Application Reliable Traffic Control Method for Efficient Data Management in Wireless-aided Computer Applications

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ABSTRACT

Wireless computer applications enclose smart homes, automated industrial environments, e-commerce, and other real-time extensions of conventional Internet of Things applications. Data management is a crucial process due to fluctuating traffic patterns and infrastructure support. By considering the significance of data management in such applications, this article introduces the Application Reliable Traffic Control (ARTC) method. The proposed method relies on the application requirement for minimum and maximum service data dissemination at the initial stage. Based on the application requirements, traffic forwarding and infrastructure allocation processes are performed for continuous data dissemination. The regressive learning model used in a linear dissemination analysis process helps to balance the application requirement. The performance of the proposed method is analyzed using the metrics of backlogs, latency, and dissemination loss.

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I. INTRODUCTION

Compared to the rapid increase in the overall number of vehicles on the road, the growth of transportation systems has been rather slow. As a result, maintaining traffic safety and safety on our roads and in our towns is a constant endeavor. Due to significant recent breakthroughs in computation, communication, and management technologies, autonomous and connected vehicles are progressively becoming a reality and have the potential to offer solutions to these unsolvable problems. It will nevertheless be some time before the advantages are realized and widely recognized. Platooning is possibly one of the programs that have attracted the greatest amount of curiosity among all those that have been thought about and tried over the last few years, in part because of how unusually it is implemented and how few vehicles are needed [1]. A platoon is just one or a few vehicles (after automobiles, or FVs), which follow the other vehicles, as shown in Figure 1.1.

