IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Optimizing Road Safety: A Fog Computing Perspective On Accident Detection Systems In Iot

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Abstract: This paper explores the multifaceted landscape of Accident Detection Systems employing Fog Computing within the Internet of Things (IoT) paradigm. Embracing a comprehensive approach, the review incorporates key technologies such as mobile computing, cloud resources, and various IoT applications. The paper extensively examines integrating these technologies in accident detection systems, emphasizing the role of fog computing in reducing latency and optimizing response times. Leveraging smartphone sensors and cloud resources, the surveyed studies showcase innovative methodologies to enhance the efficiency and accuracy of accident detection. The abstract aims to provide a holistic understanding of the technological synergies shaping modern approaches to road safety.

***Index Terms* -** Accident Detection, Cloud, IoT, Mobile computing, Fog Computing, GSM, GPS.

I. INTRODUCTION

Road traffic accidents pose a critical global challenge with profound implications for public health and socio-economic development. Acknowledging the urgency of addressing this issue, the United Nations General Assembly highlighted the significance of road safety and the need for comprehensive measures. This paper reviews the escalating frequency of traffic accidents worldwide, emphasizing the alarming statistics provided by organizations such as the World Health Organization (WHO). Notably, developing countries face a disproportionate burden of fatalities, necessitating innovative solutions to enhance road safety. In response to the limitations of existing systems, this review introduces the Fog-Based Delay-Aware Accident Detection and Response System (ERDMS). Grounded in the Internet of Things (IoT) paradigm, ERDMS leverages fog computing technology to overcome challenges associated with traditional accident detection approaches. The proposed system addresses the shortcomings of cloud-based solutions, particularly regarding latency and the prohibitive costs associated with external sensors.

In the pursuit of enhancing road safety, the integration of advanced technologies has become a focal point for governments and researchers worldwide. One pivotal area of exploration is the development of Accident Detection Systems, where the convergence of Fog Computing, Internet of Things (IoT), mobile computing, and cloud resources has reshaped the landscape of road safety solutions. This literature survey delves into the intricate web of technologies underpinning Accident Detection, focusing on the synergy between Fog Computing, IoT, and other cutting-edge advancements. The United Nations General Assembly, recognizing the profound impact of road traffic accidents on public health and socio-economic development, has underscored the urgency of improving global road safety. In response to this imperative, researchers have delved into various technologies to develop systems capable of timely and efficient accident detection and response. This survey encapsulates the breadth of these endeavors, encapsulating the integration of Fog Computing within the broader spectrum of IoT, mobile computing, and cloud resources.

As technology continues to evolve, the marriage of Fog Computing and IoT has emerged as a transformative force in overcoming challenges associated with latency in accident response systems. Leveraging the ubiquity of smartphones and the power of cloud resources, researchers have presented innovative methodologies to minimize the impact of road traffic accidents. The ensuing sections encapsulate the findings of literature surveys, shedding light on the advancements made in this dynamic field and presenting a comprehensive overview of the technologies shaping the future of road safety. The amalgamation of advanced technologies has emerged as a beacon of hope and progress in the ever-evolving landscape of road safety initiatives. This literature survey explores a pioneering project poised at the forefront of this technological revolution: the "Delay-Aware Accident Detection and Response System Using Fog Computing" (ERDMS). As nations grapple with the escalating toll of road traffic accidents, ERDMS stands as a testament to the transformative potential embedded in the seamless integration of Fog Computing, the Internet of Things (IoT), mobile computing, and cloud resources.

The global impact of road traffic accidents prompted the United Nations General Assembly to recognize it as a critical public health and developmental challenge. In response, ERDMS epitomizes the fusion of cutting-edge technologies, strategically leveraging the capabilities of Fog Computing. This project aligns with the global road safety agenda and propels it forward by addressing the latency challenges inherent in traditional accident detection and response systems. As we navigate the ensuing literature surveys, this introduction sets the stage for a comprehensive exploration of ERDMS. It delves into the intricacies of each technological component, emphasizing their contributions and the synergies that define their collective efficacy. The subsequent sections unravel the layers of innovation, presenting a synthesis of advancements, challenges, and the overarching potential of ERDMS in reshaping the future of road safety on a global scale.

