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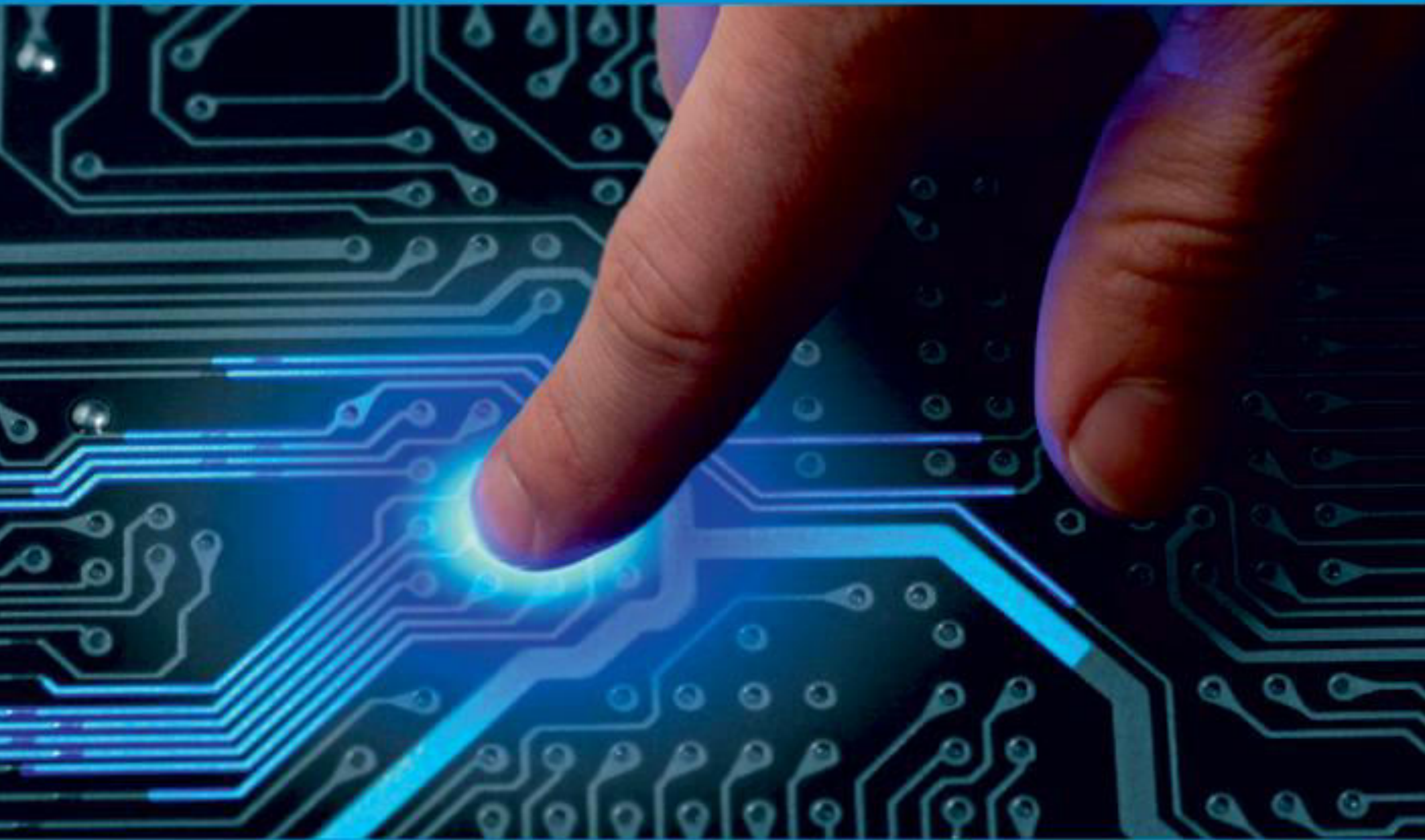

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Moving towards IOT-enabled Efficient Traffic Management and Parallel Transportation Networks in Urban Areas

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ABSTRACT*:* Intelligent transportation systems (ITS) powered by the internet of things (IoT) have a tremendous deal of potential to improve the reliability, safety, efficiency, and sustainability of transportation systems. IoT offers the means of connectivity and the impetus for smoothly incorporating transportation structures from the real world to their digital twins. In order to develop and improve the "intellect" of IoT-enabled ITS, this study provides visions and efforts on merging actual and artificial ITS. Artificialtransportation networks (ATN) can be swiftly created and are similar to real transportation networks (RTN) in computers thanks to the expanding pervasive and deep detecting capabilities of IoT-enabled ITS. Moreover, IoT-enabled efficient traffic management system is presented. As a result, there are parallel ITS, or artificial ITS and real ITS. The transportation system development has been examined from the perspective of a parallel universe. To examine the anticipated outcomes of activities, one can do numerous long-term iterative simulations. Thus, it is possible to plan, develop, build, run, and employ truly intelligent and efficient ITS. The ACEP concept, which consists of artificial communities, computational experimentation, and parallel implementation, serves as the basis for the parallel ITS. This paper also includes a case study to show the parallel transportation networks effectiveness.

KEYWORDS*:* Parallel transportation networks, intelligent transportation networks, parallel execution, traffic management, IoT

I. INTRODUCTION

In every large metropolis on the planet, issues with road traffic are a regular occurrence. More than 50 years ago, public and commercial organisations have attempted to deal with traffic congestion since it causes economic, social, and environmental issues. Three strategies have been used to try to reduce the consequences of traffic congestion: building more infrastructures, encouraging other modes of transportation, and controlling traffic flows. Road traffic conditions and flow management continue to be important research areas with a variety of potential applications. And over the last ten years, great technology concepts have gradually been incorporated into the technological landscapes of the transportation sector, leading to the development of intelligent transportation systems (ITS). Social media, sensor networks, and the Internet of Things (IoT) have surpassed conventional data collection techniques by producing enormous and constant volumes of actual facts. Trying to exploit these big data setups is a difficult task because of the enormous amount and the speed at which information is generated by transport and mobility system applications.[1]. Additionally, because of these environments' volatility in data collection due to their dynamic aspect, ITS decision-making is less effective. These cars' contribution to traffic congestion results in numerous issues. Among the most detrimental consequences of traffic congestion is an increase in environmental pollution. Regardless of age and current health conditions, people are affected differently by the toxic gases as well as fine particles that automobiles emit. Plans have been developed by experts and decision-makers to better manage traffic in crowded locations. Numerous flaws exist in these plans, one of which is their inability to adjust to shifting traffic patterns. As technology has advanced, new tools like Google Maps have made it easier for drivers to choose less crowded routes [2].

