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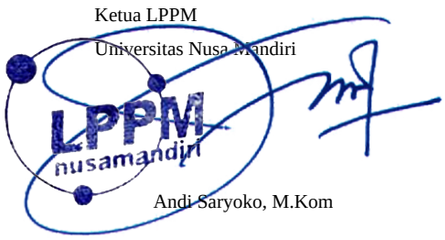

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IMPLEMENTATION OF IMAGE PROCESSING IN THE RECOGNITION OF OFFICIAL VEHICLE LICENSE PLATES

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Abstract— *Vehicle license plates are identifiers used to uniquely identify vehicles. However, to identify vehicle license plates there are several problems encountered, namely the different formats of vehicle license plates that make license plate recognition more complicated, vehicle license plates often contain visually similar combinations of letters and numbers (for example the letter "O" and the number "0" or the letter "I" and the number "1"), . in poor lighting conditions license plates may not be clearly visible. To solve this problem, image recognition, image processing, and pattern recognition technologies can be used. The three technologies can be used to recognize characters on vehicle license plates, but cannot yet be used to recognize the colors contained on vehicle license plates. The purpose of this research is to identify and record vehicle license plate numbers quickly and accurately, monitor the presence of vehicles in a supervised area, assist in managing parking, reduce the need for human interaction in the vehicle identification process, The methods used to recognize motor vehicle plates are edge detection and character segmentation which involves image processing to detect the edges of the vehicle plate, followed by segmentation of individual characters in the plate. Another method used is optical character recognition which involves using an optical sensor to take an image of a vehicle plate, then using character recognition techniques to identify the numbers and letters on the plate. The result of this research is that the motor vehicle number recognition system can work in various lighting conditions and poor weather conditions and can monitor and control vehicles in the parking area. The finding obtained from this research is that no method has been used for color recognition on motor vehicle plates.*

Keywords*: vehicle license plate, image processing, vehicle identification.*

Intisari— *Plat kendaraan merupakan tanda pengenal yang digunakan untuk mengidentifikasi kendaraan secara unik. Namun untuk mengidentifikasi plat kendaraan terdapat beberapa permasalahan yang dihadapi, yaitu format plat nomor kendaraan yang berbeda sehingga membuat pengenalan plat nomor menjadi lebih rumit, plat nomor kendaraan seringkali mengandung kombinasi huruf dan angka yang mirip secara visual (misalnya huruf "O" dan angka "0" atau huruf "I" dan angka "1"), . dalam kondisi pencahayaan yang buruk plat nomor mungkin tidak terlihat dengan jelas. Untuk mengatasi permasalahan ini dapat digunakan teknologi pengenalan citra, pengolahan citra, dan pengenalan pola. Ketiga teknologi dapat digunakan untuk mengenali karakter pada plat nomor kendaraan, tapi belum dapat digunakan untuk mengenali warna yang terdapat pada plat nomor kendaraan. Tujuan dari penelitian ini adalah untuk mengidentifikasi dan mencatat nomor plat kendaraan dengan cepat dan akurat, memantau kehadiran kendaraan di area yang diawasi, membantu dalam mengelola parkir, mengurangi kebutuhan akan interaksi manusia dalam proses identifikasi kendaraan, Adapun metode yang digunakan untuk mengenali plat kendaraan bermotor adalah deteksi tepi dan segmentasi karakter yang melibatkan proses pengolahan citra untuk mendeteksi tepi plat kendaraan, diikuti oleh segmentasi karakter individu dalam plat. Metode lain yang digunakan adalah pengenalan optik karakter yang melibatkan penggunaan sensor optik untuk mengambil gambar plat kendaraan, kemudian menggunakan teknik pengenalan karakter untuk mengidentifikasi angka dan huruf pada plat tersebut. Hasil dari penelitian ini adalah sistem pengenalan nomor kendaraan bermotor dapat bekerja dalam berbagai kondisi pencahayaan dan kondisi cuaca yang buruk serta dapat mengawasi dan mengontrol kendaraan di area parkir. Temuan yang diperoleh dari penelitian ini adalah belum digunakannya metode untuk pengenalan warna pada plat kendaraan bermotor.*

Kata Kunci*: plat kendaraan, pengolahan citra, identifikasi kendaraan.*

INTRODUCTION

The rapid development of computer technology is very helpful for humans to complete their work quickly and efficiently [1]. Various applications of computer technology advances can be seen from all areas of life [2], both applications at home, in the office, in special places, indoors and outdoors. The utilization of this technology is also used to anticipate the limited human ability to process data manually [3] when associated with the speed and accuracy produced.

One of the developments in computer technology is image processing [4], which is a field of science related to digital image processing technology [4] and pattern recognition [5]. This technology can help human work in recognizing motor vehicle numbers [6].

