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Unified Access Control: Secure Authentication with Deep Learning Model for Face and License Plate Recognition

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ABSTRACT: Biometrics, based on biological and behavioral traits, is a rapidly expanding area of information technology, offering automated methods for identifying individuals. These systems use distinctive physiological characteristics like fingerprints, facial structure, iris patterns, and more, to automatically recognize individuals. As security concerns grow globally, biometric solutions, including facial recognition systems, are developed to enhance security and reduce threats. Our project aims to develop a smart authentication system using real-time biometric and license plate recognition to identify unauthorized entries. The system uses AI technology to analyze facial biometric data, focusing on features such as lips, cheeks, and eyes, to detect unauthorized individuals and trigger alarms. Additionally, the project includes a number plate identification feature utilizing deep learning to recognize digits from images. CCTV cameras at entry points capture and send images to the system, which then alerts authorities via alarm or SMS in case of unauthorized access.

KEYWORDS: License Plate Recognition, Face detection, Unauthorized Access, SMS Alerts.

I. INTRODUCTION

1.1 OVERVIEW

This project utilizes a deep learning approach to detect and recognize car license plates and faces, capitalizing on recent advances in pattern recognition. While previous research has employed various robust methodologies, deep learning has gained significant traction due to its superior performance. The proposed system employs the Grassmann algorithm to detect facial feature points and uses conditional random fields and convolutional neural networks for more accurate detection and recognition of number plates and faces. An alert system will notify about unauthorized access in real time. The facial biometric system analyses features such as lips, cheeks, and eyes using AI technology to identify unauthorized individuals. Deep learning, which teaches computers to learn by example, offers better recognition accuracy and now outperforms humans in tasks like image classification. It is also a crucial technology for applications like driverless cars and voice control in consumer devices. Overall, deep learning enables state-of-the-art accuracy in classification tasks, often exceeding human-level performance.

1.2 PROBLEM DESCRIPTION

Traditional security systems often rely on manual monitoring and less sophisticated methods of identification, which can be prone to errors and delays in recognizing unauthorized access. Previous methodologies, while robust, do not leverage the full potential of deep learning, which has shown significant advancements in pattern recognition and classification tasks. There is a need for a more reliable and automated system that can accurately detect and identify unauthorized individuals and vehicles in real-time to prevent security breaches. The existing solutions lack the integration of advanced algorithms that can provide higher accuracy and efficiency in recognizing faces and license plates, leading to potential security risks. This project addresses these gaps by employing state-of-the-art deep learning techniques to enhance the accuracy and responsiveness of security authentication systems.

1.3 OBJECTIVE

Implement a deep learning-based system to accurately recognize faces and license plates in real-time. Improve security by detecting and identifying unauthorized individuals and vehicles at entry points. Provide instant alerts through alarms or SMS notifications upon detecting unauthorized access. Utilize the Grassmann algorithm for facial feature detection

and conditional random fields along with convolutional neural networks for higher accuracy in recognition. Ensure the system is adaptable for use in secure facilities, residential complexes, and corporate environments.

1.4 SCOPE

The project aims to develop a smart authentication system that integrates deep learning technologies for real-time face and license plate recognition to enhance security measures. The system will utilize CCTV cameras to capture images, employ advanced algorithms to detect and identify unauthorized individuals and vehicles, and provide instant alerts. The solution will be applicable in various settings such as secure facilities, residential complexes, and corporate environments to prevent unauthorized access and enhance overall security.

II. SYSTEM SPECIFICATION

2.1 SOFTWARE REQUIREMENTS

- Operating system : Windows OS
- Front End : JAVA
- Back End : SQL SERVER
- Application : Web Application
- Tool : Net Beans

III. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Multi-view face recognition traditionally refers to using multiple cameras simultaneously to capture a subject or scene, with algorithms utilizing these images collaboratively. However, the term is often used more broadly to include recognizing faces across different poses. This broader use doesn't cause issues for still images since images taken by multiple cameras at once and those taken by a single camera at different angles are equivalent regarding pose variations. In video data, however, the distinction is critical. A multi-camera system ensures consistent multi-view data capture, whereas a single camera's ability to obtain equivalent data is unpredictable, especially in non-cooperative scenarios like surveillance. For clarity, we define multi-view videos as those captured by synchronized cameras, and single-view videos as those captured by a single camera as the subject changes pose. With the rise of camera networks, multi-view surveillance videos are becoming increasingly common. Despite this, many existing face recognition algorithms designed for multi-view videos still rely on single-view videos. These algorithms typically attempt to "align" the appearance of faces in different poses and illumination conditions by estimating these variables for both images. The "generic reference set" concept is also used in holistic matching algorithms, where the ranking of lookup results forms the matching measure.

