

Excavation of the Internet of Things in Urban Areas Based on an Intelligent Transportation Management System

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Abstract

Transportation, as one of the most common aspects people use in their daily lives, has resulted in highly complex traffic in urban areas due to the large number of private vehicles. As some results of the traffic congestion, there is energy consumption, environmental pollution, unplanned accidents, and time is wasted due to congestion and traffic jams. With the aid of the Internet of Things (IoT), which is an excellent computerized technology solution for all field claims, Internet of Things (IoT) technology has recently provided an efficient and effective traffic management system, especially in transportation, due to the combined functions IoT can handle, there are management, monitoring, tracking, identifying, computing, and so on. This article provided a comprehensive overview of a variety of intelligent management systems that have been built using IoT to alleviate traffic congestion.

Keywords

Internet of Things (IoT), Intelligent Traffic, Traffic Congestion, Traffic Management

1. Introduction

In recent years, urban transportation has become more complicated and congested as a result of the popularity and use of private transportation by civilians all over the world. This has resulted in severe traffic congestion during peak hours, highlighting the importance of a well-functioning traffic management system in order to prevent collisions, emissions, and time waste [1]. The Internet of Things (IoT) seems to be gaining popularity. The Internet of Things (IoT) is a new smarter technology that has contributed to transportation during traffic management through cloud use and proper tracking using various machine

learning methods. Traffic management systems that are efficient and reliable help to reduce traffic congestion.

2. Literature Riview

2.1. Intelligent Traffic System

Existing signal system lacks the technology to handle the traffic in efficient way Authors mentioned in [2] Using IoT they have proposed a system that use of different sensors which can be deployed on the roadside for collecting data regarding congestion which will be further processed by the micro controller situated on the traffic signal higher priority for emergency vehicles like Ambulance such that the lane that contains emergency vehicle would go first until emergency vehicle passes. A hybrid approach in [3] is used to optimize traffic flow on roads and an algorithm is devised to manage various traffic situations efficiently. The authors create a system that uses data from cameras and sensors to calculate traffic density and then adjusts traffic signals. During a traffic jam, the authors employed an algorithm based on Artificial Intelligence to forecast future traffic density and to decrease traffic congestion. They also utilized RFID to prioritize emergency vehicles such as ambulances and fire trucks. The authors also considered what would happen if there was a fire on the road, and how they would handle it. Smoke sensors were employed as part of the system to identify this circumstance. The efficiency of the suggested traffic management system has been shown by the authors using a prototype that not only optimizes traffic flow but also connects adjacent rescue departments to a centralized server.

2.2. Advanced Traffic Management System

The existing traffic prediction methods mostly dedicated to highway and urban traffic management, and limited studies focused on collector roads and closed campuses Authors said in [4] where they have proposed an IoT based system model to collect, process, and store real-time traffic data for such a scenario. The system's main purpose was to increase mobility by providing real-time traffic updates on traffic congestion and odd traffic events via roadside messaging devices. The suggested technology might send out early warning signals to citizens, allowing them to save time, especially during peak hours. The device also transmits updates from the administrative authorities on traffic. With a Context of Bangladesh in [5] proposed a real-time traffic management system (TMS) using the Internet of Things (IoT) and data analytics. Ultrasonic sensors were used to detect traffic density, and after analyzing the sensor data, the system controller controlled the traffic signal timing using a traffic management algorithm, as well as sending data to a cloud server via a Wi-Fi module. As the authors pointed out, if an emergency vehicle is recognized, the proposed system offers priority, *i.e.* long signal duration, to pass through the intersection. If a car violates a traffic light, the system can identify it and issue a fine, which is paid through the Traffic Wallet smartphone app. This proposed system is low-cost, easy-to-install, and simple-to-maintain.

3. Internet of Things

The Internet of Things (IoT) is a paradigm in which objects with sensors, actuators, and processors interact with one another to accomplish a goal. About 85% of networks are disconnected and don't exchange data with one another or the cloud, The Internet of Things (IoT) is one such technology that enables interconnection and also refers to making devices smarter by linking them online to acquire and process data, as mentioned by Authors in [6]. The basic concept of creating IoT architecture is to make the machine self-reliant while also being connected to a web server for signal reception. The Internet of Things (IoT) has now reached all corners of the globe is essentially a physical-digital interaction [7]. A plethora of sensors and actuators communicate between the digital and physical worlds as **Figure 1(a)** describe and **Figure 1(b)** give a deep understanding of how Sensors, actuators, and processors are used in IoT products.



Figure 1. (a) IoT platform; (b) IoT platform.

