Logo detection and recognition using CNN

by

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ABSTRACT

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Keywords: Logo detection, Logo recognition, Computer Vision, Machine Learning, Convolution Neural Network, Classification, Recurrent Neural Network, Pattern Recognition, Object Recognition,Data augmentation

This thesis describes the research work carried out to fulfill the Bachelor in Computer Science at the Suleyman Demirel University. Research was in Technopark at Suleyman Demirel University and was supervised by Konstantin Latuta. Logo detection and recognition continues to be of great interest to the document retrieval community as it enables effective identification of the source of a document. This paper contributes the design of the system able to detect the logo of any product from the documents and images after that recognize it from the archive via the convolutional neural network. For detecting and recognize of logos implemented via convolutional neural network, which creates initial classification to determine the presence of the logo on the document or image.As regards to the former, a collection of logos was designed and implemented to train the classier, to identify and to extract the logo features which were eventually used for logo detection and recognition. The latter regards the detection of logos from an input image. In particular, the experimental study aimed to detect if the input image contains one or more logos and to decide which logos are contained.

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LIST OF SYMBOLS/ABBREVIATIONS

MSE	Mean-square-error
CNN	Convolutional neural network
RNN	Recurrent Neural Network
CV	Computer Vision
ML	Machine Learning
LRT	Learning Rate
Conv	Convolutional layer
Pool	Pooling layer
ReLU	Rectified Linear Unit
Softmax	Normalized Exponential Function
Sigm	Special case of logistic function
SS	Selective Search
κ	Clusters count
C_κ	Cluster
m_κ	Mean of cluster
D	Function of error

CHAPTER 1

INTRODUCTION

1.1. Overview

Object recognition and object detection are ones of the lasting and most important goals in the computer vision.Because of this problem in a extremely considerable range of usage. For example, in copyright detection, contextual advertise placement, vehicle logo for an intelligent AI-based traffic-control system and brand detecting in social media. As well as these algorithms have many applications in location recognition, advertisement, and marketing. Presently advertising is a very powerful tool for income and attracting of customers.For this reason, the analysis of the brand and mention on different resources are very important and primary tasks for business analysts.In order to captive, attractive their customers and make better decisions, companies needs for analyzing the presence of their logos in photos, videos and another type of contents. Logos help to evaluation of identity between something.[1604.06083] [1701.02620] [1711.09822]

The logo mainly includes text and graphical symbols. In such cases, when the logo is in different parts of the image, the logo is inverted, the logo is distorted, as well as changed in size - recognition and definition of the logo is a very problematic and difficult task. For example, logos on their clothes, which are often deformed, which complicates its detection and recognition. [1511.02462]

Recent breakthroughs in deep learning improve recognition models with very extremely minimal loss function.Models which was created for recognition based on neural networks have excellent accuracy, speed, as well as these models, have the ability to be really smart. In short, the ultimate goal of the system, which is based on the recognition model, is to create a method that defines logos accurately and continuously learn from new logos.[1711.09822]

1.2. Related Works

In literature, I can find many works on logo detection, logo extraction, logo classification , logo retrieval and logo recognition.Research that has been done on for the last 20 years and that are related to logos have been done with datasets, which consist too small data. For example, ”Flickr-Logos” dataset, which includes only 32 logos, which distributed to 5644 objects on 8240 images.Obviously available public datasets not enough for creating real-time detector machine. And this machine, will not be able to fully use its potential

of detection with a neural network, due to the lack of data about other logos.[1511.02462]

Most of recent applications of detection and recognition of object have been based mostly on Scale-Invariant Image features.Scale-invariant image features algorithm provide us transformations and representations to gradients of images. These gradients are invariant to affine type transformations and despite the conditions.Models that were made based on SIFT, basically make a better that part of the picture that is specifically different from the rest of the content.At the moment, although there is a plural number of methods for logo recognition, the performance, and power of Convolutional Neural Network is growing very strongly in the field of computer vision. After all, CNN solves many of the problems of the basic classical computer vision algorithms and includes a large range of uses in the recognition of images and objects. The structure of convolutional neural networks is very hierarchical and multilayered, as well as it is designed so that the pattern can be recognized only from the pixels themselves.[1604.06083]

