Project Title: Traffic Management System

Project Steps

Phase 1: Project Definition and Design Thinking

Project Definition: The project involves using IoT devices and data analytics to monitor traffic flow and congestion in real-time, providing commuters with access to this information through a public platform or mobile apps. The objective is to help commuters make informed decisions about their routes and alleviate traffic congestion. This project includes defining objectives, designing the IoT traffic monitoring system, developing the traffic information platform, and integrating them using IoT technology and Python.

Design Thinking:

1.Project Objectives: Define objectives such as real-time traffic monitoring, congestion detection, route optimization, and improved commuting experience.

2.IoT Sensor Design: Plan the deployment of IoT devices (sensors) to monitor traffic flow and congestion.

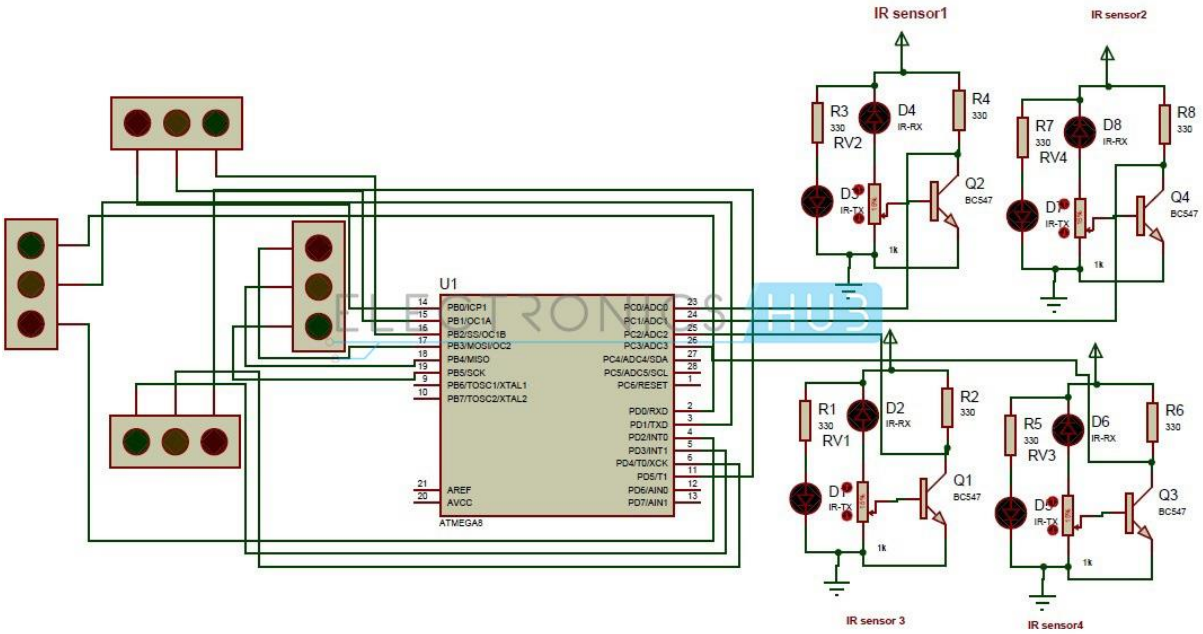
3.Real-Time Transit Information Platform: Design a web-based platform and mobile apps to display real-time traffic information to the public.

4.Integration Approach: Design a web-based platform and mobile apps to display real-time traffic information to the public.

The objectives of a traffic management system project can include:

