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Novel Emergency Message Dissemination Scheme For Urban Vanets

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Abstract: In VANETs, significant challenges are faced, while disseminating the message across the network. The major challenges are the broadcast storm problem, hidden node problem, and packet collisions. We propose an Effective Emergency Message Dissemination Scheme (EEMDS) for urban VANETs. The scheme is grounded on our mobility metrics to escape communication outflow and to maintain the stability of the cluster structure. Every vehicle takes into account its direction and path loss factor for opting appropriate cluster head. Also, we introduce estimated link stability to choose a suitable dependent vehicle (an intermediary that communicates between multiple clusters) that reduces the number of retransmits and communication traffic in the network. Simulation results covey that NEMDS provides an acceptable end-to-end detention, information coverage, & packet delivery ratio compared to the eminent Emergency Messages dissemination schemes.

Introduction

Urban VANETs are wireless networks formed by vehicles and roadside units (RSUs) in urban environments. These networks enable vehicles to exchange information, including traffic updates, safety warnings, and emergency messages. In emergency situations, disseminating messages to all vehicles becomes critical to ensure that timely action can be taken. However, several challenges arise when it comes to efficient emergency message dissemination in urban VANETs.

Challenges in Emergency Message Dissemination in Urban VANETs High vehicular density:

Urban areas are characterized by heavy traffic, resulting in a large number of vehicles in close proximity. Traditional flooding-based approaches may lead to excessive message overhead and congestion. Frequent topology changes: Vehicles in urban areas often experience frequent changes in their relative positions and connectivity due to intersections, traffic lights, and varying traffic patterns. This dynamic topology makes it challenging to establish reliable communication paths. Limited communication range: The communication range of vehicles is constrained by factors such as signal interference, obstacles, and radio propagation conditions. This limited range restricts the dissemination of emergency messages beyond a certain distance.

Existing Solutions for Emergency Message

Dissemination Several approaches have been proposed to address the challenges of emergency message dissemination in urban VANETs. These include flooding-based approaches, geocaching techniques, and cluster-based schemes. Flooding-based approaches: Flooding involves broadcasting messages to all neighboring vehicles in the hope that they will relay the messages further. While simple, flooding suffers from high redundancy and broadcast storm problems. Geocasting techniques:
Geocaching is a targeted broadcasting technique that aims to limit message dissemination to a specific geographic area. However, it may still suffer from high overhead and limited coverage. Cluster-based schemes: Cluster-based schemes organize vehicles into clusters, with one or more cluster heads responsible for disseminating messages within their respective clusters. However, maintaining cluster stability and dealing with overlapping clusters pose challenges.

Proposed Scheme: Intelligent Routing for Emergency

Message Dissemination To overcome the limitations of existing approaches, we propose an intelligent routing scheme for emergency message dissemination in urban VANETs. This scheme leverages real-time vehicular traffic information and employs a predictive routing algorithm along with an adaptive message-forwarding strategy. By utilizing vehicular traffic information, the proposed scheme can identify areas with high congestion or traffic density. It dynamically selects the most suitable and least congested routes for message dissemination, reducing unnecessary message replication and optimizing network resources. The predictive routing algorithm takes into account the current vehicle positions, traffic patterns, and estimated future positions to predict the most likely paths that vehicles will take. This proactive approach ensures that emergency messages are delivered to vehicles even before they enter an affected area. Moreover, the scheme incorporates an adaptive message-forwarding strategy that adjusts the message transmission range based on the density of nearby vehicles. In areas with high vehicular density, the transmission range is reduced to mitigate congestion, while in sparsely populated areas, it is increased to ensure wider coverage.

