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IMPLEMENTATION OF K-NEAREST NEIGHBOR (KNN) ALGORITHM FOR DETECTION OF P-WAVE

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Abstract:** In this paper, we implemented* **K-*Nearest Neighbor (KNN) algorithm as a classifier and slope as feature for detection of P-wave in ECG with the detection rate of 91.72% is achieved. The proposed algorithm is evaluated on standard databases CSE dataset-3.

I. INTRODUCTION

The P-wave, preceding the QRS-complex, is generated by the electric activity of the atria that supports the filling of the ventricular cavities prior to the contraction of the ventricular walls. The widespread application of the ECG has brought about an ever-growing demand on the diagnostic accuracy of the technique. Again, curiously enough, more than a century later, its full potential has not yet been reached, and several basic problems still remain to be resolved.

The P wave is caused by atrial depolarization. The duration is normally not greater than 120 ms. the normal shape of the P wave does not include any notches or peaks. It can be positive, negative, or biphasic in the remaining leads. An absent P wave in the ECG may signify sinoatrial block. The purpose of this study is to develop a method to distinguish healthy and abnormal subjects using the correlation coefficients of ECG waveforms. Although many detection algorithms for ECG signal have been developed to detect QRS complex, but there are only a fewer publications that describe algorithms to detect the P wave detection [1, 2, 3, 4, and 5].

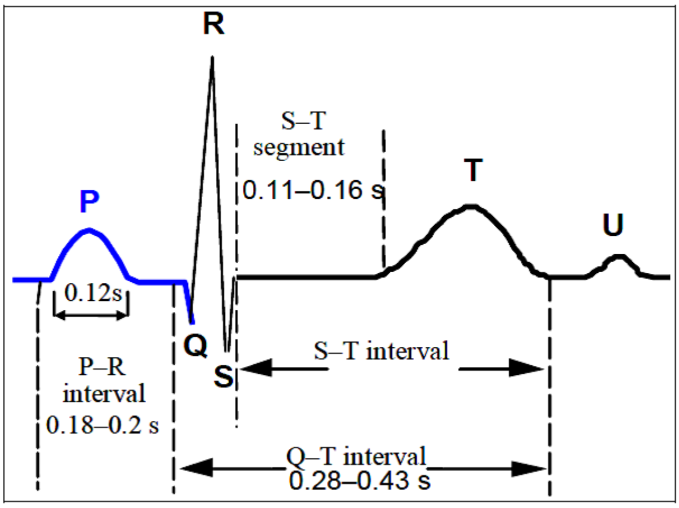

Fig. 1. The most important parameters of an ECG signal [6]

II. KNN CLASSIFIER

In pattern recognition, the **k-nearest neighbors algorithm** (**k-NN**) [7] is a non-parametric method used for classification and regression [8]. In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression:

- In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbour [9].
- In k-NN regression, the output is the property value for the object. This value is the average of the values of its k nearest neighbors.

k-NN is a type of instance-based learning, or lazy learning, where the function is only approximated locally and all computation is deferred until classification. The k-NN algorithm is among the simplest of all machine learning algorithms.

Both for classification and regression, a useful technique can be to assign weight to the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbor a weight of 1/d, where d is the distance to the neighbor.

The neighbors are taken from a set of objects for which the class (for k-NN classification) or the object property value (for k-NN regression) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required.

A peculiarity of the k-NN algorithm is that it is sensitive to the local structure of the data. The algorithm is not to be confused with k-means, another popular machine learning technique.

Algorithm

A case is classified by a majority vote of its neighbors, with the case being assigned to the class most common amongst its K nearest neighbors measured by a distance function. If K = 1, then the case is simply assigned to the class of its nearest neighbor.

Distance functions	
Euclidean	$\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$
Manhattan	$\sum_{i=1}^{k}\lvert x_i - y_i\rvert$

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Minkowsi	$\left(\sum_{i=1}^{k}(x_i - y_i)^q\right)^{1/q}$

Detection of P-waves

This section describes a typical algorithm used by many researchers for the detection of P-waves in ECG signal (referred as A1 in Fig. 6.1 and Fig. 6.2).

Step 1: Filtering of the raw ECG-signal

Step 2: Algorithm to detect QRS-complexes

Step3:Algorithm to detect T-waves (as they are usually detected before P-waves becauseof significantamplitude)

Step 4: Removing (masking-off) the QRS-complexes and T-waves from the original signal, so that more relevant data remains for P-wave detection.

Step 5: Normalizing the resultant signal.

Step 6: Using a thresholding constant, separate the P-waves

III. RESULT

Fig. 2 shows P-wave detection in record MO1_013. QRS-complexes are prominent, T-waves are inverted, and P-waves are normal in this case. The algorithm successfully detects these P-waves as depicted in Fig. 2.

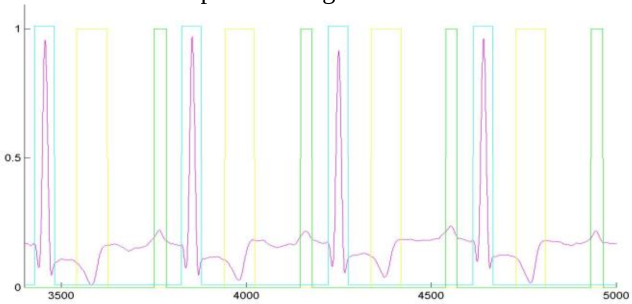

Fig. 2 Detection of P-waves in record MO1_013

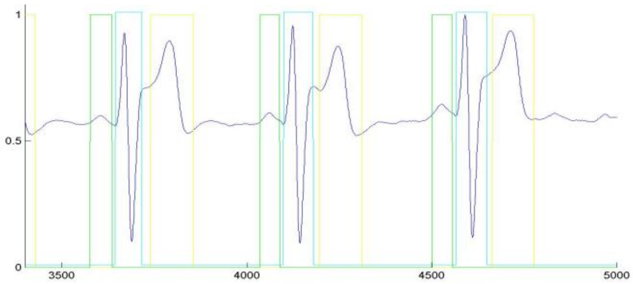

Fig. 3 Detection of P-waves in record MO1_042

Fig. 3 shows P-wave detection in record MO1_042. P-waves are lower in amplitude and T-waves are tall in this case. The algorithm accurately detects these lower amplitude P-waves.

IV. CONCLUSION

The method has been exhaustively tested using the data-set 3 of the CSE multi-lead measurement library covering a wide variety of P-wave morphologies. An algorithm based on dynamic thresholding technique is proposed in this paper. A significant detection rate of P-wave 91.72 % is obtained.

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