A Survey on Intelligent Traffic Management System

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Abstract— Intelligent road traffic flow control is one of the major area of research in transportation and city traffic management in recent times. It is found in studies that most of the pollution is attributed by vehicles waiting at the traffic signal than driving vehicles in the peak up time. The main purpose of this work is to reduce the pollution level which is emitted by vehicles at the Traffic signal. In order to reduce the city traffic pollution and at control the traffic flow effectively, we have proposed a novel technique of traffic light management based on pollution sensing

Keywords—*Traffic Management, Pollution Sensing, Physical Sensor, Traffic Simulation Framework.*

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I. INTRODUCTION

In recent years, the increase in the number of vehicles around the world, especially in urban areas and Metropolitan cities like Delhi, Mumbai etc…, has caused massive release of greenhouse gases (such as CO2), which increase the pollution level and contributes to the serious problem of global warming. Transport, especially road traffic, is a major source of air pollution in most of the cases. It contributes to 15% of the CO2 emissions in Europe . In Moroccan urban environment, there is a range of pollutants in the atmosphere with the capacity to cause harm to both humans and the ecosystem, including Carbon monoxide, Nitrogen oxides, Sulphur dioxide, Particular matter, Volatile organic compounds, Ozone, and Hydrocarbons; This situation arise because of uneven traffic management and from also number of vehicles waiting at the junction than the driving vehicles.

The IoT is an emerging area of interest for current developing networks. It has varied field of applications like industry, healthcare, transportation, smart home, etc. Internet of Things (IoT) refers to an interconnected device when these devices are connected to internet in such a way that each device communicates with every other device one which is connected to internet. Such infrastructure is called Internet of Things. The Internet of Things is not only interconnection of devices with physical world which can intercommunicate with each other. The physical world is nothing but things refer to as physical entity. The physical entity could be a microcontroller, microprocessor, sensor, actuators etc. IoT includes, for example home lighting system where controlling of entire lighting system of building through internet because all devices connected with the internet. Three Cs in IoT are: Communication, Control and Automation, and Cost Saving [1]. An IoT can be defined as "Network of physical devices, vehicles, buildings and other items-embedded with actuators, sensors, electronics, software, and network connectivity that enable these objects to collect and exchange data [2]".

Thus, the issue of Intelligent road traffic flow control is one of the major problem in transportation and city traffic management in recent times. It is found in studies that most of the pollution is attributed by vehicles waiting at the junctions than driving vehicles. For example, a truck would generate higher level of pollution than a car. In order to reduce the city traffic pollution and at control the traffic flow effectively.

The Pollution monitoring is running in an IoT device. The System and IoT device are connected by using MQTT(Message Queue Telemetry Transport) protocol. It is machine to machine protocol based on pub-sub service. We are measuring the actual pollution level in specific area. Whenever the pollution level keeps rising, the green light timing in that junction will be active for longer period of time. From thi traffic flows smoothly and reduce the CO2 level. The MQTT Protocol is basically a light weight machine to machine communication protocol. MQTT is basically a cross platform protocol that enables devices to communicate with each other, that enables the client machines to communicate with each other, that enables mobiles to communicate with each other, mobiles communicate with IoT devices, IoT devices communicate with mobiles, IoT devices to communicate with servers and so on. Machine learning tools such as ANN has been frequently used to predict air quality and pollution levels using a set of inputs, like pollutant concentrations, meteorological data and available traffic information. It is truly said that the working of ANN takes its roots from the neural network residing in human brain. ANN operates on something referred to as Hidden State. These hidden states are similar to neurons. Each of these hidden state is a transient form which has a probabilistic behavior. A grid of such hidden state act as a bridge between the input and the output.

II. LITERATURE SURVEY

T. T. Thakur, A. Naik, S. Vatari and M. Gogate et al.[1] proposed This variation in traffic Density hampers the speed of vehicles at the time of peak hours as well as regular time. The current infrastructures provides limited resources available to control of traffic congestion. To manage traffic flow real time traffic density management using IOT is used. It helps in optimization of traffic switching; controls traffic flow and prevent congestion's. These aspects are been made available on website to displays the traffic status, so that people will get early update and can avoid traffic jam and have alternative path. At time of Emergency vehicle can get early access to reach their destination. Author Proposed a Framework for traffic monitoring system based on traffic density.

A. El Fazziki, D. Benslimane, A. Sadiq, J. Ouarzazi and M. Sadgal et al. [2] describes an on-road air quality monitoring and control approach by proposing an agent based system for modeling the urban road network infrastructure, establishing the real-time and predicted air pollution indexes in different road segments and generating recommendations and regulation proposals for road users.

