Optimizing Ad Placement in Times Square Using YOLO Models and Time Series Forecasting

Chirag N
Register Number: 23122013

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1 Introduction

Advertising at strategic times in high-traffic areas like Times Square, New York, can enhance ad visibility while minimizing expenses. This project aimed to use real-time video data from Times Square to estimate foot traffic using YOLO object detection models. We compared the YOLOv8 model against the YOLOv3 model and applied time series forecasting to predict foot traffic trends.

However, due to computational challenges, the intended results could not be fully achieved.

2 Problem Statement

The goal of this project was to determine the best time of day for advertising companies to broadcast their ads on Times Square billboards by identifying periods of peak foot traffic using real-time headcount estimation. Data was gathered from a live YouTube stream of Times Square. YOLOv8 and YOLOv3 models were utilized for headcount estimation, and a time series model was applied to predict future foot traffic.

Due to computational constraints, including system overheating, real-time processing proved difficult, which limited the full execution of the proposed solution.

3 Objectives

- Use live video data from YouTube to estimate real-time headcount in Times Square.
- Compare YOLOv8 and YOLOv3 models for headcount estimation.
- Implement a time series model to predict future foot traffic.
- Identify the best times for ad broadcasting based on foot traffic analysis.
- Address the computational limitations encountered during the process.

4 Methodology

4.1 Data Collection (Live YouTube Video)

Real-time data was collected using a live YouTube stream of Times Square:

YouTube Link: `https://www.youtube.com/watch?v=rnXIjl_Rzy4`

The stream provided continuous footage, allowing headcount analysis using YOLO models for various times of the day.

4.2 YOLO Models for Headcount Estimation

4.2.1 YOLOv8 Model

YOLOv8 was selected for its ability to detect objects quickly and accurately in crowded environments. However, its real-time application posed challenges due to computational limits, including system overheating during the headcount estimation process.

4.2.2 YOLOv3 Model (Comparison)

YOLOv3, being lighter, was used to compare its performance against YOLOv8. Despite being less computationally intensive, real-time processing remained limited due to system constraints.

4.3 Time Series Forecasting

An Exponential Smoothing time series model was used to predict future foot traffic trends. The data from the YOLO models was intended to serve as the basis for forecasting, but due to the computational challenges encountered, this part of the project could not be fully completed.

5 Results and Analysis

5.1 YOLOv8 vs YOLOv3 Headcount Performance

Although the YOLOv8 model showed promising accuracy in detecting individuals, the system's heating issues prevented sustained real-time analysis. YOLOv3, though less computationally demanding, also faced similar limitations when run for extended periods.

5.2 Time Series Model Results

Due to incomplete data from the YOLO models, time series forecasting results were not fully realized. Future work will focus on overcoming the computational bottlenecks to ensure robust predictions.

5.3 Optimal Time for Ad Placement

Despite the challenges, initial observations suggest that the highest foot traffic times are between 8-10 AM and 4-6 PM, making these intervals potentially optimal for ad placement.

6 Computational Challenges

The most significant challenge in this project was the computational complexity involved in running YOLOv8 for real-time foot traffic estimation. Running the model on live video caused my system to heat up and frequently shut down,

limiting the amount of data that could be processed. Even with YOLOv3, these issues persisted, though to a lesser extent.

The hardware limitations, including overheating, prevented long-duration video processing and real-time data extraction, affecting the overall results and analysis.

7 Conclusion and Recommendations

While the project showcased the potential of YOLO models for headcount estimation, the computational challenges limited the results. Real-time processing requires higher-end hardware capable of sustaining these models over long periods.

For advertising companies, the initial insights indicate that peak times for foot traffic are likely in the morning and early evening. By focusing on these time slots, advertisers can optimize their spending. However, further analysis is required to confirm these trends.

8 Future Work

To address the computational challenges, future work will involve:

- Optimizing the YOLO models for more efficient real-time processing.
- Using cloud-based solutions or more powerful hardware to handle larger data streams.
- Further exploration of time series models to complete foot traffic forecasting.

