M# '23

COLOR GOAT

MEET THE TEAM

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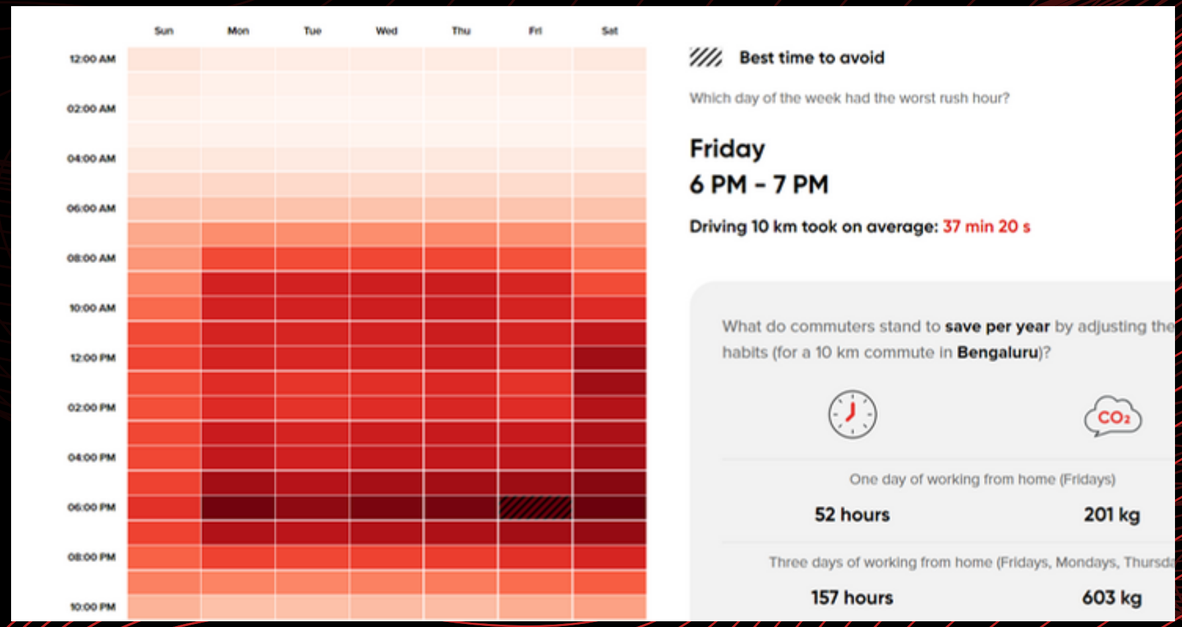
ECM_04: TRAFFIC MANAGEMENT

In Tier 1 cities, the intertwining problems of traffic congestion and air pollution have reached alarming levels, posing serious threats to the well-being of residents and the environment. The relentless growth in the number of vehicles on the roads has led to daily gridlock, extended commute times, and heightened stress for the population. Furthermore, this excessive vehicular traffic is a significant contributor to the deteriorating air quality in these urban areas, with hazardous implications for public health.The adverse effects of this situation are far-reaching, encompassing increased rates of respiratory illnesses, cardiovascular diseases, and a reduced overall quality of life. The economic impact is also substantial, with businesses facing delivery delays, increased operational costs, and reduced customer accessibility.



SOLUTION OVERVIEW

Our proposed solution will capture the live video feed/snapshots at various traffic junctions. It feeds into our deep learning model which uses YOLO to detect the vehicles and separate them into their classes and sends this data to the Signal Switching Algorithm to calculate the traffic density in all the particular lanes. It updates the RST (Red Signal Time) and GST (Green Signal Time) of the traffic lights for better management - also determining the best-case scenario to control traffic congestion, by creating a smart simulation we will control the red signal time and green signal time in traffic, and compare it to the current static controls using a traffic simulator we've created.

DETAILED DESCRIPTION OF THE SOLUTION

Real-time Vehicle Detection: Using YOLO (You-Only-Look-Once) a deep learning computer vision algorithm to detect and categorize vehicles into different categories. This will help separate cars, motorbikes, and other vehicle classes from other objects.

