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Article

Detection and Classification of Cardiac Arrhythmias using Innovative Artificial Intelligence (AI) Neural Networks and Advance Processing Algorithms

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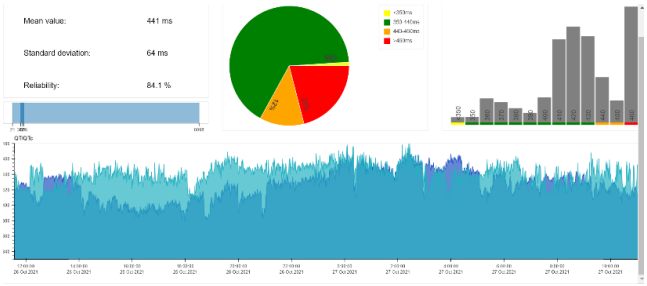
Summary

Electrocardiography (ECG) is used to measure the electrical activity of the heart and it is one of most important tools for the diagnosis of chronic cardiovascular diseases (CVDs) and other heart abnormalities including cardiac arrhythmias. CVD is one of the leading causes of death worldwide, thus it is of utmost importance to have dependable, robust, and efficient tools that can identify any symptoms as soon as possible so that an early treatment can be administered. Recently, there has been tremendous interest in harvesting continuous recordings from various devices using machine learning to fully automate the ECG diagnostic procedures. Our start-up (MEDTL) has developed a state-of-the-art **AI ECG diagnostic solution** based on inhouse **Algorithms**, and other innovative digital signal processing engineering techniques.

Figure 1 MEDTL ECG Analysis Platform

Approach

Our approach provides an end-to-end solution for medical professionals. Raw signals, especially those recorded using portable ECG devices, are often contaminated with various types of noise such as baseline wander, powerline interference, electro-myographic noise and motion artifacts. The first step of our pipeline is to read the patient's raw ECG signals and remove any noise using signal processing methods.



After denoising the signal, deep learning is used to identify P onset/offset, Q, R, S, T offset points, termed as the fiducial points of the ECG waveform. These points are crucial for the correct analysis of the ECG signal. This approach demands a large database of ECG signals as well as the development of a suitable machine learning model. An open-source research database is used, the Physio Net/Computing which contains fully annotated, single-lead (lead II) ECG data from 8,528 subjects with various types of ECG rhythms. For the beat classification step, a convolutional neural network (CNN) and other Artificial Neural Networks (ANN) are used in combination with other innovative inhouse intelligence algorithms was trained on this open-source database.

[1] MEDTL Medical Technologies Ltd or MEDTL (**www.mymedtl.com**) is a Cyprus based start-up, which is well versed in the fields of Healthcare, Software development and technological Innovation

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Results

Our AI algorithms will provide full ECG Medical Cardiological holistic solution which is based on:

I. Signal/ECG delineation method. This algorithm identifies all the fiducial points of the ECG signal. Our method yielded an unprecedented 98.8% accuracy with regards to calculating the QRS, PQ, QT, and corrected QT intervals (QTc).

II. ECG beat Classification. We have developed a second algorithm for automated ECG beat classification, which uses a 3-layer 1D Convolutional Neural Network (CNN), followed by two dense ANN layers for classification, achieving an accuracy of 97.2% for fourteen arrhythmia types in ECG beats.

III. Arrhythmias detection. Utilizing a third algorithm we can detect all the major arrythmias such as Ventricular Tachycardias, Supraventricular events and Runs, couplets and other abnormal events.

Solution Impact

Our solution can be used in both daily hospital care and post-discharge remote monitoring programs. In addition, the new service will significantly enhance current physician practice by:

I. Providing to doctors' immediate access to remote medical care information and real time monitoring of a patient's status.

II. Minimizing the time required by doctors to analyze each patient's records manually and exhaustingly by easily presenting all the abnormalities detected in a user-friendly way while allowing them to view each event individually for further examination.

III. Creating an upgraded line of business for medical professionals with a cost reduction of 40%.

IV. Promoting early discharge and reducing readmissions (readmissions have extremely high related costs).

Future steps-Conclusions

Our custom-made ECG medical platform (Figure 1) has been developed and is currently being used for preliminary trials. Based on the results of this trial, we will utilize the feedback to improve our solution as much as possible before launching it to the market. Moving forward, we will extend these capabilities, by gathering a larger amounts of training data we would be able to develop even more accurate models aiming to achieve a market-leading accuracy of 99.5% accuracy for 30 different arrhythmia types.

Furthermore, we will develop algorithms that will allow the analysis of multi-lead ECG recordings. Continuous monitoring and ongoing research will continue being conducted to ensure that the techniques used in our solution are optimal and that our solution is still relevant and competitive as technologies improve.