**CLASSIFICATION OF ARRHYTHMIA BY USING DEEP LEARNING WITH 2-D ECG SPECTRAL IMAGE REPRESENTATION**

**LITERATURE SURVEY**

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| **S.NO** | **PAPER** | **AUTHOR** | **YEAR** | **SHORT DESCRIPTION** | **RESULT** | **FUTURE WORK AND ANALYSIS** |
| 1. | Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral  Image Representation | Amin Ullah, Syed Anwar, Muhammad Bilal, Raja Majid Mehmood | 2020 | Proposal of  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. 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. | 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. | The proposed model has attained the highest sensitivity among all the compared CNN algorithms.  It is pertinent to note that detecting these cardiac arrhythmias is a labor intensive task, where a clinical  expert needs to carefully observe recordings that can go for up to hours. With such automated methods,  the artificially intelligent system could augment the performance of clinical experts by detecting these  patterns and directing the observer to look more closely at regions of more significance. This would  ultimately improve the clinical diagnosis and treatment of some of the major CVDs. |
| 2. | Cardiac  arrhythmia  detection  using deep  learning | Ali Isina, Selen  Ozdalili | 2017 | An  electrocardiogram  is an important  diagnostic tool for  the assessment of  cardiac  arrhythmias in  clinical routine. A deep learning  framework  previously trained  on a general  image data set is  transferred to  carry out  automatic ECG  arrhythmia  diagnostics by  classifying patient  ECG’s into  corresponding  cardiac  conditions. Transferred  deep  convolutional  neural network is  used as a feature  extractor and the  extracted features  are fed into a  simple back  propagation neural  network to carry  out the final  classification. | We observed  that ECG  Data  obtained  from MIT-  BIH database  are pre-  processed,  QRS  complexes  are detected  and features  in R-T  intervals are  extracted.  When all of  the tested  networks are  evaluated it  is found that  networks  based on  transferred  deep learning  feature  extraction  obtained  almost 100%  recognition  rates and  accuracies  above 96%  in training  phase. | It won’t be too  surprising to  see state-of-  the-art  performances  from deep  learning  applications  not only in  medical  signals and  imaging  diagnostics  but also in  other popular  sub-fields of  biomedical  imaging and  signals. |
| 3. | Arrhythmia  Classification Techniques  Using Deep  Neural  Network | Ali Haider  Khan,Muzammi  l Hussain ,and  Muhammad  Kamran Malik | 2021 | The automated  screening of  arrhythmia  classification  using ECG beats  is developed for  ages. The deep  learning based  automated  arrhythmia  classification  techniques are  developed with  high accuracy. The  primary concerns  that affect the  success of the  developed  arrhythmia  detection systems  are (i) manual  features selection,  (ii) techniques  used for features  extraction, and  (iii) algorithm  used for  classification and  the most  important is the  use of imbalanced  data for  classification. | The major  concerns that  affect the  success of  the  developed  arrhythmia  detection  systems are  (i) manual  features  selection, (ii)  techniques  used for  features  extraction,  and (iii)  algorithm  used for  classification  and the most  important is  the use of  imbalanced  data for  classification | The automated  arrhythmia  detection  required the  feature  extraction of  ECG images  that required  domain  knowledge.  Further, the  balanced  dataset used  for  classification  methods is  required to  avoid  overfitting. |
| 4. | A deep convolutional neural network model to classify heartbeats | U. Rajendra Acharya, Shu Lih Oh, Yuki Hagiwara, Jen Hong Tan, Muhammad Adam | 2017 | The basis of arrhythmia diagnosis is the identification of normal versus abnormal individual heart beats, and their correct classification into different diagnoses, based on ECG morphology. Heartbeats can be sub-divided into five categories namely non-ectopic, supraventricular ectopic, ventricular ectopic, fusion, and un-  known beats. It is challenging and time-consuming to distinguish these heartbeats on ECG as these signals are typically corrupted by noise. We developed a 9-layer deep convolutional neural network (CNN) to automatically  identify 5 different categories of heartbeats in ECG signals. Our experiment was conducted in original and noise  attenuated sets of ECG signals derived from a publicly available database. | This set was artificially augmented to  even out the number of instances the 5 classes of heartbeats and filtered to remove high-frequency noise. The CNN was trained using the augmented data and achieved an accuracy of 94.03% and 93.47% in the diagnostic classification of heartbeats in original and noise free ECGs, respectively. When the CNN was trained with highly  imbalanced data (original dataset), the accuracy of the CNN reduced to 89.07%% and 89.3% in noisy and noise-  free ECGs. When properly trained, the proposed CNN model can serve as a tool for screening of ECG to quickly  identify different types and frequency of arrhythmic heartbeats. | In the future studies, the authors would like to extend the proposed  model by training a CNN to recognize temporal sequences of ECG  heartbeat signals. The occurrence, sequential patterns and persistence of  the five classes (N, S, V, F, and Q) of ECG heartbeats considered in this  work can be grouped under three main categories of green, yellow, and  red, which represents normal, abnormal, and potentially life-threatening  conditions of heart electrical activity, respectively. The authors plan to  discuss the performance of the CNN model using de-skewed data and  data with added different level of noise in the future studies. |
| 5. | Classification of Arrhythmia in Heartbeat Detection Using Deep Learning. | Wusat Ullah,Imran Siddique , Rana Muhammad Zulqarnain , Mohammad Mahtab Alam , Irfan Ahmad, and Usman Ahmad Raza. | 2021 | Aims to apply deep learning techniques on the publicly available dataset to classify arrhythmia. The system combines three different types of information: RR intervals, signal morphology, and higher-level statistical data. It is concluded that fuzzy-based technology is successful in the analysis of computerized ECG but needs more research. | It has the ability to produce very accurate predictions with a 99.12 percent accuracy rate for the CNN model, 99.3 percent accuracy for the CNN + LSTM model, and 99.29 percent accuracy for CNN + LSTM + Attention Model. | This study should be conducted in binding domains like cloud and mobile systems. It is also vital to develop wearable technologies with integrated low-power consumption wearable technologies. |