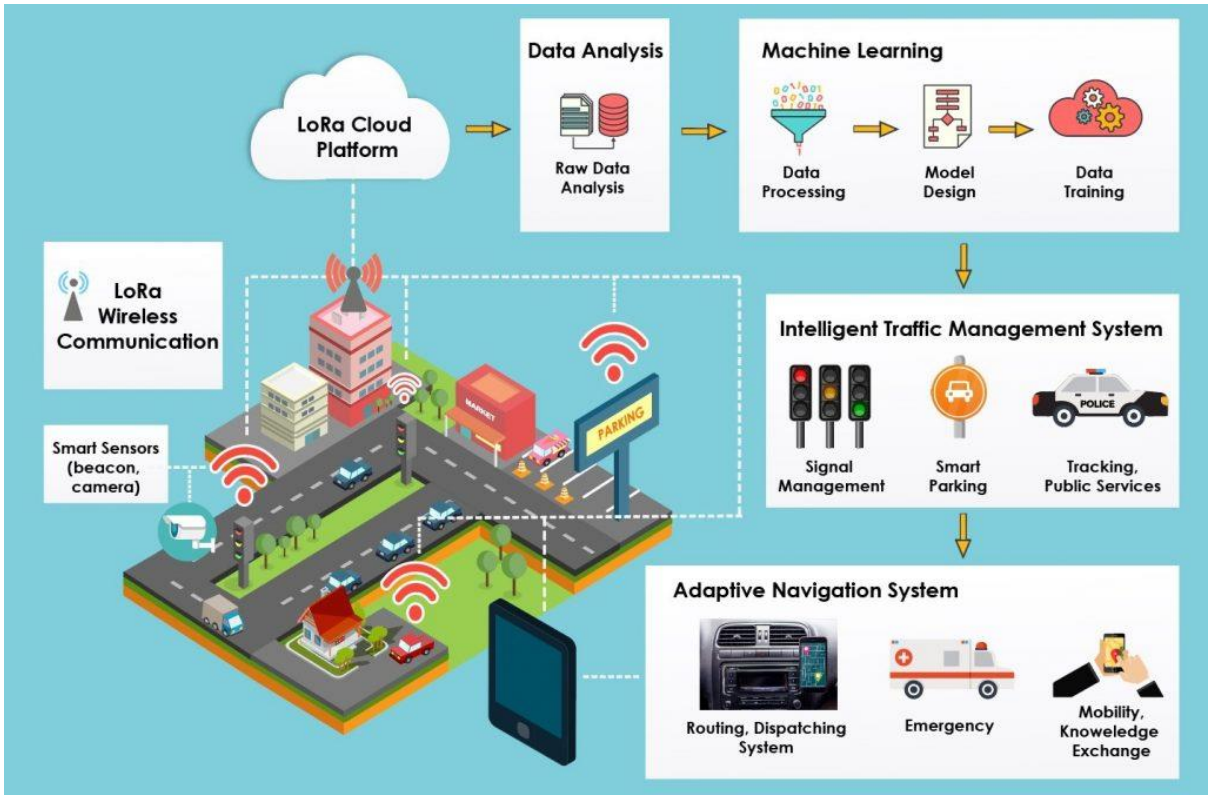
1.Safety: Improving safety requires measures such as adaptive speed control, collision detection and avoidance; enhanced vehicle safety systems; weather and road condition information.
2.Security: Maintaining security is done through evacuation route signing and priority; homeland security initiatives such as deployed in the USA, hazardous load monitoring and assistance for vulnerable road users.
3.Environmental protection: Ensuring environmental monitoring and protection requires a reduction in traffic congestion, creation of low-emission zones and promotion of public transport alternatives.
4.Support for business & commerce: Increasing productivity and operational efficiencies can be achieved by fleet management; computer aided dispatch; automatic vehicle location; automatic cargo tracking; electronic pre-clearance; vehicle compliance checking and driver monitoring.
5.Road user services: Providing comfort to users of transportation system who need to feel confident and secure is the motivation for applications such as route confirmation, journey time estimates and clear advice on approaching interchanges and connections.

Relevant services include real-time traffic and public transport information; dynamic route guidance; automotive vehicle location (AVL); smart card payment systems for toll highway and public transport use.



Designing IOT sensor for a traffic management system project involve several considerations:

The intelligent traffic management system market to grow to $19.91 billion by 2028 at a 10.1% CAGR. The demand and increased adoption rate of smart traffic management solutions can be attributed to the boom of smart city technology.



