**DESIGN AND IMPLEMENTATION OF AN AUTOMATED CAR PLATE NUMBER RECOGNITION SYSTEM**

**ABSTRACT**

In rapidly developing countries, the number of vehicles has increased in accordance with the technology. The need to recognize the vehicles has increased in parallel to the number of the vehicles. Need of vehicle recognition was emerged for the cases of security, automatic switching systems, highway speed detection, light violation. License plate recognition system consists of three main topics: finding plate location from digital images, character segmentation from the plate images and character recognition from segmented characters. In this thesis, a study is conducted on character segmentation from plate image and character recognition from segmented characters.

Character recognition work has been examined through artificial neural networks in the previously conducted studies. Instead of Artificial Neuronal Networks or complex mathematical formula, this thesis takes the features (of the character) the human eyes perceive during recognition of the character into account. Plate image was reduced to gray level, the threshold value was calculated, and the plate image was converted into the binary system. The boundary of characters in the vertical and horizontal lines were scanned after plate image was converted into the binary system. For each character, the feature classes were created for the characters scanned from left to right, right to left, top to bottom, bottom to top. The character feature classes were compared to the previously prepared feature character class’s database. The rate which is similar to other characters of the character has been displayed to the user. T.C. license plate is used during working. The software was built using Java programming language and MySQL for data storage.

**CHAPTER ONE**

**INTRODUCTION**

**1.1 Background of the study**

Massive integration of information technology into all aspects of modern life caused demand for processing vehicles as conceptual resources in information systems. Because a standalone information system without any data has no sense, there was also a need to transform information about vehicles between the reality and information systems. This can be achieved by a human agent, or by special intelligent equipment which is able to recognize vehicles by their number plates in a real environment and reflect it into conceptual resources. Because of this, various recognition techniques have been developed and car plate recognition systems are today used in various traffic and security applications, such as parking, access and border control, or tracking of stolen cars.

A car registration plate is a metal of plastic plate attached to a motor vehicle for official identification purposes. The registration identifier is a numeric or alphanumeric code that uniquely identifies the vehicle within the issuing region’s database. In some countries, the identifier is unique within the entire country, while in others it is unique within a state or province. Whether the identifier is associated with a vehicle or a person also varies by issuing agency. Depending on the country, the vehicle registration plate may be called a license plate, tag, car plate or number plate. Most governments require a registration plate to be attached to both the front and rear of a vehicle, although certain jurisdictions or vehicle types, such as motorboats require only one plate, which is usually attached to the rear of the vehicle. National databases relate this number to other information describing the vehicle; such as the make, model, color, year of manufacture, engine size, type of fuel used, Vehicle Identification (Chassis) Number and the name and address of the vehicle’s registered owner or keeper.

The term access control refers to the practice of restricting entrance to a property, a building, or a room to authorized persons. Physical access control can be achieved by a human (a guard, bouncer, or receptionist) through mechanical means such as locks and keys, or through technological means such as access control systems.

Automatic car plate recognition (ACPR) is a mass surveillance method that uses optical character recognition on images to read vehicle registration plates. They can use existing closed-circuit television or road-rule enforcement cameras or ones specifically designed for the task. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals.

ACPR can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. ACPR technology tends to be region-specific, owing to plate variation from place to place.

The software aspect of the system runs on standard home computer hardware and can be linked to other applications or databases. It first uses a series of image manipulation techniques to detect, normalize and enhance the image of the car plate, and then optical character recognition (OCR) to extract the alphanumeric of the license plate. ACPR systems are generally deployed in one of two basic approaches: one allows for the entire process to be performed at the lane location in real-time, and the other transmits all the images from many lanes to a remote computer location and performs the OCR process there at some later point in time. When done at the lane site, the information captured of the plate alphanumeric, date-time, lane identification, and any other information required is completed in approximately 250 milliseconds. This information can easily be transmitted to a remote computer for further processing if necessary, or stored at the lane for later retrieval. In the other arrangement, there are typically large numbers of PCs used in a server farm to handle high workloads. Often in such systems, there is a requirement to forward images to the remote server, and this can require larger bandwidth transmission media.

During the 1990s, significant advances in technology took automatic car plate recognition systems from limited expensive, hard to set up, fixed based applications to simple “point and shoot” mobile ones. This was made possible by the creation of software that ran on cheaper PC based, non-specialist hardware that didn’t require the pre-defined angles, direction, size and speed in which the plates would be passing the cameras field of view.

**1.2 Statement of Problem**

Over the years, vehicles have been used to perpetrate crimes such as robbery and kidnapping. Auto theft has also been a major issue to the nation.

Law enforcement agencies are increasingly adopting automated car plate recognition (ACPR).ACPR systems function to automatically capture an image of the vehicle’s license plate,transform that image into alphanumeric characters using optical character recognition or similar software, compare the plate number acquired to one or more databases of vehicles of interest tolaw enforcement and other agencies, and to alert the officer when a vehicle of interest has been observed. The automated capture, analysis, and comparison of vehicle license plates typically occur within seconds, alerting the officer almost immediately when a wanted plate is observed.

Although the ACPR term includes a specific reference to “automated,” it should be noted that human intervention is needed insofar as the officer monitoring the equipment must independently validate that the ACPR system has accurately “read” the license plate, that the plate observed is issued from the same state as the one in which it is wanted, and to verify the currency of the alert, i.e., verifying that the reason this vehicle or the owner was wanted or of interest is still valid. Technologies to enhance their enforcement and investigative capabilities, expand their collection of relevant data, and expedite the tedious and time consuming process of manually comparing vehicle license plates with lists of stolen, wanted, and other vehicles of interest has to be developed. Police officers, sheriff deputies, and other law enforcement practitioners are often on the lookout for vehicles that have been reported stolen, are wanted in connection with a crime or traffic violation, are suspected of being involved in criminal or terrorist activities, are parking violation scofflaws, have failed to maintain current registration orto comply with statutory insurance requirements, or any of a number of other legitimate reasons.

**1.3 Aim and Objectives of the study**

The aim of this research work is to develop an application that will provide access control through automated car plate recognition.

The objectives of this study are as follows;

1. To assist law enforcement agencies in tracking stolen vehicles
2. To design a database that will serve as a repository for car plate numbers already registered.
3. To design a responsive system for crime detection
4. To ensure quick collection of data about vehicles within the scope of study.

