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Intelligent Urban Cities: Optimal Path Selection Based on Ad Hoc Network

MUHAMMAD USMAN GHANI KHAN[1], MOURAD ELHADEF[2], (Member, IEEE), AND ABID MEHMOOD[3], (Member, IEEE)

[1]Department of Computer Science, University of Engineering and Technology, Lahore, Punjab 54890, Pakistan
[2]College of Engineering, Abu Dhabi University, Abu Dhabi, United Arab Emirates
[3]Department of Computer Science and Information Technology, College of Engineering, Abu Dhabi University, Abu Dhabi, United Arab Emirates

Corresponding author: Muhammad Usman Ghani Khan (usman.ghani@uet.edu.pk)

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ABSTRACT Fusion of internet of things (IoT) and artificial intelligence for smart cities has allowed structured policy making.In particular, traffic jam is one of the serious concern in metropolitan cities. In advanced countries, specific devices are installed to assemble flow of traffic. The state of traffic is streamed to commuters through network. This dependency on internet connection results in inappropriate solution in absence of stable physical infrastructure. The developing countries lack availability of internet on roadway and urban zones face even worst condition. This study proposes a smart framework to enable optimal path selection by communicating with neighbouring devices. The android smart phones serve the purpose of embedded sensors. A temporary network is created for smart transportation system. Data processing and cleaning were conducted on different routes of two urban cities. The proposed system is evaluated on conventional and proposed optimal path selection techniques. Computed results depict that travel times have been decreased to around 23.3% in comparison to conventional methods using MDSP algorithm.

INDEX TERMS Optimal path, ad hoc network, embedded sensors, IoT.

I. INTRODUCTION

More than thousands persons die regularly on the roads due to accidents daily in most of the countries. Illiteracy, bad governance, insufficient use of technologies, a lack of resources, racing on the domestic roads, intoxication, attention, and other factors have all contributed to these fatalities. Passengers, bicyclists, and motorbikes account for the most of the road casualties, as per the World Health Organization (WHO) [1]. Furthermore, vehicle traffic accidents are the primary cause of death for the people travelling on the roads everyday. The majority of road accidents based fatalities happens in underdeveloped and advanced countries.

Road traffic jams can be attributed to three main causes, published by the US Ministry of Motor vehicles [2]. The first one is linked to traffic-altering occurrences such as accidents, construction areas, and inclement climate. The next is transportation needs, which include routine road traffic changes as well as exceptional occasions. Road accidents, such as transport clashes and then crashes (25 percent), unfavourable climate Patterns (15 percent), geometric design (10 percent),remove and improper traffic control lights and timing and big occasions, account for the remaining 40% of overall road congestion and traffic jams. There isn't a single Metropolitan cities with a huge population that has not been affected by traffic jams. Overcrowding is very common during rush timings or due to sporadic road occasions such as weddings, public gatherings, gatherings, marches, and athletic, and cultural occasions. Traffic jams are caused by an increment in the number of vehicles combined with insufficient facilities. Disruptions caused by traffic often lead to recklessness. Exceeding the speed limit can be caused by a variety of factors, including practice, a sluggish beginning, both intentionally and unintentionally, competitiveness, road anger, and psychological concerns [3]. It is a well known fact that driving is a leading cause of youth-related traffic accidents, which results in several fatalities each day. In several nations, pace and stop sign sensors are now in use, with heavy fines for infractions. In reality, there are software apps, such as Google Earth, that can identify movements and fixed sensors for images and alert drivers ahead of time, allowing them to avoid traffic tickets, violations, and other consequences, even for replacing more severe offences such as crossing red lights. Figure1 depicts a typical road traffic

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FIGURE 1. **Huge traffic jam scene in Delhi, India** [2].

jam in Delhi, India. Congestion of this nature can also be found in several other places out of India.

Traffic jams result in lost time and excruciating waits. Several governments have experimented with various strategies, procedures, and approaches to deals with the issue of traffic overcrowding. Many of these approaches are technological in nature, while others are concerned with improving traffic and road infrastructures. The specific methods of traffic management are discussed that are used in various regions of the world to maintain roads and alleviate road traffic jams [4].

There are two types of traffic route guiding systems: a) fixed management systems and b) adaptive management systems. The data about congestion is gathered constantly over a set length of time in a stationary path guiding method [4]–[6]. When faced with actual traffic data, this method presents a dilemma. A more reliable alternative is a variable management network [7], which collects factual data from automobiles and IoT devices and their points along the route to identify road traffic jams. The variable management systems can be categorized as such: a) Scattered b) Semi-Scattered c) Central d) Shared and e) Semi-shared. The primary database server system in a centralised network is in charge of collecting data and information about the road and vehicle situation regarding the congestion [8]. The fundamental issue with the centralised network is that when the amount of traffic information grows, the system's efficiency suffers as a result of the high computing energy requirements and large computing load exchanges. Furthermore, there is a latency in data exchange in between both the automobiles and the computer, making this method inefficient to use on big highway system. On the other hand, In a shared database there is no static infrastructure, but every automobile works as a point, collecting and passing messages to many other points at the same time (for example, automobile to vehicular communications in the VANET) [9], [10]. This method incurs less computing power because the computational complexity of information processing is distributed between nearby vehicles points. Although shared systems have lower latency when exchanging data between them, they have little understanding of the general congestion circumstances. As a result, in times of commuter traffic, it may supply the same traffic path to multiple cars arriving from different directions. This may produce the traffic jam on the another path as well. The partly cloud infrastructure combines the capabilities of both centralised and shared systems, resolving the centralised system's latency riddle and the scattered platform's global view dilemma [11]. Following the detection of traffic jams, the next step is to determine the best path for automobiles in order to properly control transportation. In order to compute the best path for the automobiles, the path guiding systems have been categorized based on number of measurement factors. In order to calculate the best route, the single cost measure considers only one measurement: the driver's travel duration. However, in a road traffic jam situation, other measurement elements such as trip duration, automobile dimensions, roadway capacity, and distance of journey are collectively required to be considered to obtain a more accurate representation of road traffic congestion. With the advancement of legitimate data collecting, high computing resources, and multi measure path guiding systems, best solutions for road traffic control under various situation have emerged. Advances in technology such as cloud services, cloud technology, database management and video surveillance are helping to manage traffic and control traffic jams scenario in a better way [12].

