Wireless Communications and Mobile Computing using Machine learning

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Abstract:

This work deals with the use of emerging deep learning techniques in future wireless communication networks. It will be shown that data-driven approaches should not replace, but rather complement traditional design techniques based on mathematical models. Extensive motivation is given for why deep learning based on artificial neural networks will be an indispensable tool for the design and operation of future wireless communication networks, and our vision of how artificial neural networks should be integrated into the architecture of future wireless communication networks is presented. A thorough description of deep learning methodologies is provided, starting with the general machine learning paradigm, followed by a more in-depth discussion about deep learning and artificial neural networks, covering the most widely-used artificial neural network architectures and their training methods. Deep learning will also be connected to other major learning frameworks such as reinforcement learning and transfer learning. A thorough survey of the literature on deep learning for wireless communication networks is provided, followed by a detailed description of several novel case-studies wherein the use of deep learning proves extremely useful for network design. For each case-study, it will be shown how the use of (even approximate) mathematical models can significantly reduce the amount of live data that needs to be acquired/measured to implement data-driven approaches.

1. INTRODUCTION

The WSN played the tremendous role in improving the life of the people in several fields such as health, industry, surveillance, environment-monitoring, battle etc. [1-2]. For the last few years, the population of aged persons has been increasing worldwide, and therefore the rising prices of medical treatment triggered the advancements in remote monitoring of body's condition and surrounding environments [3]. A traditional medical care system use stationary wired medical apparatus which are inconvenient and have a higher impact on the standards of living of patients and involves a high cost of implementation and maintenance [4]. While diagnosing for diseases is additionally restricted in hospital in addition doctors faces difficulties in early detection and long observation of diseases. To overcome these problems a new monitoring system is emerged as Wireless Body Area Network [5]. A WBAN consists of small and intelligent sensors which are either placed on or with in human body. These sensors monitor body conditions and a coordinator collects this vital information and sends them to concerned healthcare centre through existing network links [6].
During this process of transmitting the data from the coordinator, the WBAN faces energy exhausting attacks such as collision, denial of sleep, and selfish. These attacks reduces the lifetime of the sensors and compromise the WBAN, which results in decrease in the quality of healthcare [7].Since we are dealing with the human life, these energy consumption attacks must be addressed.
The mitigations of collision and denial of sleep and selfish attacks are not proposed [8-10]. In this paper a genetic algorithm is proposed to mitigate selfish attack by detecting selfish node and blocking unusual activities.
The remaining paper is organized as follows. Section II explains the related work done in the field, Section III discusses the proposed SDMAC protocol, the Simulation Setup and Results are discussed in section IV and the paper is concluded in Section V.

2. Issues

There are following issues with Wireless Networks.

Quality of Service (QoS):

One of the primary concerns about wireless data delivery is that, unlike the Internet through wired services, QoS is inadequate. Lost packets and atmospheric interference are recurring problems of the wireless protocols.

- For application where mobility not required a wired connection provide a faster, reliable and cost-effective solution.

- Higher loss-rates due to interference (due to other communcaiotnsd)

- Restrictive regulations of frequencies (e.g., wlan operates in ISM is unlicend specprm which has huge deployment)

- Wireless network technology has low data throughput and data transmission rates due to collisions

- Higher latency, higher jitter due to channel access.

- Wireless technology does not provide the same bandwidth guarantees as a wired connection and is additionally shared with other users who are connected to the same access point.

- Wireless networks are subject to interference from any electromagnetic sources

- The signal strength is greatly reduced by obstacles.

- Congestion problems or even failure under error conditions or high or malicious traffic, the actions of a few can potentially affect the network connections of many.

- Limited channel selection induces “co-channel interference”. This interference happens when the access points are stepping on each other and is harmful to the performance of your network.

3. Security Risks

A data transfer over a wireless network. Basic network security mechanisms like the service set identifier (SSID) and Wireless Equivalency Privacy (WEP); these measures may be adequate for residences and small businesses, but they are inadequate for the entities that require stronger security.

- **Denial of Service:**

  The intruder floods network with valid or invalid messages affecting the availability of the network resources. The low bit rates of WLAN can be exploit to leave them open to denial of service attacks. Radio interference can be used to unable WLAN to communicate.

- **Spoofing and Session Hijacking:**

  The attacker may gain access to privileged data and resources in the network by using identity of a valid user. Attackers spoof MAC addresses, and act as illegitimate AP. To avoid spoofing, authentication and access control mechanisms need to be placed in the WLAN.