In this [bianco2017deep] paper they propose a method of logo detection and recognition with using main deep learning algorithms.Their recognition and detection process have given with pipeline, which consists main 5 step. These steps: taking an image, doing object proposal, cropping to regions, passing through the trained convolutional neural network and making a prediction.This algorithm recognizes logos well even if they are not exactly localized in the image.The neural network was trained and tested on the ”FlickrLogos-32” database.For improving result they trained CNN with very differently benefits. As an example, for avoiding overfitting they used class - balancing in every batch. Also, they confirm sample-weighting and add a new class ’no logo’, which includes only images without any logos.

Also, this [1511.02462] paper presents a method that works perfectly with logo recognition, and returns the bounding box of the found logo. In particular, recognition of the logo has broad application and uses it in many areas. To protect people intellectual property, logo recognition is the most convenient and effective tool.As mentioned earlier, in the area of logo recognition and identification, most tools have a very small dataset.But researchers from this article had presented a large-scale database, which has 160 classes distributed among 130608 objects. This dataset is really huge and it is called ”LOGO-net 160”. For cropping the image into regions and search regions of interest(RoI) they used selective search algorithm, that efficient for this type of tasks. After features extraction with CNN, fully connected two layers divided into softmax predictor and bounding box regressor. This mathematical operations provided us classification of logo and it’s position on image.

Guys from this [1604.06083] paper demonstrate method for recognition, which based on Region-based Convolutional Networks.A distinctive feature of this approach to solving the problem is the recognition of multiple objects in the image.

CHAPTER 2

PROBLEM STATEMENT AND THESIS ORGANIZATION

2.1. Introduction

In this chapter, we will explain the main problems that researchers faced when they recognize and detect logos. And also, briefly explain how you can solve difficulties of this complex process. We will also present you the content of the thesis, which will briefly clarify what will be shown in the following chapters.

2.2. Statement of the Problem

Logos are 2-dimensional shapes of varying complexity,with interior and exterior contours that are not necessarily connected. Therefore the recognition process seems to be difficult because of its complexity.For this reason, the logo recognition process is a difficult task.In this problem, you can also highlight the moments when the method works very well with perfectly made images, but when using some images that may be deformed, inverted and blurred, then at such moments the method was simply useless.After all, such methods are usually trained on a perfect images dataset. So, in this case, the model can work with real images.[1-s2.0-S0031320302001280-main]

Because of any transformations such as rotation, shift and scaling, as well as the position in which the logo is placed, makes the task of recognition a special case, because the slightest shift can significantly affect the result of recognition, since the classical methods of computer vision are very sensitive to the slightest changes in images.Even lighting and illumination can greatly affect the result, as they strongly affect the inversion of any pixel.Most of the methods cant cope with the recognition of logos because they are very limited in terms of the application and the structure of the algorithm.The variety of logos and their size's requirements makes it very difficult to create a fixed model that will be adapted to this variety.Optimization methods in most models are not very suitable for the case of logo recognition.Complex geometric shapes of logos and the lack of information about the cascade of the logo on the image during the training of the model lead to the fact that the model is underfitting or overfitting.[1-s2.0-S092523121631387X-main]

Another problem in logo recognition is the limited number of datasets, and collecting your own dataset is very costly and hard work.With a rapid jump in the creation of multimedia technology, the number of logos is growing up very quickly, which makes it a difficult process in the protection of intellectual property, as

well as a very interesting and challenging task.[1612.08796]

Also, the problem is complicated by the fact that most of the available and targeted images for experiments are very limited, with a small number of classes and the same type.[1803.11417]

Despite the results of logo recognition models of the most ideal and convenient for the algorithm cases, the recognition of logos from real images is a particularly difficult problem, which can handle not every algorithm. One problem is when the logo is very small and in a distorted state. Also, present the problem of logos that are on the clothes and they just become vague. Still, pose a problem for those cases when the logos of any single company may be very different at different angles.[1511.02462]