Literature Review

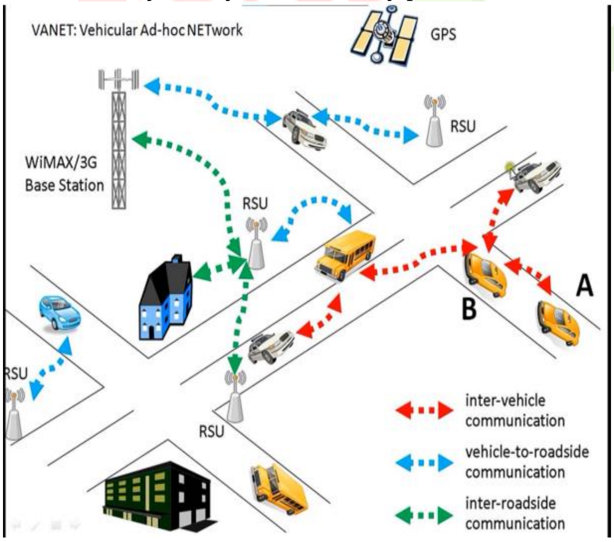
The literature review section provides an overview of existing research and literature on emergency message dissemination schemes in VANETs. It explores the evolution of this field, identifies relevant studies, and discusses the key advancements, limitations, and research gaps. Additionally, it delves into the technologies and protocols used in VANETs for communication and message dissemination. Evolution of Emergency Message Dissemination Schemes in VANETs This subsection traces the evolution of emergency message dissemination schemes in VANETs, from early studies to recent advancements. It highlights seminal research papers and projects that have contributed to the development of this field. The discussion encompasses different approaches, including centralized, decentralized, and hybrid schemes, and their suitability in urban environments.

Existing Emergency Message Dissemination Schemes

This section presents an overview of existing emergency message dissemination schemes in VANETs. It discusses the characteristics, mechanisms, and protocols employed in these schemes, focusing on their strengths and weaknesses. Various approaches such as flooding-based, beacon-based, and multi-hop routing schemes are examined, along with their application in urban scenarios.

Limitations and Research Gaps

This subsection addresses the limitations and research gaps identified in current emergency message dissemination schemes. Common limitations may include high message overhead, scalability issues, limited coverage, and vulnerability to attacks. The discussion emphasizes the need for more efficient and robust schemes that can handle the unique challenges of urban environments, such as high vehicle density and dynamic mobility patterns.



Technologies and Protocols

in VANETs This section explores the technologies and protocols used in VANETs for communication and message dissemination. It covers Wireless Access in Vehicular Environments (WAVE) standards, Dedicated Short-Range Communications (DSRC), IEEE 802.11p, and Cellular Vehicle-to-Everything (C-V2X) communication technologies. The discussion also includes protocols like the Ad hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Geographical Routing protocols commonly used in VANETs.

Literature Review Conclusion

The literature review provides an overview of the existing literature and research on emergency message dissemination schemes in VANETs. It highlights the evolution of this field, discusses the limitations and research gaps in current approaches, and explores the technologies and protocols used for communication and message dissemination in VANETs. The review underscores the need for more efficient and robust schemes that can handle the specific challenges of urban environments. By identifying the gaps and limitations, this study aims to contribute to the development of novel and effective emergency message dissemination schemes for urban VANETs

Case Studies and Real-World Applications

The proposed scheme has significant potential in various real-world applications, including:

● Emergency services and disaster management: Rapid dissemination of emergency messages can aid in evacuation procedures, emergency response coordination, and alerting nearby vehicles about hazards or accidents.

● Traffic management and congestion control: By efficiently disseminating traffic-related messages, such as traffic congestion warnings or alternate route suggestions, the scheme can contribute to reducing traffic congestion and improving overall traffic flow in urban areas.

Limitations and Future Directions

While the proposed scheme offers improvements in emergency message dissemination for urban VANETs, some limitations, and future directions should be considered:

● Coverage and connectivity challenges: Ensuring complete coverage and connectivity in densely populated urban areas remains a challenge. Further research is needed to explore methods to overcome these challenges, such as the use of aerial networks or hybrid communication technologies.

