https://doi.org/10.36719/2789-6919/43/135-139

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A Method of Comparison by Identifying the Curves of Images

Abstract

The research work is devoted to the comparison of pictures taken at different times. As a comparison method, it is proposed to identify objects from images as curves and compare the parameters characteristic of curves. As a comparison parameter, the length of the curves and their curvatures at different points are chosen. Objects from pre-taken images are identified as curves by B-Spline model, selected comparison parameters are found and stored in txt files. The parameters detected from the captured images are then compared with the stored values. The algorithm mainly designed for the comparison of UAV images is simulated in the Python programming language, and an algorithm for the identification of winding roads as curves based on the images is developed. OpenCV, SciPy, NumPy libraries are used for this.

The proposed algorithm can be used to identify various objects, parts, and curves from images. Although the UAV is mainly designed for navigation by comparison of images, it is possible to apply it to issues such as face recognition, area monitoring, and comparison of medical images.

Keywords: *image comparison, curve detection, object detection, identification, image processing*

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Şəkillərin əyriləri identifikasiya etməklə müqayisə edilməsi üsulu

Xülasə

Tədqiqat işi müxtəlif vaxtlarda çəkilmiş şəkillərin müqayisəsinə həsr olunmuşdur. Müqayisə metodu kimi obyektlərin şəkillərdən əyri kimi identifikasiyası və əyrilərə xas olan parametrlərin müqayisə edilməsi təklif olunur. Müqayisə parametri kimi əyrilərin uzunluğu və onların müxtəlif nöqtələrdə əyrilikləri seçilir. Əvvəlcədən çəkilmiş şəkillərdən obyektlər B-Spline modeli vasitəsilə əyri kimi identifikasiya edilir, seçilmiş müqayisə parametrləri tapılaraq .txt fayllarında saxlanılır. Daha sonra əldə edilən şəkillərdən aşkar olunan parametrlər saxlanılan dəyərlərlə müqayisə edilir.

Əsasən PUA (pilotsuz uçuş aparatı) şəkillərinin müqayisəsi üçün nəzərdə tutulan bu alqoritm Python proqramlaşdırma dilində modelləşdirilmiş və şəkillər əsasında dolanbac yolların əyri kimi identifikasiyası üçün alqoritm hazırlanmışdır. Bunun üçün OpenCV, SciPy, NumPy kitabxanalarından istifadə edilmişdir.

Təklif olunan alqoritm müxtəlif obyektlərin, hissələrin və əyrilərin şəkillərdən identifikasiyası üçün istifadə oluna bilər. PUA əsasən şəkillərin müqayisəsi yolu ilə naviqasiya üçün nəzərdə tutulsa da, onu üz tanıma, ərazi müşahidəsi və tibbi görüntülərin müqayisəsi kimi məsələlərə də tətbiq etmək mümkündür.

Açar sözlər: *şəkil müqayisəsi, əyri aşkarlama, obyekt aşkarlama, identifikasiya, şəkil emalı*

Introduction

Analysis and comparison of images taken at different times allows monitoring the area, studying the changes that have occurred, as well as determining whether the images belong to the same area or not. Image comparison can be applied to facial recognition, medical imaging, and duplicate image detection. There are different approaches to comparing images depending on the problem statement.

One approach to comparing images is to compare their histograms (Reinhard, 2014, p.382). Histograms are graphs based on RGB color distributions of image pixels. By comparing the histograms focusing on the pixels of two given images and their colors, it is evaluated whether the pixels of the images are the same based on their color distribution.

Other methods for image comparison are feature-based methods such as SIFT, ORB, and SURF. These methods are based on the detection and comparison of key points and descriptors from images, and show invariance to operations such as scaling and rotation (Bansal, Kumar, Kumar, 2021).

Another approach to image comparison is deep learning-based methods. In (Zhao, He, Wu, Wang, Dai, Yang, Lei, 2018) extracts features from images using a Convolutional Neural Network (CNN) and compares the feature vectors using a similarity metric.

