An Intelligent Framework for Traffic Management System Using Narrow Band-IoT

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Abstract. Traffic management system is a key parameter for highly efficient transportation system rather than depending on the speed of the vehicles and how smart it works. Police may not have all the dynamic data, which changes in a fraction of seconds, such as traffic due to accidents. The idea is to propose a system that can identify a truck in a road network and make decisions on clearing the traffic signals by getting results from the individual junction in a network. The system uses Narrow Band Internet of Things (NB-IoT) which is faster and energy-saving, and it sends signals to the particular traffic system based on the previous or the next traffic node. The Artificial Intelligence (AI) model will be biased independently. The system sends a message using radio waves from unused bandwidth. The main aim of the system is to make the passengers spend less time on traffic signals and save time as well as energy of the transportation system. It works based on getting traffic density on an individual traffic signal and the system decides which message should be open and which to close.

Keywords NB-IoT, Metropolitan traffic, Artificial Intelligence, Roadnetworks, Bias independent.

1. Introduction

There might be several reasons for traffic congestion in many places. We experience delays because of various reasons and hence it leads to waste of time. So far, there have been traffic systems working which do not watch for a whole way back. It only monitors the current place in which it is positioned. However, using the concept of IoT a long ago, these were cleared one by one for its problems, and now we will include both the idea of IoT and Machine learning services to solve our issue in real-time and which benefits all the passengers on the road. The system's maintenance is much lower, as it includes AI, it can manage on its own. There may be single or multiple constraints, that is hypothetical, so we should consider the whole thing in mind to solve traffic problems.

At present, there were many solutions proposed, but only a few cared about the city, rest all made personal benefits. Care about the city means, as total traffic should be considered as a social issue, not an individual problem. We use navigations to find clear paths and fewer traffic roadways. But we should also look out of environmental damages instead of taking it as
personal and just working on our jobs. The following diagram in figure 1 shows all the reasons for traffic congestion:

![Ishikawa (Fishbone) diagram](image)

**Figure 1.** Ishikawa (Fishbone) diagram

The problem faced at present in all cities is pollution due to high traffic density. Let us consider Delhi, it is the most top polluted city in India. The maximum of the pollutants comes from city traffic vehicles. This should be taken as a serious issue and should be solved as quickly as possible before the city's oxygen turns out.

Here the objective is to make the passengers spend less time on the road, decreasing their standby at traffic signals. This will reduce the traffic density, which in turn reduces pollution. The system includes an AI service with IoT. The AI monitors the overall traffic nodes in the city. By watching it, AI can analyze which roadway should be cleared as quickly as possible to avoid traffic load at the rest of the nodes. Using NB-IoT the traffic information of all nodes can be gathered and can work accordingly. At this moment, the system can provide a quicker way to passengers on busy roadways in real time. Things have become smart, smart cities, smart homes, fashionable furniture, etc. The proposed system acts quickly, i.e., makes decisions on its own [1] [2].

2. Existing Traffic Monitoring Systems

2.1 RFID Based Traffic Monitoring System

In figure 2, the system deals with traffic density using cameras and sensors’ digital image processing [3]. A traffic management algorithm that depends on the RFID tags is proposed,
which is attached to all the vehicles on the road. We need a lot of power to manage sensors’
digital image processing and its communication from other nodes, and also it uses RFID tags
for vehicle identification [4]. The system provides useful information to drivers, such as
showing a low traffic road or a quick way towards their destination.

![Figure 2. Roadway traffic nodes](image)

Instead of just showing a faster pathway, we can make all the paths faster, which causes
less traffic. Considering the illustrated system shows a quicker way to his or her destination, at
the same time people can reach their destination, the system displays the same path to all of
them, that brings all of them to a single junction making a huge traffic density. Instead of
saying a unique quicker way, the proposed system can make a passenger on away, deal low
halt time on roads by analyzing surrounding or straight connected highways to the traffic
junction. The system currently working takes a large power consumption, as said before,
managing all the devices connected to it.