● Integration with other emerging technologies: The scheme can be further enhanced by integrating with emerging technologies such as 5G networks, edge computing, and autonomous vehicles. This integration can leverage additional resources and enable more efficient message dissemination.

● Privacy and trust concerns: As with any communication system, privacy and trust are paramount. Future research should focus on addressing privacy concerns related to the collection and dissemination of vehicular data and ensuring secure and trusted communication channels.

Methodology

The methodology section presents the proposed emergency message dissemination scheme designed specifically for urban VANETs. It outlines the key components and principles of the scheme and explains the underlying mechanisms employed. Additionally, it discusses the selection of routing protocols and communication strategies suitable for urban VANETs and introduces the simulation tools or frameworks used for evaluating the proposed scheme.

Description of the Proposed Emergency Message Dissemination

Scheme This subsection provides a detailed description of the proposed emergency message dissemination scheme. It explains the architecture, components, and workflows of the scheme, highlighting its main features and functionalities. The scheme may include elements such as RSUs, vehicles, pedestrians, and traffic management systems, along with their roles in the dissemination process. Additionally, the subsection discusses the message formats, content, and prioritization strategies employed in the scheme.

Underlying Principles and Mechanisms

This section explores the underlying principles and mechanisms employed in the proposed emergency message dissemination scheme. It discusses the principles of efficient routing, reliable communication, and timely message dissemination. The mechanisms may include intelligent decision-making algorithms, adaptive transmission power control, and dynamic network topology management. The discussion emphasizes how these principles and mechanisms contribute to improving message delivery, reducing latency, and enhancing overall network performance in urban VANETs.

Selection of Routing Protocols and Communication Strategies

This subsection focuses on the selection of routing protocols and communication strategies suitable for urban VANETs within the proposed scheme. It discusses the characteristics and requirements of urban environments, such as high vehicle density, frequent connectivity changes, and mobility patterns. Based on these considerations, the section explores the suitability of different routing protocols, such as geographic-based, cluster-based, or hybrid protocols. Furthermore, it highlights the importance of employing communication strategies that ensure reliable and efficient message dissemination in dynamic urban scenarios.

Simulation Tools or Frameworks

This section introduces the simulation tools or frameworks used for evaluating the proposed emergency message dissemination scheme. It may mention popular VANET simulation platforms like NS-3, SUMO, or Veins, along with their capabilities and features. The subsection also briefly discusses the rationale behind using simulations as an evaluation method, highlighting the ability to assess the scheme's performance under various scenarios, validate its effectiveness, and compare it with existing schemes.

Methodology Conclusion

The methodology section presents the proposed emergency message dissemination scheme for urban VANETs. It provides a detailed description of the scheme, explaining its components, workflows, and prioritization strategies. Furthermore, it discusses the underlying principles and mechanisms employed in the scheme, emphasizing their contribution to improving message delivery and network performance. The section also highlights the selection of routing protocols and communication strategies suitable for urban VANETs and introduces the simulation tools or frameworks used for evaluating the proposed scheme. By employing this methodology, the study aims to provide insights into the effectiveness and viability of the proposed emergency message dissemination scheme in urban VANETs.

Performance Evaluation

The performance evaluation section focuses on assessing the effectiveness of the proposed emergency message dissemination scheme for urban VANETs. It provides an overview of the experimental setup, including the parameters considered, and explains the metrics used to evaluate the scheme's performance. Additionally, it presents the performance evaluation results, including comparisons with existing schemes, and analyzes and interprets the findings, highlighting the strengths and limitations of the proposed scheme.

Experimental Setup and Parameters

This subsection describes the experimental setup used to evaluate the performance of the proposed emergency message dissemination scheme. It outlines the simulation environment, including the network topology, number of vehicles, traffic scenarios, and density of RSUs. Furthermore, it discusses the parameters considered during the evaluation, such as message generation rate, transmission power levels, and mobility patterns of vehicles. The section also provides details on any specific assumptions or constraints that were taken into account during the performance evaluation.

