

Retraction

Retracted: A Novel Optimal Robotized Parking System Using Advanced Wireless Sensor Network

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

Copyright © 2023 Journal of Sensors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] H. Manoharan, Y. Teekaraman, R. Kuppusamy, and A. Radhakrishnan, "A Novel Optimal Robotized Parking System Using Advanced Wireless Sensor Network," *Journal of Sensors*, vol. 2021, Article ID 2889504, 10 pages, 2021.

Research Article

A Novel Optimal Robotized Parking System Using Advanced Wireless Sensor Network

**Hariprasath Manoharan,¹ Yuvaraja Teekaraman², Ramya Kuppusamy³,
and Arun Radhakrishnan⁴**

¹Department of Electronics and Communication Engineering, Panimalar Institute of Technology, 600123, Chennai, India

²Mobility, Logistics, and Automotive Technology Research Centre, Vrije Universiteit Brussel, Brussels 1050, Belgium

³Department of Electrical and Electronics Engineering, Sri Sairam College of Engineering, 562, Bangalore City, India

⁴Faculty of Electrical & Computer Engineering, Jimma Institute of Technology, Jimma University, Ethiopia

Correspondence should be addressed to Yuvaraja Teekaraman; yuvarajastr@ieee.org
and Arun Radhakrishnan; arun.radhakrishnan@ju.edu.et

Received 23 September 2021; Revised 26 October 2021; Accepted 7 December 2021; Published 30 December 2021

Academic Editor: Pradeep Kumar Singh

Copyright © 2021 Hariprasath Manoharan et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article addresses the importance of parking system which makes the movement of moving vehicles to be unrestricted thus providing integration between hominid classification and sensing systems. If two distinct systems are combined, then all the vehicles can monitor the parking space, and they can directly move towards the destination end within short span of time. In addition for this type of establishment, rapidity of transportation vehicles is calculated with error minimization technique where all technical hitches will be avoided by sustaining the user constraints. Further, to solve the designed user constraints, a nonlinear optimization which is termed as machine learning algorithm is introduced for avoiding high loss during packet transmission technique, and percentage of efficiency is analyzed using simulated results with network simulator (NS2). Moreover, from simulated results, it is substantiated that the projected method on automatic parking of vehicles provides high efficient operation, and even cost of installation is reduced.

1. Inevitability of Automatic Reservation Arrangement

In current generation, all metropolises have been converted to smart city-based centers by establishing a central control system, thereby providing an easy way to install automated system. But on the other hand, all the municipality areas are also facing the same traffic condition due to the amount of population in the country. In India, most of the rustic situations are also raising due to traffic conditions, where people cannot move in a short established path and even no parking facility is available for vehicles. Most of the people who are located in different areas are also using different means of transportation, and even elderly people are travelling in such roads. If elderly people are travelling, they cannot able to tread long distance after parking the vehicles. In this case, a smart parking system should be developed using

sensing system that incorporates all human activities, and this type of system will help all elderly people where they can be dropped at exact location.

After dropping elderly people, all teamsters inside the vehicles can reserve the parking space which is located in nearby areas. Moreover, a Global Positioning System (GPS) is present in the current generation system but exact locations are not shown, and no automated reservation is possible with such systems. Therefore, an automated parking system should be introduced for reducing the traffic conditions in all the places using modern technology communication transfer process.

1.1. Literature Analysis. Earth is the mother of all living species except mankind all species adopt their life style in line with the nature. The rapid rate of increase in the population may touch many fold in 2050 [1]. The rapid growth speeds

of human numbers also contribute increase of many sophistications including mode of transport. With gross increase of population in cities, the number of personal transport mode also attained huge increase which created much more problems to city managements in handling of the same. The need for vehicle parking management is imminent, which makes too difficult to the vehicle owners to find a parking slot in a congested area, in view of that automated vehicle parking system helps them to find peace of mind with saving of huge time [2]. To reduce the occupancy time and speed control mechanism while automated parking system, several have been implemented [2–5]. Traditional traffic control mechanism like traffic light system produces number of complications and in some critical places, it serves merely no job in providing better optimal performance [6–8]. The system available in the current scenario's not included the autonomous or driverless less or self driving car system which considerable increases day by day as well looked as the face of future mobility system [9].

To provide solution to the automated system, this paper proposes a novel optimal robotized parking system based on the advanced wireless sensor architecture. System provides automated cruise vehicle monitoring and guiding system [10] and introduces complicated embedded system which creates real time complications as the cost of the embedded system is considerably high as well the embedded programming and operation require skillful operations. The systems are also prone to malfunction since the embedded kit sometimes unreasonable goes malfunctioning, and hence automated vehicle management system requires much more sophisticated working environment and should not seek the skillful manpower to operate the system. To overcome such demerits, the proposed system undergoes cost-effective wireless sensor-based automated vehicle control system in specific to the automated vehicle monitoring and parking system.