A motor vehicle number is a series of letters and numbers [7] used to identify a particular vehicle. This number is usually printed on the vehicle's license plate and attached to the front and rear of the vehicle for easy identification by authorities, as well as for administrative purposes such as taxes and vehicle registration.

Different countries have different vehicle numbering systems [8], and there are often differences between states or provinces within a country [9]. These numbering systems usually include a combination of letters and numbers, and may also include certain symbols or colors [10] that indicate specific information about the vehicle [11].

Motor vehicle number recognition is important in many ways [12], including law enforcement and road safety, as well as for easy identification of vehicles involved in accidents or criminal acts. Therefore, it is important to understand the vehicle numbering system used in a particular country or region, and always ensure that the vehicle number is always attached and easily visible.

Motor vehicle number recognition can be done with image processing techniques [1], which is a field of science related to digital image processing technology and pattern recognition. The goal is to retrieve information from images of vehicles and license plates, and identify that information in a format that can be understood by computers or humans[13].

With image processing technology, motor vehicle number recognition can be done quickly and efficiently [14]. The system will obtain information from vehicle images and license plates and can identify the information in a format that can be understood by computers or humans. The image processing process starts with image acquisition from a camera or sensor, then the image is processed with image processing techniques such as filters [15], segmentation, edge detection, and pattern matching. After the license plate information is identified, the motor vehicle number recognition system then processes the information with pattern recognition techniques [15]. The results of the motor vehicle number recognition system can be utilized for traffic surveillance, parking management, security, and toll collection [16].

MATERIALS AND METHODS

This research design uses image processing that will process two-dimensional images through digital processes. Data sources are obtained from official vehicle license plates at the Ministry of Defense of the Republic of Indonesia which are centrally regulated, have standards, normalization, uniform shapes and colors and contain registration codes for each and type of vehicle. The data collection technique uses optical character recognition, to identify the letter image to be converted into a writing file. Data analysis utilizes template matching which will compare the input image with the template image in the database until it produces a large match value. A large matching value indicates that the template is the most suitable template image for the input image.

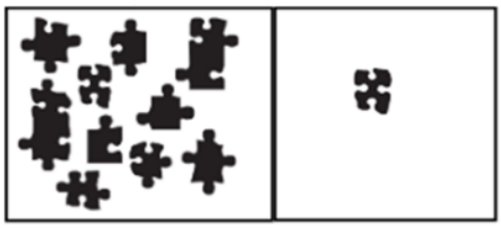

Figure 1. Illustration of Template Matching

In the figure above, the left part is an input image containing the same object as the database template image on the right. The template is positioned on the image to be compared and the degree of conformity of the pattern in the input image with the pattern in the database template image is calculated.

Image processing techniques can be effectively employed for license plate recognition in official vehicle identification systems [17]. Here's an outline of the steps involved in implementing image processing for license plate recognition:

1. Image Acquisition: Obtain an image of the vehicle with a visible license plate using a camera or any other imaging device.
2. Preprocessing: Apply various preprocessing techniques to enhance the quality of the acquired image. Common preprocessing steps

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include image resizing, noise removal, and contrast enhancement [18].

3. License Plate Localization: Use image processing algorithms to locate the region in the image that contains the license plate. This step often involves techniques like edge detection, thresholding, or template matching to identify potential license plate regions [19].
4. Character Segmentation: Once the license plate region is identified, segment individual characters or symbols from the plate. This process can be achieved using techniques like connected component analysis, morphological operations, or contour detection [20].
5. Character Recognition: Employ optical character recognition (OCR) algorithms to recognize the segmented characters. OCR algorithms analyze the pixel values and shapes of the characters to identify the corresponding alphanumeric characters [21]. Machine learning techniques like neural networks or support vector machines can be utilized for more accurate character recognition [22].
6. Post-processing: Apply post-processing techniques to refine the recognized characters and remove any errors or inconsistencies [23]. This can involve methods such as error correction, character verification, or dictionary-based validation [24].
7. Output and Integration: Finally, present the recognized license plate information as output. This can include the extracted alphanumeric characters or any additional metadata associated with the license plate. Integration with a larger system, such as a database or a real-time monitoring system, may be required depending on the specific application.

It's important to note that the implementation details may vary depending on the specific requirements and constraints of the system [25]. The choice of image processing techniques and algorithms will depend on factors like image quality, lighting conditions, and the complexity of license plate designs in the target region [26].