**1.4 Significance of the study**

The proposed system will be of great advantage to Rivers state law enforcement agency, Rivers State Internal Revenue Service and other relevant authorities in the following ways;

1. ACPR can assist the police to identify persons of interest associated with criminal activity. According to a recent article, auto theft is associated with a wide range of criminal activities, including the offences of break and enter, armed robbery, and drug-related offences. In other words, offenders steal cars for use in the commission of additional offences. For example, drug offenders may steal from within cars, but may also steal the car to raise money to purchase drugs.
2. **Improved Performance and Efficiency:** There is no comparison between the number of plates an officer on patrol entering license plate information manually into an onboard computer and the number that automated ACPR technology can handle. With the potential ability to read up to 3,000 plates an hour, this technology can improve productivity. Not only does the system read plates rapidly, but hits are collected only on vehicles displaying license plates that match the desired criteria and appear in the database.
3. **Increased Crime Detection:** The substantially larger number of vehicles pulled over as a result of ACPR technology in patrol cars means that officers will come face to face with more criminals, generating more arrests. Officers attached to ACPR teams make 10 times more arrests than non-ACPR members. Arrests that are the result of ACPR stops are primarily for vehicle crimes, robbery, theft, burglary, and drug offenses. It is well known that car thieves steal cars not just to go for a drive but to help them commit other crimes such as breaking and entering, robbery, home invasion, and drug trafficking. In this way, ACPR technology can be valuable in preventing or solving many types of crime plaguing society.

**1.5 Scope of the study**

Every project is carried out to achieve a set of goals with some conditions keeping in mind that it should be easy to use, feasible and user friendly. As the goal of this project is to develop an application that will provide access control through automated car plate recognition, this system will be designed keeping in mind the conditions (easy to use, feasibility and user friendly) stated above. The proposed project’s intended users are; Rivers State Law enforcement agencies, Rivers State Internal Revenue Service and other relevant agencies.

**1.6 Definition of terms**

1. **Optical character recognition (OCR):** This is the mechanical or electronic conversion of images of typewritten or printed text into machine-encoded text. It is widely used as a form of data entry from printed paper data records. It is a common method of digitizing printed texts so that it can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as machine traslation, text-to-speech, key data and text mining. OCR is a field of research in pattern recognition, artificial intelligence and computer vision.
2. **Automatic Car Plate Recognition (ACPR):** This is a mass surveillance method that uses optical character recognition on images to read vehicle registration plates. They can use existing closed-circuit television or road-rule enforcement cameras or ones specifically designed for the task.
3. **Surveillance:** This is the monitoring of the behaviour activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. This can include observation from a distance by means of electronic equipment (such as CCTV cameras) or interception of electronically transmitted information using no, low or high technology methods.
4. **Car Plate:** A vehicle registration plate is a metal or plastic plate attached to a motor vehicles for official identification purposes. The registration identifier is a numeric or alphanumeric code that uniquely identifies the vehicle within the issuing region’s database.
5. **Automation:** This is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Most processes today have been completely automated.The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision.
6. **Access Control:** In the fields of physical security and information security, access control is the selective restriction of access to a place or other resource. The act of accessing may mean consuming, entering, or using. Permission to access a resource is called authorization. Locks and login credentials are two analogous mechanisms of access control.

**Auto theft:** Motor vehicle theft is the criminal act of stealing or attempting to steal a car (or any other motor vehicle).

**CHAPTER TWO**

**REVIEW OF RELATED LITERATURE**

**PREAMBLE**

This chapter focuses on the review of other author’s contribution in relevant areas of study. It will cover the following areas:

**2.1 Concept of Automated Number-plate Recognition**

Automatic number-plate recognition (**ANPR**; see also [other names](https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#Other_names) below) is a technology that uses [optical character recognition](https://en.wikipedia.org/wiki/Optical_character_recognition) on images to read [vehicle registration plates](https://en.wikipedia.org/wiki/Vehicle_registration_plate) to create [vehicle location data](https://en.wikipedia.org/wiki/Vehicle_location_data). It can use existing [closed-circuit television](https://en.wikipedia.org/wiki/Closed-circuit_television), [road-rule enforcement cameras](https://en.wikipedia.org/wiki/Road-rule_enforcement_camera), or cameras specifically designed for the task. ANPR is used by police forces around the world for law enforcement purposes, including to check if a [vehicle is registered](https://en.wikipedia.org/wiki/Vehicle_registration) or [licensed](https://en.wikipedia.org/wiki/Vehicle_licence). It is also used for [electronic toll collection](https://en.wikipedia.org/wiki/Electronic_toll_collection) on [pay-per-use roads](https://en.wikipedia.org/wiki/Road_pricing) and as a method of cataloguing the movements of traffic, for example by highways agencies.

Automatic number-plate recognition can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use [infrared](https://en.wikipedia.org/wiki/Infrared) lighting to allow the camera to take the picture at any time of day or night.[[1]](https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#cite_note-1)[[2]](https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#cite_note-2) ANPR technology must take into account plate variations from place to place. Du, Shan; Ibrahim, Mahmoud; Shehata, Mohamed; Badawy, Wael (2017).

Privacy issues have caused concerns about ANPR, such as government tracking citizens' movements, misidentification, high error rates, and increased government spending. Critics have described it as a form of [mass surveillance](https://en.wikipedia.org/wiki/Mass_surveillance). Martinsky, Ondrej (2007).

**Development**

ANPR was invented in 1976 at the Police Scientific Development Branch in Britain. Prototype systems were working by 1979, and contracts were awarded to produce industrial systems, first at EMI Electronics, and then at Computer Recognition Systems (CRS, now part of [Jenoptik](https://en.wikipedia.org/wiki/Jenoptik" \o "Jenoptik)) in [Wokingham](https://en.wikipedia.org/wiki/Wokingham), UK. Early trial systems were deployed on the [A1 road](https://en.wikipedia.org/wiki/A1_road_(Great_Britain)) and at the [Dartford Tunnel](https://en.wikipedia.org/wiki/Dartford_Tunnel). The first arrest through detection of a stolen car was made in 1981. However, ANPR did not become widely used until new developments in cheaper and easier to use software were pioneered during the 1990s. The collection of ANPR data for future use (*i.e*., in solving then-unidentified crimes) was documented in the early 2000s.[[6]](https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#cite_note-6) The first documented case of ANPR being used to help solve a murder occurred in November 2005, in [Bradford](https://en.wikipedia.org/wiki/Bradford), UK, where ANPR played a vital role in locating and subsequently convicting killers of [Sharon Beshenivsky](https://en.wikipedia.org/wiki/Murder_of_Sharon_Beshenivsky). Draghici, Sorin (2004).