Vehicle density and congestion calculation: Sorted and classified data is then sent to our server which then uses signal switching algorithm to calculate vehicle density in each lane this data is then sent to the server which calculates the time for RSD (Red Signal Time) and GST (Green Signal Time).

Accident detection : Takes real time feed to recognize traffic and road incidents and alert the respective emergency services.

Traffic Simulator: Comparing our Dynamic model with the existing static model and proving our efficiency over the model currently in use.

PROOF OF CONCEPT

Incorporating Deep Learning model, specifically the YOLO Deep Learning framework, for traffic management involves training a model to detect and count vehicles in specific lanes. This real-time data is then used to adjust traffic signal timings dynamically.

Collected data is used to calculate vehicle density using our Signal Switching algorithm and signal times are adjusted to ease congestion, ensuring smoother traffic flow. This concept promises to reduce congestion, save time, lower fuel consumption, and enhance overall road safety.

Using a pygame simulation to create different traffic scenarios and proving the efficiency of our dynamic model as compared to the existing static ones.

SOLUTION ARCHITECTURE

Live camera Feed

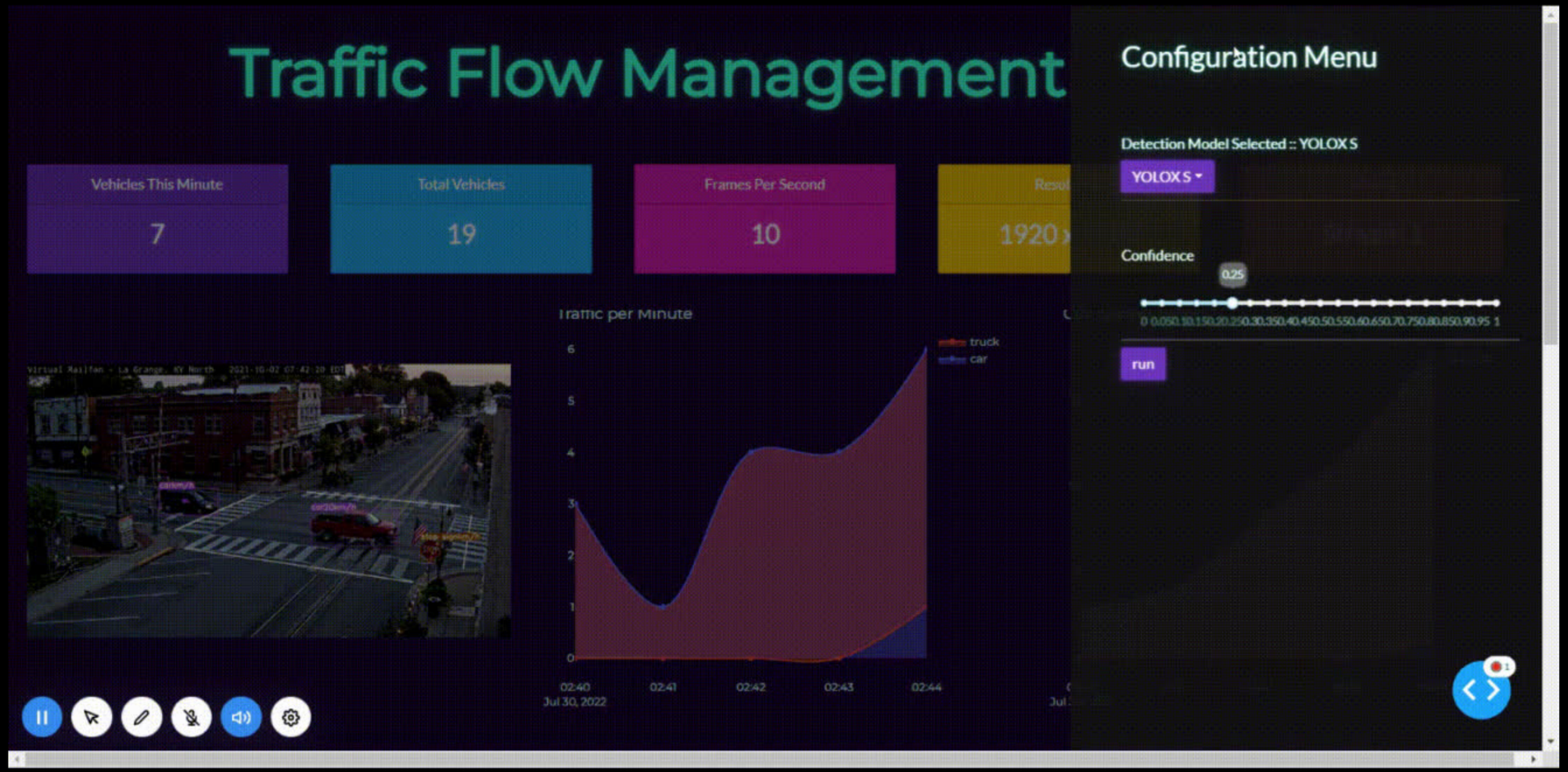
Vehicle Detection

Density calculation

Signal Switching

Efficiency Simulation

Dashboard


Traffic Flow Management
Vehicles This Minute
7
Total Vehicles
19
Frames Per Second
10
Traffic per Minute
truck
car
6
5
4
3
2
1
0
02:40
Jul 30, 2022
02:41
02:42
02:43
02:44
Configuration Menu
Detection Model Selected :: YOLOX S
YOLOX S
Confidence
0.25
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95 1
run

Current traffic management system used by mumbai police:

Dashboard Features:

- Vehicle count
- Live Camera Feed
- Stream and program health
- Pollutant emisson
- Average waiting time for vehicles
- Resolution
- Live feed frame rate