RESULTS AND DISCUSSION

In general, the vehicle license plate recognition system consists of several stages, namely:

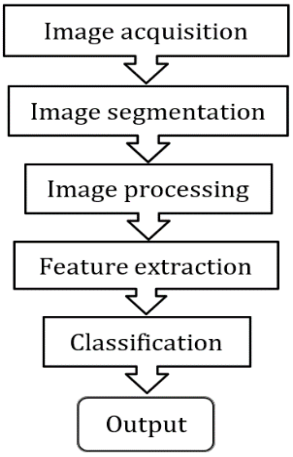

Figure 2 General processes of number plate recognition system

1. Image acquisition: The system takes an image of the vehicle license plate using a digital camera.
2. Image segmentation: The captured image is then processed to separate the license plate part from the original image.
3. Image processing: The segmented image is processed to remove noise and improve image quality.
4. Feature extraction: At this stage, the system extracts important features from the license plate image such as pattern, color, and shape.
5. Classification: After the features are extracted, the system classifies the license plate image into appropriate categories such as vehicle type or registration region.
6. Output: The result of license plate recognition is displayed in the form of human-readable text or numbers.

The license plate of the Ministry of Defense official vehicle is a metal plate containing the logo of the Ministry of Defense of the Republic of Indonesia, writing the vehicle registration number with basic color variations. The digits of the registration number are the numbers of the registration number and the numbers of the work unit identification.

Figure 3 Ministry of Defense of the Republic of Indonesia Service Vehicle Number Format

The vehicle license plate format is used by military service vehicles, ranging from two-wheeled service vehicles, four or more wheeled service vehicles to combat vehicles such as tanks [27].

Implementation of flowchart diagram design that includes input, process and output

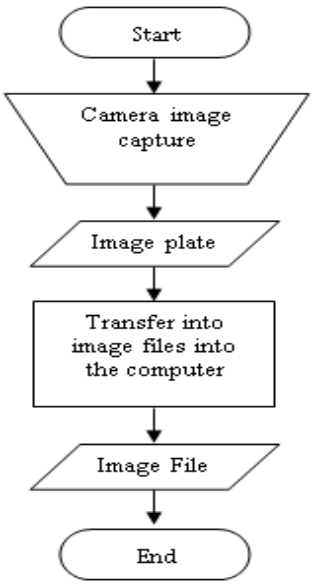

Figure 4. Input Flowchart

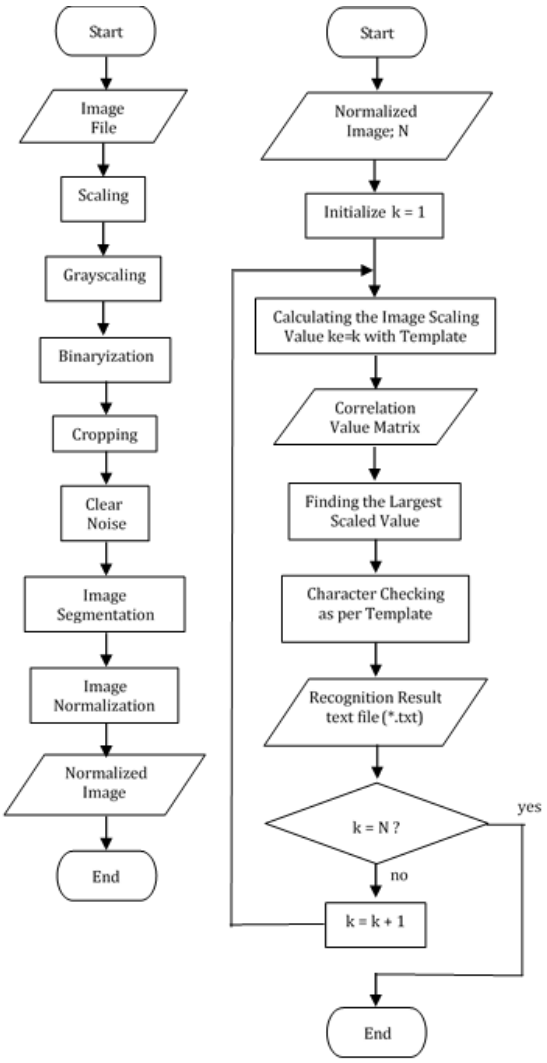

Figure 5. Process Flowchart

Algorithm design:

