

Automatic Number Plate Recognition

A report submitted for the internship under

AI Smart Bridge

Submitted By

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1. INTRODUCTION

1.1 Overview

Automatic Number Plate Recognition (ANPR), also known as License Plate Recognition (LPR), is a technology that enables automatic identification and reading of license plates on vehicles. It utilizes a combination of specialized cameras, image processing algorithms, and optical character recognition (OCR) techniques to capture, analyze, and interpret license plate information.

ANPR systems consist of the following key components:

1. **Camera:** ANPR systems employ dedicated cameras designed to capture clear images of license plates. These cameras are strategically positioned to achieve optimum visibility and image quality, even in challenging lighting or weather conditions.
2. **Image Processing Software:** The captured images go through a series of image processing techniques to enhance the quality and clarity of the license plate region. This may involve tasks such as noise reduction, contrast adjustment, and image filtering to optimize the visibility of the characters on the plate.
3. **License Plate Localization:** The ANPR software algorithms analyze the processed images to identify and isolate the license plate region within the image. By considering factors such as plate size, color, and shape, the system locates the precise area containing the license plate.
4. **Character Segmentation:** Once the license plate region is identified, the ANPR system proceeds to segment individual characters or digits on the plate. This step is crucial to isolate each character for accurate recognition.
5. **Optical Character Recognition (OCR):** The segmented characters undergo OCR techniques, where pattern recognition algorithms are applied to recognize and interpret the alphanumeric information on the license plate. Machine learning algorithms may be used to improve the accuracy of character recognition, especially in cases of variations in fonts, styles, or plate conditions.
6. **Database Comparison:** The recognized characters are compared against a database of known license plates for further analysis. This database could be locally stored within the ANPR system or connected to a larger networked repository that stores information about registered vehicles, stolen vehicles, or vehicles of interest.
7. **Decision Making and Actions:** Based on the comparison results, the ANPR system can make informed decisions or trigger specific actions. These actions may include generating alerts for law enforcement authorities, triggering gate openings for authorized vehicles, initiating toll collection processes, or logging vehicle movements for surveillance purposes.

ANPR technology offers numerous benefits in various domains. It enhances law enforcement capabilities by enabling the rapid identification of stolen vehicles, wanted criminals, or vehicles associated with criminal activities. It aids in traffic management by monitoring traffic flow, detecting violations, and optimizing toll collection processes.

ANPR systems also support parking management and enforcement by automating parking fee payments and detecting parking violations.

While ANPR technology provides valuable functionalities, concerns regarding privacy and data security are crucial considerations. Proper governance, regulation, and implementation of privacy policies are necessary to address these concerns and ensure responsible use of ANPR systems while protecting individual privacy rights.

Overall, ANPR systems play a pivotal role in automating license plate recognition, enabling efficient vehicle identification, and contributing to various applications such as law enforcement, traffic management, toll collection, and parking enforcement.

1.2 Purpose

The use of Automatic Number Plate Recognition (ANPR) technology offers several practical applications and benefits across various domains. Here are some of the key uses and achievements that can be realized using ANPR:

- **Law Enforcement:** ANPR systems are widely used in law enforcement agencies to identify and track vehicles involved in criminal activities. By instantly recognizing license plates, ANPR technology can help locate stolen vehicles, detect vehicles used in crimes, and provide valuable information for investigations. It assists in identifying suspects, tracking their movements, and generating alerts for law enforcement authorities.
- **Traffic Management:** ANPR plays a crucial role in traffic management systems. By automatically capturing license plate information, ANPR systems can monitor traffic flow, detect violations (such as speeding or running red lights), and provide real-time data for traffic analysis and planning. This enables authorities to optimize traffic management strategies, improve road safety, and alleviate congestion.
- **Toll Collection:** ANPR technology is extensively utilized in toll collection systems. By automatically capturing and recognizing license plates, ANPR systems enable seamless and efficient tolling processes. This eliminates the need for physical toll booths and manual payments, allowing for faster throughput and reducing traffic congestion at toll plazas.
- **Parking Management and Enforcement:** ANPR systems are employed in parking facilities to streamline operations and enforce parking regulations. By automatically capturing license plate information upon entry and exit, ANPR enables efficient parking fee calculations, tracks parking durations, and identifies vehicles without valid permits. This improves parking management, reduces manual interventions, and facilitates effective enforcement of parking violations.
- **Border Control and Security:** ANPR technology is utilized at border crossings and security checkpoints to monitor vehicle movements, enhance border control measures, and improve security. ANPR systems can identify suspicious or wanted vehicles, track