Future features:

- Switching between camera feeds
- Traffic violation detection

vehicle density calculation:

Figure 2: The Model. Our system models detection as a regression problem. It divides the image into an $S \times S$ grid and for each grid cell predicts B bounding boxes, confidence for those boxes, and C class probabilities. These predictions are encoded as an $S \times S \times (B * 5 + C)$ tensor.

For evaluating YOLO on PASCAL VOC, we use $S = 7$, $B = 2$. PASCAL VOC has 20 labelled classes so $C = 20$. Our final prediction is a $7 \times 7 \times 30$ tensor.

Green signal time calculation

4(fixed time) +5*2(each vehicle 2 sec)-2(last 2 sec yellow light will be displayed)

->F + Vc * 2 - 2

->4 + 5*2 - 2

->12 sec

Despite there is no vehicles in a path there will be a fixedtime for 4 sec for Pedestrains to cross.

Metrics comparison

TABLE 1: Performance comparison of different methods.

T (min)	Metrics	HA	ARIMA	SVR	DCRNN	GCN-LSTM	AST-GCN-LSTM
15	RMSE	4.2951	7.2406	4.1455	4.5000	4.1193	4.0234
	MAE	2.7815	4.9824	2.6233	3.1700	2.7701	2.7030
	Accuracy	0.7008	0.4463	0.7112	0.2913	0.7129	0.7223
30	RMSE	4.2951	6.7899	4.1628	4.5600	4.1207	4.0508
	MAE	2.7815	4.6765	2.6875	3.2300	2.7739	2.7244
	Accuracy	0.7008	0.3845	0.7100	0.2970	0.7126	0.7196
45	RMSE	4.2951	6.7852	4.1885	4.6000	4.1252	4.0587
	MAE	2.7815	4.6734	2.7359	3.2700	2.7753	2.7346
	Accuracy	0.7008	0.3847	0.7082	0.3021	0.7123	0.7172
60	RMSE	4.2951	6.7708	4.2156	4.6400	4.1262	4.0689
	MAE	2.7815	4.6655	2.7751	3.3100	2.7811	2.7403
	Accuracy	0.7008	0.3851	0.7063	0.3069	0.7119	0.7165

UNIQUE SELLING POINT

Our AI-driven traffic management system, harnessing the YOLO Deep Learning framework, revolutionizes urban mobility. What sets us apart:

Dynamic Efficiency: Unlike fixed traffic systems, our AI adapts signals based on real-time lane data, easing congestion and minimizing wait times.

Fuel & Time Savings: Reduced congestion means less fuel consumption and shorter commutes, saving money and time for commuters.