1. Character templating
   An initial process where certain characters are created that will be used as a comparison to the characters to be matched and then placed into the template. The images consisting of the reference characters are organized into a matrix of a certain size (42 x 24 pixels).
   Pseudocode:
   Matrix (42 x 24)
   save as template
2. Pre-processing
   Several parts of the process are carried out to prepare the original image so that it is ready to be forwarded to the template matching stage. Processing includes scaling, cropping, gray scale, binarization, cleaning the image from noise, segmentation and normalization.
   Pseudocode:
   Call image.
   resize image to 150xNaN size
   cropping image
   image grayscaling
   binaryization with threshold values (0.62, 0.72, and 0.82)
   cleaning noise below 80 pixels
3. Segmentation and Normalization
   This segmentation process aims to group the object pixels of the region that represents an object. This makes the boundary between the object and the background clear. The background is white and the object pixels are black. The intersection of white and black pixels is modeled as a line.
   Normalization aims to adjust the input image data with the image data in the database (template image). At this stage, a scaling process is carried out on the image so that the image has a fixed resolution, the image is scaled so that it has a resolution of 42 x 24 pixels.
   Pseudocode:
   Image segmentation
   template space preparation
   image normalization to 42 x 24
   template space blanking
4. Template Matching Correlation
   The normalized images are counted and the correlation value is calculated. Processed by calling sequentially starting from the first order image called initialization. Then the correlation value between the initialization image and all template images is compared, the largest correlation value (closest to the template image) then the image is considered a match and then printed as the character in question.
   Pseudocode:
   Normalized image = n
   initialization k=1

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calculate correlation value
find the largest correlation value
printing the recognition result to *.txt
check the number of k = n
if k ≠ n, k = k + 1, calculate the correlation value again
if k = n, finish

5. Display Result
This process displays the results with a notepad display.
Pseudocode:
Calling notepad

Software Architecture:

Establishment of character recognition application on vehicle license plates with three parts of the process: input → process → output.

1. Input
A glimpse of the appearance of the input section coding:

```
%--------------------------------------
% MAIN PROGRAM
warning off %#ok<WNOFF>
%bersihkan semua dan tutup
clc, close all, clear all
%memasukkan citra
imagen=imread('citra\2.jpg');
%tampilkan citra awal
imagen1 = imagen;
figure,imshow(imagen1);
title('Citra Input dengan Derau')
pause(1)
```

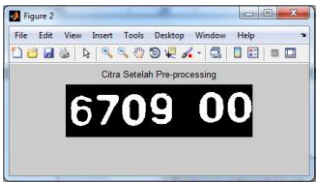
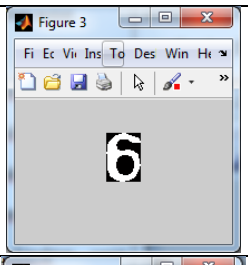
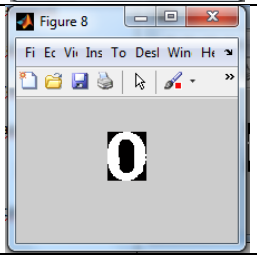
2. Process
A quick look at the coding of the process section:

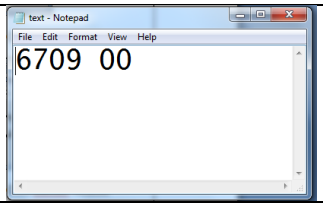
```
%tahapan pre-processing-------------------
imagen=imresize(imagen, [150 NaN]);
gray=rgb2gray(imagen);
bin=im2bw(gray,0.72);
imagen= imcrop(bin,[138 35 270 75]);

% Bersihkan pixels citra dibawah 80 pixels
imagen = bwareaopen(imagen,80);
imagen3 = imagen;
figure,imshow(imagen3);
title('Citra Setelah Pre-processing')
pause(1)

%tahapan Segmentasi----------------------
%jalankan fungsi lines_crop ------------
function [fl re]=lines_crop(im_texto)
im_texto=clip(im_texto);
num_filas=size(im_texto,1);
for s=1:num_filas
    if sum(im_texto(s,:))==0
        nm=im_texto(1:s-1, :); % Matriks
baris pertama
        rm=im_texto(s:end, :);% Matriks
sisa baris
        fl = clip(nm);
        pause(1);
        re=clip(rm);
        break
    else
        fl=im_texto;%Hanya baris.
        re=[ ];
    end
end
%jalankan fungsi letter_crop ------------
function [fl re
space]=letter_crop(im_texto)
% Membagi huruf pada baris
im_texto=clip(im_texto);
num_filas=size(im_texto,2);
for s=1:num_filas
    s;
    sum_col = sum(im_texto(:,s));
    if sum_col==0
        k = 'true';
        nm=im_texto(:,1:s-1); % Matrik
dari huruf pertama
        %huruf pertama pada fungsi ini
        rm=im_texto(:,s:end);% Sisa baris
matriks
        %sisa huruf pada fungsi ini
        fl = clip(nm);
        %pause(1);
        re=clip(rm);
        space = size(rm,2)-size(re,2);
        break
    else
        fl=im_texto;%hanya baris.
        re=[ ];
        space = 0;
    end
end
```

3. Output
A glimpse of the appearance of the last part of the coding:

```
%Tampilkan file 'text.txt'
winopen('text.txt')
clear all
```

Table 1. User Interface

Stage Description	Image
The appearance of the input image with noise is then passed on for pre-processing.	
Pre-processed image, which has undergone scaling, grayscaling, binaryization, cropping and clear noise..	
The image in the first matrix row which is the result of Segmentation and Normalization.	
The next process is carried out until the image is at the last matrix, then it is forwarded to the recognition process.	