the entry and exit of vehicles at border points, and contribute to national security efforts by providing valuable data and alerts to border control agencies.

- **Surveillance Systems:** ANPR is integrated into surveillance systems, such as closed-circuit television (CCTV), to enhance their capabilities. ANPR technology enables automated identification and tracking of vehicles within the surveillance coverage area. This aids in investigations, situational awareness, and proactive security measures.
- **Data Analysis and Insights:** ANPR systems generate vast amounts of data that can be analyzed to gain insights into traffic patterns, vehicle movements, and other relevant information. By analyzing ANPR data, authorities can make informed decisions regarding transportation planning, infrastructure development, and resource allocation.

It is important to note that while ANPR technology offers significant benefits, it also raises concerns about privacy and data security. Responsible implementation, adherence to privacy regulations, and proper data governance practices are crucial to address these concerns and ensure the ethical and lawful use of ANPR systems.

Overall, ANPR technology provides valuable capabilities for vehicle identification, tracking, and data analysis, contributing to improved law enforcement, traffic management, toll collection, parking enforcement, and security measures.

2. LITERATURE SURVEY

2.1 Existing problem

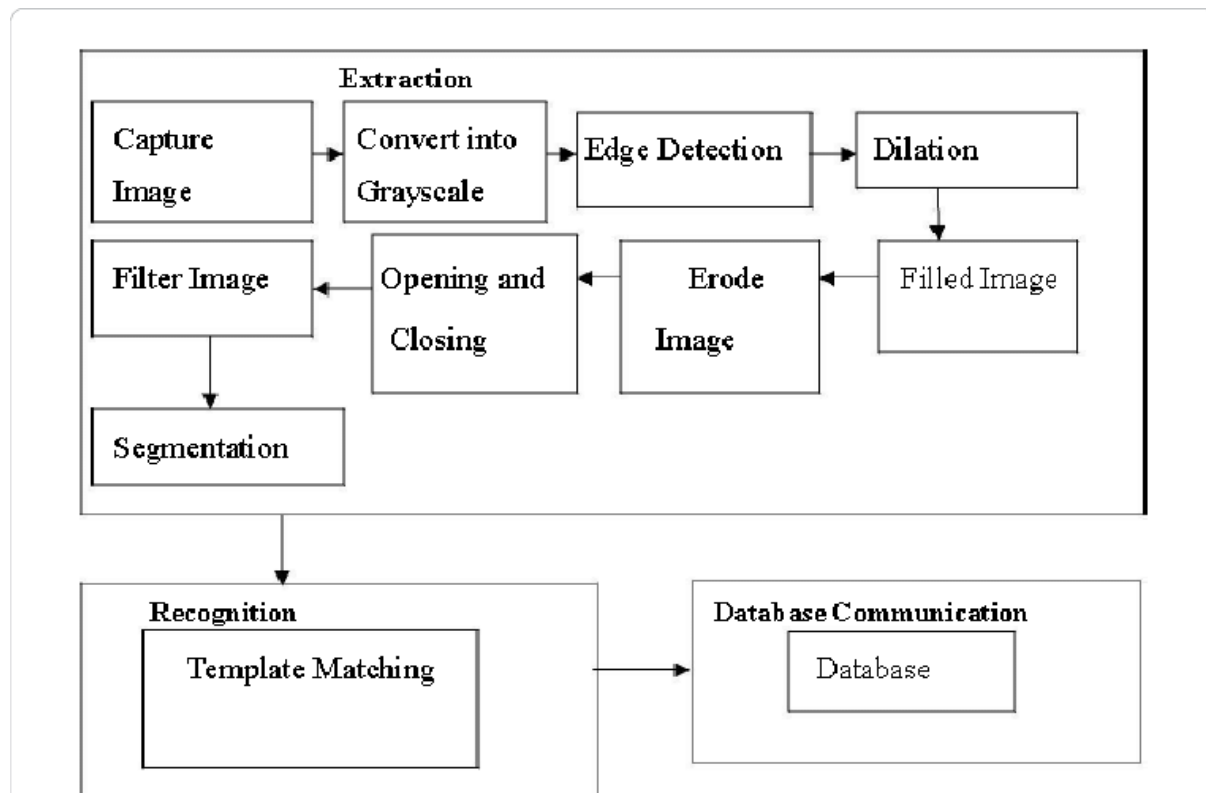
- **Manual License Plate Reading:** The process of license plate reading would rely on manual efforts by law enforcement officers, toll booth operators, parking attendants, and other personnel. This would be time-consuming, labor-intensive, and prone to human error.
- **Slower Traffic Management:** problem in role of traffic management .
- **Inefficient Toll Collection:** Difficult in collection processes. longer wait times at toll booths, increased operational costs, higher chances of errors in fee collection, and reduced overall efficiency of toll collection systems.
- **Ineffective Parking Management:** parking facilities would rely on manual ticketing, payment verification, and monitoring, leading to increased administrative workload, potential revenue losses from unpaid or fraudulent parking, and difficulty in tracking and enforcing parking violations.

