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Employing the Beamforming Technique to Enhance the Medical Ambulance Performance, IoMT

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Keywords:
IOMT; 5G; Ambulances; MIMO; V2X; Network architectures.

Highlights:

- Design a smart ambulance that can reach the patient's location.
- Structural performance using 3D beamforming technology of the fifth generation.
- Smart ambulances are supported by V2X technology, which uses beamforming techniques.

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Abstract: The radio frequency signal is important for improving the connection among patients, hospitals, and healthcare ambulances. Emergency specialists significantly monitored global healthcare in real-life conditions during the previous century, depending on telecommunications. 5G mobile telecommunication networks have increased smart navigation with 3D dimensions' position for drones, unmanned aerial vehicles, and ambulance vehicles. Ambulances equipped with the Internet of Medical Things (IoMT) enabled smart antennas are the subject of this research. The article's objective is to improve the performance of medical ambulances in real-time and safe health zones by employing the beamforming technique of 5G with advanced MIMO technologies and using vehicles for everything (V2X). Critical components like patient care, delay, and road traffic are analyzed and considered for various smart connections between ambulances and patients to hospitals. The results will help reduce the time delay in transferring data to healthcare systems, which profoundly impacts transferring patient care data faster, enabling healthcare providers to access medical information about the patient. Simulations are used to confirm theoretical results.

توظيف تقنية تشكيل الشعاع لتحسين أداء سيارات الإسعاف الطبية IoMT

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الخلاصة

تعد إشارة التردد اللاسلكي لتحسين الاتصال بين المرضى والمستشفيات وسيارات إسعاف الرعاية الصحية مهمة جدًا، اعتمادًا على الاتصالات. ساهمت شبكات الاتصالات المتنقلة G٥ في زيادة الملاحة الذكية مع وضع الأبعاد ثلاثية الأبعاد للطائرات بدون طيار والمركبات الجوية بدون طيار ومركبات الإسعاف. سيارات الإسعاف المجهزة بالهوائيات الذكية التي تدعم إنترنت الأشياء الطبية (IoMT) هي موضوع هذا البحث. هدف المقال هو تحسين أداء سيارات الإسعاف الطبية في المناطق الصحية الآمنة في الوقت الحقيقي من خلال توظيف تقنية تشكيل الشعاع G٥ مع تقنيات MIMO المتقدمة واستخدام المركبات في كل شيء (V2X). يتم تحليل المكونات الحيوية مثل رعاية المرضى والتأخير وحركة المرور على الطرق وأخذها في الاعتبار لمختلف الاتصالات الذكية بين سيارات الإسعاف والمرضى والمستشفيات. وستساعد النتائج التي تم الحصول عليها في تقليل التأخير الزمني في نقل البيانات إلى أنظمة الرعاية الصحية، مما يؤثر بشكل كبير على نقل بيانات رعاية المرضى بشكل أسرع، مما يمكّن مقدمي الرعاية الصحية من الوصول إلى المعلومات الطبية حول المريض. وتستخدم عمليات المحاكاة لتأكيد النتائج النظرية.

الكلمات الدالة: انترنت طب الاشياء؛ الجيل الخامس؛ سيارات الإسعاف؛ متعدد الادخال متعدد المخرجات؛ المركبات الى كل شيء؛ معمارية الشبكة.

