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A Smart Vehicular Communication Framework for Seamless Connectivity in WBANs

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Abstract: *Uninterrupted data connectivity is considered an essential component in sensor-based remote health monitoring systems. Ensuring uninterrupted connectivity is an important research topic in modern information technology-based medical systems, especially for mobile patients. In the context of patient mobility and changing locations, health monitoring frameworks need to be designed in a way that maintains the ability to seamlessly exchange data in any environment, even within moving vehicles. Maintaining connectivity is essential even when there is a lack of adequate network infrastructure at the roadside. In this study, we propose an intelligent vehicle-communication-based architecture, based on the concept of the "Internet of Vehicles", taking patient mobility into account. The proposed mobility management protocol is able to ensure a continuous flow of specific health information in line with the patient's movement.*

Keywords: Remote Health Monitoring; WBAN; Internet of Vehicles; Mobility Management Protocol

I. INTRODUCTION

A Wireless Body Area Network (WBAN) is a network of devices that are worn or implanted in the body to monitor various physiological parameters. WBANs have emerged as a promising technology for healthcare monitoring, fitness tracking, and medical research. These networks enable real-time monitoring of vital signs, tracking of physical activity, and detection of health anomalies.

II. LITERACY SURVEY OF WBAN

A literacy survey of WBAN would involve exploring the current state of knowledge and understanding of WBAN technology. This would include:

Key Topics

- **WBAN Architecture:** Understanding the architecture of WBANs, including the types of devices used and communication protocols.
- **Applications:** Exploring the various applications of WBANs, including healthcare monitoring, fitness tracking, and medical research.
- **Benefits:** Identifying the benefits of WBANs, such as improved health outcomes, enhanced patient care, and increased efficiency.
- **Challenges:** Discussing the challenges associated with WBANs, including security, interoperability, and power consumption.
- **Future Directions:** Examining the future directions of WBANs, including advancements in sensor technology, integration with artificial intelligence, and increased adoption.

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III. PROBLEM

The core challenges centered around the reliable healthcare data transmission issue relates to maintaining uninterrupted connectivity in WBANs, especially when the patient is in a vehicle. The movement of a patient poses a change in the physical environment of WBAN which may cause problems like network congestion, signal loss, or connection failure due to the volatile nature of wireless signals. With such changes, the need for identifying and rectifying all problems related to seamless connectivity during data transfer is vital. Although there exist many fault detection techniques, they do not appear to address the concerns or be tailored for adaptable WBANs placed in vehicles.