Due to a dramatic rise in the number of vehicles, urban traffic congestion has gotten worse during the past few decades. Urban traffic problems wastes drivers' time, and pollute the air, and noise, while also having a significant negative impact on our society. Numerous traffic control strategies are put out to address the issue of urban

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overcrowding. Street expansion and road enlargement are examples of conventional solutions. However, these methods fall short of effectively enhancing traffic networks' mobility [3]. The traffic situation is quite crowded the majority of the time in the contemporary smart city setting, notably in the industrial as well as market zones, especially during the busiest hours of the day. People encounter numerous difficulties at the main traffic intersections in business communities as a result of the growing populations and number of vehicles in urban and metropolitan areas. Not only does it prolong travel times, but, it also causes environmental damage and health risks brought on by pollution from automobile fuels [4]. Data created by transportation networks are dynamic, with patterns and conceptual drifts evolving over time. Conceptual drifts in the domain of traffic refer to variations in the data patterns in a transportation stream of data over time [5]. These alterations are further divided into two categories: recurrent and non-recurrent idea drifts, depending on the type of data stream variations. Non-recurrent concept drift is indeed an accident or interruption, and a recurrent evolution is a change in traffic congestion caused by maximum traffic. Finding any recurring idea drifts should be given special attention because they could have an impact on the whole road system. Numerous supervised machine learning methods that can adapt to new ideas and detect drifts are described in the literature [6].

Although the number of automobiles on the road is growing quickly and creating substantial environmental as well as traffic issues, traffic management is a significant issue in city transportation e.g., air pollution as well as traffic congestion. Actual traffic control mechanisms that assess traffic patterns on roads as well as implement intelligent action plans are therefore encouraged [7]. In order to reduce traffic congestion and ensure the prompt delivery of emergency messages, real-time traffic control is essential in smart cities. Its design is difficult mostly because of the following factors:

- Real-time traffic control can be done by relying solely on wireless communications between cars since vehicle actions are unpredictable and the accompanying network topology is very dynamic.
- When operated by people, cars may display social behaviours that express individuals. Although automobiles lack with limitations on battery as well as storage, there might be worries about how much fuel they use and how long it takes them to get there. Social activities, therefore, convey new meanings.
- While sending messages via free Wi-Fi or Bluetooth could result in significant end-to-end delays, sending messages through cellular networks would take up additional capacity and cost extra money.

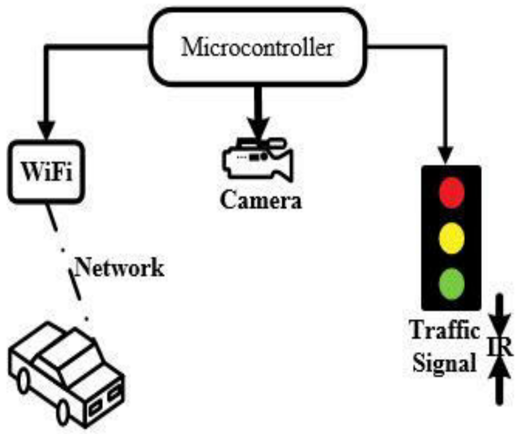

Figure1:Traffic management utilizing IoT

Traffic jamming is a problem in all major cities, predominantly in the downtown areas. By utilising information and communications technology (ICT), ordinary cities can become "smart cities". The Internet of Things (IoT) paradigm can be crucial to the creation of smart cities. An IoT centred traffic control structure for smart cities is discussed in Fig.1 in order to coordinate also with drivers to determine the signal status and choose the best route where the flow of traffic could be dynamically managed and traffic violations are recognized by on-site traffic officers through the centrally monitored or managed through Internet[8].

IoT is a technique that is employed by the majority of major cities in the world to create living more convenient and comfortable. If the right approaches are used, we may use IoT to get the precise results we desire. We can also save

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our personal or professional databases in our own gadgets with assistance of the Internet of Things[9]. After that, they could use the database that has been stored to meet their other requirements. IoT makes it unnecessary to be nearby when operating a component because it allows for remote access and control of components. This increases the suggested framework's independence and dependability. In IoT, each unique command could be used to control and commandeer a specific area [10]. These IoT-enabled ITS have sensors built in that allow for real-time monitoring of physical transportation infrastructure and the generation of enormous amounts of data. The collection of traffic information from physical sensors like GPS, induction coils, cameras, and other devices has greatly improved our lives while also being used extensively in transportation systems. The physical sensors do, nevertheless, also have a few drawbacks, particularly for select applications [11]. There is a growing gap between the physical as well as network (virtual) world as IoT-enabled ITS developed which has sparked a strong demand to unite the solutions and technologies of the two domains into one intelligent new one. In light of this context, the idea of parallel transportation systems (PTS) is kept putting up. This innovative, cross-disciplinary field of study incorporates a lot of social science, social computing, computer science, computer engineering, as well as electrical engineering [12].

This article aims to develop a work in implementing and designing Parallel Transportation Network (PTN) and IoT-enabled efficient traffic management framework. The rest of article is structured as follows: Section 2 describes the related work. Section 3 introduces PTN architecture, section 4 discusses the data collection and assessment, and section 5 discusses the parallel execution. Section 6 introduces IoT-enabled efficient traffic management framework andsection 7 describes testing and assessment. Finally, section 8 makes the conclusion.

II. RELATED WORK

A decision-making technique that aids in finding the best solution or architecture for a framework is simulation-based optimization. A smart system is enhanced if it has greater computing, sensing, and monitoring capabilities. This makes an ideal solution as well as design more significant. A computer-based simulation as well as its optimization methods is beneficial in offering affordable, quick, less resource- and time-intensive solutions in cases where evaluating the physical prototype seems challenging. This study compares generalized integrated optimization to the heuristic simulation-optimization technique for raising quality-of-service (QoS). The approach integrates Internet of Things (IoT) based systems with feature centred local (group) as well as global (network) formation processes to achieve the best performance. For obtaining global and local optimum parameters enabling minimal traffic situations, the simulated annealing approach is also used. Genetic simulation enhancement with multicriteria as well as multidimensional characteristics outperforms existing simulation-optimization techniques, according to a minor network of 50 to 100 nodes. Additionally, in comparison to the conventional method, enhancement in faster route determination for small-scale Networks incorporating simulation-optimization requirements integrated framework is seen. In complicated transportation situations with heavy traffic circumstances, the method outperforms the generalized simulation-optimization methods in order of monitoring essential infrastructure. The method has the least amount of communicational as well as computational complexity. This indirectly lessens the complexity of space. To research and analyse larger networks using related and different meta-heuristic techniques in order to determine the optimum mechanism and enhance network performance is not discussed. Likeness matrix-based local as well as global optimization methods, where similarity-based structures assist in determining optimal QoS values rather than a location-based method, not added to the study [13].

In order to recognize, gather, and send data, autonomous cars and intelligent gadgets are equipped with an Internet-of-things ITM system designed with sensors. Another method to enhance the transportation network is machine learning (ML). Numerous issues with the current transport management solutions lead to traffic jams, delays, and a high death rate. Both implementation and design of an adaptive traffic management (ATM) framework depending on ML and IoT are presented in this research paper. The system's design is founded on three key components: vehicles, infrastructure, as well as events. The design makes use of a number of scenarios to address every potential problem with the transportation system. The density-based clustering algorithm, which is based on machine learning, is also used by the Framework to find any unintentional anomalies. The ATM system continuously modifies the timing of traffic signals based on the volume of traffic and anticipated movements from neighbouring crossings. By progressively allowing cars to cross green lights, considerably reduces travel time. It also relieves traffic congestion by creating a smoother transition. According to the results of the experiment, the ATM system greatly outdone the traditional traffic-management technique and will serve as a leader in transportation projects for systems that rely in smart cities. The ATM solution decreases traffic jams and vehicle longer waits, lessens collisions, and enhances the entire travel experience. Utilizing vehicle locations as well as average speeds, vehicular activities may be assessed. Individuals who have been closest to the accident scene may also view unusual roadway incidents as a potential

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challenge. It was discovered that the ATM system performed better than the current traditional systems. The ATM system does not give energy-efficient systems or security. Instead of using a simulator with live traffic, the model was implemented in a practical situation [14].

