Indian Journal of Science and Technology, Vol 8(25), DOI: 10.17485/ijst/2015/v8i25/80974, October 2015
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

A Study on the Algorithm for Multi Cognitive Unstructured Pattern Matching

Changbae Roh[1] and Wonshik Na[2]*

[1]Department of Electronic and Radio Engineering, Kyung-Hee University, Seoul - 110810, Republic of Korea;
[2]Department of Computer Science, Namseoul University, Seoul - 110810, Republic of Korea;
winner@nsu.ac.kr

Abstract

Pattern matching technology not only utilizes artificial intelligence and cognitive science to process data, it also uses intelligent systems to effectively present and handle data, making it widely used in diverse areas such as finance, manufacturing, sports, and the service sectors. This paper proposes an algorithm that makes it easier for users to search for information that is relatively unstructured compared to existing multimedia data, by converting it into images. Rather than using just one piece of information to gather search results, symbols and color information can be designated to data to allow optimum search results. Under the assumption that a complete database of the world exists, the search results as well as the efficiency of the system would depend on the accuracy of the image drawn for the search. However, more important than the accuracy of the results is the ability of the algorithm to comprehend the user's intent and display search results accordingly. Moreover, seeing how the efficiency of the system might depend on the way the individual algorithms are combined, improvements on the search image generation module and further studies would allow people to identify methods that can improve the individual components of the whole algorithm as well as find better combinations of individual algorithms. The algorithm proposed in this study has been seen to lead to an improvement of individual matching algorithms. It is of utmost importance that an algorithm with a human-like recognition system is developed in order to create a system based on pattern recognition.

Keywords: Big Data, Cognitive System, Emoticon, Pattern Matching, Pattern Recognition, Sensing

1. Introduction

Pattern recognition is included in the scientific field where cognitive science and artificial intelligence are utilized to facilitate the comprehension of specific shapes. Here, cognitive science refers to the comprehensive scientific field that utilizes psychology, computer science, artificial intelligence, neurobiology, linguistics, and philosophy in dealing with issues pertaining to intelligence and cognition. Artificial intelligence can be defined as the technology that can be used to create a computer program, which is artificially modeled on the human abilities of learning and reasoning, to recognize outside factors as well as to understand syntactic structures such as those present in natural languages. Hence, formulating an algorithm that can display human-like cognition is a key factor in the creation of a pattern recognition system, which is the reason why artificial intelligence is a strong subject matter of interest.

Research on artificial intelligence has become so developed in recent years to the extent that it now also includes the field of information systems based on intelligence systems. Such systems are widely used for a variety of tasks, from the processing and presenting of the myriad of

*Author for correspondence

information that is easily obtainable in today's Information Age, to tasks within the areas of finance, manufacturing, sports, and the service industries. The primary goal of such services is to digitalize various jobs in people's everyday lives that until now have required man power. The pattern matching technology that is used within such artificial intelligence systems take on an engineering approach to recognize extracted subject matters, which is an issue that needs to be solved if artificial intelligence is to be utilized. Pattern matching can be defined in various ways. However, in this paper pattern matching will be used to mean, "An area of artificial intelligence that deals with the recognition of subject matters by a mechanical device (computer) that is able to perform calculations". This paper suggests a search system that will present to users search results that consist of emoticon data, saved in a database that best matches the pattern drawn by the user based on the similarity of the two images. Of course, there are existing research papers and products that look into efficient search systems for the different kinds of data such as text, images, and videos, but their rate of accuracy in matching has not been high. In contrast, the system proposed in this paper searches for emoticons that are relatively unstructured compared to existing multimedia data, and thus visualizes the data searched by users to make the search process easier.

2. Related Work

2.1 SIFT Algorithm

SIFT is largely composed of two stages. As seen in Figure 1, the first step of SIFT is identifying the key point in order to attach a descriptor to it. Following this is the matching stage, which utilizes the aforementioned descriptor for a comparison of the original DB image and target image.

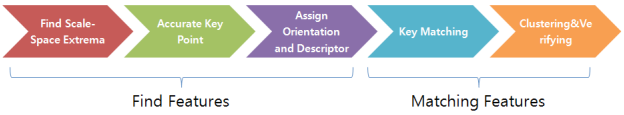

Figure 1. SIFT image matching.

