



A Sustainable Traffic Management System for Smart Cities

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Abstract. Rapid vehicle growth has generated a variety of problems for traffic management administrations in terms of traffic congestion, pothole, air pollution, accidents, and rut formation. This is due to the expanding size of cities and rising population mobility. This aim of this research to develop a sustainable and economical smart Traffic management system, which provide social and sustainable development using technology to provide an economical solution. Traffic speed can be predicted considering the pavement condition of the road using simulation. This study provides us a sustainable and economical procedure for traffic management system in smart cities. We have performed this research work using blender for simulation and modeling in which we have used a lidar sensor and raspberry pi4 to get the data and transferred it to the laptop using a SQL server. This system helps straightforward, practical, and reasonably priced technology to reduce the amount of human labor required to locate potholes, which will reduce accidents brought on by traffic jam conditions.

Keywords: Lidar · Sustainable · Simulation · Sensor · Blender · Smart Cities · Traffic Management

1 Introduction

With a clear plan in place, smart cities will benefit all citizens and undoubtedly contribute to long-term labor shortages. Even if the idea of a smart city is still somewhat hazy in people's thoughts, a few studies have tried to address the issues surrounding its creation. After conducting in-depth study in a variety of fields, including information technology, public governance, and e-governance, we have identified six essential elements that serve as the foundation for the growth of a smart city. This study paper examines numerous facets and dimensions and contributes to closing this gap by putting forth a framework that provides a clear understanding of the creation of smart cities. The framework put forth aids in recognizing current patterns and conditions necessary for a city to develop into a "smart" city. This has led to the use of technology to solve all of these problems in a more intelligent manner. Thus, the idea of "Smart Cities" is emerging. Smart cities use big data and the smart management to maintain a sustainable environment. When we refer to a city as "smart," we mean that it is more efficient, livable, and sustainable.

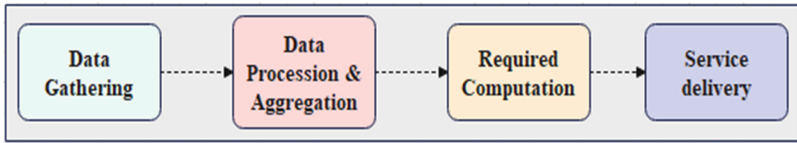


Fig. 1. Data Processing to develop a low-cost traffic management system.



Fig. 2. General traffic problem of smart cities.

By 2020, it is predicted that the smart city market will generate annual sales of roughly \$16 billion. Figure 1 provides various phase of work from data collection to the delivery system of the proposed model.

The development of congestion during the network loading phase can be precisely predicted using microscopic modelling techniques, where each individual driver-vehicle unit is specified in great depth, including its speed, acceleration, position, and driver behavior. The interactions between the vehicles on a road section will cause speeds to decrease as density increases, and either density or flow mean time can be used as a gauge of the degree of congestion.

There are additional macroscopic techniques, in which aggregated metrics that account for both space and time are used to characterize the dynamic traffic circumstances. The capacity to travel is one of the most crucial aspects of a person's existence in the modern world. Figure 2 expresses a critical condition of the traffic problem in a city. To deal with this type of scenario we have develop this smart traffic management system. The movement of people, goods, and defense forces is significantly influenced by the nation's transportation infrastructure. Since poorly maintained roads are the root of many accidents, the quality of the road surface becomes a critical issue. A variety of

real-time data about the condition of the roads can be gathered to help choose the best alternative for road repairs. This data can be collected via participating and interacting with individuals. There have been many different strategies used to address this problem. We may use a range of sensors that are already present in our telephones in place of such costly gadgets. Use a basic smart phone that is readily available to everyone to find potholes in the road.