**Components**

The software aspect of the system runs on standard home computer hardware and can be linked to other applications or [databases](https://en.wikipedia.org/wiki/Database). It first uses a series of image manipulation techniques to detect, normalize and enhance the image of the number plate, and then optical character recognition (OCR) to extract the [alphanumerics](https://en.wikipedia.org/wiki/Alphanumeric" \o "Alphanumeric) of the license plate. ANPR systems are generally deployed in one of two basic approaches: one allows for the entire process to be performed at the lane location in real-time, and the other transmits all the images from many lanes to a remote computer location and performs the OCR process there at some later point in time. When done at the lane site, the information captured of the plate alphanumeric, date-time, lane identification, and any other information required is completed in approximately 250 milliseconds. This information can easily be transmitted to a remote computer for further processing if necessary, or stored at the lane for later retrieval. In the other arrangement, there are typically large numbers of PCs used in a [server farm](https://en.wikipedia.org/wiki/Server_farm) to handle high workloads, such as those found in the [London congestion charge](https://en.wikipedia.org/wiki/London_congestion_charge) project. Often in such systems, there is a requirement to forward images to the remote server, and this can require larger bandwidth transmission media.

**Technology**

The [font](https://en.wikipedia.org/wiki/Typeface) on [Dutch plates](https://en.wikipedia.org/wiki/Dutch_vehicle_registration_plates) was changed to improve plate recognition.

ANPR uses [optical character recognition](https://en.wikipedia.org/wiki/Optical_character_recognition) (OCR) on images taken by cameras. When [Dutch vehicle registration plates](https://en.wikipedia.org/wiki/Dutch_vehicle_registration_plates) switched to a different style in 2002, one of the changes made was to the [font](https://en.wikipedia.org/wiki/Typeface), introducing small gaps in some letters (such as *P* and *R*) to make them more distinct and therefore more legible to such systems. Some license plate arrangements use variations in font sizes and positioning—ANPR systems must be able to cope with such differences in order to be truly effective. More complicated systems can cope with international variants, though many programs are individually tailored to each country.

The cameras used can be existing road-rule enforcement or closed-circuit television cameras, as well as mobile units, which are usually attached to vehicles. Some systems use infrared cameras to take a clearer image of the plates. Kwaśnicka, Halina; Wawrzyniak, Bartosz (2002).

**In mobile systems**

The [Dubai](https://en.wikipedia.org/wiki/Dubai) police use ANPR cameras to monitor vehicles in front and either side of the patrol car.

A [Merseyside Police](https://en.wikipedia.org/wiki/Merseyside_Police) car equipped with mobile ANPR

During the 1990s, significant advances in technology took automatic number-plate recognition (ANPR) systems from limited expensive, hard to set up, fixed based applications to simple "point and shoot" mobile ones. This was made possible by the creation of software that ran on cheaper PC based, non-specialist hardware that also no longer needed to be given the pre-defined angles, direction, size and speed in which the plates would be passing the camera's field of view. Further scaled-down components at more cost-effective price points led to a record number of deployments by law enforcement agencies around the world. Smaller cameras with the ability to read license plates at higher speeds, along with smaller, more durable processors that fit in the trunks of police vehicles, allowed law enforcement officers to patrol daily with the benefit of license plate reading in real time, when they can interdict immediately.

Despite their effectiveness, there are noteworthy challenges related with mobile ANPRs. One of the biggest is that the processor and the cameras must work fast enough to accommodate relative speeds of more than 100 mph (160 km/h), a likely scenario in the case of oncoming traffic. This equipment must also be very efficient since the power source is the vehicle battery, and equipment must be small to minimize the space it requires. Hoctor, Michelle (2012).

Relative speed is only one issue that affects the camera's ability to actually read a license plate. Algorithms must be able to compensate for all the variables that can affect the ANPR's ability to produce an accurate read, such as time of day, weather and angles between the cameras and the license plates. A system's illumination wavelengths can also have a direct impact on the resolution and accuracy of a read in these conditions.

Installing ANPR cameras on law enforcement in the vehicles requires careful consideration of the juxtaposition of the cameras to the license plates they are to read. Using the right number of cameras and positioning them accurately for optimal results can prove challenging, given the various missions and environments at hand. Highway patrol requires forward-looking cameras that span multiple lanes and are able to read license plates at very high speeds. City patrol needs shorter range, lower focal length cameras for capturing plates on parked cars. Parking lots with perpendicularly parked cars often require a specialized camera with a very short focal length. Most technically advanced systems are flexible and can be configured with a number of cameras ranging from one to four which can easily be repositioned as needed. States with rear-only license plates have an additional challenge since a forward-looking camera is ineffective with oncoming traffic. In this case one camera may be turned backwards. Kahraman, Fatih; Gokmen, Muhittin (2003).

2.2 **The Challenges Automated Plate Number Recognition**

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.[[101]](https://en.wikipedia.org/wiki/Automatic_number-plate_recognition#cite_note-101) 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 order to avoid surveillance or penalty charges, there has been an upsurge in car cloning. This is usually achieved by copying registration plates from another car of a similar model and age. This can be difficult to detect, especially as cloners may change the registration plates and [travel behavior](https://en.wikipedia.org/wiki/Travel_behavior) to hinder investigations.

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. Nakashima, Ellen (2014).

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. Friedersdorf, Conor (2014).

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. Angwin, Julia & Jennifer Valentino-DeVries (2012).

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. Balko, Radley (2015)..

**2.3 License Plate Recognition Processing**

In most cases, license plate localization is a necessary precursor to license plate recognition (LPR). We can group the methods used to locate the license plate’s location or region in images or videos in the literature into three processing categories: binary image, gray-level, and color. Character segmentation is an important precursor to character recognition, which we can similarly break down into the same three categories. To recognize segmented characters, several algorithms use pattern/template matching or learning-based classification. L. Miao, F. Wang, and H. Wang (2009), W. Wei (2001).

**Binary Image Processing**

To extract license plate regions from background images, techniques based on combinations of edge statistics and morphology can achieve good results. Some researchers have applied edge operators on a gray image after smoothing and normalizing to extract horizontal and vertical edge maps. They then perform statistical analysis on the edges to detect the license plate’s shape. The final decision is based on connected component analysis (CCA). This algorithm can achieve a 99.6 percent detection rate from 9,825 images—assuming that the license plate frame’s edges are clear and horizontal. To accommodate frames that were deformed or skewed, Hao Wooi Lim and Yong Haur Tay used maximally stable extremal regions to obtain a set of character regions.1 However, this method of extracting characters from the binary image to define the license plate region is time-consuming because it processes all binary objects. Furthermore, it gives an incorrect identification if there is other text in the image. Y.-C. Chiou et al. (2011).