In the initial stage, features of the images are identified on various scales and are designated values that contain information about the direction and size of each feature.

In the following stage, a matching procedure takes place based on the differences between the previously calculated features of the DB and those of the target. The matched features are categorized as being either inliers or outliers determined by the Hough transform, in order to provide an accurate match. The Least mean square is used to verify the accuracy of the match made in the last step. This is also known as the Gaussian Distribution and can be written out as Formula (1) and Formula (2) as seen below[2].

$$f_x(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \quad (1)$$

$$\int_{-\infty}^{\infty} f_x(x)dx = 1 \quad (2)$$

The Gaussian Distribution is a function frequently used in the computation of probability and statistics where σ represents standard deviation and μ represents the average. The Gaussian Distribution is of high importance due to the fact that it forms the basis of the core aspects of SIFT, such as DOG, LOG, and the Gaussian Pyramid, all of which will be introduced later on. If you detect the edge from the DOG (Difference of Gaussian) and the LOG (Laplacian of Gaussian), there will be a sudden change in the edge in that the gradient value, i.e. the differentiation value, will increase.

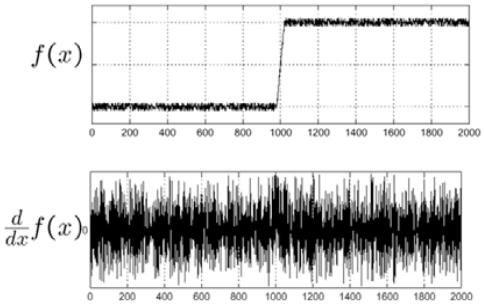

Figure 2. DOG and LOG.

The process of recognition is as such: characteristic features are first identified, followed by the identification of the trend of shape changes surrounding the feature. The trends are then compared in order to differentiate the subjects. The SIFT algorithm, although it may only seem related to computers or mathematics at first glance, is a algorithm that has been formed based on the intellect of many scientists and various scientific principals[2].

2.2 SURF Algorithm

The SURF algorithm is an extended algorithm with a color invariant feature that finds corresponding points

by comparing videos that contain identical objects or scenes in order to identify the common characteristics between videos. In the field of computer vision, finding corresponding points among multiple images of varying environments is one of the most important tasks there is in existence. This is critical and key to various features such as camera calibration, the field of 3D vision including stereo vision, image reconstruction, object recognition, and many others. However, it is not an easy task identifying common characteristics from videos that are different in scale, lighting, and perspectives from one another. Thus, the following two steps need to be taken in order to identify corresponding points that are easily recognized despite such changes. The first step is the identification of a characteristic point in the converted video. Such characteristic points should be visible in the same location in both the original and the changed images, and they should be easily identifiable. The second step is the creation of a descriptor that can describe the characteristics of the points identified. The descriptor should describe the characteristics well in a way that clearly distinguishes the identified points. Furthermore, descriptors must be established using the least amount of data possible in order to speed up the matching process[3].

3. Emoticon Pattern Analysis Technique

3.1 Sfksearch Analaysis

The Sfksearch is a search method that cuts down on the required the search time via the creation of a Ktrie pattern tree that is composed of all the patterns that are to be searched. Then, a shift is made according to a shift table, which is based on the shift abilities of each letter. This is carried out instead of undergoing a naive search for the text. The Sfksearch process can be outlined as follows: first, the patterns that are to be searched for are composed into a Ktrie pattern tree. Here, the Ktrie is based off of the shortest text length among the patterns. If there is a pattern longer than the established pattern tree, a Ktrie will be additionally formed for that specific length and saved in a keyword. The second step is that, instead of the letters in the text undergoing a naive search, a shift table is created based on the factor of how many letters are able to be shifted without requiring comparison. Following this process, it is possible to get the results of an accurate pattern search without having to resort to searching the whole text[4].

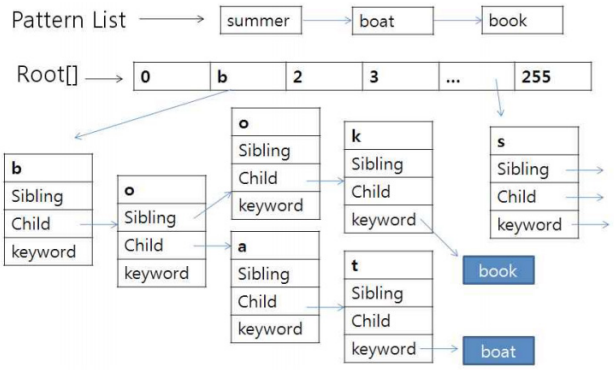

Figure 3. Patterns written with Ktrie list.

