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Deep Learning Based G-LSTM Method for Effective Communication in Wireless Sensor Networking

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ABSTRACT

Wireless technology is one of the main uses in healthcare sectors. Particularly emerging nations need a inexpensive, dependable network with effective protocols. Heterogeneity is the most difficult issue with Body Area Networks (BANs), since it necessitates dependability and fairness across all network nodes. Proposed solutions for these networks either don't offer equitable packet transport or use a lot of energy and cause delays. In this research, we present a multi-label text classification model called Graph-Long Short-Term Memory (G-LSTM). We utilize a graph database to store the documents in the suggested model. It builds the categorized dictionaries after pre-processing the documents using standard dictionaries. The sub graphs are created using these categorized dictionaries. Because the protocol can be deployed over current wireless infrastructure and offers high network reliability with energy efficiency via collaboration and adaptation, it is also practical for underdeveloped countries. The suggested system outperforms traditional BAN protocols in terms of energy consumption, throughput, reliability, and Packet Delivery Ratio (PDR) for mobile and scalable networks.

Keywords: Health care, Wireless sensor Network, G-Long and short term memory, Deep Learning algorithms, Body Area Network.

I. INTRODUCTION

In the past few decades, the use of wireless sensor networks (WSN) has improved every aspect of life, including item tracking, industrial control, military surveillance, security, and health monitoring. Every one of these applications has a particular set of requirements, and there isn't a single solution that can satisfy all of their needs. In the developing world, the use of wireless sensor networks in healthcare has become popular and has given a confinement to new problems and difficulties. These are the e-health service issues that are more common in economically developing countries [2].

The utilization of smart phones and next- generation networks for wireless target in rural regions and mobile health monitoring for the elderly must be increased [1]. With the development of 5th generation networks and new technologies like satellite, internet, mobile, and cloud computing, e- health is one of the industries that is expanding. Even in impoverished nations, remote internet aim and diagnosis may offer health care in an engaging and adaptable manner.

As a result of recent developments in the realm of wireless networks, creative and innovative medical applications are being developed for both the commercial and research sectors [3]. The current trend, which is still in its early stages, predicts that wireless networks will play a crucial role in medical solutions because of its ability to lower healthcare costs, improve patient accessibility, and boost the productivity of medical staff. Wireless network applications in the medical background area for consisting along with problems and its difficulties. The technology of wireless networks has been steadily improving over time, becoming more and more integrated into every area of our everyday lives. One area where wireless networking has the potential to advance is medicine. Cost-effectiveness and accessibility are two major concerns in the healthcare industry. These problems can be partially resolved by wireless technology [3].

Globally, the healthcare system is always becoming more intricate, but in the India alone, 98,000 individuals lose their lives to avoidable medical mistakes every year. These are mistakes that were preventable. Most of the time, doctors and other healthcare professionals treat patients without being aware of their past prescriptions and medical treatments. This leads to unnecessary procedures and duplication as well as hazy clinical choices that fail to include important information about the patient's health. This leads to unnecessary procedures and duplication as well as hazy clinical choices that fail to include important information about the patient's health.

Through a wireless network, caregivers may access up-to-date patient information in real time, including clinical histories, prescriptions, test and lab results, insurance details, and more. New and creative applications in the medical and health care fields are being considered as a result of the advancements in the realm of wireless networks. Applications for managing patients and equipment, among other things, are being developed in the medical profession. Healthcare professionals perform more efficiently when they use some of the newly available tools and software. Wireless sensor networks are being employed in the healthcare industry to address problems like smart homes and long-term patient care assistance for the elderly.

II. RELATED WORKS

Wireless technologies for medical applications have seen a sharp rise in demand recently. With several benefits over wired alternatives, such as simplicity of use, decreased failure and contamination risks, less patient pain, more mobility, and lower healthcare delivery costs, wireless applications open up intriguing new opportunities for the medical sector. According to [COR 19], empirical analyses of damage patterns have shown conflicting results. After adjusting for several variables, this research shows a temporal rise in serious damages. In order to capture trends in the damage distribution, rather than merely its mean, they utilize quantile regressions to evaluate event-level data. They uncover convincing evidence of progressive rightward skewing and tail-fattening
over time.