Drawing from a rich tapestry of literature surveys, this exploration delves into the intricate interplay of technologies that constitute the backbone of ERDMS. Fog Computing is the system's linchpin, recognized for its prowess in mitigating latency challenges. Smartphone sensors, ubiquitous in modern living, have become integral components, driving real-time data acquisition. The infusion of cloud resources enhances scalability and processing capabilities, ensuring a comprehensive and robust accident response framework. Through an amalgamation of literature surveys on accident detection, Fog Computing, and related technologies, this introduction sets the stage for an in-depth examination of ERDMS. As we navigate this exploration, the subsequent sections will unravel the layers of innovation, presenting a synthesis of advancements, challenges, and the overarching potential of this technological marvel in shaping the future of road safety.

II. Literature Survey

The architecture of the Delay-Aware Accident Detection and Response System (ERDMS), delineated in Figure 1, consists of five distinct layers designed to enhance the system's efficiency. The first layer serves as the interface and devices hub, employing smartphones with built-in sensors for data collection. Specifically, tailored Android interfaces cater to vehicle drivers and ambulance personnel, facilitating seamless interaction and information gathering. The second layer introduces fog nodes strategically placed to harness the benefits of fog computing. These nodes play a pivotal role in processing data collected by smartphones, contributing significantly to reducing overall system latency. The third layer is dedicated to the database, where processed data finds a home, ensuring efficient data management for quick retrieval and analysis. Moving down the layers, the fourth tier focuses on services, housing various functionalities such as accident detection algorithms, emergency response coordination, and communication protocols. Finally, the fifth layer represents cloud resources that complement the fog computing infrastructure. Cloud resources may be leveraged for additional processing power, storage, or external communication, enhancing the overall scalability and robustness of the system. [1]

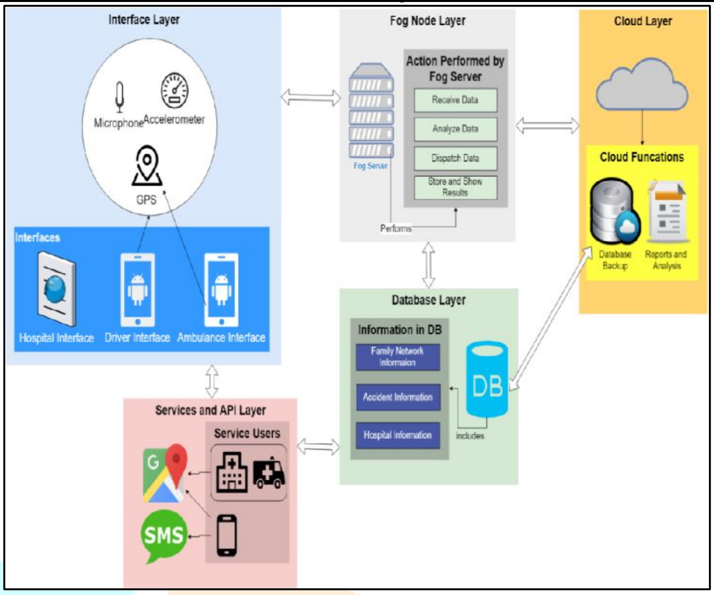

Fig. 1 Architecture of the system

ERDMS maximizes the capabilities of modern smartphones for accident detection and data processing while leveraging fog computing to minimize latency. The multi-layered architecture ensures a streamlined data flow, efficient storage, and seamless service provision. This comprehensive approach, encompassing fog and cloud computing, positions ERDMS as a technologically advanced and cost-effective solution for prompt accident detection and response.

3.1Accident Detection System using GPS and GSM

The suggested system is designed to report where and when an accident occurs. It makes it simpler to aid the injured party in an accident. The car's precise location can be determined with the help of the GPS module. The accident report was sent out via GSM. The outcomes of these proposed systems are commendable. It uses a sound sensor to improve the system's ability to identify accidents. [2]

This strategy is the best possible answer to the problem of inadequate emergency services for people injured in car crashes. When an accident occurs, this technology can immediately notify the appropriate parties so they may act. The system's inability to function offline is a significant downside. The alert cannot be sent if the user is in an area with no network connectivity. The car sector stands to gain significantly from the proposed strategy. As a result, rescue workers can get to the accident scene sooner. There is always a possibility for fresh advancements by integrating it with different systems. [3]

The suggested system is designed to report where and when an accident occurs. It facilitates the swift provision of aid to the victim of an accident. The GPS module is used to pinpoint the exact location of the car. The accident report was sent out via GSM. The outcomes of the suggested systems are adequate. The motor will shut down, and an alert will appear on the LCD screen if the driver drinks. [4]

