PROJECT REPORT ON

“Automated Entry-Exit System using Image Processing”

Submitted By:
Akshay Bhosale 234101006
Ritik Koshta 234101044
Rumit Gore 234101045

Under The Guidance Of:

Prof. Debanga Raj Neog
Mehta Family School of Data Science and Artificial Intelligence, IIT Guwahati

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Department of Computer Science and Engineering
Indian Institute of Technology Guwahati, Guwahati

Problem Statement
IIT Guwahati features numerous entry points, and Khokha gate stands out as one of the most heavily utilized. However, despite its significance, the current manual entry and exit procedures at Khokha gate present notable challenges. These include lengthy queues, excessive paper consumption, and issues like fraudulent entries and overlooked exits. Such inefficiencies not only inconvenience users but also raise concerns regarding security and accuracy. Therefore, there is a pressing need to modernize the entry and exit system at Khokha gate, transitioning it into the digital system.

By switching to a digital system, we can make things run smoother, help the environment by using less paper, and make sure everything is more secure. Going digital will also make it easier for people to use the gate, keep better track of who comes and goes, and make sure Khokha gate is up-to-date with today's technology. So, upgrading is really important to fix the problems we have now and make Khokha gate work better in the digital world.

Related work
Entry and exit management systems are essential components of campus security and operational efficiency in educational institutions, particularly colleges and universities. While technological advancements have led to the adoption of sophisticated systems. Colleges employ a variety of systems for entry and exit management, ranging from traditional manual methods to modern technological solutions.

1. Manual Sign-in/Sign-out Sheets: Paper-based records where individuals manually record their entry and exit times.
2. Security Personnel: Personnel stationed at entry and exit points physically verify identities or inspect ID cards.
3. Access Control Systems: Technologies like RFID and biometric scanners authenticate individuals during entry and exit.
4. Automated Gate Systems: Equipped with sensors and cameras, these systems monitor entry and exit points in real-time.

Each of these systems has its advantages and limitations, and colleges may choose the solution that best suits their security needs, budget, and operational requirements.

The current systems have their own problems that we need to fix. Firstly, unlike systems reliant on RFID technology, which may not be universally adopted due to cost or infrastructure constraints, our approach accommodates colleges where not all ID cards have RFID capabilities.
Plus, there are problems with other systems. For instance, using paper sign-in sheets or relying on security guards can lead to mistakes and slow things down. Access control systems and fancy gates need a lot of money for equipment and setup, so not all colleges can afford them.

Instead, we use image processing and machine learning, which work with any type of ID card. This makes our solution more accessible and flexible for different campuses. Our solution is cheaper and easier to use, helping colleges manage entries and exits without spending too much.

Dataset

The data set comprises images and videos of ID cards collected from students residing in the Brahmaputra hostel at IIT Guwahati. Each student's ID card was obtained, and images of the ID cards were captured against a black background using a mobile camera mounted on a tripod for optimal results. Additionally, videos of each ID card were recorded for testing purposes. The images in the data set have a resolution of 3000x4000 pixels, captured using a 12-megapixel camera. The videos are recorded at 1080x1920 resolution with a frame rate of 30 frames per second (fps).

Prior to collecting ID card images and videos, consent was obtained from each student, ensuring compliance with data privacy and ethics regulations. Students were informed about the purpose of data collection and provided their consent willingly.

As a potential future expansion, the college could consider implementing a system where students upload their ID card images themselves. This would streamline the data collection process and ensure up-to-date records.

Method

1. **Object detection using YOLO (ID Card detection)**

   Initially, we fine-tuned the YOLO model specifically for the detection of ID cards, enhancing its ability to accurately identify ID cards within images. This fine-tuning process involved training the YOLO model on a dataset consisting of various ID card images, including different types and orientations. Additionally, data augmentation techniques were applied to diversify the training data, ensuring robust performance in various scenarios.

   Leveraging the fine-tuned YOLO model, we implemented a system to detect ID cards from video streams in real-time. The YOLO algorithm was used to identify ID cards within each frame of the video feed. We set a confidence parameter to determine the minimum confidence threshold required for a detection to be considered valid, ensuring only high-confidence detections are captured.

2. **Automatic Capturing of ID Card image**

   Following successful detection of ID cards using YOLO, we developed mechanisms to capture images of the detected ID cards. This involved capturing frames from the video feed when the YOLO algorithm achieved the specified confidence threshold for ID card detection.

   By selectively capturing images based on confidence levels, we ensured that only high-confidence detections were processed, minimizing false positives and optimizing the reliability of the captured ID card images.

3. **Processing the captured image**

   Following the successful capture of the ID card image using the YOLO algorithm, our next objective was to enhance its quality and suitability for further analysis. To achieve this, several processing steps were implemented.

Initially, the captured ID card image underwent cropping to eliminate any extraneous background or surrounding elements. This ensured that the focus remained solely on the ID card itself, facilitating clearer identification and analysis.