Time has a difficult to discern impact on averages, but it has a big, statistically significant impact on severe damages that increases with rising percentiles. Our findings align with the widely-assumed convex damage function with an increasing trajectory found in climate-economics models. They also show that the danger of extreme damages has grown more in temperate locations than in tropical ones, and they are resistant to varied specifications of control variables and time period studied.

[REN 19] explained that it is anticipated that future wireless networks will comprise a distributed intelligent wireless communications, sensing, and computing platform. The difficult task of seamlessly and sustainably linking the digital and physical worlds will be present.

The inability to customize the wireless environment's impact on radio waves and the current state of wireless radios, which use a lot of power due to the constant generation of new signals whenever data needs to be transmitted, are the two main obstacles preventing wireless network operators from creating such networks. In this paper, we challenge the conventional wisdom that "more data requires more power and emission of radio waves." Instead, we argue that future wireless networks must adopt a transformative wireless concept known as "smart radio environment," in which environmental objects are coated with artificial thin films of electromagnetic and reconfigurable material that have the ability to sense their surroundings and modify radio waves to suit individual needs. Future wireless networks may benefit from continuous wireless connectivity and data transmission capabilities that reuse pre-existing radio waves rather than creating new ones thanks to smart radio environments.

According to [DUR 19], integrated sensing and communication has been crucial for both current and next wireless communication systems. It also explains the revolutionary new services and applications. Because of its high spectral efficiency and resistance to static multi-path channel circumstances, the cyclic prefix - orthogonal frequency division multiplexing (CP-OFDM) waveform is used extensively in communication systems across a variety of wireless protocols. In contrast, the frequency modulated continuous-wave (FMCW) waveform is widely used in radar sensing applications, particularly for self- driving cars.

While passive radars and other communication signals over the air are used for sensing applications, these systems are only partially capable of detecting. Additionally, a number of coexistence techniques that divide up the time, frequency, and space resources are presented for these various systems, communication and radar-sensing.

[FIE 20] explains the ENT department of a university hospital center, where telemedicine consultations were set up to replace planned out- patient consultations, a prospective study of patient satisfaction with telemedicine consultations was conducted. To find predictors, patients were split into

two groups based on their overall level of satisfaction. A significant criterion of $P<0.005$ was established. Patient satisfaction following an ENT telemedicine session during the worldwide shutdown was the primary outcome. Overall satisfaction prediction elements made up the secondary endpoint.

[RAB 21] The sequential mixed approach used in this study. The MHIN's database and organizational structures were recognized, and the NMHIN's two primary architectural models were introduced. During the phase, a scoping review comprising a quantitative analysis was carried out with a thorough examination of the history, records, data, and resources related to the mental health information network. The Delphi approach was used in the second phase to validate the suggested architecture. After distributing and gathering questionnaires by email as well as in person, SPSS-19 was used to evaluate the results.

III. PROPOSED G-LSTM METHODOLOGY

In informatics, networks are linked systems, services, gadgets, and applications that facilitate exchange and transmission of data. In many branches of informatics, networks including biological, social, and computer networks are crucial. A computer network is the infrastructure for communication that allows computers to share resources, exchange data, and communicate with one another. The infrastructure is comprised of software that implements TCP/IP, HTTP, and DNS protocols, as well as hardware such routers, switches, and firewalls, as shown in Figure 1.1. Social networks are online communities where people may interact and exchange messages, like Facebook, Twitter, and LinkedIn. Communities and individuals may share ideas, resources, and expertise recognitions to these platforms.

The complex webs of connections between different biological components, such as genes, proteins, and metabolites, are referred to as "biological networks." These networks may be analysed with a range of computational and mathematical techniques to comprehend biological processes, including gene expression, protein interactions, and metabolic pathways. Patient group networks are structured gatherings of people who share and trade resources, experiences, and healthcare knowledge.