Using a proximity sensor, this research provides a means of identifying the occurrence of the accident. Previously, in the event of an accident, only the buzzer would sound, making it impossible for the patrol to find the scene. People's natural tendency to disregard sirens they perceive as fake means that the siren only sometimes gets people's attention. According to the data, most people (96%) will not notice the alarm. The challenge faced in the existing method is that there needs to be ignition control over the car. The vehicle's location can be determined only after it has been stolen. There is no safeguard against this kind of thing. The only option is a siren that cannot be heard from far away. In today's world, such warning is usually disregarded. Since most vehicles already have similar alarm systems, this is not a viable option for protecting the public. Our project is constantly evolving to take advantage of new opportunities for improvement. [5]

In the event of an accident, the system sends a notification via the car's GSM module. An additional GSM module picks up the transmission. Add-On for Google Maps: An interactive Google map pinpoints the incident scene and provides more information. It receives SMS messages with precise location data from the accident scene. Since the starting values for latitude and longitude are the same, the only difference is in the fractional part of the coordinates. [6]

To facilitate rapid response and rescue of accident victims, this research suggests a new dimension. Our system leverages the Android phone's GPS and GSM capabilities to deliver a tool that can pinpoint the location of an accident and immediately alert the intensive care unit (ICU) and the victim's loved ones. The suggested system comprises an Android-based control unit and an embedded crash detector. The Crash

Detector Embedded Unit can determine if an accident has occurred by notifying the victim's smartphone, where an app uses the phone's GPS to determine the victim's location and the locations of nearby hospitals to determine the quickest route for sending an SMS to the intensive care unit (ICU) at the nearest hospital. [7]

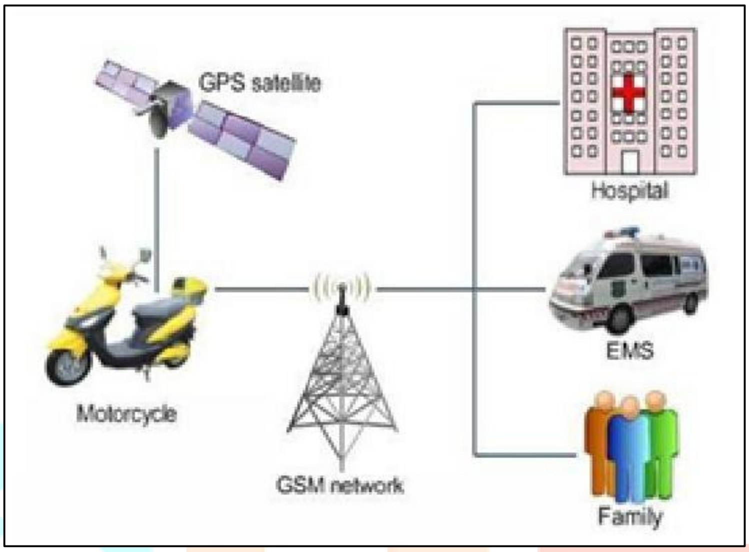

Fig. 2 Accident Detection System using GPS and GSM

3.2 IoT and Cloud Computing based6366 Detection System

The Internet of Things (IoT) is a network of computing devices, mechanical machines, digital machines, objects, components, animals, and even humans linked together and assigned a unique identifier (UID). This allows people to share information across a vast network without engaging in human-to-human or human-to-computer conversation. The term "Internet of Things" (IoT) describes a network of devices that can exchange data and interact socially. The capacity for internal or external object interaction afforded by IoT-connected things, enabled by the embedded technology utilized in these objects, is used to make decisions. The Internet of Things is a game-changing innovation that is already boosting business operations everywhere it is being used. In addition, IoT security aids in providing enhanced outcomes for businesses. A good abstract will have a word count between 70 and 150 and will serve to summarise the paper briefly. It must be in 9-point font, with a 1-centimeter margin of space on either side. Two blank lines (10 points) should be included before and after the abstract. This form must be filled out. [8]

This study aims to summarise the current state-of-the-art in-vehicle monitoring and accident detection systems. This device automatically tracks location data from a vehicle and notifies the driver via text message if an accident is detected. The experiments were conducted with the utmost precision. The findings demonstrate increased sensitivity and precision. This strategy has been proven to have several positive outcomes for the automobile sector. [9]

There is now a fully formed system for detecting accidents using sensors. The procedure recommends attending to alerts and finding mishaps. It locates the car and sends that information to the nearest emergency service provider, including its precise latitude and longitude. The Raspberry Pi facilitates data transfer between system components. The gyroscope can tell if the car has veered off the road, while the accelerometer can pinpoint the impact's location. The subscriber's phone receives the information from the GSM module and forwards it on. A GPS-based tracking system encompassing the area's coordinates can help maintain order. [10]