The discussion emphasizes the need for alternate approaches to regulating and controlling transportation, with a focus on lowering environmental pollution in urban areas. The study's authors provide a conceptual model for regulating and managing traffic in such a city utilizing internet of things (IoT), with a focus on minimizing the effects of traffic on the environment. The ICT architecture for the environmental traffic control system is presented in the article. The framework's layered structure was chosen for its various implementation benefits. Modularity, maintainability, simplicity, adaptability, scalability, movability, heftiness, as well as implementation stability are benefits of layered manner compared to ad hoc implementations. The framework will serve as the foundation for the system's two primary parts are One is the central processing as well as knowledge generation equipment, while the other is a group of sensing nodes put at various key strategic locations within a specific geographic area The sensing nodes would gather pollution data where they're situated, as well as the central control system housed in a powerful computer would analyze the information gleaned from numerous sensing nodes and produce a live map of an area's levels of pollution. Following that, it will be determined if the levels of pollution are within acceptable limits or may exceed these limits depending on the present levels of pollution at the predetermined specific geographic areas, including such close to schools, hospitals, or recognized residential neighbourhoods, and the estimated trends. The central control would start sending information to the cars directing them to seek alternative routes ignoring the vulnerable sites when the levels of pollution at the designated areas exceed a predefined threshold level. The entire system's functioning has been planned as a tiered structure for simple creation, management, and potential future improvements. There is a designated functional layer inside which each of the operation's several functions must operate. Each function's activity is isolated from the operations of other tasks by the layered operational architecture. Therefore, as long as the data exchange connection between them is kept constant, every function could be changed individually without impacting how the others work. This will make it much easier to improve the system entirely in the future and will allow users to benefit from new improvements without having to change the system entirely. The four primary layers of the framework will be further broken down into smaller layers and detailed in the following subsections. The typical can be effectively utilized as an approach for integrating ICT into any execution of traffic management that includes pollution control as a key component in there. The authors not expanded include more circumstances, such as catastrophes, accidents, etc., to encompass the whole range of traffic control [2].

The paper offers the finest technique for determining the optimum course. The process comprises three steps. Initially, the area should really be grouped under servicing; next, a time-series neural network would be used to anticipate the requests. To choose the optimal route, the Whale Optimization Algorithm (WOA) is going to be used. Different scenarios were created and put into action to evaluate the criteria. According to the numerical simulations, the technique's service time factor is up to 18% as well as 40% better compared to the Grey Wolf Optimizer (GWO) as well as Random Movement approaches, respectively. Solutions to enhance ITS and boost customer happiness may result from the combination of AI as well as IoT. WOA is utilized to increase throughput as well as time servicing. The simulation results demonstrate that this strategy can raise client satisfaction. Whale technique and HHO throughput are nearly comparable. The study does not produce an ideal vehicle movement plan for smart cities by taking into account additional environmental factors and applying new meta-heuristic techniques, which would shorten the convergence time towards the best answer. Additionally, by using a novel fitness function, it will be possible to calculate how many vehicles are necessary to meet consumer demands. Only some vehicles would be capable of being moved at any given moment under the proposed technique, while others will stay put to cut down on service costs [15].

The paper suggests a metropolitan area-based Internet of Things-based Intelligent Public Transportation System (IoT-IPTS). In some kind of metropolitan regions, an IoT is utilised to connect transportation elements including cars, routes (sensors), commuters (mobile phones), roadside equipment (RSUs), etc. Every time commuters or vehicles travel from one site to another, the IoTs offer seamless interaction between various networking technologies. As a result, IoT offers the metropolitan area's necessary seamless public transit services. Additionally, by made use of cloud-stored context data about transportation entities, including the state of the routes, the volume of traffic, the number of possible routes, traffic congestion, and thus the movements and mobility of just the vehicles. In order to provide public transportation facilities in a metropolitan area, it is necessary to determine the appropriate routes, alternate means of departure times, transportation, and numerous other things using the context information that is saved in the cloud and IoT. With Emergent Intelligence Technique (EIT), static as well as mobile agents are used in the IoT-IPTS to gather, analyse, and share context-sensitive data. The policies for offering commuters in a metropolitan region the finest possible transportation facilities are developed using the context data that has been studied. Clouds

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computing as well as the EI network are made possible by software-defined networks, which are then utilised to manage commuters' access to public transportation. The system for managing IPTS operations in a metropolitan region is effective as a result of the performance indicators indicated above. The report does not contain the protected IPTS services and data control in a metropolitan region that is provided by using the Block chain-based security architecture [16].

The Traveling Salesman Problem (TSP) approach utilizing a genetic algorithm (GA) is described with a novel parallelization technique. The approach can significantly speed up the resolution of numerous difficult vehicle routing problems (VRPs) that have comparable TSPs in the cloud-based implementations of intelligent transportation systems. In addition to all the necessary facilities by self-directed vehicles in vehicular clouds, the system offers routing information. One significant class of evolutionary procedures that really can address optimization issues in developing intelligent transportation systems is GA. However, a substantially parallelizable GA is required to satisfy time requirements in time embarrassed issues of intelligent transportation systems, such as routing and managing autonomous cars. By creating three concurrent kernels that each perform a few dependent efficient GA operators, the technique parallelizes the GA. Running on many-core as well as multi-core CPUs is easily adaptable. Threads that run each of the three kernels are synchronised by a reduced switching mechanism in order to make the most use of the important resources of these processors during the parallel implementation of the GA. A GA-based TSP approach was parallelized using this technique on multi-core as well as many platforms. The outcomes support the effectiveness of the approach for parallelizing GAs on the both many-core and multi-core platforms. The rationale is that multi-core processors' parallelization facilities are used more effectively in low starting populations than they are in systems with many cores that resemble a GPU. The CPU/GPU clusters having lately developed into elevated accelerators for programs that require a lot of computing. Therefore, the research does not explore how to expand the approach to make the best utilize of the GPU cluster's capacity for GA computations [17].

For effective traffic engineering in intelligent transportation systems, the prognosis of short-term fluctuating traffic becomes extremely relevant. Accurate forecast findings can aid with traffic control and pedestrian route planning, which will aid to reduce the system's severe congestion issue. The research proposes a novel hybrid DTMGP framework that accurately predicts the capacity of passenger movements across a number of steps, taking into account all relevant spatial, temporal, frequency, and self-similarity characteristics. Initially, a discrete wavelet transform is used to separate the traffic volume sequences into an overall component and a number of fine-grained components. It is planned to use a unique Gaussian process typical to predict the detailed components while employing a more effective tracking approach to forecast the appropriations component. Statistics on the passenger movement in Chongqing, China, in real-time are used to assess the predicting performance. Simulation results show that, particularly during rush hours, a hybrid approach can enhance accuracy by 20% to 50% overall average. The simulation outcomes indicate that the hybrid approach could achieve accuracy levels that are, on overall, 20% to 50%. It is not investigated how to further increase forecasting accuracy through fully utilising the graph structure of the roadway or light transport systems [18].

