RELATED WORK

Amin Ullah, The electrocardiogram (ECG) is one of the most extensively employed signals used in the diagnosis and prediction of cardiovascular diseases (CVDs). The ECG signals can capture the heart's rhythmic irregularities, commonly known as arrhythmias. A careful study of ECG signals is crucial for precise diagnoses of patients' acute and chronic heart conditions. **Syed M.Anwar,** In this study, we propose a two-dimensional (2-D) convolutional neural network (CNN) model for the classification of ECG signals into eight classes; namely, normal beat, premature ventricular contraction beat, paced beat, right bundle branch block beat, left bundle branch block beat, atrial premature contraction beat, ventricular flutter wave beat, and ventricular escape beat. **Muhammadh Bilal,** The one-dimensional ECG time series signals are transformed into 2-D spectrograms through short-time Fourier transform. The 2-D CNN model consisting of four convolutional layers and four pooling layers is designed for extracting robust features from the input spectrograms. **Raja M. Mehmood** Our proposed methodology is evaluated on a publicly available MIT-BIH arrhythmia dataset. We achieved a state-of-the-art average classification accuracy of 99.11\%, which is better than those of recently reported results in classifying similar types of arrhythmias. The performance is significant in other indices as well, including sensitivity and specificity, which indicates the success of the proposed method.**Zahra Ebrahimi** Deep Learning (DL) has recently become a topic of study in different applications including healthcare, in which timely detection of anomalies on Electrocardiogram (ECG) can play a vital role in patient monitoring. This paper presents a comprehensive review study on the recent DL methods applied to the ECG signal for the classification purposes. This study considers various types of the DL methods such as Convolutional Neural Network (CNN), Deep Belief Network (DBN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU). **Mohammad Loni** From the 75 studies reported within 2017 and 2018, CNN is dominantly observed as the suitable technique for feature extraction, seen in 52% of the studies. DL methods showed high accuracy in correct classification of Atrial Fibrillation (AF) (100%), Supraventricular Ectopic Beats (SVEB) (99.8%), and Ventricular Ectopic Beats (VEB) (99.7%) using the GRU/LSTM, CNN, and LSTM, respectively. **Sonain Jamil,** ECG signals provide us with information about the heartbeat. ECGs can detect cardiac arrhythmia. In this article, a novel deep-learning-based approach is proposed to classify ECG signals as normal and into sixteen arrhythmia classes. The ECG signal is preprocessed and converted into a 2D signal using continuous wavelet transform (CWT).***Tran Anh Vu***, The accuracy of the classification algorithm we employ is 99.8%, demonstrating the model's validity when compared to other reports' findings. This is the foundation for our algorithm to prove it can be utilized as an efficient model for categorizing arrhythmia using ECG signals. *Nguyen Thi Minh Huyen* Actually, deep learning algorithms are evolving and highly effective in image analysis and processing. In this research, a dense neural network model is proposed to classify normal and abnormal beats. **Shao-peng Pang**, Recently, many models based on the deep neural networks have been applied to the automatic classification of cardiac arrhythmia with great success. However, most models independently extract the internal features of each lead in the 12-lead ECG during the training phase, resulting in a lack of inter-lead features. Here, we propose a general model based on the two-dimensional ECG and ResNet with detached squeeze-and-excitation modules (DSE-ResNet) to realize the automatic classification of normal rhythm and

8 cardiac arrhythmia.**Talal AA Abdullah,** the classification comprises five different classes: non-ectopic (N), supraventricular ectopic (S), ventricular ectopic (V), fusion (F), and unknown (Q) beats. The proposed model is trained, validated, and tested using MIT-BIH and St-Petersburg data sets separately. **Mohd S Mohd Zahid,** The performance of the proposed model based on the MIT-BIH data set is also compared with the performance of existing models based on the MIT-BIH data set.**Anisha Patnaik,** In this study, a profound learning system beforehand prepared on an overall picture informational index is moved to do programmed ECG arrhythmia diagnostics by arranging patient ECG's into comparing heart conditions. Arrhythmias are more normal in individuals who are 60 years and more established. **Dilip Hingorani,** A comparison study was done where validation accuracy is 100% in GoogleNet, 94% in Squeezenet while it was near 97.33% in AlexNet.**Ramya G. Franklin[1]** The research was carried to make the assignment computerized by displaying the problem with encoder-decoder methods, by using misfortune appropriation to predict standard or anomalous information. **Jeong DU,** Electrocardiograms (ECGs) are widely used for diagnosing cardiac arrhythmia based on the deformation of signal shapes due to changes in various heart diseases. However, these abnormal signs may not be observed in some 12 ECG channels, depending on the location, the heart shape, and the type of cardiac arrhythmia. Therefore, it is necessary to closely and comprehensively observe ECG records acquired from 12 channel electrodes to diagnose cardiac arrhythmias accurately.