This can help reducing vehicle emissions in the most polluted road sections, optimizing the pollution levels while maximizing the vehicle flow. For this, we use datasets gathered from a set of air quality monitoring stations, embedded low-cost e participatory pollution sensors, contextual data and the road network available data. These data are used in the air quality indexes calculation and then the generation of a dynamic traffic network. This network is represented by a weighted graph in which the edges weights evolve according to the pollution indexes. In this work, Author propose to combine the benefits of agent technology with both machine learning and Big Data tools. An Artificial Neural Networks (ANN) model and the Dijkstra algorithm are used for air quality prediction and the least polluted path finding in the road network. All data processing tasks are performed over a Hadoop based framework: HBase and MapReduce.

M. Bani Younes and A. Boukerche et al.[3] proposed an intelligent traffic light controlling (ITLC) algorithm. ITLC is intended to schedule the phases of each isolated traffic light efficiently. This algorithm considers the real-time traffic characteristics of the competing traffic flows at the signalized road intersection. Moreover, They have adopted the ITLC algorithm to design a traffic scheduling algorithm for an arterial street scenario They have thus proposed an arterial traffic light (ATL) controlling algorithm. In the ATL controlling algorithm, the intelligent traffic lights installed at each road intersection coordinate with each other to generate an efficient traffic schedule for the entire road network.

Zhende Xiao, Zhu Xiao, Dong Wang and Xiaohong Li et.al.[4] proposed an intelligent traffic light control scheme to reduce vehicles CO2 emissions based on VANET. Within the proposed scheme, real-time traffic information can be obtained by wireless communication between the vehicles and the traffic lights. The intelligent traffic light control approach can be decomposed into two steps. First, an adaptive traffic light control algorithm is proposed with purpose of reducing vehicles waiting time.

Authors model four different phases, and design the demand function to allot the green light for each phases based on multiple traffic factors such as traffic density etc. In order to decrease vehicles stop times, we then derive recommendatory speed for each individual vehicle. This step is to maximize the throughput of the intersection so that the vehicle stopped by the light can be minimized. In addition, we introduce a CO2 emission estimation model to calculate vehicles CO2 emissions. Finally, comparing with pre-timed control method, simulation results indicate that the proposed scheme can efficiently reducing vehicle's average waiting time, stop times and CO2 emissions.

J. Contreras, S. Zeadally, J. A. Guerrero-Ibanez et.al.[5] surveys the original concept of Vehicular Ad-hoc networks (VANETS) is being transformed into a new concept called the Internet of Vehicles (IoV). We discuss the benefits of iov along with recent industry standards developed to promote its implementation. The Internet of Vehicles might be defined as a platform that enables the exchange of information between the car and its surroundings through different communication media. As a result of the integration of the Internet of Things (IoT) technology with Intelligent Transportation Systems (ITS), IoV will create an integrated network for supporting different functions (such as intelligent traffic management, dynamic information services, intelligent vehicle control, among others).

IoV is composed of three fundamental components: the inter-vehicular network, intra-vehicular network and vehicular mobile Internet. IoV allows vehicles to be permanently connected to the Internet, forming an interconnected set of vehicles that can provide information for different services such as traffic management, road safety and infotainment.

Z. Cao, S. Jiang, J. Zhang and H. Guo et al. [6] proposed a novel pheromone-based traffic management framework for reducing traffic congestion, which unifies the strategies of both dynamic vehicle rerouting and traffic light control. It bridges vehicle rerouting and traffic light control by bringing about the notion of digital "pheromone."Specifically, each vehicle agent deposits two types of pheromones (i.e., traffic pheromone and intention pheromone representing the current and future traffic densities, respectively) along its route. Specifically, each vehicle, represented as an agent, deposits digital pheromones over its route, while roadside infrastructure agents collect the pheromones and fuse them to evaluate real-time traffic conditions as well as to predict expected road congestion levels in near future.

Once road congestion is predicted, a proactive vehicle rerouting strategy based on global distance and local pheromone is employed to assign alternative routes to selected vehicles before they enter congested roads.

Cristina Vilarinho, José Pedro Tavares, Rosaldo J. F. Rossetti et al.[7] proposed approach allows updating traffic signal control and brings up the benefit of staged designs and phases being changed as needed instead of being fixed to an *a-priori* traffic signal control plan. The system structure is flexible and has the capacity to adapt traffic control, reacting to unexpected traffic events such as changes in traffic flow or topology, without requiring human manipulation. The green time is decided by traffic stream agents at same control level where no agent has more powerful control than others. Nonetheless, it is used stationary agents in offering many advantages over using vehicles as the focal point of the auction . The proposed control system requires a new detecting systems in order to collect real-time information about vehicle occupancy, queue length and traffic user arrivals at intersection. The detection systems can be any, such as sensing the GSM signal of mobile phones of traffic users or more contemporary approaches such as V2I and V2V communication infrastructures.