MSE (Mahesh, Sanjeev, 2024; Timothy, Thomas, Sydney, 2021), PSNR (Keleş, Yılmaz, Tekalp, Korkmaz, Doğan, 2021) methods treat images as arrays of pixel values and compare based on the difference between pixels. Unlike the MSE and PSNR methods, the structural similarity index (SSIM) (Anil, Krupanshu, Sunil, Geeta, 2014; Mahesh, Sanjeev, 2024) method evaluates the structural similarity between two images by taking into account the brightness, contrast and structure of the images, not just the pixels.

One approach to image comparison is extracting and comparing different shapes from images. Shapes mean straight lines, curves, circles, etc. from pictures. Selected parameters of these forms can be selected as benchmarks to be compared. In this case, it is possible to identify the objects from the images in the form of selected forms and compare those forms. Based on this approach, in (Pashayev, Goyushova, Melikov, 2024) it was proposed to identify roads in the form of broken straight lines from images and to compare the ratios of the lengths of the straight line segments that make up the broken straight line. In another research study based on this logic (Goyushova, 2024), a method of finding straight lines from images and comparing the α and d parameters of these straight lines in the parametric coordinate system and comparing them with the corresponding parameters in other images was proposed.

This research work is dedicated to the identification of roads as curves (splines) from the images and the comparison based on the selected parameters of the curves.

Research

Methodology. The proposed approach for image comparison is to detect selected parameters from the currently acquired image by comparing those parameters with the corresponding parameters of other previously acquired images. Selected parameters of previously obtained images are detected and a base consisting of these parameters is formed. We can call templates such parameters base. In order to create templates, it is intended to find curves from the images and save the features corresponding to them, so that later the same parameter selected from the acquired image can be detected and compared. Thus, instead of comparing the entire image pixel by pixel or color distributions, a method of comparing only selected parameters is proposed.

Dataset and Preprocessing. Experiments for image comparison are conducted on images acquired through the Google Earth platform and tools from libraries such as OpenCV, NumPy and SciPy are used in the Python programming language. An image example of "Aghsu Pass" located in Azerbaijan, taken from Google Earth, is given in Figure 1a. Image processing steps are performed on the original images to simplify feature detection and comparisons. Performing such steps has the effect of simplifying work on images, removing unnecessary pixels and speeding up work. From the processing steps, transition from color image to gray image, image smoothing, edge line detection steps were applied on the images.

Color information is stored in 3 channels: red, green, blue (R, G, B) for each pixel of the color images. Each pixel is represented by 3 values ranging from 0 to 255 per color channel. In grayscale

images (Reinhard, 2014, p.31), a value from 0 to 255 is obtained for the color of each pixel. The result of the step is shown in Figure 1b.

Applying blurring steps on grayscale images helps to eliminate noises and deviations in the images. The result obtained by applying the Gaussian Blurring algorithm (Reinhard, 2014, p.56) is given in Figure 2(a).

Using the Canny algorithm to find edges on smoothed images, the images are brought to black-white binary form (Reinhard, 2014, p.64). By detecting the edges, the edges of the objects in the image are found, and the remaining pixels are discarded as unnecessary, i.e., they become white. The result of the step is given in Figure 2(b).

Figure 1. Initial image from Google Erath (a), Grayscale image (b).

