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Scalable IoT based Architecture for Traffic Management

Pratham S Kundur[1], Rohit R Rao[2], Sanjay Kumar N P[3]

[1]*Student, Dept. of Information Science Engineering, NIE, Mysuru, Karnataka, India*
[2]*Student, Dept. of Information Science Engineering, NIE, Mysuru, Karnataka, India*
[3]*Student, Dept. of Information Science Engineering, NIE, Mysuru, Karnataka, India*

Abstract - *In today's ever growing world with the rise in urbanization, traffic management has become a major challenge for the authorities. This paper analyses the major risks and drawbacks that we face with the current traffic management system and tries to propose solutions which are implemented based on IOT. The functionalities of the system include path clearance for emergency vehicles, penalising traffic violators and to track stolen vehicles. The traffic management system proposed will utilize RF modules for transmitting and receiving signals, RFID tag for identification of vehicles by the system and a GPS unit which helps in tracking the vehicle.*

Key Words: **IOT, Traffic Management, RFID, RF transmitter and receiver, Automatic speed control, Reducing response time of emergency vehicles, Traffic violation, Big data**

1. INTRODUCTION

The drastic rise of population in urban areas all over the globe has resulted in an increased number of vehicles, which in turn contributes to the rising traffic problems [1]. Traffic management refers to the optimization of vehicle flow with existing infrastructure with minimal cost of maintaining the system. Every year it costs millions of dollars in revenue due to inefficient traffic management. Poor traffic management also leads to delay in response time by the emergency services, like ambulances and police vehicles, which leads to increased deaths on roads and delay in response to security threats. The safety of the drivers and the pedestrians is also an important aspect of traffic management. Every year more than 1.3 million people die because of road traffic crashes. One of the leading causes of road accidents is violation of traffic rules. One can create a safer traffic environment by introducing a more efficient traffic management system. Proposed system consists of introducing a RFID(Radio Frequency Identification) tag and a RF transmitting and receiving module in the vehicles which helps in tracking and monitoring the vehicles. The functionalities of the proposed system include:

1) Clearing the path for emergency services, to respond to their calls more quickly and efficiently.
2) Improving the safety of the drivers and pedestrians in the traffic, by monitoring the speed of the vehicles and penalising the drivers for violating the traffic rules.
3) Identifying the real time location of stolen vehicles using the RFID tag mounted on them.

2. LITERATURE SURVEY

2.1 Existing systems

Computer vision aided traffic management systems use cameras installed on roads for counting of vehicles by techniques such as Dynamic background subtraction and morphological operations for vehicle detection[2]. But the drawbacks of such a system is that it is not viable to store camera footages for a longer duration. Also it would be expensive to track individual vehicles using this system.

Magnetic sensor based systems make use of magnetic detectors which work based on the phenomenon of anisotropic magnetoresistance to report about the appearance of vehicles on the basis of Earth's local magnetic field distortion caused by them passing[3]. But this system suffers from some malfunctions like detection from neighboring lanes and double counting.

2.2 Challenges faced due to inefficient traffic management

Inefficient Traffic management leads to traffic congestion which is one of the major problems faced by the big cities in urban areas. It affects the mobilization of the ever growing population and takes a toll on the life of everyday travellers, which causes a loss in both time and money. Governments across the globe spend a lot of revenue in solving this problem.

Another major problem caused by the lack of efficient traffic management is the delay in response of emergency services, such as ambulances and police vehicles [4]. The need for signal priority is essential which allocates the path for higher priority vehicles [5]. This ensures the safe

passage of these vehicles through the intersections as quickly as possible and guarantees minimization of response time.

One of the leading causes for road accidents is violation of traffic rules, such as not following the speed limit or running a red light [6] [7]. Due to lack of proper regulation and absence of strict governing in the current system, it is difficult to make the drivers adhere to the traffic laws. Currently there are only passive safety systems, such as seat belts, ABS(anti-lock braking system) and air bags, which help in saving the life of the driver. But there is also a need for active safety systems, which controls the actions of the driver and warns them in case of any traffic violations [8].

3. PROPOSED SYSTEM

The proposed system will consist of the following hardware infrastructure. A RF transmitter at the speed limit zones and an RF receiver in the vehicles to capture the signals. RFID readers will be present at the traffic signals to register the RFID tags for identification of vehicles by the system.

