

Internet of Things for Libya Healthcare System: Challenges and Issues

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ABSTRACT

This paper proposes a system based on the Internet of Things to Human Activity Recognition by monitoring and processing smartphone sensors remotely. A machine learning algorithm could be used to determine the activity done during the day. Meanwhile, it is expected to give a feedback during and after the activity is performed, using the machine learning method with remote visualization and intelligent decisions. All in all, it is hoped that the outcome of this proposed work will be beneficial for government officials, health policy makers, and healthcare providers in the area of the healthcare industry.

Keywords: Internet of Things, Artificial Intelligence, Machine learning.

1 Introduction

The term "the Internet of Things" (IoT) is a concept reflecting a connected set of people, sensing objects, anytime, anyplace, any service, and any available network [1, 2]. This concept was, firstly, presented to the world by Kevin Ashton in 1999 [3]. According to Cisco's forecast, 500 billion smart devices will be connected by the year 2030 [4]. The recent advancements in technology and the availability of the Internet make it possible to connect various devices that can communicate with each other and share data. The Internet of Things is emerging communication concepts that will interconnect a variety of devices, sensors, actuators, smartphones, and people, where clearly identifiable and smart objects can communicate with each other in a defined environment to make autonomous decisions by analysing and processing the data collected from the environment.

With the exponential increase of human health data, a main challenge is to create suitable platforms for data analysis, where artificial Intelligence (AI) can be applied to various types of healthcare data. An artificial Intelligence (AI) system is a system that can take decisions, which would be considered intelligent if made by a human being. Artificial Intelligence is becoming more popular and particularly amenable to modelling complex systems, because it

has demonstrated superior predictive ability compared to traditional methods [5]. Artificial Intelligence enabled IoT creates intelligent things that simulate smart behaviour and support in decision making with little or no human intervention.

IoT is expected to take more important roles in healthcare, human-machine interfacing, and biological studies. Chu, et al. [6] proposed "BodyNET"; a body area sensor network, which enables wireless transmission of multiple physiological signals to the digital format in a continuous and accurate fashion. The authors indicate that their system will require an efficient communications network to connect their layers, and this is yet to be built. Therefore, it must bridge the digital and physical worlds between individuals, objects and environments. Number of vehicles on the road have growth dramatically in the past few years. It leads to accidents that are the main cause of death in many countries around the world. In most of the cases of accidents, lack of providing quick first aid and timely medical service is the cause of death. Consequently, it is needed to develop an intelligent framework for accident detection, avoiding other accidents, and provide a timely and reliable response. Kodali et al. [7] have proposed an automatic accident notification system using IoT technology. Message Queuing Telemetry Transport (MQTT) based on Wi-Fi network was used to send an alert through email service while a vehicle accident has detected and data received from accelerometer and ultrasonic sensors stored in an IoT platform. However, their system could not detect the exact location of the accident. As a result, rapid rescue and sending help is very difficult. Additionally, email communication is relatively slower than a text message service. Falls are the main cause of fatal and nonfatal injuries among older adults around the world. It has been reported that, falls cause over 37.3 million severe injuries and 646,000 deaths yearly, and hence has become a global public health issue [8]. It has become obvious that there is a need to develop an intelligent IoT system, which can monitor and detect elderly falls without human intervention. Santos et al. used a Convolutional Neural Network (CNN) to discriminate falls using three open datasets and against extant research based on acceleration measurements. Authors showed that the best results were achieved when using data augmentation during the training process. However, their model could be improved by considering different activities, e.g., standing, walking, jumping, and running and different fall types.

The messaging protocol is considered the main element in the Internet of things. These protocols play a big role to enable IoT all over life. One of IoT healthcare systems design is to choose the type of IoT messaging protocol. Chen and Kunz [9] studied IoT protocols

under limited environments: MQTT, CoAP, DDS, and XMPP, using a healthcare case study based on a medical device. They examined a number of indicators such as latency and packet loss under progressively constrained environments. They found that both MQTT and DDS have zero packet losses in high latency environments. Although, the DDS has good performance in terms of latency, However, the DSS has higher bandwidth requirements.