2.2 Proposed Solution

The primary purpose of ANPR is to automate the process of identifying and tracking vehicles for various applications. Solving by using RAPID API and interactive web page. We connect the web page and Rapid API by using FLASK and Deploy.

3. THEORITICAL ANALYSIS

3.1 Block Diagram



3.2 Hardware/Software Designing

- Rapid API
- Python environment
- Pycharm
- Flask
- Input Images
-

4. EXPERIMENTAL INVESTIGATIONS

Experimental investigations on Automatic Number Plate Recognition (ANPR) involve conducting research and tests to evaluate the performance, accuracy, and robustness of ANPR systems under various conditions. These investigations aim to improve the technology, optimize algorithms, and address challenges associated with license plate recognition. Here are some areas of focus in experimental investigations on ANPR:

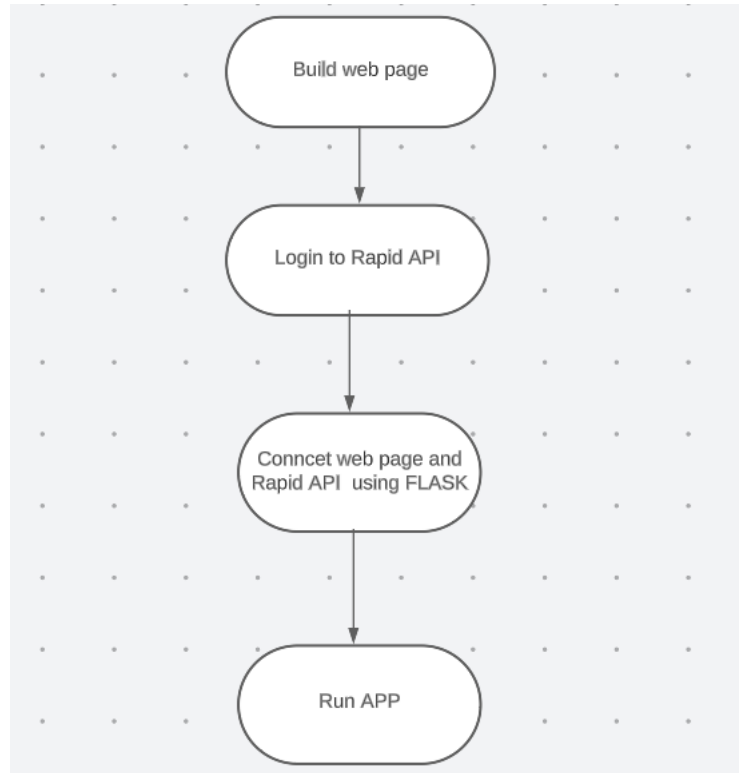
- **Recognition Accuracy:** Researchers may conduct experiments to assess the accuracy of ANPR systems in recognizing license plates under different scenarios. This involves testing the system's ability to accurately detect and interpret characters on