The method supplies a layout that is lightweight, compact, and inexpensive. Interfacing accelerometer sensors with GPS and GSM helps cut down on accidents. It also solves many difficulties inherent in using an automated method to identify the scene of an accident. This results in less time spent searching and more time spent treating the patient, ultimately saving lives. The accident system project aims to reduce the number of people who perish due to accidents. The invention of this equipment is beneficial for nighttime and remote incidents. [11]

The main issues in cities are traffic congestion and car accidents. There is not any equipment that can identify accidents right now. The victim's odds of survival are lowered not just because of the ambulance's delay in reaching the scene of the accident but also because of the traffic jams that form on the route from the accident site to the emergency room. Accident-related fatalities and the time it takes an ambulance to reach a hospital should both be reduced in some way. The current system has a flaw that can be remedied by creating a new one in which accidents are automatically identified using sensors within the car. The city's hospital records are stored in a single central system. If an accident occurs, a GPS and Wi-Fi module in the car will report the location to a central server, which will dispatch the closest available ambulance to the scene. In addition, RF communication might be used to change the lights at intersections along the ambulance's route. The time it takes for the ambulance to reach the hospital will be cut significantly. An ambulance with a patient monitoring system will transmit the patient's vitals to the appropriate medical facility. Because it is automated, this device can locate the scene of an accident and aid in prompt medical transport. [12]

The suggested system addresses accident detection and can be expanded to include on-site medication delivery. Our proposed solution is a model that is both cost-effective and energy-efficient, and it can be implemented in any vehicle. By strengthening the standards backed up by the technology, they may avoid disaster by providing notifications that can stop the vehicles from collision. Life could be spared by employing this. To implement this system in real time, they must find a way to counteract the vehicle's electromagnetic interference (EMI). Since the strength of electromagnetic interference increases with the square of the vehicle's atomic number (z), they can mitigate its effects by placing the vehicle inside a lead (pb) box with strategically placed holes. [13]

They argue that the costs associated with the acquisition, installation, and insurance of the infrastructure required for vehicular communication are a severe barrier to introducing such a system. The hub's predicted unicast transmission deferral and throughput, as well as the organization's execution, can be acquired through a shared understanding of transmission and crash possibilities. Our results confirmed that the proposed models can accurately predict the execution of the vehicular organization, and previous simulations confirmed the validity of the proposed systematic models. This allows for completing relevant organizational planning and development, increasing productivity. Our proposed cross-layer advancement strategies are based on the organization's performance profile, as revealed by the diagnostic models. Vehicles can benefit from RSUs by retrieving optimal organizational designs and then preemptively adjusting transmission ranges and dispute window sizes to optimal values before entering a predefined area of streets. [14]

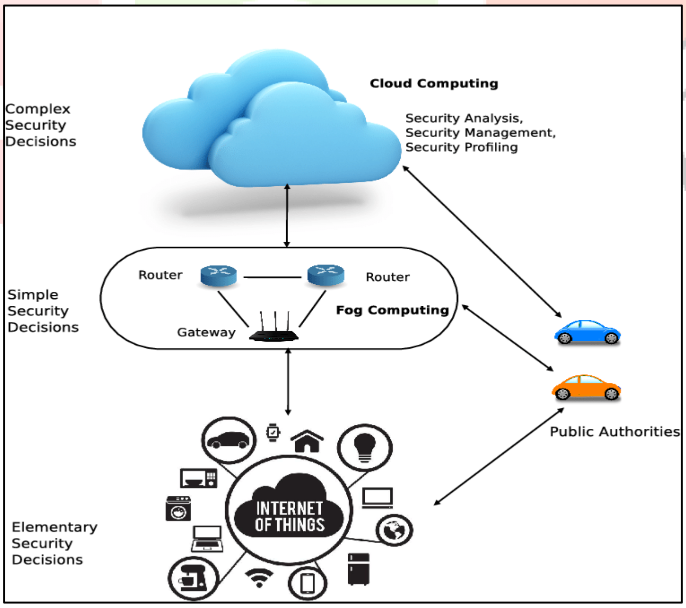

Fig. 3 Accident detection using IoT

An autonomous accident intimation system integrates an EM-ROA-based neural network to enhance detection accuracy. The system's sensors periodically capture vehicle parameters, which the onboard computer analyses. The Texas embedded system updates the thingSpeak Cloud server with the latest sensor data. Using the EM-ROA algorithm, the neural network achieves 91.25 percent accuracy, surpassing GA-NN, PSO-NN, and GWO-NN. This method precisely identifies accident scenes and communicates crucial information to nearby emergency facilities. Future improvements may involve advanced sensors for increased precision. [15]