- **Eavesdropping:**

  Eavesdropping is the most significant threat because the attacker can intercept the transmission, as it is impossible to control who can receive the signals in wireless LAN as medium is shared.

4. Related Work

The WBAN technology is the consequence of the existing WSN technology. A number of tiny wireless sensors, strategically placed on the human body, create a wireless body area network that can monitor various vital signs, providing real-time feedback to the user and medical personnel. In a WBAN, each medical sensor monitors different vital signs such as temperature, blood pressure, or ECG. The system consists of multiple sensor nodes that monitor body motion and heart activity, a network coordinator, and a personal server running on a personal digital assistant or a personal computer [8].

Figure 1 shows secure 3-level WBAN architecture for medical and non-medical applications. Level 1 contains in-body and on-body BAN Nodes (BNs) such as Electrocardiogram (ECG) – used to monitor electrical activity of heart, Oxygen saturation sensor (SpO2) –used to measure the level of oxygen, and Electromyography (EMG) – used to monitor muscle activity [9].

Level 2 contains a BAN Network Coordinator (BNC) that gathers patient's vital information from the BNs and communicates with the base-station. Level 3 contains a number of remote base-stations that keep patient's medical/non-medical records and provides relevant (diagnostic) recommendations. The traffic is categorized into on demand, emergency, and normal traffic. On-demand traffic is initiated by the BNC to acquire certain information. Emergency traffic is initiated by the BNs when they exceed a predefined threshold. Normal traffic is the data traffic in a normal condition with no time critical and on-demand events [11].

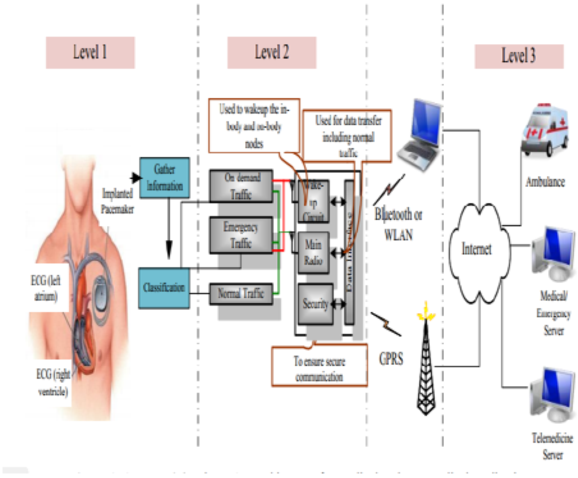

Figure 1: Secure 3-Level WBAN Architecture For Medical And Non-Medical Applications

The normal data is collected and processed by the BNC. The BNC contains a wakeup circuit, a main radio, and a security circuit, all of them connected to a data interface. The wakeup circuit is used to accommodate on-demand and emergency traffic. The security circuit is used to prevent malicious interaction with a WBAN [10], [14], [13].

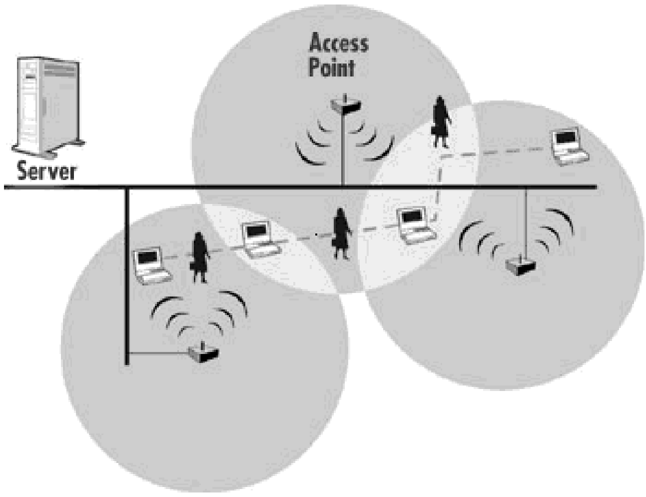

Figure 1-3: Microcells and Roaming

5. EOS Blockchain Protocol

MAC protocols used in WBAN must be low power consuming, accurate and with less latency. The most important thing is the protocol should give good performance on varying traffic load. Some popular protocols for WBAN are TMAC, SMAC, ZigBee MAC and Baseline MAC [4].