1.INTRODUCTION

The Internet of Things (IoT) has gained popularity in academic, medical, and industrial circles in recent years because of its potential to improve daily living [1] during the COVID-19 pandemic [2-7]. The 3rd Generation Partnership Project (3GPP) has supported Quality of Service (QoS) [8-9], radiofrequency bands to optimize phased array, vehicular and drones, channel fading [10], then to improve the channel capacity when the number of antennas in the transceiver is same [11]. Improving antenna selection algorithms to achieve energy efficiency while increasing capacity and processing time is discussed in [12]. Shahab et al. [13], it was conducted to compare theoretical and simulation results under additive white Gaussian noise (AWGN) with MIMO-OFDM, in which this performance improvement resulted in significant gains in energy efficiency. Therefore, Beamforming techniques were used for the radiation pattern of the antenna array to focus the transmitted energy towards the intended receiver while reducing interference from other directions in the millimeter wave (mmWave) frequency bands, as beamforming improves link reliability [14, 15]. Designed and developed portable and low-cost monitoring devices for real-time monitoring IoT-based air pollution monitoring technology helped to assess air quality and identify pollution hotspots. Also, IoT has supplied medical and transportation support services as the number of IoT devices creating and exchanging information with each other around the world has grown. IoT devices help ensure low-cost connectivity worldwide based on deep learning [16]. Al-Sharify et al. [17] must explore ways to integrate IoMT solutions into existing healthcare infrastructures by enhancing ambulances, allocating resources, and monitoring in real-time. Smart ambulances and telemedicine technologies were developed because the process of collecting, storing, processing, and retrieving information during an emergency call is inefficient and time-consuming, resulting in the most prevalent weak link, which is connected with inefficient emergency operations and ineffective communication involving information exchange between patients (or their families), ambulances, and medical facilities. Thousands of lives are lost before patients arrive at hospitals in ambulances. Spending time traveling great distances can be a deadly cause of death in rural locations where patients are placed far from the hospital. In busy metropolitan areas, unexpected traffic circumstances create a significant danger of delaying appropriate rescue procedures. Ambulances with 5G Internet of Things Connectivity Activating the Emergency Medical System Many high-tech technologies are gradually being included in the emergency medical system as IoMT technology advances. Connected Ambulances, equipped with high-bandwidth 5G and ultra-reliable connection, greatly enhance rescue efficiency with V2X. On the other hand, medical

monitoring connectivity devices are desirable in all places, especially now that 5G coverage is accessible for better healthcare. Corona-19 and the rising numbers of people suffering from chronic diseases have made it more critical to find new and better ways to treat people [18, 19]. With 5G features and the 5G key performance indicators (KPIs), the ambulance could better communicate with the monitoring telecommunication servers. From end-to-end, such as from an ambulance to healthcare servers in countries and from a mobile patient to a hospital monitoring healthcare, V2X will provide faster transit information between end-to-end that improves low latency and higher node densities. V2X will interconnect devices, such as medical operation procedures, patient terminal phones, and ambulance servers, beginning with the 3GPP specification [20-22]. V2X mobility enhancements [20, 23, 24] based on inter-cell mobility to the ambulance send a signal to the traffic light to temporarily alter the light to green so that the vehicle may proceed through the junction without stopping, accelerating mobility improvements based on the IoT and 5G technologies. V2X was incorporated into the transfer data package, so we proposed using IoT, the Internet of Medical Think (IOMT), and V2X with 5G to change the traffic light for the ambulance road so that a nearby ambulance be found as quickly as possible and then deliver the patient to the correct hospital in a shorter amount of time. The transfer data package used V2X as moving into focus. Therefore, from the literature above, it was proposed that a nearby ambulance for the patients be found as fast as possible and that the patient be sent to the correct hospital faster with IoT, Internet of Medical Think (IoMT). Also, 5G of V2X can change the traffic light for the ambulance road.

2.TAXONOMIC AND TECHNOLOGICAL INVESTIGATION

There are many terms of communication between different machines and generations of communication, which is called M2M (machine-to-machine) or (D2D) device-to-device communication, i.e., a concept that provides clear definitions of communication between the end and end (E2E) and between Point and Point P2P. There are other types of terms, such as Vehicle-to-Vehicle (V2V), Car to Car (C2C), or Vehicle to Everything (V2X). Multitasking aims to harmonize terminology to provide clarity and stability time. Sensors or other devices try to identify many interactions, such as the availability of safety updates, traffic, traffic lights, and vehicle sensor networks (VSN). The Internet of Things is critical in changing transportation services and cars into intelligent transportation systems by enabling the detection of locations and traffic congestion using artificial intelligence and analyzing more significant data processes. As a function of IOMT, ambulance in-vehicle communications garner considerable attention in the health and healthcare industry. The ambulance requires a time control unit to provide excellent travel possibilities to the nearest hospital. Smartphones, smartwatches, and tablets are the patient's primary means of telecommunication with the healthcare unit's server. This study focuses on V2X infrastructure telecommunications between ambulances and other vehicles or devices. Ambulances, for example, can be used to connect infrastructure to any other type of organization. Telemedicine infrastructure and its connectivity with city sensors, together with 5G's use of 3D-beamforming technology, would ensure that an ambulance can reach a hospital quickly in an emergency. Despite the rapid development of IoT applications and intelligent networks in cooperation with radiofrequency spectrum regulation and technology standardization by regulatory associations worldwide, some limitations still delay medical infrastructure from synchronizing the wheel of global development. Each country has a unique radio frequency band that is not interoperable across different regions and generations of communication. Also, each generation has its advantages and spectrum frequencies [25, 26]. On the other hand, the investment provides speed in development, so the healthcare units have proved this with the help of programmers, telecom engineers, doctors, and medical engineers for compatibility in medical care that takes time to implement due to the many existing infrastructures [27], indicating that 5G networks will be adopted at a rate different from infrastructure-based alternatives.

