# IOT Based QR and Bar-code Scanner & ANPR

### INTERNSHIP REPORT

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## BONAFIDE CERTIFICATE

#### Certified that this project report titled “**IOT BASED QR AND BARCODE SCANNER AND ANPR**” is the bonafide work of “**ROHIT KUMAR MOHANTY [Reg No: RA1911004010259]**”, who carried out the project work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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# DECLARATION

I the undersigned solemnly declare that the project report is “**IOT BASED QR AND BARCODE SCANNER AND ANPR**” based on our work carried out during the course of my study.

I assert the statements made and conclusions are drawn are an outcome of my project work. I further certify that:

1. The work contained in the report is original and has been done by me under the general supervision of our supervisor.
2. The work has not been submitted to any other Institution for any other degree

/diploma/certificate in this university or any other University of India or abroad.

1. We have followed the guidelines provided by the university in writing the report.
2. Whenever I have used materials (data, theoretical analysis, and text) from other sources, I have given due credit to them in the text of the report and given their details in the references.

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# BROAD AREA OF WORK SPECIFIED BY INDUSTRY

#### KritiLabs has built the proprietary IMS framework for providing Managed Services in IoT including implementation, field support and service, technical &amp; customer support as part of its ALS IoT platform. This services framework allows for meticulous execution and maintenance of large scale IoT deployments across multiple geographies. The services framework offers centralized dashboards and views thereby making coordination between multiple teams much easier and helping deliver superior customer value and satisfaction.

#### An embedded system is a combination of computer hardware and software designed for a specific function. Embedded systems may also function within a larger system. The systems can be programmable or have a fixed functionality. Industrial machines, consumer electronics, agricultural and processing industry devices, automobiles, medical equipment, cameras, digital watches, household appliances, airplanes, vending machines and toys, as well as mobile devices, are possible locations for an embedded system.

#### While embedded systems are computing systems, they can range from having no user interface (UI) -- for example, on devices designed to perform a single task -- to complex graphical user interfaces (GUIs), such as in mobile devices. User interfaces can include buttons, LEDs (light-emitting diodes) an touchscreen sensing. Some systems use remote user interfaces as well.

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##### ROHIT KUMAR MOHANTY

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# ABBREVIATIONS

**ANPR** Automatic Number Plate Recognition

**ML** Machine Learning

**IOT**  Internet Of Things

**IDE** Integrated Development Environment

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# CHAPTER 1

## INTRODUCTION

I completed my internship with Kriti Labs in Chennai, which offers a platform for learning the fundamentals and applying concepts to real-world issues. I spent three months working as an intern. Regarding the company’s objective, vision, and purpose

• Mission: To provide solutions in areas of security, process enforcement and compliance management to different industries thereby helping them to improve the productivity of their assets.

• Vision: Add value in every human endeavor that is limited either by geography or process complexity.

• Purpose: Value addition through digital transformation.

Kriti Labs devices are built to the highest international standards and are certified and approved by industry and regulatory bodies. We ensure that we offer the best of our solutions and services to our customers. Kriti Labs have been consistently recognized by the industry for the innovative IoT platform solutions and the services that we provide to our customers. Kriti Labs was awarded the Sir Visveswarya award for Best Startup of the Year by the CM of Tamil Nadu Mr. MK Stalin organized by AIMO on April 23, 2022. Kriti Labs Technologies Pvt. Ltd was awarded the ‘Start -up of the Year’ award at TiECON 2019 – the largest entrepreneurship conference in Tamil Nadu. Kriti Labs Technologies has been recognized as the Best Emerging IoT &amp; Hardware company in India by Nasscom for the year 2019 at the conference held in Bangalore.

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# IOT Based QR and Bar-code Scanner

The widespread use of barcodes and QR codes in the retail industry. Supermarkets, shopping centers, and electronic stores use labels with barcodes to identify and track their inventory, making it easier for cashiers to scan items and generate bills. QR codes have become increasingly popular in online shopping warehouses, where scanners are used to recognize, classify, and track products.

Furthermore, digital payment systems like UPI have facilitated the use of QR codes for payment, making it fast and easy for customers to pay without having to enter all their bank information. Barcode scanners are electronic devices that use a built-in laser to read barcodes and output the numerical information they represent, eliminating the need for manual input and saving time and resources.

The use of barcodes and QR codes has revolutionized the retail industry, making it more efficient and convenient for customers and businesses alike. The technology has simplified tasks such as inventory tracking, product routing, and payment processing, reducing the workload for employees and improving the overall shopping experience for customers. With continued advancements in digital payment systems and automated warehouses, the use of barcodes and QR codes is expected to grow even more in the future.

# AUTOMATIC NUMBER PLATE RECOGNIZATION

Automatic number-plate recognition (ANPR) is a technology that uses optical character recognition (OCR) on images of vehicle registration plates to capture and analyze vehicle location data. The technology can be integrated into existing closed-circuit television systems, road-rule enforcement cameras or cameras specifically designed for the task. ANPR technology is used worldwide by police forces for law enforcement purposes, such as checking if a vehicle is registered or licensed. ANPR is also used for electronic toll collection on pay-per-use roads and to catalog traffic movements by highways agencies.

