Project Title & ID: Computer vision-based object detection and classification in transportation (2425COMP3423)			
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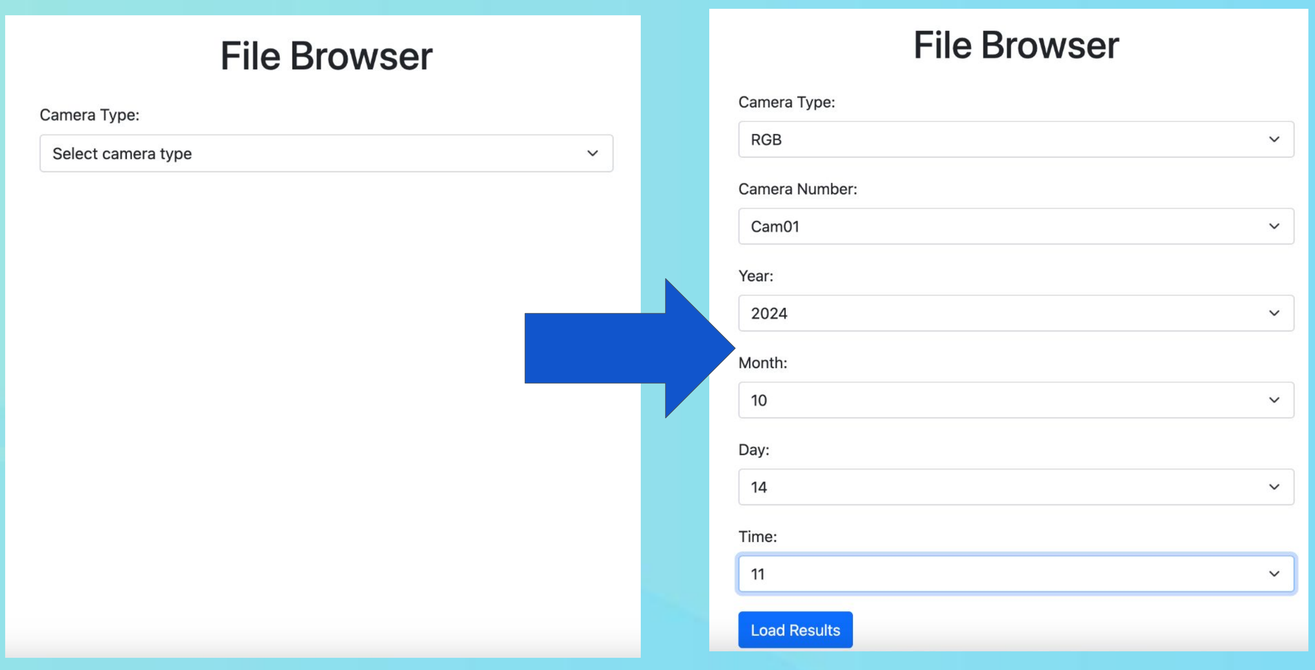
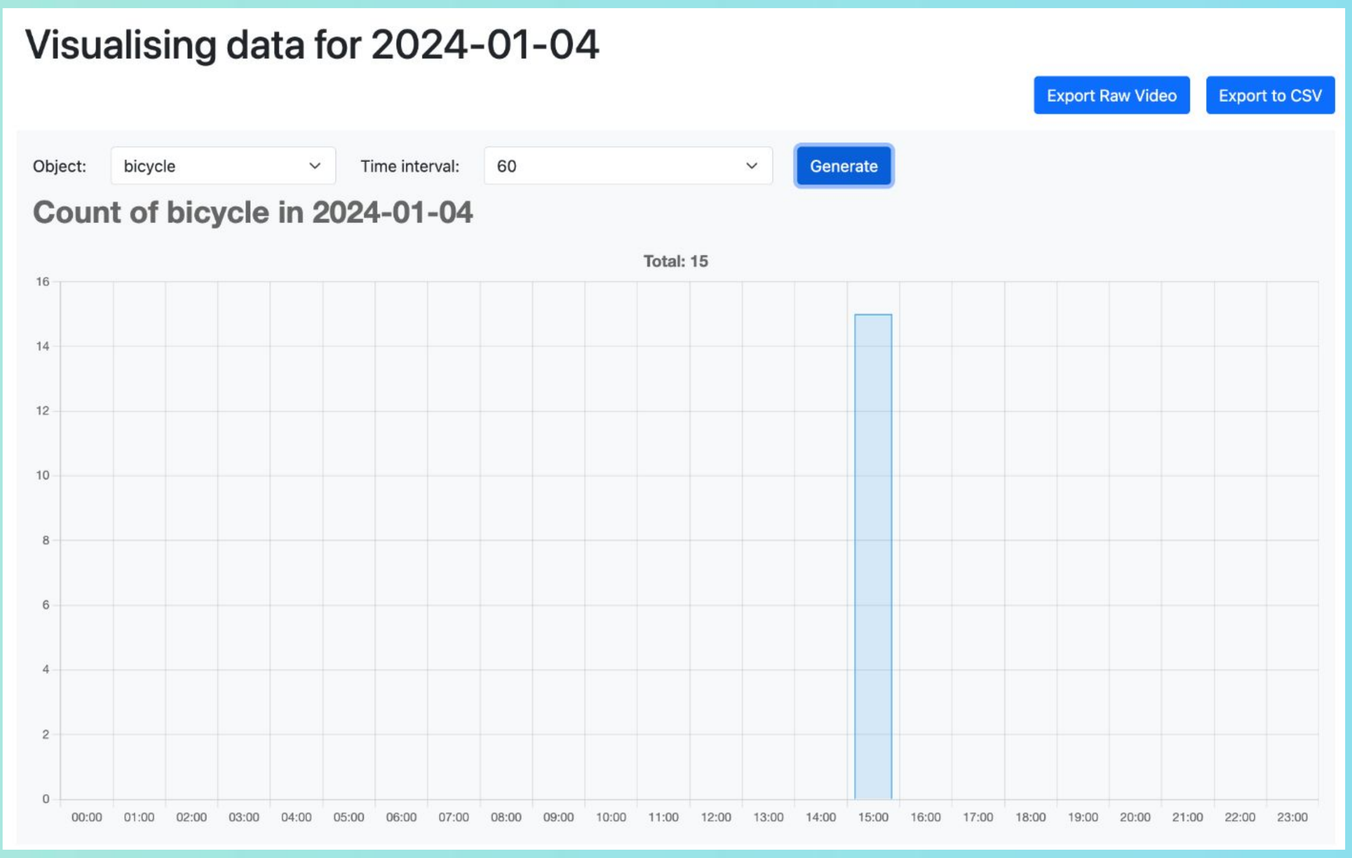
Major:	Computer Science	**Department:**	Engineering

