CVDI Year 6 Mid-Year Report

08/01/17 – 12/31/17

Project ID# –Monitoring and Advance Warning for Cardiac Arrhythmia Using PCG and ECG

Report Date	Project Start	Project End	Project Budget	Amount Spent To Date
	08/01/2017	7/31/2018	**Project Budget:** €490 000*	45%

* The budget covers all CVDI Projects at TUT and funded by Tekes and IAB members as a single project

PROJECT SUMMARY

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- Typical ECG/PCG classifier systems require a certain duration of training samples (e.g., 5 minutes) containing both normal and abnormal beats of a patient.
- In the absence of the latter, no classifier can be trained properly and thus be applied to early detection of abnormal beats –if and when- occurs for an otherwise healthy person with no history of cardiac problems.
- One needs a certain amount of abnormal samples to learn their major characteristics to accurately discriminate them from the normal beats.
- As an advance warning system, this is the first attempt to detect any abnormal beats as soon as they occur without any possibility of prior system training or tuning.
- In this project, we first design an automatic anomaly detection using ECG/PCG signals. For this purpose we follow two conventional (with hand-crafted features) and automatic feature extraction approaches.
- The proposed method will be evaluated on the largest, newly released heart sound (PCG) dataset and single-lead ECG dataset recorded using hand-held devices (AliveCor device).
- Finally, if a proper dataset (i.e., long-term recordings for each patient) is available, we will test our advance arrhythmia detection idea.

PROJECT TEAM

Team Member Name	Team Role *(PI, Co-PI, Student, Researcher)*	Academic Site
Moncef Gabbouj	PI	Tampere University of Technology
Serkan Kiranyaz	Co-PI	Tampere University of Technology
Morteza Zabihi	Researcher	Tampere University of Technology

IAB PROJECT MENTOR(S)

IAB Project Mentor Name	IAB Organization
Matti Vakkuri	Tieto

PROJECT FUNDED BY

IAB Organization(s)
TEKES and Tieto

OVERALL PROGRESS/ACHIEVEMENTS TO DATE

There are two major steps to approach the proposed objectives. The first step is to design an algorithm for classification of the anomalies in PCG/ECG data. The achievements in the first step are as follows:

1. A model is designed for automatic arrhythmia detection with focus on Atrial Fibrillation (100% accomplished):
    a. Conference Paper: **Detection of Atrial Fibrillation in ECG Hand-held Devices using a Random Forest Classifier**
2. Designing a model for anomaly detection of PCG signals (80% accomplished).

The second step is to evaluate the capabilities of the proposed approach in the detection of arrhythmia and to implement the proposed method for early warning. The last step requires an appropriate dataset.

PROJECT DELIVERABLES

Deliverable	Achievements	Remaining To Do
1. Realization of the capabilities of the PCG/ECG signals in early detection of heart anomalies.	The filter coefficients designed for the proposed method are tested on the newly released ECG dataset and has shown significant impact in the classification of different types of arrhythmia.	The same experiments need to be tested on PCG signals to evaluate the potential capabilities of the proposed method in the identification of anomalies.
2. Design the state of the art classification method (Normal vs. Abnormal) for the PCG dataset. *Using hand-crafted features*	This dataset is released on 2016. Our proposed method won the 2nd place in the PhysioNet/Computing in Cardiology Challenge 2016 among 48 intentional teams.	-
3. Design the state of the art classification method (Normal vs. Abnormal) for the PCG dataset with reasonably high signal to noise ratio. *Automatic feature learning*	The PhysioNet/Computing in Cardiology Challenge 2016 dataset is used. In this work we have achieved the sensitivity, specificity, and positive predictively of 89.67%, 86.89%, and 69.70%, respectively.	The proposed approach achieves superior performance levels in contrast with the competing method (our previous competition algorithm) Reporting the proposed method and the achieved results are in progress.
4. Design the state of the art classification method (Normal, AF, other rhythms, and too noisy) for the ECG dataset.	This dataset is released on 2017. Our proposed method won the 1st place in the PhysioNet/Computing in Cardiology Challenge 2017 among 75 intentional teams.	-
5. Modeling the common cause of "degradation system" for advance warning. **This section depends on an appropriate dataset.**	-	Design the filters which model the cause of the degradation in the system, so that can be used for an advance warning system.