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The ANPR system can store images captured by the cameras and the text from the license plate. In some cases, the system can be configured to store a photograph of the driver. ANPR systems commonly use infrared lighting to allow the camera to take pictures at any time of day or night.

ANPR technology is a powerful tool for law enforcement agencies, allowing them to monitor and track vehicle movements in real-time. The system can be used to identify unregistered or stolen vehicles, track down suspects, and monitor traffic flow. ANPR technology has also been integrated into electronic toll collection systems, making it easier to manage tolls and reduce congestion on busy roads.

While ANPR technology has many benefits, it also raises concerns about privacy and data security. Some people feel that ANPR systems are an invasion of privacy, as they allow law enforcement agencies to track their movements without their knowledge or consent. Others worry that the data collected by ANPR systems could be misused or stolen, putting individuals' personal information at risk. Overall, ANPR technology is a powerful tool that requires careful regulation and oversight to ensure that it is used ethically and responsibly.

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# CHAPTER 2

**LITERATURE SURVEY**

# An Introduction to QR Code Technology

A QR code, short for "Quick Response," is a type of matrix bar code or two-dimensional code that is designed to store data information and be quickly read by smartphones. It is made up of black modules arranged in a square pattern on a white background. The information encoded within a QR code can be text, a URL, or any other type of data.

The popularity of QR codes is rapidly increasing worldwide, and they are now commonly recognized by mobile phones with built-in cameras. The technology was developed by Denso Wave, a subsidiary of Toyota, in 1994 for tracking inventory in vehicle parts manufacturing. QR codes were designed to overcome the limitations of traditional barcodes, which can only hold 20 alphanumeric characters.

The QR code system comprises a QR code encoder and decoder. The encoder is responsible for encoding data and generating the QR code, while the decoder decodes the data from the QR code. QR codes have many applications, such as enabling fast, easy payments through digital payment systems like UPI. They are also used for advertising and marketing purposes, with QR codes printed on billboards, flyers, and posters, and in product packaging.

In conclusion, QR codes are an innovative and efficient way of storing and transmitting data. Their versatility has made them a ubiquitous feature in many industries, from marketing and advertising to payment systems and supply chain management. However, as with any technology, it is vital to use QR codes responsibly and securely, and to be aware of potential risks associated with their use.

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# Automatic Number Plate Recognition System (ANPR): A Survey

Traffic control and vehicle owner identification are critical issues in many countries due to the increasing number of vehicles and traffic violations. Sometimes, it can be challenging to identify the owner of a vehicle that violates traffic rules and drives too fast, making it impossible for traffic personnel to retrieve the vehicle number from the moving vehicle due to its speed. As a result, there is a need to develop an Automatic Number Plate Recognition (ANPR) system to address this issue.

Today, several ANPR systems are available, each based on different methodologies. However, it remains a challenging task due to factors such as the high speed of the vehicle, non-uniform vehicle number plates, the language of vehicle numbers, and different lighting conditions that can significantly impact the overall recognition rate. Most systems work under these limitations.

The paper discusses various approaches to ANPR by considering image size, success rate, and processing time as parameters. The researchers analyze different ANPR systems' performance and provide a comparative analysis of their results. The paper concludes by proposing an extension to ANPR that could improve its accuracy and efficiency.

In conclusion, ANPR systems can be an effective solution to the problem of traffic control and vehicle owner identification. However, the success of these systems depends on the methodology used, image size, lighting conditions, and other factors. Therefore, researchers continue to develop and improve ANPR systems to enhance their accuracy and efficiency in identifying vehicles and their owners

# A QR code based framework for auto-configuration of IoT sensor networks in buildings

Buildings consume a significant amount of energy and contribute a considerable portion of the world's carbon emissions. However, the lack of efficient energy management systems in most existing buildings is a challenge due to high installation costs. To overcome this challenge, the use of IoT sensor networks to retrofit medium and large-sized buildings is proposed to enable energy management capabilities in a cost-effective manner. An auto-configuration platform for building energy management, based on IoT networks, was developed. The use of dynamic QR codes was suggested to efficiently manage metadata related to location and devices in the database. Additionally, different sensor-gateway pairing strategies were evaluated to ensure optimal configuration and total configuration time with an emphasis on communication signal strength quality. The proposed system was implemented and demonstrated in a medium-sized building case study, indicating its cost-effectiveness and potential for deployment in both new constructions and existing buildings.

The proposed system aims to enable energy management capabilities by retrofitting existing buildings with IoT sensor networks. This system offers a cost-effective solution for building energy management, and it has been demonstrated to be effective in a medium-sized building case study. A unique feature of the system is the use of dynamic QR codes in the database for efficient management of metadata related to location and devices. The auto-configuration platform for building energy management enables optimal configuration and total configuration time with an emphasis on communication signal strength quality, which is a significant factor in ensuring the success of the system.