Logical control-based switching operation routed vehicle controlling mechanism creates much more complications in the real time system. Implementation, the alternative combined technique-based systems commonly known as hybrid system gain attention from the wide range of researchers in recent times [11] along with the hybrid implementation safety element incorporation also came to picture [12]; the complications incorporated are staged implementation [11, 12] such as they have implemented the hybrid system in three different phases starting with detailed planning off instructions which are actually safety features; then, they have decided that Hamilton-Jacobi-Bellman equations which are normally achievable limit in a hybrid system environment and the entire system ended with the implementation of the abovementioned equation into real time systems. Programming-based system is incorporated by [13] to solve the problems of the real time vehicle system which includes the rear and front vehicle or obstacle-based solutions. And the system exhibits high trade off in terms of programming time delay, and it is been a bottle neck in finding quick solutions for the forward and reverse-related problems make this methodology been a nonconservative as well as it requires a detailed knowledgeable mind to code the programming. The

designed system consumes considerable high amount of cost. Many introduced systems are lagging in providing better cost oriented solutions as well the systems that go beyond the allowed power consumptions which makes more cost-related issues [14]. While planning for the unmanned operations, we lose the control over the power management. The system lack in efficient power handling capabilities sooner or later become a mist, and the researchers may lose hope in such a system. The complications not limited to endurance enhancement capabilities and also leads poor power management as a key problematic areas [14]. Relay-based systems are effectively implemented in recent times and also, it gains momentum among the researchers. Few relay-based systems only concentrated relays of the moving vehicle [15, 16] as a moving node relays and fails to address the static node and its related positions.

Many papers failed to address the orientation of the node since the robot-based system is more in demand to seek its orientation to take critical decisions. In some occasions, robot orientation alone decides the fate of the decisions. The mobility-based relay control mechanisms fail to address position of the system which plays a key role in robot decision making since the robot exploration purely based on the orientation of the current node, that is, the node in action's current position, since the system should ensure the break free connection between the sink node to originating node. Congestion in road transport system becomes a core compiled problem in many countries including highly populated Asian countries where the aerial vehicle system might be the solution to the future demand [17] which requires a very high throughput and making zero of manmade errors in all kind of activities and no requirement of any human drivers to drive and control and monitor the system [18]. Since the growth of the world population is going in exponentially which equally increases the need for personal transport medium, the automated system is the optimal possible solution of the world vehicle population which crosses 1.3 billion in recent times [17, 18]. With such raising population, an examination has been carried out in smart cities for the parking allotment system where only marginal results are attained by testing under various constraints [19]. In this review stage, many information have been provided such as type of sensors to be implemented, mode of communication networks, and sorted results. In this evaluation, no information about same area parking facilities are analyzed, and information about sensor are less significant. Further existing literatures are examined for understanding the architecture of sensor networks, and the researchers [20] have provided a Linux centered situation. But in current generation, mode python centered condition has been introduced for achieving effective results; thus, a new sustenance should be established. Since the gasoline technologies are transferred to electric vehicles, the process can also be extended for detecting automated charging stations [21]. Yet, these extensions cannot use the developed sustenance which fails to deliver two different automated operations and even if combined this case will create confusion among teamsters. Besides, the sensing process an Internet of Things (IoT) has been introduced for increasing the

accuracy of automation process [22], and all data transfer phases have been expounded. Conversely, this IoT procedure can be implemented only when area of separation is larger and a central coordination system is essential.

1.2. Research Gap and Challenges. The major problem that is existing in the current generation network is that no automated systems are available in any real world applications. In current situation, individuals are using a prefixed stationary measurable device that cannot sustain all environmental conditions. By discerning the abovementioned regular system, it is obviously explicable that an automated system is needed for solving all real time problems. Therefore, this research article identifies this gap and attempts to solve the challenges that are present in the existing system. In addition, all existing systems can never be replaced in a direct way by implanting sensors where the following smart system such as park distance control, parktronic, and an assistance system are needed. These devices should be installed in all vehicles for automatic parking space monitoring, and the challenges of installation are also present where cost of installation in each vehicle will raise.

1.3. Proposed Methodology and Solution. Currently, the development of sensors is floating all over the world with different topology investigations which makes the installation process to be unpretentious. Further, by comparing the cost of installation in separate areas, it is better to install it in different vehicles as only 2 to 3 percentage of vehicle cost will raise. Even by associating the sensor-based technology with multilevel parking system, it has been observed that the entire parking facility should be changed, and some empty meadows need to be occupied, but the proposed methodology will be easily installed in the developing electric vehicle system where the entire competence has been already implemented with sensing devices. This development will not only convert people who are incarnate in urban areas but the people who are corporeal in rural areas also can adore the same benefit of automated monitoring systems at low cost of installation.

1.4. Objectives. The process of automated parking system in vehicles is implemented with sensors, and machine learning algorithm is integrated for managing the communication process by substantial objectives as follows:

- (i) To exploit the distance of separation, this is extended to 1500 meters with maximization of sequence communication process
- (ii) To moderate the delay of packet transfer using routing process with low overhead
- (iii) To exhaust the possibilities of automated sensing device by installing nodes at arbitrary points within the same area

For corroborating the abovementioned objectives, results are demonstrated in online mode for the allotted square feet area. However, in the article, the results are integrated with machine learning algorithm where all investigations are sim-