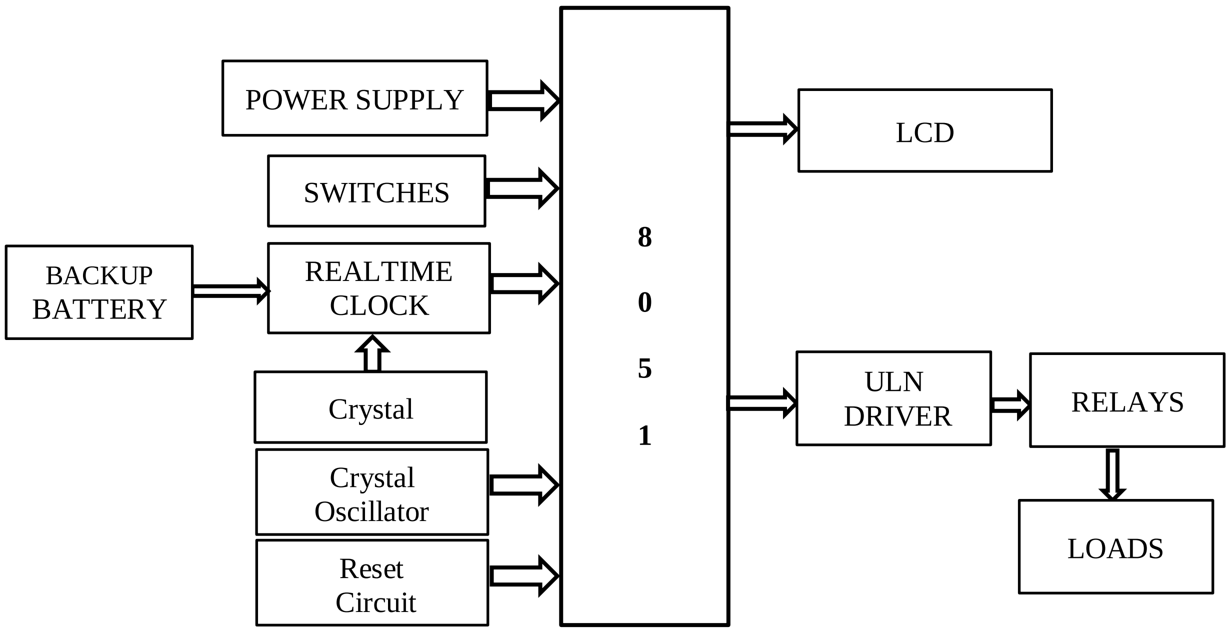

Figure 1.1. Traffic Flow Collection System

Vehicle accidents are typically brought on by avoidable human mistakes and poor driving techniques. Autonomous, networked, and self-driving vehicles are becoming more and more feasible thanks to recent developments in sensor technology. Through the utilization of straight or unintended vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and infrastructure-to-vehicle (I2V) interactions, a distributed system sharing sensor data from moving objects can lower accidents [2]. Automobile sensor technology enables drivers to enhance their driving experiences. This makes it possible for a network of roadside stations to serve as permanent waypoints and convey alerts, precautions, and data about the availability of essential services. Drivers in distant places where traffic sensors cannot be installed on roadways can especially benefit from this information.

One of the main factors contributing to automobile accidents is a sudden halt in traffic, particularly on fast-moving routes and highways with poor visibility. It may be brought on by other collisions, ongoing road construction, heavy traffic, etc. Drivers' poor visibility can be caused by a variety of things, such as sharp turns, fog, dimly lit tunnels, and so on. Unfortunately, not every street is equipped with such traffic monitors. Google Maps collects traffic data from sensors positioned on roadways and uses the 4G network to transmit notifications to users' mobile apps.

The major sections of the essay are broken down in the list that follows. Section 2 presents the study on the pertinent prior works. The elements of the proposed system are explained in Section 3 along with its suggested system architecture, development approach, and parts using data analysis and the graph-based method. The effectiveness of the system is evaluated, and the deployment setting is described in Section 4. The result is presented in Section 5.

II. RELATED WORKS

Abbasi, M., Shahraki et.al [3] The study undertakes a thorough investigation into network traffic monitoring. They classify pertinent works according to three criteria: (1) the analysis's goal; (2) the network node that monitors traffic; and (3) the chosen mobile platforms. They looked at several algorithms, including k-means, Naive Bayes, C4.5 decision trees, and random forests, to mention a few. The work examines analysis approaches, validation strategies, and outcomes with a focus on handheld devices. Additionally, while our work focuses on DL models, the emphasis has primarily been on traditional ML methods. This research examines DL models and structures for network traffic control systems. It differs from our analysis in that it focuses.

Corver, S. C., & Aneziris et.al [4] it is a delicate process to alter the operational work environment by introducing controller assistance features in route control since doing so alters how tasks are distributed between robotic and human beings. For instance, historically reserved only for human agents, dispute identification and evaluation are now shared by computers and human agents (air traffic controllers). This entails new duties, including keeping track of conflict detection technologies, interpreting the data, evaluating their dependability, looking for and examining potential contradictions, and coming to a conclusion.

Tang, F., Mao, B., Fadlullah et.al [5] Recent years have seen a significant increase in research into traffic control technologies. We discuss pertinent studies on the use of neural networks in network traffic management systems in this section. The first evidence of the concept of applying learning architectures to significantly enhance diverse network traffic control was envisaged in our prior work. A controlled deep learning technique that can be trained to utilize traffic patterns at wireless backhaul network edge routers and uniquely characterized inputs has been suggested. The deep learning system, however, was honed using OSPF, a recognized benchmark routing technique.

Mao, B., Tang, F., Fadlullah et.al [6] The technique of DL has also captured the interest of networking experts due to its exceptional performance in traditional applications like image categorization, natural language processing, and even games. However, considerable work is needed to characterize networking issues as well as deep learning frameworks due to the particular characteristics of networks. On the other hand, the anticipated sharp increase in network traffic in the coming years, traffic management is a topic that is becoming more and more popular. Our prior research suggested a deep learning-based routing technique that surpasses the Open Shortest Path First (OSPF) standard and runs in GPU-accelerated computer-defined routers

Dotoli, M., Fanti, M. P., & Meloni et.al [7] Major cities' mobility is limited by clogged urban roads. In the past, the congestion issue on public streets was solved by expanding the current transportation system with extra lanes and connections. A Greater focus is now placed on managing traffic through the installation and operation of automated transportation systems because such a remedy can no longer be dismissed because of the limited amount of space within urban centers. Particularly, surface street network signal control is crucial to effective traffic management. Despite many studies on the subject, the issue of urban junction congestion is still not fully resolved. The second actuation control category can be thought of as a transport-responsive network signal policy using signal timing plans that automatically adapt to traffic illnesses in contrast to the fixed time methods, which do not use data about the real traffic condition.

