IOT Based QR and Bar-code Scanner & ANPR

INTERNSHIP REPORT

Submitted by

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Under the guidance of

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in partial fulfillment for the award of the degree

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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Under Section 3 of UGC Act, 1956)

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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INTERNSHIP OFFER LETTER

22 Nov 2022

To

Head of the Department
Electronics & Communication
SRM IST, Kattankulathur

Sub: Permission for Internship

Mr.Rohit Kumar Mohanty, (Reg.No.RA1911004010259) Under Graduate (Final Semester - ECE) student from your college has applied for internship and is given the permission from Dec 2022 to Apr 2023, he will be part of the team in our Electronics Department, engaged into following project domains like Embedded systems, Machine Learning and AI.

Yours Sincerely,

For **KritiLabs Technologies Private Limited**

Hari Prasad
HR

KRITILABS TECHNOLOGIES PRIVATE LIMITED ★ CHENNAI

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INTERNSHIP CERTIFICATE

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.
3. We have followed the guidelines provided by the university in writing the report.
4. 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.

ROHIT KUMAR MOHANTY

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 & 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 specialized computer system that combines hardware and software to perform specific functions. They are designed to operate within a larger system or device and can be either programmable or have fixed functionality. Embedded systems are found in a wide range of products such as consumer electronics, medical equipment, household appliances, automobiles, industrial machines, airplanes, and more.

The user interface of an embedded system varies depending on its intended use. Some systems are designed to perform a single task and may have no user interface, while others have complex graphical user interfaces (GUIs) that include buttons, LEDs, touchscreens, and other input/output devices. Some embedded systems even use remote user interfaces to interact with users.

The primary goal of an embedded system is to perform a specific task efficiently and reliably. As a result, they are typically optimized for performance, power consumption, and cost-effectiveness. Embedded systems are also designed to operate in harsh environments and may include features such as ruggedized enclosures, specialized cooling systems, and high-reliability components.

Embedded systems play a critical role in modern technology and are essential to the functioning of many everyday products. They enable devices to perform complex tasks efficiently and reliably while minimizing their power consumption and cost.

ACKNOWLEDGEMENTS

First and foremost , I express my heartfelt and deep sense of gratitude to our Chancellor Shri. T.R.Pachamuthu, Vice-Chancellor Dr. C. Muthamizhchelvan, Pro-Chancellor Dr. P. Sathyanarayanan for providing us with the necessary facilities for the completion of our project. I also acknowledge our Registrar Dr. S. Ponnusamy for his constant support and endorsement.

I wish to express our sincere gratitude to Prof. T.V.Gopal Dean, (Engineering Technology), and Dr.Shanthi prince, Professor Chairperson (Department of Electronics and Communication Engineering) for their constant support and encouragement.

I am extremely grateful to my Project Co-ordinator Dr. Maria Jossy A , Associate Professor (Department of Electronics and Communication Engineering) for her invaluable guidance, motivation, timely and insightful technical discussions. I am immensely grateful for her constant encouragement, smooth approach throughout our project period and make this work possible.

I am deeply indebted to my Internal Guide Dr.Vimala C, Assistant Professor, (Department of Electronics and Communication Engineering) and other faculties of the Department of Electronics and Communication Engineering for extending their warm support, constant encouragement, and ideas they shared with me. I would also like to my External Guide, Ms. Vidhushi A R and my colleagues at Kriti Labs and Technologies for their constant support throughout this project.