2 Related Work

The smart city transportation management system is currently operational. In [1], this work developed a method for determining traffic blockage on streets using picture-preparation techniques and a model for operating traffic lights based on information obtained from camcorder-taken photographs of the streets. Instead of counting the number of cars, we segregate traffic thickness, which compares to the whole range of pixels that each vehicle has in a video frame. In order to regulate traffic lights in a sequential manner, we establish two parameters as yield, variable traffic cycle, and weighted time for every street in consideration of traffic thickness. This is both time-consuming and expensive. Therefore, it is imperative that the problem of the traffic gridlock [5] be appropriately addressed. Infrared sensors, inductive circle recognition, remote sensor systems, video information processing, and other methods are available for traffic management. All of these methods are effective ones for judicious traffic management. However, the problem with these frameworks is that they require a lot of time, money, and assistance to set up and maintain. Next, an invention called Radio Frequency Identification is introduced. When paired with the current flagging system, it can serve as the key to consistently effective traffic management [13]. Compared to other methods for managing traffic congestion, this innovation will be easier to implement and cost less to implement. Utilizing this invention will result in less traffic congestion. Early identification of bottlenecks will allow for the early implementation of preventive measures, saving the driver time and money. The author of [6] introduced the dynamic traffic monitoring system paradigm. It employs a variety of parameter parameters to gather high-quality journey data while also considering time and speed. It implies that several influencing elements should be taken into account. This GPS-based vehicle tracking system was developed by the author in [7]. It contributes to reducing short distance travel, and the same information in [8] focuses on various aspects are to be taken into account while utilizing the VSNs vector distance routing method to accept timely data. It offers extremely dependable communication [18]. It travels the farthest distance possible for data collection. For application monitoring in metropolitan areas, greedy and PDC-based data gathering systems are used in [9, 10]. By following this approach, we have to cut down on redundant data and drastically reduce bandwidth usage. This author developed an intelligent traffic management system based on RFID in [11]. It regulates traffic flow, lessens traffic-related accidents, and transmits information from faraway locations.

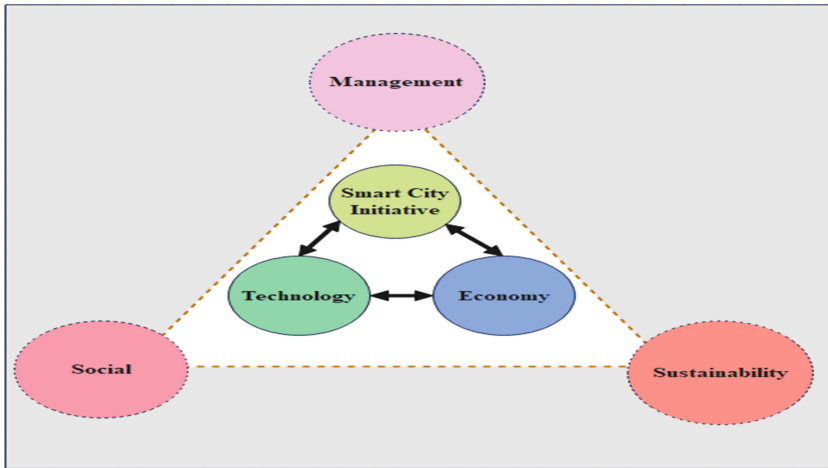


Fig. 3. General Architecture of sustainable traffic management system.

3 Methodology

It is crucial to ensure quality of life and sustainable development in the intricate social ecologies of cities and metropolitan areas. Cities are actively exploring ways to achieve the objective of becoming “smart” and managing city resources more efficiently while solving development and inclusion concerns as they become more aware of the idea of the “smart city.” Understanding the conceptual relatives of the model is the first step in comprehending the idea of a smart city. They established the theoretical groundwork for the comprehensive view of the smart city as it is today understood in the field of urban planning, despite its constrained scope. Different types of probe clients, including as navigation systems and fleet management clients, can provide additional traffic data. The properties of the data that is collected will be impacted by the client type, and it may create bias into the traffic estimates. According to the framework, each factor both influences and is impacted by each other factor. Additionally, it suggests that depending on the situation, some elements may have a greater impact than others. Two levels of the framework are possible. The factors that have a higher impact on smart city efforts are found at the inner level. This includes the technology that serves as the basis for smart cities. Before having an impact on the smart city projects, the outside level aspects may be modified by the interior level. In addition to sustainability, which ought to be the cornerstone of any development, this also encompasses governance and the socioeconomic balance of the community. Only a small number of research on smart cities for traffic management system focus on the managerial implications of smart city management and address associated concerns. The problems and management techniques involved in smart governance, which is necessary for a smart city, differ from those involved in traditional governance and management (Fig. 3).