1.Smart Traffic Sensors

IOT sensors provide the backbone of data that intelligent transportation management systems analyze to increase actionable insights. Smart traffic management systems use integrated sensors like:

- Radio frequency identification (RFID) tags
- Automatic identification and data collection (AIDC) tags
- Temperature sensors
- Air quality sensors

With amount of data that ITS generate, it's crucial that the system integrates cloud computing and edge processing.

2.Connected Video Monitoring

One of the main technological aspects of smart traffic management systems is video detection systems with integrated edge processing. Connected video monitoring solutions within the realm of traffic safety are referred to as traffic incident management systems (TIMs). A TIM allows city planners to gain real-time insights on regarding traffic conditions and respond to incidents through HD footage, image detection, and image recognition.

3.Connected Traffic Light Systems :

As opposed to conventional traffic lights, smart traffic light systems integrate the aforementioned sensor and connected video monitoring technologies to account for intersection wait times, vehicle speed, and/or pedestrian traffic. Intelligent traffic light systems incorporate artificial intelligence (AI) and Machine Learning (ML) processes to enable computer vision, optical character recognition (OCR), and reinforcement learning.

4. Hardware and software components

An extensive literature review has been conducted to select various system components and technologies . The hardware and software components used for the system development are given below.

OpenStreetMap: The OpenStreetMap (OSM) is one of the practical projects that provide map data . The map data provided by OSM is free to use. The individual users are contributed to the development of OSM, and the geographical information contributed by them is the core part of OSM. OSM provides editing, exporting, and uploading functionalities. The export functionality can be used to generate row map data or map images. The raw data can be processed by other systems that use geographical information. The OSM also provides a java interface to edit and work with maps, i.e., Java OpenStreetMap (JOSM) editor, similar to traditional geographic information system packages.

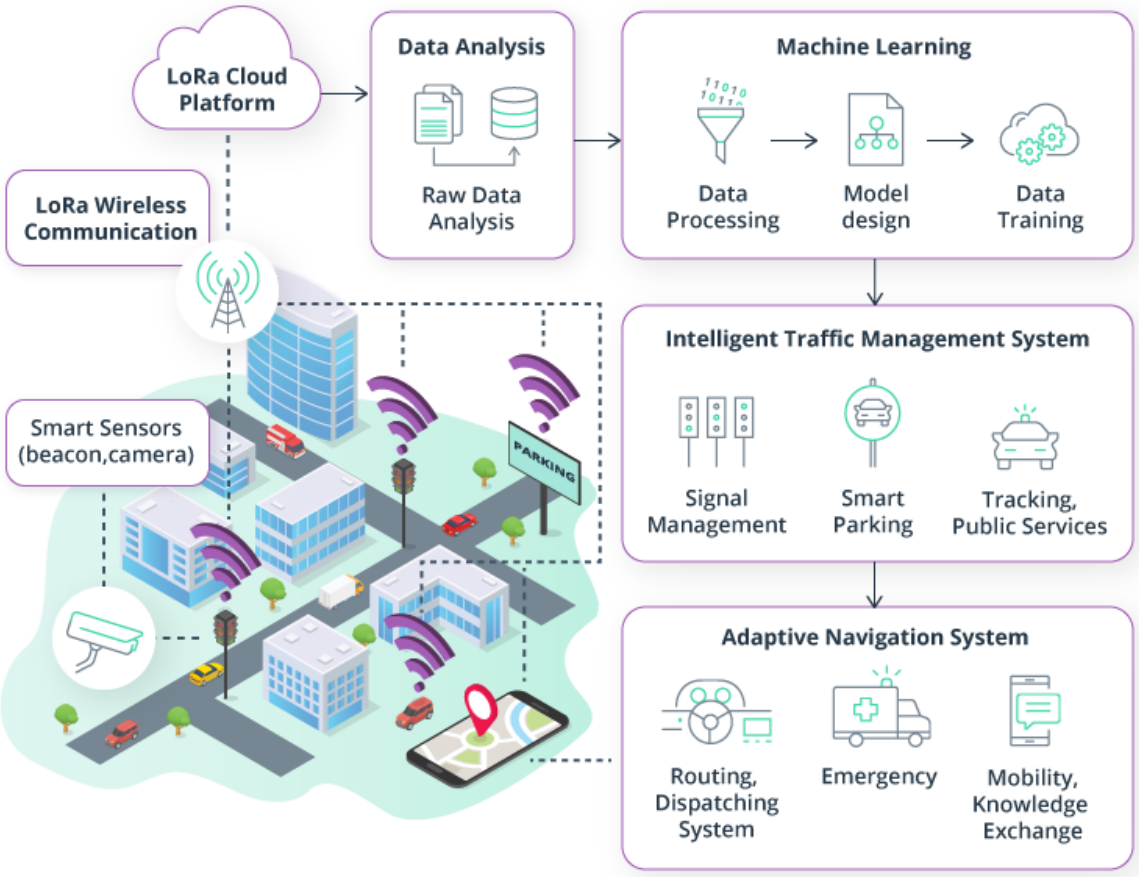
MongoDB: MongoDB is a document database, and it stores the data from JSON like documents. MongoDB provides flexible access to data and supports nested objects as values. MongoDB has both community and enterprise versions The community version of MongoDB is used in this research. A record in MongoDB consists of field and value pairs and basically, it is a document. The documents in MongoDB are stored as collections, and similar to tables. The OpenStreetMap downloaded and converted to geojson format and stored in the MongoDB for experiments. We selected MongoDB due to its performance and rich query language.