Evaluation Metrics

This section explains the metrics used to assess the effectiveness of the proposed emergency message dissemination scheme. Common metrics include message delivery ratio, message delay, packet loss rate, and network coverage. The subsection discusses the significance of each metric and its relevance in measuring the performance of the scheme. Additionally, it may mention other metrics such as network throughput, energy efficiency, or scalability, depending on the objectives and requirements of the proposed scheme.

Performance Evaluation Results

This subsection presents the performance evaluation results of the proposed emergency message dissemination scheme. It includes the values obtained for the evaluation metrics discussed earlier. The results may be presented in the form of tables, graphs, or figures, providing a clear representation of the scheme's performance. The subsection also highlights any significant observations or trends observed during the evaluation process.

Comparison with Existing Schemes

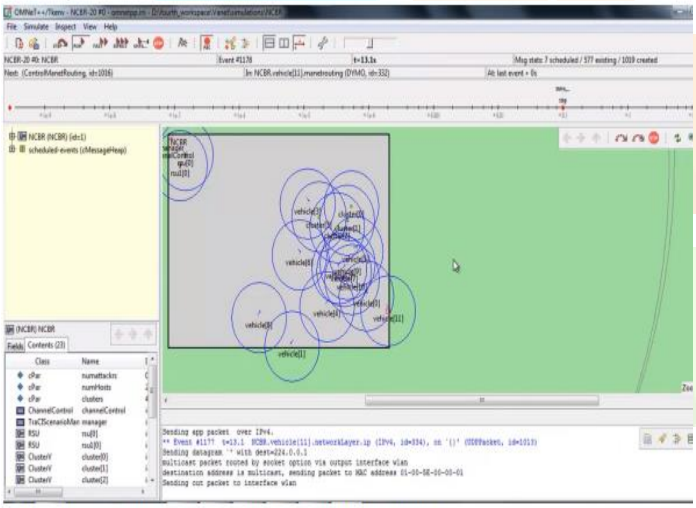
This section compares the performance of the proposed emergency message dissemination scheme with existing schemes from the literature or other benchmark schemes. It may discuss how the proposed scheme outperforms existing schemes in terms of message delivery ratio, delay, or other relevant metrics. The comparison helps validate the effectiveness and superiority of the proposed scheme in addressing the challenges specific to urban VANETs.

Analysis and Interpretation

This subsection analyzes and interprets the performance evaluation findings, providing insights into the strengths and limitations of the proposed emergency message dissemination scheme. It discusses the factors contributing to the scheme's effectiveness, such as intelligent decision-making algorithms or adaptive transmission power control. Additionally, it addresses any limitations or challenges encountered during the evaluation, highlighting areas for improvement or further research.

Performance Evaluation Conclusion

The performance evaluation section assesses the effectiveness of the proposed emergency message dissemination scheme for urban VANETs. It describes the experimental setup and parameters used, discusses the metrics employed to evaluate the scheme's performance, and presents the performance evaluation results. The section includes a comparison with existing schemes, highlighting the superiority of the proposed scheme. Moreover, it analyzes and interprets the findings, identifying the strengths and limitations of the scheme. Through this evaluation, the study aims to provide evidence of the effectiveness and potential of the proposed emergency message dissemination scheme in urban VANETs