After reviewing a decent number of methods, I decided to repeat the work of [1701.02620], and divide this problem into 2 main parts. The first is responsible for the detection of logos, or rather approximately different parts of the image. Second, make recognition using deep learning algorithms. In creating sample areas where you can find the logo, I want to use the selective search method, which will be able to divide the images into regions. And then these regions will go through CNN, reaching for softmax, which will classify and give us an answer, what kind of logo it is. But unlike other researchers, I want to try with different types of CNN architectures and try to change the SS, or try other methods in the floodplain distinguishing features of the image. Also for improvement of a result at training, the new class of the background is added. SS is a method that searches for regions of interest in an image that is somehow different from the rest of the image. But in turn, this algorithm finds the false parts of the image that are not the logo. This problem is solved by CNN, which will in most cases refer this part to a class where there is no logo.

2.3. Thesis Organization

The structure of the thesis is organized as follows:

- In Chapter 3, a general review of main methods of image segmentation and deep learning algorithms
- In Chapter 4, the proposed algorithm is presented. A review of the Selective Search algorithm and Convolutional Neural Network model, with softmax and prediction frameworks.
- In Chapter 5, an experimental study is provided in order to compare the performance of the proposed methods for logo recognition and logo detection.
- In Chapter 6, conclusions and a discussion on possibilities for future work are provided.

CHAPTER 3

REVIEW OF DEEP LEARNING AND PATTERN RECOGNITION ALGORITHMS

3.1. Introduction

This chapter provides a review of the well-known algorithms of image segmentation, pattern recognition, exhaustive search and deep learning methods.We will also explain how the main image segmentation methods work and how they developed in computer vision. Also will demonstrated methods forward and backpropagation. Between this two process, you can see the optimization process, which try to minimize function of error.

3.2. Computer Vision and Pattern Recognition

For a person, the perception of the outside world with your own eyes is a very simple task, be looking at any 2- or 3-dimensional object, you can safely tell about its shape and external structure.Looking at the crowd of people, the human brain can easily calculate the number of objects, can tell about their shape and condition. But what about the computer? Will the computer be able to handle the processing of objects that people see? Will the computer be able to find the difference between very similar objects? In this matter will help discipline called computer vision.This area is very closely related to signal processing, image processing, and video recording. As well as it includes machine learning with pattern recognition.Along with other Sciences like text processing and audio processing, science tries to create the ideal artificial intelligence that can think and act like a human.Image processing not only includes the transformation of images into a more comfortable and desired type but also this area along with computer vision will be able to show what is inside the image. Image processing not only includes the transformation of images into a more comfortable and desired look but also this area along with computer vision will be able to show what is inside the image. Also, this area helps in capturing movements inside the picture.[CVPR] Understanding what exactly is happening on images and perception of this process is an important process in AI. Draw conclusions depending on what you see is a fairly simple process for a person, but not for the computer. Since a computer without any reason cannot understand the essence of the process. The problem in object recognition is the appearance of these objects in new forms or compositions because the pre-built model cannot cope with it, because it has not seen the object in this format. These new formats can be represented

as an object in the expanded state, or it can be simply in motion. A huge number of new forms and aspects makes the object recognition a practically impossible task.[introTOCV]

3.3. Selective Search

Exhaustive search helps to find parts of the image where you want to consider the potential parts of the desired object.Although this model works well with specially selected objects, it has a number of drawbacks that significantly affect the detection of logos.After all, the search for every possible object has the ability to be impossible. To solve this, we can use selective search.To improve the whole process and the data set for testing, we can use a combined method where we will use both methods described above. Since the number of possible objects will be more and less real and possible.Diversity in this task plays an important role, as we can cover more and more possible variants of this logo in the image.Since selective search is more useful to us, it will be helpful to familiarize yourself with its dependencies.The first and most important factor is to cover as many scales as possible because the logo can be small or large. We may not warn that. After all, the situation can be quite different. Also can make problems of objects which have no clear borders, for this reason, it is necessary to look through all options of the sizes of an object.Also, it should be noted that there is no exact and general solution of searches of any objects. It is impossible to make such a general detection system. Well, at the moment of course. For this reason, you should also look at the variety of objects and their contours, which can be very important in training. Speed is an important factor when searching for possible objects in an image. After all, such systems are built to determine the objects on the camera in a short period of time.This method is exclusive in that it is possible to configure this so that it worked by concentrating on the object and not on its borders.[ssForSegmentation]