1. Introduction

This research project developed an interactive data visualization platform employing a full-stack approach to develop a system that dynamically processes JSON data through a user-friendly interface, integrating JavaScript frontend with Flask backend. Using AJAX requests and Jinja2 templating, the platform addresses the need for intuitive data interpretation tools that allow users to derive actionable conclusions from otherwise scattered datasets. The development process relied heavily on library documentation and reference implementations to maximize functionality.





2. Method

The project began with UI design using Google slides and illustrations by hand. The system architecture features a backend that handles server logic and file system traversal, paired with a JavaScript frontend utilizing AJAX for responsive interaction without page reloads.

The UI was created with Bootstrap, with a dynamic file browser page containing cascading dropdowns for navigating hierarchical data categories (camera type, number, date, and time) and a data visualisation page that includes customizable bar charts with adjustable time intervals for analyzing detection frequencies, complemented by tabular data presentation. Raw data from excel files and videos are accessed via export functionalities.

Development was guided by library documentation and reference implementations.

3. Results

The implementation of the full-stack data visualization platform successfully delivered a comprehensive solution for analyzing temporal object detection data. Upon completion, the system demonstrated robust functionality across multiple domains of data interaction, presentation, and analysis.

The file browser component provided an intuitive hierarchical navigation system, allowing users to efficiently traverse through camera types, camera numbers, and temporal dimensions (year, month, day, hour). Testing confirmed the system's ability to handle diverse data structures and file formats while maintaining responsive performance across different dataset sizes.