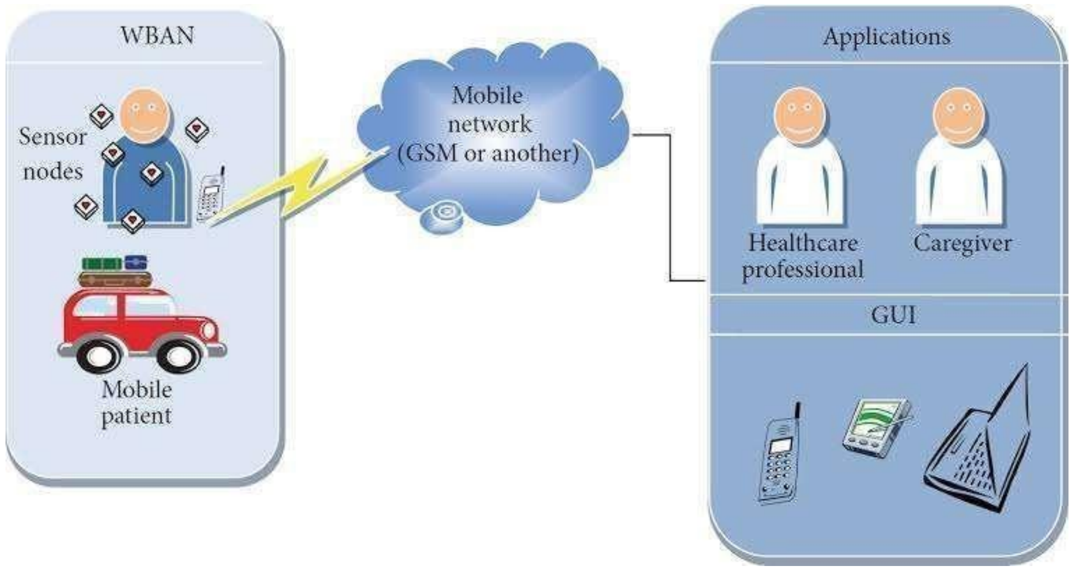

Fig.1. WBAN vehicle to human connectivity

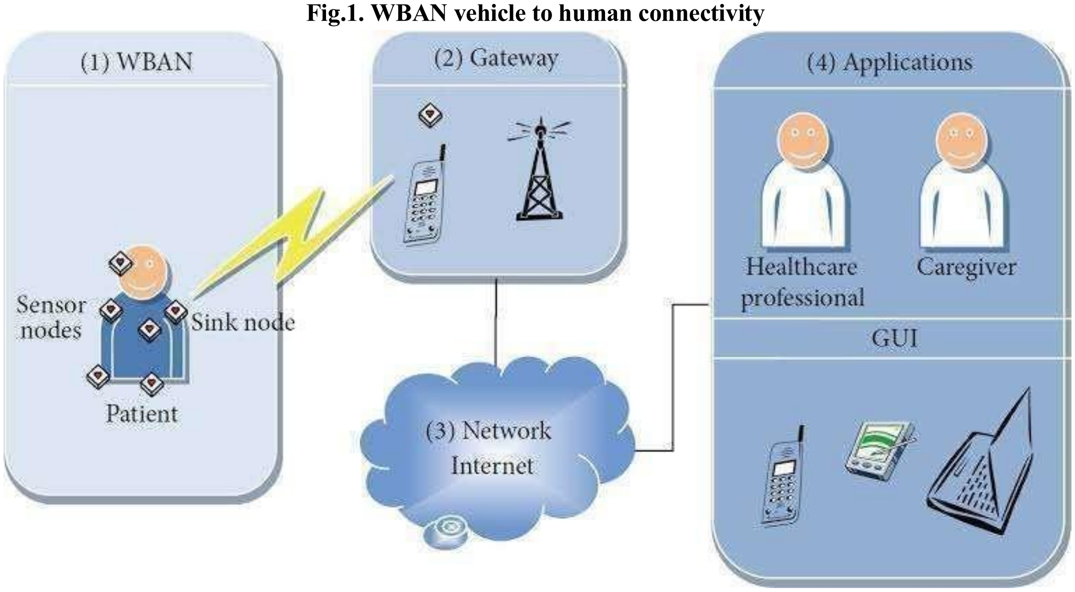

Fig.2. Data Transmission in healthcare WBAN Systems.

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IV. SOLUTION

The proposed solution focuses on reviewing all existing fault detection techniques in WBANs and then devising an enhanced one that would best deal with the challenges posed when the WBAN is placed in a vehicle. Major components of this solution include:

- Adaptive Fault Detection Mechanism. This approach forecasts and detects fault by monitoring the connectivity status regularly through real-time algorithms while tracking signal strength, node status, and interference factors.
- Optimization of Connectivity from a Vehicle Perspective. This is because the patient is in motion which makes it necessary to enhance connectivity through simple vehicle interfaces.
- Fault Recovery Strategies: The system will utilize backup modes of communication (such as temporary relay points or substitute communication frequencies) to resume transmission of data in case of wireless faults that are detected. The system can also restore or reorganize the WBAN to align with new external conditions.
- Seamless Transfer of Data: The ideal outcome is to proceed uninterrupted to transmit real-time healthcare data. In order to give the healthcare provider proper and timely information, it is the responsibility of the fault detection system to promptly detect and clear faults

