# CAR PLATE RECOGNITION SYSTEM
# (SEGMENTATION)

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# ABSTRACT

Nowadays, there are many researches on pattern recognition. Therefore, the purpose of this research is to develop a prototype by referring the University College of Engineering & Technology of Malaysia (UTEC) as the case study. The use of human workforce for the safety control in UTEC really cannot be implemented consistently and effectively since human ability is limited. Therefore, the development of the safety prototype is a stepping-stone to ensure that the safety control is getting better. The prototype is a car plate recognition prototype based on the acquired car plate image. However, in this research, it only focuses on two phases of the recognition phase which are car plate thinning phase and car plate segmentation phase. The technique that was used in every phase is based on the algorithms that are developed by previous researchers. In the research, One Pass Thinning algorithm and Partial Segmentation algorithm are the algorithms being applied. For each phase, the used technique produces quite a good result whereby it is to be discussed in detail in the thesis.

# ABSTRAK

Dewasa ini, pelbagai kajian telah dijalankan terhadap teknologi pengecaman paten. Oleh itu, tujuan kajian ini adalah untuk membangunkan sebuah prototaip dengan merujuk kepada Kolej Universiti Kejuruteraan & Teknologi Malaysia (KUKTEM) sebagai kajian kes. Penggunaan tenaga kerja manusia bagi tujuan pemantauan keselamatan ternyata tidak boleh dilaksanakan secara konsisten dan efektif memandangkan keupayaan manusia adalah terbatas. Oleh itu, pembangunan prototaip yang bercirikan keselamatan ini adalah merupakan langkah awal bagi memastikan kawalan keselamatan lebih berkesan. Prototaip ini adalah prototaip pengecaman plat kereta berdasarkan pada imej plat yang diambil. Walau bagaimanapun, pembangunan prototaip dalam kajian ini hanya memberi penekanan pada dua fasa iaitu fasa penipisan plat kereta dan fasa pengasingan karakter setiap imej plat kereta yang diambil. Teknik-teknik yang digunakan pada setiap fasa adalah berdasarkan pada algoritma yang telah dibangunkan pengkaji-pengkaji terdahulu. Dalam kajian ini, fasa penipisan Satu Laluan dan pengasingan karakter pada plat secara pembahagian adalah algoritma yang digunakan. Bagi setiap fasa ini, teknik yang digunakan ini menghasilkan produk yang memuaskan yang mana akan dibincangkan dengan lebih lanjut dalam tesis ini.

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| | | |
|---|---|---|
| CARPROS | - | Car Plate Recognition System |
| JPEG | - | Joint Photographic Experts Group |
| KUKTEM | - | Kolej Universiti Kejuruteraan & Teknologi Malaysia |
| MB | - | Mega Byte |
| Ms | - | Microsoft |
| RAM | - | Random Access Memory |
| SDLC | - | Software Development Life Cycle |
| UTEC | - | University College of Engineering &Technology of Malaysia |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Nowadays, technology is playing a major role in order to improve human life in term of their surroundings. It is the knowledge of using tools and machines to do task efficiently to make their life easier and better. Technology covers on many fields such as security, industrialization, and even construction.

In this research, it focuses on the security field, which is pattern recognition. Pattern recognition is an important field of computer science concerned with recognizing patterns, particularly visual and sound patterns. The major researches today are such as optical character recognition, voice recognition and handwriting recognition. Pattern recognition is a field that is being explored by many researchers. Pattern recognition is a field that facilitates human tasks. The final product of pattern recognition does not involve human involvement.

Today, there are many applications of pattern recognition that have already been used. There are still many other applications being developed. Today, the popular and very demanding applications in pattern recognition are such as car plate recognition, finger print recognition and handwriting recognition.

These applications are attraction to people due to their functionality to help human work. Instead, the application of pattern recognition appears to be the solution due to the ability to work effectively and consistently every day in a week. This is differing with human nature whereby human cannot work effectively every time since the performance of working is decreasing when doing any work for a very long time.

Today, quite a lot of organizations really need the technology. The use of the technology makes the flow of work becoming faster. At the same time, the use of technology also makes the quality of work getting improved. As human quite often makes mistake while doing works, the invention of this technology avoid and minimize the problems.

The growth of researches in the technology shows the important of the technology in the world today. It is because it really guaranteed to secure the organizations that use it. This is trustable by many organizations today. Everywhere, it can be seen the technology being used all over the world.

Car Plate Recognition System is one of the most important security devices that being used widely today throughout the world. Many studies have been done to technology. From time to time, it is being improved.