3.AMBULANCE AND THE ROAD

A rapid ambulance is critical to saving patients' lives. Still, road safety is also essential as using vehicle communication with cellular networks because it saves lives and avoids Safe access to primary and limited roads to avoid collisions at intersections if they are crowded or occupied in the transport lane based on a transport protocol based on emergency warning messages received from the Internet of Things software as a feature to avoid collision-based accidents on highways and allows the prediction of congestion in the area of based solutions algorithms to detect crowding situations. As shown in Fig. 1, infrastructure for ambulance traffic gives a method based on collaborative communication technologies for vehicles introduced in this research.

3.1.Security and Telemedicine

Security and confidentiality of patient and movement information in the vehicle, as many methods are included in the V2X process to protect all vehicles from security breaches that can lead to severe consequences for passengers.

Communications generation and when 4G/LTE - or 5G - is utilized as an access technology, key agreement protocols are employed to safeguard communications from potential attacks [28, 29]. Develop an appropriate protocol for transmitting and consuming low-power data that prevents denial of service attacks and protects and evaluates the dependability of nodes that communicate over the network [30-32]. It also provides a different approach as a neural network [33] to Multimedia Broadcasting-Services and Applications (MBMS) to support video streaming during the circulation of vehicles on public roads for safety purposes, while the latter is used to transmit multimedia content. Other ways, depending on connection topology, to enable network stability and scalability and data flow can also be found to solve common resource problems using graphs, producing better results than traditional methods and providing V2I connectivity in regions with a massive density of traffic and data throughput. A V2X technology recognizes traffic lights on public roads and connects with a cloud server to anticipate how quickly a vehicle must reach green lights and wait periods while the lights are red [34]. Traffic Technology Service (TTS) created it, and this technology enables more environmentally friendly driving and minor damage to vehicle components.

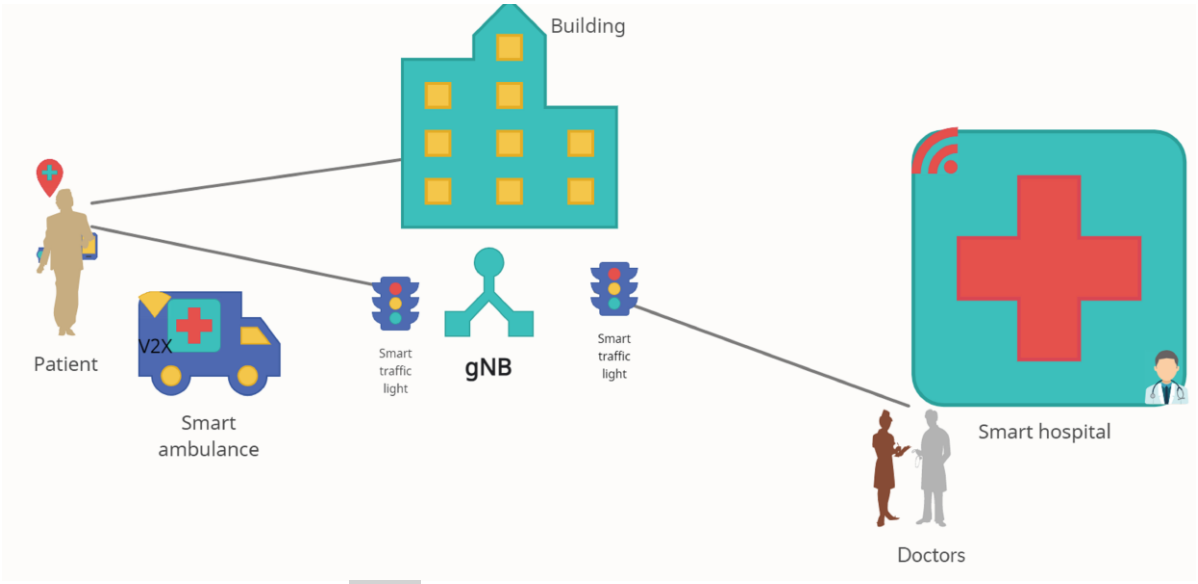

Fig. 1 Infrastructure for Ambulance Road.

