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Identify Failed ECGs and Arrythmia with 1 - D Convolutional Neural Networks

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Abstract: ***This study addresses an issue with ECGs in which a failed test cannot be recognized until the ECG is printed. Due to a variety of environmental variables and motion artifacts, the ECG signal may get distorted, resulting in erroneous judgments and predictions. As such, getting an uncorrupted and noise - free ECG recording is critical for determining the precise nature of the cardiac problem. This study employs a new technique to enhance the accuracy of an existing method presented by the researcher in another article published a few years ago. A 1 - D Convolutional Neural Network will be used to validate the quality of the image. Following that, the verified ECG will be analyzed to determine the presence of arrhythmia. The results show that this technique increased the accuracy to 99 percent when discriminating between corrupted and normal ECG data and to 93 percent when detecting arrhythmias.***

Keywords: ECG, Arrhythmia Detection, Signal Processing

1. Introduction

Willem Einthoven's development of the Electrocardiogram (ECG) in 1865 made a significant contribution to the identification of a broad variety of cardiac problems in humans. While an ECG may detect some types of heart illness, an unbroken and clear signal is required to properly diagnose any aberrant cardiac activities. Obtaining such a clear ECG is a difficult job owing to numerous artifacts such as motions caused by medical disorders such as anxiety, Parkinson's disease, and bodily tremors. Additionally, skin stretching [1] generates electricity, which disrupts the potentials in an ECG. Numerous studies have been performed to determine the most effective and efficient techniques to detect the accuracy of ECGs. We used cleaned and disturbed ECGs in this research to develop a more effective and efficient technique for accuracy validation and arrhythmia detection.

The goal of this research was to extend the accuracy of the ECG validation method introduced in [3] using 1 - D Convolutional Neural Network rather than a 3D one. Also, the ECG will be classified based on the arrythmia type of anything present. This research has two main components which are Quality Validation and ML based arrhythmia detection.

2. Literature Review

Samitha et al. [3] has proposed a novel method in ECG cleaning and identification of disturbed signals. Researchers have used MATLAB to remove the motion artefacts and clean the ECG and then a 3 - D Convolutional Neural Network for ECG evaluation. Interestingly, researcher has identified that accuracy of the proposed method is 98% present and has cleaned the ECG with less effect on ECG details.

[4] provide an interesting new suggestion onArrhythmia detection using CNN and they have used a well - known ECG database Physionet to gather relevant data. According to the researcher, an end - to - end framework was developed rather than the hand - crafted feature extraction and selection utilized in conventional techniques. Additionally, it is more rapid and efficient. According to the findings, it improved detection accuracy by 91.33 percent for arrhythmia detection.

3. Methodology

To begin, data from over 500 12 - lead ECGs were collected from public sources accessible on the PhysioNet online database. This ECGs were cleaned and disrupted ECGs of healthy and ill individuals were included in these data. These statistics included the majority of age groups and both sexes. Prior to use, collected data were cleaned using data pre - processing techniques to eliminate impacts such as baseline wander. Additionally, sounds such as frequency noise were eliminated.

In first stage of this search, cleaned ECG evaluation model was implemented using Convolutional Neural Network (ConvNet) but rather than a 3D layers, researcher replaced them with 1 - D layers.

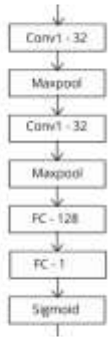

Figure 1: New ConvNet Architecture.

The architecture shown in Figure 1 was chosen after analyzing hundreds of pre - identified and classified ECGs. This model outperformed other candidate designs that were considered to meet this requirement. To develop this model, around 3500 ECG signal parts were utilized for each lead. To begin, all 12 leads' data was jumbled into two categories: with and without noise. These shuffled signal chunks totaled over 42, 000 and were classified for training, validation, and testing. These categorizations were performed on both the categories with and without motion artifacts that were used to train this model. To attain high accuracy, validation was required, as was the use of an early stop mechanism to prevent the model from being overtrained.

Secondly, the same database method in the [4] was used for Arrhythmia detection model training and same number of signal chunks in explained earlier was used for a simple Arrhythmia detection model. Since this model does not classify any of the signals to arrhythmia types, a binary classification used.

Finally, a Java - based application was created to automate these two processes and provide a final output indicating whether or not the given ECG can be used. Additionally, this enabled clinicians to examine and analyze ECGs (in their entirety or for a few seconds) prior to printing. The execution flow diagram in Figure 2 illustrates how this automation works.

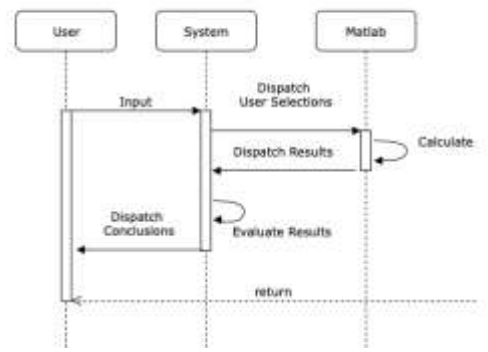

Figure 2: Execution Flow [3]

4. Results

By assessing more than 500 cleaned/disturbed healthy/unhealthy ECGs, the assessment model showed a 99.2 percent accuracy in predicting whether a particular ECG may be utilized or not. Additionally, it exhibited a sensitivity of 99.74 percent and a specificity of 98.9 percent. Because a single model was used to evaluate all 12 leads of the ECG, this substantially increased the model's performance and the total time required to make a single prediction.

In the arrythmia prediction, the model has achieved 95% of the accuracy in training and 93.1% in the testing. In order to ensure it is not overfitted, dropouts and early stopping were using.

5. Conclusion

By accomplishing all goals and providing accurate findings, this study has achieved its ultimate aim of improving the validation accuracy of the same researcher's prior research and providing an accurate machine learning model for arrhythmia identification. This increased accuracy eventually benefits both the patient and physician by reducing resource waste and identifying the existence of arrhythmias within a few seconds, even for inexperienced doctors.

References

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