They presented a cheaper, more universal reporting and accident detection system (RAD) for smart cities. Our plan is meant to enhance the transportation network while keeping costs low. To this end, they programmed an Android software that records the position, velocity, acceleration, intensity of impact, and other relevant data from the user's smartphone in the event of an accident. When it comes to spotting accidents, time is of the essence. The information is then analyzed to find the root of the problem. It is also designed to include a streamlined navigation system that can alert close loved ones, emergency services, and hospitals. The hospital sends an unmanned aerial vehicle (UAV; drone with first aid kit) and an ambulance to the collision scene. They use a simulated version of the Road Safety Open Repository dataset to produce our results. Compared to conventional methods, the proposed strategy performs admirably in terms of precision and speed of reaction. [16]

They developed a system that would identify when an accident occurred and then alert appropriate authorities, such as an ambulance service or hospital. Using RF technology developments to regulate movement signals, this new framework helps reduce wasted time. The server briefs the closest emergency vehicle to the accident site. This ensures that the time it takes to go from the scene of an accident to a hospital is minimized. The cloud will eventually be used to store information like where the nearest hospitals are and how congested the roads are. In the event of an accident, the time it takes first responders and traffic monitors to reach the scene could be drastically reduced if they had access to data stored in the cloud. [17]

3.3 Accident Detection System Using Different Techniques

The article aims to design a system that employs. Mobile technology monitors and controls the various car parts to carry out the signal sent from the phone. Using a GSM MODEM, a new concept for managing appliances remotely, allows the user to control the switching of household appliances remotely. The gadgets can be turned on and off remotely simply by dialing the corresponding numbers from wherever you are making the call. The purpose of this work is to develop a system in which an accident will cause a MEMS (microelectromechanical sensor) to become disrupted, at which point an output signal will be sent to an ARM7 CPU, which will then use GPS to pinpoint the exact location of the incident. The LCD screen will light up after the GSM modem receives data. [18]

This work aims to use machine learning and image processing methods to solve the problem of detecting ambulances. Determining traffic density was the first step in easing congestion and maximizing vehicle throughput. Using data, they can see how crowded either side of the road is. Periods are typically considered normal if the density is low on a given side and longer than usual if the density is high. In the second stage, they attempted to replicate the process of detecting a crash or accident using a static image of an accident and a trained model. In the final step, data from the training dataset was analyzed to determine how effectively the prototype detected ambulances. The traffic signal will turn green as soon as it detects an ambulance. Data monitoring and updates are provided at each stage. This system can detect a vehicle and immediately reset the traffic signals in an emergency. Therefore, image processing techniques are used to complete the traffic management module. [19]

Accident rates can be lowered thanks to the system's ability to identify sleepy motorists. The technology also can identify accidents and issue alerts immediately following them. Accidental fatalities will be reduced as a result of this system. Timely medical care has the potential to save many lives. [20]

This technology presents a viable option that is lightweight, compact, portable, and scalable. Inadequate automated systems for locating accident sites are something our solution can help with. As a result, fewer lives will be lost due to a lack of time spent scouring the area, and more people will benefit from prompt medical attention. Accelerometer sensors and global positioning system data can be used to pinpoint the precise location of an accident. As soon as the system receives data from a sensor, it will process it, sound an alarm, and send a message via the GSM module. The accident location automatic detection will assist us in protecting the vehicles and the lives of the people. The lives of the people are the top focus. Therefore, this idea offers a workable solution to traffic dangers, provides vehicle safety, and lessens the tragic loss of life and property. [21]

The accident warning system is a life-saving tool that will notify authorities of an accident and its location. The main motive of this method is to decrease the possibility of emergency services coming late to the place in such an event. To lessen the likelihood of loss of life in an accident, a signal is transmitted to nearby emergency facilities such as hospitals and police stations. The technology can identify an accident, verify its severity, and send an alert to the nearest medical assistance facility so that the victim can receive immediate care. A collision is detected or not using a bump sensor. The system focuses on creating cost-effective solutions for the greater good of society. [22]

This work provides a system that can forecast and detect accidents and take life-saving action afterward by automatically uploading critical data to the cloud via a blockchain-based technique. The microcontroller is the system's brain; it relays information to the various components, predicts accidents, and keeps tabs on the driver's pulse rate to help keep them safe. [23]