The study develops a route server that can handle well all traffic in a city as well as balance traffic flows by enchanting into account present and anticipated traffic congestion circumstances, which constitutes a step toward this revolutionary traffic control paradigm. A simulation analysis is conducted utilizing actual traffic congestion data from Valencia, Spain, to show how the remedy can enhance traffic flow throughout the course of a typical day. According to experimental results, the suggested traffic prediction equation could significantly reduce average travel times as well as speeds, two metrics that indicate how congested and fluid the traffic is, when used in conjunction with regular updates to traffic situations on the route server. The mobility simulator utilised, SUMO, is discussed in some detail. The DFROUTER tool would then be introduced, along with an iterative heuristic to create an O-D matrix utilizing information from induction loops that were taken from actual traffic traces during Valencia's morning rush hour (8 to 9 a.m.). Finally, a description of the route server's (ABATIS) capabilities is provided. Even under extremely heavy loads, the system was able to reduce travel times by about 8% in comparison to the usual traffic conditions. Additionally, the solution increased average travel speed by 16%, which meant that vehicles reached their destinations more quickly. The study does not specify the reduction in CO_2 emissions or fuel consumption brought about by the strategy [19].

III. PROPOSED ARCHITECTURE

This study offers ideas and attempts on blending actual and artificial ITS in order to develop and enhance the "intellect" of IoT-enabled ITS. Thanks to the developing widespread and deep detecting capabilities of IoT-enabled ITS, artificial transportation networks (ATN) can be quickly developed and are equivalent to real transportation networks (RTN) in computers. IoT-enabled effective traffic control is also demonstrated. As a consequence, there exist false and real ITS,

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or parallel ITS. A parallel universe's view of the development of the transportation system has been taken into consideration. One can run a number of long-term iterative simulations to analyse the expected results of actions. Thus, it is feasible to design, create, construct, operate, and utilise an ITS that is actually intelligent and effective. The following Fig.2 presents the overall workflow in the proposed model.

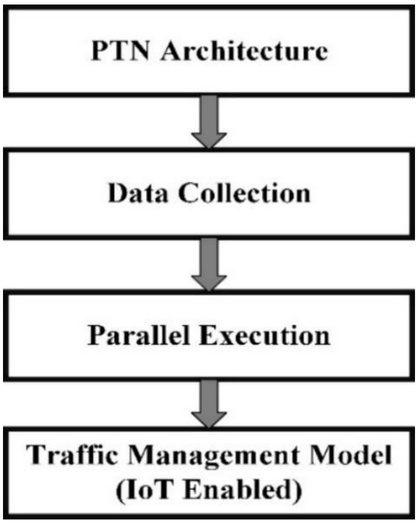

Figure2: Overall Work Flow

By tightly integrating people, things, and services, the Internet of Things (IoT) is reshaping and changing the way of living and work. The period of cyber physical social systems (CPSS), which are CPS that are closely linked, coordinated, and combined with human and interpersonal features, has arrived[20]. In CPSS, the online cyberspace as well as the real world are intricately entwined and communicate, and this new normal has become the standard for the functioning of contemporary social organization. Although there are many difficult obstacles to overcome, there are also fresh chances to govern the intricate social systems in novel ways. Social media and social networks have had a significant impact on human existence in this day and age. The range of sensing had already expanded from the actual environment to the digital environment, and it has also increased significantly in pace. As a result, enormous amounts of social signals were produced, nearly instantly. As a result, intelligent transportation systems (ITS) have expanded from integrating a lot of physical components, like transport systems, linked vehicles, and people, to a lot of social factors, like economic growth, urban planning, and emergency control. All of these created new possibilities for data-driven ITS, social transportation, and personalised traffic analysis and management[21]. The architecture for developing PTN predicated on IoT-enabled ITS is illustrated in Fig.3.

In addition to physical systems employing physical sensor networks, IoT-enabled ITS can now also gather traffic information from online systems employing social sensor infrastructures, considerably expanding the range of data collection. As a result, the physical as well as social systems have been integrating into a single overall system. Parallel transportation networks (PTN) operate in three steps predicated on this socio-technical architecture. First, models and descriptions of the real transportation network (RTN) have been created using artificial transportation networks (ATN) (A). Next, computational experimentation have been created and carried out to assess control strategies (CE). Lastly, an operational parallel mode is used to operate the artificial and real systems (P) [22]. In parallel execution, this research attempt to assist the real network to approach to the optimum level in the artificial processes rather than encouraging the virtual processes to approach to the state of the real network, as the research typically do in transportation modelling. The main goal of the ACEP strategy, which refers to the entire procedure, is to gain a deeper understanding of how traffic flow has been generated and evolves by simulating the transportation framework using the fundamental principles of individual vehicles as well as local traffic behaviour and then noticing the complicated phenomena that result from interplay between those individuals.

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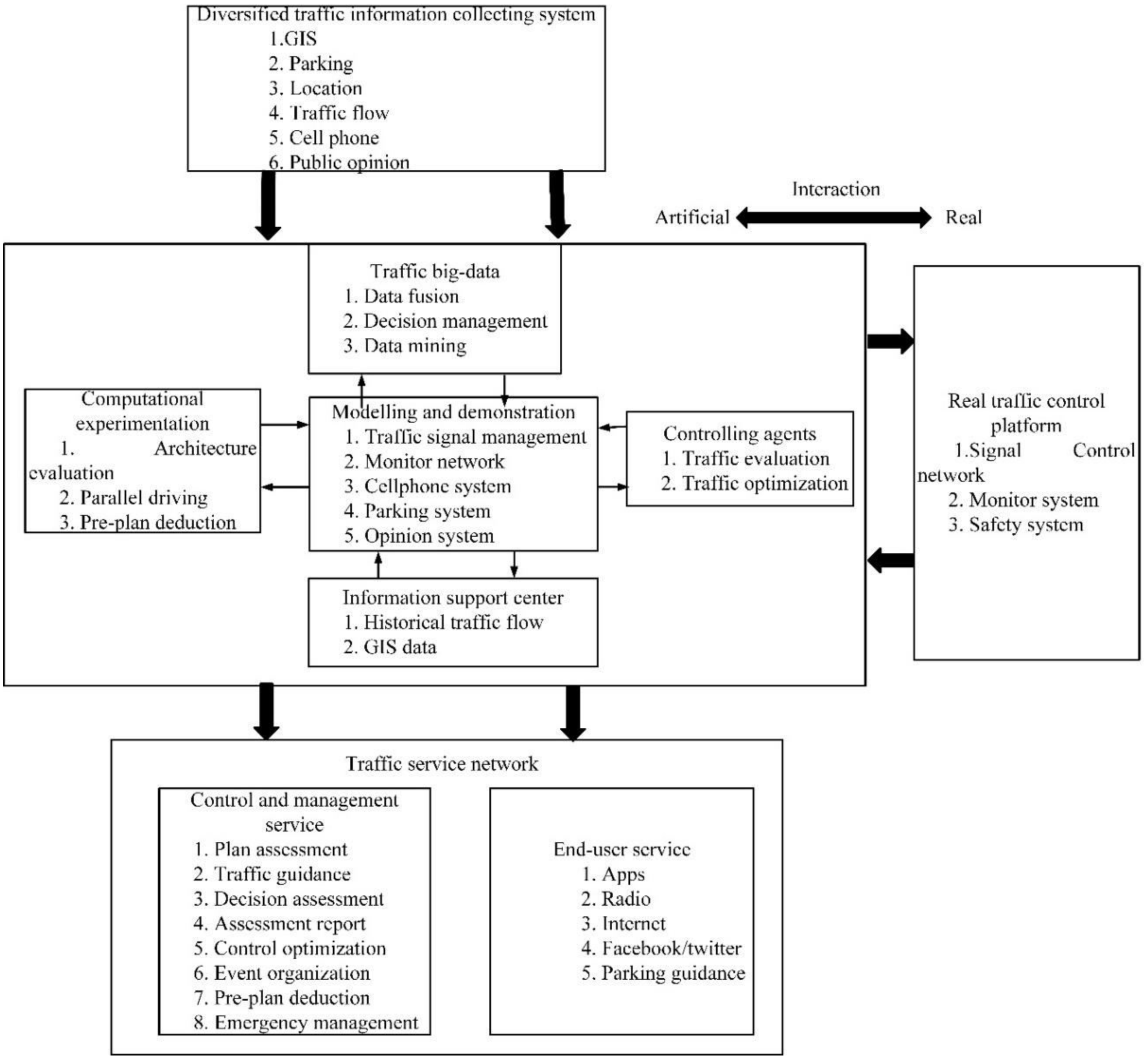

