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A Report on work: Cardiac MRI CBIR for pathologies detetion

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Introduction

The early detection of pathologies in the cardiovascular system **is very important**. One of the most accurate imaging examinations of human tissues is magnetic resonance imaging (MRI), which is a very precise yet non-invasive test. In order to process MRI images to detect pathologies, one of the most promising methods is Content Based Image Retrieval (CBIR).

The main contributions of the paper are: **a review** of the state-of-the-art methods, a **selection** of the **most promising image features** that may be used to identify pathologies, a **description of the proposed system** for preparing suggestions for doctors, which takes into consideration also **methods for presenting the results,** which are most often omitted in other researches.

Literature overview

We **reviewed 13 papers** in oder to select segmentation, feature extraction methods and metrics. The results have been shown in Table 1 and Section 2 of our paper. Below there are presented summarized results (Fig. 1-3):

Figure 1. Features

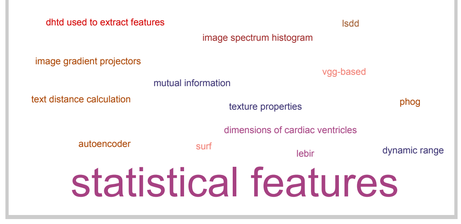


Figure 2. Segmentation algorithms

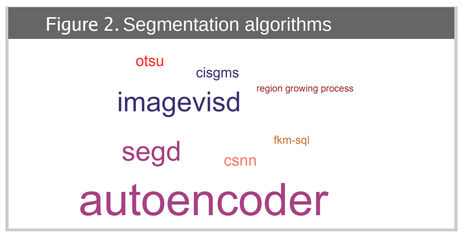
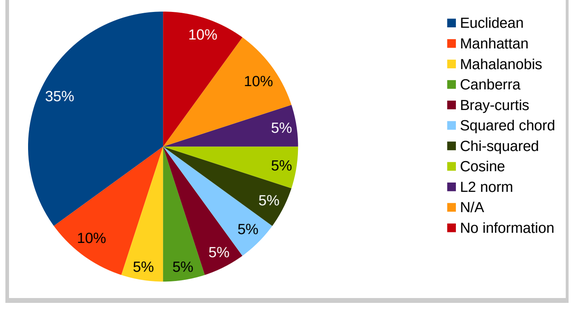


Figure 3. Metrics

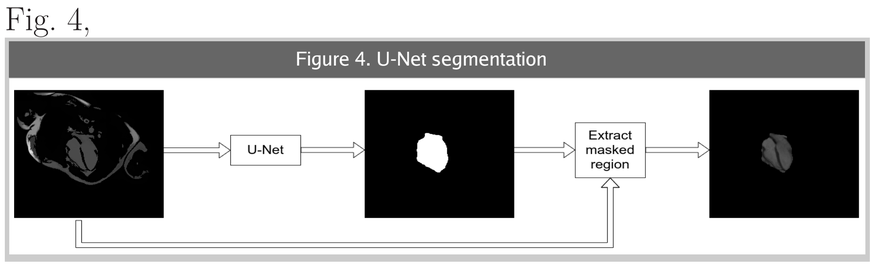


Method

The proposed system consists of the following logical modules:

- **preprocessing and segmentation** - using Mean shift and U-Net for segmenting and MRI image type detection - U-Net extraction is shown in Fig. 4,

Figure 4. U-Net segmentation



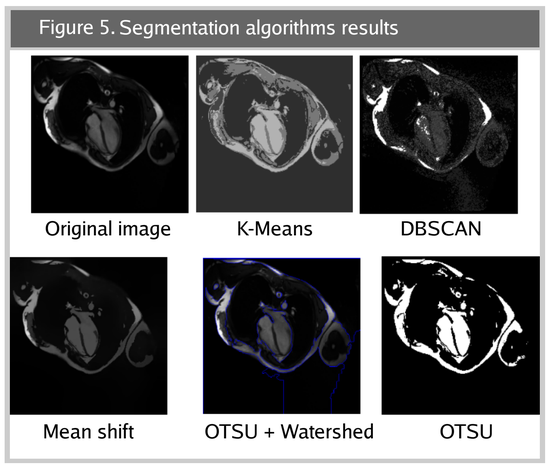
- **feature extraction** - statistical and global features, Gabor filters, heart-based, SIFT, FAST, ORB, deep learning-based - for extracted heart and it closest surrounding,
- **the CBIR suggestion module and visualization module** - extracting features and compute distances, find 5 most similar images from the database, propose suggestions using stored metadata.

Initial experiments

Only initial experiments have been performed using the dataset (Campello et al., 2021). **Following experiments were made for checking**:

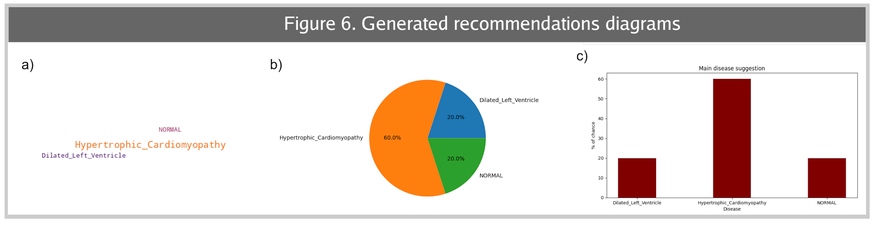
- **which type of segmentation would be most suitable for initially preprocessing the image** in order to make the heart more significant than the background and other tissues (Mean shift ant U-Net had the best perfomance) - tests of different algorithms is presented in Fig. 5:

Figure 5. Segmentation algorithms results



- **MRI image type detection idea** (the average precision for LV images was 0.87 and for Cine images was 0.83),
- **test module for generating suggestions for doctors** (as features mean, variance, median, kurtosis, skewness has been chosen) - as a result it occured that more tests with additional other features are needed,
- **how the CBIR suggestion module performs** - for all tested images only Calcaneal insufficiency avulsion images were problematic,
- **the correction of chart generation** - 3 types of diagrams were generated and evaluated for their correctness - example diagrams is shown below in Fig. 6:

Figure 6. Generated recommendations diagrams



Conclusions

In this paper, a report on work on Cardiac MRI CBIR Retrieval for pathology detection has been presented. During the research, **a review of different methods that are applied to medical CBIR has been made**. Next, all of them were analyzed for used segmentation, features and metrics for comparisons. Additionally, **an initial method for CBIR has been proposed**. Moreover, some **initial experiments were performed** in order to check the main assumptions of the proposed method.

When analyzing existing methods and working on the research, there appeared many further directions and ideas, e.g.: improving the performance of the feature set, check if an additional feature set for the heart's neighboring area may improve the results, adding information extracted from e.g. ECG analysis or patient information, move from 2D to 3D.

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Cardiovascular diseases, according to some estimates, currently account for 60 million of premature deaths each year in Europe. The risk of cardiovascular diseases increases with many factors, e.g. age. Early detection of pathologies in the cardiovascular system is very important.

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