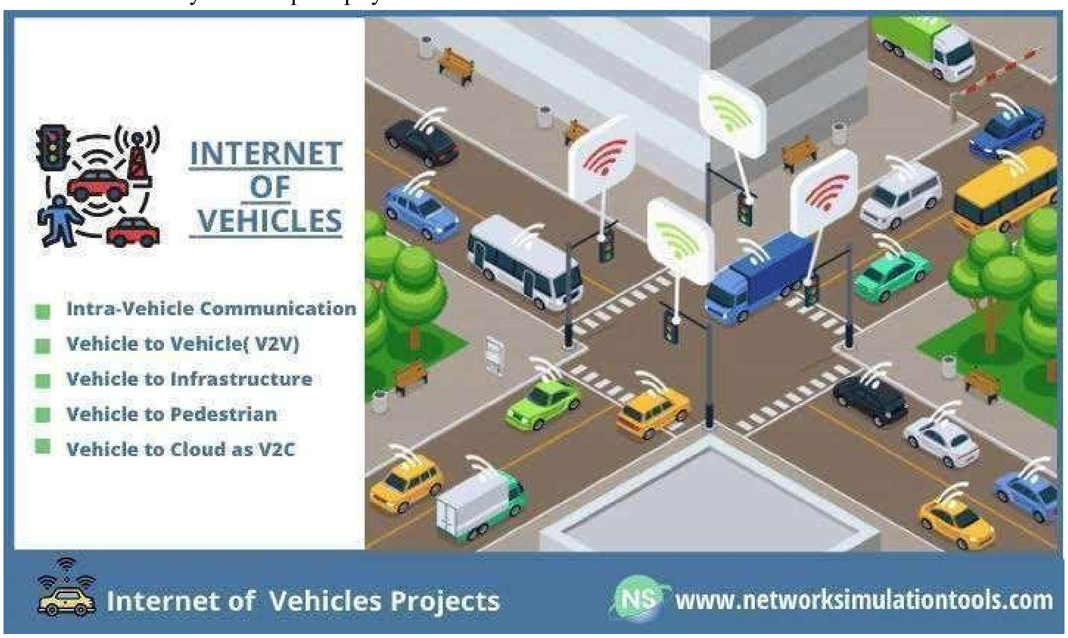

Fig.1. Movement of the Internet of Vehicles

V. OPERATIONAL SCENARIO FOR VEHICULAR FRAMEWORK IN WBAN:

Look at the following source-to-destination map (Fig. 4), which shows T1 as the source and T10 as the destination. There are several different paths between T1 and T10, along with their distances in kilometers as shown below figure. T2 and T9 denote different turning point of the road.

There are several ways to go from the source to the destination and they are as follows:

T1->T2->T3->T10 => [10+15+17] =42;
T1->T4->T5->T10 => [11+10+08] =29;
T1->T6->T7->T10 => [10+12+06] =28;
T1->T8->T9->T10 => [10+12+09] =31;
T1->T8->T7->T10 => [10+10+06] =26;

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A patient with WBAN will travel from source T1 to destination T10. Although a car can take any route, it will normally choose the shortest path to arrive at T10. The shortest path shown by the graph above is T1->T8->T7->T10. The patient's car is supposed to follow that road, but the road connecting T8 and T7 is congested with traffic. This traffic condition will also show in Google Maps. However, without a nearby Access Point (AP), connectivity may be interrupted. In that scenario, intelligent vehicle-to-vehicle will support the maintenance of seamless connectivity smoothly. In this scenario, it will follow the remaining shortest path, i.e., T1->T6->T7->T10. The car will only travel 28 kilometers to reach its destination in 42 minutes with an average speed of 40 km/hr.