Figure3: PTN architecture predicated on IoT-enabled ITS

The PTN, which is predicated on IoT-enabled ITS, intends to develop new service paradig

ms and raise the standard of traffic service. IoT serves as the foundation of the design and the motivating force behind the construction of an extensive transportation network by smoothly fusing the real world with its digital counterparts. In the real world, multi-node coordinated sensing has been possible thanks to distributed sensors operating in a cooperative manner. A distributed sensor system is comprised of physical sensor gadgets that are integrated in mobile gadgets, placed in cars, and found along roadsides. Local traffic data is combined with regional data, like traffic flow, capacity, mean speed, vehicle path, etc., through cooperation between the neighbouring node sensors. The terminal nodes, gateway nodes, and sink nodes make up the first three tiers of the coordinated information gathering system's design. Video and radio sensors that detect and track moving objects in the terminal nodes level also interact with nearby sink nodes. In order to post the gathered traffic data to the gateway nodes, the sink nodes create a self-organized multi-hop mesh system layout. Gateway nodes transmit area traffic information to the control centre for additional processing across a private network. IoT technologies enable the extension of data sources beyond the actual to the social sphere, and the implementation of traffic data gathering in the social sphere predicated on social signals and social sensors. Social networking sites and media like Twitter, WeChat, Facebook, and Weibo give users constant opportunities to communicate thoughts, feelings, and knowledge in open or in specialised communities, resulting in massive amounts of social signals being generated in real-time. Virtual reality (VR) technique is used to create simulated traffic scenarios predicated on the distribution information[23].

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The static and moving objects, video signal, climate, lighting, RF signal, and other elements of real scenes can all be found in artificial environments. The establishment of a social traffic sensing environment follows, which enables constant, real-time data collection, archiving, processing, and assessment of traffic conditions. Although IoT technologies enhance the pervasive and deep sensing capabilities of actual transportation systems, the growing concepts and implementations of artificial intelligence (AI) and big data also make it easier to digitalize, virtualize, and model actual transportation situations and systems, i.e., to create ATN. These all serve as the framework for PTN.

IV. DATA COLLECTION AND ANALYSIS

The IoT facilitates a paradigm change in the collection and analysis of traffic information, from ITS to PTN. Traffic management organisations and other stakeholders typically place traffic analysers at fixed points, like at junctions and on certain road segments, in classical ITS builds. The need for traffic management can't be met by the traditional agencies-centred method of information collection because it is not only resource-intensive but also coverage-limited. IoT makes it possible for detectors to be integrated into moving objects like mobile phones and cars, offering a dispersed and comprehensive method for gathering traffic information.Individuals and vehicles are important components of transportation networks, and because they are dispersed across the network as a whole, the distributed method of collecting traffic information by them would easily and inexpensively encompass all the road segments and intersections. In the meantime, modern vehicles and people are frequently outfitted with GPS-based intelligent gadgets, making it possible to gather traffic-related information, like speed, location, acceleration, and so forth, without incurring any additional costs.

Due to the expensive cost of gathering real-world information predicated on real detectors, another conceptual change in parallel transportation would be to artificially manufacture large-scale information rather than just acquire more information. IoT enables the collection of basic traffic information, like origin-to-destination statistics and traffic flow, which is then exploited to create artificial networks with specific functions and a constant movement of artificial information. The RTN, ATN, and traffic prediction methods (TPM) have all been constantly changing. Low-volume RTN information have been initially gathered and a small amount of information are used to train the ATN. Then ATN might produce fake data that might not exactly reflect the information gathered from RTN. The synthetic data have been employed to supplement the authentic data. The prediction framework has been then trained using both actual and artificial information. As time passes by, there has been more information stored in RTN so that the TPM and the ATN might be gradually refined. TPM information would more closely approximate actual information while ATN added diversity to the genuine dataset. TPM and ATN, correspondingly, achieve similarity and variety. Here, "resembling" refers to changing the prediction framework to more closely reflect the observed data. ATN will undoubtedly be modified during this process, but it retains a unique data generation system with the primary goal of enhancing the variety of the actual data[24].

Multinomial Naive Bayes (MNB) [25]is used to incorporate numerous data sources obtained from various sensors in order to describe the variability and ambiguity of traffic information in PTM. The following Eqn (1) is how the MNB for traffic statistics is articulated:

$$P(d|x_i) = {P(d)P(x_i|d)}\Big/{P(x_i)} \qquad (1)$$

Where, c∈C, $P(x_i|d)$indicates the probability of attaining traffic data, d is a dataset, $x_i = x_1, \dots, x_n$ represents the parameter set, $P(d)$represents the total dataset, and $P(x_i)$ indicates the normalization factor.

RTN uses parallel dynamic programming (PDP) to compute the parameters predicated on the aforementioned model. The strong pair nonlinear relationships between several data sources are being modelled using PDP. Additionally, when coping with a data context with partial data, it may forecast the missing information based on historical data. The computation formula for PDP is expressed in Eqn. (2).

$$S_i(\gamma_i, v_i, v_{-i}) = \sum_{t=0}^{\infty} \delta^t V_i(\gamma_i, v_{i,t}, v_{-i,t}) \qquad (2)$$

Where, $v_{i,t}$ and $v_{-i,t}$ are the controls among data source x_i, i and x_j, j, $\gamma_i$data source represents the error function, $\gamma_i = \sum_{j\in n} \tau_{ij}(x_{i,t} - x_{j,t})$, τ_{ij} represents the coefficient of connectivity between x_j and x_i.