2.2 **Surtrac**
Surtrac is an AI and traffic theory-based approach shown in figure 3. Its optimization technique
improves traffic flow in urban transportation leading to less waiting time and reduced
congestion time [5]. However, these do not take full advantage of the existing technologies.

3. **NB-IoT**
IoT, in general terms, deals with connecting devices and getting their data at different
locations, that may be near or far. Each device has its IP and MAC address in general.
Connected devices may or can be wired or wireless. Each of the connected devices can get
power from the primary source or have their origin. The functions are enabled using sensors,
actuators, AI, etc. Narrowband Internet of Things defines itself as a Low Power Wide Area
Network which works on radio technology standard to facilitate a full range service to cellular
devices [6] [7].
Due to ultra-reliable low latency feature of NB-IoT, it is preferred over other existing networks. Low latency prevents delay in communication; analyzing the data takes a little amount of time. To compensate for that time, NB-IoT is used to avoid delays and is preferred over other types of communication. Networking plays an important role. Providing security to the data, avoiding breaches, etc. Below the evolution of networking in IoT before NB-IoT has started; the information shows all the pros and cons of the older technologies which were used before NB-IoT. The table 1 shows data starting from the year 2011-19:

| Reference          | Methodology |
|--------------------|-------------|
| Bartoli A. et. al. [8] | This paper has discussed the technologies that include short-range capillary M2M solutions and future technologies comprising the Cellular M2M Solutions (ETSI, 3GPP LTE-M). **Pros:** It facilitated the needed connectivity breakthrough and also promoted minimum-power, low-rate connectivity across objects in vast distances. **Cons:** One of the significant flaws in the M2M communication is the presence of snoopers. Both in the wireless and wired connection, other people can connect to the device. |
| Ziegler S. et. al. [9] | This paper exposes the features of IPv6 (addressing, security, mobility, auto-configuration) and its related standards (6LoWPAN, CoAP, and CoRE) that were designed explicitly for IoT. **Pros:** The IPv6 based architectural model achieved network properties, cloud computing integration, and intelligent distribution within smart devices. **Cons:** The main disadvantage of having an IPv6 based IoT |
System is that it would be hard and expensive to make them backward compatible.

De Rose R. et al. [10] The author has proposed an interoperable architectural framework based on a centralized model having a Central Control Unit (CCU). It is the data-aggregation gateway and the decision-making core of the proposed system, which has a dedicated software application that can talk to all defined actors within the home environment with the help of smart plug and smart box.

**Pros:** It is used to monitor and manage energy consumption in SHEs and save energy, reduce costs, and improve users' comfort and safety. It provides network interoperability.

**Cons:** The limitation of this system is it is noticeably slower than flicking a switch on or off. The paper doesn't present us with alternative access to the home environment in smart box failure.

Signorello S. et al. [11] The author proposed an Information-Centric Networking scheme that recommends upgradation to a network-driven search for information sources. It is stated that WiFi, WiMAX, and similar technologies will soon have its descendant 5G.

**Pros:** In-network caching and content-based security are provided to reduce the duty cycle of resource constrained smart devices.

**Cons:** This approach seems high at first look, but due to the presence of multiple network connections, the bandwidth of every link is reduced.

Bernacki J. et al. [12] The author provided a tracking prevention method for RFID-tags named the ChangeID process with a sequential access model that was proposed, which was an extension of the universal re-encryption method. The tag can change its ID by generating random sequences and eliminating the earlier one's replacement to the database.

**Pros:** It improves the security aspect of RFID tags by preventing it from getting tracked.

**Cons:** These proposed RFID tags are more expensive than the usual ones as they use extra components.
Müller R, et. al. [13] The author has implemented MoDeNA, a context for detecting and classifying a WPAN/ WLAN connections. This makes the security settings transparent to the user smartphone application and can also provide advice to users.

**Pros:** It improves smartphone security with in-depth-know-how. It enhances user’s cognizance of security flaws while using WPANs and WLANs to evade data stealing.