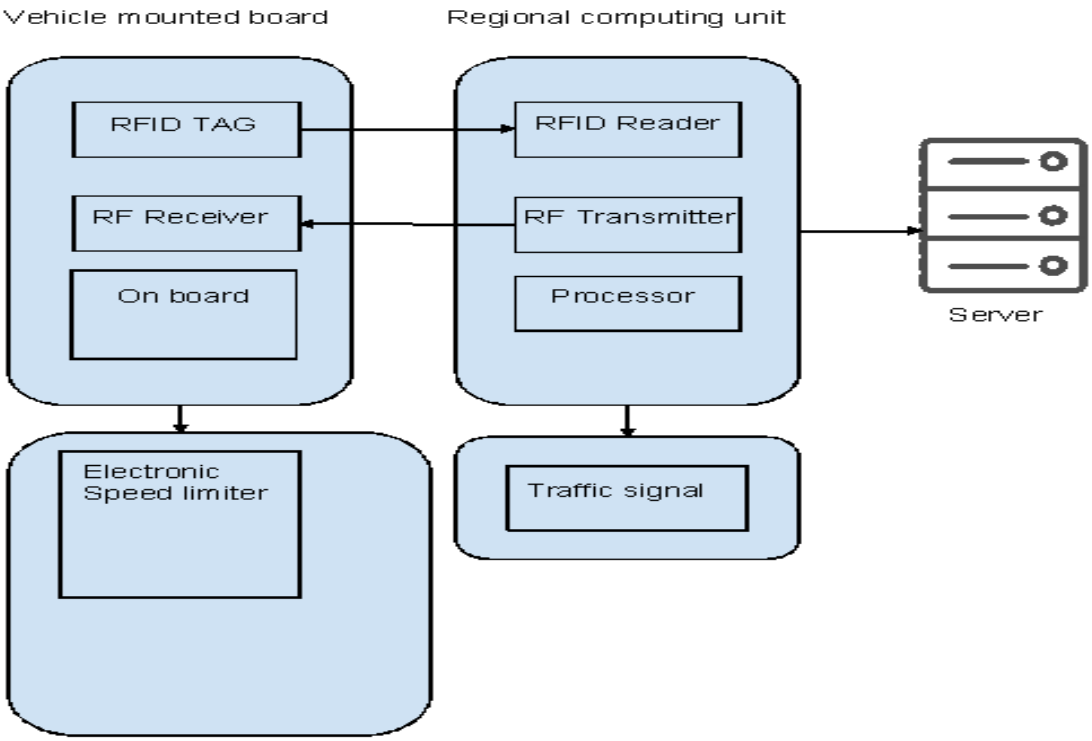

Fig -1: Block diagram of the proposed system

3.1 REDUCING RESPONSE TIME OF EMERGENCY SERVICES

During the event of an emergency, the driver of the emergency vehicle will notify the system either through on-board equipment or using a mobile application. The vehicle's location is obtained using the GPS and is sent to the application. This application then performs the necessary calculations based on an Improved Dijkastra's algorithm optimized for Geographic information systems that helps in mapping a path. It then goes on to clear the traffic signals on that path so that the time taken to respond to the call is minimized.

3.2 MONITORING TRAFFIC VIOLATIONS

At speed limit zones, the RF transmitter specifies the maximum speed a vehicle can go. It transmits frequencies equivalent to that of the limiting speed. When the RF receiver inside the vehicle reads the frequency, the maximum speed of the vehicle is restricted to that of the limiting speed. As the vehicle crosses past the speed limit zone, it can again move with its own speed.

At the traffic signals, we introduce RFID readers on the traffic lights that help in identifying and registering the vehicles containing RFID tags. The RFID reader is activated

and starts continuously monitoring when the signal is Red. If any vehicle tries to cross the signal during this phase, the module registers the vehicle. This data is then used to notify the authorities and penalize the owner of the vehicle.

3.3 IDENTIFYING VEHICLE LOCATION

The RFID reader present at every traffic signal registers all the vehicles passing through it that have an RFID tag on them. It stores the data for the last 30 minutes in its database. In the event of a vehicle reported stolen, the real time tracking of the vehicle can be done by the authorities, by identifying its last known location registered in the database.

