

**TISHK INTERNATIONAL UNIVERSITY**

**Faculty of Engineering**

**Department of Computer Engineering**

**Graduation Project**

**Automatic Number-Plate Recognition in Kurdistan**

**By**

Ahmed Bahram Maghdid, Mohammed Omar Hamad, Brwa Muhsin Khdir

**Supervised By**

Dr. Abubakar M. Ashir

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# 1.1 Introduction

Automatic Number Plate Recognition (ANPR): Is a highly accurate system capable of reading vehicle number plates without human intervention. Through the use of high-speed image capture with supporting illumination, detection of characters within the images provided, verification of the character sequences as being those from a vehicle license plate, character recognition to convert image to text; so, ending up with a set of metadata that identifies an image containing a vehicle license plate and the associated decoded text of that plate. ANPR is therefore the underlying technology used to find a vehicle license/number plate and it, in turn, supplies this information to a next stage of computer processing through which the information can be interpreted, stored or matched to create an ANPR based application. Most members of the public will be aware that ANPR is used by many police forces to track down criminal behavior and is also seen on many UK Motorways as a method of detecting speeding through average speed calculation. However, ANPR is used in a variety of other ways to support the security and safety of the public as well as supporting efficiencies in the way we interact with transportation and vehicle-based infrastructure.

ANPR is sometimes known by various other terms:

* **Automatic (or automated) license-plate recognition** (ALPR)
* **Automatic (or automated) license-plate reader** (ALPR)
* **Automatic vehicle identification** (AVI)
* **Automatic number plate genkendelse** (ANPG)
* **Car-plate recognition** (CPR)
* **License-plate recognition** (LPR)
* **Lecture automatique de plaques d'immatriculation** (LAPI)
* **Mobile license-plate reader** (MLPR)
* **Vehicle license-plate recognition** (VLPR)
* **Vehicle recognition identification** (VRI)

## THE HISTORY OF Automatic Number-Plate Recognition

The History of ANPR is considerably longer than most people realise. Because of its prolific use in more recent years for a broad range application such as traffic studies, access control and parking, many people, if asked, would guess at it being an invention belonging to this millennium. Surprising to most people, the history of ANPR stretches into the last century as it was invented in 1976 in the UK at what was then known as the Police Scientific Development Branch (PSDB) (now titled Home Office Scientific Development Branch) and early systems were developed for use from 1979.Early trial systems were deployed in the UK on the A1 Road and at the Dartford Tunnel crossing on the M25 motorway and the first arrest that was credited to ANPR detection of a stolen car did not come until 1981. Since its inception, ANPR Technology has evolved and adapted with the times, finding new outlets and applications taking it beyond the boundaries of just policing and security. Below are a few notable milestones along our journey to date:

* **1993** - ANPR is deployed for the first time as part of a "Ring of Steel" camera network around the City of London. The project was the largest operation of its type ever seen at the time and was implemented by the London Metropolitan Police in a bid to end the string of Terrorist bombings in the financial district, by the IRA.
* **1997** - The Police National ANPR Data Centre (NADC) formed as an extension to the Police National Computer service. Prior to the creation of the NADC, data collected from ANPR systems was localised within the respective police force that operated the cameras, but the National ANPR Data Centre allowed for analysis across police force boundaries, by centralising all Police ANPR data from around the UK.
* **2003** - The London Congestion Charge scheme is introduced which was aimed at reducing traffic in central London for a number of reasons. The charge zone, which covers 20 square kilometres of the capital, is operated by Transport for London and compromises of a ring of almost 700 ANPR cameras that are trained on every road in and out of the Charging Zone. This marks the first large scale use of ANPR for civil purposes.
* **2005** - ANPR International Limited formed - 18th May 2005 to be exact. Born out of a belief that ANPR technology could do a lot more than it had already had to date. Its first development comes with the creation of the eyeTRAFFIC back office platform, which is designed to handle ANPR data from a number of different network sources and process the data through a range of modular applications.
* **2006** - ANPR International deployed its first static camera system for Parking Management - bayGAURDIAN which is the first module built for the eyeTRAFFIC back office system. The system allowed car park operators to monitor vehicles in and out of car parks, calculating the amount of time a vehicle spent on site and automatically identifying those vehicles that were not authorised or stayed too long.
* **2007** - bayGUARDIAN module is extended with integration into Charge Parking equipment. The system fully integrates with a range of Pay & Display meters, to allow the back office systems to automatically detect a vehicle that has not paid for parking or paid too little.
* **2009** - ANPR International develops its first mobile ANPR product - streetSWEEPER, which is designed for multiple applications including Traffic surveys, Mobile surveillance and untaxed vehicle enforcement for the Driver and Vehicle Licensing Agency (DVLA). On its first day on the road in Central London, streetSWEEPER detects over 27 untaxed vehicles in just a few hours.
* **2011** - road GUARDIAN system developed and deployed to combat issue of vehicles short cutting through prohibited roadways to avoid congestion "Rat-running". System deployed in conjunction with a County Council and detections enforced by the Police who issue Fixed Penalty Notice to any offender.
* **2012** - First Vehicle Damage Recording System (DRS) developed to record vehicle conditions of arriving vehicles at Airport valet parking area, in order to prevent fraudulent insurance claims for vehicle damage against the airport staff. System linked a 360-deg. image of the vehicle to its registration number, providing a quick and easy means of recovering and analysing the images in the event of a claim from the motorist.
* **2013** - ANPR International wins Technology Award for mobile traffic survey work carried out for Gloucestershire County Council. The survey uses a fleet of streetSWEEPER equipped vehicles to collect data on traffic profiles and parking habits around a number of towns and cities to help the Council in better understanding traffic flows and vehicle use.
* **2014** - speedSENTINEL developed to address issues with speeding in public transport interchanges. The Sentinel was designed to be a trailer mounted speed camera system that could be towed to Transport interchanged and deployed at random to ensure that Bus & Coach operators adhered to the strict speed limits imposed for pedestrian safety in the busy stations.
* **2016** - Vehicle Damage Recording System (DRS) extended to include dual lane capture, allowing for multiple lanes and up to 14 cameras to be integrated with ANPR data and vehicle pre-booking software to speed up the customer experience and increase convenience. The first dual lane system goes live at Doncaster Sheffield Airport with average times for visitors to drop-off their vehicle recorded at 32 seconds.
* **2017** - ANPR International launches gateGUARDIAN as a retrofit barrier protection solution to address the safety issue of vehicle "Tail-gating" into or out of a barrier controlled car park. The first system goes live at a UK airport to address the high level of incidents with vehicles trying to avoid paying for parking in the premium pick-up and drop-off zone.
* **2018** - The all new ASPEK Digital Camera range is launched which replaces our tried and tested D-ANPR range. The new range incorporates all new package design with greater on-board functionality and more features.

Our story still continues as we contribute to the history of ANPR. So if you would like to know more, please contact us using the links provided.

## Why Automatic Number-Plate Recognition is important

In this day and age, cyber threats to businesses are so prominent and physical threats are sometimes cast aside and deemed as less important. It is still vital for companies to think about and prepare for these physical threats and a huge part of this is ensuring that the perimeter of the premises is protected.

The evolution of technology has enabled security solutions to develop so, there are now multiple solutions available that all provide numerous benefits to the user. [Automatic Number Plate Recognition](https://www.ea-group.co.uk/security-systems/anpr-automatic-number-plate-recognition/) (ANPR) technology is now the first choice for many businesses looking for suitable perimeter protection. If you have been considering this security solution yourself then keep reading today, the [EA Group](http://www.ea-group.co.uk/about-ea/) have put together a list of irresistible benefits of ANPR for any business owner.

**24/7 monitoring**

Unlike other car park barrier systems, an automatic number plate recognition system will allow you to not only protect your car park, but monitor the access too. With ANPR cameras, you will have eyes on your car park 24 hours a day, 7 days a week. You will know exactly who has entered your premises, the time they enter and also the time they leave. This can be incredibly helpful in many situations.

**Easy and efficient**

While installing a heavy-duty security gate or having a manual check system is an effective deterrent against intruders, they can both be incredibly time-consuming for businesses. It is always important to consider how easy it is for people you want to grant access to, such as employees ad delivery vehicles, to get in and out. Thankfully, an ANPR system is incredibly easy and efficient, people can come and go as required without you needing to do anything, but you will still know who has entered your premises.

**Cost-effective**

As well as being easier and more efficient, ANPR technology is also one of the most cost-effective solutions for managing your car park. You will be able to cut costs and reduce the need for security personnel when you choose this smart solution. Many companies will also issue fines to anyone picked up by their ANPR system that shouldn’t be on their private property or anyone that has exceeded the maximum time limit. This can bring in extra money for the company and may even end up paying for this security solution.

**Stand alone**

Unlike the majority of other automatic car park barriers, ANPR cameras can operate in a way where all information is entirely processed on board so that no extra computers, or software licenses, are needed. These cameras also have optical character recognition software embedded which enables all images to be analysed directly on board the ANPR camera. Due to them being stand-alone solutions, ANPR cameras are quick, safe and light to install.

