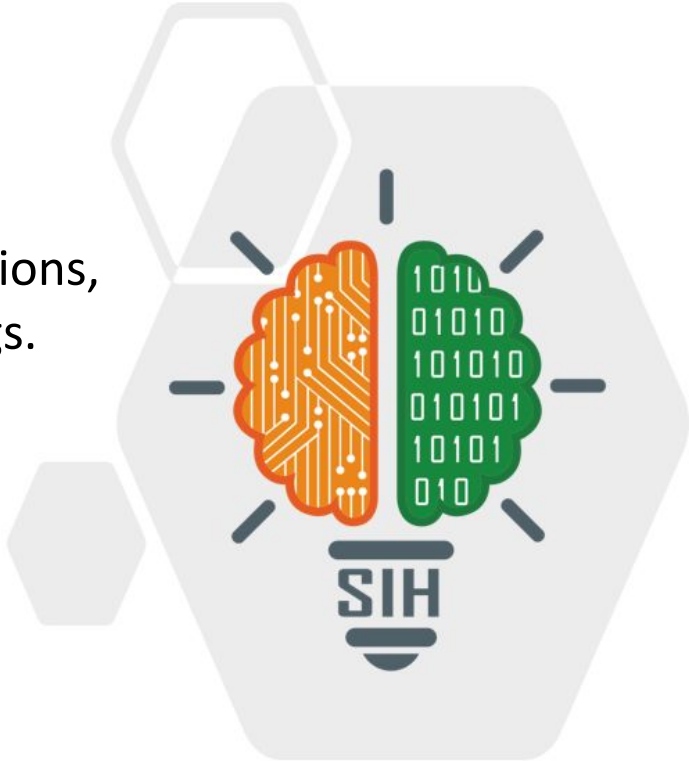
SMART INDIA HACKATHON - 2024

SMART INTERSECTIONS

Real-Time Traffic Flow Optimization with AI-Driven Adaptive Signal Systems

- **Problem Statement ID:** SIH1607
- **Problem Statement Title:** A smart AI based solution for traffic management on routes with heavy traffic from different directions, with real-time monitoring and adaptation of traffic light timings.
- **Theme:** Smart Automation
- **PS Category:** Software
- **Team ID:** 16841
- **Team Name:** SLASH 6



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Real-Time Traffic Flow Optimization with AI-Driven Adaptive Signal Systems

PROPOSED IDEA

An AI-driven traffic management system that dynamically adjusts traffic light timings based on real-time traffic conditions, reducing congestion and optimizing traffic flow.

SOLUTION

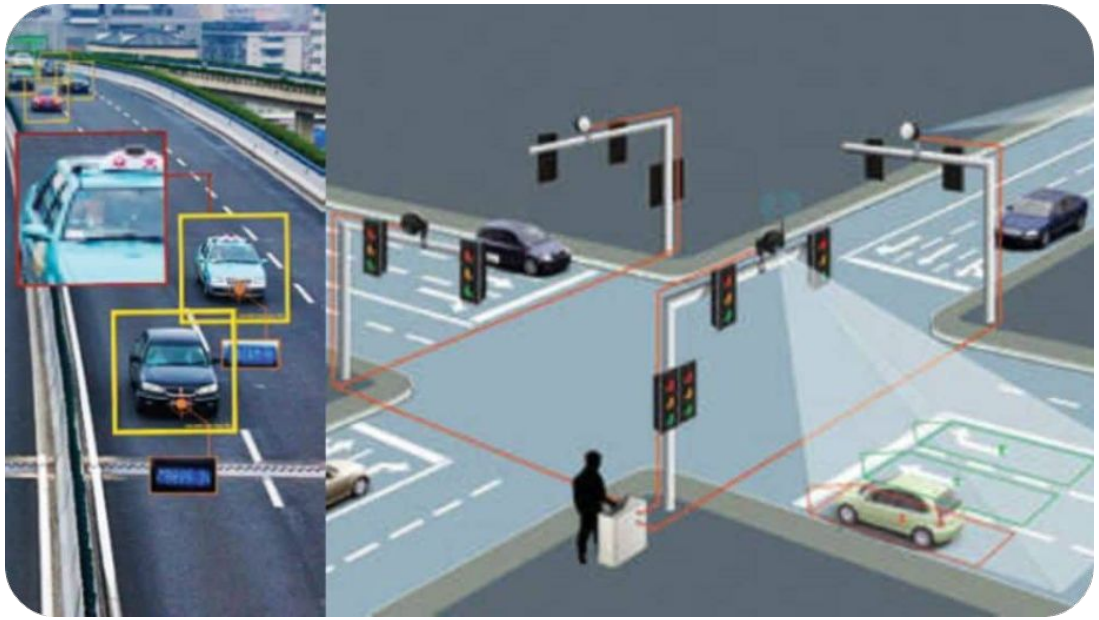
The system uses cameras to monitor traffic density at intersections, processes the data with AI models, and updates traffic signal priorities for each road based on the level of traffic density every 5 seconds.