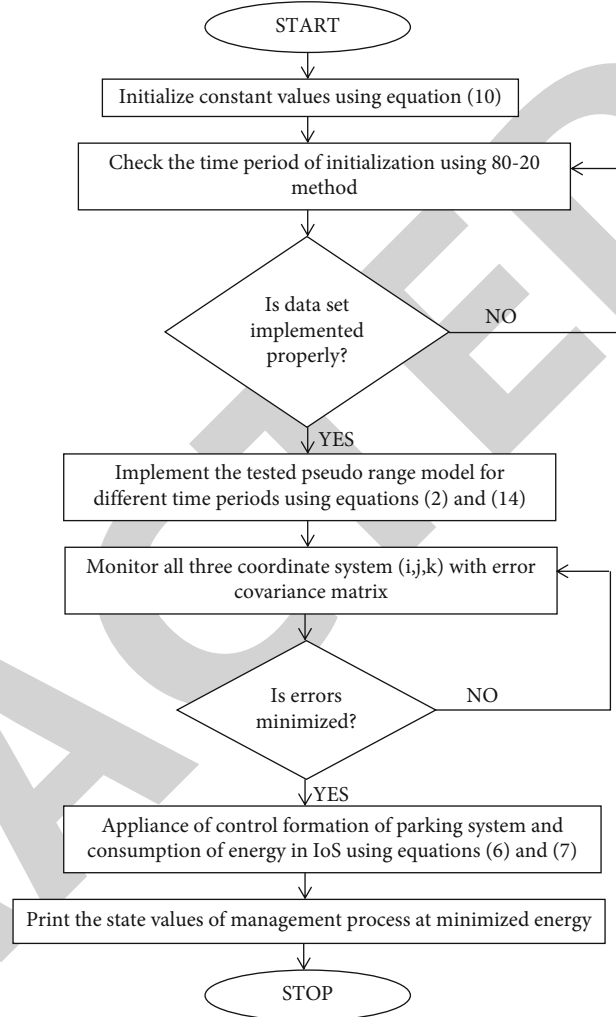


FIGURE 1: Algorithmic flow chart of proposed model.

ulated for better indulgent. If a machine learning algorithm is implemented, then accuracy of automated predictions will be increased and in addition, the designed mathematical constraints should be implemented with CatBoost algorithm, and the steps of integration are deliberated in Figure 1.

2. Problem Formulation

To overcome the unique communication between computing and control for designing the robotic system, an efficient algorithm should be integrated such that the robots should provide valuable and measurable information. Therefore, consider a set of n vehicles whose value should always be greater than 1 and is modeled using Equation (1).

$$S_i(n) = Z_i(s_i(t), v_i(t)), \quad (1)$$

where $S_i(n)$ denotes the vehicle state, Z_i represents function of both vehicle state and control field, and V_i signifies control of vehicle state.

Now, in case of the robotic vehicles are approximated by using single cycle with corresponding constraints, then n number of vehicles should be defined by using differential equation as given in Equation (2),

$$\begin{bmatrix} p \\ q \\ \delta \end{bmatrix} = \begin{bmatrix} a \cos \omega \\ b \sin \omega \\ \theta \end{bmatrix}, \quad (2)$$

where a and b represent the velocity of the vehicle in forward and reverse direction, ω signifies the direction of the vehicle, and θ denotes the velocity of the vehicle.

Equation (2) corresponds to drive vehicle in differential mode, and the vehicle can be controlled in an independent way if the model is imposed using Equation (3) and (4),

$$\begin{aligned} a &= \frac{(p_1 + p_2)}{2}, \\ b &= \frac{(q_1 - q_2)}{2}. \end{aligned} \quad (3)$$

Also, the velocity can be represented by taking the relationship between wheel speed and distance as given in Equation (4):

$$\theta = \frac{(w_1 - w_2)}{l_i}, \quad (4)$$

where w_1 and w_2 represent the wheel speed of two vehicles, and l_i signifies the length of the vehicle in meters.

The sensors will be implemented based on a priori where the meeting location should be properly utilized. Therefore, the error to be minimized can be given using Equation (5):

$$\min e_{i,j} = \frac{1}{2} \sum_{i,j=1}^n \|q_i - q_j\|^2. \quad (5)$$

where $e_{i,j}$ represents the error of individual vehicles.

Equation (5) can also be represented using gradient vector position, and the alternate form is represented using Equation (6):

$$\frac{\partial \zeta_{i,j}}{\partial \lambda_{i,j}} = \sum_{i,j \in z} (q_i - q_j). \quad (6)$$

The above equation can also be applied to individual sensors but the behavior of each system varies at time by comparing it with node level dynamics. For the above reason, all the equations are linear by nature, and the relative position difference can be calculated exactly. In addition, the cost of implementing these types of sensors plays a crucial role, and it should be calculated using Equation (7),

$$\min \gamma(i, j) = \sum_{i,j=1}^n \delta_{i,j} \|q_i - q_j\|^2, \quad (7)$$

TABLE 1: Simulation setup.

Parameter	Value
Network size	22500000 square meters
Number of sensor nodes	100-500
Number of mobile users	1-3
Initial energy of each sensor node	1000 mJ
Transmission energy	0.155 mJ
Reception energy	0.00476 mJ
Traffic type	Constant bit rate (CBR)
Packet size	12 bytes
Number of packets	1000
Transmission range	60 m
Simulation time	500000 milliseconds

where γ represents the cost function to be calculated, and δ signifies the distance between i^{th} and j^{th} vehicle.

3. Optimization Algorithms

In this section, a precise optimization algorithm [23] for managing autonomous parking system has been selected where all feature predictions can be made much easier using boosting algorithm. This type of boosting algorithm is a type of machine learning algorithm where all estimated values in different regions can be integrated in a suitable manner. For any given input, the CatBoost algorithm provides accurate output by solving different set of features where high loss can be controlled. Since in wireless networks, process data is provided in different categories; this algorithm supports different category data such as text and numerical. In addition, a fraud data can be detected, and it will be released in the next loop category; thus, time of implementation is reduced. Also, training results in this type of boosting algorithm will be much higher using different command line interfaces. In starting segment of gradient boosting, constant values must be provided which provides high step implementation for further stages because 80 percent of training set should be divided, and 20 percent of data set should be provided initially. The process of initiating constant values in stage 1 can be framed as follows:

$$\theta(i) = \sum_{i=1}^n \pi_i \forall i \in n, \quad (8)$$

where π_i indicates the constant indicator function for all values that exists in all different stages between i and n .