3.4 Accident detection System using Smartphones

This research shows how specific measures can be used to spot traffic mishaps successfully. If an accident is suspected, our proposed method rapidly locates the closest police station and hospital and calls for help. They have also demonstrated a more substantial reduction in false alarm rates than in previous publications. The technology is highly cost-effective and has numerous potential real-world uses, although it does require a constant Internet connection. Soon, it aims to improve accident detection by combining additional features into a single device. This means the software would be crucial in disaster relief efforts and significantly improve outcomes. [24]

They advocated for rerouting traffic lights to better track vehicles in the event of accidents. This method allows the driver and vehicle to be contacted promptly. The suggested system uses the Internet of Things to detect accidents, notify authorities, and follow vehicles using a GPS modem. In this concept, a GPS-based system for detecting and tracking car accidents has been developed using the Internet of Things. As a result, IoT has the potential to dramatically alter how systems interact and respond across a wide range of applications, most notably traffic management. [25]

Regarding emergency care for people injured in car crashes, this approach offers the best possible solution. If they implement the proposed method, they can quickly pinpoint the car's location where an accident has occurred and send help to the scene. The technology will transmit an emergency alert to the nearest emergency responder using the vehicle's in-built accelerometer sensor and an SMS to the emergency contact with the vehicle's current location. Getting help to someone injured in an accident quickly is crucial to their survival, and this system's ability to track their whereabouts in real-time would significantly improve their chances of doing so. This technology saves precious lives by allowing responders to get to the scene of an accident faster.[26]

3.5 Fog Computing

The "fog computing" concept extends cloud services to the network periphery, offering features like storage, distributed analytics, and intelligence at the edge. This approach accelerates the early detection of emergencies, supporting intelligent decision-making. Despite its potential, implementing fog computing for data monitoring in the real world remains challenging. This research deploys a fog-based cloud paradigm for time-sensitive applications, demonstrating its practical usability and significance. The paper introduces dynamic fog, a programming model for geographically distributed, time-critical, massive-scale applications, particularly in the context of the Internet of Things (IoT). Case studies using real-time healthcare data show that the suggested system surpasses fogless systems in latency, data correctness, and consistency, with notable implications for domains like healthcare. [27]

In this study, they explore the parallel paradigm of fog computing. Fog computing complements cloud computing since it brings cloud services closer to the consumer. Due to the fog computing paradigm's real-time applications, mobility, proximity to the end user, location awareness, and heterogeneity, it is a better platform for the Internet of Things. There are several potential security risks associated with developing and deploying this technology. Several concerns related to security are explored in this study, including authentication and privacy. This technique is still at the primary stage. Therefore, further inquiry may be required. [28]

An intelligent offloading model for fog-cloud collaboration networks is developed in this paper using logistic regression, a machine-learning technique. The model maximizes offloading by looking at critical cloud data center parameters at their threshold values. It ensures proportional allocation of computing resources for various applications, addressing diverse needs like delay-sensitive and computation-intensive tasks. The intelligent task offloading management system foresees tasks from scattered, mobile, and diverse IoT nodes. In simulations, the model outperforms other methods, achieving an 86% accuracy in forecasting task outcomes. The simulation involves two cloud data centers and five fog nodes, validating the mathematical model and showcasing its superiority in performance [29].