The recognition results are concluded by displaying the printed results in text form.	

CONCLUSION

From the results of the research and discussion that has been carried out, it can be concluded that at the test data stage, the percentage of license plate image recognition is 80% of the template matching method, so it can be concluded that in this case the template matching method has a fairly good recognition rate. Factors that affect the results of recognizing vehicle license plate images are the level of brightness, lack of accuracy when cutting images before being used as test data, and the position of the character image slope. In the character segmentation stage, almost all license plate images can be segmented well and have similarities with the original character image.

The author suggests that the next application uses a method that can recognize the color of the motor vehicle plate, so that the identity of the vehicle can be known in more detail and completely.

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IMPLEMENTATION OF IMAGE PROCESSING IN THE RECOGNITION OF OFFICIAL VEHICLE LICENSE PLATES

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IMPLEMENTATION OF IMAGE PROCESSING IN THE RECOGNITION OF OFFICIAL VEHICLE LICENSE PLATES

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Abstract— *Vehicle license plates are identifiers used to uniquely identify vehicles. However, to identify vehicle license plates there are several problems encountered, namely the different formats of vehicle license plates that make license plate recognition more complicated, vehicle license plates often contain visually similar combinations of letters and numbers (for example the letter "O" and the number "0" or the letter "I" and the number "1"), . in poor lighting conditions license plates may not be clearly visible. To solve this problem, image recognition, image processing, and pattern recognition technologies can be used. The three technologies can be used to recognize characters on vehicle license plates, but cannot yet be used to recognize the colors contained on vehicle license plates. The purpose of this research is to identify and record vehicle license plate numbers quickly and accurately, monitor the presence of vehicles in a supervised area, assist in managing parking, reduce the need for human interaction in the vehicle identification process, The methods used to recognize motor vehicle plates are edge detection and character segmentation which involves image processing to detect the edges of the vehicle plate, followed by segmentation of individual characters in the plate. Another method used is optical character recognition which involves using an optical sensor to take an image of a vehicle plate, then using character recognition techniques to identify the numbers and letters on the plate. The result of this research is that the motor vehicle number recognition system can work in various lighting conditions and poor weather conditions and can monitor and control vehicles in the parking area. The finding obtained from this research is that no method has been used for color recognition on motor vehicle plates.*

Keywords: *vehicle license plate, image processing, vehicle identification.*

Intisari— *Plat kendaraan merupakan tanda pengenal yang digunakan untuk mengidentifikasi kendaraan secara unik. Namun untuk mengidentifikasi plat kendaraan terdapat beberapa permasalahan yang dihadapi, yaitu format plat nomor kendaraan yang berbeda sehingga membuat pengenalan plat nomor menjadi lebih rumit, plat nomor kendaraan seringkali mengandung kombinasi huruf dan angka yang mirip secara visual (misalnya huruf "O" dan angka "0" atau huruf "I" dan angka "1"), . dalam kondisi pencahayaan yang buruk plat nomor mungkin tidak terlihat dengan jelas. Untuk mengatasi permasalahan ini dapat digunakan teknologi pengenalan citra, pengolahan citra, dan pengenalan pola. Ketiga teknologi dapat digunakan untuk mengenali karakter pada plat nomor kendaraan, tapi belum dapat digunakan untuk mengenali warna yang terdapat pada plat nomor kendaraan. Tujuan dari penelitian ini adalah untuk mengidentifikasi dan mencatat nomor plat kendaraan dengan cepat dan akurat, memantau kehadiran kendaraan di area yang diawasi, membantu dalam mengelola parkir, mengurangi kebutuhan akan interaksi manusia dalam proses identifikasi kendaraan, Adapun metode yang digunakan untuk mengenali plat kendaraan bermotor adalah deteksi tepi dan segmentasi karakter yang melibatkan proses pengolahan citra untuk mendeteksi tepi plat kendaraan, diikuti oleh segmentasi karakter individu dalam plat. Metode lain yang digunakan adalah pengenalan optik karakter yang melibatkan penggunaan sensor optik untuk mengambil gambar plat kendaraan, kemudian menggunakan teknik pengenalan karakter untuk mengidentifikasi angka dan huruf pada plat tersebut. Hasil dari penelitian ini adalah sistem pengenalan nomor kendaraan bermotor dapat bekerja dalam berbagai kondisi pencahayaan dan kondisi cuaca yang buruk serta dapat mengawasi dan mengontrol kendaraan di area parkir. Temuan yang diperoleh dari penelitian ini adalah belum digunakannya metode untuk pengenalan warna pada plat kendaraan bermotor.*

Kata Kunci: *plat kendaraan, pengolahan citra, identifikasi kendaraan.*

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INTRODUCTION

The rapid development of computer technology is very helpful for humans to complete their work quickly and efficiently [1]. Various applications of computer technology advances can be seen from all areas of life [2], both applications at home, in the office, in special places, indoors and outdoors. The utilization of this technology is also used to anticipate the limited human ability to process data manually [3] when associated with the speed and accuracy produced.