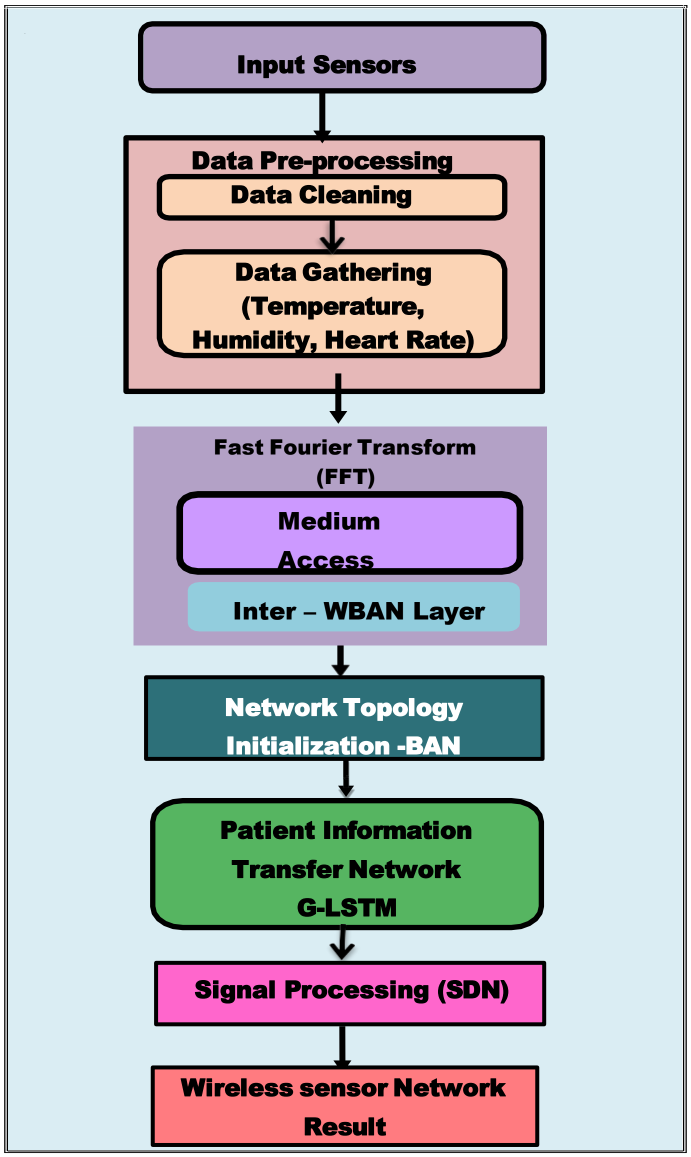

Fig. 3.1 Wireless Sensor Communication using G-LSTM for Deep Learning Algorithm

These networks provide tools, support groups, and information on certain illnesses and treatments to patients and the care givers. People may access shared resources, including treatment alternatives, medical information, research projects, support programs, and more, through the network. Additionally, they offer a forum where patients may interact with others with comparable conditions and difficulties, exchanging concepts, encouraging tales, and useful guidance.

Fast Fourier Transform (FFT)

A mathematical technique that enables the presentation of time-domain data in the frequency domain is the Fast Fourier Transform. Put simply, the oscilloscope has been transformed into a spectrum analyser, the vertical axis is still amplitude, but it is now displayed against frequency instead of time. GNU Octave is a free and open-source platform that was used to construct a Fast Fourier Transform-based (FFT) approach. This was applied to the CXR pictures for further analysis. Two factors were taken into consideration for statistical inference: the number of peaks and the greatest peak in the FFT distribution plot.

Medium Access Control (MAC)

Recently, there has been a lot of interest in health monitoring using biomedical sensors because of the development of a new field of study in sensor networks called Wireless Body Area Networks (WBANs). Many biomedical sensors that are wearable, implantable, and off-body are used in WBANs to track a patient's vital signs in order to identify and treat serious illnesses early on. Numerous Medium Access Control (MAC) protocols for WBANs have been proposed in the method to solve the particular problems in the new field of pertaining to energy, latency, collision, and reliability. MAC protocols are designed using multiple access techniques. It is a difficult effort to comprehend the foundations of MAC protocol designs in order to determine their design aims from a wider viewpoint.