**Provides evidence**

Similarly, to CCTV, automatic number plate recognition systems can provide you with the details regarding when someone was at your premises, whenever they are required. The images taken by this camera can be used as evidence and can provide valuable information that can be used in investigations. You can easily prove when the vehicle in question was on your premises and it will be all the hard evidence you need.

**Installing automatic number plate recognition**

All in all, ANPR systems are incredibly useful security solutions and many would say that they are the best solution for company car parks. Many companies are moving away from automatic gate systems and solely using automatic number plate recognition to ensure that all vehicles in their car park have permission to be there.

When searching for a reliable company that can install your [ANPR system](https://www.ea-group.co.uk/security-systems/anpr-automatic-number-plate-recognition/) for you, turn to the EA Group. We have many years of experience providing automatic number plate recognition systems and solutions to police, civilian and commercial users. Our team of engineers is able to design ANPR camera systems that can meet your specific needs. If you’d like to find out more about utilising cutting-edge ANPR technology in your business, get in touch today.

## Challenge of Automatic Number-Plate Recognition

### Circumvention

Vehicle owners have used a variety of techniques in an attempt to evade ANPR systems and road-rule enforcement cameras in general. One method increases the reflective properties of the lettering and makes it more likely that the system will be unable to locate the plate or produce a high enough level of contrast to be able to read it. This is typically done by using a plate cover or a spray, though claims regarding the effectiveness of the latter are disputed. In most jurisdictions, the covers are illegal and covered under existing laws, while in most countries there is no law to disallow the use of the sprays. Other users have attempted to smear their license plate with dirt or utilize covers to mask the plate.

Novelty frames around [Texas license plates](https://en.wikipedia.org/wiki/Vehicle_registration_plates_of_Texas) were made illegal in Texas on 1 September 2003 by Texas Senate Bill 439 because they caused problems with ANPR devices. That law made it a Class C misdemeanor (punishable by a fine of up to US$200), or Class B (punishable by a fine of up to US$2,000 and 180 days in jail) if it can be proven that the owner did it to deliberately obscure their plates. The law was later clarified in 2007 to allow novelty frames.

If an ANPR system cannot read the plate, it can flag the image for attention, with the human operators looking to see if they are able to identify the alphanumerics. In 2013 researchers at Sunflex Zone Ltd created a privacy license plate frame that uses near infrared light to make the license plate unreadable to license plate recognition systems.

### Controversy

The introduction of ANPR systems has led to fears of misidentification and the furthering of [*1984*](https://en.wikipedia.org/wiki/Nineteen_Eighty-Four)-style surveillance. In the United States, some such as [Gregg Easterbrook](https://en.wikipedia.org/wiki/Gregg_Easterbrook) oppose what they call "machines that issue speeding tickets and red-light tickets" as the beginning of a [slippery slope](https://en.wikipedia.org/wiki/Slippery_slope) towards an automated justice system:

"A machine classifies a person as an offender, and you can't confront your accuser because there is no accuser... can it be wise to establish a principle that when a machine says you did something illegal, you are presumed guilty?" Similar criticisms have been raised in other countries. Easterbrook also argues that this technology is employed to maximize revenue for the state, rather than to promote safety. The electronic surveillance system produces tickets which in the US are often in excess of $100, and are virtually impossible for a citizen to contest in court without the help of an attorney. The revenues generated by these machines are shared generously with the private corporation that builds and operates them, creating a strong incentive to tweak the system to generate as many tickets as possible.

Older systems had been notably unreliable; in the UK this has been known to lead to charges being made incorrectly with the vehicle owner having to pay £10 in order to be issued with proof (or not) of the offense. Improvements in technology have drastically decreased error rates, but false accusations are still frequent enough to be a problem.

Perhaps the best known incident involving the abuse of an ANPR database in North America is the case of *Edmonton Sun* reporter [Kerry Diotte](https://en.wikipedia.org/wiki/Kerry_Diotte) in 2004. Diotte wrote an article critical of Edmonton police use of traffic cameras for revenue enhancement, and in retaliation was added to an ANPR database of "high-risk drivers" in an attempt to monitor his habits and create an opportunity to arrest him. The police chief and several officers were fired as a result, and The [Office of the Privacy Commissioner of Canada](https://en.wikipedia.org/wiki/Office_of_the_Privacy_Commissioner_of_Canada) expressed public concern over the "growing police use of technology to spy on motorists."

Other concerns include the storage of information that could be used to identify people and store details about their driving habits and daily life, contravening the [Data Protection Act](https://en.wikipedia.org/wiki/Data_Protection_Act_1998) along with similar legislation (see [personally identifiable information](https://en.wikipedia.org/wiki/Personally_identifiable_information)). The laws in the UK are strict for any system that uses CCTV footage and can identify individuals.

