Ideation Phase Problem Statement

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Team ID	NM2023TMID448
Project Name	Traffic Management System

Project Definition:

In this day & age, the conventional systems to manage urban mobility are proving incompetent. And there's a growing need for an efficient traffic management system. Cities big and small are in dire need of technology-led digital solutions to manage & monitor traffic. They can help regulate heavy traffic, road blockages at signals & congested networks.

An Internet of Things (IoT)-enabled intelligent traffic management system can solve pertinent issues by leveraging technologies like wireless connectivity & intelligent sensors. Considered a cornerstone of a smart city, they help improve the comfort and safety of drivers, passengers & pedestrians.

Through this article, we will explore the role of IoT in traffic management, the challenges it can solve & essential technologies to develop an intelligent system. We'll also explain how a city government can implement it to offer a good citizen experience.

So, let's get started!

Design Thinking

1.**Project objectives:** City governments can improve their operations & infrastructure by placing IoT sensors and tracking devices on roads and highways for recording, analyzing, and sharing data in real-time.

This intelligent system comprises several components, including wireless sensors, RFID tags, and BLE beacons installed at the traffic signals to monitor the movement of vehicles. A real-time data analytics tool connects the Geographic Information System (GIS-enabled) digital roadmap with control rooms for real-time traffic monitoring.

The smart traffic management system captures the images of vehicles at the signals using the digital image processing technique. This data is then transferred to the control room via wireless sensors. The system also leverages BLE beacons or RFID tags to track the movement of vehicles and keep traffic congestion in control, track down stolen vehicles and even clear the road for emergency vehicles that are installed with RFID readers.

The IoT internet has come into being in numerous applications [1-4]. Also, the concept of clever cities has been evolving. In an intelligent urban context, the physical infrastructure of the city is equipped with intelligent devices that consistently produce multi-dimensional data across different areas and use it to acquire infrastructural intelligence. In order to gather road data in real time, global positioning systems, sensors, test vehicles and vehicles are some of them for communicating infrastructure. Economically efficient, powerful, and the most popular sensors for automotive monitoring, sensors like acoustic and magnetic sensors

- **Traffic Lights and IoT Control Systems**: Smart traffic signals may look like a typical stoplight, yet they utilize an array of sensors to monitor real-time traffic. Usually, the goal is to help cars reduce the amount of time spent idle. And IoT technology enables the various signals to communicate with each other. This is while adapting to changing traffic conditions in real time. The outcome is less time spent in traffic jams and even reduced carbon emissions.

- **Parking Enabled through IoT**: Smart meters and mobile apps make on-street parking spaces easily accessible with instant notifications. Drivers receive alerts whenever a parking spot is available to reserve it instantly. The app gives easy directions to the parking spot with a convenient online payment option.

- **Emergency Assistance through IoT**: A traffic monitoring system using IoT technology enables emergency responders to speed up the care mechanism in case of accidents late at night or in isolated locations. The sensors on the road detect any accident, and the problem is immediately reported to the traffic management system. This request is passed on to relevant authorities to take corrective action. Emergency response personnel would include medical technicians, police officers, and fire departments for enhanced responsiveness and timely intervention

- **Commute Assistance:** With every vehicle acting as an IoT sensor, a dedicated app can make suggestions, determine optimal routes & provide advance notice of accidents or traffic jams. Further, it can even suggest the best time to leave. It is all because of a robust algorithm that helps reduce driving time with intelligent traffic light.

2.**Iot Sensor Design**: Intelligent Transportation Systems can help solve the traffic problem by integrating IoT technology with existing infrastructure. Take, for example, an IoT-based smart traffic signal monitoring system.

It relies on a priori information provided by the IoT sensors and adjusts the traffic signals so that the time interval depends on the number of vehicles on that particular part of the road. The main advantage of this system is that it can reduce downtime and traffic density in various art.

IoT in traffic management can help municipal & transport offices to save time, money, and resources. It is while making the roads and transportation safer.

Our focused IoT app development services at Rishabh Software can help you custom-develop applications that suit your city infrastructure's eco-system. We help you determine the right fit based on your budget, infrastructure needs & more.

