Center for Visual & Decision Informatics

A National Science Foundation Industry/University Cooperative Research Center

Executive Summary

Title: Early Detection of Myocardial Infarction Using Echocardiogram Images | **Project ID: 7a.021-TUT**

Today's Date: 14 Feb 2018 | **Estimated Start Date:** 1 Aug 2018 | **Type:** [x] New [ ] Continuing

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Project Description: The significant proportion (20-30%) of emergency department admissions are related to patients with acute chest pain. In this case, the patients are needed to have a rapid assessment as time-critical treatments may be needed. It has been shown that parameters such as changes in ECG characteristics or alternation of cardiac enzyme/protein may detect only 30% of acute ischemic events. Here, echocardiography can play a valuable role as an alternative diagnostic tool in an appropriate triage of patients with acute chest pain. Echocardiography is a reliable method for revealing the anomalies in the regional heart wall motion. Due to the early manifestation of Myocardial Infarction (MI) symptoms in echocardiogram, this imaging modality is now included in the universal definition of acute MI and in international guidelines regarding the management of cardiac arrest. In this project, the aim is to design an automatic model which trace the movement of heart's wall using the echocardiogram images and detect the anomalies in the wall motion. To be more specific this project is focused on early and accurate detection of the abnormal wall movements in heart associated with the MI.

Experimental Plan: During the project period the focus will be particularly drawn to the following key research topics:
1) Literature review, i.e. study the symptoms and causes of MI in echocardiogram images, exploring different types of anomalies in the heart's wall movements, and indication of regions of interest in MI detection. 2) Dataset collection. 3) Detection of the regions of interest and their associated tracing trajectories to capture possible anomalies. 4) Design a robust model for early automatic MI detection in wall motions, using signal processing and machine learning approaches.

Related Work: Despite the promising accuracy of echocardiography in detection of MI and the necessity of using an automatic decision-making system along with this imaging modality, few research projects have been done in this field (two of them are addressed as follows).
[1] S. Narula, K. Shameer, AM. Salem. Omar, JT. Dudley, PP. Sengupta, "Machine-Learning Algorithms to Automate Morphological and Functional Assessments in 2D Echocardiography.", J. the American College of Cardiology, vol. 68, no. 21, PP. 2287-95, 2016.
[2] T. Stanton, R. Leano, TH. Marwick, "Prediction of all-cause mortality from global longitudinal speckle strain: comparison with ejection fraction and wall motion scoring.", Circulation: Cardiovascular Imaging, vol. 2, no. 5, pp. 356-64, 2009.

How this project is different: The poor specificity of ECG test in detection of MI, the late elevation of troponin level after the heart attack, and the risks of transportation of patients to potentially remote parts of the hospital (for CT, or CMR) make the echocardiography as an appropriate choice to be performed as a point-of-care imaging technique in acute cardiovascular care units. In addition to the early manifestation of MI using echocardiography, an automatic MI detection in early stages, will decrease the wrong diagnosis and improve the efficiency of the medical care output.

Milestones for Year 1:
3 months: Literature review
6 months: Dataset collection
9 months: *Designing a model to detect the regions of interest and tracing their motion trajectories*
12 months: Designing a robust model for MI detection

Deliverables for Year 1:
1. Dataset collection
2. Designing a model to detect the regions of interest and tracing their motion trajectories
3. Designing a robust model for detection of anomalies in heart's wall motion associated with MI.

Proposed Budget:

Researcher Salary	€34,400
Indirect salary costs	€18,232
Overhead	€50,527
Travel	€8,000
Material and other costs	€3,841
Total	**€115,000**

How this Project may be transformative? The ambition of this project is not only to detect the MI in the early stages but also avoid misdiagnosis and missed diagnosis in emergency departments. This will provide the capability of producing a major impact on the accuracy of heart assessment for patients with acute chest pain.

Potential Member Company Benefits: This designed model can bring the opportunity for the health companies to equip their echocardiography imaging devices with automatic MI detection, and it can be used in hospitals or any clinical environment to increase the accuracy of MI diagnosis.

Progress to Date: We have worked on a variety of heart signal problems so far, such as detection of AFib and other arrhythmia using ECG and PCG signals. Our team has tested several hypotheses on real medical datasets. Some of our recent publications:
[1] "Personalized Monitoring and Advance Warning System for Cardiac Arrhythmias", Scientific Report 7, 9270, 2017.
[2] "Detection of Atrial Fibrillation in ECG Hand-held Devices using a Random Forest Classifier", The 1st place in CinC 2017.
[3] "Heart sound anomaly and quality detection using ensemble of neural networks without segmentation", The 2nd place in CinC 2016.

Estimated Knowledge Transfer Date: 12 months