Currently, there are many versions of the system has been developed. It is developed in such a way to satisfy organizations need, the need to increase the security of the organizations.

It is also an alternative way to reduce the number of human workforce in order to increase the quality for certain organizations that use it. The decreasing of number in human workforce means that the organizations able to save their budget. This is one of the business values in an organization.

In this research, this system is developed based on the case study method. The environment that will be used to do the case study is Kolej Universiti Kejuruteraan & Teknologi Malaysia (KUKTEM), Gambang, Kuantan. The Car Plate Recognition System (CARPROS) is an image processing and recognition system.

## 1.2 Problem Statement

The car owner that enters into KUKTEM comprises of students and staffs. Every owner of the car that regularly enters KUKTEM needs to register their car every year as a condition to enter KUKTEM compound. The manual way needs the car owner to use sticker in order to identify their identity. Every year, the sticker should be replaced with a new one. This brings inconveniences to the owner of the car.

Since the car owner needs to register to KUKTEM every year, the use of the sticker is a burden to KUKTEM whereby KUKTEM needs to provide it. This needs a lot of money and time.

Meanwhile, for staffs that are using more than one car, they would not be able to enter KUKTEM easily. They need to register for other car too. This makes an uncomfortable situation that complicates the car owner.

For the car owners that enter KUKTEM and do not register their car, they need to follow procedures that have been implemented by KUKTEM. At the security guards main post, they should stop to be identified by the security guards. They need to step out of the car and introduce themselves. Then they have to jot down their purpose of entering KUKTEM and of a little bit of detail about them

## 1.3 Objectives

i. To develop the prototype of character thinning using One Pass Thinning algorithm.
ii. To develop the prototype of character segmentation using Partial Segmentation algorithm.

## 1.4 Scopes

The complete system of Car Plate Recognition System (CARPROS) consists of two main modules which are plate detection and plate recognition. However, in this research, it focuses on the plate recognition. The module of plate recognition is narrowed down to plate character thinning and character segmentation.
The research scopes for the prototype are as below:

i. Only car plate is used in this research.
ii. Only normal private car is used in this research; the character is white in colour. Meanwhile the background is black in colour.
iii. The models of the car used in the research are Proton Waja, Proton Wira, Proton Saga, Proton Iswara and Perodua Kancil.
iv. The amount of characters of the car plate is 7
v. The format of the car plate is the Malaysian format which is the character is white in colour and the background is black in colour.
vi. Thresholded images are used.
vii. Single line car plate is used.
viii. The image of the character is using the JPEG format.
ix. Image size is 160 x 40 pixels. It only shows the plate region.
x. The amount of car plate tested is this research is 50 in all.

## 1.5 Thesis Organization

The organization of this thesis consists of five main chapters that are very important. The chapters are from the first chapter till to the fifth chapter. The first chapter describes basis overview about pattern recognition. Besides that, there is also the problem statement, objective and scope included in this chapter. Meanwhile, the second chapter narrates the literature review of this research. It is about the research done by some researchers before. Chapter 3 describes the in detail the methodology of this research and the prototype being developed. Test results are discussed in Chapter 4. Finally, the last chapter, Chapter 5 is the conclusion of this research.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Today, pattern recognition is a very important field that being explored widely. It has been proved that the technology is really helping many organizations in working environment. It helps to enhance the operability of the organizations. In return, the safety of every organization that uses this technology is guaranteed. The quality of work is becoming very effective. Even the government sectors such as the police department using the technology in order to recognize the owner of the car through the plate number that has speeding beyond the limit. Even there are many more applications using the technology are being developed. This is in meaning that this technology plays a major role in the security system. This is the reason why many researchers are getting involved in this field.

In previous chapter, the general definition of pattern recognition is given. The more accurate is; the term 'pattern' refers to a collection of features from an unknown object. Meanwhile the term 'recognition' is the process of correctly assigning the unknown object to their respective pattern. This means that the produced prototype should be effective and error free.

In this research, a few of research papers are referred in order to gain the knowledge and idea about the important aspects of the prototype being developed. There are a number of important aspects identified during the research. These

aspects should be emphasized in order to produce better and required result. One of the aspects that should be seriously cared is on the research of the methodology, techniques and algorithms applied. These three items will be elaborated in detail in the following chapter.

## 2.2 Malaysian Car Plate

There are many commercialized software in the market that has been used for identification of car plate recognition which are mainly come from the western country such as Europe and United States. Unfortunately, the different of formatting of car plate number used, it is cannot be used in Malaysia. (Marzuki et al)

Every country has its own car plate number format. Malaysia car plate number format is different from other country. In spite of the different, in certain situation, the format of car plate number in Malaysia is different based on the owner of the car. The plate number for normal private car is black in its background and white characters as shown in Figure 2.1.