Basic Architecture of Smart Traffic Management System:

A basic architecture that serves as a launchpad for feature enhancements and service upgrades will integrate the following components:

- **Sensors** for collecting data and sending it to a centralized cloud platform
- **Actuators** for physical devices to make necessary adjustments like – restricting the water supply in pipelines with leakages or dimming & brightening streetlights based on weather conditions.
- **Field gateways** to collect & compress data before moving it to a cloud platform.
- **Cloud gateways** enable secure data transfer between field gateways & the cloud storage of the traffic management system

- **A data lake** to store the raw, unstructured information before it is cleansed, processed, transformed & moved to a data warehouse for extracting actionable insights
- **Data warehouse** stores contextual information about connected objects and devices installed with sensors and actuators.
- **Data analytics** for analyzing the data from streetlight sensors on a centralized dashboard to adjust the intensity of lights
- **ML algorithms** to analyze traffic patterns & trends from historical data – stored in the data warehouse. The identified trends are then used to build predictive models for control apps. These apps modify the average vehicle speed to avoid congestion.
- **Rules** to enable actuators to automate the functioning & control of smart city objects and devices. These rules are manually defined to tell actuators what needs to be done to solve a specific problem.
- **User applications** that allow citizens to receive instant notifications in case of traffic jams and congested routes. Desktop user apps for control rooms send commands to actuators for altering traffic signals. It helps to relieve congestion and optimize routes.
- **Cross-solution integrations** with traffic lights or streetlight management systems. Control apps apply ML models or predefined rules to prompt appropriate output action if the air quality is poor.

Cities of all sizes can leverage this approach. Depending on the budgetary and procurement constraints, they can start small. It would be with solutions like – a littering offense ticketing system or a smart parking app. Later they can expand the range of services.

3.**Real-time Transit Information Platform:** Real Time Traffic Management systems manage traffic behaviours in real time by utilising a network of technologies including sensors, smart cameras, global positioning systems (GPS) and Bluetooth/Wi-Fi. This can be used to efficiently reduce congestion, bottlenecks and other traffic issues. Real-time data can be used to suggest alternate routes to drivers when routes are congested and indicate to public transport operators and decision makers where user demand and supply is located. Technology improvements have allowed the

development of sophisticated services to operate networks to resolve the conflicting demands of all road and transport users.

Advanced traffic management systems improve the quality and performance of road services, as they provide accurate real-time data from multiple sources such as sensors, GPS, smart cameras, dynamic message signs, traffic lights and road weather information systems. Without this traffic information, network improvements, integration of new transport modes, and infrastructure development will not be suitable for current and future transport needs (i.e. it will not provide the flexibility and adaptability required from new transport infrastructure to respond to changing demand).

Highlights

- Estimation of traffic bulkiness performed using real time video feed.
- Vehicle recognition in order to differentiate between emergency and non-emergency vehicles.
- The system proposed relies on the efficient det lite model, which later provides output in order to manage light switching for each lane.

4.**Integration Approach:** An important concept of integrated corridor management is the coordinated operation of freeways and arterial streets during incidents. A critical component of this coordination is the activation of special signal timing plans to accommodate the diverted traffic on the alternative routes during incidents on the freeway. This study investigates the use of clustering analysis, multi-resolution modeling (MRM), and optimization techniques in the development of such plans. An important aspect of the methodology is the calibration of the utilized mesoscopic simulation-based MRM based on the increase in demands and travel times on alternative routes during incidents. Another important aspect is the use of microscopic simulation-based optimization of signal timing utilizing a multi-objective optimization that jointly minimizes the delays and maximizes the throughputs considering the whole intersections as well the specific impacted movements on the alternative routes. The evaluation of the signal timing plans resulting from the multi-objective signal timing optimization indicates that the derived special signal timing plans are able to reduce the delays

and increase the throughputs in the network and particularly for the traffic movements impacted by the diverted traffic. The degrees of improvements depend on the level of impacts of the diverted traffic on the operations of the alternative routes.

INTEGRATED TRAFFIC MANAGEMENT SYSTEM. ("ITMS") shall mean a comprehensive traffic control sys- tem, to be owned by the City, consisting of mast arms, signal heads, pedestrian signals, traffic control signs, street name signs and lane marking, loop detectors, conduit, wiring and appurtenant equipment, all interconnected to interact in a coordinated fashion.