**Gray-Level Processing**

Some researchers have exploited the contrast between the characters and the background—for example, Hsi-Jian Lee and colleagues considered blocks with a high edge magnitude and variance as the license plate region.2 Researchers have also applied image transformation methods based on the Hough transform (to detect straight lines) and Gabor filters (to analyze textures).2 However, this method is valid only when the image background is simple. Another disadvantage of this method is that the Hough transform’s computational complexity is very high. M.-L. Wang et al. (2010).

**Color Processing**

In many countries, license plate text and background colors are strictly fixed, based on algorithm design, but such algorithms still fail because of varying lighting conditions. Accurate plate location is fundamental to the whole recognition process’s success. Some researchers propose the use of color features to localize the plate, but this approach fails when plates have multiple colors. Yu-Chiun Chiou and colleagues proposed using vertical edge matching for plate recognition, but varying plate sizes or poor contrast between the plate and the car body make this method unreliable. Mu-Liang Wang and colleagues used horizontal scans of repeating contrast changes for plate recognition, but it suffers from a ringing effect that occurs along the edges of the filtered spatial domain image. Fully connected feed forward artificial neural networks with sigmoidal activation functions have also been used for character recognition, but the successful number plate identification rate is only 80 percent and processing time is 15 seconds. One study proposed a license plate detection method based on sliding concentric windows and a histogram, but it was both time-consuming and only suitable for Taiwanese plates. Zhen-Xue Chen and colleagues combined the rectangle shape, texture, and color features to extract the license plate, and had a success rate of 97.3 percent, but the process was too computationally complex and time-consuming. Another study used dynamic programming to extract license plate numbers, but the success rate of segmentation was only 84.5 percent. K. Deb, H.-U. Chae, and K.-H. Jo (2009).

**CHAPTER THREE**

**SYSTEM ANALYSIS AND METHODS**

**3.0 Research Methodology**

Robinson et al, 1970 define system analysis as the methodological study of a system, its current and the future required objectives and procedures in order to inform a basis for the system and the design. Jerry, 1989 also define system analysis as the process of analyzing system with the potential goals of improving and modifying it. In other words, system analysis is the detailed look at the current system and what a new system will be required to do; system analysis always leads to system design which is the development of new system that will meet the future requirements. The basic tool of system analysis is the ability is to prove, enquire, observe more and reconciles all what happens in any situation. With this alone, the information gathered is analyzed to identify the components of the system, creating a structure from which the essential requirements can most efficiently be met. The scope of the research covers the Motor Licensing office Abuja in the registration of vehicle and identification of missing vehicles in the country.

**3.1 Fact Finding Method Used**

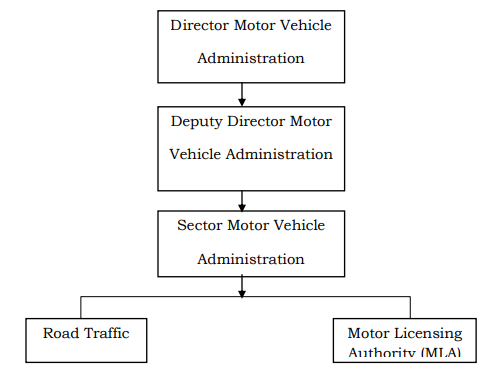
The data used in the study were collected from two sources of data collection, the primary and secondary source. Primary Source: This involves oral interviews conducted with various personnel in the licensing office Enugu state, the licensing office and the Board of Internal Revenue in reviewing and sharing their experience about 53 the difficulties they undergo in using the manual system in vehicle and plate number registration issuance and allocation. Secondary Source: These include the use of textbooks, dictionary, journals newspaper and Internet downloads to collect data in order to understand what the vehicle and plate number registration and identification is all about. Close Observation Method: This involves my personal visit to the Motor Licensing office Enugu. I observed the untidiness of the offices, long queue of the vehicle owners and the difficulties the staff face in preparing these documents.

**3.2 Analysis of Existing System**

Vehicle plate number recognition used to involve manual recording of vehicle’s information which ranges from cars to buses and later to trucks and heavy duty equipment on ledgers and tracking other related information such as registration, road worthiness test certificates, change of ownership, engine and chassis numbers; and expiration of road license. This process has been extremely inefficient and recovery of the information was not possible once ledgers were damaged or lost as it frequently occurs. The current manual process employed by the state agencies and parastatals charged with administering motor vehicle documentation and registration has over the years failed to effectively address the objectives of the stakeholders to the process i.e. the federal and state authorities, and the vehicle owners and users in the country.

An organization’s operation is always out by employing a particular system or method, which may be by use of machine or manual system of operation. Enugu motor licensing offices carries out their operation on motor vehicle registration manually. During this process of manual operation, the applicant who requires that his (New Vehicle, fairly use or Brand-New Vehicle) should be registered, the motor licensing Authority (M.L.A) expects him to fill three copies of form B. He should also come with the necessary documents like custom duty certificate, bill of entry, bill of lading, custom payment schedule, import duty certificate, receipt authenticating the total amount paid to the former owner be it government or the vehicle dealer together with the host of other document. These documents are checked in order to make sure that they are bear custom stamp and signature and also complete. After he has gone through this, he now instruct the inspector officer in writing on the completed form for the applicant to go ahead with registration of his vehicle as well state the fees to be paid for the vehicle. The fees are charged based on the following: The category of the vehicle The amount the vehicle is bought The purpose the vehicle will serve These fees are summarized below: N500.00 (Motorcycle) N1, 000.00 (Motor vehicle bought below one million naira) N20, 000.00 (Commercial vehicle bought up to one million naira) 55 N3, 000.00 (private vehicle bought up to one million naira) After the applicant has been charged the next person who is the inspection officer will now inspect the vehicle to know if the vehicle component numbers are filled in the form like the chassis and engine numbers with what he has on his vehicle. After inspection, the officer will now forward the form to the sub-cashier, who collects the money, write a receipt specifying the amount paid and pass back the receipt to the motor licensing authority for signing.