Inter Wireless Body Area Network (BAN)

A new area of WSN called "BAN" monitors health by deploying several sensors both inside and outside the human body. Competitive protocol design is needed for these networks in order to enable robust health parameter communication for prompt diagnosis and treatment. Medical wireless networks fall into two categories: remote monitoring and hospital-based applications. Wireless sensor networks are applicability in many healthcare settings. Monitoring and identifying anomalies in big data sets is made simpler by gathering information for several patients into a single database system. Additionally, older persons can roam freely while being continually observed recognitions to sensor networks utilized for remote monitoring.

Based on network and data types, wireless sensor networks can be generally categorized as homogeneous or heterogeneous. Since homogeneous networks are made up of nodes with comparable functionalities, they are utilized for detecting comparable types of data. However, because heterogeneity requires processing of many types of data, wireless networks become more complicated. Various varieties of both heterogeneous and homogeneous networks are in use. Heterogeneity in BAN occurs when nodes with varying power and computing capabilities are implanted to assess distinct health metrics and carry out diverse activities.

Because sensors affixed to the human body are within radio range of one another, BANs are often dense networks. It's possible that multiple BANs are active in the same region. As a result, BANs should be able to overcome heterogeneous network difficulties and interference problems. A few of the standards, applications, problems, and solutions related to BANs are suggested. According to research, BANs have serious energy and interference problems, which have an impact on network dependability. For this reason, compared to a traditional WSN, creating a BAN network and associated protocol is more challenging.

Standards and communication frequencies in BANs must allow for interference-free transmission without endangering human health. Techniques including Bluetooth classic, Bluetooth low energy, ZigBee, sensium, and ANT were employed in the early days of BAN communication. However these protocols lacked the dependability needed for a Body Area Network. A new protocol called 802.15.6 was designed for medical applications, taking into account the significance of dependable communication.

A new trend called Intra Body Communication (IBC) uses the body as a propagation medium to transmit data. However, these sophisticated communication techniques come at a high cost. Our goal in this G-LSTM method is to achieve high dependability in healthcare applications using an 802.15.4 low-cost communication connection. Online medical assistance and treatment can also be impacted by the resilience and latency of healthcare systems. For the purpose of increasing system dependability, the majority of BAN protocols add complexity and latency to the network. BAN applications must, nevertheless, have minimal latency in order to handle emergency situations. Robustness in communication will be preserved in the suggested system.

Algorithm of G-LSTM Wireless Communication Network

Step 1:	*FC-based blockchain system creation & Patient selection*
Step 2:	*Retrieve of PHD*
Step 3:	*Patient = (Pa1, Pa2, Pa3,—— Pax)* *while Pax in Patient do*
Step 4:	*Select* P_{ax}

Step 5:	*for each H_IoTz in IoT do*
Step 6:	*if the doctor d1selects H_IoTz then*
Step 7:	*Retrieve PHD (Pax,H_IoTz);*
Step 8:	*function retrieve PHD (Pax,H_IoTz)*
Step 9:	*Connect with the patient body and ON the devices*
Step 10:	*CloudDB < − IoT data*
Step 11:	*Enable U − Net,CNN, LSTM*
Step 12:	*For k = 1 to len (data)*
Step 13:	*If (data.type == image) then send data to U − Net*
Step 14:	*while H_IoTz in IoT do*
Step 15:	*if H_IoT z€ Pa1then*
Step 16:	*deviceList = query All Devices In H_IoT (H_IoTID)*
Step 17:	*config= R.next();*
Step 18:	*ioTdevice= deviceList.next();*
Step 19:	*Assign Doctor for IoT implant to* P_{a1}
Step 20:	*End*

BAN-XL: the suggested plan and the cross-layer BAN-XL protocol is very reliable in BAN applications within a limited amount of time. It has a cooperative routing algorithm and is flexible enough to adjust to changing network conditions. The 802.15.4 MAC technology, which has cooperative AODV routing and flexibility, is utilized in BAN-XL. Because several nodes use the shared connection tosend data concurrently, radio channel interference is the primary factor contributing to the decreased network resilience in BAN networks. Cooperation between source nodes is established to remove this problem. With enhanced spectrum efficiency, BAN- XL's half-duplex collaboration preserves dependability. In order for a human body's sensor nodes to effectively communicate data, they must collaborate with one another.