3.2.Smart Ambulance

The 5G smart ambulance enables patients and ambulance crew to be connected at the scene of an accident or during a sudden health attack with the emergency department team equipped in the hospital to improve the patient rescue rate and simulate algorithmic performance. Smart Ambulance aims the smart ambulance service, supporting 5G technology in health care settings for different emergency scenarios in accessing and assisting in the treatment speed and the accuracy of a smart ambulance equipped with 5G technology, and provides practical insights to build a 5G network, business development, and network optimization for the smart ambulance service.

3.3.Architecture of IoMT Networks

The network's primary goal is to measure, collect, and process information [35, 36], so IoMT will be presented by the monitored real items (i.e., the patient's body and the patient's environment), as well as transmit data collected through all the IoMT portal to the medical server database, at which healthcare-based platform is found. Cloud computing for a healthcare system using IoT to process, analyze, store, and make decisions by providing the best transportation for the patient to the appropriate hospital. Moreover, the IoMT terminal network facilitates receiving appropriate control orders from the smart medical processing unit to the actuators through IoMT applications. From Fig. 2, the architecture and design of the smart ambulance, it is crucial to indicate the requirements of the ambulance and the Internet of Medical Things devices must meet to support the delivery of the ambulance to the proposed location of the patient using the 3D-Beamforming in 5G technology. First of all, work to provide the fastest route as well as control traffic lights by using V2X technology supported by the fifth generation of communications that facilitate access to the behavior data of paramedics (for example, chronic or infectious diseases such as COVID-19), and then be able to capture packets and network information about IoMT devices and healthcare services; And then extract the data to support each of the standard operations and investigate them at the maximum speed, such as the transfer and specialization of the

receiving doctors in the hospital at the moment of the patient's arrival. On the other hand, each IoMT is necessary to access patient data and find the best and closest medical staff available in that province.

3.4.Analyze the Objectives of Using IoMT

Monitoring is the server's behavior hosted by the health organization or hospital, collecting relevant behavior data, such as the cumulative consumption of the central health control unit, and providing the specific medical analysis (sampling). Monitor network-assisted road traffic passing through the server and collect traffic data to provide the fastest transmission routes, such as V2X, a destination address, connection state information, and packet content information. Then, the receiving reports are analyzed by sending them from monitoring and data acquisition components operating on IoMT devices connected to the server, as well as more operations on it.

4.METHODS AND MATERIALS

Employing beamforming technology to improve the performance of medical ambulances will transform the smart ambulance system that takes advantage of telemedicine and 5G technology, with a special focus on V2X and IoMT applications. It will depend primarily on the design of the smart ambulance, including the integration of telemedicine capabilities and 5G technology and the use of specifications for smart ambulance equipment based on remote control through IoMT systems. One of the features of the fifth generation is the availability of two very distinctive features, namely massive MIMO and 3D beamforming. With the development of V2X deployment models for the smart ambulance system, which considered V2X communications in different geographical regions, the network algorithms used to improve V2X operation under different scenarios were determined. It included communication units, sensors, and simulation tools to determine the patient's location, knowing that the simulation tools would provide smart healthcare services and emergency interventions through the smart ambulance system. At this moment, the importance of the integration would include integrating the smart ambulance system with an accurate model of the fifth-generation wireless network to support the 5G network infrastructure through high-speed data transfer, recalling patient data between the server located in each patient's health care centers and communicating with telemedicine applications. To implement and know the accuracy of the patient's location and send the ambulance to the most accurate location and in the fastest time, it will depend entirely on three-dimensional beam formation, which will enhance the performance of the automated record analysis in the smart ambulance system, which will improve the signal dissemination and reception in different environmental conditions, as shown in the fifth section, with several scenarios and statistical analysis. Each scenario in the fifth section will provide a comprehensive overview of the methods, materials, and experimental procedures used in 5G telecommunication for modern telemedicine ambulances.

5.RESULTS AND DISCUSSION

The proposed smart ambulance to be used, depending on telemedicine in the fifth-generation technology with models of the environment for the deployment of V2X as an application through network algorithm, allowing the operation of emergency services under different scenarios and verifying the effectiveness of the behavior of the Internet of Medicine Things with a test of the first therapeutic models of V2X applications in cooperation with an accurate fifth-generation wireless network model to implement a 3D-beamforming propagation model and improve the performance of automated log analysis.