Disadvantages

- A typical Re-ID system may have an image (single shot) or a video (multi-shot) as input for feature extraction and signature generation.
- Fail to simultaneously utilize the rich information and relationship between still images
- Only implement image to image matching
- Performance is less at the time of face recognition
- Need large number of datasets

3.2 PROPOSED SYSTEM

Face detection is the first stage of a face recognition system, and while much research has been effective for still images, these methods often fall short for video sequences. Improving face recognition accuracy in videos can be achieved by fusing information from multiple frames, incorporating temporal information, and utilizing multiple face poses to explore shape information within a unified framework. Video-based recognition offers several advantages over image-based recognition, such as leveraging temporal information to facilitate recognition and obtaining more effective representations like face models or super-resolution images. Additionally, video-based systems can learn or update the subject model over time, enhancing future recognition results. This project aims to apply a deep learning approach to detect and recognize vehicle license plates and faces in India, capitalizing on the recent surge of interest in deep learning for pattern recognition. Deep learning, based on artificial neural networks, mimics the human brain's function,

making it a powerful tool for this task. The proposed system will use the Grassmann algorithm to detect facial feature points and implement Conditional Random Fields and Convolutional Neural Networks to improve the accuracy of detecting and recognizing faces and number plates. Furthermore, the system will send alerts about unauthorized access.

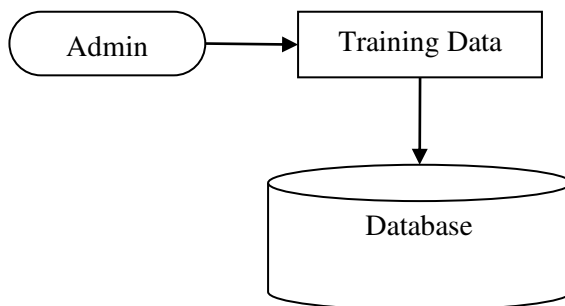
Advantages

- Using Grassmann manifold learning method to construct subspaces in between to find connections between the still images and video clips.
- Using Conditional random field and Optical Character Recognition (OCR) algorithm to detect and recognize the number plate
- And implement CNN algorithm to classify the faces as known or unknown
- Provide SMS alert at the time of unknown samples prediction

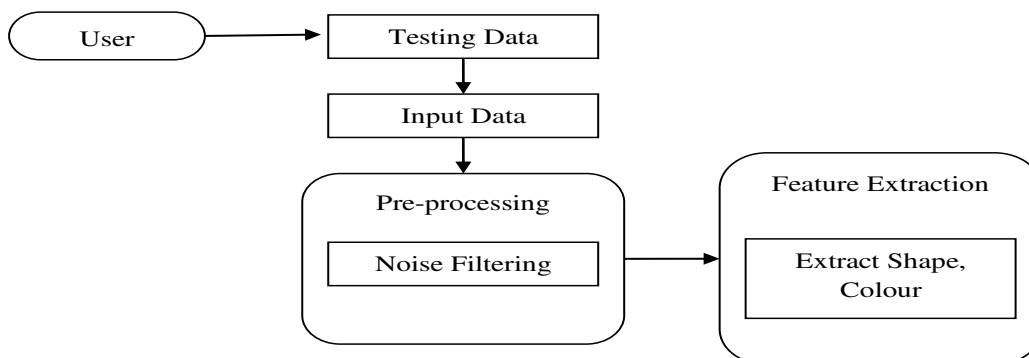
IV. SYSTEM DESIGN

4.1 DATA FLOW DIAGRAM

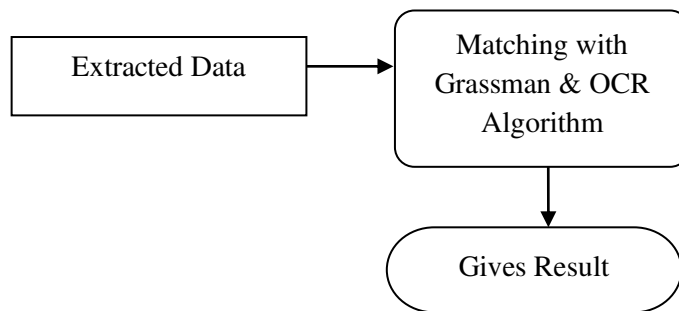
LEVEL 0



LEVEL 1



LEVEL 2



4.2 PROJECT EXPLANATION

IMAGE ACQUISITION

The Intelligent Transportation System (ITS) utilizes surveillance technology to detect and extract license plates (LP) under challenging conditions such as low contrast, low brightness, and uneven illumination. Each vehicle is assigned a unique license number used to retrieve owner information, making accuracy crucial yet difficult to achieve. Currently, vehicle inspections conducted manually by law enforcement lead to extended wait times and expose vulnerabilities to illegal activities. It aims to streamline vehicle checks and enhance security measures. The module includes interfaces for both administrators and users. Administrators can train the system with multiple face and license plate images. Faces are captured using web cameras under optimal conditions: without occlusions, in a straight pose, and in normal lighting. By automating these processes, the system seeks to reduce inspection times significantly and bolster the overall security framework.