The findings of the related literature analysis show that it will be better if we can transform our signals data into images and then merge signal processing with image processing techniques using deep learning. As a result, we use deep learning models to implement such as, CNN works better and gets higher accuracy using different classifiers.

We have included some of the reference papers.

1)Convolutional neural network for classification of eight types of arrhythmia using 2D time-frequency feature map from standard 12- lead electrocardiogram.

Jeong DU, Lim KM

In the year 2021 Abstract Electrocardiograms (ECGs) are widely used for diagnosing cardiac arrhythmia based on the deformation of signal shapes due to changes in various heart diseases. However, these abnormal signs may not be observed in some 12 ECG channels, depending on the location, the heart shape, and the type of cardiac arrhythmia. Therefore, it is necessary to closely and comprehensively observe ECG records acquired from 12 channel electrodes to diagnose cardiac arrhythmias accurately. In this study, we proposed a clustering algorithm that can classify persistent cardiac arrhythmia as well as episodic cardiac arrhythmias using the standard 12-lead ECG records and the 2D CNN model using the time-frequency feature maps to classify the eight types of arrhythmias and normal sinus rhythm. The standard 12-lead ECG records were provided by China Physiological Signal Challenge 2018 and consisted of 6877 patients. The proposed algorithm showed high performance in classifying persistent cardiac arrhythmias; however, its accuracy was somewhat low in classifying episodic arrhythmias. If our proposed model is trained and verified using more clinical data, we believe it can be used as an auxiliary device for diagnosing cardiac arrhythmia.

Conclusions:

The results of classifying eight cardiac arrhythmias using the proposed algorithm are shown. The F1 scores of the proposed model were over 0.8 during the classification of persistent cardiac arrhythmias such as AF, I-AVB, LBBB, and RBBB. The highest F1 score was observed for LBBB prediction at 0.89, and the classified F1 scores for AF, RBBB, and I-AVB were 0.86, 0.85, and 0.80, respectively. On the other hand, the classification performance of episodic cardiac arrhythmias such as PAC, PVC, and STE was relatively low compared to persistent cardiac arrhythmias. The lowest F1 score (0.52) was observed during the classification of STE, which had the smallest number of data classes. The F1 scores for PAC and PVC were 0.53 and 0.64, respectively. In addition, the F1 scores for NSR and STD were moderate as scores of 0.77 and 0.76, respectively. There was a difference in the number of data classes used for training and testing. Accordingly, the final macro F1 score of the proposed model was 0.74; however, the weighted F1 score, considering the difference in the number of data classes, was 0.78.

2)Arrhythmia and Disease Classification Based on Deep Learning Techniques

Ramya G. Franklin1, * and B. Muthukumar

In the year 2021 Abstract Electrocardiography (ECG) is a method for monitoring the human heart's electrical activity. ECG signal is often used by clinical experts in the collected time arrangement for the evaluation of any rhythmic circumstances of a topic. The research was carried to make the assignment computerized by displaying the problem with encoder-decoder methods, by using misfortune appropriation to predict standard or anomalous information. The two Convolutional Neural Networks (CNNs) and the Long Short-Term Memory (LSTM) fully connected layer (FCL) have shown improved levels over deep learning networks (DLNs) across a wide range of applications such as speech recognition, prediction etc., As CNNs are suitable to reduce recurrence types, LSTMs are reasonable for temporary displays and DNNs are appropriate for preparing highlights for a more divisible area. CNN, LSTM, and DNNs are appropriate to view. The complementarity of CNNs, LSTMs, and DNNs was explored in this paper by consolidating them through a single architecture firm. Our findings show that the methodology suggested can expressively explain ECG series and of detection of anomalies through scores that beat other techniques supervised as well as unsupervised technique. The LSTMNetwork and FL also showed that the imbalanced data sets of the ECG beat detection issue have been consistently solved and that they have not been prone to the accuracy of ECG-Signals. The novel approach should be used to assist cardiologists in their accurate and unbiased analysis of ECG signals in telemedicine scenarios.