The majority of path management network research has concentrated on identifying traffic jam and determining the best path for automobiles, which extends to certain other congested situations on the roads environment.

Road traffic overcrowding is a major worldwide issue since it renders life difficult for those who live and work in metropolitan areas, as well as travelers from industrialized, emerging, and under developing countries. As previously stated, traffic overcrowding arises when facilities cannot satisfy the demands of rising traffic. The stream of transportation flow is distributed decreases as the number of cars on the route increases, eventually leading to uncontrollable road overcrowding. The increasing number of cars on the road hinders traffic flow, resulting in unsustainable traffic congestion.

Real time road traffic monitoring is an integral aspect of smart transportation networks in smart grids. The GPS sensors and cameras are used to gather actual location and information about automobiles. The cars are positioned in groups, and the car closest to the group's centre is known as the group head, and it is incharge of gathering information for group and transfer the information to the adjacent groups. The information is then disseminated through out the vehicle monitoring system in this manner. When an automobile gets traffic data, a confident system kicks in, predicting the current guiding path's road traffic density depending on a threshold value. If the current path's estimated road congestion exceeds the threshold number, the application will show the alternative path [13]. The majority of path management network research has concentrated on identifying traffic and

[2]https://www.hindustantimes.com/delhi/odd-even-repairs-breakdowns-chaos-jams-ruled-delhi-roads-on-monday/story-e7pemlXHQ4KN2xadjBiJdL.html

determining the best route for automobiles, which extends to many other overcrowding situations. Consider, for instance, a situation in which numerous routes are blocked owing to overcrowding; the re-forwarding system will direct the automobiles to a nearby road.However, reducing traffic on the alternative road would increase the traffic congestion because all the automobile would divert this way hence it will create another problem.

To tackle these challenges, The proposed system is based on routing algorithm that will produce efficient road traffic control situation. To begin with, multi measure factors are used to identify traffic jams. These factors will be evaluated in order to detect overcrowding situation, such as the size of the road, the dimension of an automobile, and the driver's journey duration. The road traffic jam is classified into three categories to assess the severity of situation: a) severe overcrowding b) medium traffic jams c) light Overcrowding. Alternative path will be suggested depending on the kind of obstruction. This proposed technique guarantees that, in the event of traffic jams, all automobiles are not diverted to other route.

The define capacity management system ensures that automobiles choose the most efficient path possible while also remove complete overcrowding throughout the whole transportation network in a given geographic region. This paper proposes the Automobile Constraint Distribution function, which will characterize overcrowding based on traffic situations and then recommend correct methods to prevent overcrowding. This work offers following contributions:

- System that suggests the shortest path between source and destination point in real-time.
- Offline system that builds the local network in the absence of internet connection.

Moreover, section II examines the related proposed work; section III explains the proposed methodology and describes the modules involved in depth. Section IV, shows the experimental environment and the comparative study among used algorithms. Finally, section V, summarize the proposed work.

II. RELATED WORKS

To gain additional understanding in related research areas linked to this topic, a thorough theoretical survey is conducted. A detailed literature review of the fundamentals of vehicular networks is conducted, accompanied by an examination of similar research on the deployment of Tabu search and Artificial neural networks to address transportation difficulties. The pros and cons of the existing work are analyzed which lead to the conclusion to merge the two clustering algorithms in different ways than the existing related work.

Kelarestaghi KB *et al.* [15] conducted a thorough review of the studies on Connecting and Automatic Vehicles (CAV) safety, taking into account the safety flaws and remedies of sensor communications and communication technologies. In a straightforward way, the authors have discussed the fundamental and technical aspects of sensor communications and their operational method. M. Silva *et al.* [16] gave a comprehensive review of further than one decade of studies on foundations, remote access methods and strategies, and implementation that enable vehicle connection. They also suggested a number of potential traffic network options.

The studies under review provided the authors with a complete understanding of the network architecture, and devices utilised to construct routing algorithm. The researchers' concepts provided essential concepts for applying the change routing algorithms and evaluating their effectiveness.

Hongmei Jia *et al.* [17] developed and executed a new Search for addressing the shortcomings of existing transportation systems difficulties by incorporating mutagens and hybrid regional seeking strategies. The researchers evaluated how computational techniques, as well as their characteristics, influence the effectiveness of the proposed Tabu Search algorithm. Researchers evaluated their learning methodology to different routing methods and discovered that their new technique outperformed the others.