One of the developments in computer technology is image processing [4], which is a field of science related to digital image processing technology [4] and pattern recognition [5]. This technology can help human work in recognizing motor vehicle numbers [6].

A motor vehicle number is a series of letters and numbers [7] used to identify a particular vehicle. This number is usually printed on the vehicle's license plate and attached to the front and rear of the vehicle for easy identification by authorities, as well as for administrative purposes such as taxes and vehicle registration.

Different countries have different vehicle numbering systems [8], and there are often differences between states or provinces within a country [9]. These numbering systems usually include a combination of letters and numbers, and may also include certain symbols or colors [10] that indicate specific information about the vehicle [11].

Motor vehicle number recognition is important in many ways [12], including law enforcement and road safety, as well as for easy identification of vehicles involved in accidents or criminal acts. Therefore, it is important to understand the vehicle numbering system used in a particular country or region, and always ensure that the vehicle number is always attached and easily visible.

Motor vehicle number recognition can be done with image processing techniques [1], which is a field of science related to digital image processing technology and pattern recognition. The goal is to retrieve information from images of vehicles and license plates, and identify that information in a format that can be understood by computers or humans[13].

With image processing technology, motor vehicle number recognition can be done quickly and efficiently [14]. The system will obtain information from vehicle images and license plates and can identify the information in a format that can be understood by computers or humans. The image processing process starts with image acquisition from a camera or sensor, then the image is processed with image processing techniques such as filters [15], segmentation, edge detection, and pattern matching. After the license plate information is identified, the motor vehicle number recognition system then processes the information with pattern recognition techniques [15]. The results of the motor vehicle number recognition system can be utilized for traffic surveillance, parking management, security, and toll collection [16].

MATERIALS AND METHODS

This research design uses image processing that will process two-dimensional images through digital processes. Data sources are obtained from official vehicle license plates at the Ministry of Defense of the Republic of Indonesia which are centrally regulated, have standards, normalization, uniform shapes and colors and contain registration codes for each and type of vehicle. The data collection technique uses optical character recognition, to identify the letter image to be converted into a writing file. Data analysis utilizes template matching which will compare the input image with the template image in the database until it produces a large match value. A large matching value indicates that the template is the most suitable template image for the input image.

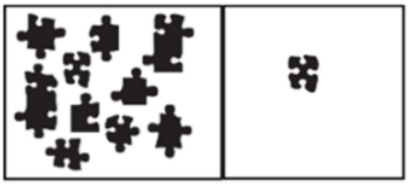

Figure 1. Illustration of Template Matching

In the figure above, the left part is an input image containing the same object as the database template image on the right. The template is positioned on the image to be compared and the degree of conformity of the pattern in the input image with the pattern in the database template image is calculated.

Image processing techniques can be effectively employed for license plate recognition in official vehicle identification systems [17]. Here's an outline of the steps involved in implementing image processing for license plate recognition:

1. Image Acquisition: Obtain an image of the vehicle with a visible license plate using a camera or any other imaging device.
2. Preprocessing: Apply various preprocessing techniques to enhance the quality of the acquired image. Common preprocessing steps

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include image resizing, noise removal, and contrast enhancement [18].

3. License Plate Localization: Use image processing algorithms to locate the region in the image that contains the license plate. This step often involves techniques like edge detection, thresholding, or template matching to identify potential license plate regions [19].
4. Character Segmentation: Once the license plate region is identified, segment individual characters or symbols from the plate. This process can be achieved using techniques like connected component analysis, morphological operations, or contour detection [20].
5. Character Recognition: Employ optical character recognition (OCR) algorithms to recognize the segmented characters. OCR algorithms analyze the pixel values and shapes of the characters to identify the corresponding alphanumeric characters [21]. Machine learning techniques like neural networks or support vector machines can be utilized for more accurate character recognition [22].
6. Post-processing: Apply post-processing techniques to refine the recognized characters and remove any errors or inconsistencies [23]. This can involve methods such as error correction, character verification, or dictionary-based validation [24].
7. Output and Integration: Finally, present the recognized license plate information as output. This can include the extracted alphanumeric characters or any additional metadata associated with the license plate. Integration with a larger system, such as a database or a real-time monitoring system, may be required depending on the specific application.

It's important to note that the implementation details may vary depending on the specific requirements and constraints of the system [25]. The choice of image processing techniques and algorithms will depend on factors like image quality, lighting conditions, and the complexity of license plate designs in the target region [26].