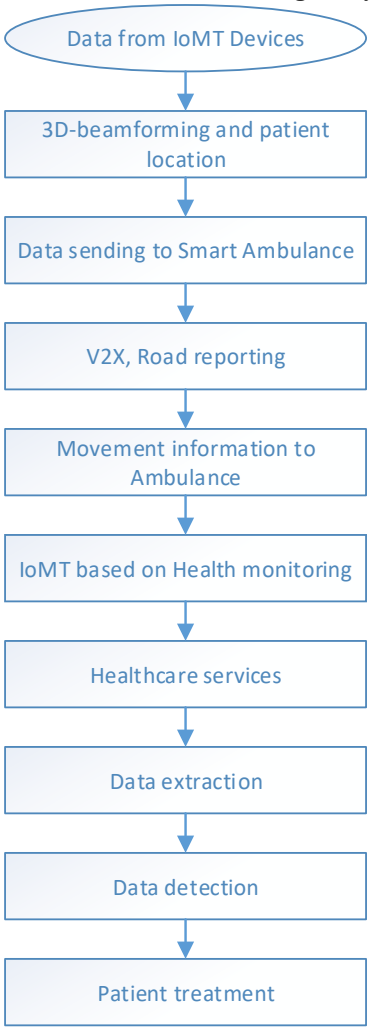

Fig. 2 Flowchart of Extraction of Patient Data Health from IoMT Devices.

Table 1 The Main Parameter of the Smart Ambulance Antenna used 5G Technology and V2X.

Parameter	Range
Frequency	28 GHz
Bandwidth	800 MHz
Distance range	10-1000 meter
Environment	LOS
Number of the transmission antenna	8
Number of receiving antenna	8
Highest V2X antenna in the ambulance	1.5 m – 3 m
Transmitter power	30 dBm
Higher base station	2.8 m
Type of receiver location	Patients, Traffic lights, healthcare servers, and Hospital
Ambulance velocity	1 till 30 m/s
Transmission antenna type	URA
Modulation	8x8 MIMO
Transceiver's antenna spacing	0.5 wavelength
Transceiver's antenna Azimuth	10 degrees

Based on the Table 1 above, the velocity of the ambulance to the patient locations can help to give the perfect healthcare to patients despite different distances fast (the results are shown in Fig. 3). It also assists in the arrival of the ambulance to the patient's site by relying on the Internet of Things systems and helps to control traffic lights based on the V2X technology available in the 5G. Also, it is possible to rely on the previous algorithm in Fig. 2 to deliver the patient as quickly as possible to the available doctor in the hospital while informing the doctor of the patient's condition by relying on the smart medical devices available in the ambulance.

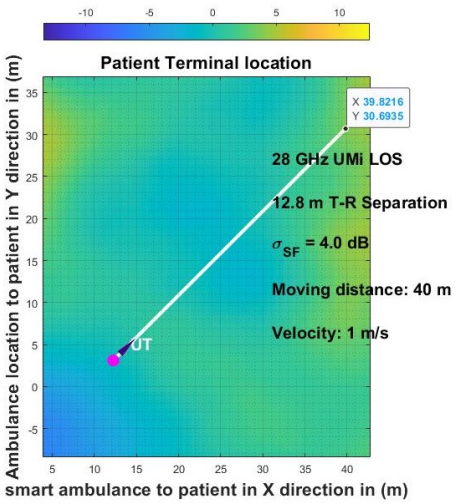

Fig. 3 Smart Ambulance and Direction to the Patient Depend on V2X used 28GHz and LOS.

5G operates in the frequency range (3-30 GHz) or (30 to 100 GHz). Line-Of-Sight (LOS) is a direct line between the wireless transmitter (ambulance) and a receiver (everything else). This paper adopts a study in the 28 GHz band as an example of mm-wave, where the radio propagation mechanisms that affect network performance in the form of time delays can be used in smart ambulances. Also, based on the 3D-beamforming theory, the distance can be tracked with propagation time between the ambulance and all surrounding networks, such as V2X. The result from 3D-Beamforming shows QoS in Fig. 4 as an omnidirectional power delay profile among ambulances, patients, hospitals, and 5G networks. Also, it can use the strongest power to find the patient's location in the X and Y direction, then the time delay will be less, as shown in Fig. 5, and the data transmitted will be faster to healthcare systems.

