SYLWIA KOSECKA-ŻUREK[*]

RIGHT VENTRICLE DETECTION ON MRI IMAGES FOR VERIFICATION MORFOMETRIC SYMPTOMS OF PULMONARY HYPERTENSION

DETEKCJA PRAWEJ KOMORY SERCA NA OBRAZACH MRI W CELU WERYFIKACJI OBJAWÓW MORFOMETRYCZNYCH NADCIŚNIENIA PŁUCNEGO

Abstract

This paper presents the usage of image analysis methods for solving the problem of the right ventricle detection in the rats hearts. Images which have been analyzed were created by the Magnetic Resonance Imaging. Rat's hearts images which have been analyzed were created by experimental magnetic tomography, which gives the opportunity for measuring *in vivo*. Pointing of the right ventricle and the describing data allows to analyze changes in the heart under the influence of pulmonary hypertension and help specialists in the designation of the characteristics of pulmonary hypertension.

Keywords: image analysis, magnetic resonance imaging, objects detection, pulmonary hypertension

Streszczenie

W artykule omówiono zastosowanie metody komputerowej analizy obrazu do rozwiązania problemu detekcji prawej komory serca. Analizowane obrazy szczurzych serc otrzymywane są za pomocą jądrowego rezonansu magnetycznego (MRI), co pozwala na prowadzenie badań *in vivo*. Wyznaczenie prawej komory serca oraz opisujących ją danych liczbowych ma umożliwić analizę zmian zachodzących w sercu pod wpływem nadciśnienia płucnego i pomóc specjalistom w wyznaczeniu charakterystyki nadciśnienia płucnego.

Słowa kluczowe: analiza obrazu, jądrowy rezonans magnetyczny, detekcja obiektów, nadciśnienie płucne

[*] MSc. Sylwia Kosecka-Żurek, Institute of Applied Informatics, Faculty of Mechanical Engineering, Cracov University of Technology.

1. Introduction

This paper presents the usage of image analysis methods for solving the problem of the right ventricle detection in the rat's hearts. Monocrotaline (MCT) is administered to rats to cause pulmonary hypertension. It was observed that in this disease is subject to change right ventricle. Changes in vascular lung function and abnormal biochemical parameters are preceded by the appearance of morphometric symptoms. This is overgrowth of right ventricle. Since the heart weight measurements are possible only after excision, it is reasonable to automatic detection of right ventricle on MRI images of hearts, in order to assess these changes. MRI gives the opportunity for measuring in vivo. Measurements of area helps to accurately describe changes in the heart at an appropriate time after administration of MCT.

The disease causes changes in pulmonary arteries, the excess muscles of membrane, shrinkage, endothelial damage, changes in vascular reactivity (systole/diastole). It cause to increase in resistance of pulmonary vessels. Such conditions force the right ventricle to intensified labour. This causes the overgrowth heart muscle in the right ventricle area and consequently the development of right ventricular failure. Therefore, the analysis of cardiac images is important in a research into pulmonary insufficiency.

2. Methodology

Images which have been analyzed were created by experimental magnetic tomography. The Magnetic Resonance Imaging is generally used in medical diagnostic because it is not-intrusive procedure. The aim of this method is to receive high quality images of body interior. This method is very good for imaging the blood, because differences in the intensity of signals, which emits blood vessels and walls, allow good visibility jam heart and heart muscle.

The aim of the research is to estimate changes of right ventricle area caused by pulmonary hypertension. The goal of performed MRI image analysis is the detection of right ventricle and getting data in the form of the ventricle area on each image. Elaborated algorithm analyzes these images and gets the data from which specialists can investigate a pulmonary hypertension. This algorithm is a new approach to problem solution, it also includes known techniques of image analysis.
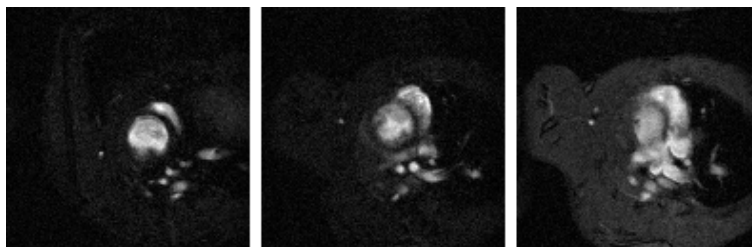

Fig. 1. Examples of input images

Rys. 1. Przykłady obrazów do analizy

3. Discussion about algorithm and results of detection

The images are first subjected to filtration, in order to improve quality and remove noise, and then converted to a binary form. This operation converts a gray image into a binary image. It is a very popular image analysis tool. The aim of binarization is radical reduction the amount of information contained in the image. The proposed algorithm implements automatic binarization procedure, which uses a method proposed by Kapur, Sahoo and Wong. Further operations are realized on binary images.

The next step is segmentation, that is extraction of objects from the image. On some images (Fig. 2) right and left ventricle are very close to each other and detected as one object, therefore, elaborated algorithm divides the connected objects (Fig. 3).
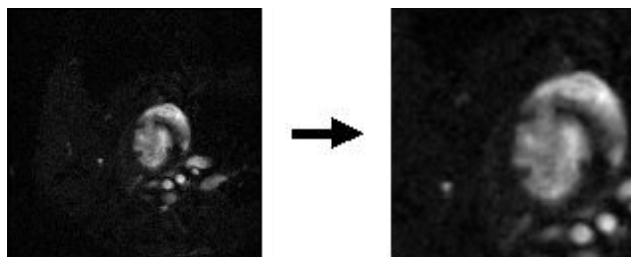

Fig. 2. Examples of images with connected ventricles

Rys. 2. Przykład obrazu, na którym prawa i lewa komora serca stykają się ze sobą
(są połączone i później wykrywane jako jeden obiekt)

Fig. 3. Separation of connected objects

Rys. 3. Rozdzielenie połączonych obiektów

After that the analysis is performed, which consists of eliminating objects, which are not a right ventricle. Used for selection are the anatomical features of the ventricle as the elongation, concavity, position relative to left ventricle, and the properties resulting from the method of obtaining images, which allow to the exclusion of objects that is on the edge of the image.