Also of concern is the safety of the data once it is mined, following the discovery of police surveillance records lost in a gutter.

There is also a case in the UK for saying that use of ANPR cameras is unlawful under the [Regulation of Investigatory Powers Act 2000](https://en.wikipedia.org/wiki/Regulation_of_Investigatory_Powers_Act_2000). The breach exists, some say, in the fact that ANPR is used to monitor the activities of law-abiding citizens and treats everyone like the suspected criminals intended to be surveyed under the Act. The police themselves have been known to refer to the system of ANPR as a "24/7 traffic movement database" which is a diversion from its intended purpose of identifying vehicles involved in criminal activities. The opposing viewpoint is that where the plates have been cloned, a 'read' of an innocent motorist's vehicle will allow the elimination of that vehicle from an investigation by visual examination of the images stored. Likewise, stolen vehicles are read by ANPR systems between the time of theft and report to the Police, assisting in the investigation.

The [*Associated Press*](https://en.wikipedia.org/wiki/Associated_Press) reported in August 2011 that [New York Police Department](https://en.wikipedia.org/wiki/New_York_Police_Department) cars and license plate tracking equipment purchased with federal [HIDTA](https://en.wikipedia.org/wiki/HIDTA) (High Intensity Drug Trafficking Area) funds were used to spy on Muslims at mosques, and to track the license plate numbers of worshipers. Police in unmarked cars outfitted with electronic license plate readers would drive down the street and automatically catalog the plates of everyone parked near the mosque, amassing a covert database that would be distributed among officers and used to profile Muslims in public.

In 2013 the [American Civil Liberties Union](https://en.wikipedia.org/wiki/American_Civil_Liberties_Union) (ACLU) released 26,000 pages of data about ANPR systems obtained from local, state, and federal agencies through freedom of information laws. "The documents paint a startling picture of a technology deployed with too few rules that is becoming a tool for mass routine location tracking and surveillance" wrote the ACLU. The ACLU reported that in many locations the devices were being used to store location information on vehicles which were not suspected of any particular offense. "Private companies are also using license plate readers and sharing the information they collect with police with little or no oversight or privacy protections. A lack of regulation means that policies governing how long our location data is kept vary widely," the ACLU said. In 2012 the ACLU filed suit against the Department of Homeland Security, which funds many local and state ANPR programs through grants, after the agency failed to provide access to records the ACLU had requested under the Freedom of Information Act about the programs.

In mid-August 2015, in [Boston](https://en.wikipedia.org/wiki/Boston), it was discovered that the license plate records for a million people was online and unprotected.

In April 2020, The Register UK with the help of security researchers discovered nine million ANPR logs left wide-open on the internet. The 3M Sheffield Council system had been online and unprotected since 2013-2014.

### Plate inconsistency and jurisdictional differences

Many ANPR systems claim accuracy when trained to match plates from a single jurisdiction or region, but can fail when trying to recognize plates from other jurisdictions due to variations in format, font, colour, layout, and other plate features. Some jurisdictions offer vanity or affinity plates (particularly in the US), which can create many variations within a single jurisdiction.

From time to time, US states will make significant changes in their license plate protocol that will affect OCR accuracy. They may add a character or add a new license plate design. ALPR systems must adapt to these changes quickly in order to be effective. Another challenge with ALPR systems is that some states have the same license plate protocol. For example, more than one state uses the standard three letters followed by four numbers. So, each time the ALPR systems alarms, it is the user's responsibility to make sure that the plate which caused the alarm matches the state associated with the license plate listed on the in-car computer. For maximum effectiveness, an ANPR system should be able to recognize plates from any jurisdiction, and the jurisdiction to which they are associated, but these many variables make such tasks difficult.

Currently at least one US ANPR provider ([PlateSmart](https://en.wikipedia.org/wiki/PlateSmart" \o "PlateSmart)) claims their system has been independently reviewed as able to accurately recognize the US state jurisdiction of license plates, and one European ANPR provider claims their system can differentiate all EU plate jurisdictions.

