Hybridization of Medical Images: Fusion of Echocardiogram and MRI

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Abstract

Introduction:
Acquiring and analyzing medical images is often a routine and critical part of the initial diagnosis and tracking the recovery process of a cardiac patient. The goal during the examination process is to optimize patient wait time and accuracy of diagnoses. Currently, echocardiography and magnetic resonance imaging (MRI) consist of the mainstay of imaging modalities used in the diagnosis of congenital heart disease from the fetus to the adult. The ECHO provides a two-dimensional view of the heart structure, and an accurate view of blood flow by leveraging a continuous or pulsed wave Doppler. However, due to the movement produced in the ultrasound, ECHOs often produce poor resolution and field of view for the physician to work with. MRIs are therefore used in conjunction with an ECHO to yield a clearer anatomic description of the heart. This process of continuously swapping between ECHOs and MRIs however, results in an elongated time to accurately diagnose a patients condition.

Goal:
Hybridizing images, such as ECGs and MRIs, together will reduce the time needed to view and diagnose patients medical images, while enhancing the overall image quality.

Method:
We will develop a system utilizing unsupervised machine-learning techniques including fuzzy logic, genetic algorithms and neural networks to accurately fuse ECHOs and MRIs into a single view. The framework of our system will begin with an established set of enhancement filters, which will be selected through a genetic algorithm process. The primary layer of the system will also include fuzzy logic, which allows the selection of multiple enhancement filters, to optimize enhancement of image quality. Once image quality is enhanced, neural networks will be established to accurately determine placement of the ECHO onto the MRI. This final phase is completed through learned data about image characteristics, which are then able to correctly resize and manipulate images to fuse together.

Conclusion:
The resultant echocardiographic MRI yields important anatomic and hemodynamic information and facilitates the decision-making process for the cardiologist and cardiac surgeon. Future applications of the image fusion strategy can include three-dimensional images as well as image-directed therapy for congenital heart disease. With the success of this image fusion, we will be able to begin applying the system to other imaging combinations such as PET imaging with CT, to extend the benefits of image hybridizations into other healthcare disciplines.

Keywords
Hybridization, Image fusion, fuzzy logic, genetic algorithms, neural networks