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V. PARALLEL EXECUTION

In a dynamic parallel-world viewpoint, PTN researches how transportation networks are generated and evolve. First, artificial traffic instances are effectively built in ATN employing bottom-up methodologies in order to model and depict potential conditions of complicated transportation networks. By doing this, it is possible to create virtual "large" traffic information at a minimal cost from real "little" traffic information. By employing ATN and virtual sensors, it is feasible to circumvent the expensive costs as well as the challenging—if not impossible—task of conducting tests in the real world as well as collecting experimental data using actual sensors.

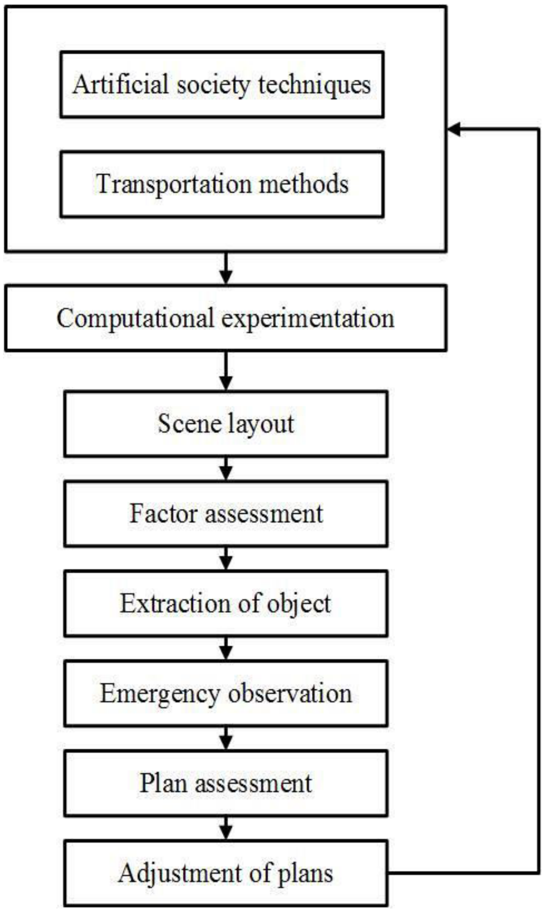

Figure4: PTN workflow

Through interaction evolution between simulated and real systems, the control plan refinement procedure is carried out. Given the significant cost of conducting transportation tests, it is challenging, if not unattainable, to evaluate the RTN control plans objectively. Nevertheless, the ATN makes it simple to calculate the evaluation. Numerous studies on performance efficiency and dependability can be undertaken as a result of the computer experiment's repeatability and designability on artificial systems. In addition to regular experiments, it is also simple to conduct particular tests in unique circumstances, like accelerated tests, pressure tests, boundary tests, and so forth. These "tests" are typically unable to carry out in RTN in the conventional sense. The PTN's workflow is indicated in Fig.4.

Computational experimentation on the ATN could be designed using a variety of learning methods, including integrated learning, predictive learning, and others. The RTN may receive recommendations from learning procedures on how to choose data sources and set up sensors for information collecting. The response from the recommendation can be thought of as the learning procedure, and the cycle of engagements between the real world as well as the digital world repeats itself. So many computer experiments are run, the outcomes are examined. The best course of action is then brought back into the real world, guiding the real traffic network toward the ideal conditions of artificial systems.

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The control plans optimization uses adaptive dynamic programming (ADP), which is frequently employed in parallel implementation. The procedure is indicated in the following.

First, the ATS defines the critic function is described in Eqn (3):

$$U(x(0), v) = \sum_{g=0}^{\infty} V(x(g), v(g)) \qquad (3)$$

Where, $v(g)$ and $x(g)$ are ATN's output and input, correspondingly, $V \geq 0$ indicates the particular utility function. In order to minimise the function in Eqn (6), research attempt to construct the controllers with the best feedback predicated on data-driven ADP theory.

Next, let $\bar{v}_g = (v(g), v(g+1), v(g+2), \ldots)$ be the controlling order from time g, and $U^*(x(g))$ be the performance index optimal function, which is described in Eqn (4).

$$U^*\big(x(g)\big) = min_{\bar{v}_g} U\big(x(g), \bar{v}_g\big) = U\big(x(g), \overline{v*}_g\big) \qquad (4)$$

Where, $\overline{v*}_g = (v*(g), v*(g+1), v*(g+2), \ldots)$ be the optimal control order, and $v*$ represents the effective control function.

Third, as per Bellman DP theory, the HJB function is attained that is expressed in Eqn (5).

$$U^*\big(x(g)\big) = \left\{min_{\bar{v}_g} U\big(x(g), \bar{v}_g\big) + U^*\big(x(g+1)\big)\right\} = U\big(x(g), \overline{v*}_g\big) + U^*\big(x(g+1)\big) \qquad (5)$$

Finally, to produce the best controller for parallel execution, a type of data-based iterative method employing value function has been used. Define the iterative phase (also named as iterative index) i=0, 1, 2,...n. The iteration begins from $U^0(x) = 0$, and upgrades as follows:

$$\begin{cases} v^i\big(x(g)\big) = H\left(x(g), \partial U^i(x(g+1)) / \partial x(g+1)\right) \\ U^{(i+1)}\big(x(g)\big) = V(x(g), v^i\big(x(g)\big) + U^i(x(g+1)) \end{cases} \qquad (6)$$

Normally, $V(x(g))$ represents the status parameter $x(g)$'s non-linear function and its solving procedure rely on the next time values, $U\big(x(g+1)\big)$, hereafter, $U\big(x(g)\big)$ is commonly unknown.

VI. IOT-ENABLED EFFICIENT TRAFFIC MANAGEMENT MODEL

The block design below should be put into practise in order to construct a real-time model of an effective traffic control system based on IoT, as depicted in Fig.5.The sensors in the illustration are employed to gauge the level of congestion before the data is sent via wifi controllers to the gateway. The gateway additionally receives data from the actuator block regarding the state of the traffic signals right now, and it utilizes this whole data along with the logic to control the traffic light. To offer any additional long-term fixes, the cloud is also used to view and store the current traffic condition. The following are the specifications for each block:

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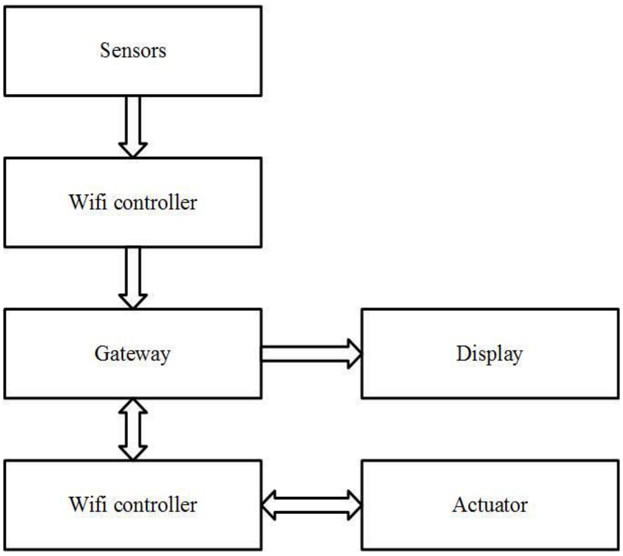

