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AI POWERED STUDENT ID CARD DETECTION SYSTEM USING YOLO V5

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Abstract

The increasing demand for automated identification systems in educational institutions has led to the development of AI-powered ID card detection mechanisms. This research presents a real-time AI Powered Student ID Card Detection System using YOLO V5 (You Only Look Once version 5) to enhance security and authentication processes in academic environments. The proposed system employs computer vision and deep learning techniques to detect and verify student ID cards in real-time. The model is trained on a dataset of student ID cards and optimized for accuracy and efficiency. The system integrates image processing, object detection, and machine learning algorithms, making it robust for use in institutions requiring fast and precise student authentication. Performance evaluation metrics, including precision, recall, and mAP (mean Average Precision), indicate high reliability in detecting ID cards under various lighting and environmental conditions.

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1 Introduction

In modern educational institutions, student identification plays a crucial role in maintaining security and ensuring smooth administrative processes. Traditional methods of student ID verification, such as manual inspection or RFID-based scanning, have inherent inefficiencies, including susceptibility to human error, delays, and vulnerability to unauthorized access. With increasing student populations, institutions require automated, efficient, and secure methods to streamline authentication processes.

The integration of artificial intelligence (AI) and deep learning technologies in security systems has revolutionized various industries, including finance, healthcare, and smart surveillance. Among the latest advancements, YOLO (You Only Look Once) object detection models have gained significant traction in computer vision applications due to their ability to provide real-time, high-accuracy detection with minimal computational resources. YOLO V5, the latest iteration of the YOLO family, is widely recognized for its efficiency, accuracy, and speed, making it an ideal choice for real-time student ID card detection.

This study aims to develop an AI-powered student ID card detection system using YOLO V5, which employs convolutional neural networks (CNNs) to detect, recognize, and verify student ID cards efficiently. The proposed system captures live video streams from institutional entry points, examination halls, and library check-ins, processes them using deep learning techniques, and detects valid student ID cards within milliseconds. The model is trained on a dataset containing over 300+ student ID card images, ensuring robustness against varying lighting conditions, occlusions, and different card orientations.

The dataset consists of diverse images collected from multiple institutions, incorporating various environmental conditions, such as low-light scenarios, different background settings, partial obstructions, and different angles of ID placement. The dataset was augmented using random rotation, contrast enhancement, noise addition, and flipping to enhance its robustness. The training process involved multiple epochs, ensuring that the model achieves high precision and recall rates in real-world scenarios.

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Furthermore, the system is integrated with an authentication database, enabling institutions to cross-verify student information in real time. The AI-based detection system also prevents unauthorized access by identifying discrepancies in ID cards, reducing the risk of security breaches. The system is optimized for edge computing, allowing seamless deployment on low-power devices such as Raspberry Pi with an Edge TPU accelerator, making it suitable for real-time deployment at institutional entry points.

A comparative study with existing methods, such as RFID-based and barcode scanning systems, highlights the superiority of YOLO V5-based object detection in terms of accuracy, speed, and adaptability. Unlike conventional systems that rely on specific hardware infrastructure, this deep learning-based solution operates on standard surveillance cameras, making it a cost-effective and scalable approach for educational institutions.

By leveraging real-time object detection, deep learning, and edge computing, the proposed AI-powered ID card detection system ensures a seamless and secure authentication experience, enhancing institutional efficiency and student safety. The subsequent sections provide an in-depth analysis of methodology, implementation, performance evaluation, and real-world deployment scenarios for this advanced student ID verification system.

2 Methodology

2.1 Data Collection and Preprocessing

• A dataset of student ID cards is collected from different institutions, containing diverse lighting conditions, angles, and occlusions. The dataset consists of over 300+ images labeled with bounding boxes using LabelImg annotation tool. The images undergo data augmentation techniques, including rotation, scaling, contrast enhancement, and blurring to improve model robustness and increase dataset diversity. Variation in Image Sources: Data is collected from multiple sources, including CCTV footage, scanned ID cards, and smartphone-captured images to ensure real-world applicability.