To obtain the patient data and process it intelligently, different studies use different mechanisms such as RFID, 3G, 4G, 5G, and Wi-Fi technology. The 5G networks stand for fifth-generation mobile technology, which can outperform earlier generations of wireless communication technology. Al-Falahy et al. [10] have discussed the potential techniques for 5G networks, which lead to the upcoming challenges and prospects for future research. However, the trend in future networks has shown a different pattern from that of existing networks, because the main objective has changed from enabling users to connect wirelessly to the Internet to enabling massive numbers of users and devices to seamlessly connect by the internet of things technology.

Nowadays, Wi-Fi technology can be considered as a ubiquitous technology found in a wide range of consumer devices such as smartphones. However, in the past, Wi-Fi technology has not shown a significant existence in the IoT market, without any specification focused on IoT and its singularities. Taking into account the near future scenario for IoT communications; the new Wi-Fi 6 "IEEE 802.11ax" technology could bridge the gap by offering new amendment such as high data rate, less interference, and larger data channel widths [11].

Although Wi-Fi technology has enabled the rapid growth of personal wireless networks, the security protocols have shown weaknesses that can be exploited in order to gain unauthorized access to the network and the encrypted communication data. Leca [12] have gathered a database consisting of approximately 100000 unique access points gathered through war-driving in Romania. Results show that rural areas adopted WPA security directly when compared to urban areas that have made the transition from WEP to WPA and still use legacy equipment. The results also show that provider wireless access points on average offer better security than private networks. This work is also concerned with highlighting known vulnerabilities in Wi-Fi networks and their spread. The authors have gathered a database consisting of approximately 10,000 access points gathered through war-driving in Rabat, the capital of Morocco. They indicate that 77% of networks have used

accepted Wi-Fi security algorithms. Furthermore, the network operators were aware of high interference that can occur on channel 6 and therefore, act to minimize interferences [13].

Due to the emerging technology, small wireless solutions which are coupled to IoT can make it possible to monitor patients remotely instead of visiting the traditional hospital. A variety of smart sensors which are attached to the body of a patient can be used to obtain health data securely, and the acquired data can be analysed (by means of Machine learning algorithms) and sent to the server using different network connections. All doctors, emergency centres, hospitals, and relatives can access from anywhere at any time, visualize the data, and take a decision accordingly. However, it has been noticed that in most of the above-mentioned studies and related discussion, a comprehensive platform is still missing in the IoT healthcare sector. Since, IoT is a new concept in Libya, there is a need to increase public awareness about its security and capabilities.

The aim of this work is to propose a system based on the Internet of Things to Human Activity Recognition by monitoring and processing smartphone sensors seamlessly and remotely.

2 The proposed system

With the continuous demand of an efficient healthcare system, a major challenge is to design suitable IoT model for an accurate recognition system. The IoT model proposed in this work for efficient deployment of IoT in the field of healthcare consists of four layers (sensor layer, network layer, internet layer, and service layer) as mentioned in [14]. The Human Activity Recognition system will be able to use the smartphone sensors to collect the patient data, which is integrated with the Internet of Things. A patient used built-in accelerometer sensor to obtain health related data. Machine learning algorithms will be applied on data to verify the conditions of the patient. If the value is out of the normal range, then an alert message is sent to a doctor, relatives and the emergency centre will take appropriate action accordingly. The whole scenario of the proposed system is shown in Figure 4 .