Adamski, A et.al [8] With the belief that average congestion state signals are suitable and adequate for control objectives, the fixed-time traffic patterns and pattern-oriented traffic control philosophy place an unreasonable burden on the system. As a result, the poor effectiveness of the control approaches is evident, particularly in atypically dynamic and crowded conditions and when accommodating sudden or unexpected changes in traffic status. This happens as a result of the behavioral mechanisms underlying temporary congestion occurrences being disregarded, as well as the ineffectiveness of average and small change-oriented control actions in such circumstances. The necessity for human operator involvement in the form of oversight and oversight of actions is greatly motivated by this.

Majid, M., Habib, S., Javed et.al [9] review the most recent research on IoT and WSN in this part. The fourth industrial age has resulted in significantly lower costs for communication, processing, and storage, making the combination of IoT with WSN possible and affordable on a worldwide scale. Numerous review articles and primary studies were studied.

III. METHODS AND MATERIALS

WSN-based traffic data gathering method

A magnetometer is used in the plan to count the cars and determine their speeds. Normally, the Earth's magnetic field, which ranges in strength from 0.25 to 0.65 gauss, is practically uniformly spread throughout the whole surface. The earth's magnetic field in the targeted area is disturbed when a vehicle drives through a sensor since it is typically made of an extremely permeable ferrous substance [9]. A magnetic sensor can typically find vehicles up to 10 meters away. Figure 3.1 depicts the architecture of the system.

