Comparison of the calculation QRS angle for bundle branch block detection

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Abstract. QRS angle represent condition of blood circulation in the heart. Normally QRS angle is between -30 until 90 degree. Left Axis Defiation (LAD) and Right Axis Defiation (RAD) are abnormality conditions that lead to Bundle Branch Block. QRS angle is calculated using common method from physicians and compared to mathematical method using difference amplitudos and difference areas. We analyzed the standard 12 lead electrocardiogram data from MITBIH physiobank database. All methods using lead I and lead avF produce similar QRS angle and right QRS axis quadrant. QRS angle from mathematical method using difference areas is close to common method from physician. Mathematical method using difference areas can be used as a trigger for detecting heart condition.

1. Introduction
The electrocardiogram (ECG) is a tool to record electrical activity of the heart. ECG result can be printed or showed in the monitor is commonly used to non-invasively evaluate the cardiac activity of a patient [1]. ECG data is representative of cardiac physiology, used to analysing cardiac condition. The condition of cardiac health is usually seen in the shape of ECG waveform and heart rate. Human activities, lifestyles and food consumption have direct impact to condition of the heart [2].

ECG data is recorded in different forms according to the location of electrodes (leads) [3]. Standard ECG device records activity of the heart from six frontal plane leads and six horizontal plane leads. Frontal plane leads contain lead I, II, III and augmented lead avF, avL, avR. Horizontal plane leads contain lead V1, V2, V3, V4, V5 and V6. QRS axis is a spatial visualization of two frontal leads. It shows condition of the heart whether normal or abnormality conditions which lead to Bundle Branch Block. Previous research algorithm to detect condition of heart is slow and better method is need [4].

2. Theoretical Review
There are five parameters in normal ECG data which are P, Q, R, S and T as can be seen in figure 1. P wave is a recording of depolarization through the atrial myocardium from start to finish, the QRS complex is reflecting depolatization of ventricular myocardial and T wave represents ventricular repolarization [5]. A normal QRS complex is consisting of a small Q wave, a large R wave and a small S wave. Physicians usually analyse four intervals in ECG waveform. PR interval typically is analysed in lead II of the 12 leads ECG consisted of P wave and the straight line connecting it to QRS complex. QRS interval is visualized using frontal plane leads. ST interval is used to examine Myocardial Infraction. QT interval is usefull for heart rate correction.
Physicians usually analyse a pair of leads from frontal plane leads which are perpendicular. The pair leads are lead I – lead avF, lead II – lead avL and lead III – lead avR. Resultant of the pair leads is visualized in the QRS axis. The visualization shows conditions of the heart especially in ventricular area. This research used 12 lead electrocardiogram data from MITBIH physiobank database. We compared three methods of calculation QRS angle in the QRS axis which are normal physician method, calculation directly from ECG data using different peaks and different areas.

Noise removal and baseline wander are done as preprocessing. Algorithm for QRS detection is complied to get values of QRS complex. Mathematical formulation to calculate area of surfaces in the QRS complex area is used.

3. Experimental Analysis
The 12 lead ECG data from MITBIH is converted to .mat extension in order to match MATLAB software requirement. All preprocessing and mathematical formulation is done using MATLAB. Three methods are compared to know difference of QRS angles.

**Figure 1.** Normal ECG waveform, parameters and intervals

**Figure 2.** Result of different peaks and different areas from normal heart condition
Figure 2 shows two visualizations from normal condition of ECG data using lead I – lead avF. QRS angle from physician interpretation is 8°. Result of calculation from different peaks is 5.7884° and from different areas is 6.3604°. All results of QRS angle are in the normal quadrant.

There are two visualizations from abnormal heart condition. QRS angle from physician interpretation is -51°. Result of calculation from different peaks is -42.8548° and from different areas is -52.1493°. All results of QRS angle are in the left axis deviation (LAD) quadrant which lead to Left Bundle Branch Block.

Figure 3. Result of different peaks and different areas from abnormal heart condition

Result of the experiment with normal heart conditions are calculation using different peaks and different areas lead to normal axis. Difference between calculation from data and interpretation from physician is 1.0215° to 3.2250°. Experiment with LAD heart condition also show same quadrant of QRS axis between calculation from data and physician’s interpretation. The difference is 1.1135° to 18.8105°. These result lead to Left Bundle Branch Block condition. Other abnormal heart condition which is Right Bundle Branch Block also can be detected using three methods because the result lead to right axis deviation (RAD) quadrant. Comparing to interpretation of physician, the difference is 1.2147° to 17.4415°.

4. Conclusion
Calculation QRS angle using different peaks and areas give similar result to physician’s interpretation. These methods were calculated using computer software which can produce QRS angle in the same quadrant. Like other computer result in reference, it is cost advantages by use of existing computer [6].

References
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