9 Image Gallery

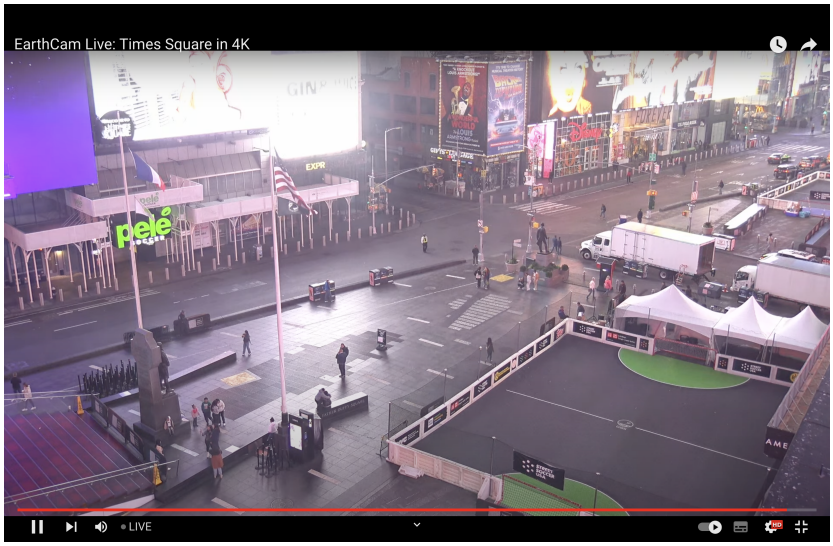

Figure 1: Sample frame from the Times Square YouTube live stream.

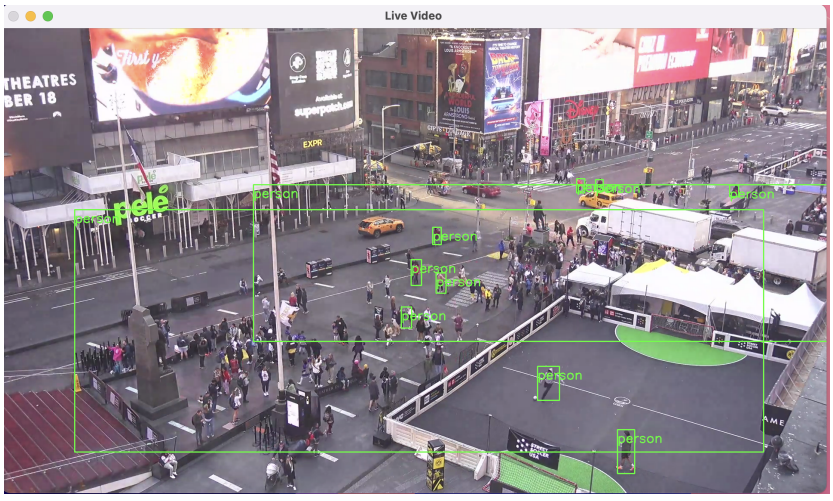

Figure 2: Results of YOLO V3 model

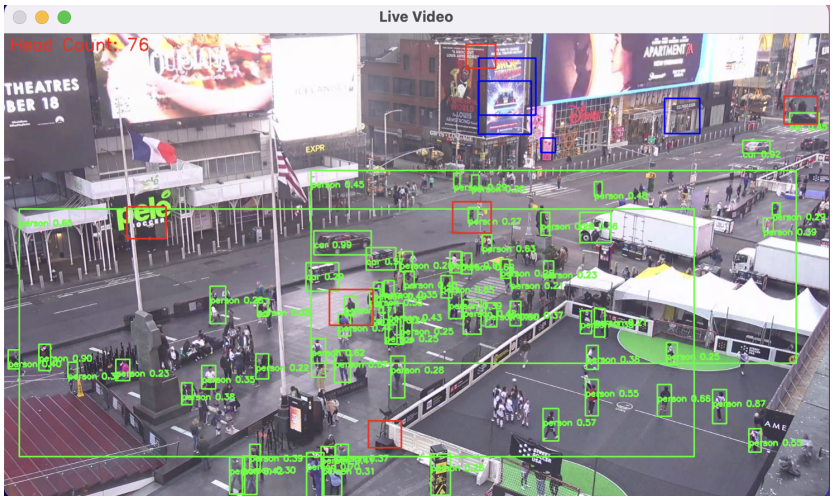

Figure 3: Results of YOLO V8 model