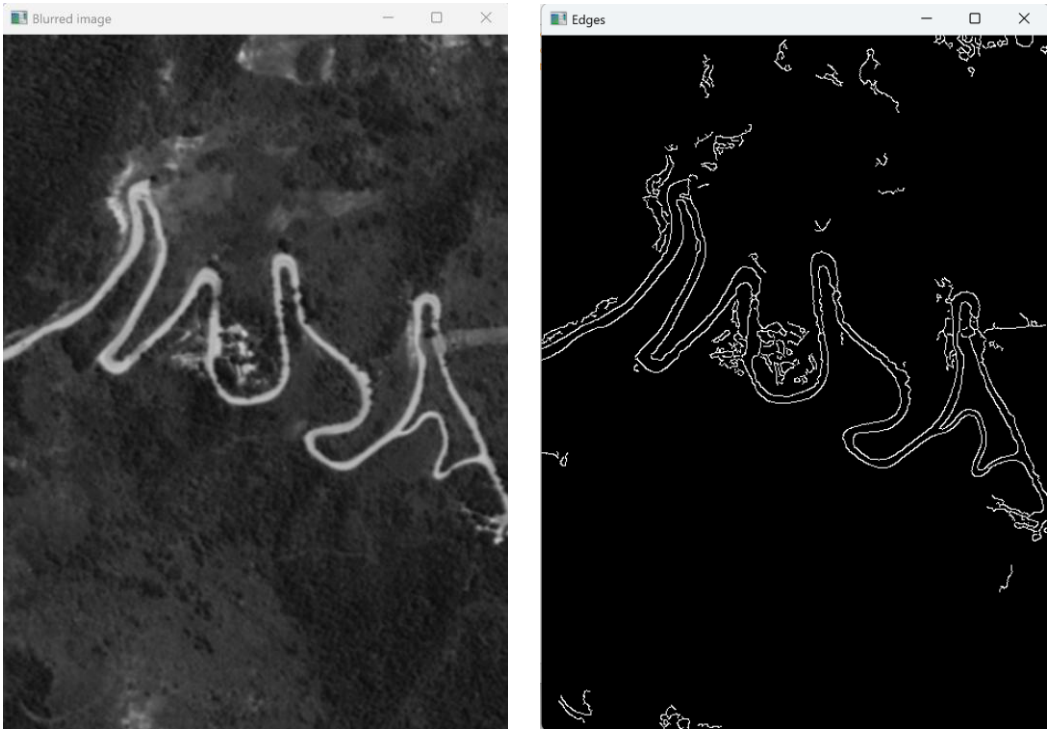

Figure 2. Blurring image (a) , after Canny edge detect step (b)

Detection of curves. After applying the Canny algorithm for edge detection on images, the contours of the edges are found. Contours represent continuous curves that describe objects in an image. To extract them, the find Contours() function in OpenCV is used. Each detected contour consists of a series of points along the boundary. To fit a smooth curve, we need to make sure that the contour has enough control points. Control points are the points required to draw splines, and their number can vary depending on the type of spline. By increasing the number of control points, the curve can be made smoother. B-Spline interpolation (Prautzsch, Boehm, Paluszny, 2002, p.60) is chosen to fit the curves to the detected contours. An illustration of the curve fitted to the detected contours using the splprep() and splev() functions of the SciPy library is given in Figure 3.

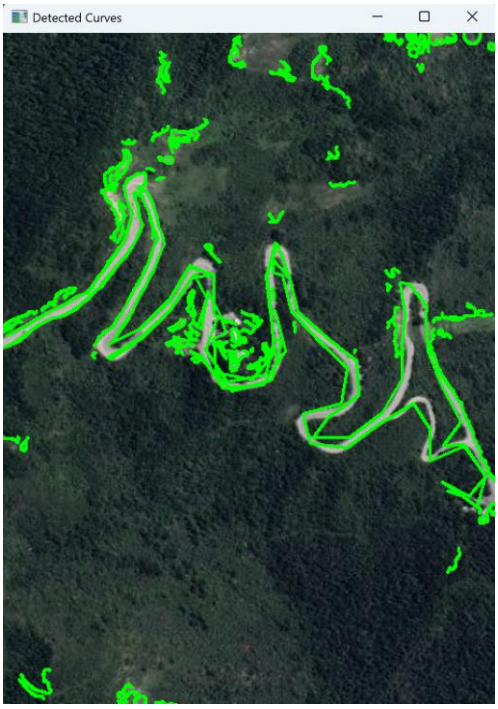

Figure 3. Description of the detected curve from the image

Results and discussion. The splprep() and splev() functions of the SciPy library are used to detect curves from images. These functions detect found contours by fitting them to a B-spline model. Although there are various types of interpolation for the detection of curves, the B-spline model is chosen because it shows invariance to the displacements of the control points. B-spline does not depend on control points. B-spline has local control unlike other curve identification methods. Thus, the curve is divided into several segments, and the displacement of any control point affects only the segment in which the point is included.

