CHAPTER 6

Conclusion

Cardiomegaly, an abnormal enlargement of the heart in fetus, is known to be a sign of hemoglobin Bart's disease and is the most dangerous thalassemia found in Thailand. Early detection of cardiomegaly is consequently very important during the first trimester of pregnancy.

Cardiothoracic ratio or CT ratio, which is the cardiac diameter (Cd) divided by thoracic diameter (Td), is used to diagnose cardiomegaly. However, it is difficult to visually detect the fetal heart structure due to low signal-to-noise ratio of ultrasound images and small fetal heart's sizes.

In order to help physicians on this work, we developed an automatic system to measure Cd and Td values. Based on Horn-Schunck algorithm, the motion estimation method was utilized to detect the heart chamber position and select the proper frames in either end-diastolic or end-systolic stages. Rib positions were then specified by the thresholding method. The rib positions would be used to measure the Td value and finding the ROI which was the region that covered all of the heart areas. The heart structure was segmented by performing patch-based possibilistic c-means (PCM) to the ROI. In order to measure the cardiac size, the interventicular septum line (IVS) in the heart structures was located, and finally, the biggest cardiac size was used as a Cd value to compute the CT ratio.

To evaluate the performance of our algorithm, we first worked on 99 videos by comparing the result with expert number 1. The Td average error in this case was 6.16% with the Cd average error, the average CT ratio error, and the cardiomegaly diagnosis accuracy at 21.23%, 18.64%, and 58.58%, respectively. Then, we further worked on 75 videos with expert number 2. The Td average error in this case was 7.57% with the Cd

average error, the average CT ratio error, and the cardiomegaly diagnosis accuracy at 22.07%, 20.36%, and 56%, respectively.

When comparing between the two expert opinions on the 75 videos, the Td average %difference opinion was 3.67%, the Cd average %difference opinion was 6.17%, the average CT ratio %difference was 7.56%, and the cardiomegaly diagnosis difference opinion was 13.33%. The different opinions between the experts due to CT ratio values are very close to 0.5 which is the diagnosis boundary of normal and abnormal cases. There were 42 cases from 99 cases whose CT ratios were close to 0.5. Furthermore, with the improvement of Cd and Td values by adding up with the computed correction factor, the accuracy of cardiomegaly diagnosis became 71.72%, comparing to expert number 1.

For further improvements, the following problems are needed to be addressed in the future research work. First, our proposed method measures only the heart chamber (heart structure) while the experts also included the heart wall in their measurement. Therefore, the next step is to be able to compute the thickness of the heart wall as a correction factor. In other words, the image after segmentation should include the heart wall.

In addition, cardiomegaly diagnosis by an expert is based on the value of CT ratio from the biggest heart frame which is the end-diastolic stage. However, the biggest heart frame selection by our proposed methodology may differ from the experts. The program perhaps reveals bigger atrium than ventricle in the end-systolic stage while the experts' measurement target has the biggest ventricle in the end-diastolic stage. Therefore, a further improvement of the algorithm should also include an ability to identify the biggest ventricle.

Moreover, the direction of IVS given by the program has some differences from the experts, so the Cd measurement that is perpendicular to IVS was misplaced. Normally, the angle of an IVS line is approximately 45 degrees to a line connecting spine and sternum. A future work should also be able to locate the spine-sternum line and used it as a reference to get more correct IVS direction.

The correction factor used in our proposed method was computed from the ultrasound images with a resolution equal to 71.984 pixels/inch. The correction should be recalculated if our algorithm is applied to different image resolutions.

All of the videos used in our research are also the ones that are used for teaching in general. They are not specific for Cd and Td measurements. Since some videos used in our experiments have incomplete four chamber views, videos collected for future research should fulfill the requirements of the program such as with complete four chambers and clear ribs.

As a final remark, the program developed in this research should be applied as a semi-automatic program, if used in real-life scenarios. The video input should be checked for completeness before being used and the result comes out from the program should be treated only as a second opinion after an expert's.