Network Topology Initialization

SDN is one of the alternative methods that many academics and service providers concentrate on in order to boost the bandwidth and adaptability of the WBAN architecture. Conventional network solutions are unable to meet the needs of WBANs due to their highly dynamic structure. The static network paradigm is replaced with a programmable and adaptive network paradigm through SDN. Intelligent routing may eliminate bottlenecks in the network obligations to the SDN paradigm, which offers a broad view of the network and a controller that can reroute traffic as needed. In this regard, network analysis and WBAN decision-making procedures are also made possible by the SDN method. Furthermore, SDN offers a range of algorithms that may be used to the WBAN environment to enhance the network's capacity for control and administration.

The implementation of services like intelligent hospitals, intelligent healthcare, or intelligent remote healthcare will be made possible in large part by the SDN-based WBAN strategy. By utilizing control and management mechanisms created with SDN requirements, WBAN performance may be enhanced.

Graph-Long- and Short-Term Memory Method

In many practical applications, the unique approach utilized to analyse the multi-label health care and patient information and frequently monitor the patient is a difficult task. Word2vec is often utilized in all conventional approaches to display sequential information inside text. Word2vec, on the other hand, treats each label as a separate unit and disregards the logical relationships and context within the text. As a result, the current methods were unable to capture the actual situations and get the semantic data pertaining to the relationships between texts. Developing the various types of options in the activation function layers, for various uses. Every single LSTM recurrent unit further keeps track of a vector known as the internal cell state, which conceptually explains the data that was selected for retention by the preceding recurrent unit.

IV. RESULTS AND DISCUSSIONS

Simulation parameters for simulation to examine how well the BAN-XL and BAN-Conv protocols operate at varying network sizes, simulation is used for both small and big networks. A heterogeneous node network with several hops is called a model network. Various network circumstances are taken into consideration in order to examine how the protocol affects various BAN applications.

1.1 X(k)=∑n=0N-1x(n)e-i2πkn/N ---------(1)

The performance metrics are a list of some of the network parameters that were utilized in the simulation. The network's performance indicators that are taken into account include energy consumption, packet delivery ratio (PDR), throughput, and dependability.

4.1.1. Reliability

The quantity of data that is precisely and quickly received at the recipient end is what reliability is all about. High dependability in BAN places a high priority on appropriate medical care and diagnosis. Equation (2) provides the expression for a network's reliability. Reliability ¼ Received bytes and the total bytes transferred to 100 ð1Þ.

Xk=Σn=0N−1xnWNkn,k=0,1,2,…,N−1 ------- *(2)*

Reliability of a network is the duration of uninterrupted infrastructure operation. Reliable protocols are usually slower and less scalable than unreliable protocols because they have more overhead. For dependable multicast protocols, this could become a concern, but for unicast protocols.

4.1.2. Throughput

A network's throughput is determined by how many bits are successfully received at the receiving end in a certain amount of time. In order to respond quickly to any emergency, BAN is required to communicate patient information at all times, especially aberrant data. Consequently, a high network throughput is required to maintain network management updates.

TH= I/T ------- *(3)*

The network throughput can be expressed mathematically by consideration such factors as network traffic, protocol overhead and so on.

4.1.3. PDR Packet Delivery Ratio

(PDR) is used to assess the network's efficiency. It represents the proportion of data packets transferred to packets received. PDR is represented via

PDR = ∑ number of packets received / ∑ number of packets sent ------- *(4)*

Longer intervals between packet loss occurrences may result from coupled packet losses brought on by fading. One kind of assault is node replication, whereby a hacker attempts to take down a node and create a duplicate or clone of it within the same network.