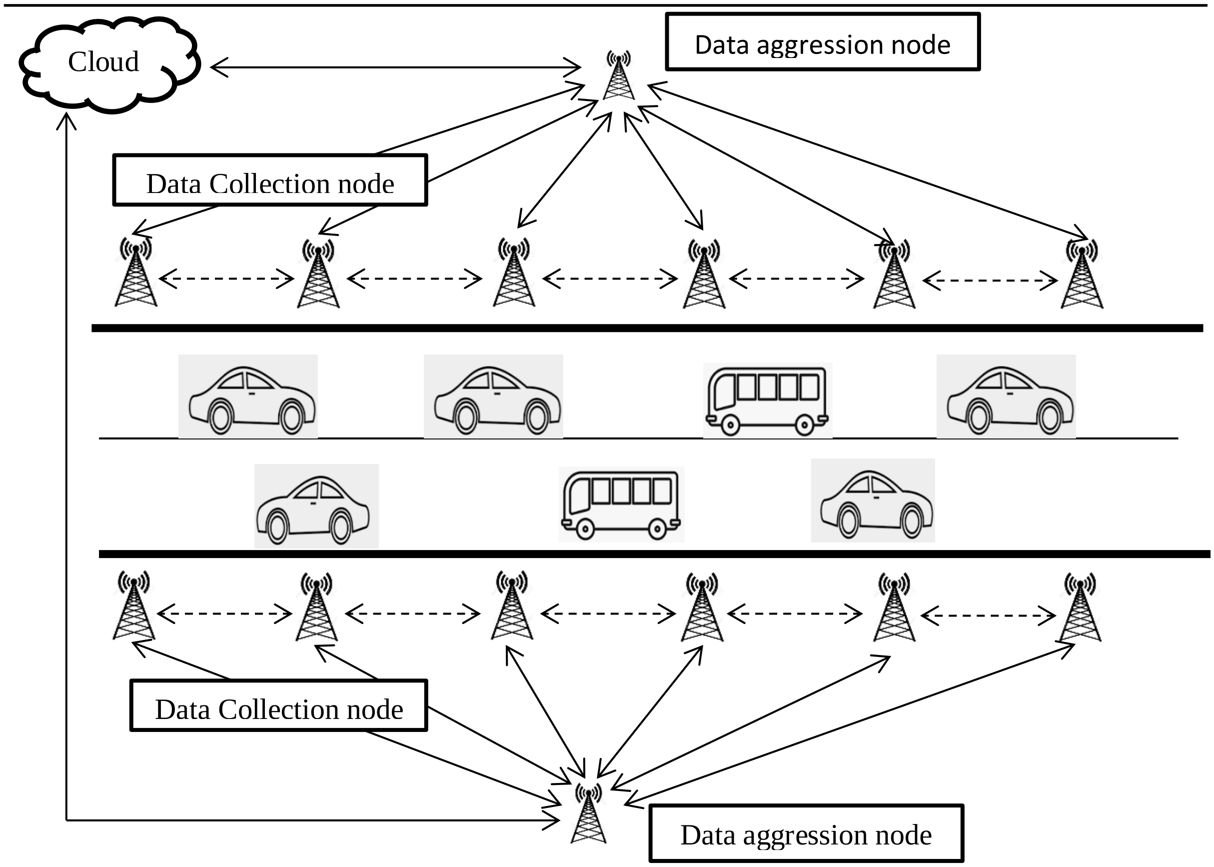

Figure 3.1. The Architecture of the Traffic System

Each data collection node in the system is in charge of gathering information about the movement of vehicles. These nodes then transfer this information to the aggregating node using the ALOHA protocol, which ultimately transmits it to the remote server via mobile internet. The system is well suited for tracking urban traffic since it is highly scalable and has cheap building, repair, and operation costs.

Monitoring System for Congestion in Traffic

The proposed road congestion monitoring system is described, along with VD gathering, traffic-flow simulation, segmented organization companies, publish/subscribe processes based on time and place, local section gridlock forecasting, and the service for drivers experiencing origin-to-destination traffic jams.

- **Data Gathering:** For the creation of a realistic system, accurate data gathering, and analysis are essential prerequisites. The authors discuss the gathering of real-time traffic data and VD data in this chapter. The information gathered is utilized to create segmented structures, forecast traffic congestion, and formalize essential elements following macroscale traffic flow models.
- **Vehicle Detector Information Gathering:** The authors of this study employed VD data to ascertain traffic conditions. In order to formalize the key elements of information about the distribution of traffic flows, the macroscopic traffic flow model was utilised to collect data. VD data analysis was carried out. Additionally, there were about 184 million previous VD records of traffic on Taichung City's principal roadways at the start of the system's construction.
- **Vehicle Data Collection in Real-Time:** One of the main factors contributing to traffic congestion is the lack of just-in-time information. This study focuses on real-time movement-related automotive data to control traffic congestion issues. The authors assume that there are two roles for automobiles in this system. In their first duty, vehicles take on the role of regular users. You can use the MQTT paradigm to subscribe to topics that have been published to obtain data on traffic congestion. In reality, every car

takes a different path from its starting point to its final destination. However, the suggested method allows moving objects control over their traffic data from point of origin to point of destination.

- **Segmented Organization:** In actuality, each road segment in a network has a different level of traffic flow and traffic congestion typically occurs on high-traffic road segments. When the number of vehicles equals the segment's capacity, traffic congestion begins at that particular road segment. As a result, congestion in traffic may spread to nearby roadway sections from a congested road section. This characteristic led the authors to study road network traffic flow levels using historical VD data, which benefits local traffic congestion prediction. To begin with the authors located VD devices on a map using longitude and latitude data.