Figure5: Block diagram

The above Fig.5 presents the general work follow on IoT enabled efficient traffic management model. At first the sensor is connected to Wi-Fi controller and the connection is passed to the gateway from the gatewayfrom the gateway the connection is passed to the Wi-Fi controller and the display section, from the Wi-Fi controller the connection is feed to the actuator. The actuator and the Wi-Fi controller have double side connection and same as that the gateway and Wi-Fi controller has the double side connection. The main process involved in this parameter is explained as follows:

a. **Sensors:**In this research, the ultrasonic sensors have been employed to gauge congestion. It uses ultrasonic transmitters to transfer waves, and a recipient to acquire returned waves from the destination in order to calculate the distance depending on how long it took from transfer to receipt.
b. **Wi-Fi controller:**Here, two ESP-32 Wi-Fi controllers were employed. One has been employed for one-way interaction from the sensors to a gateway, while the other enables two-way interaction between the gateway and the actuator node.
c. **Gateway:**Here, a Raspberry Pi 3B+ single-chip processor is employed as a gateway, as well as it employs the logic that has been built to regulate the lights duration based on the data obtained from actuator and sensor nodes.
d. **Actuator:** It is a representation of the drive circuit switches as well as traffic lights.
e. **Display:** The gateway's Node-Red application displays and stores the real-time traffic data.

VII. CASE STUDY AND EVALUATIONS

Testing and assessments were done in more than five Indian cities, and the following two situations are representative.

A. Mumbai traffic signal control

Mumbai serves as a good example of a growing metropolis in India. The economic growth of this city has significantly outpaced that of its neighbouring cities during the past ten years, and at the same time, owning a car has increased quickly and there has occasionally been significant traffic congestion. The initial one of the city's features is that it has a lot of older urban districts, and it is challenging to alter the current patterns of land utilization and transportation. Numerous different vehicle types, uneven road gradients, unequal round-trip traffic patterns, a great level of connection between junctions, and a complicated road network are other features. These have been all clearly distinct from those seen in developed cities. As a result, it is hard to efficiently optimise urban traffic by using the typical traffic methods that other cities have employed. It has emerged as critical to create a particular and efficient urban traffic signal controlling system that is tailored to the features of urban area traffic in India, particularly to the

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motor vehicles and road network features in medium- and small-sized cities, since this has been an issue that affects India's developing cities.

The majority of Mumbai's roadways are relatively narrow, the land development intensity is high, and the amount of land used for road building is low. As a result, the old city suffers from severe traffic jams. The majority of the west urban zone is still under development, and the majority of the six- or eight-lane, two-way, roads were built with good quality materials. Except for the area near the municipal administration, the road network has a low population density. The new urban region now has favourable road traffic conditions and a modest saturation level since its population size as well as land usage intensity have been less than those of the olden urban area. Following the completion of the RTN's creation, this study also built Mumbai's ATN, which has a scaled-down artificial populace of 954,000. After PTN was put into place, the system's effectiveness was assessed by looking at information on traffic flow.The outcome showed that there has been little variation among the two weeks' traffic flows and that they are fairly similar. One metric employed to assess the impact of Mumbai-PTN seems to be queue length.

B. Bengaluru Traffic control and management

The PTN has been created and utilized to address issues in transportation operations and regulation, like operation objectives that have become too complicated, experiments that can't be conducted due to time, financial, or legal restrictions, and so forth. The PTN has been an engaging procedure and evolution among the ATN and the RTN. By linking the RTN and ATN-Bengaluru, computational experimentation may be performed on the ATN, making it considerably simpler to execute optimization as well as assessment. The hardware-in-the-loop technique and common external interfaces have been provided by the ATN-Bengaluru, allowing for interconnections between real equipment and artificial software elements. The following computational experimentation was conducted:

- Fixing the peak evening and morning hours while assessing the impact of changing working hours.
- Setting the parking lot's availability and position, assessing the parking demand while holding significant events in a particular area.
- Setting the participants and time, estimating the amount of traffic to expect when conducting huge events, and distributing the police officers as efficiently as possible.
- Setting the traffic accident's impact range and position, evaluating how it affects traffic.
- Setting the bus escape route and studying the evacuation procedure.
- Setting precise traffic control tactics, like restricting vehicles on certain days or making a route one way, and assessing the effects they have on traffic.
- Setting bus priorities, evaluating the capability of the public transportation system, and assessing how it affects social transportation.
- Anticipating the effects of bad precipitation on traffic and modelling traffic conditions.
- Simulating various traffic signal layouts at certain locations and assessing the impact of those plans.
- Enhancing and assessing additional traffic control methods.

The connections between the RTN and the ATN have been used in computational research. The following three aspects at least distinguish computational experimentation from those other optimization techniques based on conventional traffic modelling or mathematical models, which can be thought of as a greater level of modelling software.

1. While computational experimentation have been focused on exploring deep insights into the processes of transportation, like the formation and evolution procedure of traffic overcrowding, simulation software focuses on creating traffic phenomena.
2. The goal of simulation software has been to create the present traffic situation, but the goal of computational experimentation was to create the situation that hasn't happened yet but could in the later.
3. While the approaches in computational experimentation have been more active and attempt to direct the traffic flow, the approaches in modelling software were most often passive and attempt to respond to the traffic flow.

The outcome suggested that real-time traffic data is now more accurate. The cornerstone for creating management plans and offering services to travellers is traffic data. And over 90% of the world, real-time data about traffic has been distributed accurately. In addition to the state of traffic jams, PTN-Bengaluru provides information on point-to-point travel times, traffic regulations, traffic maintenance, traffic accidents, etc. This information has been more complete and useful than that provided by other systems.

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VIII. CONCLUSION

Researchers are now working in the realm of the cyber-physical social network, where IoT has made it simple to acquire sensing, interaction, and regulation in both the real world and digital ones. PTN have been constructed in three stages using IoT. ATN were first configured to represent and characterise the RTN. Secondly, computational experimentations are planned and carried out to assess control strategies. The final step is the collaborative parallel mode execution of the real and artificial networks. As is typical in transportation modelling, research intend to direct the real network to achieve the ideal state in the simulated networks during parallel execution rather than directing the virtual networks to approach the state of the real network.Additionally, an IoT-based effective traffic control system depending on traffic level is created. The Node-Red software has been used for the real-time creation of the IoT in regards of unidirectional interaction between gateway and sensor node and bidirectional interaction between actuator nodes and gateway.Descriptive statistics, predictive statistics, and prescriptive statistics seem to be the other three PTN operations. PTN seems to have a bright future in creating smart cities in addition to assisting in the improvement of transportation networks. Since PTN construction remains in its early stages, future research will concentrate on things like horizontal optimization relying on computational experimentation, parallel learning methods based on real-world data and simulated data, and other things.Additionally, in the future, AI can be integrated into the network to create a reliable traffic management system.