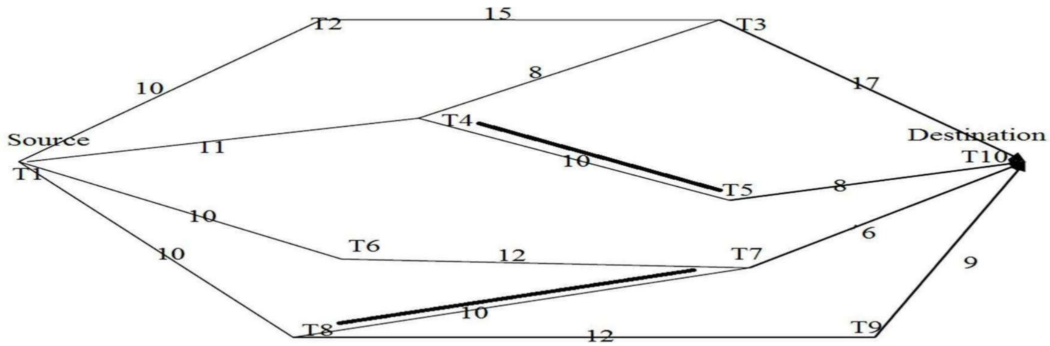

Fig.4. Source to destination path map

VI. ANALYSIS OF SEAMLESS WBAN CONNECTIVITY:

We divide our journey into two sections. The first section of our journey covers that portion when patient walks from his home to his car (Fig .1). When there is proper infrastructure, we classify this distance as D1. A car will be used to cover the remaining distance, which is classified as D2 (Fig .2). When proper infrastructure may not be there on the highway. Vehicle-to-vehicle connectivity can be used to offer real-time information on the shortest distance, traffic conditions and foremost ensuring uninterrupted connectivity via the WBAN. In a typical case, the car will follow the shortest distance path, T1->T8->T7->T10 and will travel 29 kilometers to reach its destination in 39 minutes. However, due to a huge traffic jam between T8 and T7, we estimate a 20-minute waiting time. So, the total time taken by the travel will be [30+20] = 59 minutes. Figure 5 shows a graphical representation of distance traveled against time taken

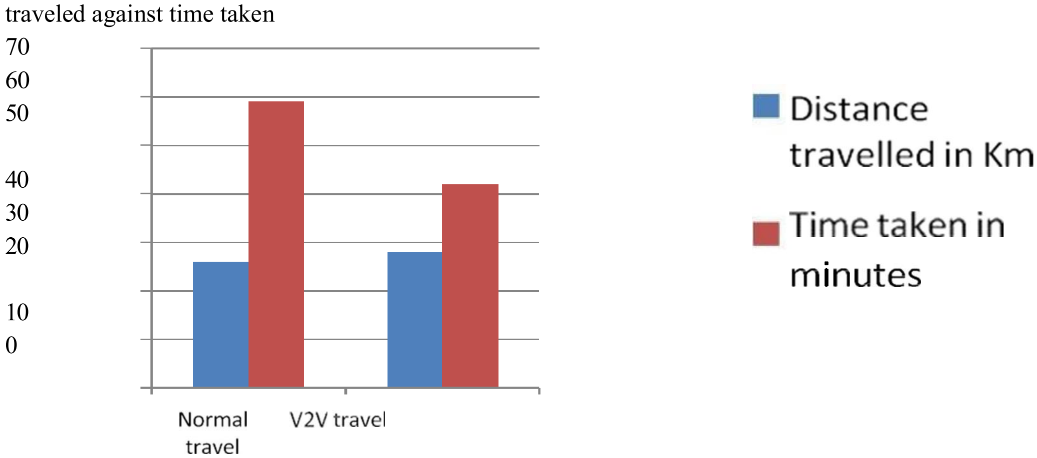

Fig.5. Distance travelled vs. time taken

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VII. CONCLUSION

This research talks about providing seamless data connectivity in WBAN. This protocol is effective for patients travelling between one place to another in a car. It offers complete connectivity when no fixed infrastructure is available in the nearby area.

The protocol was developed to account for various patient relocation scenarios. It facilitates remote access for the patient and outdoor movement.

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