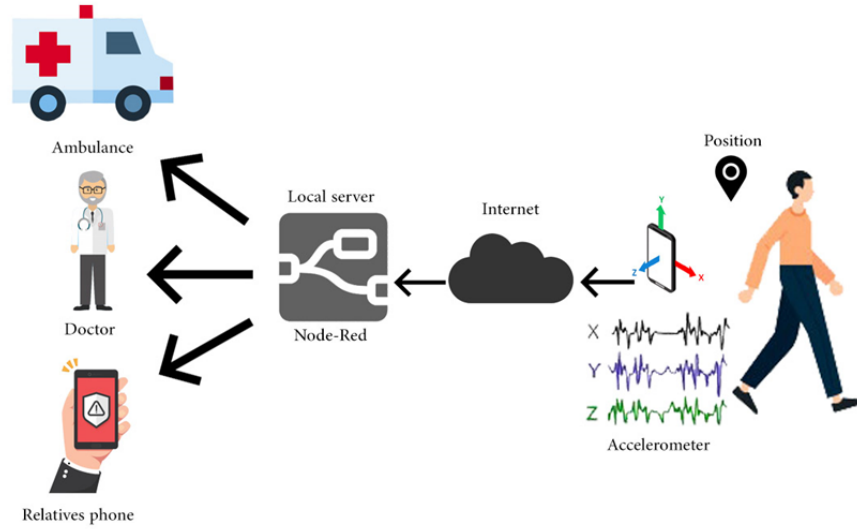


Figure 4. Human Activity Recognition -IoT system

In order to implement a practical IoT system for a healthcare application, the following tools can be used:

1. A smartphone with embedded accelerometer and Global Positioning System GPS; These embedded sensors allow the smartphone to be used as a useful tool to collect patient data.
2. Node-RED runs on a Node.js server; Node-RED is a programming tool for IoT software development created by IBM for “wiring together hardware devices, APIs and online services in new and interesting ways”.
3. A machine learning algorithm that runs on a Node.js server in order to Human Activity Recognition by monitoring and processing smartphone sensors seamlessly and remotely.

This system is proposed to be used by patients with chronic heart diseases, patients who have their health status in a non-critical condition but still need constant monitoring. The proposed system focuses on the daily routine, activity and physical therapy that each patient must have as part of their recuperation process .

The activity recognition can be implemented using a machine learning algorithm that uses the information gathered by the IoT system. The human activity recognition system is a specific application of pattern recognition and expert systems. This system works in two phases: a training phase and a recognition phase. Although both have similar steps, the

training phase has a priori information of the activities done and the recognition phase uses the knowledge of the training phase to have accurate recognition. The learning or training phase is the first phase of any recognition algorithm. It has three main steps (see figure 5); Data collection, Feature extraction, and Learning process. On another hand, the recognition phase is considered as a final phase of an HAR system. It does the recognition of the activity performed using the training phase result. The recognition phase has three main steps (see figure 6); Data collection, Feature extraction, Recognition process.