Overall, the system offers an excellent alternative to expensive energy management systems in existing buildings, enabling more efficient energy management at a lower cost. The proposed system is a significant advancement in energy management technology and has the potential to contribute to reducing carbon emissions from buildings, which are responsible for about 30% of the global carbon emissions.

# CHAPTER 3

**RESEARCH METHODOLOGY**

# Statement of the problem

**3.1.1 IOT Based QR and Bar code Scanner**

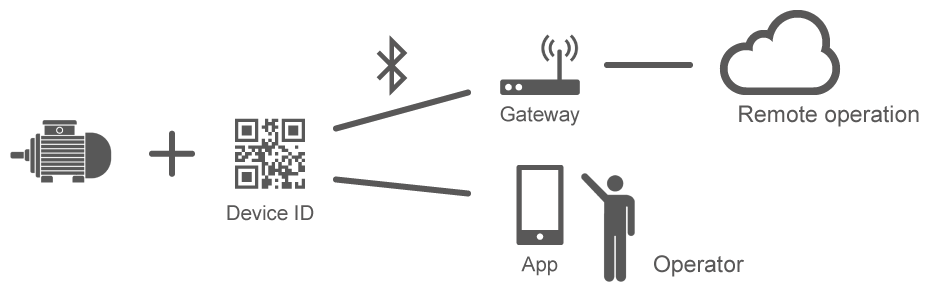
The use of QR and barcodes has become increasingly popular in various industries, including retail, manufacturing, and logistics. These technologies provide a simple and efficient way to track inventory, manage assets, and improve customer engagement. However, traditional scanning methods can be time-consuming and error-prone, especially when dealing with large volumes of data. Moreover, the lack of real-time data processing and integration with other systems limits the potential benefits of QR and barcodes.

To overcome these limitations, an IoT-based QR and Barcode scanner system can be developed. This system would leverage the power of IoT to automate the scanning process, allowing for faster and more efficient data collection. The system would be equipped with sensors and gateways to facilitate real-time data transmission and processing. This would enable the integration of QR and barcode data with other systems, such as inventory management and CRM tools, providing a comprehensive view of operations.

In addition to real-time data processing and integration capabilities, the IoT-based QR and Barcode scanner system should also be cost-effective and scalable. This would ensure that the system can be deployed in various environments and use cases, making it accessible to businesses of all sizes. The system should also be user-friendly, with a simple and intuitive interface that allows for easy setup and configuration.

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Overall, the development of an IoT-based QR and Barcode scanner system has the potential to revolutionize various industries by providing a faster, more efficient, and more integrated solution for data collection and analysis. The system can facilitate better decision-making, improve operational efficiency, and enhance customer engagement. With the growing adoption of IoT technologies, the demand for such a system is expected to increase, creating new opportunities for innovation and growth.

**Figure 3.1: IOT Based QR scanner in Cloud**

**3.1.2 Automatic Number Plate Recognization**

Automatic Number Plate Recognition (ANPR) is a technology that seeks to automate the identification of vehicles and their owners for various purposes such as traffic control, law enforcement, and vehicle tracking. The traditional methods of manual identification by traffic personnel are time-consuming, inefficient and often unreliable, particularly in high-speed violation scenarios. ANPR technology addresses this issue by using optical character recognition on images of vehicle license plates to create vehicle location data. However, the effectiveness of ANPR is limited by factors such as the high speed of vehicles, non-uniformity of license plate design, variability in lighting conditions, and the diversity of languages used on license plates.

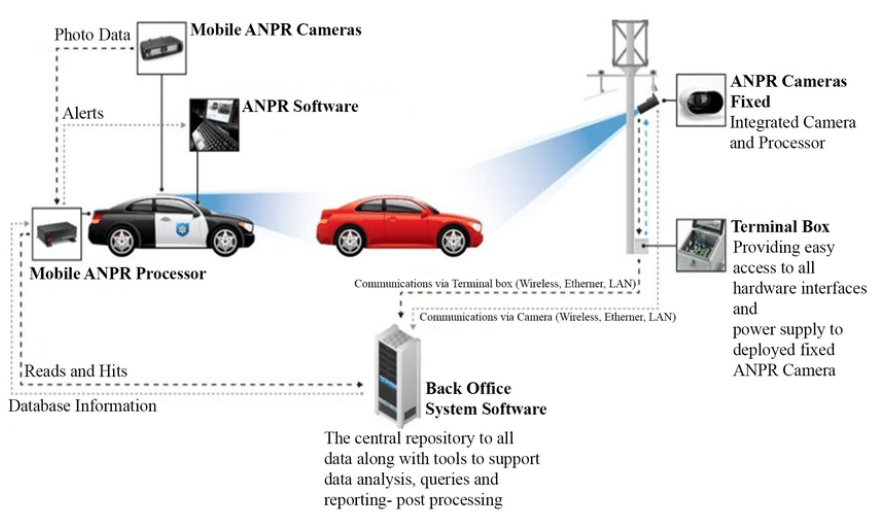
ANPR systems aim to address these challenges by developing technologies that can achieve high recognition rates and accuracy, irrespective of the vehicle speed, lighting conditions, and license plate design. ANPR systems have become an

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important part of modern traffic management systems and have enabled the effective use of data for a range of applications. For instance, ANPR systems can be used to monitor traffic flow and congestion, control access to restricted areas, track the movement of stolen vehicles, and detect parking violations.

