ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0024

YOLOv3 for Elevator Security: Detecting Electric Bikes

Yichen Li, Meina Zhang*, Jiayu Wang, Yuxuan Liu, Yutong Xing, Xinyuan Wang

School of Computer Science and Software Engineering, University of Science and Technology Liaoning, Anshan 114001, China

*zhangmeina@163.com

Abstract

In recent years, electric bicycles in elevators of high-rise buildings have caused many safety hazards, reminding people to pay attention to the potential threat of electric vehicles in elevators. This paper proposes an enhanced YOLOv3 model that integrates the lightweight GhostNet backbone YOLOv3-G to improve efficiency and accuracy for real-time detection of electric bicycles. The improved model significantly reduces computational requirements and is easy to deploy on edge devices in confined environments such as elevators. Through experiments, this paper demonstrates the effectiveness of YOLOv3-G in real-world scenarios, providing a promising solution to enhance urban life security measures in emerging smart city infrastructures.

Keywords

Elevator Security; E-Bike Detection; Yolov3.

1. Introduction

Electric bikes have become a primary mode of transportation for many, thanks to their convenience and speed which cater to the daily commute of numerous individuals[1]. However, the safety risks associated with electric bikes in elevators cannot be overlooked. In May 2021, an incident involving e-bike combustion within an elevator occurred in a residential area in Sichuan Province, China. Another incident in November 2021 saw an e-bike catching fire while charging inside an apartment in Hefei, China, underscoring the severe potential hazards that e-bikes pose when brought into high-rise buildings. To prevent such accidents, measures like public notices and monitoring surveillance footage inside elevators have been considered; albeit these methods are somewhat inefficient and lack compelling enforcement.

With object detection algorithms proving their worth across various industries by delivering outstanding results, applying these technologies to detect electric bikes within elevators emerges as a novel research direction over recent years. Yet, this application has not achieved satisfactory levels of accurate detection thus far. Most algorithms capable of detecting e-bikes currently suffer from high rates of false positives and negatives, posing inconveniences in daily life. Addressing this issue, this paper proposes enhancing elevator security by employing YOLOv3 for electric bike detection and integrating GhostNet as a more lightweight and efficient backbone network. This substitution not only streamlines the model but also facilitates easier deployment on edge devices, offering a promising solution to improving safety measures in urban living environments.

2. Methodology

2.1 Dataset and Preprocess

Through web scraping and online collection methods, we gathered 1700 images, which were then subjected to data augmentation to expand our dataset. To convert the data into a format compatible

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0024

with the YOLO series, we preprocessed the dataset. Initially, manual labeling was performed using the LabelImg tool, followed by automated labeling via an application. Figure 1 demonstrates the method of using annotation tools, where pulling the relevant bounding boxes allows for the acquisition of corresponding coordinate information.