For outsourced logistic operations, Yunyun Niu *et al.* [18] suggested a public green vehicles route problem (GOVRP) paradigm with petrol or energy usage limitations. The authors also proposed a hybrid Tabu search method to handle cargo logistics concerns with figuring out the optimal ways to get to a location in a certain amount of time. Their techniques added a new perspective application of Tabu search to traffic path related routing issues.

Ari Pranata Purba *et al.* [19] devised and developed a path finding algorithm that is utilised by a corporation to offer transit for workers to pick them up and drop off at numerous places. Their method was superior to the company's current approach, capable of minimizing fuel or gas. It reduced expenditures by 8% for fuel and 7% for gas, divided by the average distance travelled by smaller vehicles. The writer's thoughts inspired and encouraged us to continue working on this project.

Gurpreet Singh *et al.* [20] developed a smart cars mobility monitoring system based on smart data transmission, car collision avoidance, and transport congestion avoidance. The researchers' goal was to create a new hurdle to find path mechanism for smart vehicle networks that uses Neural Networks principles to promote better experience in a range of ways. Their discoveries reduce total communication delays and the probability of accidents in the smart vehicle network device connected.

New Adjustable Route and Switch Strategy (NARSS), developed by Liang Zhao *et al.* [21], is an embedded system that implements path routing mechanism in the micro controller. For a certain traffic congestion scenarios, this adaptable technique can actively choose path algorithms. The author work provided thorough information about how to properly employ an ANN approach to address traffic path routing problems. Yosuf Sayeed *et al.* [22] suggested a structured methodology for cars to make independent decisions that uses analytic memory to store navigation encounters in related experiments. In order to build their conceptual

TABLE 1. This below table presents the research papers related to our work with respect to years of publication, methodologies they have adopted, datasets they have used to complete the task, motivation, and limitations in their work. We have chosen the papers from 2017 to 2021 and describe their methodology briefly.

No.	Paper Title	Methodology	Dataset	Motivation / Purpose	Limitation
1	Autonomous vehicles: challenges, opportunities, and future implications for transportation policies, [14] 2016	Conceptual navigation model based on a fleet of AVs that are centrally dispatched over a network seeking system optimization	Not specified, Self-collected	Communication over cars and infrastructure (connected vehicles)	Software challenges such as system security and integrity have also emerged as serious issues to be addressed
2	Survey on Vehicular Ad Hoc Networks and Its Access Technologies Security Vulnerabilities and Countermeasures, [15] 2020	Improvements in Vehicular Ad hoc Networks (VANETs)	Not mentioned	Connected and Automated Vehicle security	Impact of known/unknown cyberattacks on transportation
3	An Improved Tabu Search Approach to Vehicle Routing Problem, [16] 2013	New Tabu Search by introducing mutation and mixed local searching tactics	Not mentioned	Vehicle Routing Problems in theoretical and practical interest, (due to its real-world applications)	Its performance is good for the small size of problems in the real world.
4	A Hybrid Tabu Search Algorithm for a Real-World Open Vehicle Routing Problem Involving Fuel Consumption Constraints, [17] 2018	A green open vehicle routing model with fuel consumption constraints for outsourcing logistics operations.	Realistic road data of Beijing, China	Fuel consumption model in the context of outsourcing logistics	There are no heterogeneous fleet of vehicles that can be used to minimize the total cost
5	Routing and Scheduling Employee Transportation using Tabu Search, [19] 2020	Development of Vehicle Routing Problem Split Delivery with Time Windows	Travel time data	Determining employee bus pick-up vehicle routes for the company workers	This is a static system with 7 pickup points and 5 mins wait time for each worker
6	Congestion Control by Dynamic Sharing of Bandwidth among Vehicles in VANET, [20] 2017	A congestion control mechanism in vehicular ad-hoc network	Not mentioned	Communication of safe and unsafe messages among vehicles and infrastructure	Evaluating the dynamic priority of a message as a function of network condition in terms of vehicle density, congestion level of the network
7	A Novel Adaptive Routing and Switching Scheme for Software Defined Vehicular Networks [21], 2019	Software-defined routing method, namely, Novel Adaptive Routing and Switching Scheme	Feature Data	Existing routing protocols lack flexibility and adaptive approaches to deal with changing and dynamic traffic conditions	Multi-agent reinforce learning framework to collaborate more agents
8	Unmanned Aerial Vehicles as Store-Carry-Forward Nodes for Vehicular Networks, [22] 2019	Flip and Rotation and considers All Phase configurations	Private real-world datasets	Existing RL methods typically take a long time to converge and the learned models may fail to adapt to new scenarios	The policy of reversible lane Dynamic vehicle routing
9	Diagnosing Reinforcement Learning for Traffic Signal Control, [13] 2017	Minimize the path availability's dependence on vehicular density and cooperation, by utilizing unmanned aerial vehicles	Datasets Packets	Enhance the availability of a connectivity path as well as reduce the end-to-end packet delivery delay	Development of fully interconnected Internet of Things (IoT) architectures
10	Intelligent Vehicle Counting and Classification Sensor for Real-Time Traffic Surveillance [23], 2018	Implementation of a novel smart wireless sensor for traffic monitoring	Self generated dataset	Real-time traffic surveillance	It can be used for short-term installment (e.g., work zone safety, traffic flow studies, roadways, and bridges design, traffic management in atypical situations)
11	Routing of Two Unmanned Aerial Vehicles with Communication Constraints, [24] 2020	Approximation algorithm, Traveling Salesman Problem	GPS data	Routing two UAVs with communication constraints in a GPS denied environment	The transformation method was relatively time consuming
12	Opportunistic fleets for road event detection in vehicular sensor networks, [25] 2019	Behavior-aware fleet construction schemes to form and maintain the opportunistic fleet topology	sensing data	High mobility and variable road surface condition	The prediction part of the DQN algorithm is producing a delay
13	Direction based Hazard Routing Protocol (DHRP)for disseminating road hazard information using roadside infrastructures in VANETs, [26] 2017	Dissemination ofhazard messages on highways with sparse traffic	Not mentioned	Direction based Hazard Routing Protocol	RSU de-ployment with large inter-spacing and also to highwayswith varied traffic
14	Integration of congestion and awareness control in vehicular networks, [27] 2016	The control protocol that integrates two congestion and awareness control processes.	dataset not mentioned	The exchange of positioning of Cooperative vehicular networks and basic status information between neighboring nodes	Efficiently and reliably support the communication requirements of future vehicular applications
15	An Adaptive and VANETs-based Next Road Re-routing System for Unexpected Urban Traffic Congestion Avoidance, [28] 2019	Novel vehicle rerouting strategy that can adapt itself to the sudden change of urban road traffic conditions	floating car data	Unexpected road traffic congestion	Effectiveness of a NRR using more scenarios if more datasets become available in SUMO community