If Equation (8) is integrated, then binary values should be indicated that it provides the training data information for boosting process. This can be framed using Equation (9) as follows:

$$\pi_i = \begin{cases} 1 & \text{if } i \in n \\ 0 & \text{Otherwise} \end{cases}. \quad (9)$$

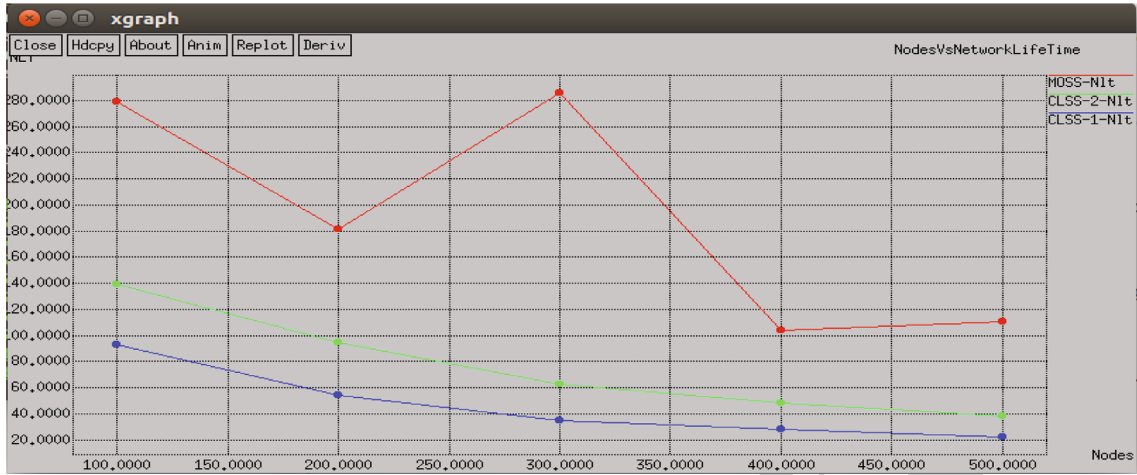


FIGURE 2: Comparisons of schemes node vs. network life time.

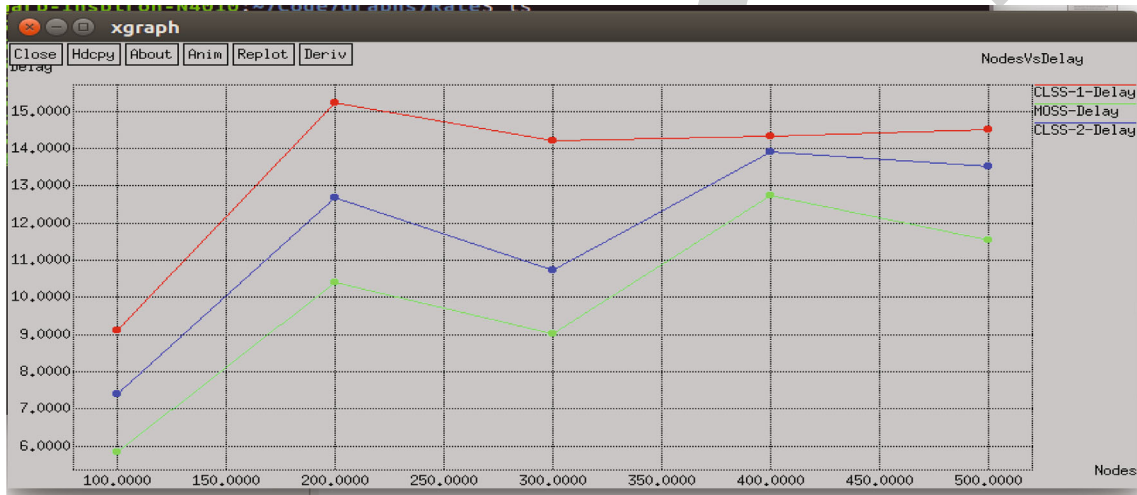


FIGURE 3: Comparisons of scheme node vs. delay.

If the condition in Equation (9) is gratified, then approximation can be made with reduction of losses in overall network. Further, to simplify the equations, an approximate function should be derived by combining Equation (8) as

$$Z_i = \sum_{i=1}^n \pi^t, \quad (10)$$

where π^t indicates the sum of different approximations in corresponding time intervals.

Equation (10) provides valuable information on periodic time changes that is provided at different time periods. Since more number of data set is represented, it is necessary to consider time division multiple access (TDMA) in this type of boosting algorithm. Further, the update for every data set can be represented using Equation (11) as

$$|\hat{A}(i)| = \frac{\min_i e_i^t}{e_i^{t-1} - e_i^{t+1}}, \quad (11)$$

where e^t , e^{t-1} , and e^{t+1} represent the current, preceding, and next time samples for exchanging periodic information.

Once data set has been updated, then this algorithm has to be integrated with pseudorange model using residual function as follows:

$$\vartheta_i = \frac{\partial(R_{in}, Z_i)}{\partial(R_s)}. \quad (12)$$

Equation (12) indicates that partial derivative of reading clock and time period of each sample should be integrated for all corresponding pseudo functions that are provided in three different coordinate systems. The step by step implementation of CatBoost algorithm is provided in Figure 1 where it starts with initialization of constant set values, and the output will be based on exact prediction.