Conclusions

The early diagnosis of cardiovascular infection is focused on exploration and distinction signs of arrhythmia. Throughout this analysis we proposed the interaction between CNN-LSTM and FCL to improve the preparedness influence, limiting the effects on the model training of an enormous amount of basic specific ECG beat information. The proposed architecture utilizes CNNs to decrease each spectral variation in the input feature but instead moves it on to LSTM layers while providing outputs to DNN layers, which have a more effective feature representation. The findings indicate that CNN-LSTM and FCL have obtained 99.33%, 96.06%, 94.36%, and 92.65%, individually, with the results being accuracy, F1 score, precision, and recall. The adequacy and intensity of the proposed architecture were seen by the MIT-BIH arrhythmic test results. The methodology proposed could be used to help cardiologists in diagnosing ECGs with a better level of accuracy and impartiality in telemedicine scenarios. In conclusion, in future examinations, various kinds and specific beats will be included. In addition, to analyze the appearance of the CNN LSTM using the FCL pattern, we intend also to introduce specific rates of noise to ECG signals. Convolutional neural network for classification of eight types.

3)Arrhythmia Classification Algorithm Based on a Two-Dimensional Image and Modified EfficientNet

Cui-fang Zhao, Wan-yun Yao, Mei-juan Yi, Chao Wan, Yong-Le Tian

In the year 2022 Abstract The classification and identification of arrhythmia using electrocardiogram (ECG) signals are of great practical significance in the early prevention and diagnosis of cardiovascular diseases. In this study, we propose an arrhythmia classification algorithm based on two-dimensional (2D) images and modified EfficientNet. First, we developed a method for converting original one-dimensional (1D) ECG signals into 2D image signals. In contrast with the existing classification method that uses only the time-domain features of a 1D ECG signal, the classification of 2D images can consider the spatiotemporal characteristics of the signal. Then, to better assign feature weights, we introduced an attention feature fusion module (AFF) into the EfficientNet network to replace the addition operation in the mobile inverted bottleneck convolution (MBConv) structure of the network. We selected EfficientNet for modification because, compared with most convolutional neural networks (CNNs), EfficientNet does not require manual adjustment of parameters, which improves the accuracy and speed of the network. Finally, we combined the 2D images and the improved EfficientNet network and tested its performance as an arrhythmia classification method. Our experimental results show that the network training of the proposed method requires less equipment and training time, and this method can effectively distinguish eight types of heartbeats in the MIT-BIH arrhythmia database, with a classification accuracy of 99.54%. Thus, the model has a good classification effect.

Conclusion

In this study, we developed a method for converting original 1D ECG signals into 2D image signals. To better assign feature weights, we introduced AFF to replace the addition operation in the MBConv structure of the EfficientNet network. The main limitation of the proposed arrhythmia classification algorithm is the low positive prediction accuracy for identifying APC beats. This is caused by data imbalance: specifically, there are many more NOR beats than other beats. The ratio of APC beats is only 2.3% in the data set. Moreover, multiple ECG samples from the same patient will generally exhibit the greatest similarity in heartbeats. The study results of the data augmentation show that the positive prediction accuracy for identifying VEB is substantially increased and ranges from 97.9% to 99.1%. Given the influence of available laboratory equipment, we converted 1D ECG signals into 2D image signals and used spatiotemporal characteristics to perform classification experiments on eight ECG signal types in the MIT-BIH arrhythmia database, achieving relatively high accuracy of 99.54% based on the improved EfficientNet-B0 network. Most medical data sets have sample imbalance problems, which are generally mitigated by increasing a few types of samples or decreasing most types of samples. In this study, we applied the preprocessing method of 1D to 2D ECG signal conversion, which increased the amount of data, and selected the best length. Additionally, we performed data augmentation for two categories, VEB and VFW, and we added four similar groups of different-length images to this data set, which alleviated the data imbalance problem to some extent. Finally, we employed three evaluation indices, namely, sensitivity, specificity, and precision rate ground, to evaluate the model's effect, all of which were found to be high, indicating that the model has a good classification effect. To extend the sample, the next step will be to identify relevant volunteers for sample collection. Validation of more ECG signal databases will be considered in the future to improve the practicality and robustness of the classification method for eventual application on medical robots or ECG signal monitoring devices. This approach can help doctors more accurately and quickly diagnose cardiovascular diseases from ECG signal.