ROHIT KUMAR MOHANTY

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ABBREVIATIONS

ANPR	Automatic Number Plate Recognition
ML	Machine Learning
IOT	Internet Of Things
IDE	Integrated Development Environment
AES	Advanced Encryption Standard
SHA	Secure Hash Algorithm

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 is committed to providing top-quality solutions and services to its customers, with devices that meet international standards and are approved by industry and regulatory bodies. The company has received recognition from the industry for its innovative IoT platform solutions and services. Kriti Labs Technologies Pvt. Ltd has been awarded several honors for its exceptional work in IoT and hardware development. In 2019, Nasscom awarded Kriti Labs the Best Emerging IoT & Hardware company in India at a conference in Bangalore. Later that year, the company won the Start-up of the Year award at TiECON 2019, the largest entrepreneurship conference in Tamil Nadu. Recently, the company was presented with the Sir Visveswarya award for Best Startup of the Year by the CM of Tamil Nadu Mr. MK Stalin, organized by AIMO in April 2022. These awards showcase Kriti Labs' commitment to innovation and excellence in its industry.

1.1 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.

1.2 AUTOMATIC NUMBER PLATE RECOGNIZATION

ANPR (Automatic Number Plate Recognition) is a system that employs OCR (Optical Character Recognition) to recognize and capture vehicle registration plates and their location data. It can be incorporated into existing CCTV systems, dedicated cameras, or road enforcement cameras. Law enforcement agencies globally use ANPR to authenticate vehicle registration and ensure compliance with traffic regulations. ANPR is also employed to manage toll collection on usage-based roads and to track traffic movements.

ANPR systems can store images of captured license plates and the corresponding text. Some systems are designed to capture driver photographs as well. ANPR cameras are equipped with infrared lighting to ensure that they can capture clear images during the day or night.

In summary, ANPR is a useful technology that enables law enforcement agencies to enforce traffic laws and manage toll collection. It operates by capturing license plates and analyzing the information using OCR technology. ANPR cameras use infrared lighting to capture clear images in various lighting conditions.

ANPR technology is a potent asset for law enforcement agencies as it enables 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. ANPR technology is a highly effective tool that can provide valuable benefits, but it must be used with caution and closely monitored to ensure ethical and responsible use.

CHAPTER 2

LITERATURE SURVEY

2.1 An Introduction to QR Code Technology[1]

A QR code is a two-dimensional matrix barcode that contains a variety of data and can be rapidly scanned by smartphones. It is made up of black modules arranged in a square pattern on a white background. The encoded data can be in the form of text, URLs, or other data types. With the widespread use of smartphones equipped with cameras, QR codes are now ubiquitous globally. Denso Wave, a Toyota subsidiary, originally developed the technology in 1994 to keep track of inventory in vehicle parts manufacturing. QR codes were created to overcome the limitations of conventional barcodes, which were restricted to storing no more than 20 alphanumeric characters.

The QR code system includes two parts: an encoder that encodes the data and produces the QR code, and a decoder that reads and decodes the information from the code. QR codes have multiple applications, including facilitating quick and effortless digital payments using payment systems like UPI. They are also commonly used for advertising and marketing, with QR codes printed on flyers, billboards, posters, and 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.

2.2 Automatic Number Plate Recognition System (ANPR): A Survey [7]

In many countries, the increasing number of vehicles and traffic violations has made it imperative to implement effective traffic control and vehicle owner identification measures. It can be difficult for traffic personnel to identify the owner of a speeding vehicle that violates traffic rules and fails to display its number plate. To address this challenge, an Automatic Number Plate Recognition (ANPR) system is required.

Despite the availability of various ANPR systems that use different approaches, recognizing number plates remains a difficult task due to factors such as non-standardized number plates, different languages, and varying lighting conditions that can significantly affect the recognition rate. However, most systems operate within these limitations to improve their performance.

The present paper examines several ANPR methods and considers image size, recognition accuracy, and processing speed as key factors.By analyzing the pros and cons of each approach, the paper aims to determine the most suitable ANPR system for different scenarios. 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

2.3 A QR code based framework for auto-configuration of IoT sensor networks in buildings [9]

The high energy consumption of buildings is a major contributor to global carbon emissions. However, the installation cost of efficient energy management systems in existing buildings remains a challenge. To address this, a proposed solution for medium and large-sized buildings is to retrofit them with cost-effective IoT sensor networks for energy management capabilities. To achieve this, an auto-configuration platform based on IoT networks was developed, which utilizes dynamic QR codes for efficient metadata management of location and devices in the database. Different sensor-gateway pairing strategies were also evaluated to ensure optimal configuration and communication signal strength quality within the shortest possible time.