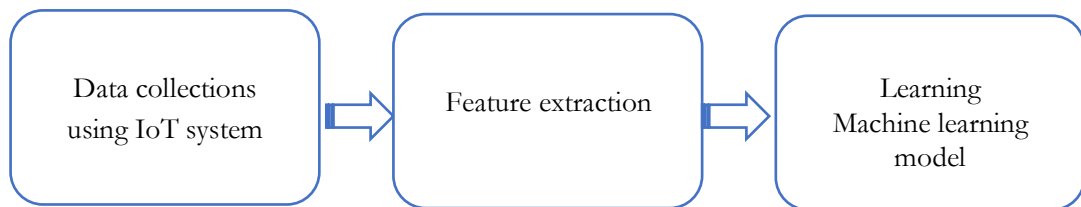


Figure 5. Learning process of the proposed system

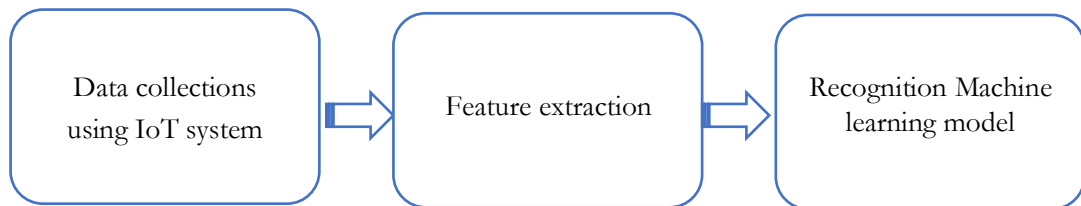


Figure 6. Recognition process of the proposed system

This proposed system aims to achieve a set of goals that have to do with the Internet of Smart Things in the field of health care through monitoring, analysis and making decisions in the right time, so that the followings can be considered: (1) Develop experimental platforms for interfacing smartphone equipped sensors using state-of-the art IoT technologies. (2) Observing the person' s condition throughout the day and sending reports periodically and predicting any unfamiliar behaviour. (3) To increase public awareness on IoT wireless network security and to highlight existing vulnerabilities in Wi-Fi networks that could be avoided.

3 Discussion and future perspectives

Violence in Libya continues to have a huge impact on healthcare sector, with hospitals and other medical facilities bombed, shelled and patients at times denied prompt life-saving care or attacked while getting treatment. Moreover, there are so many people in Libya whose health may suffer because they do not have proper access to hospitals and health services. Furthermore, the accelerated spread of coronavirus has exposed and exacerbated many structural problems in the healthcare systems. These problems can only be solved if there is a solution that is easily scalable and automated. Due to the emerging technology, small wireless solutions which are coupled to IoT can make it possible to monitor patients remotely instead of visiting the traditional hospital. A variety of smart sensors which are attached to the body of a patient can be used to obtain health data securely, and the acquired data can be analysed (by means of Machine learning algorithms) and sent to the server using different network connections. All doctors, emergency centres, hospitals, and relatives can access from anywhere at any time, visualize the data, and take a decision accordingly. Patients should be continuously monitored when they are out of the hospital. This should be possible by an efficient remote monitoring system that expands access to medical services. In this perspective, because most of the IoT sensing devices have low computing capability and small storage, the HTTP protocol, due to its complexity, cannot be considered in such an environment. The MQTT protocol, has some outstanding features that can change HTTP properties to increase requirements of IoT. Some of the key features of this protocol are low power consumption and overhead that make MQTT a suitable solution for the IoT implementation.

Personal wireless networks are one of the main components of IoT. Wi-Fi is used in various fields such as home healthcare, wearable sensor devices, mobile devices, and smart grids. In Libya, Wi-Fi is a favourite way to connect to the Internet. The falling costs and high availability of wireless equipment in Libya have enabled the growth in the number of wireless networks. Because of broadcast technology used, they are subject to security attacks. It is crucially important to investigate the risks and potential vulnerabilities of Wi-Fi networks to recommend users how to improve their security with less interference.

In most of the above-mentioned studies and related discussion, however, it has been noticed that a comprehensive platform is still missing in the IoT healthcare architectures to use smartphone sensors to sense and transmit important data related to a patient's health. In this work, it is important to conduct a study of Wi-Fi performance and security in Misurata

(as a case study) in order to increase public awareness on IoT wireless network security. Moreover, we wonder if accurate recognition of activity can be obtained using the Internet of Things and artificial intelligence technology in a non-controlled environment.

4 Conclusions

In the near future, healthcare sector will be developed by IoT technology and Artificial intelligence tools. These emerging technologies will play a prominent role in vital signs monitoring system in hospitals and more importantly at homes. Remote patient monitoring gives great opportunities to not only increase services quality but also minimize services costs by diagnosing diseases and harmful situations. Nowadays, the healthcare services in Libya are costlier than ever before, while most of the patients are needed to enter the hospital for a certain period of time. Using AI-based IoT with a capability to seamlessly and remotely monitor patients can somehow overcome the healthcare challenges. These technologies, by acquiring the patient's real-time health data and transferring it to decision makers, will not only reduce the cost of healthcare services, but also enable the treatment of health issues before they become critical.

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