Table.4.1 Wireless Sensor Communication Using G-LSTM for Deep Learning Algorithm

Methods/ Metrics	T_R	T_P	PDR	Accuracy
PSO	89.76	87.19	88.67	89.34
LEACH	89.67	89.45	90.34	90.21
DBN	90.23	90.56	91.48	91.78
G-LSTM	91.34	91.23	92.62	92.51

The outcomes of several current wireless sensor communication techniques, including deep belief networks (DBN), low energy adaptive clustering hierarchy (LEACH), and particle swarm optimization (PSO), are described and contrasted in table 1.1 above. In fig 4.1 when compared to the proposed approach with the existing methods, Graph-Long Short Term Memory (G-LSTM), produces superior accuracy results.

Results are acquired for several mobile and scalable networks to guarantee the suggested scheme's high caliber of performance. It is believed that there is only one patient with a large number of heterogeneous nodes in a small-scale network. Two separate kinds of source nodes are utilized in simulation: the pressure sensor and the heart rate sensor. The electrical activity of the cardiac cycle is measured by the heart rate sensor, while blood pressure is measured by the pressure sensor.

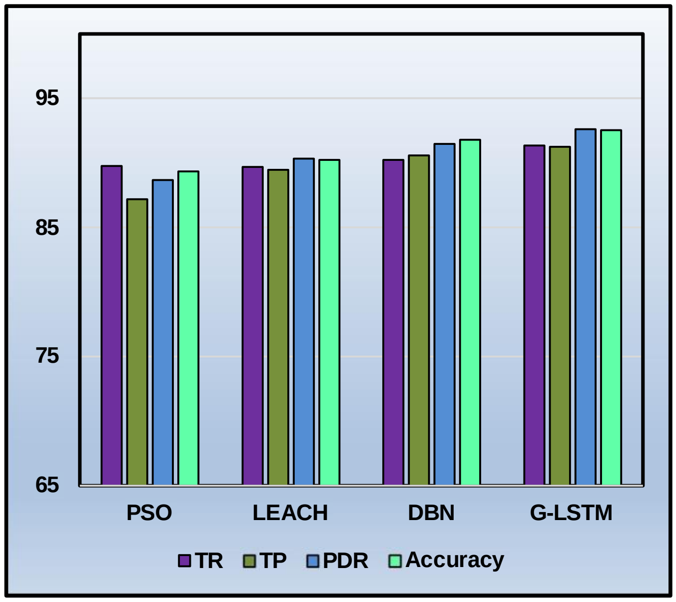

Fig.4.1 Wireless Sensor Communication Using G-LSTM for Deep Learning Algorithm

These nodes employ a microprocessor to transform analogy signals into digital data, which is subsequently sent to the sink node. If these source nodes meet the requirements for collaboration, namely being present within the radio range and possessing sufficient power to collaborate, they will aggregate their data.

To simulate the large-scale BAN, more patients within the range are added. Display the result after aggregating data from its own sensor nodes. Patients with several wireless sensors in BAN are free to walk around. Similar-type data from several patients are combined. Instead of providing combined packets of their own data, each patient sends data packets mixed with comparable nodes from surrounding bodies to the impact of mobility. The mobile network's two distinct speed results are gathered and examined.

V. CONCLUSION

For any healthcare service to be successful, it must be implemented as a responsive and long-lasting healthcare network. These health networks demonstrate how important it is to provide the general public with access to high-quality treatment. They have all embraced innovative approaches to delivering healthcare services and are dedicated to improving the health of their local populations. These nodes seek to deliver health services globally and to gather, store, andprocess the patient's physiological data. Unique characteristics of WBANs include their tiny size, varying data speeds, short battery life, need for quality of service (QoS), and heterogeneous network traffic. Such circumstances can benefit from the instruments that wireless technology offers. In order to minimize the search space for new documents, the model keeps track of a lookup table. The primary idea of the suggested technology, the Graph Long Short Term Memory Network (LSTM), is that a recurrent unit attempts to recall all of the previous information that the network has seen thus far and to discard unnecessary material. The suggested G-LSTM approach finds a cross-layer protocol for medical applications that satisfies the demands and difficulties of the diverse BAN in the medical field.

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