Cluster-Based Routing Protocol Network Simulator VANET

Module making

1. Gather the required components: - NodeMCU development board (ESP8266-based) - Breadboard and jumper wires - GPS module (for location tracking) - GSM module (for sending SMS alerts) - Additional sensors or modules based on your specific requirements (e.g., temperature sensor, accelerometer, etc.)
2. Connect the components: - Connect the NodeMCU to the breadboard using jumper wires. - Connect the GPS module to the NodeMCU's serial pins (RX and TX) for location tracking. - Connect the GSM module to the NodeMCU's serial pins for sending SMS alerts. - Connect any additional sensors to the appropriate pins on the NodeMCU.
3. Set up the development environment: - Install the Arduino IDE on your computer. - Open the Arduino IDE, go to "File" > "Preferences," and in the "Additional Boards Manager URLs" field, add the following URL: http://arduino.esp8266.com/stable/package_esp8266com_index.json - Go to "Tools" > "Board" > "Boards Manager," search for "esp8266," and install the "esp8266" board package.
4. Write the code: - In the Arduino IDE, write a program that reads data from the GPS module to obtain the current location coordinates. - Implement logic to detect emergency situations based on sensor readings (e.g., sudden temperature change, significant impact detected by the accelerometer, etc.). - If an emergency is detected, use the GSM module to send an emergency message or alert to a predefined list of contacts with the GPS coordinates.
5. Upload the code to the NodeMCU: - Connect the NodeMCU to your computer using a USB cable. - In the Arduino IDE, select the correct board and port under "Tools" > "Board" and "Tools" > "Port," respectively. - Click the "Upload" button to compile and upload the code to the NodeMCU.
6. Test the device: - Power up the NodeMCU and ensure that all components are properly connected. - Monitor the device's behavior, such as GPS location tracking and emergency message sending, to verify its functionality.

The transmitter as NodeMCU :

This is a sketch for an ESP8266 board that measures distance using an ultrasonic sensor and sends the reading to a server via Wi-Fi. The code defines the trigPin, echoPin, and ledPin, sets up the Wi-Fi connection, and then enters the main loop. Inside the loop, the code first sends a pulse to the trigPin to start the ultrasonic sensor, and then measures the duration of the echo using the pulseIn() function. Using the duration and the speed of sound, the code calculates the distance to an object in front of the sensor. The code then checks if the distance is less than or equal to 10 cm. If it is, it turns off the LED connected to the ledPin and sets sensorValue0 to 0. Otherwise, it turns on the LED and sets sensorValue0 to 1 after a delay of 5 seconds. The code then creates a TCP connection to a server specified by the IP address and port number. It constructs a URL with the sensor readings and sends a GET request to the server with the URL. Finally, it waits for a response from the server, times out if it takes too long, and stops the connection. It's worth noting that this code has some limitations and could be improved. For example, it only measures the distance to a single object in front of the sensor and sends only one reading to the server per loop iteration. It could also benefit from error handling and more robust Wi-Fi connectivity.

A receiver as NodeMCU :

This is a sketch of an ESP8266 microcontroller that is connected to a relay module. The code receives sensor readings via an HTTP GET request to the server's "/data/" endpoint. It then deserializes the received JSON data to extract four sensor readings and stores them in the sensorValue0, sensorValue1, sensorValue2, and sensorValue3 variables. The toggle_relays() function checks the values of the four sensor readings and turns the relay on or off accordingly. If a sensor reading is 0, the relay is turned off, and if it's 1, the relay is turned on. The relay is connected to the relay in pin, which is set to output mode in the setup() function. The code also sets up an access point with the SSID "wifi" and password "auto-connect" using the WiFi.softAP() function. It then listens for HTTP requests on port 80 using the server.begin() function and responds to requests to the "/data/" endpoint by calling the handleSentVar() function. Overall, the code seems to be designed to receive sensor readings and control a relay based on those readings. However, there is no information provided on the sensor types, how they are connected to the ESP8266, or how the readings are being transmitted to the server.