PROTOTYPE

A simulation environment demonstrating real-time traffic analysis and adaptive signal control, ensuring smooth traffic flow even in high-density areas.

WHY OUR APPROACH ?

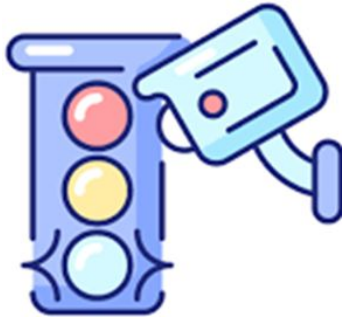
- Real Time Adaptation and Decision Making
- Coordination of Traffic Signals in an Intersection
- Scalable and Flexible
- Emergency traffic support for Ambulances



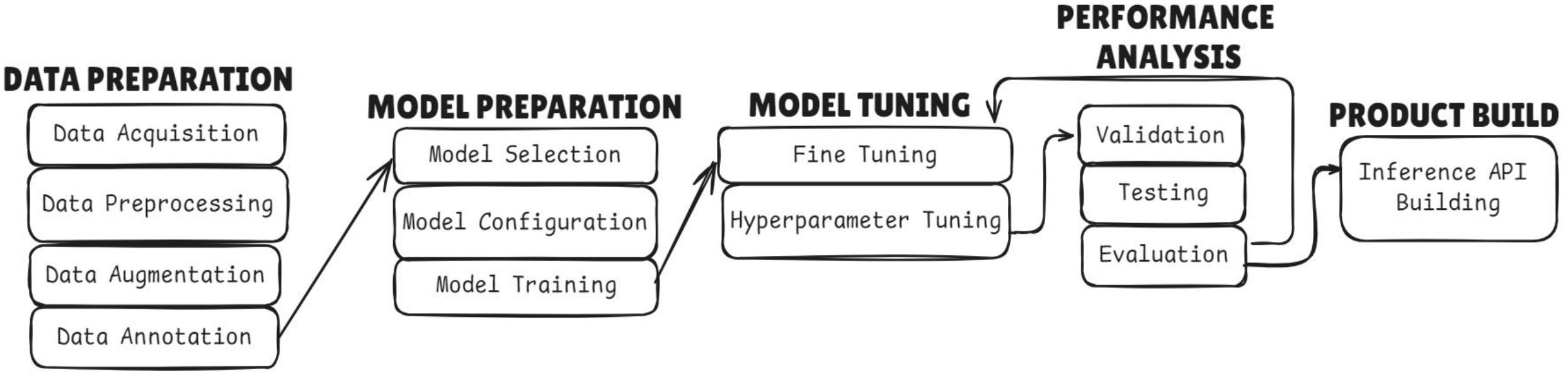
TECHNICAL APPROACH

TECHNOLOGIES USED:

- Primary Language will be Python with C++ build dependency for GPU & CUDA support
- Hardware component like GPU/TPU for model training with CUDA support.
- Deep Learning libraries such as PyTorch, Ultralytics, Torchvision .
- Frameworks to build Interfaces Django, MySQL, CassandraDB, Pygame, Streamlit.
- Other core python dependencies and libraries such as OpenCV, NumPy, Pandas.