REFERENCES

[1] I. Lana, J. Del Ser, M. Velez, and E. I. Vlahogianni, "Road traffic forecasting: Recent advances and new challenges," *IEEE Intell. Transp. Syst. Mag.*, vol. 10, no. 2, pp. 93–109, 2018, doi: 10.1109/MITS.2018.2806634.

[2] M. F. Mohamed Firdhous, B. H. Sudantha, and N. A. Hussien, "A framework for IoT-enabled environment aware traffic management," *Int. J. Electr. Comput. Eng. IJECE*, vol. 11, no. 1, p. 518, Feb. 2021, doi: 10.11591/ijece.v11i1.pp518-527.

[3] J. Yang, J. Zhang, and H. Wang, "Urban Traffic Control in Software Defined Internet of Things via a Multi-Agent Deep Reinforcement Learning Approach," *IEEE Trans. Intell. Transp. Syst.*, vol. 22, no. 6, pp. 3742–3754, Jun. 2021, doi: 10.1109/TITS.2020.3023788.

[4] M. Rath, "Smart traffic management system for traffic control using automated mechanical and electronic devices," in *IOP Conference Series: Materials Science and Engineering*, 2018, vol. 377, no. 1, p. 012201. doi: 10.1088/1757-899X/377/1/012201.

[5] D. Nallaperuma *et al.*, "Online incremental machine learning platform for big data-driven smart traffic management," *IEEE Trans. Intell. Transp. Syst.*, vol. 20, no. 12, pp. 4679–4690, 2019, doi: 10.1109/TITS.2019.2924883.

[6] J. L. Lobo, J. Del Ser, M. N. Bilbao, C. Perfecto, and S. Salcedo-Sanz, "DRED: An evolutionary diversity generation method for concept drift adaptation in online learning environments," *Appl. Soft Comput.*, vol. 68, pp. 693–709, 2018, doi: 10.1016/j.asoc.2017.10.004.

[7] X. Wang *et al.*, "A city-wide real-time traffic management system: Enabling crowdsensing in social Internet of vehicles," *IEEE Commun. Mag.*, vol. 56, no. 9, pp. 19–25, 2018, doi: 10.1109/MCOM.2018.1701065.

[8] S. Bansal and A. Gupta, "IoT-Enabled Intelligent Traffic Management System," in *IoT Based Smart Applications*, Springer, 2023, pp. 89–111.

[9] D. Goel, S. Chaudhury, and H. Ghosh, "An IoT approach for context-aware smart traffic management using ontology," in *Proceedings of the International Conference on Web Intelligence*, 2017, pp. 42–49.

[10] S. M. F. Malik, M. Nafis, and M. Khan, "IoT enabled traffic control model using Raspberry PI," *Int. J. Adv. Res. Comput. Sci.*, vol. 9, no. 3, pp. 157–160, 2018, doi: 10.26483/ijarcs.v9i3.597.

[11] X. Li, P. Ye, J. Jin, F. Zhu, and F.-Y. Wang, "Data augmented deep behavioral cloning for urban traffic control operations under a parallel learning framework," *IEEE Trans. Intell. Transp. Syst.*, vol. 23, no. 6, pp. 5128–5137, 2021, doi: 10.1109/TITS.2020.3048151.

[12] F. Zhu, Y. Lv, Y. Chen, X. Wang, G. Xiong, and F.-Y. Wang, "Parallel Transportation Systems: Toward IoT-Enabled Smart Urban Traffic Control and Management," *IEEE Trans. Intell. Transp. Syst.*, vol. 21, no. 10, pp. 4063–4071, Oct. 2020, doi: 10.1109/TITS.2019.2934991.

[13] A. Kumar, K. Rajalakshmi, S. Jain, A. Nayyar, and M. Abouhawwash, "A novel heuristic simulation-optimization method for critical infrastructure in smart transportation systems," *Int. J. Commun. Syst.*, vol. 33, no. 11, p. e4397, 2020, doi: 10.1002/dac.4397.

[14] U. K. Lilhore *et al.*, "Design and Implementation of an ML and IoT Based Adaptive Traffic-Management System for Smart Cities," *Sensors*, vol. 22, no. 8, p. 2908, 2022, doi: 10.3390/s22082908.

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[15] M. Abdollahi and Z. Boujarnezhad, “Intelligent Transportation System based on the Whale Algorithm in Internet of Things,” *J. Electr. Comput. Eng. Innov. JECEI*, vol. 10, no. 2, pp. 351–362, Feb. 2022, doi: 10.22061/jecei.2022.8184.494.

[16] S. Chavhan, D. Gupta, B. N. Chandana, A. Khanna, and J. J. Rodrigues, “IoT-based context-aware intelligent public transport system in a metropolitan area,” *IEEE Internet Things J.*, vol. 7, no. 7, pp. 6023–6034, 2019, doi: 10.1109/JIOT.2019.2955102.

[17] M. Abbasi, M. Rafiee, M. R. Khosravi, A. Jolfaei, V. G. Menon, and J. M. Koushyar, “An efficient parallel genetic algorithm solution for vehicle routing problem in cloud implementation of the intelligent transportation systems,” *J. Cloud Comput.*, vol. 9, no. 1, pp. 1–14, 2020, doi: 10.1186/s13677-020-0157-4.

[18] Z. Diao *et al.*, “A hybrid model for short-term traffic volume prediction in massive transportation systems,” *IEEE Trans. Intell. Transp. Syst.*, vol. 20, no. 3, pp. 935–946, 2018, doi: 10.1109/TITS.2018.2841800.

[19] J. L. Zambrano-Martinez *et al.*, “A centralized route-management solution for autonomous vehicles in urban areas,” *Electronics*, vol. 8, no. 7, p. 722, 2019, doi: 10.3390/electronics8070722.

[20] F.-Y. Wang, “The Emergence of Intelligent Enterprises: From CPS to CPSS,” *IEEE Intell. Syst.*, vol. 25, no. 4, pp. 85–88, Jul. 2010, doi: 10.1109/MIS.2010.104.

[21] X. Zheng *et al.*, “Big Data for Social Transportation,” *IEEE Trans. Intell. Transp. Syst.*, vol. 17, no. 3, pp. 620–630, Mar. 2016, doi: 10.1109/TITS.2015.2480157.

[22] F.-Y. Wang, “Parallel Control and Management for Intelligent Transportation Systems: Concepts, Architectures, and Applications,” *IEEE Trans. Intell. Transp. Syst.*, vol. 11, no. 3, pp. 630–638, Sep. 2010, doi: 10.1109/TITS.2010.2060218.

[23] M. F. M. Firdhous, B. Sudantha, and N. A. Hussien, “A framework for IoT-enabled environment aware traffic management,” *Int. J. Electr. Comput. Eng.*, vol. 11, no. 1, p. 518, 2021.

[24] A. Das, P. Dash, and B. K. Mishra, “An innovation model for smart traffic management system using internet of things (IoT),” in *Cognitive Computing for Big Data Systems Over IoT*, Springer, 2018, pp. 355–370.

[25] H. Chen, S. Hu, R. Hua, and X. Zhao, “Improved naive Bayes classification algorithm for traffic risk management,” *EURASIP J. Adv. Signal Process.*, vol. 2021, no. 1, p. 30, Dec. 2021, doi: 10.1186/s13634-021-00742-6.

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