RESULTS AND DISCUSSION

In general, the vehicle license plate recognition system consists of several stages, namely:

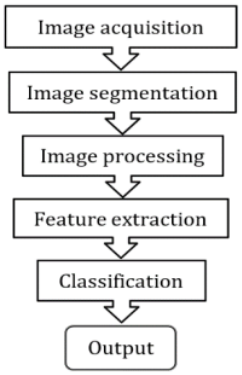

Figure 2 General processes of number plate recognition system

1. Image acquisition: The system takes an image of the vehicle license plate using a digital camera.
2. Image segmentation: The captured image is then processed to separate the license plate part from the original image.
3. Image processing: The segmented image is processed to remove noise and improve image quality.
4. Feature extraction: At this stage, the system extracts important features from the license plate image such as pattern, color, and shape.
5. Classification: After the features are extracted, the system classifies the license plate image into appropriate categories such as vehicle type or registration region.
6. Output: The result of license plate recognition is displayed in the form of human-readable text or numbers.

The license plate of the Ministry of Defense official vehicle is a metal plate containing the logo of the Ministry of Defense of the Republic of Indonesia, writing the vehicle registration number with basic color variations. The digits of the registration number are the numbers of the registration number and the numbers of the work unit identification.

Figure 3 Ministry of Defense of the Republic of Indonesia Service Vehicle Number Format

The vehicle license plate format is used by military service vehicles, ranging from two-wheeled service vehicles, four or more wheeled service vehicles to combat vehicles such as tanks [27].

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Implementation of flowchart diagram design that includes input, process and output

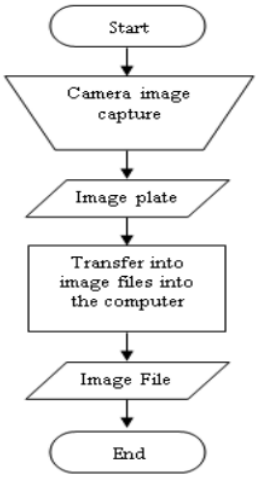

Figure 4. Input Flowchart

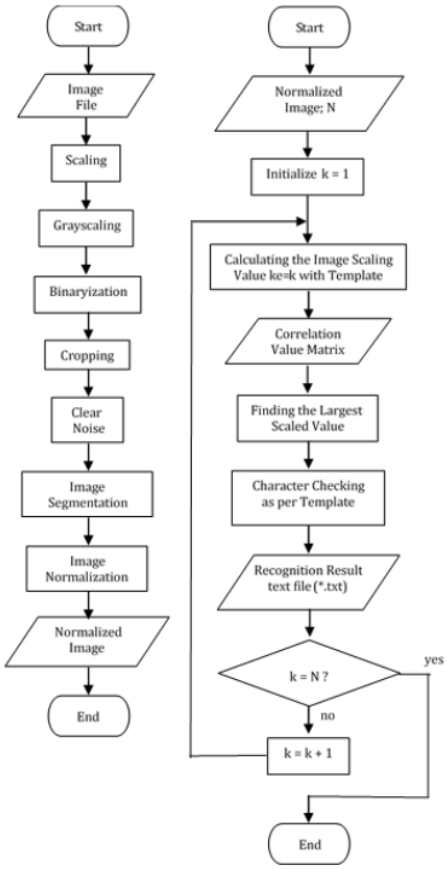

Figure 5. Process Flowchart

Algorithm design:

1. Character templating
   An initial process where certain characters are created that will be used as a comparison to the characters to be matched and then placed into the template. The images consisting of the reference characters are organized into a matrix of a certain size (42 x 24 pixels).
   Pseudocode:
   Matrix (42 x 24)
   save as template
2. Pre-processing
   Several parts of the process are carried out to prepare the original image so that it is ready to be forwarded to the template matching stage. Processing includes scaling, cropping, gray scale, binarization, cleaning the image from noise, segmentation and normalization.
   Pseudocode:
   Call image.
   resize image to 150xNaN size
   cropping image
   image grayscaling
   binaryization with threshold values (0.62, 0.72, and 0.82)
   cleaning noise below 80 pixels
3. Segmentation and Normalization
   This segmentation process aims to group the object pixels of the region that represents an object. This makes the boundary between the object and the background clear. The background is white and the object pixels are black. The intersection of white and black pixels is modeled as a line.
   Normalization aims to adjust the input image data with the image data in the database (template image). At this stage, a scaling process is carried out on the image so that the image has a fixed resolution, the image is scaled so that it has a resolution of 42 x 24 pixels.
   Pseudocode:
   Image segmentation
   template space preparation
   image normalization to 42 x 24
   template space blanking
4. Template Matching Correlation
   The normalized images are counted and the correlation value is calculated. Processed by calling sequentially starting from the first order image called initialization. Then the correlation value between the initialization image and all template images is compared, the largest correlation value (closest to the template image) then the image is considered a match and then printed as the character in question.
   Pseudocode:
   Normalized image = n
   initialization k=1

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calculate correlation value
find the largest correlation value
printing the recognition result to *.txt
check the number of k = n
if k ≠ n, k = k + 1, calculate the correlation value again
if k = n, finish

5. Display Result
This process displays the results with a notepad display.
Pseudocode:
Calling notepad

Software Architecture:

Establishment of character recognition application on vehicle license plates with three parts of the process: input → process → output.