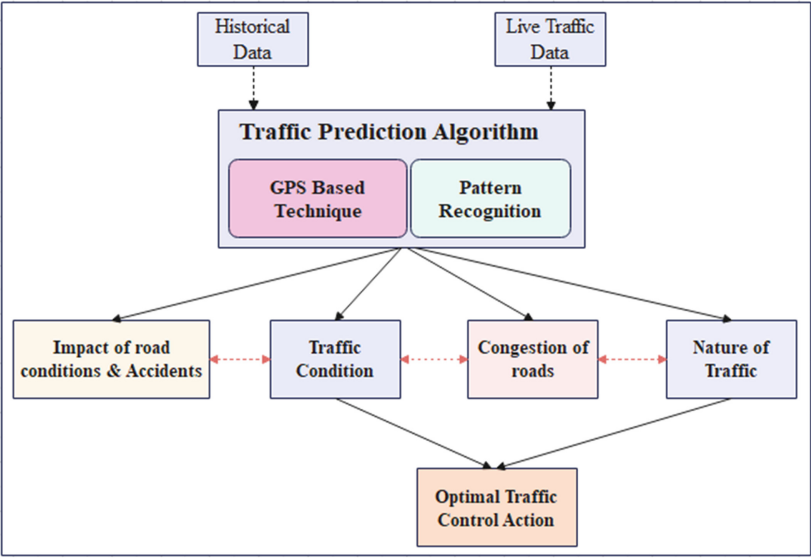


Fig. 4. General Flow chart of traffic management system.

The digital city, a technologically defined metropolis that leverages pervasive huge infrastructure to support e-Government and “a global environment for public transactions,” is another forerunner to the smart city. By interpolating and eliminating noise and bias in measurements, the processes of filtering, fusing, and assimilation work to increase the precision of a traffic status estimate. The primary distinction between the various notions has to do with how the estimate is improved. There is often only one measuring modality included in plain filtering. Assimilation focuses on combining measurements with the results of a mathematical model, while fusion focuses on combining measurements from several modalities. Fusion often contains a model for the evolution of the system, whereas assimilation can incorporate a variety of measurement types. A number of procedures must be carried out in order to convert the raw traffic data into a state estimate.

Figure 4 explains the traffic prediction algorithm based on historical as well as present data. Traffic prediction algorithm uses pattern recognition and GPS based technique to provide accurate result. Cities that just focus on their economy are not at all wise if they ignore the social conditions of their populace. Initiatives towards smart cities should be responsive to the needs of different populations. The quality of life of residents is impacted by smart city projects, which also seek to create a population that is more aware, educated, and informed. Initiatives for smart cities also enable residents to have an active role in the administration and management of the city. They may have the chance to participate in the initiative to the point where they can affect whether it succeeds or fails if they are essential participants. Many residents are unaware of the smart city, making it challenging to engage them. The smart city, however, concerns all residents, not simply a small number of enthusiasts. It is about the tasks of daily living. Initiatives aimed at creating smart cities also heavily rely on social media. Since changing attitudes



Fig. 5(a). Simulation of vehicles to avoid traffic Congestion.

is a key component of the smart city, communication is essential for involving the public by demonstrating the huge value of data. The media now needs to concentrate on becoming the -Disseminator of information; - on a range of areas of modern urban living; and Simplifier of policy and how it effects individual lives, in addition to the simple function of being a supervisor on behalf of the people. In a time when the media environment is changing quickly, reaching a broad audience is challenging. These days, the internet allows us to instantly learn what's happening anywhere in our surroundings and city.