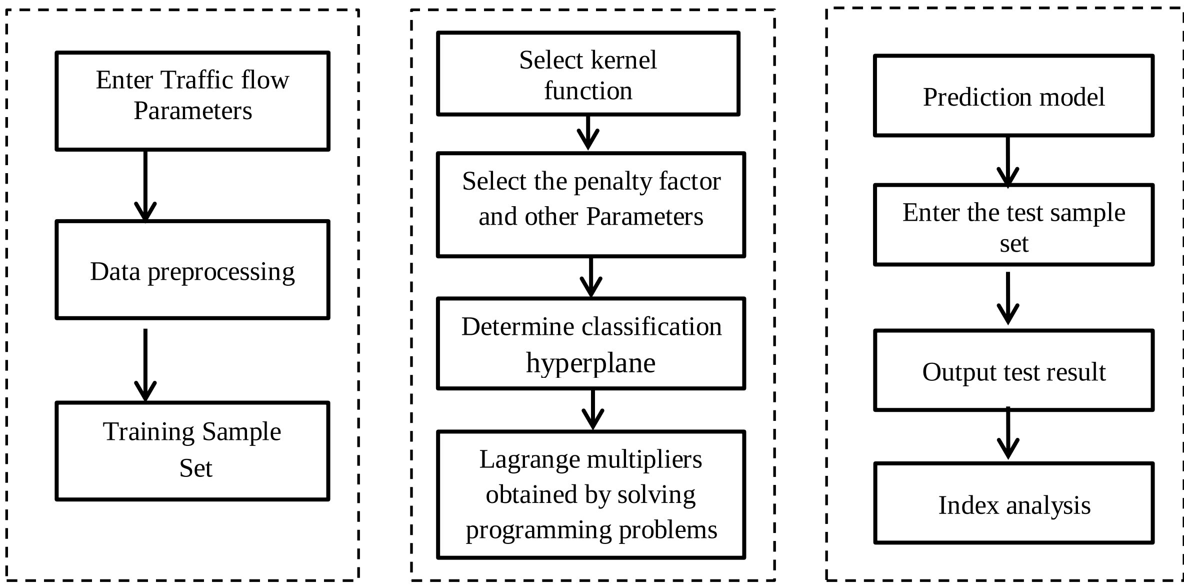

Figure 3.2. Modelling of Short-Term Traffic Flow

When a flow becomes anomalous, it should be able to constantly feed back into the computation model so that it can be adjusted following the current circumstances. The short-term traffic flow modeling process is shown in Figure 3.2.

IV. IMPLEMENTATION AND EXPERIMENTAL RESULTS

This section assesses the efficiency metrics of an edge-assisted vehicular environment. The effectiveness of the suggested method is evaluated in comparison to earlier research. OMNeT++ and SUMO traffic models are used in an integrated modeling system to simulate the suggested edge-based vehicular environment. The ad hoc network in this instance is designed using INETMANET.

For the OMNeT++ simulation setting, a model library known as INETMANET was developed as open-source software. Ad hoc network protocols as well as essential wireless protocols are also supported. A realistic motor vehicle motion touch that may be used in real life will be provided by the extensive simulation environment. SUMO-0.21.0, INETMANET-2.0, and OMNeT-4.6 are used to simulate the network. INETMANET is an open-source network simulation tool that can simulate a wide range of network architectures, including traffic networks. In addition to performance evaluation, traffic control, safety evaluation, and environmental impact assessment, it can support road transportation systems in a number of other ways as well.

Table 1. Contrast of the Proposed and Existing Methods' Results

unique feature	**According to this definition of congestion**	**Presentation**	**Construction**
efficient spatial information encoding	queue size	RMSE~1	LSTM
Scalable construction	Traffic flow	Precision: 84.2%	Novel PredNet, constructed with CNN&LSTM
clogging tree	Not relevant (data provider pre-labeled)	MSE: 0.73 during the week and 0.37 on weekends	Conv-LSTM
a thorough sensitivity analysis for the input horizon	Traffic flow	96.32% 91.55% Correctness 96.75% 92.89% Correctness	LSTM
Observation: A task's complexity depends on the type of network	Traffic flow	Urban MAPE: 4.29% MAPE: 6.08 percent (urban)	LSTM

The importance of hyperparameters for the training phase has been stressed more and more in Table 1 in several different ways. To fine-tune RNN replicas for the traffic data from the highway structure, this study takes into account five hyperparameters: knowledge rate, numeral of RNN layers, swellings, bunch size, and failure. This is based on our earlier works.

Table 2. Bi-Directional RNN Hyperparameter Tuning with Soft GRU

Limit	**Clarification**	**Types and Standards**
Neurons: Number	The units within the buried layer's accuracy-maximizing methods	[1, 200] Log Uniform or Int
Failure	Avoiding neural network overfitting	[1, 0] floating
Adaptive Rate	The weight values are used to adjust error values	Floating/Uniform Log [0.1, 0.2, 0.004]
Secret Layers	layers for contribution and production that maximize accuracy	Int [0, 3]
Sample Size	describing how many samples are spread out through the process	Int [1, 512]

The search areas and explanations for the aforementioned hyperparameters are specifically displayed in Table 2. The goal of this study is to use the automatic hyper-parameters tuning challenge to decrease the square error for predicting traffic flow.