It should be noted that automatic input is necessary in changing a bitmap document video into text data. This is due to the costs and time constraints involved, as manual input is only possible up to a certain and limited extent. In light of such facts, research has been taking place for decades both within Korea and in other countries on the issue of the layout analysis, recognition, and understanding of document videos, and has been successfully commercially utilized in certain fields.

3.2 The Calculation of LBP

The analysis calculation of LBP has the benefit of being much simpler in comparison to other image analysis methods. The LBP calculation also has the added benefit that even though it is easier, the method actually has a far larger spectrum of application than that of other methods, all the while providing results that are as equally accurate as others. Such strengths are in line with the current trend of electronics becoming increasingly smaller in size, mobile, and ubiquitous. This method also allows for a more precise calculation than the analysis of a whole image carried out all at once. This is due to the fact that the algorithm is relatively simpler and that it analyses sections of the image for their characteristics to create a sum of all results, in its calculation of the final LBP value. The radius can be set as 1 to get results with a higher precision, and a larger radius can be set if the capacity of the device used is low, or if a quicker calculation time is required. To give an example, the results would be attained very quickly in analyzing images on a smart phone if the radius is set as 16, in consideration of the limited capacity of the device. However, if the search is conducted on a desktop

computer, the radius would be best set as 1 for the optimum, most precise results, in light of the fact that there would be no capacity limitations involved. The experiment carried out for this paper set the radius as 1, as it was conducted on a desktop computer[5].

When comparing Pbi (i: 0~7) with Pc, if Pbi<Pc then Cbi(Compare)=0, and if Pb>=Pc then Cbi=1.

1	0	0
1		0
1	0	1

The BPb value is calculated using the formula BPb (Big part)=Cb*2p. P is the fractional value i.

1	0	0
8		0
32	0	128

The analysis value (lbp) of the segment (where N*M is the total number of segments) is the sum of each fractional BPb.

$$lbp = \sum_{i=0}^{n} BPb_1 \tag{3}$$

The LBP value of an image is calculated by finding the sum of the individually calculated lbp values of each segment.

$$LBP = \sum_{i=0}^{N^*M} lbp \tag{4}$$

The algorithm used in the search for multi pattern matching for emoticons include Retinex in order to improve the video input; a segmentation in HSI and the YCbCr color space, as a way to ensure efficient searching despite noise present in an image; a smooth histogram to ensure the improvement of contrast; and a rotation based on a constant incline.

First of all, the Retinex algorithm, which is an algorithm that improves videos, is able to reduce the impact of lighting elements. This is because Retinex is modeled on the human eye. Case in point, the input video (I) was found to be a product of the reflective element (r) and the lighting elements (S). However, human eye perception is largely unaffected by lighting elements and is mostly influenced by reflective elements. Thus, the Retinex algorithm only calculates the reflective elements much like how humans are able to visually perceive the world. [Formula 5] is the formula used by Retinex[6,7].

$$\begin{aligned} I(x,y) &= S(x,y) \times r(x,y) \\ S(x,y) &= F(x,y) \times I(x,y) \\ \log[r(x,y)] &= \log[I(x,y)] - \log[S(x,y)] \\ &= \log[I(x,y)] - \log[F(x,y) \times I(x,y)] \end{aligned} \tag{5}$$

Second is the segmentation within the HSI and YCbCr color space. The RGB color space has the disadvantage that colors are hard to distinguish and that it is susceptible to the brightness factor. Here, the HSI color space is used in place of the RGB color space because it allows for easy distinction between colors and due to its low susceptibility to brightness. However, the HSI color space also has the downside of being susceptible to severe red-colored noise when the light gives a reddish tint to the surroundings, such as roads during a sunset. As a countermeasure, the YCbCr color space is thus also utilized here in order to reduce the noise. The YCbCr color space primarily uses brightness and a chrominance signal that displays colors by distinguishing brightness even in darkly lit videos, although it may not allow for a clear distinction between hues[8].