3.1. Background on IoT Components in Vehicles

Vehicles of past year's technology was not more developed compared with today's technology as SAE has described in vehicle's levels, where a digital revolution in the 21st century is in form of connected and autonomous vehicle (vehicle to everything, which includes vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-network, vehicle-to-cloud, vehicle-to-device and vehicle-to-pedestrian), and we are living in such kind of digital because of integration of Internet of Things (IoT) components have been applied into vehicles day to day as shown in **Figure 2**. They become part of a network. Vehicles can communicate with each other, with the surrounding infrastructure and with other drivers. Gradually the technologies of IoT in vehicles assisted driving (steering, acceleration and brake support) which help to decrease different problems in transportation [6]. As the technology in vehicle increase as the transportation issues decrease the international Society of Automotive Engineers (SAE) helped to describe the technology in vehicles using levels on **Figure 3**.



Figure 3. Connected and autonomous vehicle levels [8].

3.2. Ways IoT Is Transforming Transportation Management

The Internet of Things (IoT) is transforming our lives at a breakneck rate. Environmental monitoring and transportation networks are two areas where the Internet of Things finds use. This is particularly true in the automotive industry, which is home to some of the most significant inventions [9]. Here are some of the biggest ways the IoT is transforming the automotive industry and our roads [10]:

- ➤ The way people drive
- Reduce pollution and energy
- Improving road safety
- Solve traffic congestion in cities
- > Expenditure
- ➢ Lead to better roads
- Environment applications
- Mobility applications

3.3. Intelligent Traffic Management System

As shown in **Figure 4**, an intelligent traffic management system based on IoT can be divided into three groups. This refers to a range of tools such as traffic engineering principles, software, hardware, and communication technologies that can be applied to the transportation system in an integrated manner to enhance its efficiency and safety. **Table 1** discusses various methods of traffic and vehicle monitoring and control several techniques and methods are based on internet of things (IoT) approaches, as seen in **Figure 5**. For future Enhancement in Intelligent Transportation Management system **Table 2** gives the inclusive outlook of few recent research articles in the intelligent traffic management system based on internet of things (IoT).



Figure 4. Intelligent traffic management system block.

No	System	Performance parameters	Performed work	Applications
1	Intelligent Traffic Information System [11] [12]	Infrared Ray Sensor, RFID, Wireless Sensor Networks; Agent Technology	The paper proposes an architecture that combines internet of things and agent technology into a single framework, with the agent technology handling effective communication and interfaces among a large number of heterogeneous, highly distributed, and decentralized IoT devices	Smart City
2	Development of the Flexible Traffic Control System Using the Lab View and Thing Speak	Lab view, Arduino Board, Thing Speak, HTTP and MQTT Protocols, MATLAB [13]	The Raspberry Pi, Arduino board, and webcams are among the lower-level hardware used. The HW model is built around road marking requirements. The MATLAB help in Thing Speak is pre-installed	Traffic control System
3	Intelligent Transportation System [14] [15]	WSN, an Active Radio-Frequency Identifica- tion (RFID), and IoT	The internet of things was combined with agent technology to create a single platform that handled effective communication and interfaces among a large number of heterogeneous, highly distributed, and decentralized devices within the IoT	Road Traffic
4	Intelligent Traffic Congestion Control System/IoT Based Intelligent Traffic Signal System for Emergency Vehicles [16]	Ultrasonic Sensor Node (USN), Wi-Fi. Traffic Density Monitoring Module (TDMM) [11]	Sets the signal operating time dependent on traffic congestion density measurements	Traffic Congestion
5	An Intelligent Traffic and Vehicle Monitoring System	ATMEGA, GPS, IoT, Traffic Management, Ublox-Neo 6M, Zigbee, RFID, Bluetooth	The monitoring module uses an ATMEGA series Microcontroller, while the tracking module uses a NodeM- CU. They've also set up a cloud data stream with the alias "mtech track" and used it to publish the data [17]	Traffic Congestion
6	Intelligent Transportation Sys- tem. An IoT-VANET-Based Traffic Management System for Emergency Vehicles in a Smart City [18]	Intel Galileo Gen 2 Board, Arduino Duemilanove Board, Wyliodrin IDE Studio, Arduino IDE 1.6.8, Algorithm	The system is linked to the internet, allowing for continuous monitoring of the various lanes. From a single location, the data collected from various lanes is examined and monitored by the Central Traffic Control Office [19]	Traffic Congestion
7	IoT-Based Traffic Management System for Ambulances	Arduino UNO, GPS neo 6M and SIM 900A	An Arduino-based traffic control system for healthcare-related emergencies was developed, with 12 V, 1A power for the GSM SIM 900A and 10 V for the Arduino UNO incorporated into the ambulance, with power supplied from the fuse board to make a path to one or more ambulances	Traffic Control
8	Intelligent Traffic Monitoring/ An Internet of Things (IoT) based Smart Traffic Management System: A Context of Bangladesh [5]	OWL Urban Traffic System (UTS), Granular Computing, Ubiquitous Computing [20]	The Zigbee Protocol is used to decide the concentration of traffic. Web 2.0 services are used to connect traffic light clusters and road information	Road Traffic
9	Automated Traffic System Pedestrian Safe Smart Crossing System/Internet of Things Network Cognition and Traffic Management System [21]	Sensors, CCTV, Fuzzy logic	For an efficient smart city traffic management, propose smart pedestrian crossing management at traffic light junctions using a fuzzy based approach	Traffic Congestion [22]
10	Car Parking System	Internet of Things (IoT), Autonomous Car Parking, Arduino, ESP8266 Wi-Fi Module, Ultrasonic Sensors [23]	In conjunction with an ultrasonic sensor The Internet of Things (IoT) is used. Wi-Fi is used to trans- mit sensor data ESP8266 module for any open source IoT platform that is simple to use To view data, HTTP is used	Car Parking
11	Traffic Monitoring System [24]	KNN Algorithm, IoT RFID · GSM [25]	Within three major areas, TMS uses multiple IRs in an IoT model using the KNN algorithm:1) Android Software2) Communication on the server side3) User Interaction	Road Traffic