Subsequently, alignment techniques were applied to standardize the orientation and aspect ratio of the ID card image. This standardization process aimed to ensure consistency across different orientations. By optimizing the captured ID card image through cropping and alignment, our intention was to enhance the accuracy and reliability of subsequent processing tasks.

4. **Classifying ID cards using a Machine Learning Model**

   In this step, we used a machine learning model to classify ID cards and determine if they are college ID cards or not. To make this model better at its job, we trained it using Convolutional Neural Networks (CNN), a type of deep learning algorithm known for its effectiveness in image classification tasks.

   As of now, our model can accurately classify whether an ID card is of college student or not. However, our future plan is to enhance this classification model to identify other types of ID cards, such as Aadhar cards or other forms of identification. This expansion will enable us to capture details of individuals who may not be students but still require access to the college premises for various purposes.

5. **Extracting Face Images from ID cards**

   In this step, we focused on extracting the face images from the ID cards for further analysis.
   First, we created a mask with defined coordinates specifying the location of the face image on the ID card. This mask helped us pinpoint the exact area where the face image was located within the ID card.

   Next, utilizing image processing methods, we applied the mask to the ID card image to isolate and extract the face image. By carefully defining the coordinates and applying the mask, we ensured accurate extraction of the face image from the ID card, ready for subsequent processing tasks such as face recognition.

6. **Live Face Matching for identity verification**

   We captured a live image of the person presenting the ID card using a camera at the entry point. This live image served as the input for the face recognition process.
   Next, we utilized the face image extracted from the ID card in the previous step as a reference. By comparing the features of the live image with the reference face image, we employed face recognition techniques to determine if they matched.

   Through this comparison, we were able to verify if the person presenting the ID card was indeed the rightful holder of the card. Face recognition played a crucial role in ensuring the authenticity of entry requests, enhancing security measures at the entry point.

7. **Text extraction from ID cards**
   In this step, we extracted roll no. from the id card. We employed a similar approach as used for extracting the face image, utilizing masks and image enhancement techniques to isolate the area containing the roll number on the ID card.
   By applying masks and enhancing the image, we optimized the clarity of the text for better extraction results. This preprocessing step aimed to improve the accuracy of text extraction from the ID card images. Subsequently, we passed the enhanced image containing the roll number to the Pytesseract library, which performed optical character recognition (OCR) to extract the text.

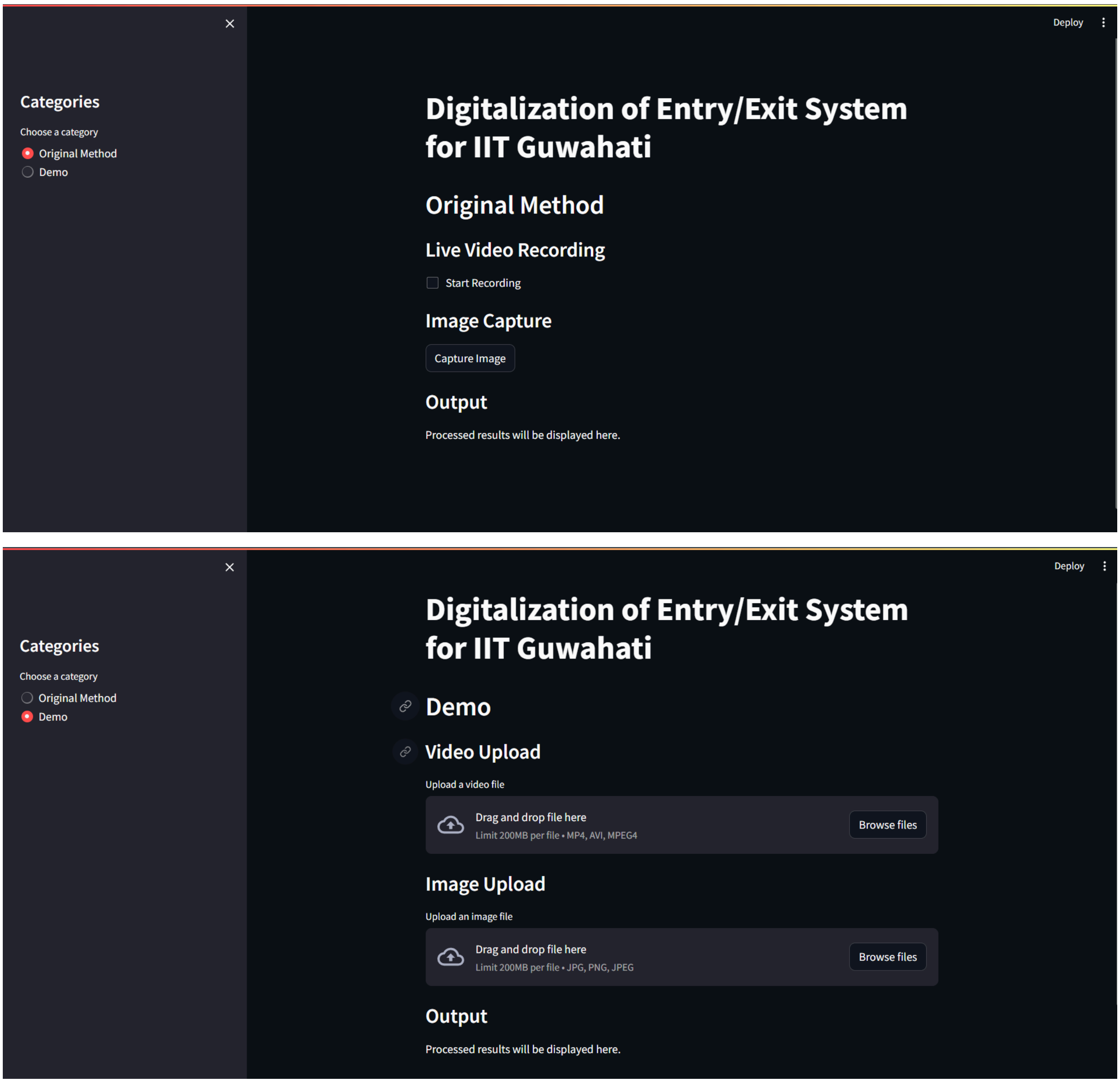
8. **Database Validation using roll number**
   In this step, we cross-checked the roll number extracted from the ID card with the database to confirm the student's information. We accessed the database containing comprehensive student details, including their name, branch, course, ID card validity, and more, all organized by the roll number.