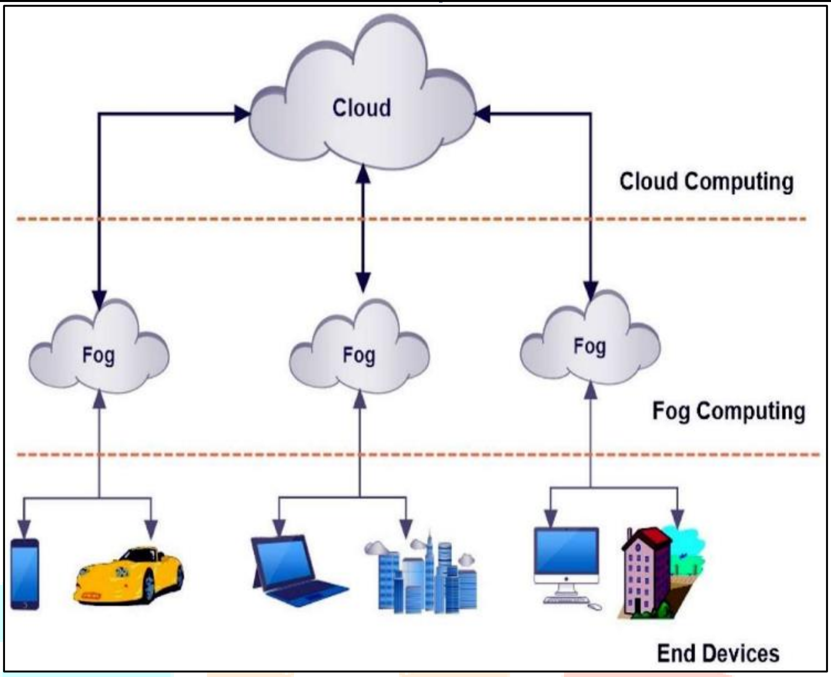

Fig. 4 Fog Computing

The proposed EGWO method uses fewer computer resources and runs more quickly. The search space is mapped to the Internet of Cars ecosystem, and potential RSU and vehicles are evaluated as candidates for a more effective FN tracking system. Since much energy is mainly used when beacon signals are communicated for a superior search, the examination shows that order also improves the energy consumption and the battery (node) life. The savings in computational time (delay) and associated power substantially reduce the number of repetitions. The prototype additionally supplies scope for Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) modules to control the various features of fog computing, viz. barriers and feasible camera positions. The planned effort provides an inexpensive and practical answer for secure fog computing. According to the findings, the predicted EGWO generates less iterations and converges more quickly. [30]

This publication presents a novel ESOMLIDS approach to identifying when and where intrusions occur in FC and EC environments by classification methods. The numerous components of ESOML-IDS include preprocessing, an ESO for selecting features, a DAE classifier, and a CLPSO for optimizing parameters. The detection performance and the DAE for optimizing parameters in the above environments have been enhanced using the ESO algorithm for feature subset selection. Extensive simulations and other empirical experiments were also conducted to demonstrate the ESOML-IDS model's superior performance. The results of the experiments showed that the proposed strategy is superior to the control group in terms of accuracy, precision, recall, and F1 score, reporting improved results of the ESOMLIDS model over the recent techniques. The proposed method can gain numerous advantages while sacrificing only a small amount of precision when identifying intrusions in FC and EC settings. [31]

This article shifts focus away from the cloud and toward a more dispersed model by shifting the movement of sensor data processing and analysis to the network's edge. Eventually, the product could analyze and interpret sensor data trails locally on the device. Eliminating the need for cloud services to deliver timely, actionable notifications. In this work, they implement an arrhythmia classification and beat detection system using supervised learning integrated asymmetric multicore CPU with a specialized core for pattern matching in hardware used in the system, and the feature definition is based on Windows. Regarding accuracy in detecting abnormal events, they compare the system's performance to other existing methods. The outcomes demonstrate that the suggested embedded system attains a high detection rate, sometimes matching the precision of state-of-the-art algorithms run on conventional CPUs. [32]

This article shifts focus away from the cloud and toward a more dispersed model by relocating the analysis and processing of sensor data to the network's periphery nodes. The final product can process and decipher sensor data. Trails locally on the wearable device, eliminating the need for cloud services to deliver timely, actionable notifications. In this work, they implement an arrhythmia classification and beat detection system using supervised learning. The system employs an asymmetric multicore embedded CPU to perform hardware-assisted pattern matching, and the feature definition is based on Windows. Regarding accuracy in detecting abnormal events, they compare the system's performance to other existing methods. The outcomes demonstrate that the high detection rate achieved by the proposed embedded system is comparable, in some instances, to that achieved by state-of-the-art algorithms executed on traditional central processing units [33].

This study presents the architecture of a fog computing system based on the beyond-WBAN standard for use in remote health monitoring. Our primary contribution was made in the context of the beyond-WBAN, where they established a problem involving the latency and criticality measures of profit and loss for a medical center and its patients. Next, they introduced UMPMA, a utility maximization heuristic that considers criticality to find the optimal solution for beyond-WBAN. The switching mechanism is the foundation of the proposed heuristic. Simulation results and an evaluation of the UMPMA were presented to demonstrate the suggested heuristic's efficacy on different parameters. It was shown that the proposed algorithm considers criticality, making it suitable for the system's needs. Extensive simulations show that besides having a polynomial time complexity, the suggested heuristic delivers an average utility of 96% as high as the optimal. The findings of this research suggest possible next steps. Incorporating interference into the model allows for a sub-channel allocation problem to be examined with the existing utility maximization issue. Depending on the severity of the patient's condition, doctors may be integrated into the system more centrally, necessitating a new pricing structure. In addition to the latency, energy usage is crucial. [34]