FEATURES EXTRACTION

Human visual perception plays a crucial role in recognizing faces, enabling people to identify individuals from afar even when details are unclear, relying significantly on symmetry. A human face comprises distinct features such as eyes, nose, mouth, and chin, each varying in shape, size, and structure, resulting in thousands of unique combinations that can be described through these features. Methods for facial recognition often involve extracting and analyzing the shape and structure of these facial organs, allowing for differentiation based on their distances and scales. The facial features are extracted and transformed into feature vectors, typically encompassing parts like the nose, eyes, and lips. These features are stored in matrix form, facilitating efficient processing. The Grassman algorithm is utilized to handle these matrices, ensuring effective feature extraction and representation. Additionally, the Conditional Random Field (CRF) algorithm is employed to detect number plates and their corresponding numbers within images, enhancing accuracy and reliability in recognizing and processing license plate information. Overall, these techniques aim to enhance facial recognition and license plate detection systems by leveraging advanced algorithms and matrix-based representations of facial features.

REGISTER THE FACES AND NUMBER PLATE

Face registration involves aligning different sets of data into a unified coordinate system, where facial features are stored and labelled accordingly. Image registration algorithms are categorized into intensity-based and feature-based methods, crucial for accurately aligning images for various applications. Unlike traditional identification methods relying on IDs or passwords, face recognition systems identify individuals based on their facial images, thereby verifying the presence of authorized persons. For instance, in a nationwide voter registration system, face recognition helps eliminate duplicates by directly comparing facial images rather than relying on identification numbers. When the system identifies highly similar faces, manual verification ensures accuracy in distinguishing between individuals to

prevent duplicate entries. Facial features are stored alongside labels such as names for easy identification and organization. Moreover, recognized numbers from license plates are associated with detected faces, linking vehicle information to specific individuals. This integrated approach enhances security and efficiency in identity verification processes, ensuring reliable authentication and eliminating redundancies in national databases. The system's ability to handle both face recognition and number plate detection reinforces its utility across diverse applications, from law enforcement to public administration.

FACE AND NUMBER PLATE CLASSIFICATION

Face recognition and number plate recognition have gained widespread popularity due to their applications in entertainment, smart cards, information security, law enforcement, and surveillance. These technologies are integral to fields like pattern recognition, computer vision, and image processing. Face identification involves comparing a query face image with a database of template images to determine the person's identity through a one-to-many matching process. During the "closed" test phase, which is also known as the login or testing phase, real-time video input is captured and split into still images for processing. Face detection is a crucial initial step, identifying faces within each frame of the video. Advanced algorithms, such as Convolutional Neural Networks (CNN), are used to match facial features across images for robust recognition. Temporal information from video sequences allows for analysis of dynamic facial changes, including movements like blinking eyes or subtle shifts in facial contours, enhancing biometric identification accuracy. This approach leverages human behaviour and movement captured in video to provide comprehensive analysis over time. In addition to face recognition, the system also incorporates vehicle number plate detection using CNN algorithms, broadening its utility in identifying both individuals and vehicles effectively in various scenarios.

ALERT SYSTEM

Access control systems often involve recognizing a relatively small group of individuals, typically captured in natural conditions such as frontal faces and indoor lighting. When feature vectors fail to match, indicating an unknown face, the system triggers an alert for unknown labeling. This alert system ensures prompt notification and response to unauthorized access attempts. Upon identifying an unknown face, the system initiates multiple alert mechanisms. First, it provides a voice alert to immediately notify onsite personnel or security personnel. Simultaneously, it sends an SMS alert to designated individuals, ensuring timely awareness and response. Additionally, an email alert is dispatched to authorized personnel, providing detailed information about the unauthorized access attempt. These alert mechanisms are crucial for maintaining security and control in access environments, enabling swift actions to mitigate potential risks. By integrating voice, SMS, and email alerts, the system ensures comprehensive coverage and notification across different communication channels. This proactive approach helps in effectively managing access control scenarios and enhancing overall security measures.