**Cons:** WLAN Scan and connection time is increased as the algorithm takes some time to run.

Bauer J, et. al. [14] The author has created a concept that enables the AI platform to work in smart living applications. The services allow each of the individual and business users to be adequately secured and reliable.

**Pros:** With this platform, the services can be used with less effort in management. It is used for achieving flexible energy control and transition and offers monitoring services.

**Cons:** One of the Drawbacks of AI-based services is that most of the AI depends on machine learning, and machine learning is dependent on training data. Thus, the results can end up being unexpected due to biased datasets.

4. Artificial Intelligence

The evolution of quantum computing has begun, qubits started to change the era, and things are getting faster and smarter. AI can think faster than humans and also has a positive edge in its current speed. We use AI to calculate and analyze the traffic nodes at different locations and transmit those analyzed data with the result to other nodes that need the result[15]. AI services have enabled quicker decision-making, which would allow for the idea to make decisions based on the model. The AI model to be produced will be bias independent, i.e., it will not get the output based on the already trained dataset; instead, it will have dynamic data that will be used as a training dataset.

5. Proposed System Model

The proposed model solves the issue by analyzing the data of all the nodes in the city and making decisions based on the analyzed result. This will regulate the bulk traffic at signals, which will reduce pollution too. The model is also easy to implement, and as concerned about the cost analysis, it is low cost. The AI monitors the overall traffic nodes in the city. By following it, AI can analyze which roadway should be cleared as quickly as possible to avoid traffic load at the rest of the nodes. Using NB-IoT, signals from one traffic node to another traffic node can be gathered and work accordingly. As a result of this, the system can provide a quicker way to passengers on busy roadways in real time, as any day things can change any time, the system dynamically changes accordingly. Things have become smart, smart cities,
smart homes, fashionable furniture, etc. The proposed system acts quickly, i.e., makes decisions on its own.

Consider you are in a traffic junction; you follow a natural way to your office. But your office is a capital workplace for a maximum of the city people. Therefore, the road will be rushed, and there will be a natural way you travel, let us consider all the traffic nodes in that way. You cannot wait in all the nodes, as the road is more rushed and you have to reach in time. Your current traffic node has been filled, and it will be cleared, so let's take the average time taken to reach the next traffic node. Within the average time to achieve, the node you were past was filled, so the next node should be clear to go as soon as you reach the next node. The density at the current node is low, but you have spent a lot of time in the previous node since the last junction has been filled for a long time, even though the density is low, the node will be cleared quickly.

Let us consider we reach from A to B, and the nodes between them are X, Y, Z, P, Q, R as shown in figure 4. The passenger can go through any of the ways. Their weights are densities, as y is the main junction, it will have the highest frequency, it can also be low when the passenger goes around. The city will have the most density too. Consider the passenger starts from A. The mass will be a little high. He spends a few minutes reaching either of the nodes P or X as the next node. Both nodes should have less time as compared to the first node.

The time taken will be less as compared to the conventional system. Consider he travels in A, X, Y, R, and B as indicated in figure 5. These nodes have the highest traffic, as we can see by its weight. Y is the middle node, its previous node, and next nodes are X, and R. R has a higher density, but z is less, so the way to Z will be cleared first than R. So, this is how the system works in a real-time environment. The control flow is shown in figure 6.
6. Conclusion

This paper only deals with the framework which lacks centralized network breakdown security. If one node is down, the system may give inappropriate results without proper backup. This must be rectified with the help of neural networks that have a dynamic resolution of the overall output of all the nodes. Another thing to look after is that each of the individual service providers' cellular IoT services gets each of them a low income per connection compared with the regular one. At present, connectivity is sold at a low price, say $1 per month. The providers aim to address about 3.5 billion cellular mobile IoT connections by 2025, including 1.9 million licensed LPWA connections. This competitive economy of the provider's risks in the loss of their business might be avoided to reach high network performance and health.

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