4. Results and Analysis

The parametric values such as lifetime of sensor nodes, energy consumed, delay in the network, communication

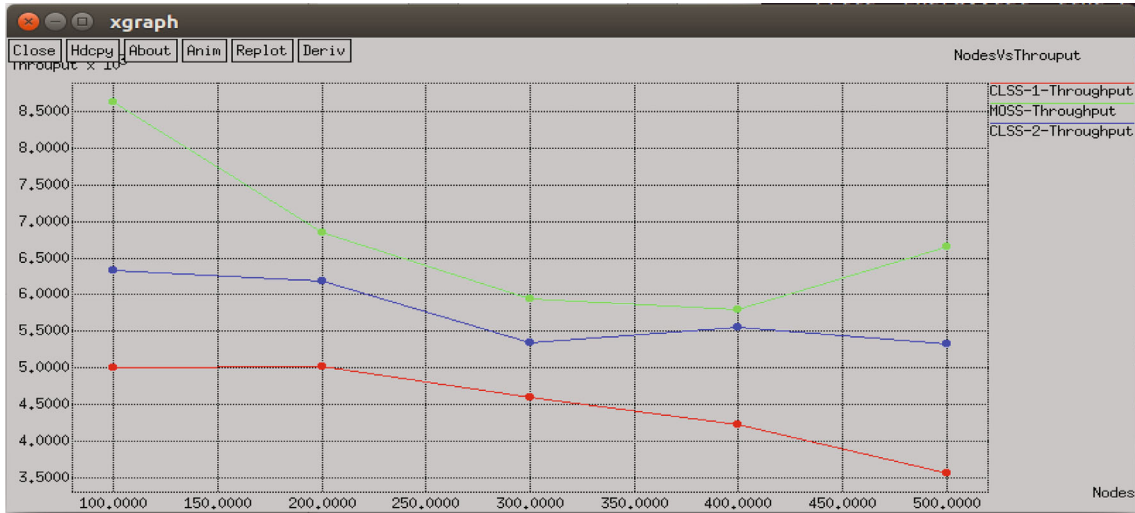


FIGURE 4: Comparisons of scheme node vs. throughput.

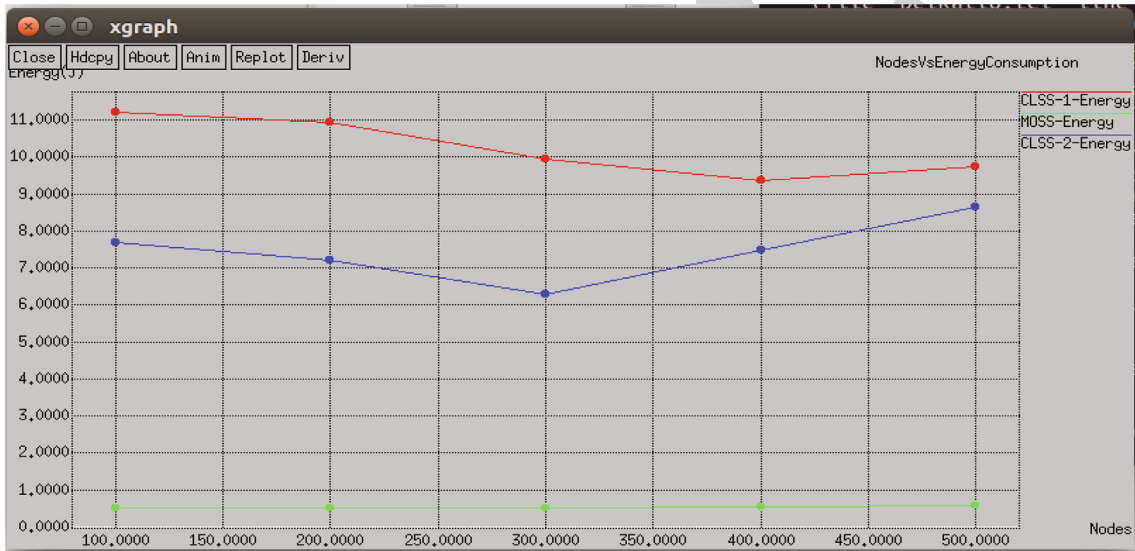


FIGURE 5: Comparisons of scheme node vs. energy consumption.

throughput, and delivery of packets to the endpoint are monitored. In the proposed exertion, the experimental analysis is carried out by installing discrete node points at certain coverage area which is totally considered as 22500000 square meters. In this considered area, 100 nodes are installed for twenty five percentage of area and after taking measurement values, number of nodes will be further increased to remaining areas up to 500. In this case study, all vehicles are in moving position; therefore, moving nodes are considered which is termed as ad hoc networks, and the energy initialized in this process will be 1000 mJ. Meanwhile, distance of separation is measured to a maximum extent of 1500 meters all around the same area, and packets will be transmitted only in this group by converting light to electrical signals. Table 1 expresses the simplified version of the simulation setup.

4.1. Case Study 1: Network Lifetime. This is one of the important factor which shows how long the system with

stand if the current trend of transmission takes place and also, wireless sensor network concern that this is very much important since the sensing node lifetime cannot be extended (in most of the scenarios). Figure 2 explains the proposed system performance in comparisons with the existing methodologies from that we may understand that the presented protocol produced considerable improvements over the existing techniques.