The proposed system was implemented and demonstrated in a case study involving a medium-sized building, showing that it is a cost-effective solution for building energy management. The system's unique feature is its utilization of dynamic QR codes for efficient metadata management. The auto-configuration platform for building energy management optimizes configuration while prioritizing communication signal strength quality. This solution is suitable for retrofitting existing buildings with IoT sensor networks and can also be deployed in new constructions., 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

3.1 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.Conventional scanning techniques can be inefficient and prone to mistakes, particularly when handling substantial amounts 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.

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.

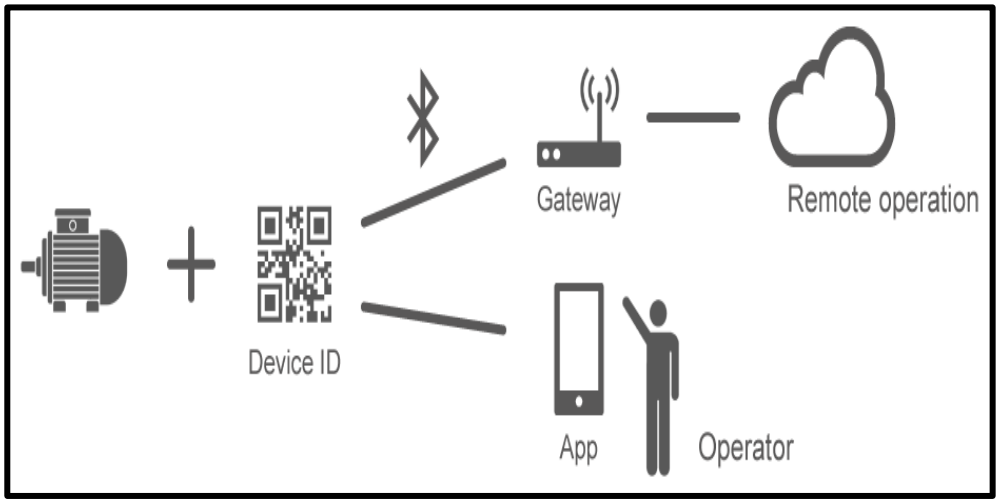

Figure 3.1: IOT Based QR scanner in Cloud

3.1.2 Automatic Number Plate Recognization

ANPR technology is aimed at automating the identification of vehicles and their owners for multiple applications, including traffic management, law enforcement, and vehicle monitoring. The traditional methods of manual identification by traffic personnel are time-consuming, inefficient and often unreliable, particularly in high-speed violation scenarios. ANPR technology overcomes this problem by utilizing optical character recognition (OCR) to extract vehicle registration plate information from images, thus generating data on the location of the vehicle. 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

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.