**Figure 2.1** Normal private car

Meanwhile the plate for taxis is white in background and black characters. Diplomatic car plate number have red background and yellow or white characters. Another type of car plate number, which are rarely produced are special plates such as 'Proton', 'Satria' and 'Sukom'(Marzuki et. al). In Figure 2.2 shows the specification of the normal car plate.

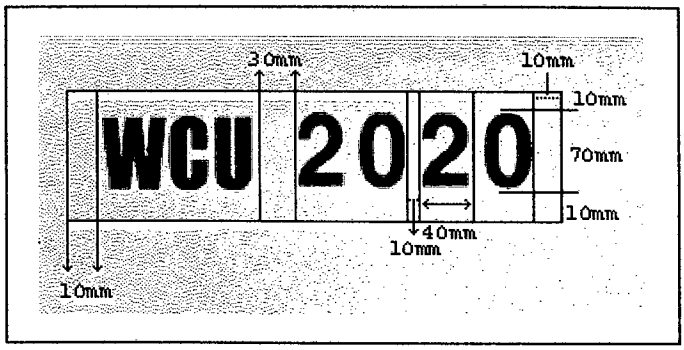


**Figure 2.2** Specification of normal car in Peninsula Malaysia

## 2.3 Car Plate Recognition

CARPROS is using an image processing technology to identify cars by their plate number. It can be used in various security systems. One of the purposes is the access-control system. The owner of the car could be identified in a very fast moment.

Early car plate recognition is not very effective. The rate of recognition phase is low. The external effects such as light intensity, bad plates and wide number of plate's types produced low quality system. However, in these days, many solutions have been identified in order to enhance the system.

Besides that, another factor that brings to ineffective prototype is because the algorithm used is not appropriate with either the current situation or the technique used is not accurate.

Due to this situation, a car plate recognition system is the technology that continuously developed to this day. This is to make sure it is more reliable and robust from time to time.

In general, a car plate recognition system comprises of two which are the plate detection and the plate recognition itself. The plate detection phase commences

by thresholding the image of the car and followed by determining the location of the car plate region. Finally, the plate is detected. Meanwhile in this research, the plate recognition phase begins with the thinning of the character of car plate. Then, this character is segmented. A complete car plate recognition recognizes each of the character by matching the image with the character template.

## 2.4 Literature Review

There are many research papers could be referred. Having study the research from previous researchers is a good way to produce a better and more effective product. Therefore, a few research paper done by previous researchers have been analyzed as references. Examples of the research papers are as proposed by Yungang Zhang and Changshui Zhang (1999), Fernando Martin and David Borges(1998). The research papers cover a few things in developing the car plate recognition system. Every research paper explains the solution of certain problem that arises during the development phase.

According to Yungang Zhang and Changshui Zhang (1999), in his paper entitled *A New Algorithm for Character Segmentation of License Plate*, a car plate recognition system consists of three steps which are plate locating, character segmentation and character recognition. Figure 2.3 shows the flow of the processes.

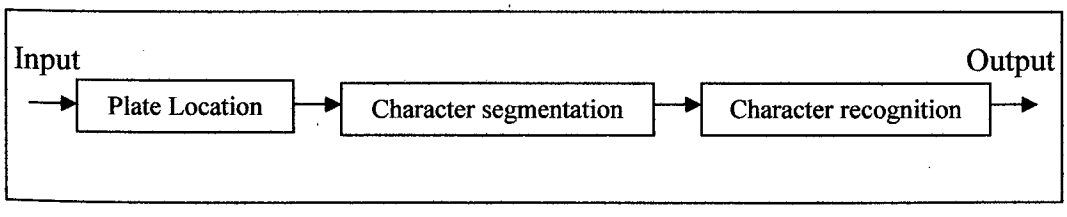


**Figure 2.3** Flow of Car Plate Recognition System

### 2.4.1 Car Plate Thinning

In this research, thinning algorithm is a part of recognition phase. By thinning the plate characters, it may reduce the thickness of each character. The thickness of the line of image is about a size of a pixel.

Lei Huang et al (2003) in *An Improved Parallel Thinning Algorithm* quoted that in the past several decades, some thinning algorithms obtained good results, but there are still some deficiencies. For instance, some fully parallel algorithms cannot conserve the connectivity of an image. In Datta's algorithm, some basic properties of thinning are ensured. But it uses multi-pass iterative and is not fully parallel algorithm. Then, Han et al proposed a fully parallel algorithm. However, this algorithm takes much time. The similarity of Datta's algorithm and Han et al algorithm is the inefficient of the algorithms that can cause loss of information of pattern.