**3.2.1 Data Collection Flowchart**

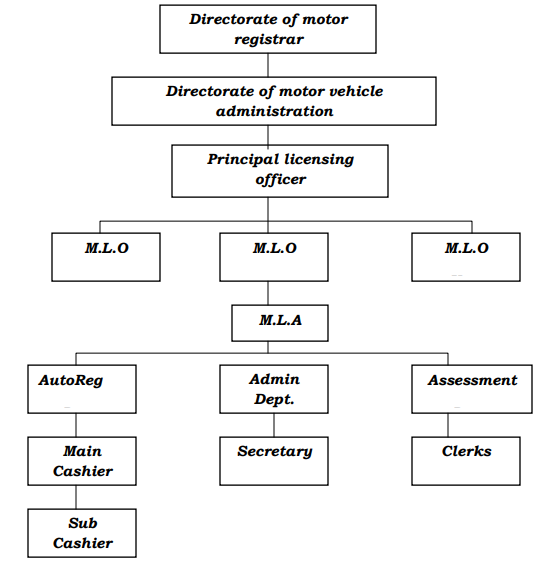


**Figure 3.1:** **Data Collection Flowchart**

**3.3 Organization Structure of Motor Licensing Office Abuja**

Board of internal revenue to an establishment that yields money for the government through motor licensing operation of which motor vehicle registration is one of the functions. Motor licensing office, Abuja is a body, which has their operational area at different local government and districts. Motor licensing office, Abuja has the Directorate of motor vehicle administration as one of the order of command. They are in charge of administration of motor licensing operations all over the state, which is headed by Directorate of motor registration who is under the order of chairman of board of internal revenue, which is the apex of this structure. Below the directorate of motor vehicle administration is the principal licensing officer who is in control of the urban licensing offices: M.L.O Gwagwalada M.L.O Wuse zone 3 and M.L.O Central Area. M.L.O. Wuse zone 3 operates under the command of motor licensing authority as the boss having three departments attached to it namely AutoReg, administration and assessment departments. Administration department is headed by a administration officers working under him is the secretary of this department in charge of correspondence, management and public affairs of the office. The assistant motor licensing authority heads assessment department. They are in charge of every inspection done both in the vehicle and the form. They have clerks that write for them. AutoReg is a proprietary, web-based, business solution, developed and trademarked by Courteville Business Solutions PLC, to address the inefficiencies of the motor-vehicle administration system in Nigeria. Courteville Business Solutions PLC is proud to be partnered with the following banks: Oceanic bank, Bank Phb, Sterling Bank, Afri Bank, Uba, Skye Bank, Fidelity Bank, Intercontinental Bank, Eco bank, Unity Bank, Wema Bank, Fin Bank. Government approved inspection officer’s heads AutoReg department and it is presently controlled by Fin Bank. Vehicle licenses are to be renewed annually and they give the vehicle the right to drive on Nigerian roads within that period. It has been designed to show the details of the vehicle owner and vehicle details. Since the commencement of AutoReg, over fifty thousand (50,000) cases of number plate duplication have been discovered and sorted out in Lagos State alone. The following are the inherent benefits of the AutoReg: Creation and maintenance of a credible data base and provision of accurate statistics of number of vehicles within the state We have more than doubled the revenue of the states the business solution has been deployed Quick and easy access to renewing genuine vehicle license The business solution model has been able to control crime in case of stolen vehicles Auto Reg was deployed first in Lagos State in (February 2007), Oyo (June 2008), Delta (Jun, 2008), Anambra (Mar 2008), Abia (Dec 2008), Rivers (Jan 2009), Enugu (Sept, 2008), Niger (Oct, 2009), Kebbi (Nov, 2009), Borno (Jan, 2010) and Sokoto (Jan, 2010) Auto Reg Hackney Permit: it is an automated permit issued to owners of commercial vehicles, trucks, buses, commercial motorcycles, staff buses and all 58 other heavy-duty vehicles. This was launched in Lagos State in Dec 2007,Oyo (Nov, 2008), Abia (Dec, 2008), Anambra (July, 2009), Niger (Oct, 2009) and Kebbi (Nov, 2009).

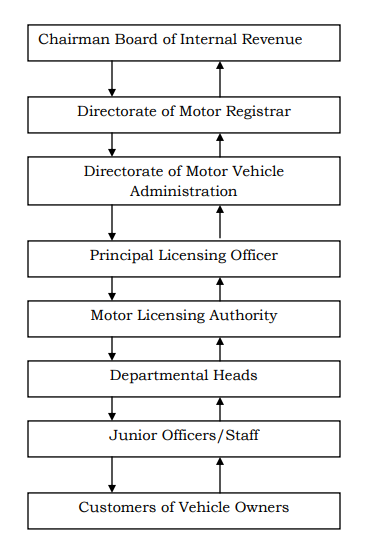
**3.3.1 Diagram Showing the Organization Structure**



**Fig 3.2: Organizational Structure**

**3.3.2 Information Flow Diagram**

Information, which is a source of organizational life, is important to be adequately communicated. The diagram below shows the way information flows in the motor licensing office.



**Figure 3.3: Information Flow Diagram**

**3.4 Objectives of the Existing System**

The existing system i.e. the manual system of operating motor licensing office has some objectives which they want to achieve as much as possible to its maximum. The following are the objectives: (i) This system aims at eliminating fraud by making the process to pass from one person to another yet it has not been possible since authorized officers still involve themselves in the work. (ii) This system has aimed at rendering/offering quick service to customers not minding that it is done by hand, which they know will help in pleasing their customers by attending to them within few minutes which has not been achieved. (iii) This existing system aims at keeping accurate account of money yielded in the registration of vehicles. (iv) This system keeps a comprehensive record of all registered vehicle owners in the states at large.

**3.5 Problems of the Existing System**

Presently, the mode of storage is both in paring form and in digitized (i.e computer) form. Owing to lack of proper database maintenance plan, database recovery plan coupled with the increase in the vehicle registration various problem raise their ugly head in various fashions. The problems are itemized below. • Poor performance experienced during information retrieval, due to Lack of efficient storage of data.

• Lack of proper, correct, accurate and concise information about the car owner. • The delay associated with the registration, because of the manual methods of operation.

• Lack of proper and accurate keeping of information about old records that have been stored for some time.

• The issue of security of records.

• Time wastage: some activities are time consuming in the system for instance, searching for a particular car owner’s record will take some time.

• As different people are in charge of registration, it is possible for registration anomalies to result.

• The problem of work monotony and tediousness that result from doing the same thing repeatedly.

**3.6 Evaluating the Existing System**

We can conclude that the existing system is: Ineffective Tedious Monotonous to its operation Inaccurate Inconsistent Incapacitated Unreliable Unproductive Substandard etc. Having considered all these, it becomes obvious that a new computerized system is needed.

**3.7 Justification of the Proposed System**

New system, which is computerized, has so many benefits that will obviate the problem experience in the current system. The need this new system cannot be over emphasized as it is aimed at achieving;

**(i) Accuracy of Computation:** Measures of accuracy will be achieved since the computer system will maintain stability in assigning fees based on assessment and making of accurate calculation.

**(ii) Neatness/Reduced Use of Paper:** Computerization gives room for production of a very neat job. Besides, since the vast volume of paper, which is used in keeping/storing information, will no longer be needed, it will help in keeping a very neat office.