Table 1. Technology and performance parameters used in transportation using IoT.



Figure 5. IoT approach for traffic management.

4. Future Anhancement in Intelligent Transportation Management System

 Table 2. Future anhancement in intelligent transportation management system.

No	Title	Author's name	Future anhancement
1	Development of the Flexible Traffic Control System Using the Lab View and Thing Speak.	Anatoliy Sachenko, Maciej Dobrowolski, Oleksandr Osolinskyi, Volodymyr Kochan, Pavlo Bykovyy (2020)	The analysis of function separation between the microcomputer and the cloud in order to choose the best set of functions for each device component.
2	Intelligent Design and Implementation of Blockchain and Internet of Things— Based Traffic System.	Qilei Ren, Ka Lok Ma, Muqing Li, Bingjie Gao and Jieming Ma (2019)	How to boost the efficiency of running a blockchain- based system on a low-power embedded system, and how to address the shortcomings of blockchain smart contracts that could improve the system's expandability.
3	Implementation of IoT Based Intelligent Transportation System	Arun. V and Dr. M. Poongothai (2018)	It considers adding other sensors to the mobile propagation node, such as proximity sensors at college transportation stops and in the passenger seat, and connecting them to the Internet of Things. Using the Big Data approach, it will also be important to develop models for analyzing data that the monitoring system offers.
4	A vehicular Network—Based Intelligent Transport System for Smart Cities	Tayyaba Zaheer, Asad Waqar Malik, Anis Ur Rahman, Ayesha Zahir and Muhammad Moazam Fraz (2019)	To test a hybrid solution that combines the use of RSUs and/or a central server to store traffic data using the Internet and physical infrastructure.
5	IoT Based Intelligent Transportation System (IoT-ITS) for Global Perspective: A Case Study	S. Muthuramalingam, A. Bharathi, S. Rakesh kumar, N. Gayathri, R. Sathiyaraj and B. Balamurugan (2019)	In the current road situation, to deal with the applied energy conservation process in ITS and the efficiency scheme.
6	An IoT based Intelligent Traffic Congestion Control System for Road Crossings	Pampa Sadhukhan, Firoj Gazi (2018)	The output of this proposed congestion management system will be evaluated using a test bed.

Continued

7	Applying the IoT Platform and Green Wave Theory to Control Intelligent Traf- fic Lights System for Urban Areas in Vietnam	Cao Tho Phan, Duy Duong Pham, Hoang Vu Tran, Trung Viet Tran and Phat Nguyen Huu (2019)	 A method of implementing the framework for a network of arterial roads common in large cities. A real-world evaluation in a dynamic urban setting should be conducted to assess the system's reliability and effectiveness.
8	Software Defined Network—Based Con- trol System for an Efficient Traffic Man- agement for Emergency Situations in Smart Cities	Albert Rego, Laura Garcia, Sandra Sendra, Jaime Lloret (2018)	IoT networks could benefit from the addition of cam- eras or other detection systems, and the SDN network could benefit from the addition of a detection system.
9	Internet of Things Network Cognition and Traffic Management System	Abida Sharif, Jian Ping Li, Muhammad Irfan Sharif (2018)	IoT algorithms should be implemented in big data and IoT security systems.
10	An Innovation Model for Smart Traffic Management System Using Internet of Things (IoT)	Amardeep Das, Prasant Dash and Brojo Kishore Mishra (2018)	The proposed model, which is intelligent and future-oriented, uses transportation scheduling methods to identify the packages of interventions that can better achieve goals.
11	IoT-Based Traffic Management System for Ambulances	Mohammad Moazum Wani, Samiya Khan, Mansaf Alam	Sensor-based patient data collection modules and the planned system's integration.
12	An IoT-VANET—Based Traffic Management System for Emergency Vehicles in a Smart City	Lucy Sumi and Virender Ranga (2018)	Managing traffic protection against cyber-attacks or other malicious intent can be a difficult job.

5. Conclusion

This research paper provides a comprehensive overview of the intelligent traffic system based on the Internet of Things (IoT), its benefits and drawbacks in terms of real-time analysis of traffic congestion, pedestrian crossings, and free path availability for emergency vehicles in urban areas, as well as its future development toward intelligent traffic regulations and alert systems for vehicles.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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