approach, the researchers have only relied on ANN model. The author insights provided a solid foundation for understanding how to use ANN to tackle transportation problems.

Table 1 shows different methods for overcrowding identification and prevention have been studied in the past. The method allows for cars numbering and classification in a certain route, that can readily lay the groundwork for more intelligent transport control throughout cities / regions to ease congestion on their routes [13]. To prevent traffic jams in metropolitan areas, S. Wang *et al.* [23] developed a distributing and completely automated self-deciding vehicle system. The suggested algorithm is called "DIVERT," and it is able to recognizing and localizing locations of big vehicles. It disrupt road traffic, as well as computing a de-congestion remedy at an early phase to reduce congestion in the roadway regions.

Y. Zeng *et al.* [24] investigated the administration of automobile fleets, which included the monitoring of road events. This concept is based on data gathered by vehicle detectors, which are also utilised to create an impulsive workforce, that is a localised automotive grid (or partial mesh). Pause, resume, and other occurrences are included in the image captioning to control the transportation of the cars and assist them in making the quickest response possible to prevent vehicular dangers M. Berlin *et al.* [25] have focused on the construction of adaptive forwarding in order to prevent numerous risks and roadblocks. The path dependant hazard routing set of rules and regulations model is created using a dispersed digital platform among some of the cars travelling. The number of obstacles and risks are recognized as occurrences, such as severe flooding, shrub toppling, ground slides, collisions, and so on, and correct measures are performed for the cars such as, redirecting the cars to escape from the current scenario. The combination of traffic and alternative management in vehicular network has been the subject of research work done by M. Sepulcre *et al.* in [26]. The researcher merged the capacity of consciousness management approach for traffic jam control. This study focuses on the stream busy rate (SBR). Each car's transportation characteristics are tuned in such a manner that the stress can be maintained underneath the CBR limit. It calculates the minimal power necessary for transport network transfer by gadget is device or sensor in vehicle. The researchers have included the conceptual model in order to gain flexibly vehicle configuration at each and every minute, stream Loaded Consciousness, and the ability to build stable levels of channels loading, all of which improve system throughput. The define INTERN concept hasn't been proved in severely congested areas, and it doesn't use a burden sharing strategy to reduce vehicles strain on a one way road. Moreover, the proposed method does not include message reduction technique to give improvement. Manyam, S. *et al.* have carried out their research on vehicular Adhoc network(VANET). [27]. A novel cloud services architecture dubbed VANET-Cloud for vehicle d-hoc networks is suggested to reduce distractions during driving by aiding in cognitive abilities of driver. VANET- Cloud services for automobile are examined, and several recommendations for advance research, particularly privacy are emphasized.

In the presence of refueling stations, Akhtar *et al.* [28] devised a method for routing an automobile. The goal of this article is to identify a path for the automobile that meets each destination at least one time, work was to rarely exceeds the energy limit throughout the travel. It presents strategies for speedy building and refinement of model to address the issues and provides an estimation method for it. S. Bitam *et al.* [29] suggested an automobile fueling restriction method. This study focused on reducing the amount of fuel used in transmission and other management system settings. This is accomplished by sending a continuous stream of information from detectors to the goal. In wireless-networks, the same information is conveyed with fewer nodes and longer packets to limit the likelihood of a clash. Video codecs methods can be used to gain additional advantages.R. S. Batth *et al.* [32] addressed the current topologies in Time Division Multiple Access TDMA-based VANETs that are accountable for maintaining secure transmission of broadcast of safety messages between automobiles in ad hoc vehicle network.

O. Senouci, Z *et al.* [14] conducted a unique study on several internet of vehicle (IoV) traffic forwarding technique. Their research provided a broad understanding of the core features of several path forwarding rules and regulations, motivating them to continue their research.

The majority of related research work employ non interrogative graph based techniques, which become ineffective as the transportation issues on roads become more complicated. Furthermore, most current scheduling algorithms aren't sturdy enough even to tackle dynamic situations, therefore techniques that find precise answers can't be employed to solve them. To overcome these concerns, the researchers have employed intuitive strategies to solve dynamic situations, which give approximation rather than exact answers. In this research, the principles of two analytical based methods, Tabu Searching [18] and ANN, are employed to design and develop path routing algorithms.

