



GRID  
2022

11. INTERNATIONAL SYMPOSIUM  
GRAPHIC ENGINEERING AND DESIGN  
03-05. NOVEMBER 2022



# Number plate recognition using template matching technique

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## Introduction



The leading factor for the development of digital image processing in the last few decades is the need to extract information from images and interpret certain content from images. There is a necessity to create a system capable of providing information based on digital images that are used especially in the field of license plate recognition. The main goal of this paper is to present automated license plate extraction and character recognition that are subsequently written into a text file. The characters on license plates, easily readable by humans but not by algorithms, are typically used to identify vehicles uniquely. License plate recognition technology works based on converting image data from the camera into a character format that enables further processing in a specific application area. In this paper, the emphasis is on the recognition of the characters of license plates in the Republic of Serbia. The proposed methodology is presented, textually described, and visually presented with a real example. After a thorough review and testing of the proposed methodology, the observed limitations were addressed, and at the end, based on the presented and analyzed work, the conclusion was drawn along with directions for future work and improvement are provided.

## Problem Description



Systems using image processing techniques may be affected by camera resolution, low visibility, and environmental and weather factors while recognizing objects. Therefore, there is a necessity to create a system for providing user-relevant information based on digital images that are used as input in different methodologies, especially in the field of license plate recognition.

## Methods



The algorithm for extracting license plate features implemented in this paper requires an input image, followed by image preprocessing operations, localization of the position of the plate in the image, as well as segmentation of the identified plate. The aforementioned phases are followed by the segmentation of special characters that are subsequently read with the help of optical character recognition, while at the end of the process, it prints the output of the process - the registration number written in a text file. A visual representation of the phases of the proposed methodology is shown in Figure 1.



Figure 1  
Phases of the proposed methodology

## Results



The first step in the proposed methodology is providing an input image that serves as the basis for further steps. The input image may have light or dark image tones, low contrast images, blurred images, or noisy images. The main goal of preprocessing is to improve the contrast of the input image, reduce the noise in the image and minimize the image processing time. A color image is converted to a greyscale image before image processing, and after noise removal and contrast adjustment, the image is converted to a binary image. Adjusting the image contrast is the next phase, and contrast is defined as the difference between the lowest and highest intensity levels. The contrast of the greyscale image is transformed using adaptive histogram equalization. The following phase includes edge detection. The next step as one of the fundamental techniques for removing unnecessary elements from a binary image is erosion. Figure 2 shows a concrete example of the application of the mentioned steps on the input image.

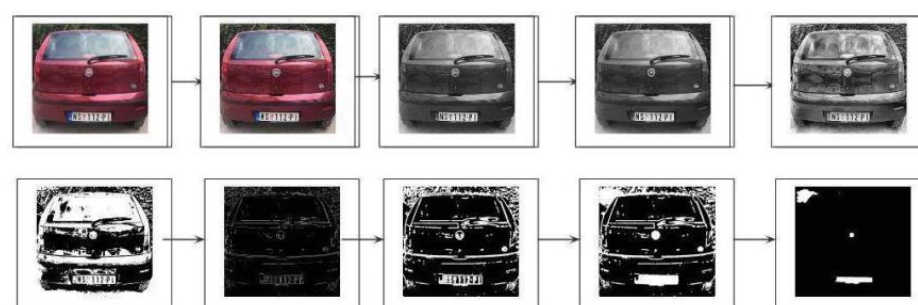


Figure 2  
Image preprocessing

The result of the previous series of steps and the result and output from the methodology give the value of the license plate that is written to the text file, which can then be saved for further manipulation of the data.

The methodology will be presented to the end user in a graphical representation that was created with within the MATLAB. An interface that requires an image as input and converts it into a textual format using the previously mentioned image processing methods has been designed to facilitate the usage of the methodology. The end user just receives the final outcome of the methodology in a form of textual file, while the phases of image processing are not displayed within the GUI in order to retain transparency. A simple layout of the developed GUI application is presented in Figure 3.

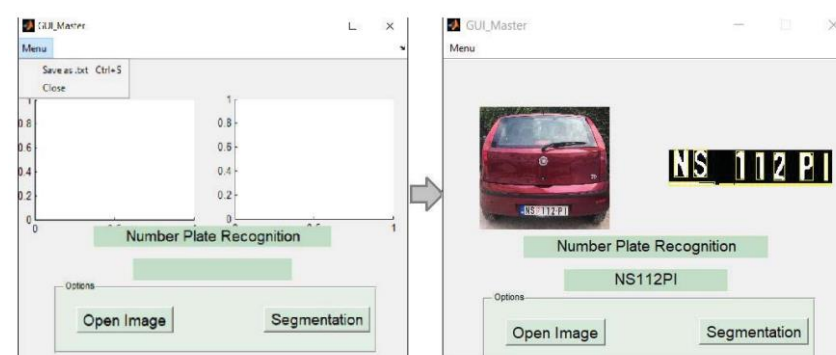


Figure 3  
Graphical user interface

## Discussion / Conclusion



Based on testing phase, it can be concluded that the segmentation step was adequately performed in most examples, as well as the segmentation of all individual characters and the creation of sub-images. However, difficulties arise at the last step - character recognition, where the search for the highest level of correlation occurs, in some cases lead to the mismatch of letter and number characters as well as between letters. Due to the use of the application, it was established that certain numbers and letters are mixed up, specifically "O" and "0" or "B" and "8" or "6". A potential solution that arises is to define specific positions of letters and numbers within the license plate. If the license plates of the Republic of Serbia are observed, a template can be created by defining in which positions either a letter or a number can occur.

The difficulty that occurs when reading the characters of license plates from the Republic of Serbia is also mixing the letter "C" with "Č" or "Ć" in conditions of poor visibility or low image quality. Also for letter designations "Z" with "Ž" and "S" with "Š", however, by applying a series of operations to improve image quality and correct the imaging angle, these difficulties could be overcome.

The importance of license plate recognition systems integrated with optical character recognition techniques, is influenced by the need to minimize the human element in this process, achieve a higher level of vehicle access control in a particular area, for example in parking billing solutions, and automatically determine how much time vehicle has spent in certain area and charges that are needed to be paid after the use of specific services.

Based on the aforementioned potential fields of use, this methodology offers a broad spectrum of applications, and future research will be concentrated on enhancing it. The direction of future development can be focused on the elimination of the limitation of optical character recognition, which is reflected in the mixing of letter and number marks within the license plates of the Republic of Serbia.

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