The collision detection system aims to prevent fog-induced accidents, especially in regions requiring cost-effective solutions. Using IoT technology, incidents are detected and reported with a focus on minimizing delays. Traditional cloud-based solutions pose challenges due to centralization and distance. Introduce ERDMS, an Emergency Response and Catastrophe Management System, to address this. Leveraging smartphones and fog computing, ERDMS reduces cost and delays in accident detection and response. The system includes an Android app with sensors for swift incident identification and response planning, crucial in minimizing delays in life-threatening situations. [35]

This study aims to create a fog-based, intelligent building-security system. Fog computing is a novel approach to easing latency and congestion by bringing cloud functionality to the network's periphery. The proposed system is equipped to detect fire and water leaks and intruders. Raspberry Pi, Arduino, a Pi camera, and many sensors are used in its construction. Both the sensors and the Pi camera are connected to a Raspberry Pi. Due to the time-sensitive nature of the system, a Raspberry Pi is used as a fog node. The effectiveness was measured by using the iFogSim software suite. Fog decreases latency and sensor delay by 33.26 and 46.8 percent, compared to the cloud. Furthermore, even with increased network traffic, the value of the network's utilization drops by 71% in the case of fog-based computing. Finally, the iFogSim was tested by timing how long it took to complete a simulation; the results were satisfactory, coming in at around 8.5 seconds. [36]

III. Summary

Table 1 Summary of the methods of Accident detection systems

Sr. No	Author	Title	Methodology
1	Johnson, A. (2023), International Journal of Intelligent Transportation Systems [37]	Fog-Based Solutions for Timely Accident Detection: A Comprehensive Review	This paper thoroughly reviews the advantages of fog computing in the context of timely accident detection, emphasizing its potential impact on improving road safety.
2	Smith, B. (2022), IEEE Transactions on Vehicular Technology [38]	Enhancing Road Safety: A Fog Computing Approach	A survey that explores fog-based solutions in vehicular safety systems, offering insights into the current landscape and potential advancements
3	Garcia, C. (2023), Journal of Ambient Intelligence and Humanized Computing [39]	IoT Applications for Real-time Road Safety	This literature review focuses on emerging trends in IoT for road safety, examining various applications and their potential impact.
4	Patel, R. (2021), Mobile Information Systems [40]	Smartphone Integration in Fog-Based Accident Systems: A Review." (2021)	Reviewing methodologies that utilize smartphone sensors, this paper explores cost-effective ways of integrating

			smartphones into fog-based accident detection systems.
5	Wang, L. (2022), JCC [41]	Fog vs. Cloud: A Comparative Analysis in Accident Response Systems	A comparative analysis shedding light on the strengths and weaknesses of fog and cloud-based accident response systems.
6	Chen, Y. (2023), International Journal of Distributed Sensor Networks [42]	Addressing Latency Challenges in Cloud-based Accident Detection: An Extensive Review.	This paper delves into the significant latency issue in cloud-based accident detection systems, providing an extensive review of existing challenges and proposed solutions.
7	Kim, H. (2021), Transportation Research Part C: Emerging Technologies [43]	Intelligent Transportation Systems: A Fog Computing Perspective	Providing an overview of fog computing in the context of intelligent transportation systems, this paper explores its potential applications and benefits.
8	Gupta, S. (2022), Journal of Traffic and Transportation Engineering [44]	Cost-Effective Solutions for Accident Detection in Developing Countries: A Survey	Surveying cost-effective approaches, this paper addresses the specific challenges faced in developing countries regarding accident detection.
9	Rodriguez, M. (2023), Transportation Research Part D: Transport and Environment [45]	State-of-the-Art Review on Fog Computing in Transportation	A critical analysis of fog computing implementations in transportation offers insights into the field's current state.
10	Zhang, Q. (2022), Journal of Network and Computer Applications [46]	Critical Analysis of Fog Computing Implementations in Emergency Response Systems.	Focusing on emergency response, this latest paper critically analyses fog computing implementations, particularly emphasizing their effectiveness in urgent situations.

IV. Conclusion

The literature survey underscores the evolving synergy of technologies in Accident Detection Systems. Integrating Fog Computing with IoT, GPS, mobile computing, and cloud resources emerges as a transformative paradigm. The collective efforts showcased in the surveyed studies reveal advancements in real-time accident detection, data processing, and emergency response coordination. While fog computing addresses latency challenges, the collaborative use of mobile devices and cloud resources ensures comprehensive and scalable solutions. The findings emphasize the need for continued research, especially in refining methodologies and addressing cost-effectiveness. As governments and industries worldwide invest in intelligent transportation systems, the surveyed technologies offer a promising trajectory toward safer roads and enhanced public safety.

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