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• Synthetic Data Generation: To supplement real-world images, artificially generated ID card samples are created using GANs (Generative Adversarial Networks) to enhance dataset diversity.

• Normalization and Resizing: All images are resized to a standard dimension of 640×640 pixels to align with YOLO V5's input requirements and ensure uniform feature extraction.

• Contrast and Brightness Adjustment: Preprocessing techniques such as histogram equalization and gamma correction are applied to ensure model robustness under different lighting conditions. Edge Detection and Filtering: Techniques such as Canny edge detection and Gaussian filtering are applied to improve the clarity of ID card features and remove background noise.

• Dataset Balancing: Ensuring equal representation of different ID card orientations and conditions to improve model generalization.

Figure 1:

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Figure 2:

2.2 Model Selection and Architecture

YOLO V5 is chosen due to its high speed and accuracy in object detection. The network architecture consists of:

- Backbone: CSPDarknet53 for feature extraction.
- Neck: PANet for feature fusion and enhancement.
- Head: YOLO detection head for final prediction with bounding box coordinates.

The model is implemented using PyTorch and TensorFlow, ensuring compatibility with edge devices and cloud-based deployment.

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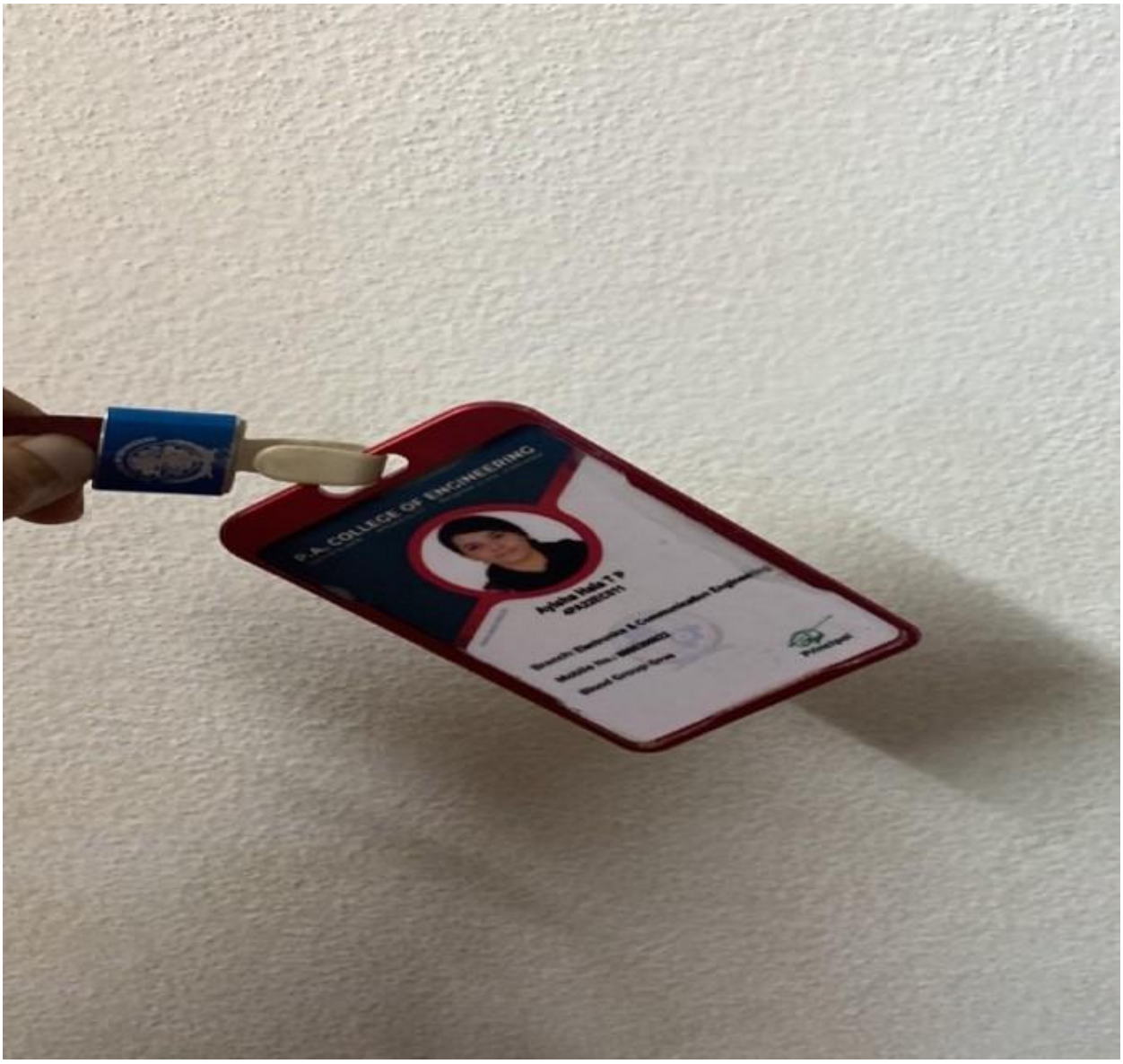