Maram Bani Younes, Azzedine Boukerche et al.[8]This paper shows However, traffic lights decrease vehicles' efficiency over road networks. This reduction occurs because vehicles must wait for the green phase of the traffic light to pass through the intersection. The reduction in traffic efficiency becomes more severe in the presence of emergency vehicles. Emergency vehicles always take priority over all other vehicles when proceeding through any signalized road intersection, even during the red phase of the traffic light.

In experienced or careless drivers may cause an accident if they take in appropriate action during these scenarios. In this paper, Author aim to design a dynamic and efficient traffic light scheduling algorithm that adjusts the best green phase time of each traffic flow, based on the real-time traffic distribution around the signalized road intersection. This proposed algorithm has also considered the presence of emergency vehicles, allowing them to pass through the signalized intersection as soon as possible. The phases of each traffic light are set to allow any emergency vehicle approaching the signalized intersection to pass smoothly. Furthermore, scenarios in which multiple emergency vehicles approach the signalized intersection have been investigated to select the most efficient and suitable schedule. Finally, an extensive set of experiments have been utilized to evaluate the performance of the proposed algorithm.

Thakur A., Malekian R., Bogatinoska et al.[9] proposed that Road safety, traffic congestion and efficiency of the transport sector are major global concerns. Improving this is the primary objective of intelligent transport systems (ITS). Having Internet of things (IoT) based solutions for ITS would enable motorists to obtain prior contextual guidance to reduce congestion and avoid potential hazards. IoT based solutions enabling collection of data from client nodes in a wireless sensor network in the transport environment implementing ITS goals is studied. The parameters to be monitored, type of sensors and communication related design parameters are identified to develop an effective IoT based solution. Road safety techniques studied include distance sensing, improper driving detection and accident prevention, weather related events and negligent driving detection and accident avoidance. Vehicle to vehicle communication and vehicle to infrastructure based channels are studied. Wireless communication technologies suitable for the channels are explained. Additional benefits and services that can be added to a system with the IoT approach are also showed. The effectiveness of such a system is studied with the use of validation framework. Multiple case studies of current and future IoT based ITS along with the challenges in the application is discussed.

M. R. Jabbarpour, A. Nabaei and H. Zarrabi et al.[10] discusses vehicle traffic congestion which leads to air pollution, driver frustration, and costs billions of dollars annually in fuel consumption. This given a proper solution to vehicle congestion is a considerable challenge due to the dynamic and unpredictable nature of the network topology of vehicular environments, especially in urban areas. Recent advances in sensing, communication and computing technologies enables us to gather real-time data about traffic condition of the roads and mitigate the traffic congestion via various ways such as Vehicle Traffic Routing Systems (VTRSs), electronic toll collection system (ETCS), and intelligent traffic light signals (TLSs). Regarding this issue, an innovative technology, called Intelligent Guardrails (IGs), is presented in this paper. IGs takes advantages of Internet of Things (IoT) and vehicular networks to provide a solution for vehicle traffic congestion in large cities. IGs senses the roads traffic condition and uses this information to set the capacity of the roads dynamically.

III. SIMULATION TOOLS[11]

MATLAB

It features an interesting IoT module that allows you develop and test smart devices, as well as collect and analyze IoT data in the cloud.

Iot platforms collect data from smart devices, aggregate it in the cloud and then analyze it in real time. Patterns and algorithms are then extracted and engineers can then use this information to create prototype algorithms and execute them in the cloud.

We can use MATLAB to prototype and build IoT systems. More specifically, you can develop algorithms in Simulink and then deploy them on your embedded hardware. You can also prototype your smart devices using Arduino and Raspberry Pi.

Iotify

It is a powerful IoT simulator that allows you to quickly develop IoT solutions in the cloud. This tool lets you simulate large scale IoT installations in your own virtual IoT lab. You can generate customizable traffic from thousands of virtual endpoints and test your platform for scale, security and reliability in order to identify and fix issues before rolling out the final product. You can simulate heavy network traffic to see how network latency affects your overall system performance.

Netsim

It is a powerful network simulator that you can use to simulate IoT systems. You can use it to test the performance of real apps over a virtual network. If you're building a new IoT network from the ground or expand an existing one, you can use NetSim to predict how the respective network will perform.