A flexible star technique for vehicular networks was introduced by Chabini I. *et al.* [33] in 2002. It employs the cost estimating function to determine the path's extent in order to arrive at the best solution. In 2012, M. G. H. Bell *et al.* [34] presented a hyper-star approach for finding a quick and cheap path in congested areas. Again from place of obstruction, it calculates multiple paths. In 2014, P. Khan *et al.* [35] introduced a revised Floyd Warshall method that finds the quickest distance using the directed graph structure. Furthermore, for every travelled route, there is a verification path choice open. S. Hamrioui *et al.* [36] investigated IoT connections for small metropolitan in order to build an intelligent and organized routing mechanism in 2018. The researchers of this study attempt to address contact issues in small metropolitan by examining the efficiency deterioration of IoT systems throughout interactions and proposed a new forwarding technique to improve network Quality of Service parameters(QoS).

III. PROPOSED SYSTEM ARCHITECTURE

Our proposed methodology presents a smart transportation architecture to alleviate traffic congestion control, with an emphasis on advanced nations. The purpose is to help in making in time judgement to choose the best route if their is low internet connectivity. The architecture propagates automobiles information through transport network communication in which every automobile in the network share the data in order to calculate the traffic congestion. We can find the path of a vehicle by using the index for location or direction that is suitable. The proposed model is an information distribution system to help smart automobiles networks of smart cities. The suggested model work if there is no internet facility or alternate communication facility by utilizing improvised connections in order to distribute data. Depending on the data collected from neighbouring vehicle the proposed model calculates an over crowed index. This index is utilized to determine the number of less crowed routes from a central entity and selects the optimal route to the target that is adjusted in time-based on each coming junction. The model was developed for low-power devices and then tested on constrained resources mobile phone sensors based on technology used, communication latency, information loss, and overall travel duration. A modular method is used to create the suggested smart-net model. The proposed system contains a graphical interface, map management, data storage, dissemination module and path selection module. The proposed architecture is composed of five modules:

1) Map management
2) Graphical View Module
3) Data Storage
4) Dissemination Part
5) Path Selection Module

The offline location data is gained through built-in GPS facility, these data statistics are stored on server and then adhoc network is established to share the traffic history to the neighbouring vehicles. The embedded system of the vehicle then choose the path according to that data.

Figure 2 illustrates the architecture level details of the proposed system.

1) **Map Management:** The maps are stored and managed by this module. In order to prepare off-line maps the map manager module needs to acquire previous maps. These maps will be used later to learn about the location and handle the data for communication with the device.
2) **Graphical View Module:** The graphical view element has been introduced to show the current direction of the automobile utilizing the map data without Internet. Graphical view module process location-based query and obtains data from the map management module. The graphical view module demonstrates blockage and jamming on neighboring roads and junctions. Real-time location update from the vehicle is non-trivial for path mapping and selection. For this purpose, every device has been embedded with a built-in GPS facility. Hence based on the present location of a vehicle, the intelligent system will project possible roads to the destination. All paths are composed of numerous road sectors, each of which contains a tag with a blockage index. The blockage index of each region is computed from data obtained by the alternate automobiles in right-times. Consequently, the calculated index is employed for route selection to avoid traffic jam.
3) **Data Storage:** This module uses several data statistics i.e., routes blockage index, and travel history for the final selection of the optimal route. The data stats are stored on a server and retrieved to handle a query for path selection. This is the central module of the proposed system as all of the data is being stored and disseminated from the server for final computation..
4) **Dissemination Part:** This dissemination part establishes an ah hoc connection to the neighboring devices. A dynamic network is established to share traffic information. To establish communication between vehicles, a standard protocol defines a link layer. All connected devices share specific data attributes including identity and link status to validate accessibility. Once a link is maintained, the next process is to create a group. All devices within the group utilize the single link communication protocol.
5) **Path Selection Module:**
One of the most significant modules of the proposed system is path selection. The data populated from other devices is used as an input to advocate the fastest path toward the target point. The path selection is centered on the traffic evidence that has been obtained by the adjoining vehicle associated with the improvised ad hoc network. Then data gathered will be utilized to calculate the blockage index of all road sectors using the current location. The junction with minimal traffic congestion will be selected as the next path. The suggested next path will be calculated using the famous shortest path algorithms like optimal uniform cost search, Dijkstra Shortest Path (DSP) and A* search algorithms.

IV. EXPERIMENTATION

A. IMPLEMENTATION DETAILS

The proposed system has been implemented as a portable module and as in-vehicle equipment (sensor and mobile devices). The technology enables dynamic construction of transport pool to distribute the traffic data from surrounding vehicles in real-time. The least crowded path toward goal points is recommended based on the gathered data. Furthermore, each available equipment saved the current movement logs. The acquired traffic data was used to create a graph that is weighted graph from the start point to the end point. The classic single point least route techniques was used to