Ioannis Pitas (1993) in his book entitled *Digital Image Processing Algorithms* stated that thinning is a set of successive erosions of the outermost layers of a shape, until a connected unit-width set of lines is obtained. This means thinning algorithms are iterative algorithms that delete border pixels. The deleting of the pixel occurs to the pixels located at the middle pixel of a 3x3 window in a binary image by satisfying the thinning phase condition.

Connectivity is an important property that must be conserved in the thinned image. Therefore, one of the thinning algorithm condition is that the border pixels that being deleted should maintain the connectivity of the image. They should maintain the connectivity at each loop of process. Figure 2.4 shows the border pixel whose removal may cause discontinuity.

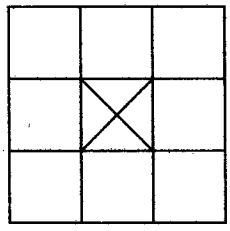

**Figure 2.4** Removal of border pixel that may cause discontinuity

Besides that, another condition of a thinned image is that the removal of border pixel should not shorten the end of the thinned image. The condition is pictured as the Figure 2.5

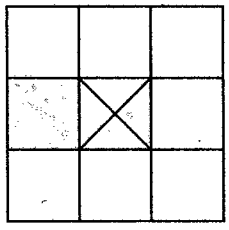

**Figure 2.5** Border pixel whose removal will shorten an image

Chin et al (1987) proposed an algorithm called as One Pass Thinning. During development, this algorithm is being used in the methodology of the prototype due to its simplicity. This algorithm is using only one iterative pass in order to thin the thick image of plate character. To this day, most of the algorithms being developed are using the 3x3 windows of image. The main focus of the window in the algorithm is the middle pixel, $P_0$. The $P_0$ is either to be deleted or to let it that way. Basically, $P_0$ is not deleted if the deletion of $P_0$ may cause the line of image disconnected (Figure 2.4) or the deletion of $P_0$ could cause the line becomes shortened (Figure 2.5). The process of deletion or thinning stop until the line of image is the size of a pixel. This iterative process is done by the movement of 3x3 window. The neighbour of the middle pixel is the other 8 pixels or so-called 8-neighbour. The 8-neighbour is necessary in this algorithm. Figure 2.6 shows the coding of One Pass Thinning algorithm.

```
int thin_1(x,N1,M1,N2,M2)
image x;
int N1,M1,N2,M2;

/*One pass thinning algorithm
x:input and output image buffer
N1,M1:start coordinates
N2,M2:end coordinates*/

{int k,l,i,j,count=0,y[9],trans=0,m,OK=1;
 do
 {
        OK=1;
         for(k=N1+1;k<N2-1;k++)
  for(l=M1+1;l<M2-1;l++)
              if(x[k][l]==1)
              {
              /*Count number of 1s in 3 x 3 window.*/
                count=0;
               for(i=-1;i<=1;i++)
                for(j=-1;j<=1;j++)
                  if(x[k+i][j+1]==1
                    count++;
               if((count>2)&&(count<8))
                 {/*Count number of transitions.*/
                   y[0]=x[k-1][l-1];y[1]=x[k-1][l];y[2]=x[k-1][l+1];
                   y[3]=x[k][l+1];y[4]=x[k+1][l+1];y[5]=x[k+1][l];
                   y[6]=x[k+1][l-1];y[7]=x[k][l-1];y[8]=x[k-1][l-1];
                   trans=0;
                   for(m=0;m<=7;m++)
                     if(y[m]= =0 && y[m+1]= =1)
                       trans++;
                     /*If the number of transitions is 1,delete current pixel*/
                     if(trans= =1)
                       {x[k][l]=0;
                        OK=0;}}
 }while(OK==0);
}
```

**Figure 2.6** One Pass Thinning algorithm

However, in Han et al's algorithm (2003), it is not only depending to the 8-neighbour, but also the weight-value which is the sum of the 8-neighbour pixels of black pixels. Figure 2.7 shows the middle pixel in a 3x3 window.