Analysis results are binary images (Fig. 6) and files with numerical data. Numerical data about ventricles areas are write to spreadsheet files.

The devised method is universal and gives correct results irrespective of images quality. It is not susceptible quality, sharp, brightness and contrast of image. The program is sensitive to forced changes of heart action.
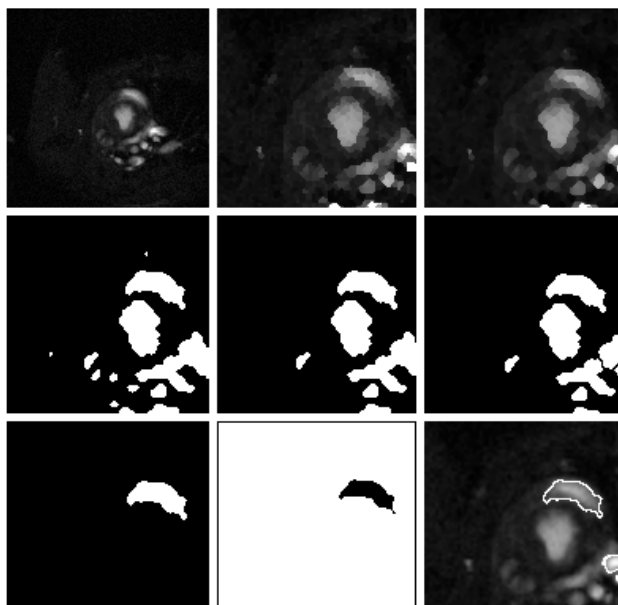
Fig. 4. Exemplary stages of analysis
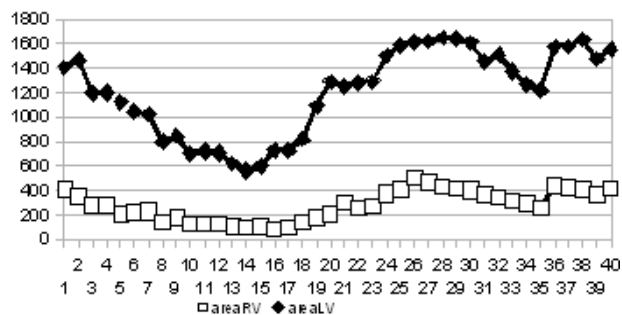
Rys. 4. Przykładowe etapy analizy

Fig. 5. The graph illustrating ventricle area of images from one seria

Rys. 5. Wykres przedstawiający powierzchnię komory dla obrazów jednej serii

Graph (Fig. 5) presents a graphical interpretation of numerical results obtained for chosen series of measurements. The graph shows the heart work. This chart present both changes on the left and right ventricle in cardiac cycle. Those changes can be interpreted by specialists, who conduct their research for pulmonary insufficiency. Apart from numerical data, analysis of gives binary images of right ventricle (Fig. 6). Based on these results, numerical results are obtained. Besides the program gives the images after visualization (Fig. 7) That is initial images with right ventricle boundary. This allows to easily assess the effectiveness of detection. It lets to rate analysis precision, because after visualization on images it can see right ventricle contour. Algorithm is highly efficient, but if there are any

inaccuracies, then it gives the ability to manual edit binary results. The program allows to manual modification of the detected area.

Fig. 6. Examples of binary images
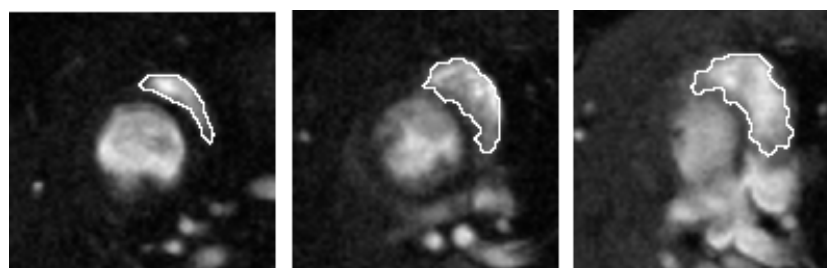
Rys. 6. Binarne wyniki analizy

Fig. 7. Examples of images after visualization

Rys. 7. Przykłady obrazów po wizualizacji

R e f e r e n c e s

[1] W o j n a r L., K u r z y d ł o w s k i K., S z a l a J., *Praktyka analizy obrazu*, Polskie Towarzystwo Stereologiczne, Kraków 2002.
[2] Z i e l i ń s k i K ., *Komputerowa analiza obrazu biomedycznego*, PWN, Warszawa 2002.
[3] N i e n i e w s k i M., *Segmentacja obrazów cyfrowych*, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2005.
[4] O g i e l a M., *Strukturalne metody rozpoznawania obrazów w kognitywnej analizie zobrazowań medycznych*, Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków 2004.
[5] M a l i n a W., S m i a t a c z M., *Metody cyfrowego przetwarzania obrazów*, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2005.
[6] W a t k i n s C., S a d u n A., M a r e n k a S., *Modern image processing*, WNT, Warszawa 1995.
[6] K u c h a r i e w G ., *Przetwarzanie i analiza obrazów cyfrowych*, Wydawnictwo Uczelniane PS, Szczecin 1998.