

The Role of Artificial Intelligence in Traffic Management of Smart Cities

M2 Research Project

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Abstract

The purpose of smart city is to enhance the optimal utilization of scarce resources and improve the resident's quality of life. The smart cities employ Internet of Things (IoT) to create a sustainable urban life. The IoT devices such as sensors, actuators, and smartphones in the smart cities generate data. The data generated from the smart cities are subjected to analytics to gain insight and discover new knowledge for improving the efficiency and effectiveness of the smart cities.

Over the last few years, traffic data have been exploding, and we have truly entered the era of big data for transportation. Latest technological improvements increased the quality of transportation. New data-driven approaches bring out a new research direction for all control-based systems, e.g., in transportation, robotics, IoT and power systems. Combining data-driven applications with transportation systems plays a key role in recent transportation applications.

This research project aims to project some of the important techniques on smart traffic management in the literature. Another major contribution of this research project is the case study based on intelligent transportation system (ITS) in Singapore, Copenhagen and smart cities of developing nations, in general. This helps us to understand the importance of factors like infrastructure, financing capacity and environmental challenges in the implementation and execution of intelligent transportation system.

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1 Introduction

Smart cities have attracted great attention since 2008, with the launch of IBM's Smarter Planet project. Since then, the concept of smart cities has continued to grow and evolve and so is the definition of smart cities. Harrison et al. [5] defined a smart city as an instrumented, interconnected and intelligent city. Another definition, by Giffinger and Gudrun, provided six smart characteristics to be considered: economy, governance, environment, people, mobility and living. A common definition for a smart city involves ICT (Information and Communication Technologies) to make a city (administration, education, transportation, etc.) more intelligent and efficient.

The objective of a smart city is to improve the city's sustainability from the aspects of governance, citizens, businesses and the environment. Smart applications are developed to fulfill the information and decision-making requirements of government, citizens, companies and the environment.

Washburn et al.[8] listed seven critical infrastructure components and services for a smart city: city administration, education, healthcare, public safety, real estate, transportation and utilities.

With the rising number of smart cities across the globe, it can be fatal to climate change if the smart cities are not developed to incorporate the sustainable factors. Cities contribute to 75% of the global carbon emission [14]. However, by using advanced technology, we can start shaping cities which are better equipped to address today's urban challenges which have a negative impact on the environment. The adoption of sensors and IoT devices in Smart Traffic System helps to capture the user's preferences and context information which can be in the form of travel time, weather conditions or real-life driving patterns.

According to [1], top 5 ways to smart cities can help achieve the UN Goal 11 [27] are:

1. Reduce Carbon Emissions:

The way smart cities can contribute to a solution to reduce carbon emissions is by incorporating smart alternatives to transport so that citizens do not depend as much on privately-owned cars for mobility.

A few examples are:

- Smart bike-riding services which allow users to unlock dedicated bikes located all over the city via an app on their phones
- Smart-ride sharing
- Self-driving, autonomous vehicles which use less fuel.

2. Support Energy Efficiency:

One example is smart LED street lights, which last longer and require less energy to operate. They can be dimmed or brightened based on the location

and time of day to ensure efficiency without compromising safety. Some smart lights can even automatically turn off when they don't detect any activity on the street.

Implementing energy-efficient IoT systems like GPS, cameras and traffic light coordination systems to regulate traffic is another way smart cities can save energy.

3. Improve Urban Solid Waste Management:

The environment has an incredible self-cleaning capacity and an extraordinary ability to heal itself — but the way we live places an excessive burden on it. Using technology to enhance city functions, like the way we deal with garbage, can lessen the strain we place on the environment. Smart waste solutions are already a reality. The BigBelly solar-powered trash compactors [12], for instance, use smart sensors to know when to begin compacting. Furthermore, the containers communicate with local waste management organization via the cloud to signal when they need to be emptied. This reduces the activity of garbage trucks, thus reducing their carbon footprint and harmful emissions.

4. Real-time Monitoring and Management of Energy and Environment:

The system leverages new technologies such as Internet of Things (IoT) connectivity, big data, machine learning and analytics to gather energy and environment data, including:

- air pollution levels
- how much water is being wasted
- renewable energy performance
- solid waste measurements

The data is collected via sensors and cameras placed in strategic places, like on solar panels on top of buildings or garbage bins across the city. City officials and citizens alike can access and use this information to make educated, more conscious decisions and identify new opportunities which can ultimately lead to improved air quality, less energy use and a cleaner city.

5. Smart Cities Can Spark Citizen Engagement:

Whether we like to admit it or not, human behavior, how we choose to live, is what causes so many of the environmental problems we are dealing with today. In many cases, it's a matter of ignorance, not being aware that a problem exists or that a solution exists. One of the fantastic ways in which smart city technologies can be used is to connect urban citizen with the environmental issues which affect them.

The goal is to encourage people to make more sustainable decisions about what they consume and how they manage their waste. Citizen engagement is essential to any city's efforts to reduce its environmental impact, and technology-enabled

5 Conclusion

This research project summarizes important techniques in smart traffic management. To conclude, we describe some of the major challenges that arise in the smart cities which in turn effects implementing ITS.

The challenge for smart city data is to understand the interactions between the city and its people. From the perspective of computers and systems, the city is defined by its sensed data. Therefore, to understand the city, it is necessary to understand the interactions of the city, the data and the citizens. This is why the basic infrastructure of different sensors is an essential element in a smart city architecture.

One of the main challenges in data mining is how to find appropriate data sets from massive urban data to fit with concrete domain applications.

On a broader perspective, research on city smartness is very broad because of its multidisciplinary characteristics. ICT (Information and Communication Technology) issues, social issues, environmental issues, economic issues, administrative issues, etc., are all included in smart city research.

Different functional urban areas often overlap, so it is very difficult to accurately define the actual function of a specific urban area by any means. Also, the urban area function depends on deep-level semantic characteristics, and there are no urban data that can directly reflect these characteristics, so it is a challenge for researchers to retrieve urban semantic characteristics from urban dynamic data.

The major challenge identified remains the known open problem of lack of systematic procedure for estimating the proper parameters of the deep learning algorithms.

“Often, the challenge for ITS lies in getting the end-users to accept the system and use it correctly,” said Dr Chin in an interview with Urban Solutions[43]. Public engagement and effective communication are important components when interventions and policies are introduced to better manage the traffic.

We have also conducted a case study highlighting ITS in Singapore, Copenhagen and developing nations. This serves as a reference for upcoming smart cities to understand the challenges and how other smart cities have overcome these challenges. This research can be extended to conduct a case study based on cities having similar geographic terrains/ environmental factors or cities with a similar finance structure. This will indeed help cities to prepare for the otherwise unseen circumstances and make their journey towards deploying IoT services easier.

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