**(iii) Reduction of Cost:** The computerized system will keep in reducing cost of operation due to constant production of forms and registers for keeping records as less form will be used.

**(iv) Use of Less Space for Record Storage:** There will be elimination of much space used in storing records by introducing a computer storage media (disks) which can keep vast volume of information in a less space.

**(v) Speed Optimization:** This will eliminate the problems of time wasting in registering records, checking from one line to the next as well as preparing a revenue report which is faster than using manual process to do it.

(vi) **Quick** **Retrieval of Information:** There will be fast retrieval of information, which has advantage over the manual system that enables the user to retrieve information faster most especially as it concerns the vehicle owner by making use of his/her vehicle registration number to call up their information than in manual system where you search for information record line after the other.

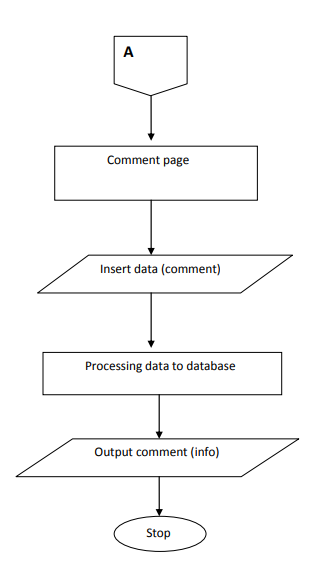
(vii) Less tedious (viii) Reliability (ix) Effectiveness and efficiency by reducing work intensity (x) Ease of update and maintenance of operation (xi) Consistency of data.

**CHAPTER FOUR**

**DESIGN, IMPLEMENTATION AND TESTING OF THE NEW SYSTEM**

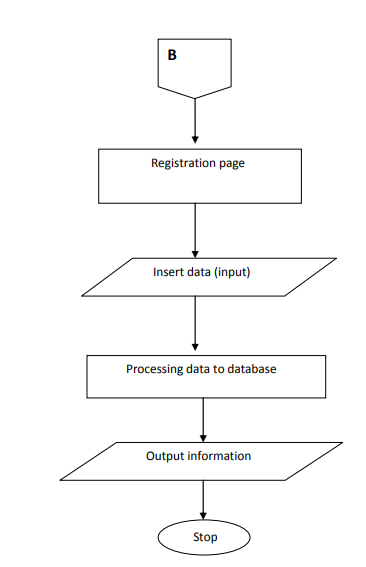
There is need for one to design system by showing what the system entails, identifying and defining the various components of the system before the actual implementation. The whole aim is to determine how the information can be built. This gives the design the chance of making a choice of the way the problem can best be solved.

**4.1 Comment Flowchart**



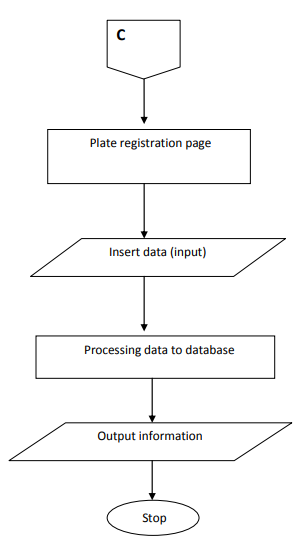
**Figure 4.1:** **Comment Flowchart**

**4.2 Registration Flowchart**

****

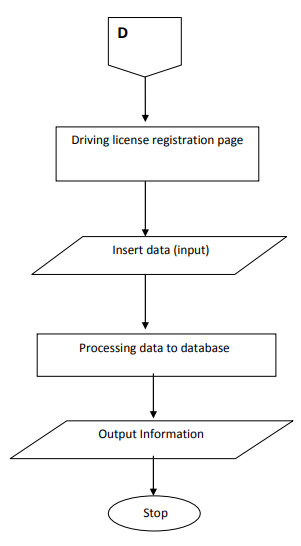
**Figure 4.2: Registration Flowchart**

**4.3 Plate Registration Flowchart**

****

**Figure 4.3: Plate Registration Flowchart**

**4.4 Driving License Registration Page**

****

**Figure 4.4: Driving License Registration Page**

**4.5 File Design**

A file is a collection of related records, which is made up of fields, field in this context means data items. Random file processing and access technique shall be employed because of the need for random retrieval of the needed record regardless of its location in the memory. The automated or computerized method of registration of a vehicle uses MySQL and the database holds its important data and their specifications.

**4.6 Implementation**

The implementation requirement for software development varies and these requirements depend on some predefined factors, at these points we won’t dwell on what those factors are but on what is required of the vehicle registration system. Another area of this systems development that is analyzed in this chapter is the use of modules, not only forms are used in this design. Modules are non-object oriented entities in visual basic that place an important role in programming application. The simplicity of the programming language employed in the developments of this software makes the whole development process less tasking, which is a very important feature of software development. The software can run conveniently on a system of Pentium IV processor with at least an operating system of window 8, considering the platform upon which the software was developed.

**4.7 Programming Paradigm and Methodology**

Understanding the method and paradigm of proper programming is essential in the implementation of presentable software. The following points are important in coming about this.

**- Writeability**

**- Readability**

**- Ability to handle exception**

**- Modifiability**

**- Optimisability**

**4.7.1 Writeability**

The ability to express a program in a way that is natural for the problem is an attribute of a good programming language, in that the write-ability of the programming language itself is a way that opens up an understanding of the problem solving the ability of the programs that is written therein. The programming platform used in the development of this software is highly writeable and easy to understand.

**4.7.2 Readability**

Another feature of a good programming language or of a well written programming code is the readability of codes, in that it should be easy to read through sequence of codes, how they follow through the achieving of what they are implemented to do.

**4.7.3 Ability to Handle Exceptions**

No written programming code is perfect in every sense, no matter the programming language used and so the ability to cater for unforeseen and expected errors in written code is very essential.

**4.7.4 Modifiability**

Think of a case when the line of code as stretched to a lengthy sum and in the implementation there are no modules (sub programs) when the need to modify the code comes up it becomes very tasking because every aspects of the program has to be modified which is not professional, it means therefore that another 73 feature of programming language is modifiable that is the ability to easily modify when the need arise.

**4.7.5 Optimisability**

Just like in the case of modifying, optimisability is more of been able to upgrade an already implemented program, often times when problems become larger the need to increase the efficiency of the program implemented to solve the problem becomes necessary and when the program is not written in a way that will not make that very easy, it determines the ability of the programming language even if it caters for such.