4. Multi Pattern Matching Search Simulation

There are two ways of applying the emoticon multi pattern matching search simulation; comparing input data with the Hand-Drawing Sketch Image DB, and using the Query-adaptive Shape Topic (QST) and the Edgel Index with Chamfer Matching (CM) technique. The first method, comparing it with the Hand-Drawing Sketch Image DB, requires a DB to be established that consists of various hand-drawn images that are expected to be input in the future, and using this to compare and analyze image patterns searched by the user to present search results based on the images' similarities. The Query-adaptive Shape Topic (QST) and Edgel Index with Chamfer Matching (CM) technique indexes the free curve image drawn by the user and categorizes it into groups according to the QST technique, which then displays the grouped results in a map of related results[10].

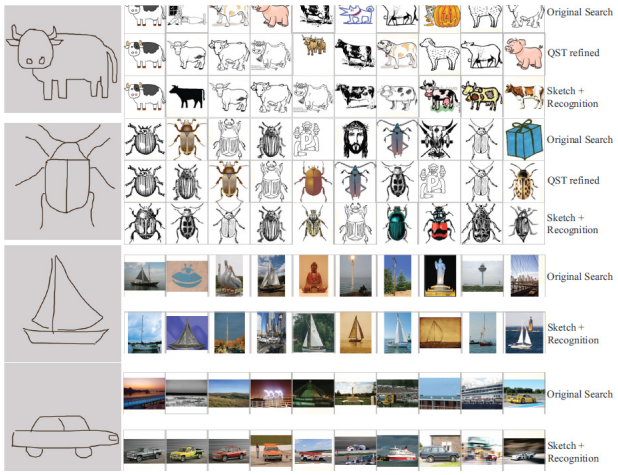

Figure 4. Example of an enhanced sketch-based image search. Top two rows: the top results of an clipart image search.

Bottom two rows: the top results of a nature image search

Establishing a DB of hand-drawn sketch images has been realized via the collaborative research carried out by universities in Germany in 2012. The results have been made into a program that suggests keywords and the more sketch images are saved in the DB for a single object, the higher the recognition accuracy will be. Due to the large size of the DB, a mobile device would require the services to be provided via a server.

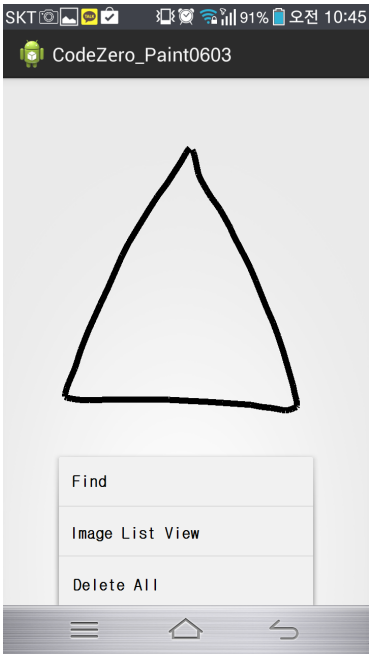

Figure 5. Pattern image search.

Figure 6. Pattern search result.

This paper suggests a model where simple sketches can be utilized to search for results. Pre-approved emoticons would be indexed and compared with the outlines of the emoticons drawn by the users for the search. Here, tools such as slide bars can be used to set the matching rate, where less result will be provided for matches that require a higher level of match accuracy. When users hand-draw images similar to the pre-approved emoticons, the search mechanism will recognize this and match them, providing the loaded matching results in a map of related images. Pressing "Image List View" will show the user a list of images saved in the program below.

5. Conclusions

Currently the program suggested in this paper allows for searches and will show the search results in a list of images, but in the future a database can be utilized to contain emoticons to be matched with user input data to provide matching search results. The advantages of having such a system is that users would not have to input emoticons directly to the database for results; they would be able to use existing image galleries or any kind of system where emoticons are saved to search and get results.

It is evident that the algorithm suggested by the emoticon multi pattern matching search system has led to an increase in the performance of individual matching algorithms. Assuming that a complete database exists, the performance of the whole system would depend on how accurately the input image is drawn by the user. However, what is more

important that that is for the system to show results that reflect an understanding of the users' intent, even if the users do not put too much effort into the drawing.