1. Input
A glimpse of the appearance of the input section coding:

```
%-------------------------------------
% MAIN PROGRAM
warning off %#ok<WNOFF>
%bersihkan semua dan tutup
clc, close all, clear all
%memasukkan citra
imagen=imread('citra\2.jpg');
%tampilkan citra awal
imagen1 = imagen;
figure,imshow(imagen1);
title('Citra Input dengan Derau')
pause(1)
```

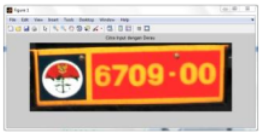
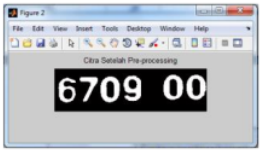
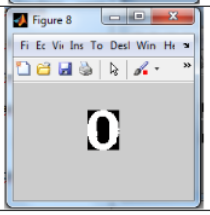
2. Process
A quick look at the coding of the process section:

```
%tahapan pre-processing-------------------
imagen=imresize(imagen, [150 NaN]);
gray=rgb2gray(imagen);
bin=im2bw(gray,0.72);
imagen= imcrop(bin,[138 35 270 75]);

% Bersihkan pixels citra dibawah 80 pixels
imagen = bwareaopen(imagen,80);
imagen3 = imagen;
figure,imshow(imagen3);
title('Citra Setelah Pre-processing')
pause(1)

%tahapan Segmentasi----------------------
%jalankan fungsi lines_crop ------------
function [fl re]=lines_crop(im_texto)
im_texto=clip(im_texto);
num_filas=size(im_texto,1);
for s=1:num_filas
    if sum(im_texto(s,:))==0
        nm=im_texto(1:s-1, :); % Matriks
baris pertama
        rm=im_texto(s:end, :);% Matriks
sisa baris
        fl = clip(nm);
        pause(1);
        re=clip(rm);
        break
    else
        fl=im_texto;%Hanya baris.
        re=[ ];
    end
end
%jalankan fungsi letter_crop ------------
function [fl re
space]=letter_crop(im_texto)
%Membagi huruf pada baris
im_texto=clip(im_texto);
num_filas=size(im_texto,2);
for s=1:num_filas
    s;
    sum_col = sum(im_texto(:,s));
    if sum_col==0
        k = 'true';
        nm=im_texto(:,1:s-1); % Matrik
dari huruf pertama
        %huruf pertama pada fungsi ini
        rm=im_texto(:,s:end);% Sisa baris
matriks
        %isa huruf pada fungsi ini
        fl = clip(nm);
        %pause(1);
        re=clip(rm);
        space = size(rm,2)-size(re,2);
        break
    else
        fl=im_texto;%hanya baris.
        re=[ ];
        space = 0;
    end
end
```

3. Output
A glimpse of the appearance of the last part of the coding:

```
%Tampilkan file 'text.txt'
winopen('text.txt')
clear all
```

Table 1. User Interface

Stage Description	Image
The appearance of the input image with noise is then passed on for pre-processing.	
Pre-processed image, which has undergone scaling, grayscaling, binaryization, cropping and clear noise..	
The image in the first matrix row which is the result of Segmentation and Normalization.	
The next process is carried out until the image is at the last matrix, then it is forwarded to the recognition process.	

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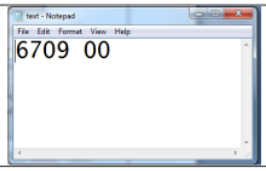
The recognition results are concluded by displaying the printed results in text form.



CONCLUSION

From the results of the research and discussion that has been carried out, it can be concluded that at the test data stage, the percentage of license plate image recognition is 80% of the template matching method, so it can be concluded that in this case the template matching method has a fairly good recognition rate. Factors that affect the results of recognizing vehicle license plate images are the level of brightness, lack of accuracy when cutting images before being used as test data, and the position of the character image slope. In the character segmentation stage, almost all license plate images can be segmented well and have similarities with the original character image.

The author suggests that the next application uses a method that can recognize the color of the motor vehicle plate, so that the identity of the vehicle can be known in more detail and completely.

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