.

Typical CBIR systems employ user queries to get pictures. We describe an AIA system that identifies the right keywords for images based on the information they contain. Systematic image annotation is used in an annotation-based image retrieval system (ABIR).

Researchers in the field of content-based image retrieval (CBIR) have historically concentrated their efforts on developing new algorithms, while neglecting the impact on users. The desired search output is received from the client side, which is where image matching and retrieval take place. Research on retrieval systems has yielded some results, notwithstanding this fact.

DATA ANALYSIS AND RESULTS

Techniques of Segmentation

Digital image analysis is intended to identify standard image characteristics for the acquisition of image information. This can be accomplished by utilizing various image content attributes such as colour strength, edges, areas, and so on. Content-based strategies are classified as thresholding-based, edge-based, region-based clustering-based, and grid-based.

A. Threshold based segmentation

To partition the image, histogram thresholding and slicing techniques are utilized. They can be applied directly to an image or coupled with pre- and post-processing procedures.

It is a frequent practice to employ a threshhold for image segmentation. The thresholding technique is characterized as a remapping of grey values as follows:

$$g(v) = \begin{cases} 0 & , \text{if } v < T \\ 1 & , \text{if } v \geq T \end{cases}$$

Heterogeneity is sought by using the histogram's probability values to determine the optimal threshold value.

⇒ **Otsu' Algorithm [Otsu, 1975]**

a) Select an initial estimate for T.

b) T is used to segment the image. These results in two groups of pixels: G_1 is made up of all pixels with intensity values. >= T and G_2 consisting of all pixels with intensity values < T.

c) Determine the average intensity values μ_1 and μ_2 for pixels in areas G_1 and G_2.

d) Determine a new threshold value.

e) Repeat steps 2–4 until the difference in T between iterations is less than a predefined parameter T_0.

B. Segmentation based on Edge

Edge detection refers to the process of looking for and detecting sharp breaks in a picture. These things may be identified by looking for edges in a picture that are believed to indicate object boundaries. There are a multitude of ways to identify an edge. The bulk of the methods were divided into two groups, as well as a particular edge detection methodology.

a) **Based on a gradient:** Equation 4.1 gives the gradient of a picture, which is used to find the image's greatest and minimum values in its first derivative.

$$\nabla f = \left[\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right] \quad (4.1)$$

The gradient magnitude determines the edge strength.

$$||\nabla f|| = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}$$

The gradient's direction is denoted by:

$$\theta = \tan^{-1}\left(\frac{\partial f}{\partial x} / \frac{\partial f}{\partial y}\right)$$

The three operators Sobel, Robert's cross, and Prewitt are provided via gradient-based procedures, which are first derivative-based techniques. All the image points in a 3x3 area are represented by the following 3x3 array. The centre point z5 signifies f(x, y) at any point (x, y).

Z_1	Z_2	Z_3
Z_4	Z_5	Z_6
Z_7	Z_8	Z_9

In this case, z_1 denotes f(x-1, y-1), z_2 denotes (x-1, y), z_3 denotes (x-1, y+1), z_4 denotes (x, y-1), z_6 denotes (x, y+1), z_7 denotes (x+1, y-1), z_8 denotes (x+1, y), and z_9 denotes (x+1, y=1)

- **Sobel Operator:** The Sobel Operator is made up of a pair of 33 convolution kernels.

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

$$Gx=(Z_7+2Z_8+Z_9)-(Z_1+2Z_2+Z_3)$$
$$Gy=(Z_3+2Z_6+Z_9)-(Z_1+2Z_4+Z_7)$$

- **Robert's cross operator:** This operator measures 2-D spatial gradients in a short amount of time. The size of the convolution kernels is reduced to 2x2.

-1	0
0	1

$$Gx=(Z_9-Z_5)$$
$$Gy=(Z_8-Z_6)$$

0	-1
1	0

- **Prewitt operator:** The Prewitt operator is used to detect vertical and horizontal edges in pictures.

-1	-1	-1
0	0	0
1	1	1

-1	0	1
-1	0	1
-1	0	1

$Gx=(Z_7+Z_8+Z_9)-(Z_1+Z_2+Z_3)$
$Gy=(Z_3+Z_6+Z_9)-(Z_1+Z_4+Z_7)$

b) **Laplacian Based:** The Laplacian technique uses zero crossings in the second derivative to find picture edges. The image's derivative can indicate the position of an edge, which has the one-dimensional shape of a ramp.
$\nabla^2$is the Laplacian operator given by:

$$\nabla^2 f = \frac{\partial^2 f}{\partial^2 x} + \frac{\partial^2 f}{\partial^2 y}$$

Isotropic Laplacian measures the second spatial derivative of a picture in two dimensions. It is common practice to use the Laplacian of a picture to identify areas of rapid intensity shift.

- **Gaussian Laplacian:** To reduce the image's sensitivity to noise, the Laplacian is typically used after it has been smoothed with an approximation of a Gaussian smoothing filter. The three most typically utilised tiny kernels are as follows:

	1	0
1	-4	1
0	1	0

1	1	1
1	-8	1
1	1	1

-1	2	-1
2	-4	2
-1	2	-1

For the reason that they are emulating a second derivative measurement of the picture, these kernels can be quite noisy. To avoid this, the picture is usually smoothed with a Gaussian filter before using the Laplacian filter. This pre-processing phase reduces high-frequency noise components before the differentiation stage.

- **Zero-crossing:** When calculating the second-order derivative, it is advisable to keep an eye out for when it crosses 0. For example, if the second derivative crosses zero, then this pixel location is considered an edge point. The zero-crossing edge location method is commonly referred to as this. The zero crossing algorithm operates similarly to the Laplacian of Gaussian, however the filter is user designed rather than Gaussian.

c) **Canny's Edge Detection Algorithm**
The canny edge detection approach is the optimal edge detector. The algorithm is broken down into the following steps:
→ Use a two-dimensional Gaussian filter to smooth the picture.
→ Separate the picture into two equal halves by dividing it orthogonally.
→ Determine the magnitude and direction of the gradient.
→ Identify the image's traceable edge direction.
→ Don't go overboard with the repression. In the absence of a local peak, the gradient is zero. The gradient direction is employed in this method.

→ Reduce the number of unwanted edges by setting a threshold..

CONCLUSION

Segmentation is used to distinguish regions of interest by dividing an image into pieces. The shape's border must be extracted before the shape photos can be tagged. Edge detection techniques are used to accomplish this. When compared to gradient-based approaches, the results of Laplacian-based edge detection are superior. Gradient-based algorithms have the disadvantage of being extremely sensitive to noise. They may increase the signal-to-noise ratio, but they also cause erroneous edge suppuration. Despite the fact that Sobel, Prewitt, and Robert's operators are less computationally expensive than Canny's edge detection algorithm, the signal-to-noise ratio improves significantly to support Canny's edge output. Similarly, a visual comparison of output revealed that Canny's edge image had superior results. Color picture labelling necessitates a grid or segmentation divide of the image. According to the four methods tested, k-means clustering produces segmented output that is better for region-based annotation. The k-means clustering technique is supported by the segmentation algorithms evaluated using the probabilistic rand index.

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