4.2. Case Study 2: End-to-End Delay. In a wireless sensor network, the main focus given to reduction of delay since the delay increases sensing node switch on time which directly consumes huge energy from its tiny battery which ultimately reduces its lifetime. And also, it indicates the quality of quality of service of the WSN. Figure 3 is the pictorial view of the comparison analysis done using network simulator tool. From Figure 3, we can understand that the proposed

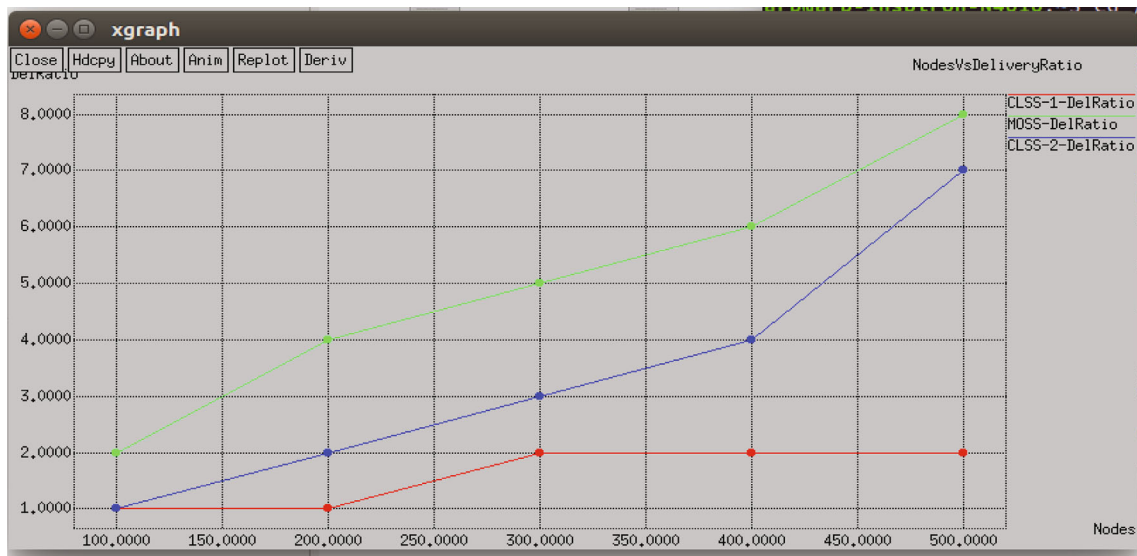


FIGURE 6: Comparisons of scheme node vs. delivery ratio.

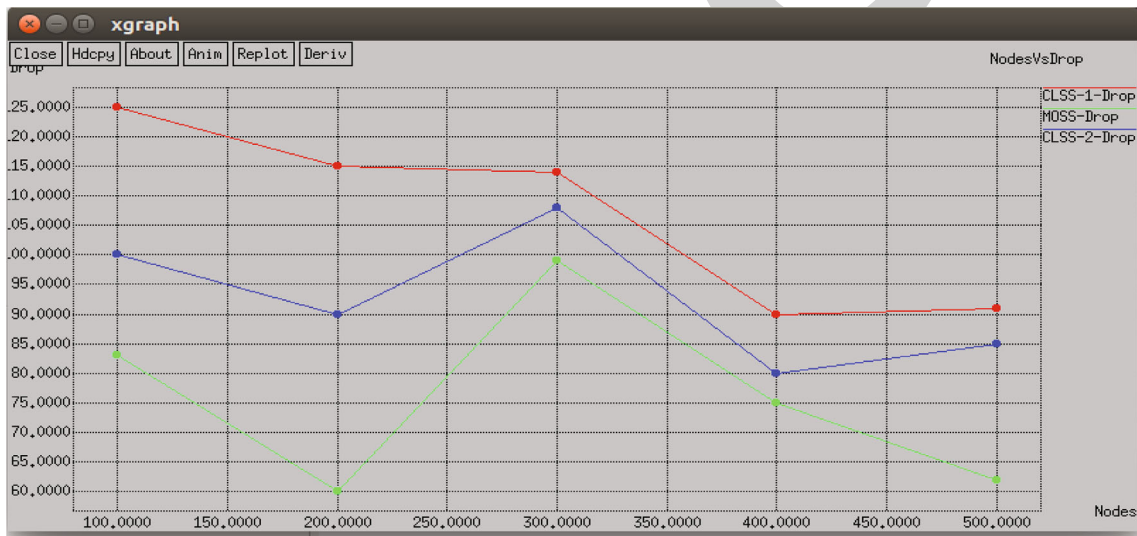


FIGURE 7: Comparisons of scheme node vs. drop.

methodology produces reduced transmission time which reduces the overall network end-to-end delay.

4.3. Case Study 3: Throughput. To understand the sensor network speed of action, the essential tool comes in handy which is throughput. This is also one of the QoS parameters which explain how many number of bits transmitted through a network within the time period of one second. Figure 4 elaborates the detailed analysis of this factor, and results performed using NS 2 clearly show that the proposed method is outperform by many of the existing methodologies.

4.4. Case Study 4: Energy Consumption. By definition as per this work concern, it is the quantity of energy spent during the time period of binary data transmission as well as data reception. Figure 5 shows that the proposed scheme utilizes

very minor power in comparisons with the existing methodologies.

4.5. Case Study 5: Delivery Ratio. The important parameters show the effectiveness of the data delivery. The interaction between the transmitting node and receiving station is taken as a percentage. Figure 6 shows a comparison analysis of the proposed algorithms with the existing methodologies, and it clearly shows that proposed technique produces better results. Similarly, the rate of packet drop is explained through Figure 7.