4. HANDLING THE DATA

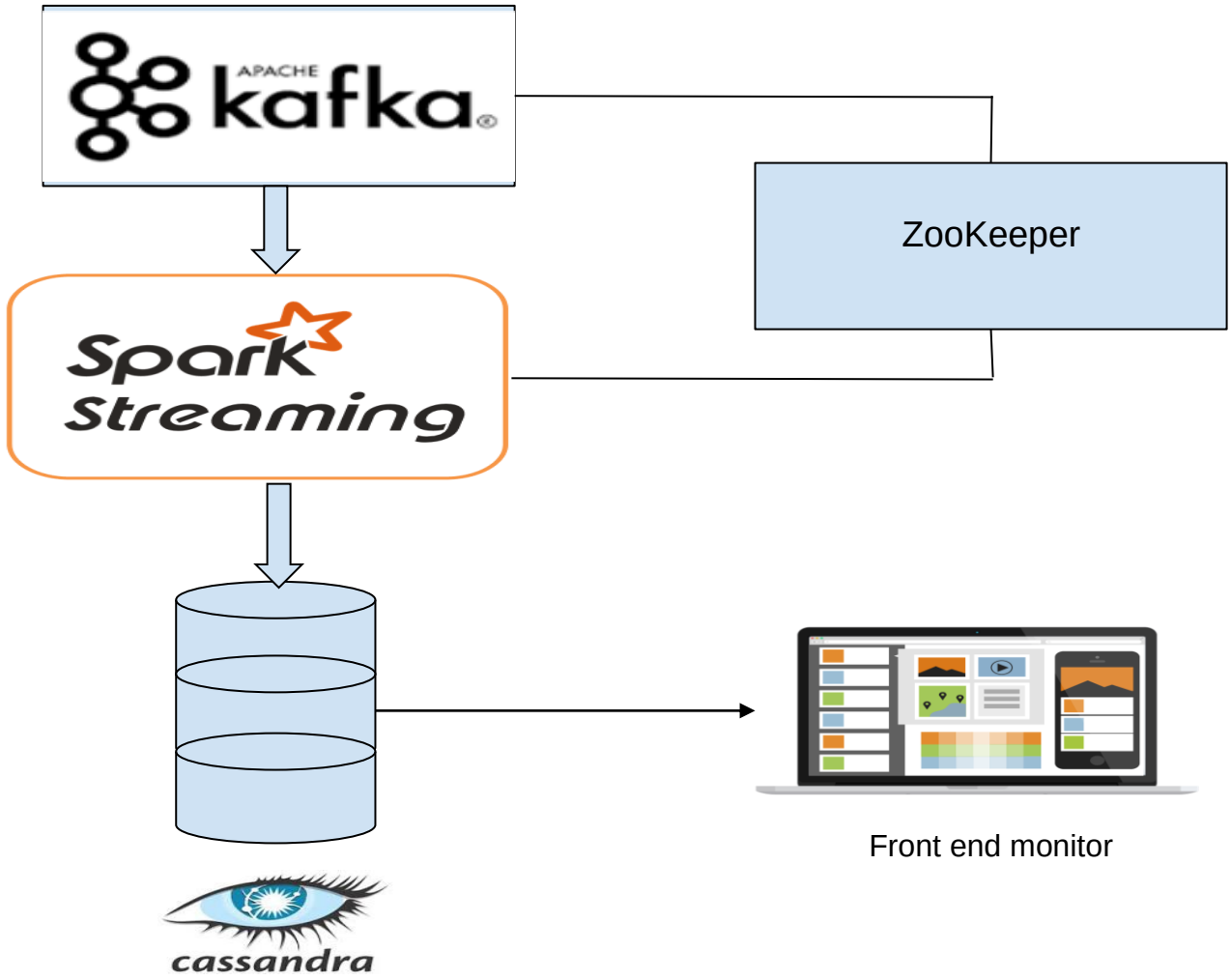

Fig -2: Data management architecture

IoT edge devices can make use of MQTT protocol to send data to the broker. The MQTT broker transposes the message to the Kafka protocol. To extend the traffic management system to necessary scale Spark streaming is the most viable option as it ensures high throughput and fault tolerant stream processing of live data streams[9]. The data can be stored in Cassandra DB which provides distributed, NoSQL DBMS designed to handle huge amounts of data across multiple servers providing high availability and no single point of failure[10].

5. SCOPE FOR FUTURE ENHANCEMENT

The above system can be further improved by the following enhancements:

- Adding image recognition software to the vehicle mounted system, which identifies pedestrians and other vehicles, thus reducing the chance of road accidents.
- Introducing a Smart Traffic Control System that recognises the number of vehicles present in a lane and clears the traffic based on the concentration of vehicles on each lane.
- Introducing a crash detection system, which in the event of a crash notifies the authorities immediately so that the response time of the emergency services is reduced further.
- Integration of the system with a mobile application, so that the vehicle owners can track the amount of traffic in their surroundings and identify the wait time for clearance of path.

6. CONCLUSIONS

This paper discusses the problems faced by the urban population of big cities due to the inefficient traffic management. The shortcomings of the existing traffic management system is discussed which affects drivers and pedestrians and causes disruption to the emergency services. An efficient system is proposed in which we develop a new system to control and monitor the speed of the vehicles. There is also a traffic violation alert and management system which warns the drivers violating the traffic rules. The paper also discusses a system which assists the emergency vehicles in their path by clearing the traffic along the path and hence reducing the time taken by them to respond.

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