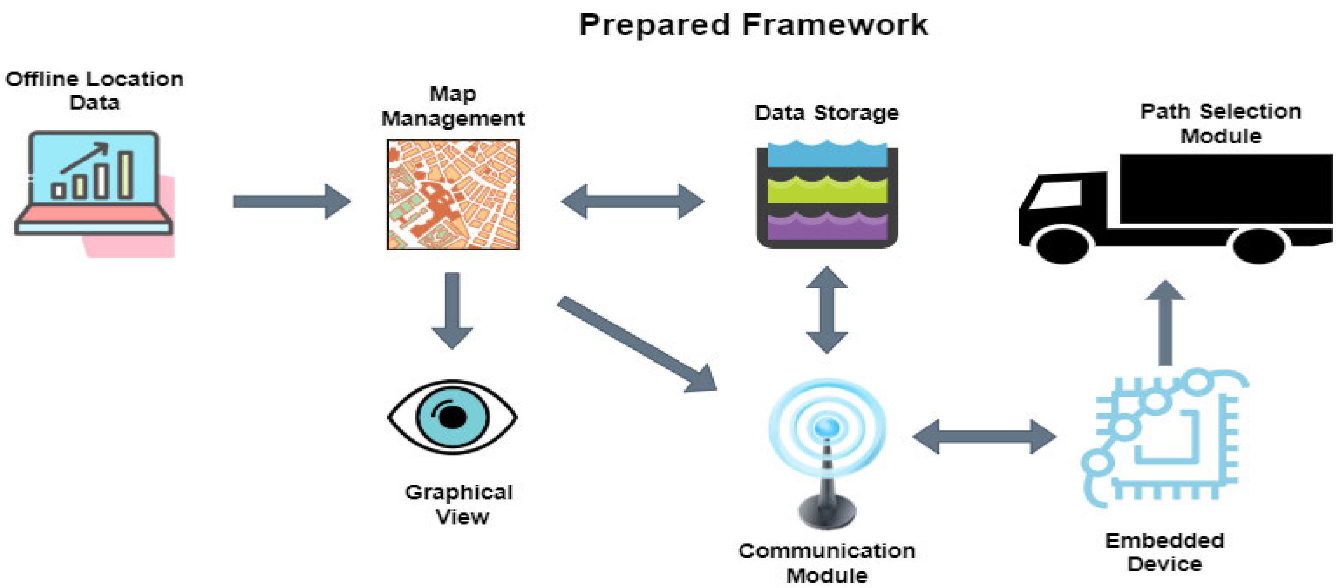

FIGURE 2. The embedded system of the vehicle will select the optimal path using the offline data gained through built-in GPS facility of the neighboring vehicles over an adhoc network.

calculate route costs. Moreover, the weights that are at the edges were set based on section of the road in kilometers(L) and speed ratio (V^{max}). To assign these weights to the road section in graph we have utilize the cost function. Table 4 shows the parameters for simulation.

$$CostFunction = \frac{L}{V^{max}} \tag{1}$$

The DSP technique was used to calculate the shortest path. This computed path served as a baseline against which various route selection algorithms were compared in this study. Even though traffic circumstances are always changing, static weights computed from the outset produce lower outcomes. As a result, we included the expense of altering road segments on continuous distances. The system computes an overcrowded index for each road section based on real time traffic data from nearby vehicle. The speed ratio on a section of the road was calculated by the proportion of automobile normal speeds to the number of vehicle on a road section using a velocity averaging approach. The average speed is computed using equation 2 listed below that is the ratio of the sum of speed of all the vehicles on the road ($\sum_k v$) to the total number of vehicles on the road (K).

$$\bar{v} = \frac{\sum_k v}{K} \tag{2}$$

here K shows the count of all vehicle on a road section. Most recent traffic for the road index's section is calculated by:

$$\circledast = \frac{\bar{v}}{v^{max}} \tag{3}$$

where V^{max} denotes the road segment's top speed,$\bar{v}$ denotes the average speed of all the vehicles on the road and $\circledast$ denotes the least amount of traffic congestion to choose the further road section.

TABLE 2. Devices Characteristics.

Device Model	Operating System version	RAM	Battery
Samsung A21	Andriod 11	4GB	5000mAh
OPPO A12	Andriod 9.0	3GB	42300mAh
RedMi 7	Andriod 9.0	2GB	4000mAh

B. EVALUATION

The proposed system has been developed using the JAVA programming language. This system was built as portable and all testing was done on cellphones. Table 2 shows the gadget's qualities.

We evaluated the resources utilization of the proposed information generation architecture on resource constrained mobile device. The CPU, memory, and network utilization, as well as packet loss and transmission latency, were all measured. Additionally, the route selection algorithms returned travel time.

To analyze the proposed system a road traffic generating scenario is constructed to use traffic data available computation blocks. Therefore, to produce road traffic dynamic, we have obtained transport data for the city of Delhi, India. Although, we generated the dataset linking the two terminals however there is no openly available traffic database for the Delhi city and no RSUs mounted to surveillance and communicate transport data. We have collected the dataset of one point to five different destinations A, B, C, D and E. It should be noted that all the destinations are located in Delhi. However a large number of workers and student come from