license plates, even in challenging conditions such as varying lighting, different fonts, and plate damage.

- **Variations in Plate Formats:** ANPR experiments often include testing the system's performance on license plates with different formats, styles, and designs. This helps identify the limitations of existing algorithms and guides the development of more robust and adaptable recognition models that can handle various plate formats encountered globally.
- **Environmental Factors:** Experimental investigations also consider the impact of environmental factors on ANPR performance. Researchers may simulate adverse weather conditions, such as rain, fog, or snow, to evaluate how these conditions affect the accuracy and reliability of license plate recognition. The aim is to develop algorithms that can handle these challenging scenarios.
- **Computational Efficiency:** Evaluating the computational efficiency of ANPR systems is another aspect of experimental investigations. This involves measuring the speed and resource requirements of the system, including image processing, character segmentation, and recognition tasks. The goal is to optimize algorithms and hardware configurations to ensure real-time performance in practical applications.
- **Dataset Creation and Evaluation:** Researchers often create specialized datasets for ANPR experiments, containing a variety of license plate images captured in different environments. These datasets are used to train and test ANPR models, evaluate their performance, and compare the results with other existing methods. Researchers analyze the dataset to understand the challenges faced by ANPR systems and propose improvements.
- **Machine Learning Techniques:** Experimental investigations explore the application of machine learning techniques in ANPR. Researchers may employ deep learning algorithms, convolutional neural networks (CNNs), or other advanced machine learning models to enhance recognition accuracy, optimize feature extraction, and improve overall system performance.
- **Real-world Deployment and Validation:** Experimental investigations may involve deploying ANPR systems in real-world scenarios, such as parking lots, toll booths, or traffic monitoring points, to validate their performance and gather data for further analysis. This allows researchers to assess the effectiveness of ANPR systems in practical settings and identify any additional challenges or limitations that may arise.
- By conducting experimental investigations on ANPR, researchers aim to push the boundaries of the technology, overcome challenges, and enhance its accuracy, efficiency, and reliability. The findings from these investigations contribute to the

continuous improvement and advancement of ANPR systems for various applications.