Magnetic Sensors: The magnetic sensor has the following advantages: (i) it can be easily installed on roadsides, (ii) reduces detection error, (iii) there is no climate influence Honeywell HMC5883L is a tri-axial magnetic sensor used in many traffic monitoring research due to its high sensitive and cost-effectiveness. Hence, this research also used the HMC5883L magnetic sensor to collect vehicle data. It is worth to note that there exist many PCBs with all the necessary components for vehicle detection and classification as discussed in related work. These boards have individual physical sensors as well as the firmware. It is also a good idea to go ahead with these readymade nodes as they are cost-effective and the expected cost of a single node is less than $50.

NodeMCU: NodeMCU is a firmware developed for ESP8266 WiFi system on chip (SoC). It is also an open-source platform. NodeMCU helps to prototype IoT products . ESP8266 has a general-purpose input/output interface , hence the sensors/devices can be integrated easily. NodeMCU board has WiFi capability, digital pins (D0-D8), analog pin (A0), and supports serial communication protocols (I2C, UART, etc.). ESP8266 chip is developed by Espressif Systems . ESP8266 has 2.4 GHz WiFi, 64 KB boot ROM, 96 KB data RAM, and 64 KB instruction RAM. ESP8266 module can be used for end to end IoT system developments.

Thinger. io: Thinger. io is an open-source IoT platform that supports sensor data collection, management, analysis, and visualization Thinger. io supports the deployment of data fusion applications with the integration of cloud, IoT technologies, and big data. It supports the remote sensing and actuation of any sensor, and provide readymade services to connect devices. Thinger. io is unique in terms of transmission efficiency by providing an optimized encoding scheme, namely Protoson . Thinger. io is highly interoperable and provides real-time bidirectional communications. The storage management mechanism of Thinger. io is called data buckets and supports document storages such as MongoDB. The Thinger. io platform offers an interface to configure devices, create data buckets, and model devices in this research.

LCD Unit: The message board unit can be a WiFi-enabled character type LCD unit. However, to experiment, a 16 x 02 LCD unit was used that can display only 32 characters.



Creating a traffic management system involves various components and integration approaches.

It could be argued that a smart city isn't completely intelligent without a smart transportation solution. Additionally, many ITS benefits extend past roadways to optimize city infrastructure as a whole. We've outlined the top 5 benefits of smart traffic management systems below.

1. Predictive Insights

One of the top benefits of smart traffic management systems is the predictive insights that they offer. Data collected from smart traffic sensors can be analyzed to assist governing bodies in determining how frequently roadways are used, the daily quantity of vehicles at specific intersections, and essential urban data. Ultimately, ITS can provide crucial preventative roadway insights.