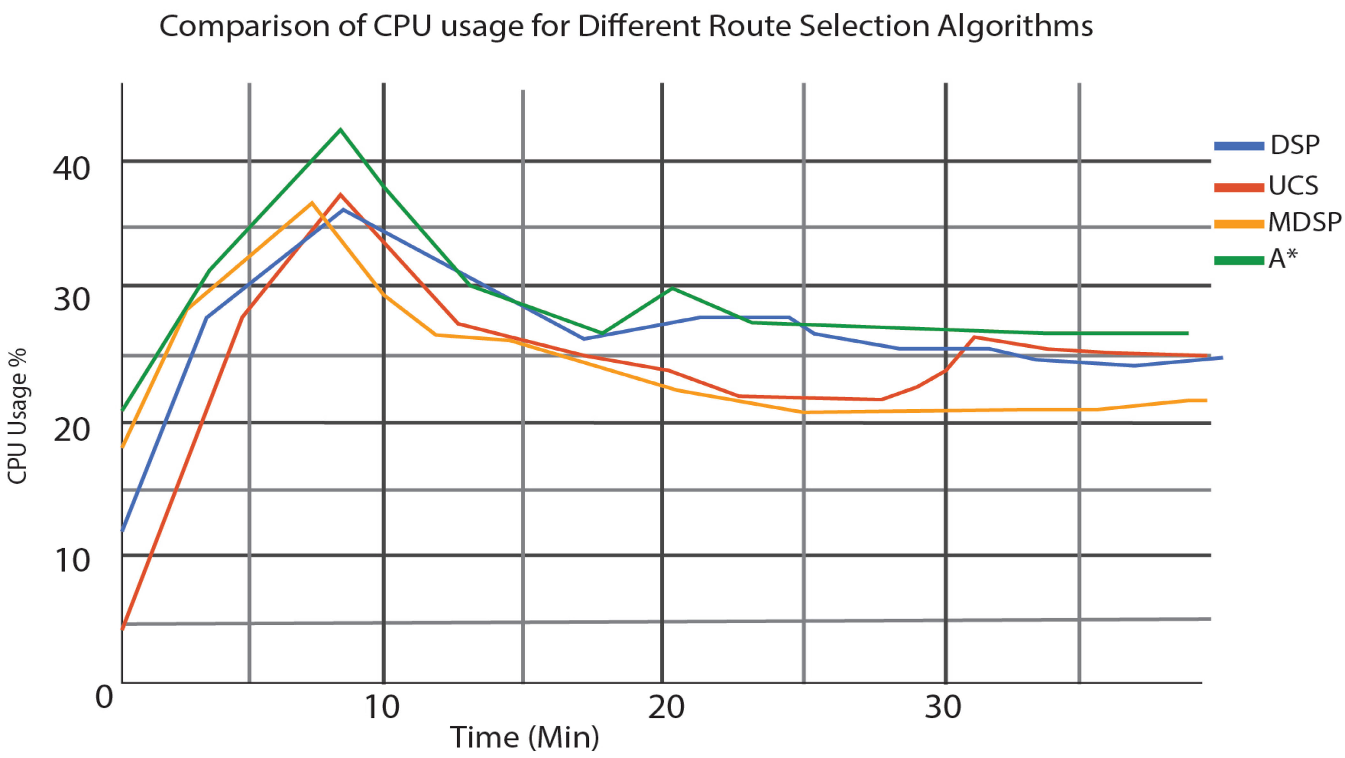

FIGURE 3. CPU usage graph.

surrounding areas. There were many alternative bi-directional paths which start from the starting point to all the destinations but we considered five routes for each scenario. The total data collection included 4018 bi-directional track recordings between starting point and the destinations. The raw data, which included distances, timestamps, and GPS points were translated into tuples including attributes such as time duration, start time, average speed, track length, maximum speed, and source and destination locations. We employed grouping to quantify constant and dynamic information to access quality of the collected data set. track length, Average velocity, time laps, starts points and the end points directions, and maximum speed were all used to measure quality. We have used four algorithms to select the optimal path in each situation. The resulting route for all the algorithms are then compared to worst case scenario. Among the A* Search Algorithm, Uniform-Cost Search (UCS) Algorithm, Multi-Domain Signal Processing (MDSP) Algorithm and Digital Signal Processing Algorithm (DSP), MDSP performed the best with a difference of 23.3 from the worst case i.e A*. It is shown in Table 5. The hyperparameters of the model is shown in the Table 6

The traffic generator module generated traffic based on the previously described self-collected data set. The module, which was running on many devices, used Wi-Fi Direct to inject traffic information into other devices, all of which were functioning as available modules in a vehicle to simulate transport data by nearby automobiles. In addition, mobile device dispatch the received traffic to alternate transport points. In our region, GPS might be used for these updates. Following location update, traffic information was shared by the alternate transport. Moreover, a path is chosen at each intersection based upon selection of single optimal path from several alternative routes. The experimental setup's the used parameters are summarized in Table 3.

TABLE 3. Different routes for each destination.

	Route 1	Route 2	Route 3	Route 4	Route 5
Destination A	37	57	31	47	58
Destination B	29	37	47	34	43
Destination C	58	39	53	41	49
Destination D	67	79	73	83	68
Destination E	89	71	79	83	78

TABLE 4. Parameters for simulation.

Properties	Scores
Range of transmission	90-130M
Network category	Ad hoc
Count of routes for each destination	5

The proposed framework is bench marked against resource utilization parameter which includes network, CPU, and Memory (Mbs), due to limited resources on portable devices. The OPPO A12 was used to model a hand held mobile device, and findings were received after several runs of the proposed framework procedures. The framework was evaluated