4.6. Case Study 6: Overhead. The congestion created during the data transfer from source to sink is known as data overhead. This analysis is very important to design an efficient sensor-based system. Figure 8 discusses about this scenario. The simulated results show that our proposed

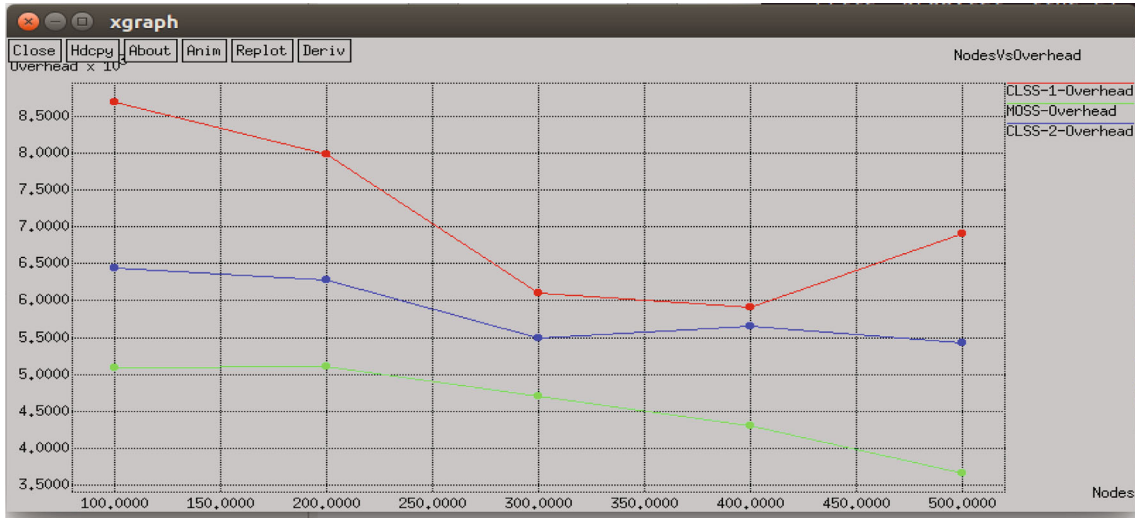


FIGURE 8: Comparisons of scheme node vs. overhead.

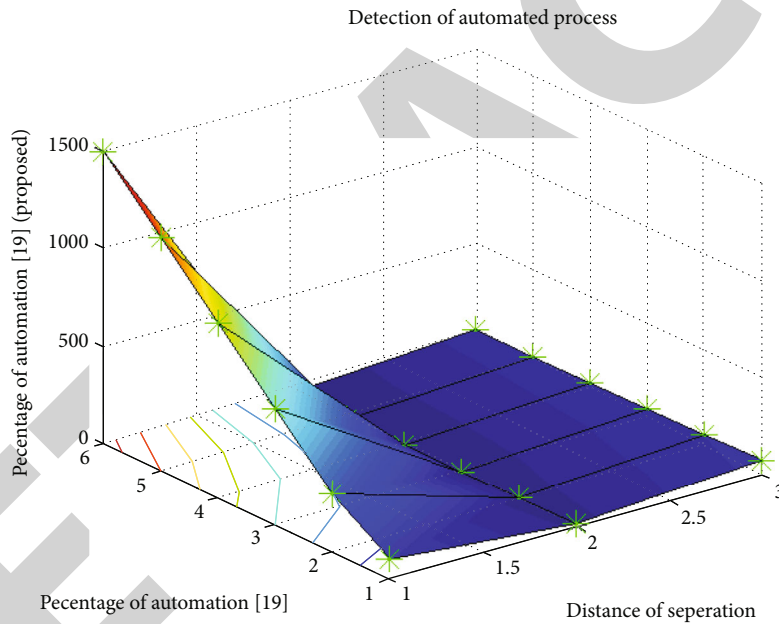


FIGURE 9: Recognition of automated development.

methodologies outperform many of the similar technique in present use.

4.7. Case Study 7. In this case study, percentage of automation with respect to monitored parameters has been described where distance of separation is considered for actual automation process. The foremost intention for discussing this case study is that if ultrasonic sensors are implemented, then percentage of automation will diverge from high percentage values. Also, the same case study can be evaluated using variation in speed where the introduced Cat-Boost algorithm will vary depending on the allocated tasks.

For further evaluation of the automated monitoring system, a new configuration is needed for managing the operation strategy and is designed using Equations (3) and (4). Subsequently, integrating both the equation in the design

process exact automated proportion is calculated and is plotted in Figure 9. From Figure 9, it can be perceived that distance of current installed sensing nodes is varied from 100 to 1500 meters that is represented within a disk. Since only initial measures are taken, a constant speed of vehicles is only considered in the proposed setup which varies from 10km/h to 45 km/h. It is eminent that behind this threshold values, sensing devices will not replicate the location correctly as the vehicle is moving in much faster speed. The same incident is compared with existing method [19] where the efficiency in automated process is much higher for the projected method. For example, if the distance of separation is 600 meters, then at a changing speed of vehicles, the parking space will be detected with an automation percentage of 68 when machine learning algorithm is integrated. But without machine learning procedure, existing method can able to

TABLE 2: Automated developments with sensing device.

Distance separation (meters)	Percentage of automation [19]	Percentage of automation (proposed)
100	20	82
300	16	74
600	10	68
900	8	65
1200	7	62
1500	3	60

sense only 10 percentage of automated vehicles where in such cases, only manual operations will be processed shown in Table 2.