   Utilizing the extracted roll number, we retrieved the corresponding student information from the database. This involved confirming the student's identity, enrollment status, and the validity of their ID card for entry authorization.

9. **Updating excel sheet and automating Entry/Exit marking**
   In this step, we populated our Excel sheet with the extracted details corresponding to the roll number. Utilizing the historical data stored in the Excel sheet, we implemented an automated mechanism to determine whether the action associated with the current entry was an entry or exit. This allowed us to efficiently manage access control at the Khokha gate while maintaining accurate entry and exit logs.

10. **Alert system**
    We established a mechanism to alert students about the gate closure. Specifically, we ensured that students who had exited through the gate received advance notification before its closure. We developed a system that triggered an alert message, as an email, to students who exited through the gate, approximately half an hour before the scheduled closure time, for example, at 10 PM.

    By implementing this alert mechanism, we enhanced communication with students and facilitated a smooth transition during gate closure periods, contributing to overall convenience and safety on campus.



Homepage of our web application

Experiments and Results

To start, we deployed a web application locally, offering two modes: live mode and video upload mode. In the live mode, we captured video feed from the laptop webcam and employed YOLO to detect ID cards. Upon detection, we captured an image of the ID card. Additionally, we captured images of live individuals for further analysis.

Additionally, we implemented a feature allowing users to manually upload videos for demonstration purposes, enabling testing with higher-quality video footage. However, due to limitations in webcam quality, we encountered challenges during this process and identified the need for better hardware.

Furthermore, we conducted testing at the Khokha entry gate to assess the system's performance in a real-world setting. This on-site testing provided valuable insights into system functionality and user experience in practical scenarios.

Moreover, we solicited feedback from students and security guards regarding our project and its potential future scope. The responses were overwhelmingly positive, indicating the system's effectiveness and the potential for further development and implementation.

During development, we faced challenges like dependency issues, importing errors, and integration issues. We solved these by using virtual environments, manual installation of libraries like dlib, and debugging for seamless integration.

Overall, the experiments yielded valuable insights into the system's performance, usability, and potential for real-world application.

Our experiments revealed the effectiveness of our entry and exit system:

1. The system accurately spots ID cards in live webcam videos using YOLO.
2. It handles live images effectively, even in different settings.
3. Testing at the Khokha gate proved the system is user-friendly.
4. Users liked the system and found it helpful for security and convenience.

Conclusion

Our entry and exit management system brings big improvements compared to the old ways campuses used to handle things. It has several advantages that make it better than traditional methods. First off, it's much faster and more accurate. This means less time spent waiting in line and fewer mistakes made. Plus, it helps cut down on long lines, saves paper, and deals with fake entries and missed exits, making things run smoother overall.

Also, our system offers a centralized solution for managing entry and exit points. This makes the whole process easier for everyone involved. Having everything in one place ensures consistency and reliability across all gates, making the user experience better overall.

Additionally, our system uses modern technology to automate many tasks involved in entry and exit management. This saves time and reduces the chance of mistakes. By using features like image processing and machine learning, our system can adapt to different situations and handle them easily.

But our project isn't just about fixing current problems, it's also about setting the stage for future upgrades in how campuses manage entry and exit.

In summary, our entry and exit management system offers a better, faster, and more reliable solution compared to traditional methods. It's a big step forward in campus safety and organization, showing how technology can make a real difference in how educational institutions run.

Project Github link
https://github.com/Ritikkoshta02/Automated-Entry-Exit-System-using-Image-Processing