4 Simulation and Results

Simulation work is done on the system to identify the nature of the traffic. Vehicle also consist of specific distance centre so that accident can be minimized. The aim of this work is to produce low cost as well sustainable traffic management system. Sustainability is the process of achieving social and economic advancement without causing environmental harm. Social, economic, and environmental sustainability are three main categories of sustainable development. These would include the main needs of urban environments, such as maintaining food, energy, and water supplies, managing water resources, and lowering greenhouse gas emissions. In fewer than 40 years, 70% of the world's population is anticipated to reside in cities.

This is a 3d visualization simulation in which it can be identified that how many vehicles around are a particular vehicle and with their specific distance also. We have made this using blender in which I have used a lidar sensor and raspberry pi4 to get the data and transferred it to the laptop using a SQL server. Then I used object detection on



Fig. 5(b). Aerial view Research area.

some printed images of vehicles to detect and run that vehicle on a 3D GIS map of my college, RGIPT. In this video you can see vehicles and a person changing their distance from the blue car according to real-time distance provided by the sensor. Figure 5(a) is set up for simulation of research vehicle whereas Fig. 5(b) is implementation of research idea in RGIPT campus. The standard deviation of travel times can be understood as a measurement of travel time dependability and exhibits a similar relationship with the infiltration rate; with one in four vehicles being able to transport, the standard deviation's value measures as it were 80 s, in contrast to and more than 150 s when correspondence is not measured.

Diagrams of flow are used to identify the pace at which the ideal flow takes place. Figure 6 explains the traffic density-time curve currently comes in two different forms. The free flow and congested branches of the density-time curve are also present. Since the diagram is not a function, the flow variable is allowed to have two possible speeds. When the speed is higher and the density is lower or when the speed is lower and the density is higher, the flow variable exists at two different speeds and allows for the same flow rate. The free flow branch is depicted as a horizontal line in the first density-time diagram, indicating that the roadway is at free flow speed up until the optimal flow is reached. The diagram changes to the crowded branch, which has a parabolic form once the optimal flow has been reached. A parabola represents the second speed flow diagram. Traffic density depends on the vehicle speed, road pavement condition, and type of the residence.

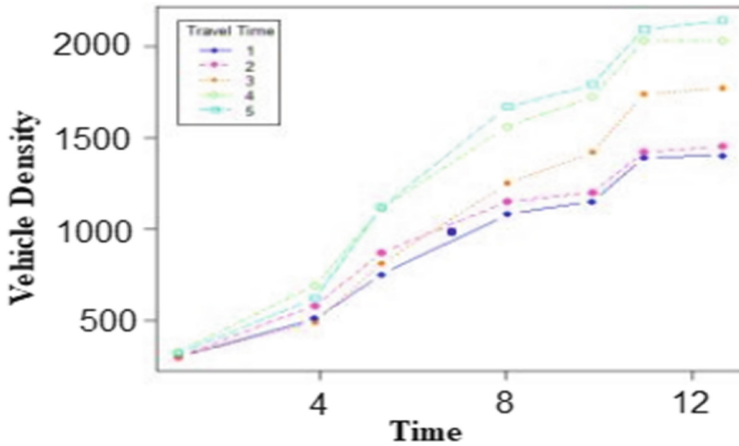


Fig. 6. Traffic density vs time graph for various locations

5 Conclusion

In order to improve service, our research suggested a low-cost Real-Time smart traffic management system that uses traffic indicators to update traffic information quickly. In upcoming 40 years, 70% of the world's population is anticipated to move into the cities. The various road conditions can be found and saved in the traffic center based on a review of the present road circumstances. Drivers can use early warning signals to obtain information about neighboring roadways from other vehicles, which will help them to regulate their driving behaviors and promote safety, comfort, and efficiency. It is possible to make it safer and more convenient for people to use the roadways to get from one place to another. Problems with road surfaces are a source of public concern in the modern day since they directly affect people's safety. For road upkeep and repairs, the government pays out millions of dollars. The primary concern of the relevant authorities is the health and safety of the passengers, which is why the reliability of the vehicles depends on a well-maintained road system. The person using phrases.

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