5. FLOW CHART



6. SOURCE CODE

Index.html:

```
<!DOCTYPE html>
<html>
  <head>
    <link href="{{ url_for('static_css', path='main.css') }}"
rel="stylesheet">
    <link
href="https://cdn.jsdelivr.net/npm/bootstrap@5.0.1/dist/css/bootstrap.mi
n.css" rel="stylesheet">
  </head>
<body>
  <div class="bg">

  </div>

  <main class="form-signin">
    <h1 class="h3">Automatic Number Plate Recognition</h1>
    
```

```

        <form id="uploadForm">
            <div class="form-floating">
                <input type="url" class="form-control" id="imageURL"
placeholder="Enter image URL">
                <label for="imageURL">Enter Image URL</label>
            </div>
            <button class="btn btn-lg" type="submit" style="background-
color: #59adce; margin-top: 10px;">Check</button>
        </form>
        <div id="imageContainer" class="input_img" style="margin-
top:10px"></div>
        <div class="form-floating">
            <textarea id="output" rows="4" readonly></textarea>
        </div>
    </main>

    <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.0.1/dist/js/bootstrap.bund
le.min.js"></script>
    <script>
        document.getElementById('uploadForm').addEventListener('submit',
function (event) {
            event.preventDefault(); // Prevent form submission

            var imageURL = document.getElementById('imageURL');
            var output = document.getElementById('output');
            var imageContainer =
document.getElementById('imageContainer');

            var formData = new FormData();
            formData.append('imageURL', imageURL.value);

            var xhr = new XMLHttpRequest();
            xhr.open('POST', '/process', true);
            xhr.setRequestHeader('Content-Type', 'application/x-www-
form-urlencoded');

            xhr.onreadystatechange = function () {
                if (xhr.readyState === XMLHttpRequest.DONE && xhr.status
=== 200) {
                    var response = JSON.parse(xhr.responseText);
                    if ('plate' in response && 'confidence' in response)
                    {
                        var plate = response.plate;
                        var confidence = response.confidence;
                        output.value = 'Detected license plate: ' +
plate + '\nConfidence: ' + confidence;
                    } else if ('error' in response) {
                        output.value = 'Error: ' + response.error;
                    }
                }
            }
        }
    </script>

```



```

        } else {
            output.value = 'No response received.';
        }

        // Display the image in imageContainer
        var img = document.createElement('img');
        img.src = imageURL.value;
        img.style.height = '150px';
        imageContainer.innerHTML = ''; // Clear existing
content
        imageContainer.appendChild(img); // Append the image
    } else {
        output.value = 'Error occurred while processing the
image.';
    }
};

xhr.send(new URLSearchParams(formData));
output.value = 'Processing image...';
});
</script>

</body>
</html>

```

App.py:

```

from flask import Flask, render_template, request, jsonify
import http.client
import json

app = Flask(__name__)

@app.route('/')
def home():
    return render_template('index.html')

@app.route('/process', methods=['POST'])
def process():
    image_url = request.form['imageURL']
    if image_url:
        conn = http.client.HTTPSConnection("openalpr.p.rapidapi.com")
        payload = f"image_url={image_url}"
        headers = {
            'content-type': "application/x-www-form-urlencoded",
            'X-RapidAPI-Key':
"f702f985bcmsh99c9982e34a8b66p13a274jsn360379ced8a6",
            'X-RapidAPI-Host': "openalpr.p.rapidapi.com"
        }

```

```

        conn.request("POST", "/recognize_url?country=eu", payload,
headers)
        res = conn.getresponse()
        data = res.read()
        response_data = json.loads(data.decode("utf-8"))

        if 'results' in response_data and len(response_data['results'])
> 0:
            results = response_data['results'][0] # Assuming the first
result is the most confident one
            plate = results['plate']
            confidence = results['confidence']
            output_data = {'plate': plate, 'confidence': confidence}
            response = jsonify(output_data)
        else:
            response = jsonify({'error': 'No license plate found.'})

        return response
    else:
        response = jsonify({'error': 'No image URL provided.'})
        return response

@app.route('/static/css/<path:path>')
def static_css(path):
    return app.send_static_file('css/' + path)

if __name__ == '__main__':
    app.run(debug=True)