CUSTOM MODEL BUILDING



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WORKFLOW

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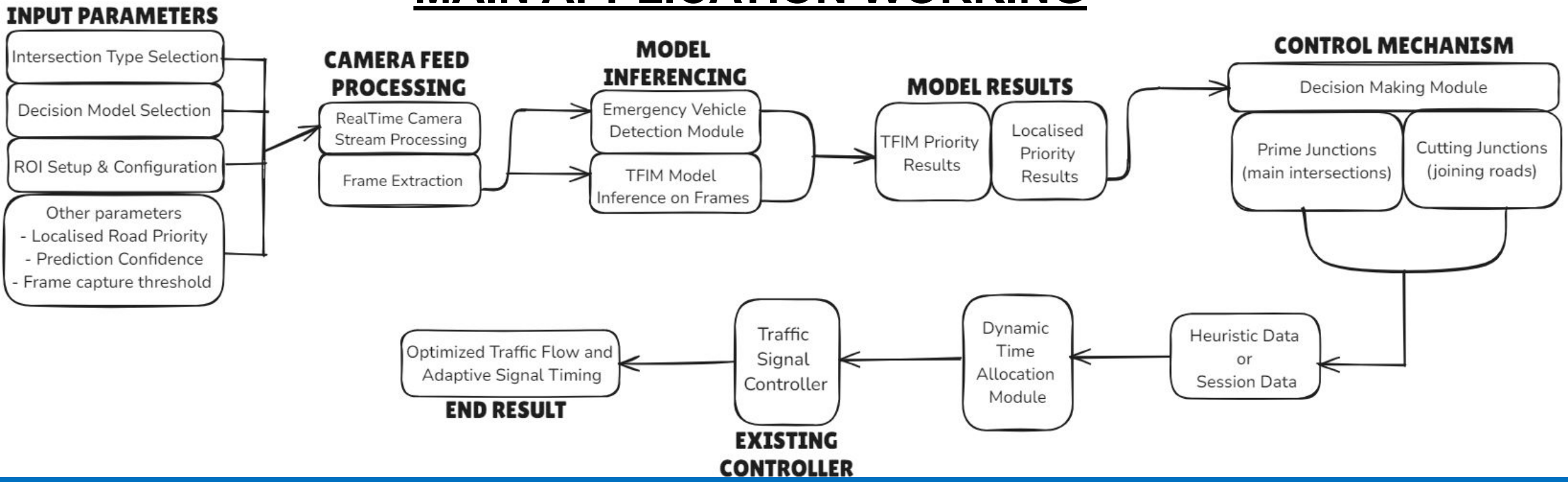
- The required parameters are configured during initial setup for a particular intersection
- Required frames are extracted from Real Time Camera Feed in regular intervals
- Initial data for the decision making system is taken from these data
- Any other constraints or approaches to be followed can be set in the heuristic data
- Time is allocated based on the obtained results
- The final results are sent as signals to the traffic controller

MAIN APPLICATION WORKING



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FEASIBILITY AND VIABILITY

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FEASIBILITY ANALYSIS

Technical Feasibility:

- Usage of Existing Technology – Computer Vision, AI and Real-Time Data Processing
- Seamless Integration and Deployment with existing systems.
- Develop a fail-safe mechanism to revert back to traditional traffic light control

Economic Feasibility:

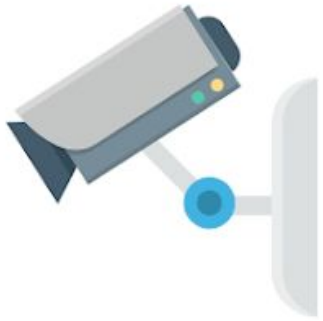
- Cost Efficiency
- No requirements for special sensors and actuators

Operational Feasibility:

- Availability of emergency case support
- Real-time Data Processing and cloud infrastructure
- User Acceptance – Users are likely to welcome a system that reduces delays and travel times

POTENTIAL CHALLENGES

- Uniformity in Camera position
- Use of parallel processing power



STRATEGIES TO OVERCOME CHALLENGES

- Standardize the setup of camera and its position
- Equipping with cloud based architecture for better utility