3.4. Image Segmentation Methods

In practice, the importance and value is not always fully the image itself, namely what are the specific parts of the image, and sometimes just the number of channels of the image.The first and one of the most important technologies for understanding what is happening inside this image is segmentation.Since only a segmentation can be divided into important and different parts.After all, it helps to understand the image inside the image, as well as to extract useful information for us. These aspects are extremely important for programs where image recognition is paramount.For all these reasons, it can be understood that segmentation is a very important discipline within computer vision, and in turn, segmentation has a huge number of difficulties in implementing many methods.In short, segmentation is important for recognition, because it can pull out those areas that are very important for humans. And are the basis for all methods of recognition of contours and objects.There are many types of segmentation and a huge number of places where you can

use them.One of the most common methods is threshold segmentation.The basis of this algorithm creates a segmentation of the image by its regions.This method searches for a threshold by a specific criterion to create a grayscale that will be distributed from other colors. This method sets a specific threshold for pixels and depending on the condition they change from 0 to 255 in grayscale.You can also mark a method called edge segmentation. This method is particularly the fact that he refers to the saturation of gray on the borders of any object.In the discipline of computer vision and related industries, there is no single segmentation method that can work in all cases. To use the segmentation method correctly, you need to consider the advantages and disadvantages. After all, each method will lead in different ways depending on the situation and the state in the image. And it is also very important to apply the correct parameters of segmentation methods. Since the parameters play a significant role in the algorithm.[1707.02051]

Segmentation, by itself, is splitting the image into several areas, depending on their structure, size, and saturation of any particular colors. These areas can include grouped pixels, which represent the object itself, and can represent a variety of shapes, such as an arc, circle, or just a line. Developed regions can be simple lines or full-fledged objects that can have boundaries separating them from other content. Since the area of interest may not cover the entire image, we are interested in using segmentation in such cases. Segmentation has two main goals that it pursues. The first is to expand the image to the desired regions. The second task is to change the representation.Considering the simplest cases, when the interesting part of the image is very different from the rest, the segmentation will not be a problem. After all, the area of our interest, especially its color and saturation help to clearly separate it from the rest of the image. After all, the rest of the area does not have similar components as in the desired image area.But there are also severe cases where the boundaries are strongly distorted and erased as the color saturation is very similar, and the components do not differ from each other.Considering the second objective pursued by the segmentation can be sure it will ultimately give us a richer and more precise representation of the object within the image. Here our task is to gather pixels into one whole, into a more integral area, which is much useful and important for future research, because we create a clearer outline of the object. The perspective of an image can serve both as a useful tool and a very strong drawback since the borders can be clearly highlighted or even erased in the image. **Here will be one two images, seg1.png and seg2.png**Typically, classic segmentation techniques may not work well for images where the boundaries between the desired features are blurred and blurred, making this work practically impossible because the pixels are too similar and the features cannot be separated or isolated.To divide the image into several parts according to the regions, have to be extremely homogeneous as the level of gray. After all, black-and-white images are easier to work with due to algorithms. As well as the color and texture of the image are also important when dividing by regions. Neighboring areas of the desired object should have very different characteristics

and features because the uniformity prevents the algorithm. Also, borders of the object should be evenly distributed, and also they should not be torn or distorted. Achieving all the above characteristics gives a certain amount of difficulty, after all, how would the objects did not have their uniform or completely, they still have dire and slits, which interfere with segmentation algorithms, making a homogeneous region in a heterogeneous region. Also, our eye can also be mistaken in terms of the homogeneity of the object inside the image, because sometimes there may be holes or cuts that are not subject to our eye, so the number of pixels that we can not see, can interfere with the segmentation.[ch10]