Safety First: Our system enhances road safety by responding to changing traffic conditions, and lowering accident risks.

Versatile Customization: Scalable to various city sizes, our system can be tailored to meet specific needs.
Eco-Friendly: By curbing idling time and fuel waste, our system helps cut emissions, aligning with environmental goals.

Privacy Assurance: We prioritize data privacy, ensuring individual anonymity while collecting traffic data.
Future-Proof: Constant learning keeps our system at the forefront of traffic management, adapting to new challenges.

In essence, our AI-powered traffic solution offers real-time efficiency, savings in time and fuel, enhanced safety, customization, environmental responsibility, privacy protection, and future readiness.

UNIQUE SELLING POINT

Technological Advancements: AI, deep learning, and computer vision innovations continuously enhance the effectiveness and feasibility of AI traffic management.

Versatility: AI systems adapt to diverse urban settings, making them suitable for markets of various sizes, from small towns to sprawling metropolises.

Global Demand: Traffic congestion is a universal concern, expanding the market's international reach.
Data-Driven Insights: AI systems provide valuable traffic data, aiding informed decisions on infrastructure and transportation planning.

Competitive Edge: Early adopters gain a competitive advantage by offering efficient transportation services, attracting businesses and residents alike.

In sum, the market potential for AI-driven traffic management thrives on urbanization, environmental consciousness, government support, safety enhancement, economic advantages, technological progress, adaptability, global relevance, data-driven insights, and competitive benefits. With cities seeking smarter, sustainable transportation solutions, the demand for AI traffic management systems is poised for significant growth, presenting lucrative opportunities for industry players.

TECH STACK

Module 1: Yolo v8, a deep learning based computer vision algorithm used to detect and classify objects

Module 2: Python Scripts for Signal Switching Algorithm

Module 3: Flask based User Interface / Management dashboard

Module 4: Cloud Based Hosting to make the model available for everyone

Module 5: ngrok/Pyngrok to host the dashboard

Module 6: Pygame library for traffic simulation

MARKET POTENTIAL

The market potential for AI-driven traffic management is exceptionally promising. Several factors contribute to its growth:

1. **Urbanization**: As more people move to cities, traffic congestion worsens. This trend fuels the demand for advanced traffic management solutions that optimize traffic flow efficiently.
2. **Environmental Focus**: The push for eco-friendly transportation options and reduced emissions drives the adoption of AI-based traffic management systems. These systems help mitigate environmental impact.
3. **Government Backing**: Governments globally invest in smart city projects, embracing AI-powered traffic solutions to enhance urban living. This governmental support ensures a substantial market.
4. **Safety Emphasis:** AI traffic management improves road safety by rapidly responding to potential hazards, reducing accidents, and saving lives.
5. **Economic Benefits:** Traffic congestion results in economic losses due to time and fuel wastage. Businesses and governments aim to boost productivity, making AI traffic solutions economically attractive.

BUSINESS MODEL

Licensing Model: Collaboration with state goverments and other companies to integrate our model with their existing infrastructure and collect licensing fee from them .

Data Monetization: Collect and aggregate traffic data from your ITMSS and sell it to third-party businesses, such as navigation apps, logistics companies, or advertisers who can use this data for location-based services and targeted marketing.

Consulting Services: Provide consulting and integration services to help clients implement and customize your ITMSS into their existing traffic management systems.

Data Analytics and Insights: Provide clients with in-depth traffic data analysis and insights that can help them make informed decisions in transportation planning, infrastructure development, and urban management.