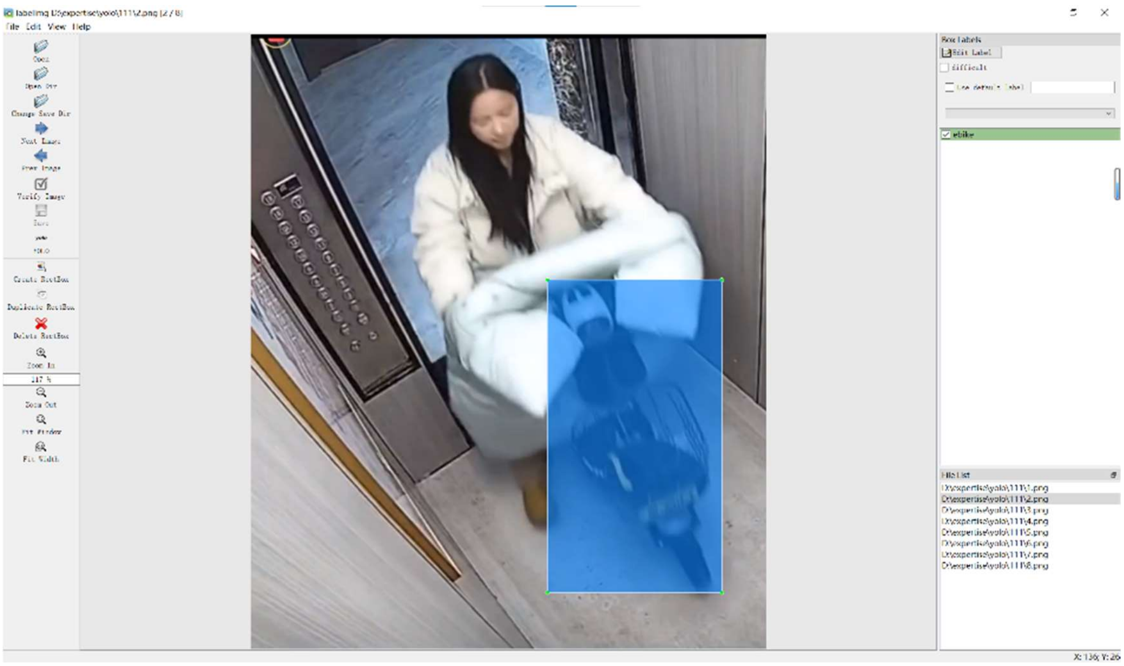

Figure 1. The method of using annotation tools

2.2 Improved Yolov3 Model

YOLOv3[2] is recognized as a well-established algorithm in the field of object detection; however, due to its significant parameter size, it's not ideally suited for deployment on edge devices with constrained computing resources. The enhanced version of YOLOv3 transitions to GhostNet as its backbone network, reducing the model size from 13.68GB to 6.45GB making it considerably more appropriate for elevator surveillance deployment. Moreover, this version accounts for real-life elevator conditions such as low lighting and tight spaces by implementing targeted data augmentation tactics to ensure adaptability to these environments[3]. The inference capabilities of the refined YOLOv3-G and its application in real scenarios are showcased as illustrated in the video demonstration provided. Figure 2 illustrates the detection performance before and after the improvements, showcasing that even with an accelerated inference speed, high accuracy is still maintained.

Figure 2. Detection performance of Yolov3 and Yolov3-G

2.3 Comparative Analysis

A streamlined network architecture implies a reduction in computational parameters, which could potentially lead to a decrease in accuracy. However, the improved YOLOv3-G, compared to the original YOLOv3 model, has seen a 53% reduction in computational requirements without a significant drop in precision, achieving comparable results. Figure 3 and 4 illustrates the comparison of model accuracy before and after the improvements, showing that the enhanced model still maintains high accuracy. The two pictures represent the average accuracy over different thresholds.