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IMPACT AND BENEFITS

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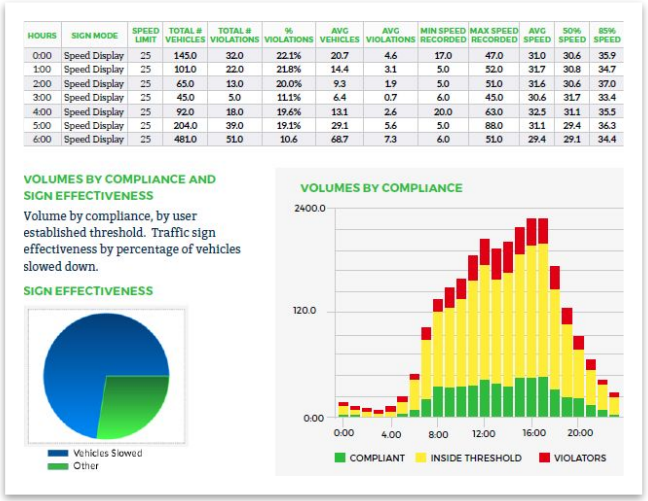
POTENTIAL IMPACT

- **Impact on Urban Commuters**
  - Reduced Travel Time
  - Improved Road Safety
- **Impact on Traffic and Transportation Authorities**
  - Efficient Overall Traffic Management
  - Improved Decision Making and Resource Allocation
  - Availability of Traffic related Analytical Data
  - Scalable Integration with existing Smart City initiatives
- **Impact on Public Transportation Users**
  - Improved Service Reliability
  - Reducing Delays and Congestions

BENEFITS

- **Social Benefits**
  - Ensures fairness in Traffic, avoids prioritization
  - Enhanced Quality of Life
  - Sustainable use of fossil fuels
- **Economic Benefits**
  - Fuel Cost Savings
  - Increased Productivity
- **Environmental Benefits**
  - Reduced Carbon Emissions
  - Energy Efficiency
  - Sustainable Ecosystem



HOURS	SIGN MODE	SPEED LIMIT	TOTAL # VEHICLES	TOTAL # VIOLATIONS	% VIOLATIONS	AVG VEHICLES	AVG VIOLATIONS	MIN SPEED RECORDED	MAX SPEED RECORDED	AVG SPEED	50% SPEED	85% SPEED
0:00	Speed Display	25	145.0	32.0	22.1%	20.7	4.6	17.0	47.0	31.0	30.6	35.9
1:00	Speed Display	25	101.0	22.0	21.8%	14.4	3.1	5.0	52.0	31.7	30.8	34.7
2:00	Speed Display	25	65.0	13.0	20.0%	9.3	1.9	5.0	51.0	31.6	30.6	37.0
3:00	Speed Display	25	45.0	5.0	11.1%	6.4	0.7	6.0	45.0	30.6	31.7	33.4
4:00	Speed Display	25	92.0	18.0	19.6%	13.1	2.6	20.0	63.0	32.5	31.1	35.5
5:00	Speed Display	25	204.0	39.0	19.1%	29.1	5.6	5.0	88.0	31.1	29.4	36.3
6:00	Speed Display	25	481.0	51.0	10.6	68.7	7.3	6.0	51.0	29.4	29.1	34.4

VOLUMES BY COMPLIANCE AND SIGN EFFECTIVENESS

Volume by compliance, by user established threshold. Traffic sign effectiveness by percentage of vehicles slowed down.

SIGN EFFECTIVENESS

VOLUMES BY COMPLIANCE

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RESEARCH AND REFERENCES

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The following resources were referred:

- Research paper titled “Design and Implementation of a Dynamic Intelligent Traffic Control System” - [link]
- Research paper titled “A Dynamic Traffic Light Control Algorithm to Mitigate Traffic Congestion in Metropolitan Areas”- [link]
- Research paper titled “Dynamic Traffic Control System with Reinforcement Learning Technique” - [link]
- An open-sourced resource by *Shubham001official* - [link]
- An open-sourced resource by *gigahidjrikaaa* (Universitas Gadjah Mada) - [link]
- An open sourced resource by *ericsherman4* - [link]