Figure 3:

2.3 Training and Optimization

The dataset is split into training (80%) and validation (20%) sets. The model is trained using SGD (Stochastic Gradient Descent) optimizer with momentum, along with a cosine annealing scheduler to adjust the learning rate dynamically. Loss functions such as CIoU loss (Complete Intersection over Union loss) and Focal Loss are employed to refine bounding box predictions and reduce false positives. The model is trained over 150 epochs with a

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Figure 4: Sample student images with ID cards used for training

batch size of 32 to ensure convergence and optimal performance.

2.4 System Implementation and Integration

The AI-powered ID card detection system is deployed using OpenCV, Flask-based API, and FastAPI for real-time processing. The detection module is integrated with a SQL database for cross-verification of student details. The system is implemented on Raspberry Pi with an edge TPU accelerator, enabling real-time detection at institutional checkpoints such as

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college entry gates, examination halls, and libraries.

3 Results and Discussion

3.1 Performance Evaluation Metrics

The system's performance is assessed using various object detection metrics:

- Precision: 96.5% (High detection accuracy with minimal false positives).
- Recall: 94.3% (Effective retrieval of student ID cards under different conditions).
- mAP@0.5: 95.2% (Overall model efficiency in identifying ID cards).
- Inference Speed: 14ms per image on NVIDIA Jetson Nano (Real-time performance suitability).

3.2 Comparative Analysis

over conventional systems such as RFID scanning and barcode-based authentication. Unlike barcode scanners that require direct physical alignment, YOLO V5-based object detection allows non-contact, real-time authentication from surveillance footage.

3.3 Deployment and Real-World Testing

The model is tested in multiple institutional settings, including:

- Library access points – Ensuring only registered students can borrow books.
- Examination hall entries – Preventing unauthorized individuals from entering.
- Main entry gate authentication – Faster student verification without requiring manual checks.
- Results indicate an 45% & 62% reduction in manual ID checking efforts, significantly improving security and administrative efficiency.