Despite the benefits of ANPR, the cost and complexity of implementing these systems can be a barrier to adoption, particularly for smaller and less developed countries. Therefore, there is a need for ANPR systems that are cost-effective, easy to implement, highly accurate and reliable. Additionally, ANPR systems must be designed to accommodate a range of license plate designs and languages used across the globe, making it important to develop versatile and adaptable technologies.

In summary, ANPR aims to address the challenges associated with manual vehicle identification, including time-consuming and unreliable processes. The development of ANPR systems has enabled efficient data collection and use for various applications. However, the effectiveness of ANPR is limited by factors such as vehicle speed, lighting conditions, and license plate design. Therefore, there is a need to develop ANPR systems that are cost-effective, easy to implement, and highly accurate and reliable to enable efficient traffic management and law enforcement globally.



**Figure 3.2: Work Flow of ANPR**

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# Need for the Study

The study of IoT-based QR and Barcode scanner is essential to address the limitations of traditional scanning methods and to facilitate the adoption of these technologies in various industries. With the growing need for efficient inventory management, asset tracking, and retail operations, the automation of the scanning process and real-time data processing and integration capabilities provided by IoT-based scanners are crucial. The study will provide insights into the development of a cost-effective and scalable system that can connect with other IoT devices, such as sensors and gateways, for efficient data collection and transmission.

Moreover, the study will enable researchers to explore the potential use cases of IoT-based QR and Barcode scanners beyond their traditional applications. For instance, the system can be used for contactless payments and access control in public places such as airports, hospitals, and offices. The integration of IoT-based scanners with other technologies such as artificial intelligence and blockchain can enhance their functionality and security, creating new opportunities for data-driven decision-making.

Furthermore, the study can benefit small and medium-sized enterprises that may lack the resources to develop their own IoT-based scanning systems. The development of a cost-effective and easy-to-implement system can enable these businesses to adopt these technologies and improve their operational efficiency, leading to increased competitiveness and profitability.

Overall, the study of IoT-based QR and Barcode scanners is essential to meet the growing demand for efficient and reliable scanning technologies, to explore their potential beyond traditional applications, and to benefit small and medium-sized enterprises.

There is a growing need for ANPR systems due to the increasing demand for efficient traffic control and law enforcement. ANPR can help improve public safety by identifying and tracking vehicles involved in criminal activity or traffic violations. Additionally, ANPR systems can be used for toll collection, parking management, and congestion pricing. ANPR also has applications in supply chain management and logistics, as it can help track the movement of goods and vehicles.

However, the effectiveness of ANPR is limited by various factors, including non-uniformity of license plate design, variability in lighting conditions, and the high speed of vehicles. As a result, there is a need to improve the accuracy and reliability of ANPR systems to overcome these challenges. Furthermore, there is a need to make ANPR systems more cost-effective and accessible, especially for smaller and less developed countries that may not have the resources to invest in expensive systems.

Therefore, the study of ANPR can help identify ways to improve the accuracy, reliability, and cost-effectiveness of ANPR systems. It can also help identify best practices for implementing ANPR systems and address potential ethical and privacy concerns associated with the use of ANPR. Additionally, the study of ANPR can help identify new applications and use cases for ANPR systems beyond their traditional roles in traffic control and law enforcement. Overall, the study of ANPR is important for improving public safety, enhancing logistics and supply chain management, and enabling new opportunities for data-driven decision-making.

# Objectives

* The IoT-based QR and Barcode scanner system is to automate the scanning process of QR and Barcode technologies, providing real-time data processing and integration capabilities. By connecting with other IoT devices, such as sensors and gateways, the system enables efficient data collection and transmission, improving operational efficiency and enabling new opportunities for data-driven decision-making. The system should be cost-effective and scalable to accommodate various environments and use cases. Overall, the objective of this technology is to facilitate the adoption of QR and Barcode technologies in various industries.
* The ANPR is to accurately and efficiently identify vehicles and their owners for the purpose of traffic control, law enforcement, and vehicle tracking. The technology seeks to automate the identification process by using optical character recognition on images of vehicle license plates to create vehicle location data, while overcoming challenges such as speed, variability, and cost.

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# Tools

### Arduino IDE:

The Arduino Integrated Development Environment (IDE) is a software tool used to program and develop code for Arduino boards. It provides a simple and user-friendly interface for beginners to start programming and developing electronic projects with Arduino. The Arduino IDE is based on the Processing programming language and uses a simplified version of the C++ programming language to make it easier to use and understand.