2. Enhanced Safety

According to the GHSK, drivers struck and killed an estimated 7,485 people on foot in 2021. ITS' integrated sensor technology is a next-generation life-saving solution. Portland, Oregon is already putting intelligent traffic management systems to the test. Their public transit agency, that communicate with traffic light receivers to appropriately time stops. While these meters offer a safe transportation solution, it also enables faster transportation.

3. Cost Reduction

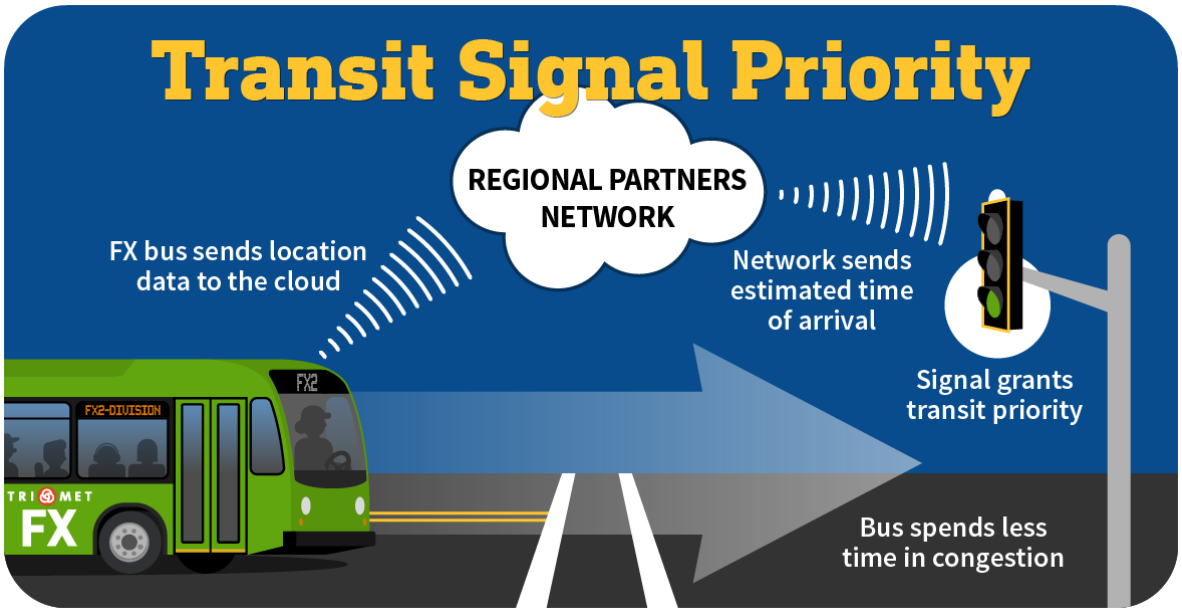
The National Highway and Traffic Safety Administration reported that traffic collisions cost the United States $340 billion in 2019. Smart traffic management systems enable safe transportation. Intelligent traffic systems help to limit and mitigate traffic collisions, fatalities, injuries, and property damage through its inherent advanced safety properties.