```

7. SAMPLE INPUT

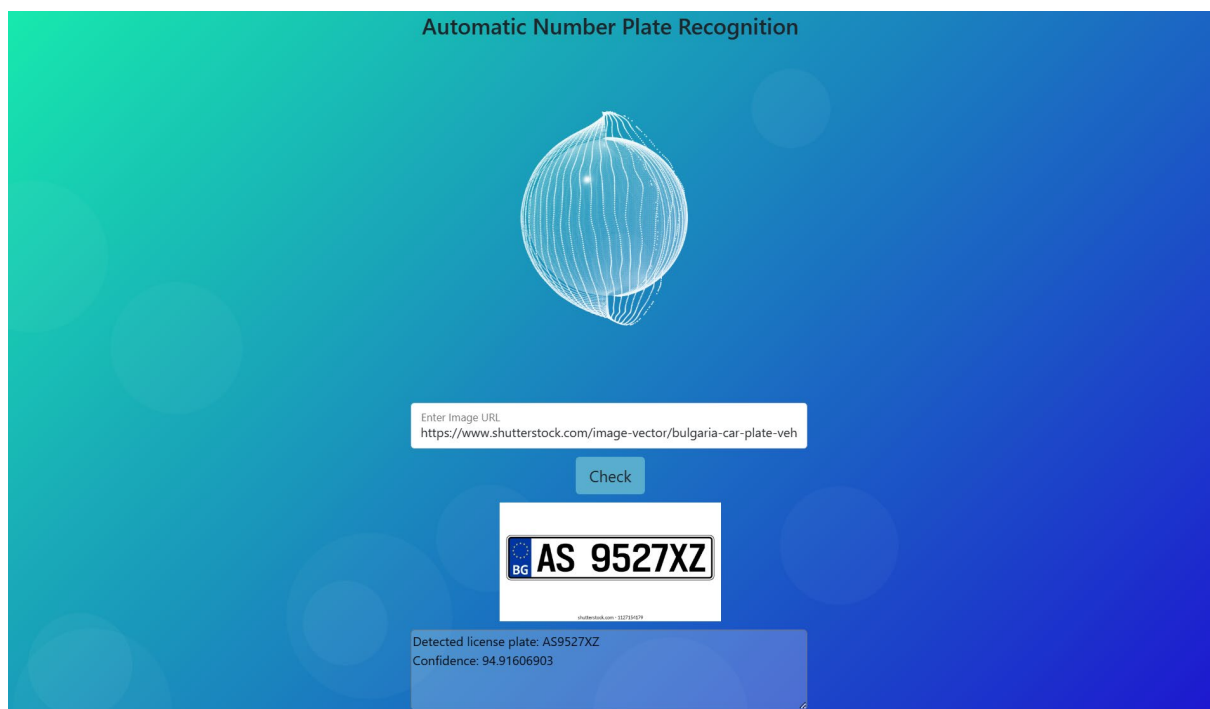
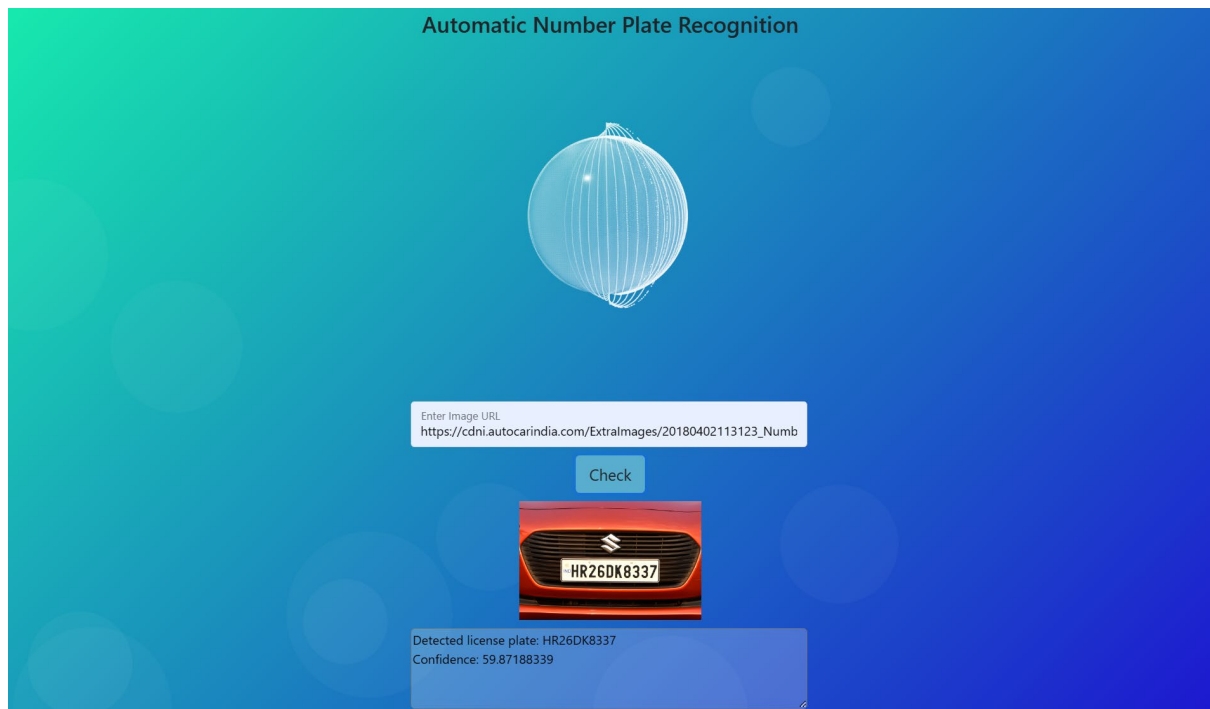
https://cdni.autocarindia.com/ExtraImages/20180402113123_NumberPlate_Swift.jpg

