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Open-Source Automated External defibrillator OAED

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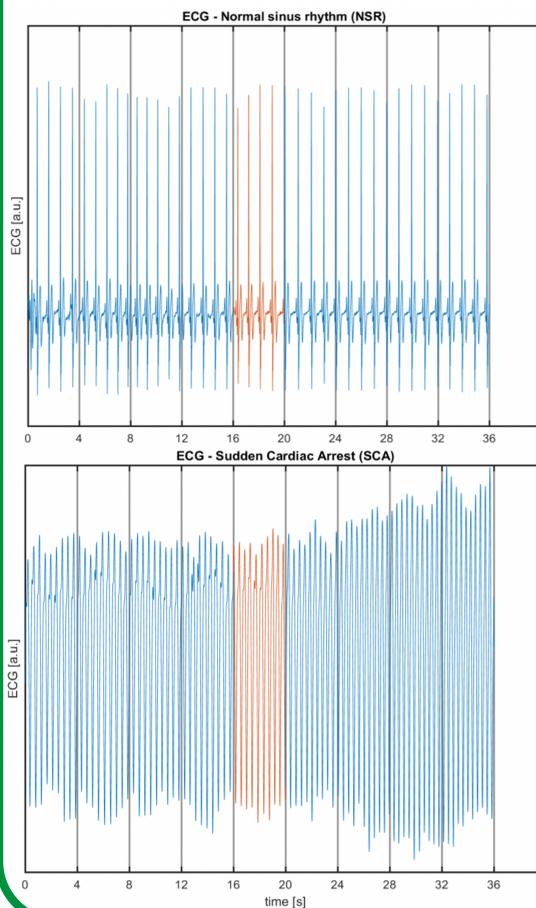
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Introduction

Sudden Cardiac Arrest (SCA) is a condition that causes more than 300000 deaths per year in EU and the USA. The release of a therapeutic dose of electrical energy through an Automated External Defibrillator (AED), is necessary in order to treat SCA. The Open-Source AED analyses patient electrocardiograms combining the results of multiple algorithms. Computer simulations show that the OAED is capable of detecting SCA with sensitivity and specificity higher than 90%.



Electrocardiogram Pattern Recognition



The Electrocardiogram (ECG) is one of the most studied physiological signals. In the OAED, the ECG is obtained from the patient and digitalized by the Delta-Sigma Analog Digital Converter, filtered with a 3-40 Hz band-pass filter in the Digital Filter Block (DFB), and finally moved to the memory, where it is stored as a 4 s window at a sampling frequency of 500sps. To analyse and to assert if the patient is suffering from SCA, the ECG is analysed in 4s windows. This choice is a good compromise between the amount of data to analyse and the speed of diagnosis. As a mean of comparison. The figure on the left show a Normal Sinus Rhythm (NSR) ECG, acquired with the OAED, and a pathological ECG taken from the PhysioNet ECG signal database [1].

SCA Recognition algorithms in OAED

We have implemented five SCA recognition algorithms [2].

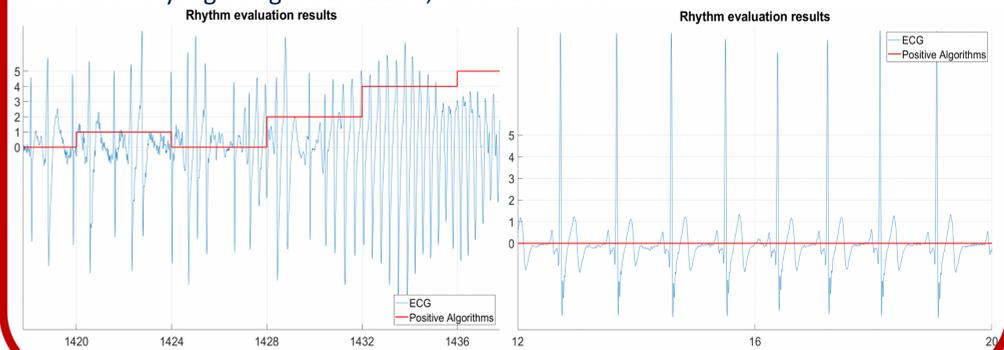
Algorithms

Threshold Crossing Interval	Traditional algorithms
VF Filter	
Threshold crossing Sample Count	Innovative algorithms
Phase Space Reconstruction	
Hilbert Transform Algorithm	

If the majority of algorithms are positive, SCA is confirmed otherwise the heartbeat is assumed as simply *not-shockable* rhythm.

Results

An example of a pathological signal and a healthy signal respectively tested in Matlab® in shown below. The blue line represents the ECG signal with superimposed the individual results of the five algorithms described above; these are represented with a binary logic: high means SCA, low means no SCA.



Conclusions

The OAED design is compliant with the standards defined by the IEC 60601. Its firmware is open source freely available and properly commented for teaching purposes [2].

UBORA e-Infrastructure

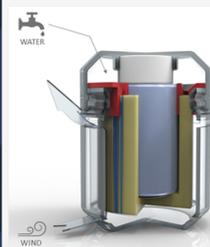
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Area: Pediatrics
Device classification: Ila

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References

- [1] Physionet, PhysioBank database. <https://www.physionet.org/physiobank/database/>
[2] <https://github.com/CentroEPiaggio/Open-Automated-External-Defibrillator>

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