3.4.1. Thresholding

In the methods of segmentation are the segmentation types of image in parallel. The most common and easiest method is to segment an image using a threshold. This method is based on the use of gray color. After all, we know that translating the image into a black and white contour with it is more convenient to work with than 3 color channels. This method segments the image based on image separation by saturation and grayscale. It is able to divide image according to its local threshold, which is automatic, depending on the distribution of the white and black color. And also, you can split the image using a global defect which can be defined as static and automatic and manually. It can also be noted that the threshold can be dynamic because it changes from area to area by an image.Global threshold divides the image into the desired area and its background, which he considered not similar to the area of interest to us. The local one does this by going through the image, and depending on the situation and position, select a threshold to be divided into the main part and the background part.THE most common and convenient method of threshold segmentation is - Otsu method. This method uses the interclass variance to separate areas of an image. The method is special and distinctive in that it selects only the global threshold. And the threshold is chosen by the maximum dispersion between all classes inside the image. The segmentation method has found extensive application due to the fact that it is very simple to calculate and does not require costly calculations and calculation when the algorithm itself. Also, due to a simple calculation and increases the speed of the algorithm. This algorithm can work very well when the boundaries between the object and the background are separated by an accurate and bold contrast line. In such cases, you can obtain accurate segmentation results for the image. But in the opposite case, when the boundaries are erased, this method is not able to cope, because it will not know exactly what is the object and its background. Noise can easily interfere with this method. Because the noise erases the boundaries. And uniformity also can ruin the quality of the method is the segmentation threshold.This method is effective in combined use with other methods.[1707.02051]

3.4.2. Clustering Methods

Clustering is a very powerful and unpredictable method in machine learning and computer vision. In computer vision, or rather in segmentation, it works by splitting image vectors into groups called clusters. Since clustering methods are not the same type, we can consider several types of clustering methods, but the essence of its work is based on similar points, which are very similar, and then they are grouped into separate clusters.The main problem of clustering is the correct splitting of the image into the correct sets of vectors. In this case, these vectors must be collected to have a similar value in the numbers, which means their structure must be similar. In these vectors consists mainly of the pixels of the image. Also, components can be indicators of the intensity in a given area, and 3 channel parameters that are related to each other. Texture, namely their calculated values can also be components. To associate pixels in groups, you can use any component or parameter that combines these pixels into a single value. Due to this, it is possible to find the associated objects and re-create the segmentation for the pixel count.[ch10]The *least squares error* is one of the most common measures to compare clusters that use the traditional method to break into groups. Clustering involves the process that determines the number of clusters κ. the same is created the number of groups from C_1 to C_κ. Each such cluster has its own personal measure of average m_κ. The formula of the error, said earlier, is calculated as follows:

$$D = \sum_{k=1}^{\kappa} \sum_{x_i \in C_\kappa}^{1} \|x_i - m_k\|^2 \tag{3.1}$$

This formula shows how close this object's data is to a particular cluster. This procedure will help you to see all the possible options for partitioning into K-th number of clusters. As a result, it will find the best option to minimize our error function D. the Disadvantage of this method is that it is impossible to calculate everything. For this reason, they find the closest number in value and divide the rest of the objects into clusters. It is also very difficult to find a global and optimal variant of the error function iteratively, for this reason, they usually resort to the random selection of clusters and selection of their mean values for further calculations. This method is called k-means clustering. There is also a method that is different from it. It is called isodata clustering. It uses a similar method of splitting and merging.This method is based on creating groups from their distance from the center of a particular cluster. Clusters are initialized randomly and iteratively go through the positions to find the most optimal point at which the error function will be reaching.[ch10]

This method is the simplest and fastest, and most efficient for large datasets. Because it's easy to scale, it's very responsive for large datasets. The iterative nature of this method makes the optimization process easier

and more convenient for calculations. But it also has a number of drawbacks, such as the number of clusters and the parameters by which these clusters need to be calculated. The iterative method is bad because every step goes through the whole sample, which is very expensive and time-consuming to calculate. There is also a problem with non-convex clusters, as they are difficult and impossible to calculate.[1707.02051]