A. TMAC:

It is a duty-cycling protocol. In this protocol the node is awaken for a particular period that is called active time. Duty cycle changes according to the information traffic load of the network. When traffic load is high than the duty cycle becomes large so that nodes can handle high traffic load. When traffic load is low then duty cycle is adjusted to small value so that nodes can save their power reducing the problem of idle listening. TMAC protocol is able to handle varying load with low power consumption.

B. SMAC:

SMAC protocol is similar to TMAC but only difference is its fixed duty cycle. This protocol is the previous version. This protocol is not efficient in handling continuously varying data rates in WBAN.

C. ZigBee MAC:

ZigBee MAC protocol can use two schemes- CSMA/CA or TDMA. While using CSMA/CA mechanism this protocol gives average performance but using TDMA mechanism (applying Guaranteed Time Slot or GTS) it reduces the power consumption up to a great extent. At high rates the data loss becomes high in TDMA mechanism so it is best when there is less no of nodes or low traffic load.

D. Baseline MAC:

This MAC protocol uses CSMA/CA scheme. The performance of Baseline MAC in terms of energy consumption is not average but throughput is average.

6. LITERATURE SURVEY

In [13] (2012) proposed a reliable topology design and provisioning approach for Wireless Body Area Networks (named RTDP-WBAN) that takes into account the mobility of the patient while guaranteeing a reliable data delivery required to support healthcare applications' needs. To do so, they first proposed a 3D coordinate system able to calculate the coordinates of relay-sensor nodes in different body postures and movements. This system uses a 3D-model of a standard human body and a specific set of node positions with stable communication links, forming a virtual backbone. Next, they investigated the optimal relay nodes positioning jointly with the reliable and cost-effective data routing for different body postures and movements. Therefore, they use an Integer Linear Programming (ILP) model, that is able to find the optimal number and locations of relay nodes and calculate the optimal data routing from sensors and relays towards the sink, minimizing both the network setup cost and the energy consumption. They solved the model in dynamic WBAN (Stand, Sit and Walk) scenarios, and compare its performance to other relaying approaches.

In [14] (2013) presented an analytically discussion about energy efficiency of Medium Access Control (MAC) protocols for Wireless Body Area Sensor Networks (WBASNs). For this purpose, different energy efficient MAC protocols with their respective energy optimization techniques; Low Power Listening (LPL), Scheduled Contention and Time Division Multiple Access (TDMA), are elaborated. They also analytically compared path loss models for In-body, On-body and Off-body communications in WBASNs. These three path loss scenarios are simulated in MATLAB and results shown that path loss is more in In-body communication because of less energy level to take care of tissues and organs located inside human body. Secondly, power model for WBASNs of Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) and beacon mode is also presented. The results shown that power of CSMA/CA mode is less as compared to beacon mode. Finally, they suggested that hybrid mode is more useful to achieve optimization in power consumption, which consequently results in high energy efficiency.

In [15] (2014) proposed a mechanism to route data in WBANs with minimum path-loss over the link; and in which the merits of single-hop and multi-hop are utilized. The proposed scheme uses a cost function to select the most appropriate route to sink. This cost function is calculated based on their distance from the sink as well as their residual energy. Nodes with lesser value of cost function are elected as parent node. Other nodes become children of that parent node and forward their data to parent node. Two of the eight nodes forward their data directly to sink as they are placed near the sink; and will serve as the parent nodes. The channel for wearable BAN can be basically described by path loss models with two parameters of frequency and distance. It is calculated from its distance to sink with constant frequency 2.4GHz. The results shows that proposed routing scheme has considerably enhanced the network stability time and in terms of cross-layer application, it has reduced the path-loss to a significantly low-level

7. CONCLUSION

The increasing use of wireless networks and the constant miniaturization of electrical devices has empowered the development of Wireless Body Area Net- works (WBANs). In these networks various sensors are attached on clothing or on the body or even implanted under the skin. The wireless nature of the network and the wide variety of sensors power numerous new, practical and innovative applications to improve health care and the Quality of Life. The sensors of a WBAN measure for example the heartbeat, the body temperature or record a prolonged electrocardiogram. In this survey, we have reviewed the current research on Wireless Body Area Networks. In particular, this work presents an overview of the research on the human body, MAC-protocols in WBAN, challenges in WBAN and also describes the various applications in WBAN.

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