Moreover, another factor that affects the performance of the system is the combination of the individual matching algorithms. Thus, the search image generation module should be enhanced and further research should be carried out to improve individual algorithms as well as to discover better a combination of algorithms. The system suggested in this paper can be used in existing image applications, but it also shows the potential for a wider range of application as a simple yet effective image-based search system that can be used in various internet environments. This system could provide more meaningful search results based on the shape of images compared to search systems based on text where users have to explain what they are searching for. In addition, this system can be commercially applied in the mobile industry or the internet business sector, which implies that it has the potential for a wider range of applications. The algorithm for the search system suggested in this paper searches for emoticons that are relatively unstructured in comparison to existing multimedia data, with the end goal of allowing users to easily find information through images.

The suggested search algorithm does not carry out its search based on a single piece of information but instead accurately carries out searches by designating symbols and color information to data. Currently, the search results are derived from pattern matching emoticon data, but in the future the system will see an increase in its usage and be utilized in various search environments. Extensive research can also be expected to be carried out regarding multi pattern matching search systems.

6. Acknowledgments

Funding for this paper was provided by Namseoul University.

7. References

1. Choi S-P. Scale Invariant Feature Transform (SIFT). KIST; 2014. p. 1–21.
2. Bay H, Tuytelaars T, Gool LV. Surf: Speeded up robust features in Computer Vision. ECCV. 2006; 3951:404–17.
3. Park G, Song G, Park H. Parallel processing and performance analysis of modified wu–manber algorithm for multi–pattern matching. KIISE. 2011; 38(2):320–1.
4. Ojala T, Pietikainen M, Maenpaa T. Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. IEEE; 2002. p. 973–4.
5. Parthasarathy S, Sankaran P. An automated multi Scale Retinex with Color Restoration for image enhancement. IEEE National Conference on Communications (NCC); 2012.
6. ur Rahman Z, Jobson DJ, Woodell GA. Multi-scale retinex for color image enhancement. Proceedings International Conference on Image Processing. 1996; 3.
7. Xin LB, Seo L, Na W, Roh CB. Multimedia search system in a distributed computing environment. KKIST; 2013. p. 43–8.
8. Roh CB, Hong SR, Na WS. Cloud network system determining the optimal transmission power and modulation level. JIST; 2014. p. 94–102.
9. Sun Z, Wang C, Zhang L, Zhang L. Query-Adaptive Shape Topic Mining for Hand-Drawn Sketch Recognition. ACM Multimedia; 2012. p. 519–28.
10. Kim K, Kang D. Smartphone Protection Technology in Open Mobile Environment (wirtten in Korean) in Journal of Information Protection. 2009; 19(5):21–8.
11. Hoppe H. Progressive meshes. Proceedings of the 23rd annual conference on Computer graphics and interactive techniques. ACM; 1996.
12. Yang J, Parekh R, Honavar V, Dobbs D. Data-driven theory refinement algorithms for bioinformatics. IJCNN '99, International Joint Conference on Neural Networks. 1999; 6:4064–8.
13. Chen WJ, Brown DG. Optimistic bias in the assessment of high dimensional classifiers with a limited dataset. The 2011 International Joint Conference on Neural Networks (IJCNN); 2011. p. 2698–703.
14. Dietz JLG, Hoogervorst JAP. The Principles of Enterprise Engineering, Advances in Enterprise Engineering VI. Lecture Notes in Business Information Processing. 2012; 110:15–30.
15. Pluim JPW, Antoine Maintz JB, Viergever MA. Interpolation Artefacts in Mutual Information-Based Image Registration. Computer Vision and Image Understanding. 2000; 77:211–32.
16. Wang Y, Liang X, Flener C, Kukko A, Kaartinen H, Kurkela M, Vaaja M, Hyyppa H, Alho P. 3D Modeling of coarse fluvial sediments based on mobile laser scanning data. Remote Sensing. 2013; 5:4571–92.
17. Wang Y, Wang G. Integrated registration of range images from terrestrial LiDAR. The International Archives of the Photogrammetry. Remote Sensing and Spatial Information Sciences. 2008; 37(B3b):361–6.
18. Kim DM, Park JK. Inclination Analysis of Structure using Terrestrial LiDAR Data. Journal of Nect Generation Information Technology. 2013; 4(8):463–9.