3.4.3. Edge detection

The edge segmentation method has its own feature to work faster due to the lack of a large amount of information that needs to be processed somehow because this method uses only the detected edges, which store all the necessary information for this method.Because of the very easy and understandable implementation, it is included along with other segmentation algorithms for recognition of an object. It has good ability to work in big data processing.The main advantage of this method we can call the extraction of accurate edge lines, which in the future will help to create their own borders and segment the image. Also when removing it takes out edge with the desired orientation. But we can not say for sure that the performance and reliability of this method are good or bad, because of the formulation of problems and the benefits of the method, each researcher must judge himself, based on the results that shows this method.This working method transforms the original image into divided regions which are clearly separated by edges in which the grey tone prevails. The edges that are at work of the algorithm become the boundaries between the object and its background, but again only the researcher can judge what is the background and what is the desired object. The benefit and contribution to the computer vision of this method are simply colossal. Also, a feature of this method in the creation of localization in the image of dependence on the level of gray color in the certain region.What are these edges? This is basically a change from pixel to pixel intensity of any color depending on a certain direction. From the same edges are extracted the main objects that will be used in the future. Because of the importance of grey, exploring the gaps between them is very important. Breaks can represent points, lines, and edges as well. Since breaks are useful, and they have based the basic methods of segmentation at the edges. It is possible to allocate methods such as Roberts, Sobel and Kirsh edge detection methods.[1211csit20]

For the definition process, we can know for sure that not all points in the gradient have nonzero values. But at this point, we can say that not all points are important to us.During the improvement process, special pixels are highlighted. Under the peculiarity, we can say about the gradient change and about the intensity in this region. Also, to restore the image and get rid of unnecessary noise, we can recreate the filtering process.For example, we can talk about its two most common methods like Sobel operator and Laplacian of Gaussian Operator.**Sobel Operator:** It goes through all gradients and highlights the rich and intense frequencies that pass through the object boundaries in the image.

Table 3.1. **Sobel Operator**

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

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

Laplacian of Gaussian Operator: For use this method, you need to calculate the derivative of the second order and create a mask on the Laplacian distribution, which is listed below:

Table 3.2. **Laplacian of Gaussian Operator**

0	-1	0
-1	4	-1
0	-1	0

The edge segmentation method has other methods, but all methods mainly work with masks that go through the entire image and converts it to the desired shape.[1210ijcsit14]

3.4.4. Histogram-based methods

Since the other segmentation methods require a full pass through the image, there is a method that works with histograms, and its speed is much faster than the rest. It involves the least time pass on the pixels of the entire image.This process involves grouping the space of an entire dimension, in which all similar objects behave the same way and are grouped into sets, in other words building their histogram. Segmentation in this process is carried out by comparing all the existing groups in the set in its area inside the image, in which all the related parts will look like a group. The intervals between histograms represent a change as hills, where colors shimmer from each other. The peculiarity here is the gray color that will be distributed between the multi-modal histograms, and the regions will be defined by peaks. Then again you need to define a threshold that will determine what region we want. This motivates the need threshold value methods, focused on understanding and creating conclusions, in which the selected thresholds are closely related to the histogram and the quality of the region or area.[ch10]

3.4.5. Compression-based methods

The compression process is a more advanced segmentation method, so it includes 2 main processes, it is segmenting the image, and further compressing it. A result is a huge number of regions that do not intersect each other, and their combination can lead to a return to the original position, which in some cases is

convenient. After the segmentation has occurred, the compression process continues, which compresses all created segments to a specific state or size. Segmentation on the output gives different objects, such as smoothed parts of the image, text, individual images, graphics, and areas that overlap the rest. Smooth areas use a compression method that uses an arithmetic encoder that operates on the basis of contrast and color palettes. The text uses a different method that uses text encoding. Classic JPEG-based compression methods are used for the image.[compressionBased]