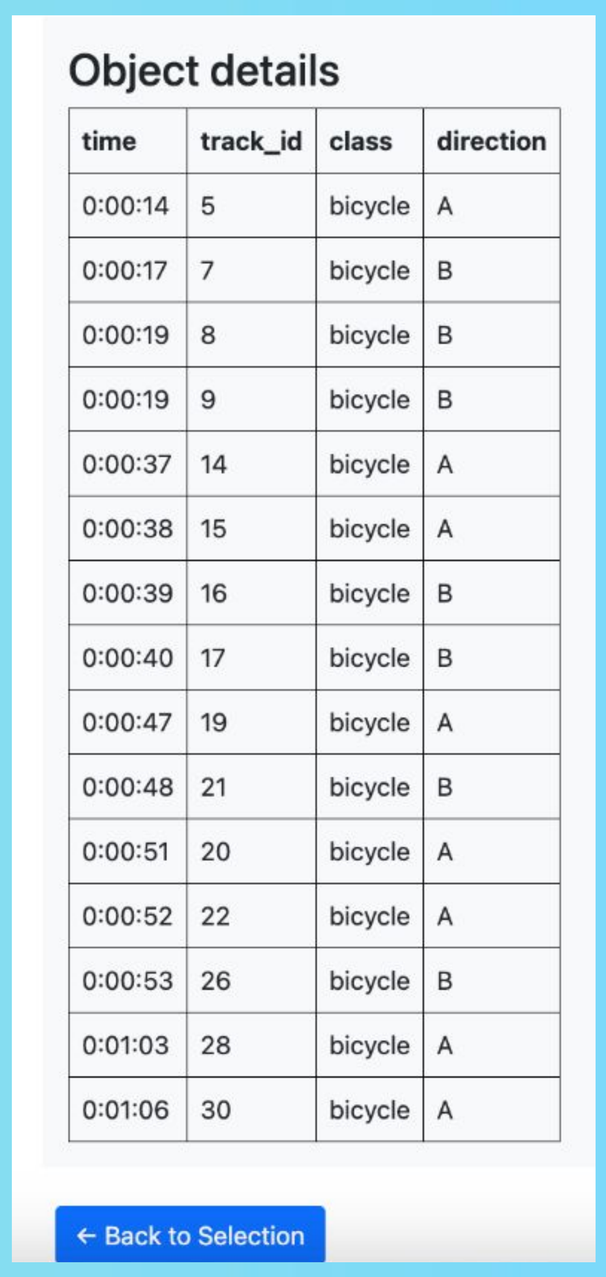
The visualization engine proved particularly effective, with the bar chart component successfully rendering object frequency distributions across user-selected time intervals. When applied to the sample dataset, the system accurately aggregated and displayed object detection frequencies across 15, 30, and 60-minute intervals. Performance testing demonstrated that the visualization engine could process and render up to 96 time intervals (in 15-minute mode) without significant latency, maintaining sub-second response times on standard hardware configurations.

Data analysis capabilities were enhanced through the implementation of dynamic filtering and aggregation mechanisms. Users could isolate specific object types from the detection data, revealing temporal patterns with the bar chart that would otherwise remain obscured in the raw dataset.

The tabular data presentation component rendered nested JSON structures in an accessible format, preserving all detection metadata including the object's class, id, direction of travel, and time of appearance. The table's comprehensive data access complemented the bar chart's aggregated visualizations, providing users with both macro-level patterns and granular detection details.

Export functionality performed as designed, with both CSV data export and raw video export mechanisms functioning correctly when their respective buttons are pressed. File integrity verification confirmed that exported data maintained complete fidelity with source files.

Overall, the platform successfully transformed complex detection data into accessible visualizations that revealed temporal patterns and object frequencies, demonstrating its effectiveness as a data analysis tool for object detection systems.



4. Conclusion

This research project successfully developed a full-stack data visualization platform that transforms complex JSON detection data into accessible, interactive visualizations. By implementing a hierarchical file browser, customizable charts, and data exportfunctionalities, the system enables users to identify temporal patterns and derive meaningful insights from object detection data. The platform demonstrates how effective integration of Flask backend services with JavaScript frontend components can create useful data analysis tools that bridge the gap between raw detection data and actionable information, serving as a valuable resource for object detection analysis workflows.