| | | |
|---|---|---|
| $P_8$ | $P_1$ | $P_2$ |
| $P_7$ | $P_0$ | $P_3$ |
| $P_6$ | $P_5$ | $P_4$ |

**Figure 2.7** Middle pixel, $P_0$ in 3x3 windows

Besides of One Pass Thinning Algorithm, another algorithm was developed by Zhang & Suen (1984). They proposed the Two Pass Thinning algorithm. Compare to One Pass Thinning, which is an iterative pass, the Two Pass Thinning requires two successive iterative passes. Similar to One Pass Thinning, the arrangement of 8-neighbour is such in Figure 2.7. In the first iterative pass, the logical rule P1 is applied in the 3x3 window to mark the pixels that can be deleted. The pixels are deleted until it fully finished the scan the entire image. The deletion is performed later. At the second iterative pass, another logical rule P2 is applied to mark extra pixels that can be deleted. After the image finished the scanned activity, all the marked pixels are deleted. Following are the logical rule P1 and P2 applied in the algorithm:

$$\text{P1: } (2 \leq N(P_0) \leq 6) \;\&\&\; (T(P_0) = 1) \;\&\&\; (P_1 \cdot P_3 \cdot P_5 = 0) \;\&\&\; (P_3 \cdot P_5 \cdot P_7 = 0) \qquad (2.1)$$

$$\text{P2: } (2 \leq N(P_0) \leq 6) \;\&\&\; (T(P_0) = 1) \;\&\&\; (P_1 \cdot P_3 \cdot P_7 = 0) \;\&\&\; (P_1 \cdot P_5 \cdot P_7 = 0) \qquad (2.2)$$

The conditions $(2 \leq N(P_0) \leq 6)$ for both logical rules clarify that the middle pixel only can be deleted if it satisfies the rule which is the amount of 8-neighbour is in between 2 and 6 pixels. If the pixel $P_0$ only has one pixel among the 8-neighbour, so the pixel $P_0$ cannot be deleted because it may shorten the limb of image. If the amount of 8-neighbour is more than 6 neighbours, the pixel $P_0$ cannot be deleted too due to erosion of image. The situation of $(T(P_0) = 1)$ is to ensure the connectivity of pixels to avoid the image line disconnected.

Meanwhile the situation ( $P_1 . P_3 . P_5 = 0$) && ($P_3 . P_5 . P_7 = 0$) in the logical rule, P1 is satisfied if ($P_3 = 0$) or ($P_5 = 0$) or ($P_1 = 0$ and $P_7 = 0$). For the first iterative, the pixel P is deleted if satisfy one of the following cases:

i. Pixel $P_0$ of South boundary. Refer to Figure 2.8

ii. Pixel $P_0$ of East boundary Refer to Figure 2.9

iii. Pixel $P_0$ of North-West corner point. Refer to Figure 2.10

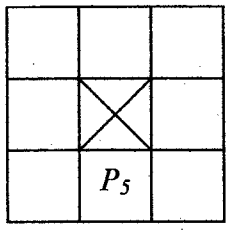


**Figure 2.8** South boundary

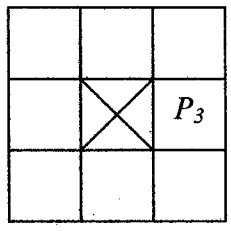


**Figure 2.9** East boundary

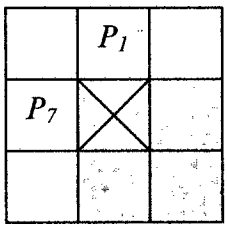


**Figure 2.10** North-West corner point

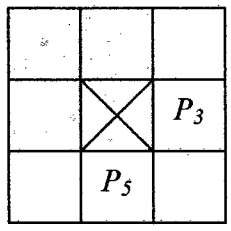


**Figure 2.11** South-East corner

In the P2 logical rule, the pixel $P_0$ can be deleted if it satisfies the situation of ( $P_1 . P_3 . P_7 = 0$) && ($P_1 . P_5 . P_7 = 0$) which is ($P_1 = 0$) or ($P_7 = 0$) or ($P_3 = 0$ and $P_5 = 0$). For the second iterative, the pixel located at North boundary (Figure 2.12), West boundary (Figure 2.13) or at the South-East corner (Figure 2.11) is deleted. Figure 2.14 shows the coding of Two Pass Thinning algorithm.

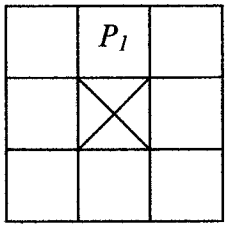


**Figure 2.12** North boundary

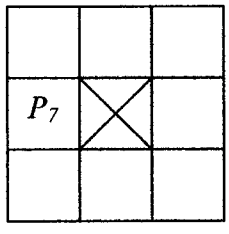


**Figure 2.13** West boundary