In past efforts to further demonstrate the effectiveness of the new traffic congestion forecast, various outcomes are offered for all three data sources where we have suppressed specific data segments. In comparison to all other currently employed methodologies, especially for flow and aptitude data watercourses, demonstrate outstanding results for current traffic predictions. The advantages of the suggested road congested estimates can be observed overall when both methods are used, along with many other results such as MSE, MAPE, and RMSE, which show the mean values, RMSE, and average difference ends achieved across every station and all data from incoming amounts message streams. Therefore, the rest of the study results will emphasize on how DL impacts precision. Efficiency was evaluated in both congested and uncongested areas.

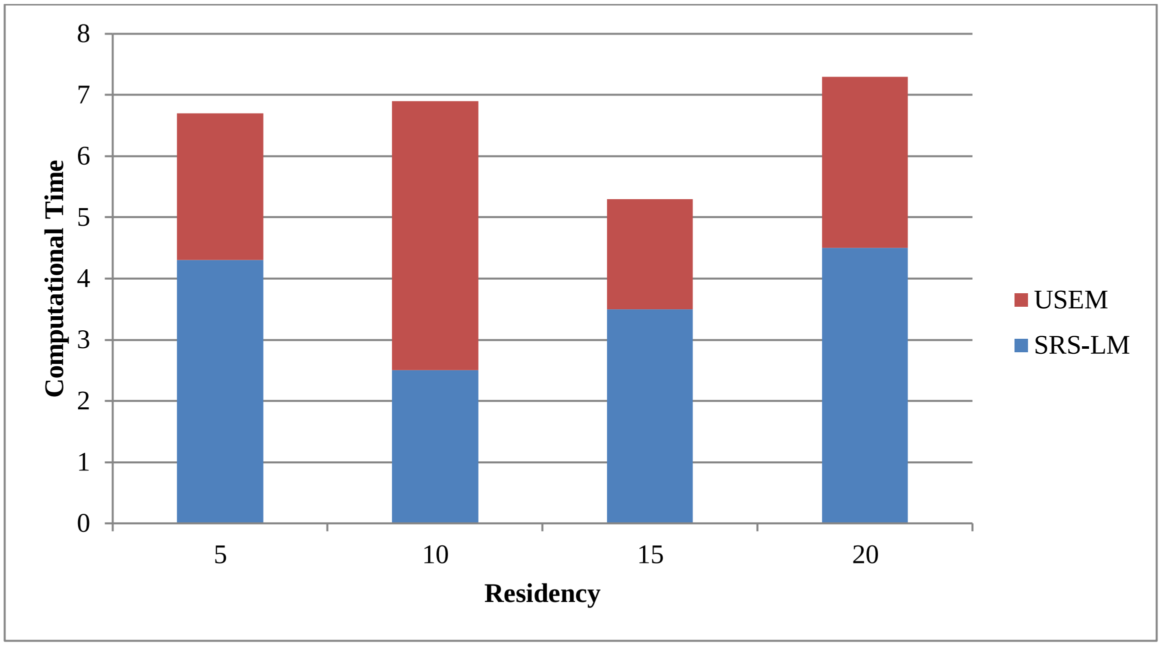

Figure 4.1. Comparison of Residency and Computation Time (ms)

Figure 4.1 illustrates how balancing these variables might result in the best performance and efficiency for a particular activity or procedure. Due to the large number of parameters they contain, DL is a complicated problem. Changing every hyperparameter, in particular, can make the process more difficult. Additionally, to find the best result, search algorithms take into account all hyperparameters equally, which might result in computationally challenging and time-consuming problems. The formulas demonstrate that while MAPE is a dimensionless variable, RMSE and MSE are based on the unit. We tried to include MAPE whenever it was available in this survey, along with the outcomes of multiple regression experiments. In many domains, residency and time spent computing are crucial considerations.