This simulator supports multiple sources and destination and can be scaled to hundreds of nodes. You can simulate a wide variety of situations with the help of the'What-if' scenarios and test metrics such as loss, delay, error, quality of service, and more.

IBM Bluemix

It is an innovative cloud platform that allows you to sample the company's Internet of Things Platform even if you don't have a physical device using simulated data.

The built-in web console dashboards lets you monitor and analyze your simulated IoT data and then use it to build and optimize your own apps. The tool supports a wide variety of functions for manipulating data, storing it and even for interfacing with social media.

IV. CHALLANGES

With the ever increasing vehicles on road, the transportation industry faces the following unprecedented challenges.

Data Extraction

Transportation industry cant meet the rapid growth of data both in volume and variety. The data of transportation industry have rich sources, diverse types, and new sets of data are produced continually. Dynamic data generated by various sensors, such as induction coil at bayonet point, infrared detector, microwave detector, ultrasonic detector, laser detector, video detector, and so on, are of huge volumes. The data are generated by GPS vehicle location tracking system and other mobile device search equipments yearly have raised over the threshold level. The amount of data generated by the transportation industry in a city per month has exceeded TB (terabyte) level, are developing from PB (Petabyte) to EB (Exabyte) levels. A massive data storage space and equipment is required and it must have fault tolerance and stability.

Data Processing

The conventional data processing systems are faced with the lack of efficiency and accuracy. The information system of transportation industry has had a certain foundation and scale, but generation of new business, rapid growth of data, complexity of the data processing have not been foreseen. The traffic information management system using traditional data processing technology can’t meet the rapid growth of data; collapses and failures have occurred. In the course of project construction and maintenance, the construction was emphasized, the maintenance was overlooked, data have not been excavated deeply, with the change of leadership and life cycle of the system is shortened, as the raise in data volumes have been overlooked. With the research in big data growing in recent years, new projects and renovation of the old system are being carried out in some cities.

Synchronization

The existing traffic management system appears single functioned, lacking integration, using backward technology and has other issues. In the process of building the transportation information system, homogenization is serious, at the same time, development of information technology in different regions is not balanced. Data acquisition is at different depths in different areas, and without uniform standards, the administrative department authorities for the project examine and approve it, lacking in supervision and evaluation. The data in most information system is scattered in grassroots enterprises, the functional department just collects the report and ledger on a fixed time period and they do not achieve connections and data synchronization between systems.

Poor network connectivity and stability

Due to the high mobility and rapid changes of topology, which lead to frequent network disconnections and link failures, message loss should be common. Then, how to elongate the life of communication links is always challenging.

Hard delay constraints

Many IoT applications have hard delay constraints, although they may not require a high data rate or bandwidth. F or example, in an automatic highway system, when a brake event happens, the message should be transferred and arrive in a certain time to avoid a car crash. In this kind of application, instead of an average delay, a minimal delay would be crucial.

High reliability requirements

Transportation and driving-related applications are usually safetysensitive. Obviously, such an application requirement is high reliability. However, due to complex network architecture, large network scale, and poor stability of network topology, achieving high reliability is far from trivial. A special design should be conducted in various layers, from networking protocols to applications.

High scalability requirements

High scalability is another big challenge in Intelligent transportation system. As mentioned before, It is usually very large in terms of node number and deployment territory. Such a large scale certainly requires high scalability in this technology.

Security and privacy:

Keeping a reasonable balance between the security and privacy is one of the main challenges in Transportation. The receipt of trustworthy information from its source is important for the receiver. However, this trusted information can violate the privacy needs of the sender.

Service sustainability:

Assuring the sustainability of service providing in IoV is still a challenging task, calling for high intelligence methods, as well as a user-friendly network-mechanism design. There are challenges in adjusting all vehicles to provide sustainable services over heterogeneous networks in real-time, as they are subject to limited network bandwidth, mixed wireless access, lower service platforms, and a complex city environment.

V. CONCLUSION

Managing the city traffic to reduce the traffic congestion has been one of the major challenges of 21st century across the globe. Many intelligent system have been proposed in past and have been adopted by different city authorities to reduce the traffic flow. However the traffic control is something which is at not been solved. Not only has cities failed to control the vehicle congestion, the over congested vehicles has attributed tremendous amount of pollution which has increased both CO_2 and CO gas levels in the environment. This has resulted in significant amount of global warming, ozone layer leakage and so on. Therefore our observation control and population control cannot be thought of independent mutually exclusive problems.

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