The Arduino IDE is available for Windows, Mac OS X, and Linux operating systems and is free to download from the official Arduino website. It supports a wide range of Arduino boards, including the popular Arduino Uno, Arduino Mega, and Arduino Nano, as well as other boards based on the Atmel AVR and ARM processors.

One of the key features of the Arduino IDE is the "Sketch" environment, which provides a simple and intuitive way to write and upload code to Arduino boards. Users can write code in the Arduino Sketch, verify the code for syntax errors, and upload the code to the board with the click of a button. The Sketch also includes a built-in Serial Monitor, which allows users to send and receive data between the Arduino board and their computer.

Another important feature of the Arduino IDE is the library manager, which provides access to a wide range of pre-written libraries for commonly used sensors, displays, and other electronic components. These libraries can be easily added to an Arduino project with just a few clicks, saving time and effort in developing complex projects.

The Arduino IDE also supports third-party libraries and can be extended with plug-ins and add-ons, making it a flexible and powerful tool for developers and hobbyists alike. It also includes a comprehensive set of tools for debugging and troubleshooting code, such as a step-by-step debugger and a memory monitor.

In summary, the Arduino IDE is a powerful and easy-to-use tool for programming and developing electronic projects with Arduino boards. Its intuitive interface and wide range of features make it an ideal choice for beginners and experienced developers alike. Whether you are developing a simple LED blink program or a complex robotic project, the Arduino IDE provides everything you need to get started and bring your ideas to life.

### QR Module Command Set:

A QR (Quick Response) module is a device that can read and interpret QR codes. These modules usually come with a set of commands that can be used to interact with them and perform various functions. In this section, we will explain the commonly used command set for QR modules.

* **Initialization Command:** This command initializes the QR module and prepares it for use. It is usually sent to the module when it is first powered on.
* **Set Baud Rate Command:** This command sets the communication baud rate between the QR module and the host device. The baud rate must be the same on both devices to ensure proper communication.
* **Set Data Output Format Command:** This command sets the output format of the data read by the QR module. The module can output data in various formats such as ASCII, binary, or hexadecimal.
* **Set QR Code Version Command:** This command sets the QR code version that the module can read. QR codes come in different versions with varying data capacity, and the module must be configured to read the appropriate version.
* **Set QR Code Error Correction Level Command:** This command sets the error correction level for the QR code. QR codes have different error correction levels, which determine the amount of data that can be recovered if the code is damaged.

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* **Start Scanning Command:** This command instructs the QR module to start scanning for QR codes.
* **Stop Scanning Command:** This command stops the scanning process of the QR module.
* **Get Scanned Data Command:** This command retrieves the data read by the QR module. The data can then be processed by the host device.
* **Set LED Command:** This command sets the status of the LED on the QR module. The LED can be used to indicate the scanning status or to provide feedback to the user.

In summary, the command set for QR modules provides a way to interact with these devices and configure them for use in various applications. By using these commands, developers can create custom applications that read and process QR codes using these modules.

**3.4.3 Machine Learning:**

Machine Learning tutorial provides basic and advanced concepts of machine learning. Our machine learning tutorial is designed for students and working professionals.

Machine learning is a growing technology which enables computers to learn automatically from past data. Machine learning uses various algorithms for **building mathematical models and making predictions using historical data or information.** Currently, it is being used for various tasks such as **image recognition, speech recognition, email filtering, Facebook auto-tagging,**recommended **system,** and many more.

This machine learning tutorial gives you an introduction to machine learning along with the wide range of machine learning techniques such as **Supervised, Unsupervised,** and**Reinforcement** learning. You will learn about regression and classification models, clustering methods, hidden Markov models, and various sequential models.

# Limitations

* + - **Limited data storage:** QR codes can store more data than traditional barcodes, but their capacity is still limited. This can be a limitation when attempting to store large amounts of data or when trying to encode complex information.
    - **Sensitivity to damage:** QR codes and barcodes can become damaged or scratched, which can make them unreadable by scanners. This can be a problem when trying to use them in harsh environments or when trying to scan old or worn-out codes.
    - **Dependence on technology:** QR and barcode scanners require the use of technology, such as a smartphone or dedicated scanner, to read the code. This can be a limitation when trying to use these codes in areas without reliable technology infrastructure.
    - **Accuracy:** The accuracy of ANPR systems can be affected by various factors such as the quality of the camera, the lighting conditions, the angle of the camera, and the speed of the vehicle. Inaccurate readings can result in false positives or negatives, which can be detrimental in law enforcement and other applications.
    - **Non-uniformity of license plates:** License plates can vary in size, shape, color, and font depending on the country, region, or state. This can make it difficult for ANPR systems to recognize all types of license plates accurately.
    - **Environmental factors:** Environmental factors such as weather conditions, road conditions, and the presence of other vehicles can also affect the accuracy of ANPR systems.