4)Cardiac Arrhythmia Detection using Deep Learning

Monali Choudhary, Anisha Patnaik, Dipali Phatak, Dhanashri Deokar, Dilip Hingorani

Abstract :

An electrocardiogram (ECG) is a significant indicative device for the appraisal of cardiovascular arrhythmias in clinical daily practice. In this study, a profound learning system beforehand prepared on an overall picture informational index is moved to do programmed ECG arrhythmia diagnostics by arranging patient ECG's into comparing heart conditions. Arrhythmias are more normal in individuals who are 60 years and more established. A convolutional neural organization (in particular AlexNet) is utilized for feature extraction and the removed highlights are taken care of into a basic back spread neural organization to complete the last classification. Fundamental focal point of this investigation is to execute a basic, solid and effectively pertinent learning method for the grouping of the chosen three diverse heart conditions (heart arrhythmia, Congestive Heart Failure, Normal sinus rhythm) so that diagnosis can be done for the same. The results exhibited that the moved profound learning highlight extractor fell with a traditional back proliferation neural organization had the option to get exceptionally elite rates. A comparison study was done where validation accuracy is 100% in GoogleNet, 94% in Squeezenet while it was near 97.33% in AlexNet. Conclusion In this study, ECG Data obtained from the hospital are digitized, pre-processed, converted into scalogram images for classification , feature extraction is done using deep learning and training and validation of data is done. The overall images were classified as heart arrhythmia, Congestive Heart Failure and Normal sinus rhythm. A detailed performance comparison among three networks is done and validation accuracy is checked in all the three cases i.e. 97.33% in AlexNet, 94% in Squeezenet and 100% using googlenet. With the confusion matrix, we analysed how many images were incorrectly classified. This investigation was started because of the reality individuals in our nation influenced via cardiovascular illnesses are expanding step by step. Arrhythmias are more normal in individuals who are 60 years and more established. It's to some extent because of mileage of a more established heart.

5)Classification of cardiac arrhythmia using a convolutional neural network and bi-directional long short-term memory

Shahab UI Hassan, Mohd S Mohd Zahid, Talal AA Abdullah, Khaleel Hussain

In the year 2022 Abstract Cardiac arrhythmia is a leading cause of cardiovascular disease, with a high fatality rate worldwide. The timely diagnosis of cardiac arrhythmias, determined by irregular and fast heart rate, may help lower the risk of strokes. Electrocardiogram signals have been widely used to identify arrhythmias due to their non-invasive approach. However, the manual process is error-prone and time-consuming. A better alternative is to utilize deep learning models for early automatic identification of cardiac arrhythmia, thereby enhancing diagnosis and treatment. In this article, a novel deep learning model, combining convolutional neural network and bi-directional long short-term memory, is proposed for arrhythmia classification. Specifically, the classification comprises five different classes: nonectopic (N), supraventricular ectopic (S), ventricular ectopic (V), fusion (F), and unknown (Q) beats. The proposed model is trained, validated, and tested using MIT-BIH and St-Petersburg data sets separately. Also, the performance was measured in terms of precision, accuracy, recall, specificity, and f1-score. The results show that the proposed model achieves training, validation, and testing accuracies of 100%, 98%, and 98%, respectively with the MIT-BIH data set. Lower accuracies were shown for the St-Petersburg data set. The performance of the proposed model based on the MIT-BIH data set is also compared with the performance of existing models based on the MIT-BIH data set.

Conclusion

Arrhythmia is a severe CVD that can be predicted via ECG segment processing. Arrhythmia must be accurately diagnosed and prevented early to reduce cardiac disease. Our proposed system model met the study’s primary goal of assisting doctors in swiftly determining the kind of ECG or verifying their diagnostics in a medical context while maintaining a high level of precision and cost. In this work, a CNN-Bi-LSTM model is proposed to categorize five categories of ECG fragments to construct an effective and resilient autonomous computer-aided diagnosis system. The developed network achieved maximum accuracies of 100%, 98.0%, and 98.0% of training, validation, and testing using MIT-BIH data set. In comparison, the StPetersburg data set achieved 98.0%, 95.0%, and 95.0% accuracies of training, validation, and testing in identifying arrhythmia