Smart Telecardiology System using IoT Environment and Deep Learning

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ABSTRACT

Due to the COVID-19 pandemic, IoT environments and deep learning algorithms have been encouraged in healthcare for remote patient monitoring. Telecardiology is one of the delicate sectors that require extra attention to effectively manage the patient's health status. We propose a practical approach to ensure the telecommunication between the doctor and the patient via a smart system that enables to use of sensors and detect the type of disease by RNN-LSTM deep neural network. The experimental results demonstrate the effectiveness and efficiency of our proposal.

Keywords: Smart telecardiology system, IoT, Deep learning

1 Introduction

Internet of Things (IoT) environment in healthcare consists of biosensors to monitor health and environmental conditions, such as temperature, pressure, oxygen, etc. and to timely transfer patient-generated data from the patient to the care team and back to the patient. Telecardiology is considered a promising field for an IoT environment, where patients can be monitored at home using applications equipped with medical devices and sensors, such as ECG sensor, pacemaker, rhythmic Holter [1].
The COVID-19 epidemic in recent years has increased the use of virtual care alternatives in telehealth and many healthcare systems have been developed, such as Texas Medical Board [2], Teladoc [3], Orion Health [4], the heart disease RPM [5], etc. A typical example of a telecardiology system with an IoT environment is the heart disease RPM system [5], a low-cost cardiovascular patient monitoring system, which is used in any region of Cameroon. This system can capture important factors, well reflecting the patient's condition and provide alerting mechanisms. A recent work in IoT Telecardiology application development [6] used the AD8232 ECG sensor and Arduino Uno to collect ECG data, which was subsequently kept in a database and shared with the doctor's caregiver. The proposed system allows a doctor to remotely interpret the data for the medical follow-up of a patient. This work represents IoT application without any intelligence tasks for predicting or classifying cardiac diseases.

2 TECA2 a smart system for telecardiology

We present our smart telecardiology system called TeCa2 (Telemonitoring of patients with cardiovascular diseases) system, which is equipped with an AD8232 ECG sensor and Arduino Uno as a microcontroller board to transfer the ECG data between the doctor and the patient. From ECG data, we can detect cardiovascular diseases and detect types of diseases via deep learning techniques. Initially, in our recent research [7], we focused on one essential issue, which is the ECG data visualization to represent data and help physicians to interpret a diagnostic test result. The proposed solution is based on the InfluxDB database management system and the Grafana tool to store and visualize ECG signals, respectively.
We further explore the ECG data by developing a smart healthcare monitoring system, which can provide communication between doctor and patient, giving different tasks such as updating the profile, accepting patients, choosing a doctor, consultation, ECG signal, video calling and chatting features.

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3 Evaluation

TeCa2 system is associated with our RNN-LSTM (Long short-term memory) model to detect types of cardiac diseases from ECG data. The architecture of our model is illustrated in Figure 1.

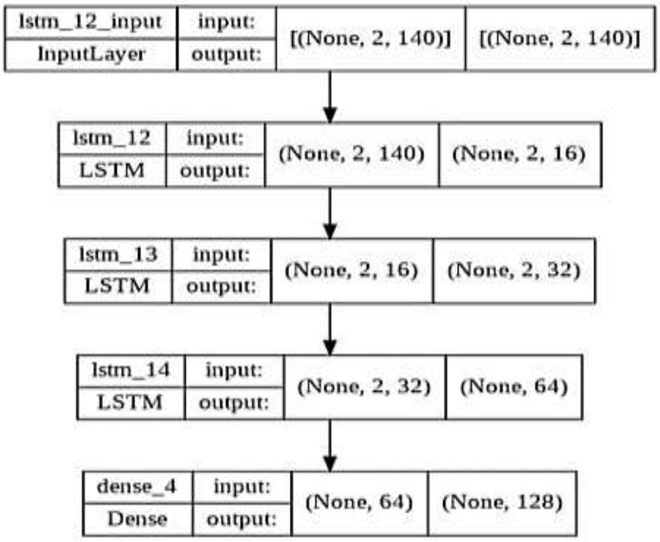

Figure 1: *The architecture of RNN-LSTM model*

The parameters of our model are as follows:

- The input layer has the same dimension (number of neurons) as the number of features (Features) in the input vector.
- The activation function used was ReLU.
- The output layer has the same dimension as the number of classes.
- The dropout technique is used when we encounter the problem of overfitting to obtain a generalizable model.
- The Loss function selected was binary-cross-entropy.
- The "Adam" optimizer was used with a Learning Rate of 0.001.

In our experiment, the training data was divided into three subsets: six for learning and 15 for validation and 25 for testing. The results of our experiments demonstrate that our model converges to a minimum loss value. This means that this model learns better and makes better detection after each optimization epoch for the ECG data.

4 Conclusion

We have investigated the integration of the IoT environment and deep learning issues in the telecardiology domain. We have presented a completely practical approach through the development of a smart system called TeCa2, which is equipped with the RNN-LSTM model for detecting the type of anomalies. Based on the results of this work we will improve our solution by establishing a solution for the security and privacy of distributed medical information by using blockchain. Besides, we will associate to TeCa2 system our electronic prescription management application [7] to store and manage prescription information electronically within TeCa2.

How to Cite

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