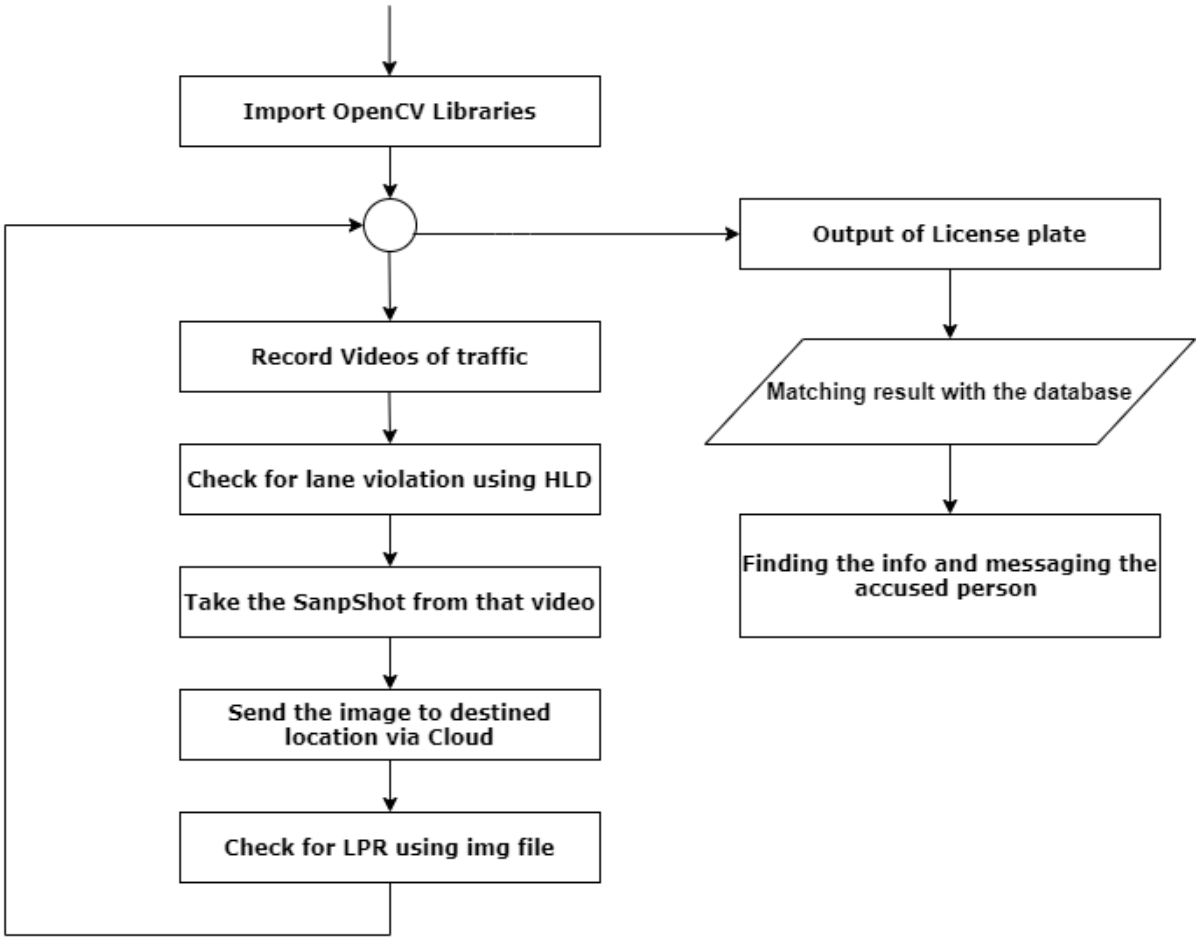
4. Improved Emergency Response

Behind every smart traffic management system is route optimization. When roadways provide ideal traffic conditions, cities are better prepared for emergencies. Minimized congestion enables improved emergency vehicle response time and the real-time insights provided by smart traffic management systems allow for enhanced flexibility, action, and organization in the event of a large-scale public emergency (tornado, earthquake, flood, etc.).

5. Minimized Emissions

The organic route optimization, ridesharing opportunities, and parking solutions that smart traffic management systems offer equates to environmentally friendly, sustainable technology predicts that continued smart traffic management systems could potentially cut 205 million metric tons of CO_2 emissions by 2027. It's clear that smart solutions can play a large role in reducing our carbon footprint.


Transit Signal Priority
REGIONAL PARTNERS NETWORK
FX bus sends location data to the cloud
Network sends estimated time of arrival
Signal grants transit priority
Bus spends less time in congestion
FX2-DIVISION
TRIMET
FX


Import OpenCV Libraries
Record Videos of traffic
Check for lane violation using HLD
Take the SanpShot from that video
Send the image to destined location via Cloud
Check for LPR using img file
Output of License plate
Matching result with the database
Finding the info and messaging the accused person