The segmentation algorithm works together with intensity values. In intensity, it is important to keep in mind the similarity between pixels. Due to the fact that the object is taken as a whole, its edges can be saved intact, to continue to use. The image quality is also maintained. At the stage of compression, for each segment, its type is determined, and then the method by which it will be compressed is determined. For efficiency, segments are encoded into a specific format. Effective and reliable (adaptive) methods of image compression using remote sensing become more and more necessary both in quantity and in size images for archiving and transferring the purpose of the network is constantly growing. In addition, all remote sensing images have a huge amount frequency component. Therefore, it is important to reach a maximum the degree of compression while maintaining a reasonable the computational complexity of implementation and high the visual quality of the restored image and, possibly, only Segmentation based on image compression.Amount of segmentation compression methods of general and remote control are offered picture.An algorithm for lossless image compression is proposed, using the Segmentation of the size of the variable block. Duplication in the representation of a digital image can be divided into two categories: local and global. In this work, a lossless image compression scheme is used, using redundancy at the local and global levels ensures maximum compression efficiency. This algorithm segments the image into blocks of variable size and encodes them depending on the characteristics presented pixels inside the block. The execution of this algorithm is superior to other lossless compression schemes, such as Huffman, arithmetic, Lempel-Ziv, and JPEG. But the characteristics of estimating the distribution of the image and the resulting efficiency of compression are a very difficult task because of the huge amount of computation.[fulltext24632013]

3.4.6. Dual clustering method

This method represents a combination of other methods we are familiar with. It uses the three most important features of image segmentation. The image is taken, segmented using a histogram-based method, then their density and completeness are checked by clustering, and last but not least the boundaries of these segments are checked by the integrity of their gradients. The method is carried out by creating two spaces we need. The first is responsible for the intensity and brightness of the image. Next, in another space is the original image itself, which has a dual feature. As mentioned earlier, the first space checks the intensity and

brightness distribution. Everything happens in the clustering process.[Vadim V. Maximov, Alex Pashintsev Gestalt and Image Understanding. GESTALT THEORY 2012, Vol. 34, No.2, 143-166.]

3.4.7. Region-growing methods

The last in our list and also one of the most common segmentation methods is the method of regional growth. This method is based on searching for similar and consistent areas within the image. Also, during the search process, similar pixels are merged into a region, which includes similar areas of the image. The method is simple in that it simply merges all similar pixels together to form an area as a whole region.Due to the fact that this method shares a well-connected region, a region well is a clear boundary that provides an excellent segmentation. When the segmentation process is started, there is a search for and an increase in the criterion, which depends on several factors. Segmentation is due to separation and the creation of clear boundaries. Again, the disadvantage is too expensive a number of calculations during the process. Noise and unevenness can also affect the result of this method.[1707.02051]

Methods based on the region rely on the assumption that all neighboring pixels in the same region have a similar value or a certain range. This leads to a class of algorithms known as an area whose growth the technique of ”splitting and merging”, perhaps the most famous. The general procedure is to compare specific one-pixel function for its neighbors. If the homogeneity criterion is satisfied, then the pixel assigned to the same class as one or more of its neighbors. Choice of the criterion of homogeneity critical for even moderate success, and in all cases the results are disappointed by the noise. The fourth type hybrid methods, which combine boundary and regional criteria. This class includes morphological Segmentation of the catchment area and a landing surface of variable order. The catchment method is usually applied to gradient image. This gradient image can be viewed as a topography with boundaries between regions ridges of hills. Segmentation is equivalent to filling the topography of the starting points of the boundaries of the region so that they are open to keeping water from different points of sowing from the meeting. Like the whole perverted method, the technique encounters difficulties with images in which the areas are both noisy, and blurred or fuzzy volume. In addition, this method is also very expensive to calculate. In this article, A segmentation method based on the method of growing the sown area is proposed, which is less sensitive to noisy image and quantitatively and avoid an explosion, leakage, segmentation, and segmentation problems.[1412.3958]

3.5. Supervised Learning

Soon

3.6. Optimization

Soon

3.7. Backpropagation

Soon

3.8. Neural Networks

Soon

3.8.1. Vanilla Neural Networks

Soon

3.8.2. Convolutional Neural Networks

Soon

3.8.3. Recurrent Neural Networks

Soon

3.8.4. Capsules Neural Networks

Soon

3.9. Summary

Soon