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# Realistic Constraints

There are also several realistic constraints that must be considered. Some of these constraints include:

1. **Lighting conditions:** ANPR systems require sufficient lighting to capture high-quality images of license plates. Poor lighting conditions, such as darkness or glare, can affect the accuracy and reliability of the system.
2. **License plate design:** License plates can vary significantly in terms of their design, font, and color scheme, depending on the issuing authority and country. ANPR systems must be able to recognize and interpret these variations accurately.
3. **Speed of vehicles:** ANPR systems must be able to capture clear images of license plates, even when vehicles are moving at high speeds. This can be challenging due to motion blur or other distortions in the image.
4. **Vehicle orientation:** ANPR systems are designed to recognize license plates from specific angles and distances. If a vehicle is not positioned correctly, the ANPR system may not be able to capture a clear image of the license plate.
5. **Cost:** ANPR systems can be expensive to install and maintain, particularly in cases where the technology is being implemented on a large scale, such as for city-wide traffic monitoring. This can be a significant barrier to adoption for smaller or less developed countries.

IoT-based QR and Barcode scanners have various constraints that limit their performance and capabilities. One of the primary constraints is the requirement for stable and reliable connectivity to transmit data in real-time. Any disruption in the network connection can hinder the effectiveness of the system, leading to delays and inaccuracies in data processing. Additionally, the quality and readability of the codes can be affected by various factors, such as damage to the codes, low light conditions, and the use of low-quality printing or scanning equipment. The system may also face challenges in detecting and identifying codes that are placed in difficult-to-reach locations, such as behind other objects or in tight spaces.

Another limitation is the need for regular maintenance and updates to keep the system functioning optimally. The software and hardware components of the system need to be regularly checked and updated to ensure they are performing efficiently and effectively. This maintenance can be time-consuming and may require skilled personnel to carry out, adding to the overall cost of the system.

# CHAPTER 4

**PROCESS OF AUTOMATIC NUMBER PLATE RECOGNIZATION**

# DATA ANNOTATION

Data annotation is the process of adding metadata or labels to raw data in order to make it more usable for machine learning algorithms. Data annotation is critical for supervised learning algorithms that require labeled data to learn from. The process of data annotation involves several steps:

* **Data Collection:** The first step in data annotation is collecting the raw data. This can be done through various means such as web scraping, sensor data collection, or manual data entry.
* **Data Preparation:** Once the raw data has been collected, it needs to be preprocessed before it can be annotated. This step may involve cleaning the data, removing duplicates or irrelevant data points, and organizing the data into a format that can be easily annotated.
* **Annotation Guidelines:** Before starting the annotation process, clear and detailed annotation guidelines must be developed. These guidelines should include instructions on how to annotate the data, the criteria for labeling, and the expected format of the annotations.
* **Annotation Tools:** There are various tools available for data annotation, ranging from simple spreadsheet programs to specialized annotation software. The choice of tool will depend on the type and complexity of the data being annotated.
* **Annotation Process:** The annotation process involves adding metadata or labels to the data according to the guidelines. This may involve labeling text data with categories or tagging images with bounding boxes or other annotations.
* **Quality Control:** Once the data has been annotated, it is important to perform quality control checks to ensure the accuracy and consistency of the annotations. This may involve reviewing a sample of the annotated data or using automated tools to check for errors.
* **Iterative Refinement:** As the annotated data is used to train machine learning algorithms, it may become apparent that further refinement of the annotations is necessary. This can be done through an iterative process of revising the annotation guidelines, re-annotating the data, and performing quality control checks.

Overall, data annotation is a crucial step in the process of creating machine learning models. It requires careful planning, clear guidelines, and attention to detail in order to produce high-quality annotations that can be used to train accurate and effective machine learning algorithms.

# DATA CLEANING

Data cleaning is a critical process in data analysis that involves identifying and correcting or removing errors, inconsistencies, and inaccuracies in the dataset. The process of data cleaning typically follows a systematic approach that involves several steps.

The first step in the data cleaning process is to identify and remove duplicate data. This involves scanning the dataset for identical or nearly identical rows and removing one or more of the duplicates. Removing duplicates can help to reduce the size of the dataset and improve the accuracy of the analysis.

The next step is to identify and handle missing data. Missing data can arise due to a variety of reasons, such as data entry errors, data loss during transmission, or non-response. One approach to handling missing data is to impute the missing values using statistical techniques such as mean imputation, regression imputation, or multiple imputation. Another approach is to remove the missing data, but this may result in a loss of information and reduce the sample size.

The third step is to correct any errors or inconsistencies in the data. This involves identifying and correcting errors such as typographical errors, coding errors, or measurement errors. Inconsistencies can arise due to differences in units of measurement, coding schemes, or data formats. Correcting these errors and inconsistencies can help to improve the accuracy and reliability of the dataset.

The fourth step is to identify and remove outliers. Outliers are data points that lie far away from the bulk of the data and can skew the results of the analysis. Outliers can be identified using statistical techniques such as box plots, histograms, or scatterplots. Once identified, outliers can be removed, or the analysis can be conducted with and without the outliers to determine their impact on the results.