**4.8 System Performance Analysis**

In analyzing the performance of this software, some features would be considered one of which is the speed of information retrieval and storage though this might depend on the speed of the machine on which the program is installed considering this therefore this program was installed on a Pentium IV system with corresponding processor speed, it was observed that speed information storage and retrieval is real time i.e as soon as information is stored, it can be retrieved almost at the same time to reflect what was stored.

**4.9 System Specification/Requirement**

The system requirements are the software and hardware requirements. The system requires a set of instructions that controls a computer action. It is a computer program that accomplishes some specific applications or tasks. This software can be purchased or a user can develop the software from software developers. 74 The hardware requirements unlike software refer to the physical components of the computer i.e the peripherals in this design. The hardware and the software requirements for this system are listed below: System’s software application requirements System’s Hardware requirement.

**4.9.1 System’s software application requirements**

**Operating System:** Windows 8

**Software designer:** Micromedia Dreamweaver, Micromedia firework, flash, switchmax - Local Server (Xampp)

**4.9.2 System’s hardware requirement**

Pentium IV processor (minimum) - 256MB-4GB RAM/ memory space - 10GB hard disk space (minimum) - Standard keyboard - SVGA Colour monitor - Mouse - A Stabilizer - CD ROM driver or DVD driver - 1600V uninterrupted power supply (UPS).

**CHAPTER FIVE**

**SUMMARY, CONCLUSION AND RECOMMENDATION**

**5.1 Summary**

Automated car plate number recognition used to involve manual recording of vehicles information, which ranges from cars to buses and later to truck and heavy duty equipment. Plate number recognition in Nigeria began over 100 years ago and the records have been essentially manual which in turn is not helped to raise the efficiency of general automotive services in recent years. The federal government of Nigeria has identified economic development as a major for achieving the 2020 socio-economic development. The vehicle plate number recognition system is a must for any country that wants to be information and communication technology inclined and ready to reduce the car crime rate and corruption in her system.

**5.2 Conclusion**

The understanding of the problems that very peculiar to old car plate number recognition system was opened up also in the chapter one and three of this project these problems includes ineffective, time consuming, tedious, in accurate, inconsistent etc. which vary from operating system compatibility to machine dependencies. However big a software project is, these problems and more are what they face and the bigger the software are project the more probable it is that they face these problems. When the first computer was designed, the development of all that came after the first computer is founded on the concept of the very first and now it has gone from development of just computers to the development of software as this project is done so far. Vehicle Registration in Nigeria began over 100 years ago and the records have been essentially manual which in turn has not help to raise the efficiency of general automoted services in recent years. This was only focused on vehicle registration and inspection, and not on other supporting services such as vehicle tracking, learner’s driving permission, and drivers’ license management, monitoring of drivers and vehicles operations and documentation of both accident and crime report.

**5.3 Recommendations**

If one thing must be researched in the Computerization of car plate number recognition system with the mind of perfecting it and making it more useful in the real sense of things, it is the security of information handling software. The security of car plate number recognition system is very crucial considering the prevention of vehicle crime and similar vices so it is worth further researching. Therefore, I Recommend that motor licensing office in Abuja should set up a computer based system.

**REFERENCES**

[*"A License Plate Recognition algorithm for Intelligent Transportation System applications"*](https://web.archive.org/web/20080420191357/http:/www.aegean.gr/culturaltec/canagnostopoulos/cv/new%20site/journals.htm)*.*[*University of the Aegean*](https://en.wikipedia.org/wiki/University_of_the_Aegean)*and*[*National Technical University of Athens*](https://en.wikipedia.org/wiki/National_Technical_University_of_Athens)*. 2006. Archived from*[*the original*](http://www.aegean.gr/culturaltec/canagnostopoulos/cv/new%20site/journals.htm)*on 20 April 2008. Retrieved 24 January 2012.*

["A Real-time vehicle License Plate Recognition (LPR)"](http://visl.technion.ac.il/projects/2003w24/). VISL, Technion, 2003

["Algorithm for License Plate Recognition"](http://visl.technion.ac.il/projects/2002w02/) [Archived](https://web.archive.org/web/20070428203119/http:/visl.technion.ac.il/projects/2002w02/) 28 April 2007 at the [Wayback Machine](https://en.wikipedia.org/wiki/Wayback_Machine" \o "Wayback Machine). VISL, Technion. 2002.

[*"An Approach To License Plate Recognition"*](http://pages.cpsc.ucalgary.ca/~federl/Publications/licensePlate1996/license-plate-1996.pdf)*(PDF).*[*University of Calgary*](https://en.wikipedia.org/wiki/University_of_Calgary)*. 1996. Retrieved 24 January 2012.*[[*permanent dead link*](https://en.wikipedia.org/wiki/Wikipedia:Link_rot)]

[*"An introduction to ANPR"*](http://www.cctv-information.co.uk/i/An_Introduction_to_ANPR)*. Cctv-information.co.uk. Retrieved 11 March 2017.*

[*"Automatic Number Plate Recognition"*](http://www.cctv-information.co.uk/constant3/anpr.html)*. Cctv-information.co.uk. Retrieved 24 January2012.*

[*"Cameras for insurance verification considered"*](http://www.tulsaworld.com/news/article.aspx?subjectid=16&articleid=20091129_16_A20_OKLAHO172449)*.*[*Tulsa World*](https://en.wikipedia.org/wiki/Tulsa_World)*. 29 November 2009.*

[*"CCTV network tracks 'getaway' car"*](http://news.bbc.co.uk/1/hi/england/bradford/4455918.stm)*. BBC News. 21 November 2005. Retrieved 12 August 2013.*

[*"Forensic person tracking method and apparatus"*](http://www.google.com/patents/US20050075836)*. Google Patents. 7 April 2005. Retrieved 22 May 2016.*

[*"History of ANPR"*](http://www.anpr-international.com/history-of-anpr/)*. ANPR Internatonal. Retrieved 18 December 2019.*

[*"History of ANPR"*](http://www.anpr-international.com/history-of-anpr/)*. ANPR Internatonal. Retrieved 26 October 2020.*

[*"How are Innovations in Technology Transforming Policing?"*](https://web.archive.org/web/20130129220334/http:/policeforum.org/library/critical-issues-in-policing-series/Technology_web2.pdf)*(PDF). Police Executive Research Forum. January 2012. Archived from*[*the original*](http://policeforum.org/library/critical-issues-in-policing-series/Technology_web2.pdf)*(PDF) on 29 January 2013.*

[*"License Plate Reader Technology Enhances the Identification, Recovery of Stolen Vehicles"*](https://www.fbi.gov/about-us/cjis/cjis-link/september-2011/license-plate-reader-technology-enhances-the-identification-recovery-of-stolen-vehicles/)*. FBI. September 2011.*