<https://www.shutterstock.com/image-vector/bulgaria-car-plate-vehicle-registration-260nw-1127154179.jpg>

https://c.ndtvimg.com/2018-10/a7sp8ji_high-security-number-plates_625x300_12_October_18.jpg

https://stage-drupal.car.co.uk/s3fs-public/styles/original_size/public/2019-09/why-are-number-plates-yellow-and-white.jpg?rt1UJUyIi7L2DpS613hFYII5ng3U4QT3&itok=3SZjXU0B

8. RESULT



9. Demo Video Link:

https://drive.google.com/file/d/1gNeHJTECsOnUv1_7pR3_ZR2jYLS9JftR/view?usp=sharing

10. ADVANTAGES & DISADVANTAGES

Advantages:

- Enhanced security and Law Enforcement
- Crime Deterrence
- Traffic Management
- Parking management
- Efficient Toll collection

Disadvantages:

- Privacy concerns
- Accuracy Limitations
- Maintenance
- Cost and Infrastructure Requirements

11. APPLICATIONS

- Law enforcement
- Traffic management
- Toll collection
- Parking management and enforcement
- Border control and security
- Surveillance systems
- Access control and gated communities
- Electronic vehicle identification
- Vehicle tracking and fleet management
- Road safety and enforcement
- Congestion charging
- Automated vehicle identification for fuel stations
- Vehicle access for car parks and buildings
- Traffic data collection and analysis
- Red light enforcement
- Speed enforcement
- Bus lane enforcement
- Automatic toll payment systems

12. CONCLUSION

In conclusion, the Automatic Number Plate Recognition (ANPR) project has proven to be a valuable and versatile technology with numerous applications. Through the development and implementation of ANPR systems, several benefits have been realized in areas such as law enforcement, traffic management, toll collection, parking management, border control, and more. ANPR has enhanced security measures, improved traffic flow, facilitated efficient

tolling processes, streamlined parking operations, and contributed to public safety initiatives.

However, it is essential to address the associated challenges and considerations, such as privacy concerns, accuracy limitations, cost and infrastructure requirements, vulnerability to tampering, and legal compliance. Responsible implementation of ANPR systems requires maintaining a balance between the advantages it offers and safeguarding individual privacy rights, adhering to regulations, and ensuring transparency in data usage.