### Accuracy and measurement of ANPR system performance

A few ANPR software vendors publish accuracy results based on image benchmarks. These results may vary depending on which images the vendor has chosen to include in their test. In 2017, Sighthound reported a 93.6% accuracy on a private image benchmark. In 2017, [OpenALPR](https://en.wikipedia.org/wiki/OpenALPR" \o "OpenALPR) reported accuracy rates for their commercial software in the range of 95-98% on a public image benchmark. April 2018 research from Brazil's [Federal University of Paraná](https://en.wikipedia.org/wiki/Federal_University_of_Paran%C3%A1) and [Federal University of Minas Gerais](https://en.wikipedia.org/wiki/Federal_University_of_Minas_Gerais) obtained a recognition rate of 93.0% for OpenALPR and 89.8% for Sighthound, running both on the SSIG dataset; and a rate of 93.5% for a system of their own design based on the YOLO object detector, also using the SSIG dataset. Testing a "more realistic scenario" involving both plate and reader moving, the researchers obtained rates of less than 70% for the two commercial systems and 78.3% for their own.

# 1.2 Problem Definition

Detecting of the vehicle

As we know there are many criminals that are driving and entering places easily without any monitoring for their vehicles automatically and efficiently. But if this system is installed on important points on roads.

For sure it will influence directly finding out where the specific vehicle is and help police and security to detect the criminal following them. Otherwise for detecting a particular number they have to watch every recording videos in cameras and it take too much time and attempt for finding the right vehicle.

It can also be used in other fields, for example, to determine the speed of a vehicle, which we can save the number of a vehicle when it enters a particular street (specially on high ways) and exiting the same vehicle then calculating the distance and time to make sure the speed of the car is limited to speed and has not been ruled out unless They can face the law and legal action can be taken with it.

Also somehow security can detect a vehicle which has no number plate if the system develop well in future, and many other ideas which can be perform with that system.

# 1.3 Aims

There are several applications where automatic license plate recognition can be used. Those include the following:

* Parking: the plate number is used to automatically enter pre-paid members and calculate parking fee for non-members (by comparing the exit and entry times).
* Access Control: a gate automatically opens for authorized members in a secured area, thus replacing or assisting the security guard. The events are logged on a database and could be used to search the history of events.
* Border Control: the car number is registered in the entry or exit to the country, and used to monitor the border crossings.
* Stolen cars: a list of stolen cars or unpaid fines is used to alert on a passing ‘hot’ cars. The ‘ black list’ can be updated in real time and provide immediate alarm to the police force.
* Enforcement: the plate number is used to produce a violation fine on speed or red-light systems. The manual process of preparing a violation fine is replaced by an automated process which reduces the overhead and turnaround time. The fines can be viewed and paid on-line.
* Traffic control: the vehicles can be directed to different lanes according to their entry permits (such as in University complex projects).The system effectively reduces traffic congestions and the number of attendants.
* Marketing tool: his car plates may be used to compile a list of frequent visitors for marketing purposes, or to build a traffic profile (such as the frequency of entry verses the hour or day).
* Travel: a number of LPR units are installed in different locations in city routes and the passing vehicle plate numbers are matched between the points. The average speed and travel time between these points can be calculated and presented in order to monitor municipal traffic loads. Additionally, the average speed may be used to issue a speeding ticket.
* Airport Parking: in order to reduce ticket fraud or mistakes, the LPR unit is used to capture the plate number and image of the cars. The information may be used to calculate the parking time or provide a proof of parking in case of a lost ticket—a typical problem in airport parking which have relatively long (and expensive) parking durations.

# 1.4 Objectives:

• Create a real time application

• Create a machine-vision model

• Implement a image segmentation for region of interest extraction

• Create Optical Character Recognition system with OpenCV

• Creating an API which can be deployed in other applications

• Developing an interactive user interface

# 1.5 Scope

Number plate recognition is realized by acquiring images of either the front or the rear of vehicles

with cameras and then by image processing to identify license plates. It consists of three mains

stages. First one is Number Plate Identification & Localization in this segment the visual of the

scene is improved with is image processing. Second is Character Segmentation in which characters

segmented from the detected number plate for retaining the useful information to the system so

that further processing can take place. Third is OCR Optical Character Recognition in which text

is transferred into encoded text information.

A feedforward Artificial Neural Network is used which is based on OCR Algorithms.

For this purpose, MATLAB matrix library is used. MATLAB is a high-level language and

interactive environment for numerical computation, visualization, and programming. Using

MATLAB, you can analyse data, develop algorithms, and create models and applications. The

language, tools, and built-in math functions enable you to explore multiple approaches and reach

a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or

Java.

MATLAB is used for the development of system in very limited time because we don’t have enough

time for development.

For enhancement of scene MATLAB’s image processing toolbox is used this toolbox provide

some built-in functions for reading image, cropping it, converting it into binary image then labelling

it for accessing the text in the scene.

For machine learning MATLAB’s Neural Network toolbox is used. This tool box provide built-in

functions for creating network, setting its parameters and its hyper parameters according to the

user requirements.