By identifying objects from images, detours as curves, the comparison of images is brought to the comparison of curves, more precisely, to the comparison of selected parameters of curves. One or more parameters specific to the curves can be selected for comparison. As such parameters, the coordinates of the control points of the curves, the length of the curves, the curvature values (bends at different points), the lengths of the individual segments of the curve and the angles between the segments, etc. can be selected. In order to compare the two images based on the curves, in the study, the bending values at different points and total lengths of the curves are extracted as features from the images. Each detected curve is compared with each curve in the other image according to the calculated parameters.

Features are detected and stored from images previously acquired by Google Earth or other methods. Then, the parameter selected from the image obtained at the current time is detected and compared with the stored values.

Conclusion

In this research work, the identification of roads in the form of curves from the images and the comparison of these curves based on the selected parameters are carried out. B-Spline interpolation is used for the detection of curves, and parameters such as their lengths and curvatures are taken as the main criteria for comparing the obtained curve models.

The proposed approach can be an effective method for the analysis of the winding structure of roads and the comparison of images of the same area. Unlike traditional pixel-based comparison methods, this approach enables more efficient and optimized data analysis by comparing only selected structural elements.

The proposed algorithm and built software for image comparison can be applied to medical image comparison, face recognition, UAV autonomous navigation, etc.

References

1. Anil, W., Krupanshu, S., Sunil, W., Geeta, S. (2014). SSIM Technique for Comparison of Images. *International Journal of Innovative Research in Science, Engineering and Technology*, 3(9), 16281-16286. Doi:10.15680/IJIRSET.2014.0309068.
2. Bansal, M., Kumar, M., Kumar, M. (2021). 2D object recognition: a comparative analysis of SIFT, SURF and ORB feature descriptors. *Multimedia Tools and Applications,* 80 (12), 18839–18857. Doi:10.1007/s11042-021-10646-0
3. Goyushova, U. (2024). Determining the location of a moving device based on video images. *Informatics and Control Problems,* 44(2), 51-57. Doi: 10.54381/icp.2024.2.06
4. Keleş, O., Yılmaz, M.A., Tekalp, A.M., Korkmaz, C., Doğan, Z. (2021). On the Computation of PSNR for a Set of Images or Video. *In 2021 Picture Coding Symposium (PCS),* 1-5, IEEE.
5. Mahesh, C., Sanjeev, J. (2024). Improved Quality Measurement of Multicamera Image for Possible Distortions. *IOSR Journal of VLSI and Signal processing*. 5(5), 66-75.
6. Pashayev, A., Goyushova, U., Melikov, S. (2024). On the road identification method from images. *Proceedings of 2nd International Conference on Information Technologies and Their Applications,* Part 3., 1-12.
7. Prautzsch, H., Boehm, W., Paluszny, M. (2002). *B´ezier and B-spline techniques.* Springer.
8. Reinhard, K. (2014). *Concise Computer Vision: An Introduction into Theory and Algorithms.* London: Springer.
9. Timothy, H., Thomas, O., Sydney, F. (2021). Mean Squared Error. *Deconstructed. Journal of Advances in Modeling Earth Systems,* 13(12). Doi: 10.1029/2021MS002681
10. Zhao, K., He, T., Wu, S., Wang, S., Dai, B., Yang, Q., Lei, Y. (2018). Application research of image recognition technology based on CNN in image location of environmental monitoring UAV. *Journal on Image and Video Processing,* 150, 1-11. Doi: 10.1186/s13640-018-0391-6

Received: 06.12.2024
Accepted: 17.03.2025