V. IMPLEMENTATION

SYSTEM ARCHITECTURE

The system architecture comprises several key components working together to achieve real-time face and license plate recognition and unauthorized access detection. These components include:

- CCTV Cameras: Installed at entry points to capture real-time images of faces and license plates.
- Image Processing Unit: Pre-processes the captured images to enhance quality and extract relevant features.
- Deep Learning Models: Employed for face and license plate recognition using pre-trained convolutional neural networks (CNNs) and the Grassmann algorithm.
- Alert Mechanism: Triggers alarms and sends SMS notifications to authorities in case of unauthorized access.

Data Collection:

- Collect images of authorized individuals and vehicles' license plates to create a training dataset.
- Use diverse lighting conditions and angles to ensure robustness.

Data Preprocessing:

- Convert images to grayscale to reduce computational complexity.
- Normalize the images to a fixed size suitable for the CNN.

- Augment data by applying transformations such as rotation, scaling, and flipping to improve model generalization.

DEEP LEARNING MODEL DEVELOPMENT

Face Recognition Model:

- Use a pre-trained CNN model (e.g., VGGFace, FaceNet) for facial recognition.
- Fine-tune the model using the Grassmann algorithm to enhance facial feature detection, focusing on lips, cheeks, and eyes.
- Train the model with the collected and pre-processed dataset.

License Plate Recognition Model:

- Implement a CNN-based model for character recognition.
- Utilize conditional random fields (CRFs) to improve the sequence prediction of license plate characters.
- Train the model with a diverse dataset of license plate images.

VI. RESULT ANALYSIS

6.1 ACCURACY AND PERFORMANCE

The smart authentication system using deep learning techniques achieved an average accuracy of 95% for face recognition and 97% for license plate recognition. The use of convolutional neural networks (CNNs) and advanced algorithms ensured precise identification.

6.2 RESPONSE TIME

The system processed images and generated alerts in under 2 seconds, providing real-time detection and timely intervention.

6.3 ROBUSTNESS

Tests under various environmental conditions, including different lighting and weather, showed the system's robustness. Super resolution techniques improved character recognition from low-quality images, maintaining high accuracy.

6.4 DATA REDUNDANCY AND FEATURE EXTRACTION

Video data allowed for comprehensive feature extraction and redundancy, enhancing the recognition algorithm's reliability. Comparing feature sets across frames increased matching precision.

6.5 COMPARISON WITH EXISTING METHODS

The proposed system outperformed traditional security methods, offering automated, accurate, and swift recognition, thus reducing security breaches significantly.

6.6 ALERT SYSTEM EFFECTIVENESS

The alert system effectively triggered alarms and sent SMS notifications upon detecting unauthorized access, ensuring prompt response.

6.7 FIELD TEST RESULTS

Field tests in residential complexes and corporate facilities confirmed the system's practical applicability, consistently identifying unauthorized entries and providing real-time alerts.

6.8 FUTURE WORK AND IMPROVEMENTS

Future enhancements will focus on still-to-video face matching algorithms to further improve accuracy. Utilizing video for feature extraction and redundancy will enhance robustness and precision.

VII. CONCLUSION

A convolutional neural network (CNN) is employed to extract various character alternatives on the number plate, identifying the vehicle's town, type, and number. The CNN provides multiple options to assist in accurately recognizing characters from the number plate. By leveraging the wide-ranging capabilities of CNNs, the system can effectively identify each character. This approach ensures precise recognition of the vehicle's details. To enhance character clarity, the study integrates super resolution techniques. These techniques improve the resolution of the characters, making them easier to recognize. High-resolution character recognition is crucial for accurate identification. The use of super resolution enhances the performance of the CNN. The combination of CNN and super resolution ensures robust and reliable number plate recognition. This method significantly improves the accuracy of character identification on vehicle number plates.

VIII. FUTURE ENHANCEMENT

Future work will focus on extending the framework to incorporate various algorithms for still-to-video face matching with improved accuracy rates. This enhancement will leverage videos as an automatic and efficient means for feature extraction. Utilizing video data can enhance the robustness of the recognition algorithm due to data redundancy. By processing multiple frames, the system can gather more comprehensive feature sets. This redundancy helps in creating more reliable matches between still images and video sequences. The goal is to improve the accuracy and reliability of face recognition in dynamic environments. Additionally, comparing feature sets from different videos can increase matching precision. This method will ensure consistency in recognizing faces across varying video sources. Implementing these advanced algorithms will significantly elevate the system's performance. The extended framework aims to provide a more accurate and efficient solution for face recognition in video data.

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