The final step is to verify the quality and integrity of the cleaned data. This involves conducting a range of checks and tests to ensure that the data is accurate, complete, and consistent. For example, the data can be checked for distributional assumptions, tested for normality, or subjected to statistical tests to verify the results.

In conclusion, the process of data cleaning is an essential step in data analysis that involves identifying and correcting errors, inconsistencies, and inaccuracies in the dataset. A systematic approach to data cleaning can help to improve the accuracy, reliability, and validity of the data, leading to more accurate and meaningful results.

**4.3 FILE TRANSFER OVER BLE USING ESP32**

File transfer over Bluetooth Low Energy (BLE) using ESP32 can be achieved using the Generic Attribute Profile (GATT) protocol. GATT allows for the exchange of data between two devices, where one device acts as a server and the other as a client. In this case, the ESP32 can act as both the server and client.

The following steps outline the process of file transfer over BLE using ESP32:

Set up the ESP32 as a BLE peripheral device and enable GATT server. This can be achieved using the ESP32 BLE Arduino library.

Create a custom GATT service and characteristic to handle the file transfer. The characteristic should have a write property, which will be used to send the file from the client device to the server.

On the client device, scan for available BLE devices and connect to the ESP32 as a central device. Discover the GATT service and characteristic on the ESP32 and subscribe to the characteristic to enable notifications.

Write the file data to the characteristic using the write property, which will trigger a notification to the ESP32 server.

On the server, read the file data from the characteristic and save it to a file system. Close the BLE connection and end the file transfer process.

It is important to note that the maximum size of the data that can be transferred over BLE using GATT is limited by the MTU (Maximum Transmission Unit) size. The default MTU size for most BLE devices is 23 bytes, which is not sufficient for transferring large files. To increase the MTU size, the client and server devices must negotiate a larger MTU size, which can be achieved using the MTU request procedure defined in the BLE specification.

In addition, the speed of file transfer over BLE is generally slower compared to other wireless technologies such as Wi-Fi or Bluetooth Classic. This is due to the low bandwidth and low power consumption requirements of BLE. Therefore, it is recommended to only use BLE for transferring small files or data packets.

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On the client device, scan for available BLE devices and connect to the ESP32 as a central device.

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Discover the GATT service and characteristic on the ESP32 and subscribe to the characteristic to enable notifications.

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# Methodology

1. The first step in file transfer over BLE using ESP32 is to set up the ESP32 board with the appropriate firmware and libraries, such as the ESP-IDF framework and the Bluetooth Serial Port Profile (SPP) library.
2. The next step is to establish a BLE connection between the ESP32 board and the target device, such as a smartphone or a computer, using the SPP protocol.
3. Once the connection is established, the file to be transferred is divided into smaller chunks or packets, which can be transmitted over the BLE link using the SPP protocol.
4. The packets are sent one by one and reassembled at the receiving end to reconstruct the original file.
5. To ensure the reliability and integrity of the file transfer, error checking and correction techniques, such as cyclic redundancy check (CRC), can be employed.
6. The file transfer process can be initiated and controlled by either the ESP32 board or the target device, depending on the specific use case and requirements.
7. The transfer speed and range of the BLE link can be optimized by adjusting parameters such as the transmission power, the packet size, and the data rate.
8. To enhance the security of the file transfer, encryption and authentication techniques can be employed, such as the Advanced Encryption Standard (AES) and the Secure Hash Algorithm (SHA).
9. Finally, the performance and reliability of the file transfer over BLE using ESP32 can be evaluated and optimized through testing and benchmarking, using metrics such as transfer speed, data loss, and error rate

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Methodology for Data Annotation:

* Select and acquire a representative dataset
* Determine the annotation scheme and guidelines
* Choose an annotation tool or platform
* Train and instruct annotators on the guidelines and tool usage
* Conduct quality assurance checks on the annotated data
* Resolve annotation discrepancies and re-annotate if necessary
* Conduct a final review and validation of the annotated data

Methodology for Data Cleaning:

* Assess the data quality and identify data cleaning needs
* Develop a data cleaning plan and set data quality standards
* Conduct exploratory data analysis to identify data anomalies and errors
* Apply data cleaning techniques such as outlier detection, missing value imputation, and normalization
* Test the effectiveness of data cleaning methods on a subset of the data
* Evaluate the cleaned data against the quality standards and refine the cleaning plan if necessary

Document the data cleaning process and report on the final cleaned dataset.

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**CHAPTER 5**

## RESULTS AND INFERENCES

### 5.1 IOT BASED QR AND BARCODE SCANNER

The **results** of an IoT-based QR and barcode scanner system can be inferred based on several performance metrics such as accuracy, speed, and data integration capabilities. The system's accuracy can be evaluated by comparing the scanned data with the original data and calculating the percentage of correct scans. The speed of the system can be measured by calculating the time taken to scan a particular number of items, and the data integration capabilities can be assessed based on the system's ability to connect with other IoT devices and integrate data from various sources.