RISKS & CHALLENGES

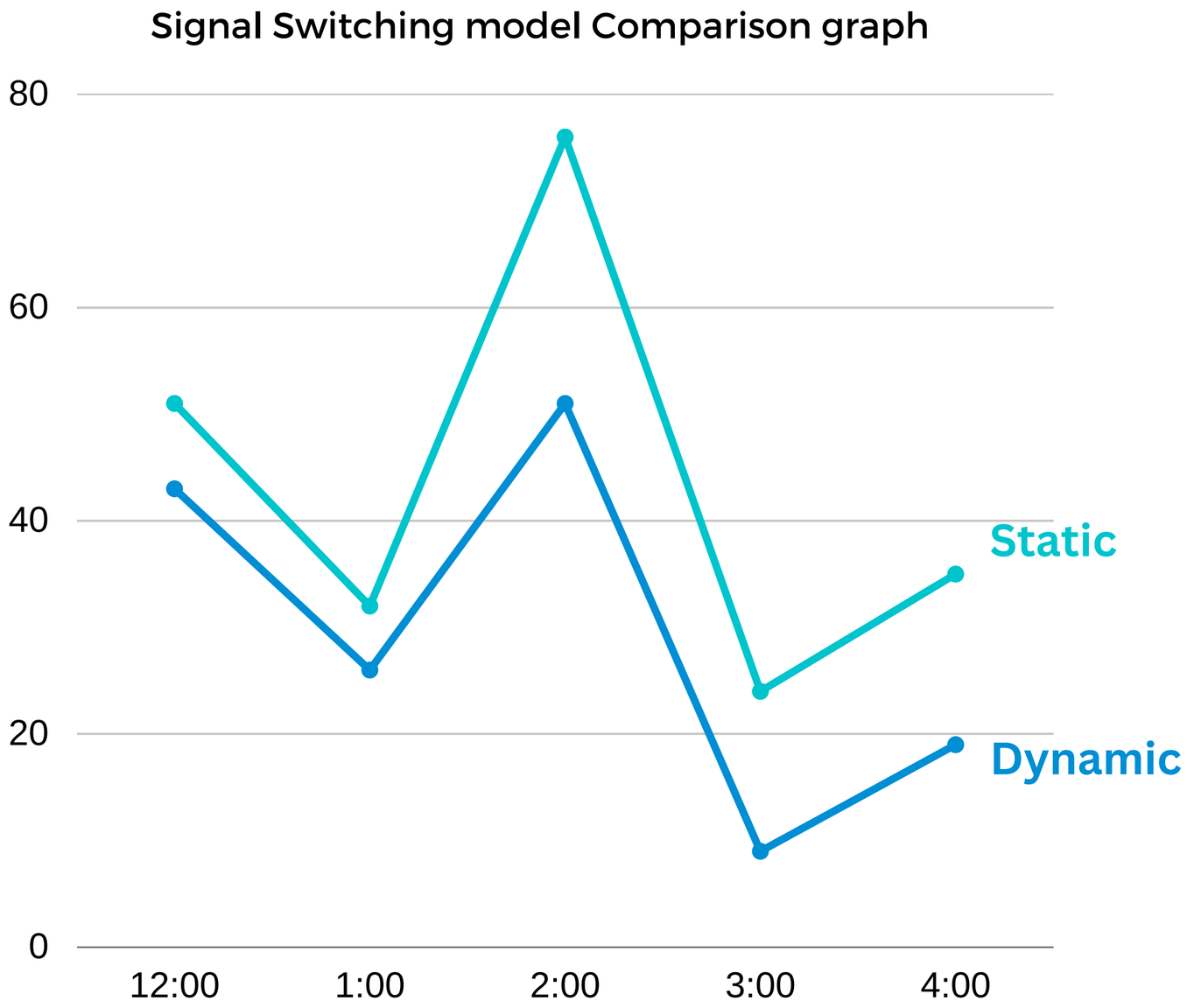
Data Quality and Reliability: The accuracy of the solution heavily relies on the quality and reliability of the live video feed. Poor weather conditions, camera malfunctions, or obstructions can lead to inaccurate traffic data and potentially incorrect signal adjustments.

Real-Time Processing: Processing live video feeds in real-time can be computationally intensive. Ensuring low-latency processing is crucial for timely traffic signal adjustments.

Traffic Variability: Traffic patterns are highly variable and can change rapidly due to accidents, special events, or road closures. The system needs to adapt quickly to unexpected situations.

Cost: Implementing software, and ongoing maintenance can be expensive. Securing funding and managing costs effectively is a challenge.

Scalability: Expanding the system to cover all critical junctions and roads in a city while maintaining efficiency is a significant challenge.


Signal Switching model Comparison graph
80
60
40
20
0
12:00
1:00
2:00
3:00
4:00
Static
Dynamic

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