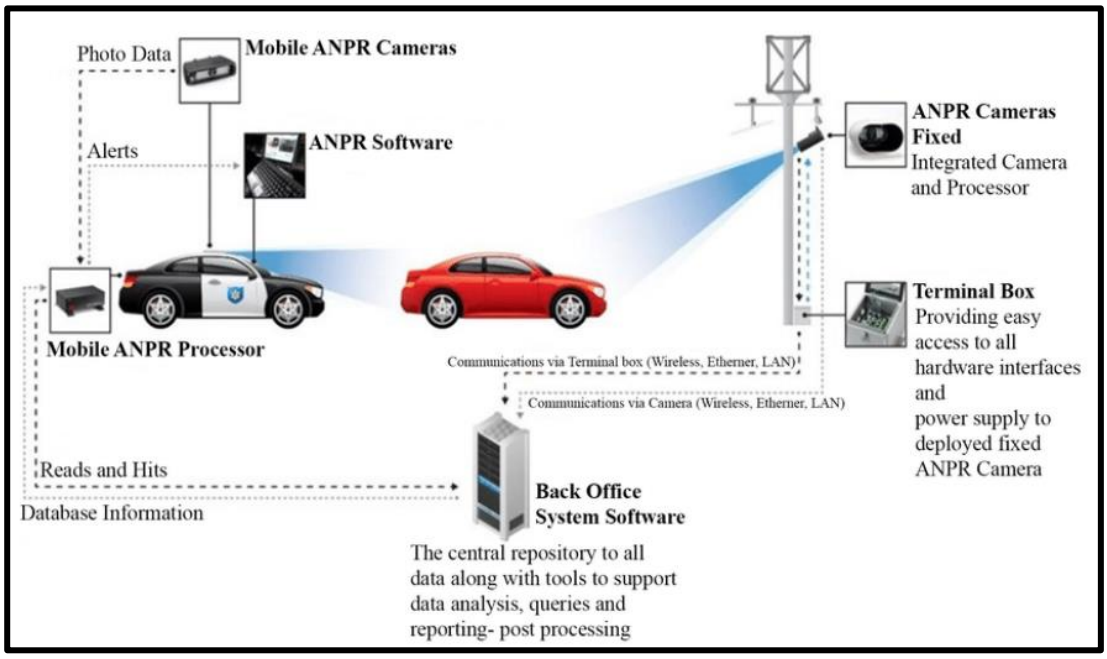

Figure 3.2: Work Flow of ANPR

3.2 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. The challenges of ANPR systems require improvements in accuracy and reliability. Additionally, there is a need to increase accessibility and affordability for smaller and less developed countries that may struggle to invest in costly systems. The study of ANPR can help identify solutions to these issues and lead to enhanced 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.

3.3 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 ANPR technology utilizes optical

character recognition on pictures of vehicle registration plates to generate data on the location of the vehicles, while overcoming challenges such as speed, variability, and cost.

3.4 Tools

3.4.1 Arduino IDE:

The Arduino IDE is a software application that simplifies the development and programming of code for Arduino boards. It is designed to be user-friendly and beginner-friendly, allowing individuals to easily start coding and creating electronic projects with Arduino. This IDE is built using the Processing programming language and incorporates a simplified version of the C++ programming language to make it easier to understand and use.

One can download the Arduino IDE for free from the official Arduino website and install it on various operating systems like Windows, Mac OS X, and Linux. It supports a wide range of Arduino boards, including the Arduino Uno, Arduino Mega, and Arduino Nano, along with other boards that rely 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. With the Sketch, there is an integrated Serial Monitor feature that enables users to exchange data between their computer and the Arduino board. This means that users can send and receive information through the Sketch interface.

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.

The Arduino IDE provides a range of powerful tools for debugging and troubleshooting code, including a memory monitor and step-by-step debugger. It is an easy-to-use and powerful tool for developing electronic projects with Arduino boards, making it a suitable choice for both novice and experienced developers. With its intuitive interface and comprehensive feature set, the Arduino IDE is an ideal platform for programming and creating electronic projects. 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.

3.4.2 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:** By using this command, you can specify the error correction level for the QR code. QR codes are designed to have varying degrees of error correction, which determines the amount of data that can be recovered from the code in case it becomes damaged.
- **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:

The tutorial on machine learning provides an introduction to the basic and advanced concepts of this rapidly evolving technology. With the ability to automatically learn from past data, machine learning has become a crucial tool in various applications, including image and speech recognition, email filtering, recommendation systems, and more.

The tutorial aims to cover the fundamental concepts of machine learning, including the different techniques like Supervised, Unsupervised, and Reinforcement learning. The tutorial explains how these techniques are used to create mathematical models, and how these models are used to make predictions. Additionally, it delves into regression and classification models, clustering methods, hidden Markov models, and other sequential models. This comprehensive guide provides a broad overview of machine learning and its applications, making it accessible to both students and professionals.