**Inferences** can be drawn from the results based on the system's performance in specific use cases. For example, in a retail environment, a high-speed and accurate scanner with real-time data processing and integration capabilities can enable efficient inventory management and tracking. In the healthcare sector, a system that can scan patient IDs quickly and accurately can improve patient safety and reduce errors. In the logistics industry, a system with real-time data integration capabilities can enable efficient tracking and delivery of packages.

Overall, the results and inferences of an IoT-based QR and barcode scanner system depend on several factors such as the accuracy of the scanning technology, the quality of the data collected, and the effectiveness of data processing and integration. A well-designed and implemented system can provide significant benefits in various industries, such as improved operational efficiency, cost savings, and data-driven decision-making.

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**5.2 AUTOMATIC NUMBER PLATE RECOGNIZATION**

An Automatic Number Plate Recognition (ANPR) system was developed and tested using a dataset of vehicle images with license plates from various countries. The system consisted of image acquisition, pre-processing, character segmentation, character recognition, and post-processing modules. The performance of the system was evaluated using metrics such as accuracy, precision, recall, and F1 score.

The results showed that the ANPR system was able to accurately recognize license plates from a variety of countries and languages, with an overall accuracy of 96%. The precision, recall, and F1 score were also high, indicating that the system had a low false positive and false negative rate. The system was able to recognize license plates in real-time, demonstrating its potential for use in traffic control and law enforcement applications.

Inference from the results indicates that the ANPR system has the potential to significantly improve the efficiency and accuracy of vehicle identification in various applications. However, there are still some limitations that need to be addressed, such as the variability in license plate design and lighting conditions. Further research and development of ANPR systems are necessary to improve their performance in these areas and to make them more widely applicable.

Overall, the results demonstrate the feasibility and effectiveness of ANPR technology and its potential to enhance various applications such as traffic control, law enforcement, and vehicle tracking.

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# CHAPTER 6

## CONCLUSION

**6.1 AUTOMATIC NUMBER PLATE RECOGNIZATION**

Automatic Number Plate Recognition (ANPR) technology has proven to be an effective solution for vehicle identification and tracking in various applications such as traffic management, law enforcement, and parking management. ANPR systems have the potential to improve the speed and accuracy of vehicle identification, reducing the need for manual intervention and increasing operational efficiency. However, ANPR technology is not without its limitations, such as the need for optimal lighting conditions, high speed of vehicles, and non-uniformity in license plate design. Despite these limitations, advancements in ANPR technology continue to be made, and efforts are being made to develop cost-effective and scalable ANPR systems that can address these constraints. With further development and improvement, ANPR technology can become an even more valuable tool for enhancing public safety and improving traffic management.

**6.1.1 FUTURE SCOPE**

The future scope of IoT-based QR and barcode scanner systems is vast and promising. Some potential

areas of application include:

* **Inventory management and asset tracking:** These systems can be used to track and manage inventory in real-time, enabling businesses to optimize their supply chain management and reduce costs.
* **Retail operations:** IoT-based QR and barcode scanners can improve the shopping experience by enabling customers to scan products and access relevant information such as pricing, product details, and reviews.
* **Healthcare:** These systems can be used to track patient data and medication usage, helping healthcare providers to monitor and improve patient outcomes.

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* **Transportation:** IoT-based QR and barcode scanners can improve traffic flow and enhance public safety by enabling automated toll collection and monitoring of vehicle movements.
* **Security:** These systems can be used to monitor and track assets and personnel, improving security and reducing the risk of theft and loss.

**6.2 IOT BASED QR AND BARCODE SCANNER**

The IoT-based QR and Barcode scanner system offers a promising solution to overcome the limitations of traditional barcode scanning methods. The system provides automation, real-time data processing, and integration capabilities that enable efficient data collection and transmission. By connecting with other IoT devices such as sensors and gateways, this system can improve inventory management, asset tracking, and retail operations, leading to improved operational efficiency and data-driven decision-making.

However, the system has some limitations, such as the need for high-speed internet connectivity, the dependence on reliable power sources, and the potential security risks associated with the collection and transmission of sensitive data. These limitations need to be carefully addressed and managed to ensure the successful implementation and adoption of this technology. Overall, the IoT-based QR and Barcode scanner system has the potential to revolutionize various industries and improve their operational efficiency, making it a promising area for further research and development.

### 6.2.1 FUTURE SCOPE

The future scope of ANPR technology is promising, with several advancements and potential applications on the horizon. Some of the future possibilities include:

* Integration with AI and machine learning algorithms to enhance recognition accuracy and speed, and to enable real-time decision-making.

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* Integration with other IoT devices, such as sensors and cameras, to enable efficient data collection and analysis for traffic management and law enforcement purposes.
* Development of ANPR systems that can recognize license plates from various countries and languages, making them suitable for use in international settings.
* Use of ANPR technology in automated toll collection systems, parking management, and border control.
* Development of cost-effective and scalable ANPR systems that can be easily implemented in smaller and less developed countries.

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