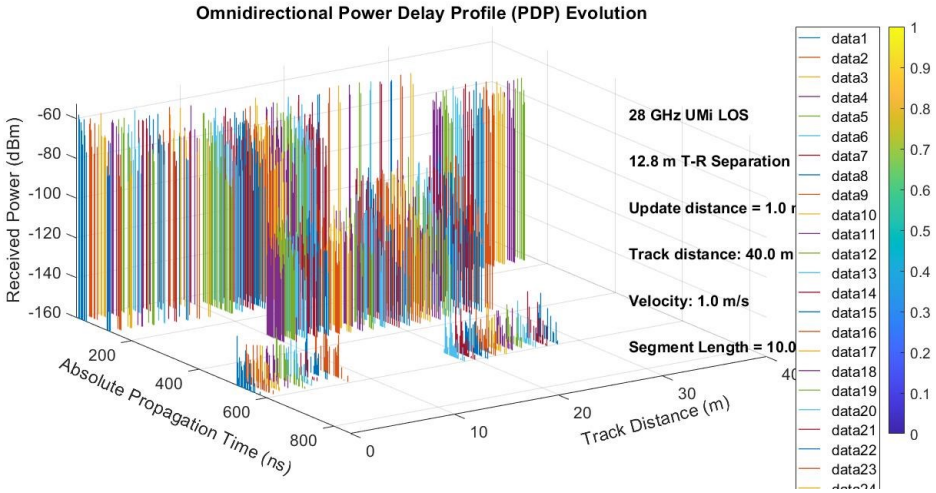

Fig. 4 Data Transmission Using 3D-Beamforming Among Ambulance and Patient with Healthcare Server.

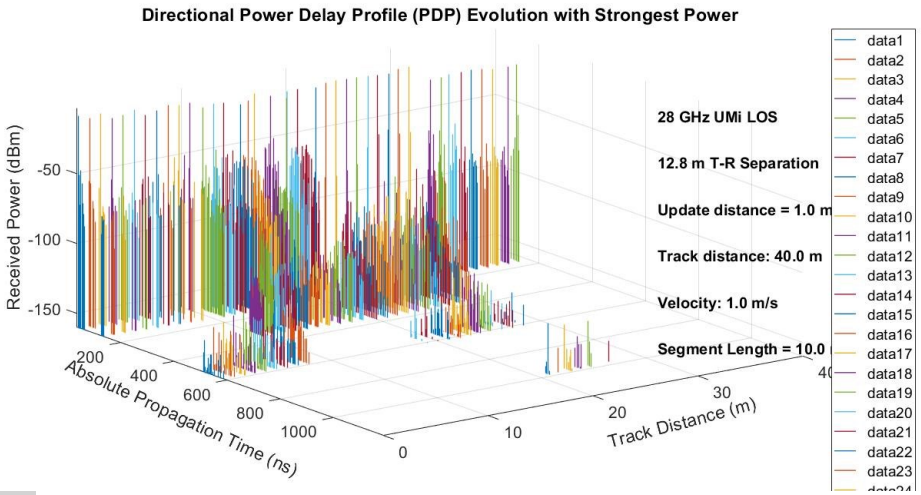

Fig. 5 Ambulance Direction with High-Power Transmission to the Patient and Hospital.

From Figs. 4 and 5, and based on the flowchart in Fig. 2, we can find the patient in the fastest way and deliver him to the hospital by finding the best solutions for treatment and the appropriate doctor available for each case.

6.CONCLUSION

5G telecommunication for modern telemedicine ambulances underscores the critical role of radio frequency signals in enhancing connectivity among patients, hospitals, and healthcare ambulances. Emergency specialists have relied significantly on telecommunications to monitor global healthcare in real-life conditions. This study focused on ambulances equipped with IoMT and enabled with smart antennas. The primary objective is to enhance ambulances' real-time and health zones by leveraging V2X applications and advanced MIMO technologies within the 5G framework, analyzed to facilitate smart connections between ambulances and patients to hospitals. The results showed that the reduced data transfer delays to healthcare systems, thereby expediting the dissemination of patient care data. Utilizing simulations to corroborate theoretical findings further strengthens the robustness of our proposed methodologies. Therefore, equipping ambulances with advanced IoMT-enabled systems ensures the timely delivery of critical medical assistance in real-time monitoring of patient's health conditions. Thus, this proactive approach optimizes treatment decisions and ultimately saves lives, significantly advancing modern healthcare delivery.

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