The continuous advancement of ANPR technology, along with ongoing research and development efforts, will further enhance its capabilities, accuracy, and adaptability to various license plate formats and challenging environments. As ANPR systems evolve, they will continue to play a crucial role in improving security, optimizing traffic management, and enhancing various aspects of transportation and surveillance systems.

Overall, the ANPR project has demonstrated the effectiveness and potential of this technology, providing valuable insights and paving the way for future advancements in the field.

13. FUTURE SCOPE

The future scope of Automatic Number Plate Recognition (ANPR) technology is promising, as advancements in various areas continue to push its capabilities and applications. Here are some key areas that indicate the future scope of ANPR:

- **Improved Accuracy:** The ongoing development of sophisticated algorithms and machine learning techniques will enhance the accuracy of ANPR systems. Future advancements may focus on handling challenging conditions such as low lighting, adverse weather, and obscured or damaged license plates, ensuring reliable performance in a wider range of scenarios.
- **Real-time Processing:** ANPR systems will become even faster and more efficient, enabling real-time processing and analysis. This will be essential for applications such as law enforcement, traffic management, and toll collection, where immediate responses and decisions are crucial.
- **AI and Deep Learning:** The integration of advanced artificial intelligence (AI) and deep learning techniques will lead to significant improvements in ANPR technology. AI-based ANPR systems will be able to adapt to new license plate formats, recognize non-standard characters, and continuously self-improve their recognition capabilities.
- **Integration with Smart City Initiatives:** ANPR will be an integral part of smart city initiatives, contributing to data-driven decision-making and optimized urban planning.

ANPR data will be combined with other sensors and IoT devices to create intelligent transportation systems, enhance public safety, and improve overall city management.

- **Mobility and Vehicle-to-Everything (V2X) Communication:** ANPR technology may be integrated into future vehicle systems, enabling vehicles to communicate with ANPR infrastructure and other vehicles. This can enhance traffic flow, enable vehicle-specific services, and improve overall road safety.
- **Privacy-enhancing Measures:** To address privacy concerns, future ANPR systems may implement privacy-enhancing techniques, such as on-device processing, encrypted data storage, and anonymization of collected data. These measures will ensure that ANPR technology remains ethically and legally compliant.
- **Global Standardization:** As ANPR is deployed globally, there will be efforts to standardize license plate formats and communication protocols. This will facilitate interoperability and seamless data exchange between ANPR systems across different countries and regions.
- **Cloud-based ANPR Solutions:** Cloud-based ANPR services will become more prevalent, allowing businesses and organizations to leverage ANPR capabilities without the need for extensive on-site infrastructure. Cloud solutions will offer scalability, flexibility, and easier access to ANPR technology.
- **Autonomous Vehicles and ANPR:** ANPR technology will likely be integrated into the autonomous vehicle ecosystem. Self-driving cars can benefit from ANPR for navigation, parking, and adhering to traffic rules.
- **Multi-modal Biometric Systems:** ANPR may be integrated into multi-modal biometric systems, combining license plate recognition with other biometric data (such as facial recognition) for enhanced security and authentication purposes.
- **The future scope of ANPR is exciting,** with potential advancements enabling more accurate, efficient, and responsible use of this technology across various domains. As ANPR continues to evolve, it will play a crucial role in shaping smarter, safer, and more efficient transportation and surveillance systems in the years to come.

14. BIBILOGRAPY

Source code Github repo link:

<https://github.com/smartinternz02/SI-GuidedProject-526691-1688105893.git>

Demo Video Link:

https://drive.google.com/file/d/1gNeHJTECsOnUv1_7pR3_ZR2jYLS9JftR/view?usp=sharing

References:

https://www.researchgate.net/publication/224565257_Automatic_Number_Plate_Recognition_System_for_Vehicle_Identification_Using_Optical_Character_Recognition

<https://github.com/openalpr/openalpr>

<https://alpr.cloud/>

<https://platerecognizer.com/>

<https://www.anprcameras.com/about-us/understanding-anpr/>