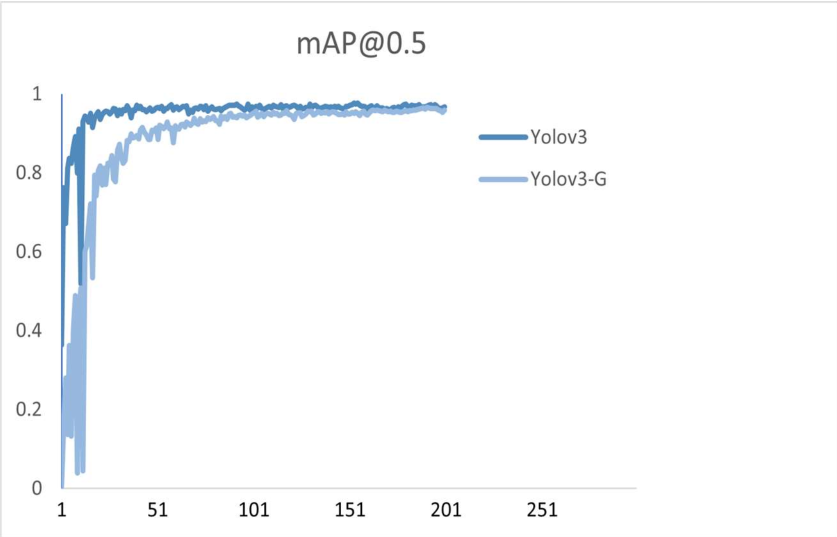

Figure 3. The comparison of mAP_0.5

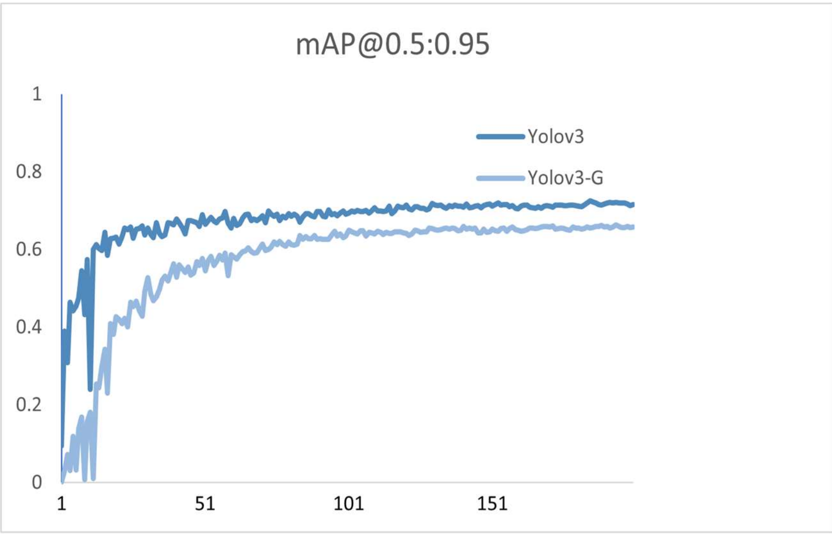

Figure 4. The comparison of mAP_0.5:0.95

3. Practical Application Scenarios

The advancements in object detection technology, specifically through the enhanced YOLOv3-G model with its GhostNet backbone, open up a plethora of practical applications, particularly in public safety and smart infrastructure domains. Below are key scenarios where YOLOv3-G's deployment could significantly contribute to operational efficiency and safety.

3.1 Elevator Surveillance for E-Bike Detection

Given the growing concern around electric bikes in elevators due to their potential fire hazards, deploying YOLOv3-G offers a robust solution. Its optimized model ensures real-time detection of e-

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0024

bikes within elevator spaces, enabling immediate alerts and preventative measures to be taken by building management systems. This application not only enhances passenger safety but also aligns with regulatory compliance efforts[4].

3.2 Smart Building Security

Beyond elevators, YOLOv3-G can be integrated into broader smart building security systems. Its capability to accurately identify a range of objects makes it an invaluable tool for monitoring restricted areas, detecting unauthorized entries, or identifying potential security threats within complexes, thereby contributing to overall building safety.

3.3 Automated Parking Systems

In parking facilities where space optimization and vehicle security are paramount, YOLOv3-G can automate vehicle detection and classification processes. It can facilitate efficient use of parking spaces by identifying specific vehicle types (e.g., e-bikes vs cars) and monitoring occupancy in real time.

3.4 Urban Traffic Management

Municipalities can leverage YOLOv3-G within traffic management systems to monitor traffic flow, detect congestion points, or identify accidents swiftly. The model's quick processing capabilities allow for immediate data-driven decisions that can alleviate traffic issues and enhance road safety.

3.5 Retail Customer Analytics

Retailers looking to gather insights into customer behavior without compromising individual privacy may employ YOLOv3-G for non-intrusive monitoring. It enables the counting of foot traffic, analysis of movement patterns within stores, and optimization of product placements based on actual customer interaction data.

4. Conclusion

As we venture further into the era of smart cities and IoT-enabled infrastructures, the role of sophisticated yet efficient object detection models like YOLOv3-G becomes increasingly critical. By offering a balance between high accuracy detection and resource efficiency suitable for edge computing devices, YOLOv3-G not only promises enhancements in public safety measures but also opens new avenues for automation across various sectors-each playing a part in shaping responsive urban environments conducive to modern living demands.

Acknowledgments

Fund:2024 Innovation and entrepreneurship training program for College Students

References

[1] Li Dongfeng. Elevator Safety Operation Monitoring System based on Internet of Things Technology [J]. Communications World,2017(17):8-9.

[2] REDMON J, FARHADI A. YOLOv3: An incremental improvement[J]. arXiv preprint arXiv: 1804.02767, 2018.

[3] Cen Siyang. Research and Application of Object Detection in Elevator Based on Deep Learning [D]. Master's Degree, Anhui University of Technology,2020.

[4] Yang Yang. Cohesion to Improve the Level of Elevator Safety Management [N]. Xiangtan Daily,2024-03-02(002).

[5] Thuong T N ,Kun-Ming Y .IoT enable Low-Cost Implementation of Data Center Infrastructure Management System[C]//SCIence and Engineering Institute (SCIEI).Proceedings of 2019 the 9th International Workshop on Computer Science and Engineering (WCSE 2019).Dept.of Computer Science and Informatics, Chung Hua University;,2019:6.