[*"National ANPR Standards for Policing Part 2 – Infrastructure Standards"*](https://s3-eu-west-1.amazonaws.com/policeuk/uploads/20141015_NASP_Part_2_Approved_version_2.0.pdf)*(PDF). Home Office. October 2014. Retrieved 31 January 2016.*

[*"National ANPR Standards for Policing Part 3 – Data Access and Management Standards"*](https://s3-eu-west-1.amazonaws.com/policeuk/uploads/20141015_NASP_Part_3_Approved_version_2.0.pdf)*(PDF). Home Office. October 2014. Retrieved 31 January 2016.*

[*"National ANPR Standards for Policing: Part 1 – Data Standards"*](https://s3-eu-west-1.amazonaws.com/policeuk/uploads/20141015_NASP_Part_1_Approved_version_2.0.pdf)*(PDF). Home Office. October 2014. Retrieved 31 January 2016.*

[*"You Are Being Tracked"*](https://www.aclu.org/files/assets/071613-aclu-alprreport-opt-v05.pdf)*(PDF). American Civil Liberties Union. July 2013.*

Angwin, Julia & Jennifer Valentino-DeVries (29 September 2012).[*"New Tracking Frontier: Your License Plates"*](https://www.wsj.com/news/articles/SB10000872396390443995604578004723603576296)*. WSJ.*

Balko, Radley (1 December 2015).[*"The age of 'pre-crime' has arrived"*](https://www.washingtonpost.com/news/the-watch/wp/2015/12/01/the-age-of-pre-crime-has-arrived/)*. Washington Post.*

Draghici, Sorin (2004).[*"A neural network based artificial vision system for license plate recognition"*](https://web.archive.org/web/20051102215828/http:/vortex.cs.wayne.edu/papers/ijns1997.pdf)*(PDF). Dept. of Computer Science,*[*Wayne State University*](https://en.wikipedia.org/wiki/Wayne_State_University)*. Archived from*[*the original*](http://vortex.cs.wayne.edu/papers/ijns1997.pdf)*(PDF) on 2 November 2005. Retrieved 24 January 2012.*

Du, Shan; Ibrahim, Mahmoud; Shehata, Mohamed; Badawy, Wael (11 March 2017). *"Shan Du; IntelliView Technol., Inc., Calgary, AB, Canada; Ibrahim, M.; Shehata, M.; Badawy, Wael; Automatic License Plate Recognition (ALPR): A State-of-the-Art Review". IEEE Transactions on Circuits and Systems for Video Technology.****23****(2): 311–325.*[*CiteSeerX*](https://en.wikipedia.org/wiki/CiteSeerX_(identifier))[*10.1.1.352.2586*](https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.352.2586)*.*[*doi*](https://en.wikipedia.org/wiki/Doi_(identifier))*:*[*10.1109/TCSVT.2012.2203741*](https://doi.org/10.1109%2FTCSVT.2012.2203741)*.*[*S2CID*](https://en.wikipedia.org/wiki/S2CID_(identifier))[*206661467*](https://api.semanticscholar.org/CorpusID:206661467)*.*

Friedersdorf, Conor (19 February 2014).[*"Mass Surveillance of All Car Trips Is Nearly Upon Us"*](https://www.theatlantic.com/politics/archive/2014/02/mass-surveillance-of-all-car-trips-is-nearly-upon-us/283922/)*. The Atlantic.*

K. Deb, H.-U. Chae, and K.-H. Jo (2009). “Vehicle License Plate Detection Method Based on Sliding Concentric Windows and Histogram,” J. Computing, vol. 4, no. 8, 2009, pp. 771–777.

Kahraman, Fatih; Gokmen, Muhittin (2003).[*"License Plate Character Segmentation Based on the Gabor Transform and Vector Quantization"*](https://web.archive.org/web/20090320025941/http:/www.be.itu.edu.tr/~kahraman/License%20Plate%20Character%20Segmentation%20Based%20on%20the%20Gabor%20Transform%20and%20Vector%20Quantization.pdf)*(PDF). Archived from*[*the original*](http://www.be.itu.edu.tr/~kahraman/License%20Plate%20Character%20Segmentation%20Based%20on%20the%20Gabor%20Transform%20and%20Vector%20Quantization.pdf)*(PDF) on 20 March 2009. Retrieved 24 January 2012.*

Kwaśnicka, Halina; Wawrzyniak, Bartosz (2002).[*"License plate localization and recognition in camera pictures"*](https://www.ii.pwr.edu.pl/~kwasnicka/download/kwasnickawawrzyniak.pdf)*(PDF), AI-METH 2002 – Artificial Intelligence Methods November 13–15, Gliwice, Poland, retrieved 13 January 2014.*

L. Hsi-Jian, C. Si-Yuan, and W. Shen-Zheng, “Extraction and Recognition of License Plates of Motorcycles and Vehicles on Highways,” Proc. 17th Int’l Conf. Pattern Recognition (ICPR 04), 2004, pp. 356–359.

L. Miao, F. Wang, and H. Wang (2009). “Automatic License Plate Detection Based on Edge Density and Color Model,” Proc. IEEE Control and Decision Conf. (CDC 09), 2009, pp. 3718–3721.

M.-L. Wang et al. (2010). “A Vehicle License Plate Recognition System Based on Spatial/Frequency Domain Filtering and Neural Networks,” Proc. 2nd Int’l Conf. Computational Collective Intelligence: Technologies and Applications (ICCI 10), LNCS 6423, Springer, 2010, pp. 63–70.

Martinsky, Ondrej (2007).[*"Algorithmic and mathematical principles of automatic number plate recognition systems"*](http://javaanpr.sourceforge.net/anpr.pdf)*(PDF). Brno University of Technology. Retrieved 24 January2012.*

Nakashima, Ellen (19 February 2014).[*"Department of Homeland Security cancels national license-plate tracking plan"*](https://www.washingtonpost.com/world/national-security/dhs-cancels-national-license-plate-tracking-plan/2014/02/19/a4c3ef2e-99b4-11e3-b931-0204122c514b_story.html)*. Washington Post.*

W. Wei (2001). “An Automatic Method of Location for Number-Plate Using Color Feature,” Proc. IEEE Int’l Conf. Image Processing (ICIP 01), 2001, pp. 782–785.

Y.-C. Chiou et al. (2011). “Optimal Locations of License Plate Recognition to Enhance the Origin-Destination Matrix Estimation,” Proc. Eastern Asia Soc. Transportation Studies, vol. 8, 2011, pp. 1–14.