One of the most significant advantages of machine learning is that it enables computers to learn and adapt to new data without explicit programming. This means that machine learning algorithms can be trained to recognize patterns in data and make predictions based on these patterns. Additionally, machine learning can be used to automate

processes and make decisions based on data, leading to more efficient and accurate results.

3.5 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:** ANPR systems' accuracy can be influenced by several factors, including camera quality, lighting, camera angle, and vehicle speed. The potential for false positives or negatives exists if ANPR readings are inaccurate, which could have serious consequences in applications like law enforcements.
- **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.

3.6 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.The readability and quality of the codes captured by

ANPR systems can be influenced by several factors. For instance, the codes may become damaged, or there may be low-light conditions that hinder the cameras' ability to capture clear images. Additionally, the use of low-quality printing or scanning equipment can further affect the accuracy of the data captured by ANPR systems. 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

4.1 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 stage may require preparing the data, which could involve eliminating duplicates or irrelevant data points, tidying up the data, and arranging it in a format suitable for annotation.

- **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 many tools available for the data annotation, ranging from simple spreadsheet that programs to specialized annotation software. The choice of tools which depend on the type and complexity of the data being annotated.

- **Annotation Process:** The process of annotation involves adding descriptive information or markers to data based on predetermined guidelines. This can include assigning categories to text data or applying bounding boxes and other forms of labeling to images.

- **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.

4.2 DATA CLEANING

In the process of data analysis, data cleaning plays a significant role as it involves identifying and rectifying any inconsistencies, errors, or inaccuracies present in the dataset. Its primary objective is to ensure the completeness, reliability, and accuracy of data. A systematic approach is followed in data cleaning that consists of various stages to ensure the preparedness of the dataset for analysis.

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. Eliminating duplicates from a dataset can have several benefits, such as reducing the dataset's size and improving the accuracy of the analysis. By removing redundant data, you can streamline the dataset and potentially avoid errors caused by repeated observations. Additionally, this can lead to more efficient data processing and better utilization of resources. Overall, duplicate removal is an important step in ensuring high-quality data analysis.

After collecting data, it is important to address any missing data. There are various reasons why data can be missing, including mistakes during data entry, loss of data during transmission, or lack of response. The next step is to identify any missing data and determine the best way to handle it. 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 This involves identifying and fixing mistakes, such as errors in typing or coding 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 stage involves the detection and elimination of outliers, which are data points located far from the majority of the data. These outliers can potentially distort the results of the analysis and therefore need to be identified and removed. 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.

After cleaning the data, the last stage is to validate its quality and reliability. This involves performing various tests and checks to ensure that the data is complete, consistent, and error-free. The objective is to verify that the data is accurate and suitable for use in analysis or decision-making processes. For example, the data can be checked for distributional assumptions, tested for normality, or subjected to statistical tests to verify the results.

To ensure accurate and reliable data analysis, it is crucial to perform data cleaning, which involves detecting and correcting any errors, inconsistencies, or inaccuracies present in the dataset. This process is essential to ensure that the data is of high quality and can be used for meaningful analysis. 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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4.3 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 improve the safety of transferring files, it is possible to use encryption and authentication techniques like AES and SHA. AES is an encryption standard that enhances data confidentiality, while SHA is a secure hash algorithm that ensures data integrity. These techniques can be applied to ensure that transferred files are secure and protected against unauthorized access or modification.

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

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.

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.

5.2 AUTOMATIC NUMBER PLATE RECOGNIZATION

An Automatic Number Plate Recognition 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.

Figure 5.1: Automatic recognization of number plate

CHAPTER 6

CONCLUSION

6.1 AUTOMATIC NUMBER PLATE RECOGNIZATION

The use of ANPR (Automatic Number Plate Recognition) technology has demonstrated its efficiency in identifying and tracking vehicles for purposes like traffic control, law enforcement, and parking management. ANPR technology can enhance the speed and accuracy of vehicle identification, thereby minimizing the requirement for human intervention and enhancing operational productivity.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.
- **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.
- 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.

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