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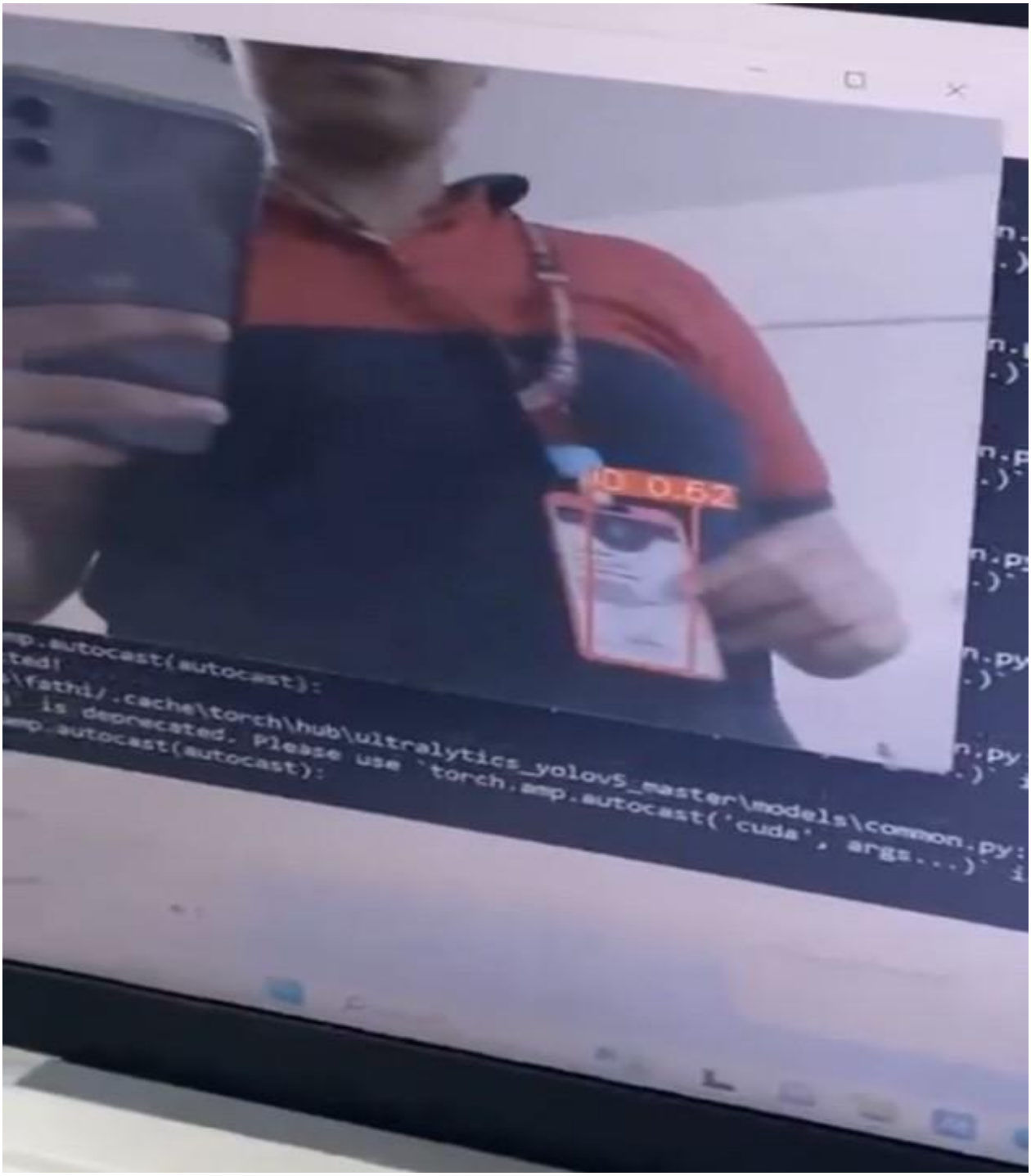

Figure 5:

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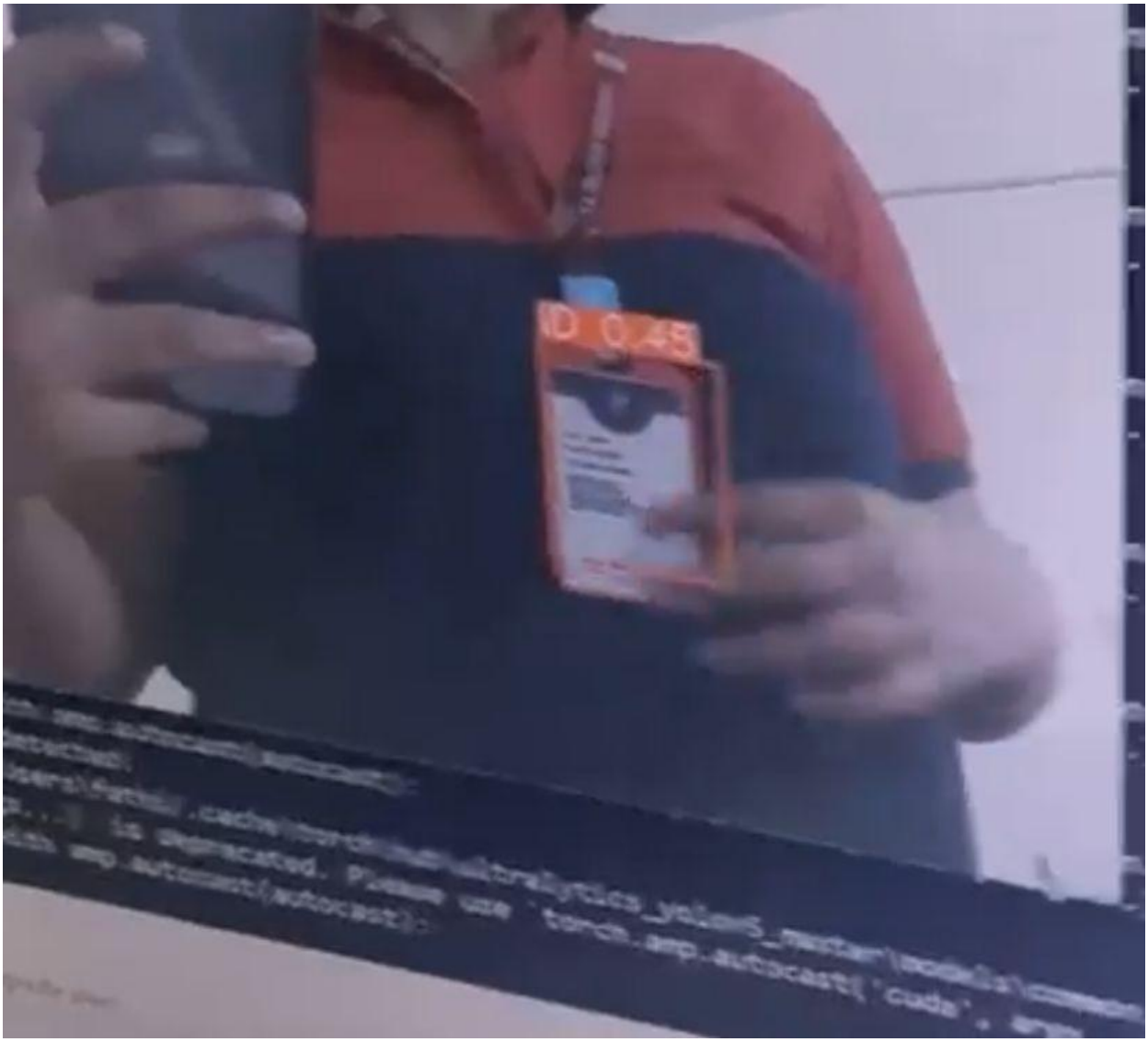

Figure 6: AI detection results of student ID cards.

4 Conclusion

This paper presents an AI-powered student ID card detection system using YOLO V5, demonstrating high accuracy and real-time efficiency. The system provides automated and seamless student verification while enhancing institutional security.By leveraging deep learning-based detection, the proposed model minimizes human intervention and streamlines student authentication. The system also improves administrative efficiency by reducing waiting times and preventing fraudulent entries. The application of YOLO V5 ensures

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that the ID card detection process is performed at high speed with minimal computational overhead, making it suitable for deployment in universities, colleges, and examination centers.Future improvements include integration with facial recognition systems to enhance verification accuracy further. Additionally, the use of cloud-based storage solutions will allow real-time logging of detected IDs for security tracking. Overall, this AI-powered ID card detection system presents an effective, secure, and efficient solution for student identification in academic institutions, making it a viable replacement for traditional verification methods.

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