5. Conclusion

In this article, a novel method is introduced for the first time by integrating the algorithms in twofolds. The benefit in establishing this kind of sensor is for avoiding the traffic where the users will stay for a long time in order to get their vehicle parking slot. When a user enters at the particular area, they will be alerted about the parking slot with the help of installed sensor and with a GPS device; the users can able to go to that particular location without facing any delay. The main motive behind establishing this technique is to make the transportation in urban areas much easier than expected. The unified formulation model will provide accurate calculations, and it is made flexible even when user constraints are defined. In real time, the sensor model will work well, and its throughput performance will be higher when compared with other systems. In addition, this is the first sensor technique that provides efficient approach in terms of both throughput and delay. In future, the projected model on automated parking system using machine learning can be extended using unbounded distance separation without any radius, and the sensor technology can be integrated with IoT procedure using a central data transfer stage.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- [1] C. T. Kulik, S. Ryan, S. Harper, and G. George, "Aging populations and management," *Academy of Management Journal*, vol. 57, no. 4, pp. 929–935, 2014.
- [2] K. Dresner and P. Stone, "Multiagent traffic management: a reservation-based intersection control mechanism," in *Autonomous Agents and Multiagent Systems, International Joint Conference*, pp. 530–537, New York, New York, USA, 2004.
- [3] O. Mehani, A. De, and F. Trajectory, "Trajectory planning in a crossroads for a fleet of driverless vehicles," in *Computer Aided Systems Theory – EUROCAST 2007: International Conference on Computer Aided Systems Theory*, Lecture Notes in Computer Science, Springer, 2008.
- [4] L. Fortelle and A. De, "Analysis of reservation algorithms for cooperative planning at intersections," in *13th International IEEE conference on intelligent transportation systems*, pp. 445–449, Funchal, Portugal, 2010.
- [5] A. Colombo and D. del Vecchio, "Least restrictive supervisors for intersection collision avoidance: a scheduling approach," *IEEE Transactions on Automatic Control*, vol. 60, no. 6, pp. 1515–1527, 2015.
- [6] H. O. Ban, I. S. Shin, J. J. Kim, and K. J. Han, "Design and implementation of an access control system based on GeoX-ACML," *Journal of Korea Spatial Information Society*, vol. 21, no. 4, pp. 15–24, 2013.
- [7] J. Garcia-Nieto, A. C. Olivera, and E. Alba, "Optimal cycle program of traffic lights with particle swarm optimization," *IEEE Transactions on Evolutionary Computation*, vol. 17, no. 6, pp. 823–839, 2013.
- [8] Y. Yin, "Robust optimal traffic signal timing," *Transportation Research Part B: Methodological*, vol. 42, no. 10, pp. 911–924, 2008.
- [9] G. E. Pattie and Trailer Trains, *Automated Guided Verde Systems*, 1981.
- [10] Hybrid, Embedded, and Control Software, *Girard2005*, 2005.
- [11] J. Lygeros, D. N. Godbole, and S. Sastry, "A game-theoretic approach to hybrid system design," in *International Hybrid Systems Workshop*, vol. 1066 of Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), pp. 1–12, Springer, Berlin, Heidelberg, 1996.
- [12] C. J. Tomlin, J. Lygeros, and S. Shankar Sastry, "A game theoretic approach to controller design for hybrid systems," *Proceedings of the IEEE*, vol. 88, no. 7, pp. 949–970, 2000.
- [13] "Dynamic optimization for reachability problems," *Journal of Optimization Theory and Applications*, vol. 108, no. 2, pp. 227–251, 2001.
- [14] Y. Zeng, R. Zhang, and T. J. Lim, "Wireless communications with unmanned aerial vehicles: opportunities and challenges," *IEEE Communications Magazine*, vol. 54, no. 5, pp. 36–42, 2016.
- [15] F. El-Moukaddem, E. Torng, and G. Xing, "Mobile relay configuration in data-intensive wireless sensor networks," *IEEE Transactions on Mobile Computing*, vol. 12, no. 2, pp. 261–273, 2013.
- [16] Y. Yan and Y. Mostofi, "Robotic router formation in realistic communication environments," *IEEE Transactions on Robotics*, vol. 28, no. 4, pp. 810–827, 2012.
- [17] J. Sousanis, "World vehicle population tops 1 billion units," February 2015, http://wardsauto.com/ar/world_vehicle_population_110815.
- [18] "Population Division of the Department of Economic; Social Affairs of the United Nations Secretariat. World Population Prospects: The 2012 Revision," February 2015, <http://esa.un.org/unpd/wpp/index.html>.
- [19] A. Fahim, M. Hasan, and M. A. Chowdhury, "Smart parking systems: comprehensive review based on various aspects," *Heliyon*, vol. 7, no. 5, article e07050, 2021.
- [20] R. Atiqur, "Automated smart car parking system for smart cities demand employs Internet of Things technology,"

International Journal of Informatics and Communication Technology (IJ-ICT), vol. 10, no. 1, p. 46, 2021.

- [21] R. Gandhi, S. Nagarajan, J. Chandramohan, A. Parimala, and V. S. Arulmurugan, "IoT Based Automatic Smart Parking System with EV- Charging Point in Crowd Sensing Area," *Annals of the Romanian Society for Cell Biology*, vol. 25, no. 6, pp. 6398–6409, 2021.
- [22] A. Sharma, P. K. Singh, and Y. Kumar, "An integrated fire detection system using IoT and image processing technique for smart cities," *Sustainable Cities and Society*, vol. 61, article 102332, 2020.
- [23] K. Haseeb, K. A. Bakar, A. H. Abdullah, and T. Darwish, "Adaptive energy aware cluster-based routing protocol for wireless sensor networks," *Wireless Networks*, vol. 23, no. 6, pp. 1953–1966, 2017.