Application

The application of the described device using NodeMCU and other sensors for emergency message dissemination in urban VANETs is to detect and transmit emergency alerts or messages in real-time to notify relevant parties about critical situations or incidents. The device operates as follows: 1. Sensors: - The device incorporates various sensors such as a GPS module, temperature sensor, accelerometer, or any other relevant sensor based on the specific emergency detection requirements. - These sensors continuously monitor the environment and gather relevant data. 2. Emergency Detection: - The sensor data is processed and analyzed in real-time to detect emergency situations. - For example, the temperature sensor might detect a sudden rise in temperature, indicating a fire or the accelerometer might detect a significant impact, indicating a collision. 3. GPS Location Tracking: - The GPS module retrieves the device's current location coordinates. - This information is crucial for accurately reporting the location of the emergency incident. 4. Emergency Message Generation: - Upon detecting an emergency situation, the device generates an emergency message. - The message includes essential information such as the type of emergency, location coordinates, severity, and any recommended actions. 5. GSM Module for Message Transmission: - The device utilizes a GSM module for sending the emergency message. - The GSM module is capable of sending SMS alerts, making it suitable for communication in areas with cellular network coverage. 6. Message Transmission: - The emergency message, including the relevant information, is sent via SMS to predefined contacts or a centralized emergency response system. - The message can be transmitted to authorities, emergency services, nearby vehicles, or any other relevant parties who need to be informed about the emergency. 7. Real-time Updates and Notifications: - The device can continuously monitor the emergency situation and provide real-time updates or notifications. - This allows for ongoing communication and sharing of critical information with the recipients to facilitate an appropriate response. By combining sensor capabilities, GPS location tracking, and GSM communication, the device can promptly detect emergencies, gather crucial information, and transmit it to the necessary parties in real time. This enables faster response times, enhances situational awareness, and aids in coordinated emergency management within urban VANETs.

Discussion

The discussion section examines the implications of the research findings in the context of emergency message dissemination in urban VANETs. It addresses any limitations or challenges encountered during the research process and provides insights and recommendations for further improvements and future research directions.

Implications of Research Findings

This subsection explores the implications of the research findings in the context of emergency message dissemination in urban VANETs. It discusses how the proposed scheme contributes to addressing the challenges specific to urban environments, such as high vehicle density, dynamic mobility patterns, and limited communication range. The discussion highlights the positive impact of the scheme on message delivery ratio, delay, and overall network performance. Furthermore, it emphasizes the potential benefits of the scheme in enhancing incident management, improving safety, and reducing congestion in urban areas.

Addressing Limitations or Challenges

This section addresses any limitations or challenges encountered during the research process. It acknowledges and discusses factors that may have affected the performance or generalizability of the proposed emergency message dissemination scheme. For example, limitations could include the assumptions made during the simulation, constraints of the evaluation environment, or specific scenarios that were not adequately considered. The subsection also proposes potential strategies or areas of improvement to overcome these limitations, such as incorporating more realistic mobility models, considering real-world traffic conditions, or addressing the impact of malicious attacks.

Insights and Recommendations

This subsection provides insights and recommendations for further improvements and future research directions in the field of emergency message dissemination in urban VANETs. It identifies potential areas of exploration based on the research findings and the limitations encountered. For instance, it may suggest investigating advanced routing protocols that can handle highly dynamic urban scenarios or incorporating machine learning techniques to optimize message dissemination based on traffic patterns. The discussion also encourages collaboration between academia, industry, and government agencies to address the challenges of deploying and integrating the proposed scheme in real-world urban environments. Furthermore, it recommends conducting field trials or pilot projects to validate the effectiveness of the scheme in practical settings and explore its interaction with existing infrastructure and traffic management systems.

Conclusion

In conclusion, the proposed intelligent routing scheme for emergency message dissemination in urban VANETs addresses the challenges posed by high vehicular density, frequent topology changes, and limited communication range. By utilizing vehicular traffic information, predictive routing algorithms, and adaptive message forwarding strategies, the scheme improves the message delivery ratio, reduces propagation delay and enhances scalability and efficiency. Real-world applications include emergency services, disaster management, and traffic management. While further research is needed to overcome coverage challenges and address privacy concerns, the proposed scheme holds promise for enhancing emergency message dissemination in urban VANETs.

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