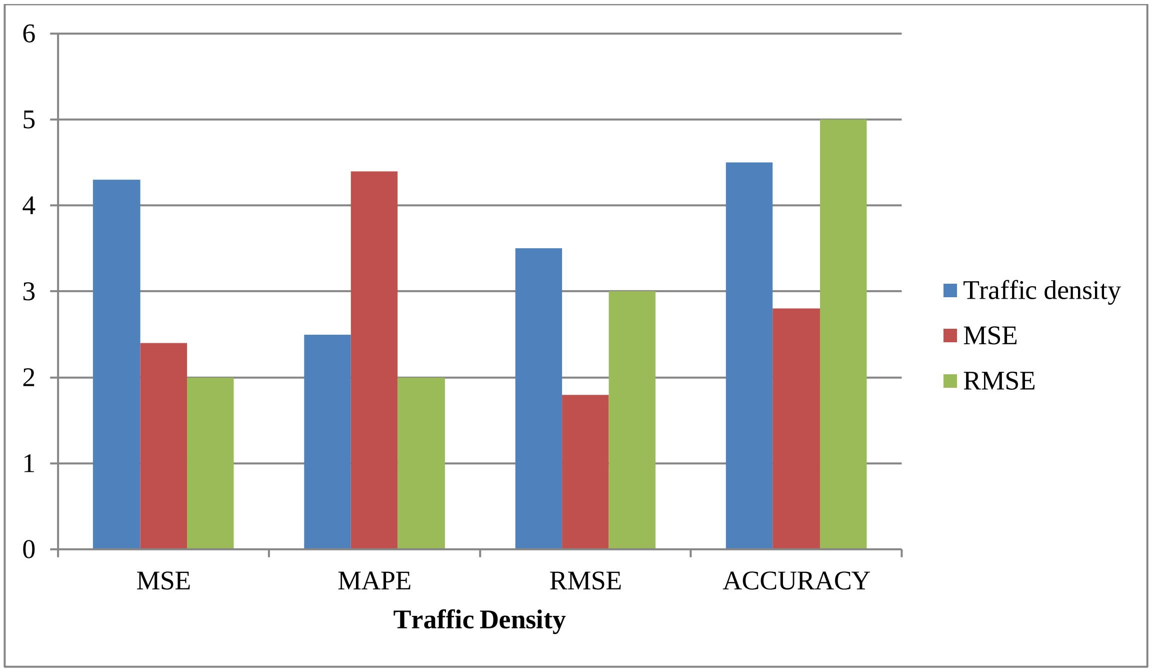

Figure 4.2. Results of Comparison for RMSE, MSE, and Accuracy

Figure 4.2 displays the variance for all models as determined by the MSE and MAPE. The conclusions of the RMSE examination that was previously published are consistent. For estimating traffic congestion based on traffic density, computation time is determined. As we project further into the future, the prediction efficiency of each system drops, as expected. The Conv-LSTM model performs badly to the fact that it ignores the spatial and temporal links between the two counting stations. The proposed model outperforms all competing algorithms in every situation, while the RNN and soft GRU hybrid approach comes in last. The best overall results come from advanced DL models. The other two performance parameters that were compared between all models are also represented graphically.

V. CONCLUSION

In this research, a cheap and power-efficient WSN-based traffic data collection method is provided. The plan can correctly and promptly gather data on vehicle position and speed, and it provides a framework for studying traffic flow. The chaotic identification of traffic flow signals is then suggested using an approach based on incremental noise calculation.

In smart cities, traffic flow management is a major issue, and DL techniques like RNNs may greatly improve congestion calculation. Soft based on GRU By detecting temporal patterns in traffic flow data, RNNs have shown promising results in the prediction of traffic congestion. By accurately predicting traffic jams, altering traffic lights, or suggesting alternate routes to cars, intelligent city planners can increase traffic flow. Along with reducing greenhouse gas emissions and enhancing air quality, cutting down on the amount of time that cars spend stuck in traffic is beneficial. To sum up, using GRU-based soft RNNs for congestion prediction is a potential method to enhance traffic flow in smart cities. This technology can help create more efficient and environmentally friendly transportation systems that benefit both people and the environment.

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