

Title: Intelligent algorithms for real-time monitoring of cardiovascular diseases

Industrial Applications ☐Intelligent Manufacturing ☐Intelligent Driving ☐Intelligent Life ☒Smart Medicine ☐Smart City

Background description

[Overall background]

Cardiovascular disease is the "number one killer" that endangers human life and health worldwide. It accounts for 29% of the world's deaths in the world every year. In China, 2 of the 5 deaths die from cardiovascular disease. At present, there are about 290 million cardiovascular diseases, including 11 million coronary heart diseases, 4 million 500 thousand heart failure and 2 million 500 thousand rheumatic heart disease, 2 million congenital heart disease, 270 million hypertension. The huge number of patients with cardiovascular disease has produced huge market space.

[Business background]

The market analysis agency studies report that smart health care devices are replacing consumer technology products represented by smartphones, becoming the fastest growing area. Electronic auscultation equipment market has appeared. However, how to make electronic auscultation equipment from only record, storage data, to provide intelligent monitoring, data fusion, disease early warning and other diagnostic levels of application services, is the biggest challenge at present.

Project description

[Problem description]

At present, the prevention and treatment of cardiovascular disease generally uses the Holter ECG recorder to monitor the dynamic ECG data. The instrument needs to wear the electrode sensors that contact the skin for 24 hours to collect the ECG signals. It is inconvenient and cost high. At the same time, the disease of cardiac pump blood function, valve disease, myocarditis and so on cannot even monitor. However, the use of heart sound data, can be a good way to avoid the above problems, the key is accurate processing on the heart sound data, algorithm. The heart sound intelligent terminal based on good data and algorithm can monitor and feedback the heart health problem of users in real time, evaluate the blood function of cardiac pump by a small amount of data and detect the risk of heart valve, arrhythmia and other diseases.

[User expectations]

- (1) Convenient and easy-to-use cardiovascular disease prevention and early warning equipment;
- (2) Intelligent, high precision cardiovascular disease prediction alarm;
- (3) Detection process is simple, quick, short and efficient.

[Economic effect]

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million 500 thousand rheumatic heart disease, 2 million congenital heart disease, 270 million hypertension. The huge number of patients with cardiovascular disease has produced huge market space. Suppose that 1% of the patients implemented family cardiac monitoring (2 million 900 thousand), the hardware market capacity was over 1 billion (the price of \$500 / piece), the service market was larger and the capacity exceeded 500 million (the service fee of 200 yuan per year).

Task requirements

[Technical path]

Based on the mainstream terminal (Android, IOS, PC).

[Technical indicators]

- (1) Accurate assessment on myocardial blood pumping function and detection of heart valve and arrhythmia risk can be achieved.
- (2) The algorithm is best tested in clinical trials of not less than 500 cases.

[Standard Submission]

- (1) Submitting the source code of the algorithm and the implementation of the file;
- (2) Submitting an algorithm to implement a document;

[Score standard]

The performance of the algorithm on the validation set is taken as the grading standard, and the calculation procedures of the specific performance indicators are as follows:

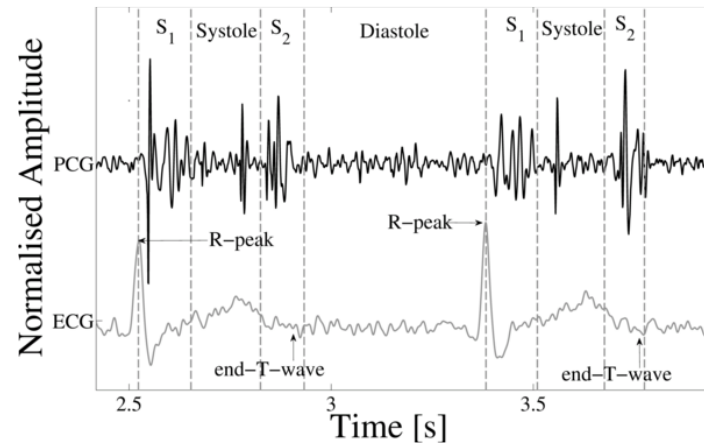
		Entry's output		
		Normal (-1)	Uncertain (0)	Abnormal (1)
Reference label	Normal, clean	Nn_1	Nq_1	Na_1
	Normal, noisy	Nn_2	Nq_2	Na_2
	Abnormal, clean	An_1	Aq_1	Aa_1
	Abnormal, noisy	An_2	Aq_2	Aa_2
$wa_1 = \frac{\text{clean abnormal records}}{\text{total abnormal records}}$		$wa_2 = \frac{\text{noisy abnormal records}}{\text{total abnormal records}}$		
$wn_1 = \frac{\text{clean normal records}}{\text{total normal records}}$		$wn_2 = \frac{\text{noisy normal records}}{\text{total normal records}}$		
$Se = wa_1 \frac{Aa_1}{Aa_1 + Aq_1 + An_1} + wa_2 \frac{Aa_2 + Aq_2}{Aa_2 + Aq_2 + An_2}$				
$Sp = wn_1 \frac{Nn_1}{Na_1 + Nq_1 + Nn_1} + wn_2 \frac{Nn_2 + Nq_2}{Na_2 + Nq_2 + Nn_2}$				

Where Nn , Nq , Na , An , Aq , Aa are classified as normal, undetermined, and abnormal samples, respectively; W is the weight of the calculated sample proportion; Se and Sp are calculated sensitivity and specificity of the algorithm. Taking the average of sensitivity and specificity as the final result of the competition, the highest winner is the winner.

[Data set]

A standard heart sound training and verification data set (see Attachment training/ validation) is provided, which contains 3126 pieces of heart sound data samples, each length range from 5 to

120 seconds. To facilitate processing, all data are resampled to 2000 Hz, and then stored as standard .Wav format. All samples were labelling by doctors or professionals: heart sounds were normal, abnormal, and noise was too large to be judged. Participants need to train their own machine learning models to achieve intelligent heart sound diagnosis. The following is a sample of heart sounds data file for about 3 seconds.



[Reference model]

The code reference model is shown in Appendix sample, based on the MATLAB platform, using the traditional hidden Markov model and logistic regression classifier, the result is 66%.

Reference information

[Reference data]

Reference: <https://physionet.org/challenge/2016/papers/>

Open source dataset: <https://physionet.org/challenge/2016/>

[Data interface]

None