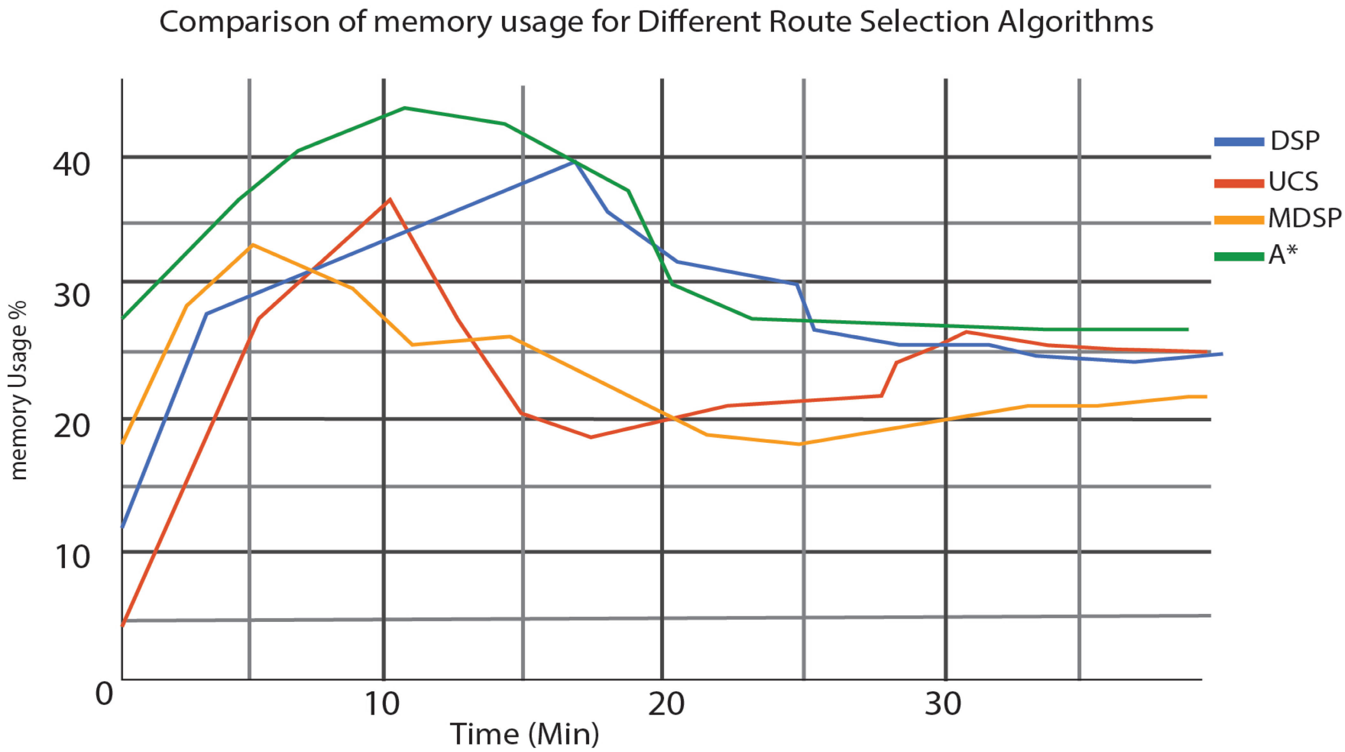

FIGURE 4. Memory usage graph.

TABLE 5. Algorithms comparison for each destination.

	Destination A	Destination B	Destination C	Destination D	Destination E	Difference from worstcase
Worstcase	58	47	58	83	89	
Algorithm UCS	37	29	49	79	89	14.6
Algorithm A*	58	43	41	83	78	9.56
Algorithm MDSP	31	37	39	67	83	23.3
Algorithm DSP	47	37	58	73	79	12.3

in terms of communication latency, travel time, and packet loss.

C. CPU UTILIZATION

As a starting point, the proposed framework uses a DSP-based shortest path method. The other three algorithms used traffic data from nearby automobiles to calculate a congestion index, then a least congested route is chosen. The three algorithms are tested based on number of CPU cycles consumed to calculate the overcrowding index of incoming road segments to choose the shortest path.Consequently, it is concluded that the DSP alogrithm perform better than UCS, A*, and MDSP. Considering the prevalence of battery-operated gadgets, CPU utilization is a significant aspect in establishing an algorithm's viability for such devices.The graph in Figure 3 shows CPU usage over time by different algorithms like DSP, UCS, MDSP and A*. In DSP algorithm, CPU usage increase dramatically at start, but flatten out after a slight drop. There is also a steady rise in CPU usage of UCS and A* algorithms, but the show some fluctuation after dropping until they hit a flat point. While MDSP's CPU usage increase significantly and drop before reaching a plateau.

TABLE 6. Hyperparameters for the network and set values for the experimentation.

Hyperparameter of Network	Value for Experimentation
Epoch	1000
Batch Size	16
Learning Rate	0.0001
Optimizer	Adam
Maximum Support	5
Minimum Support	-5
Alpha	0.1
Beta	0.5

D. MEMORY UTILIZATION

We have found that all algorithms used moderate amounts of memory, averaging around 140 MB, which is far less than many social media applications like Twitter, Facebook. These social application use around 360Mb memory. Moreover, offline maps and tracks storage require 27Mb and 300Kb respectively. Depending on how far back in time the route history is kept, memory utilization may grow. Also, as the number of vehicles increased, the computational intelligence (CI)-based algorithms used more energy to process more data.The graph in Figure 4 shows memory usage over time, by different algorithms like DSP, UCS, MDSP and A*. In DSP, UCS and A* search algorithms the memory usage show steady increase, while in MDSP, it reaches to a plateau after a slight rise.

V. CONCLUSION

This research study proposes an optimal path selection strategy without a physical infrastructure supporting internet connection. This study contributes to path selection techniques for blockage-aware traffic path. A well-organized and comprehensive study with respect to memory and time depicts that proposed technique utilized mi minim memory and lesser bandwidth. Furthermore, results depicts that travel times have been decreased to around 23.3% in comparison to conventional methods using MDSP algorithm.

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