
Design of a Miniaturized Automated External Defibrillator

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Section: Biomedical Engineering **Thesis supervisor:** Prof. Jean-Michel Redouté

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Abstract

Since the design of the first defibrillator in 1947, a lot of improvements have been made in terms of technologies. This device has evolved through time to try to give the best treatment as possible with the easiest use as possible. These last years, defibrillators have already seen their size decrease a lot. However, a pocket-size AED is not yet on the market. Some companies have shown promising solutions, but these still need to be classified as medical devices. These improvements show that this topic of research is a field in which a lot of interest is placed.

The purpose of this project is to go through the designing steps of an automated external defibrillator of small size to allow ease of use and portability. The device should be fully automated, meaning that the heart rhythm should be automatically detected, and the defibrillation process should start by itself if needed. The first shock should deliver an energy pulse between 100 and 200 joules depending on the transthoracic impedance (TTI) measured and the next shocks should increase with steps of 50 joules with a maximum of 360 joules until a normal heart rhythm is detected.

To reach this goal, the project has been divided in 3 main parts. At first, a low voltage acquisition board has been made. This board measures patient's TTI and records the ECG activity with almost no noise. The second part is the high voltage defibrillation part. The working principles have been investigated and are described in this work. This part could be continued in a future work to find the adequate solution to control the biphasic pulse and to power a flyback converter able to provide enough energy to charge the capacitor. Finally, an arrhythmia detection algorithm has been designed, using a machine learning model. This enables to detect ventricular fibrillation and tachycardia which are the shockable rhythms, i.e. rhythms for which a shock can be delivered to restart the heart. The model selected is a neural network classifier able to classify the activity with a sensitivity of 97.3 % and a specificity of 99.2 %, using predictions of two consecutive subwindows of 5 seconds.

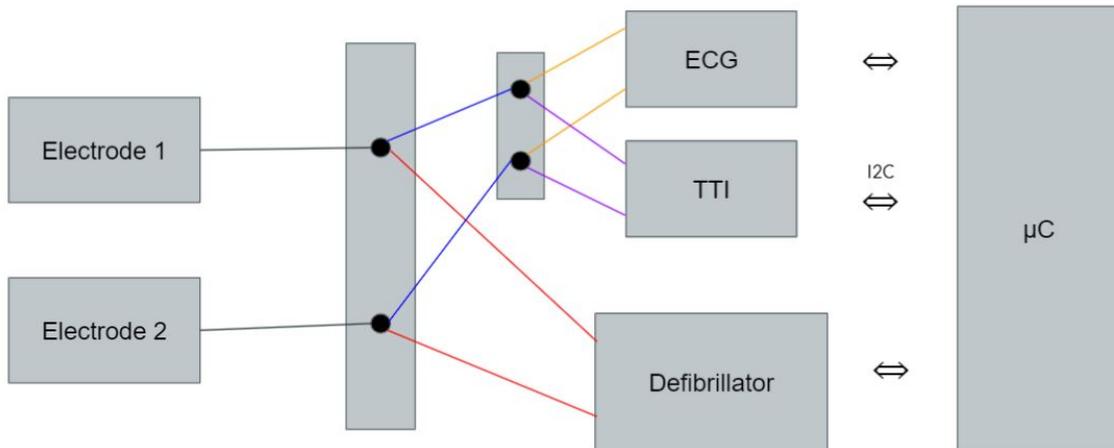


Figure 1: Whole structure

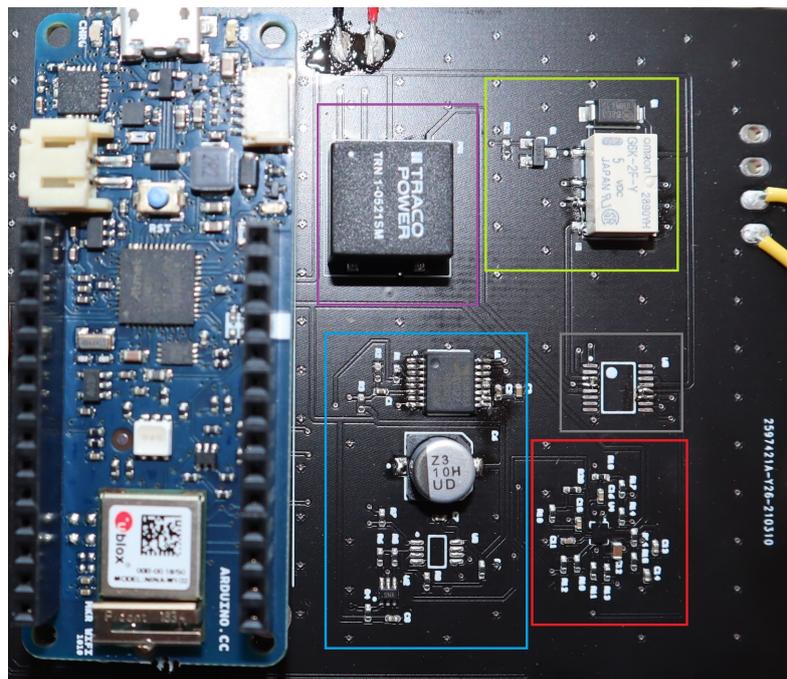


Figure 2: Low voltage PCB

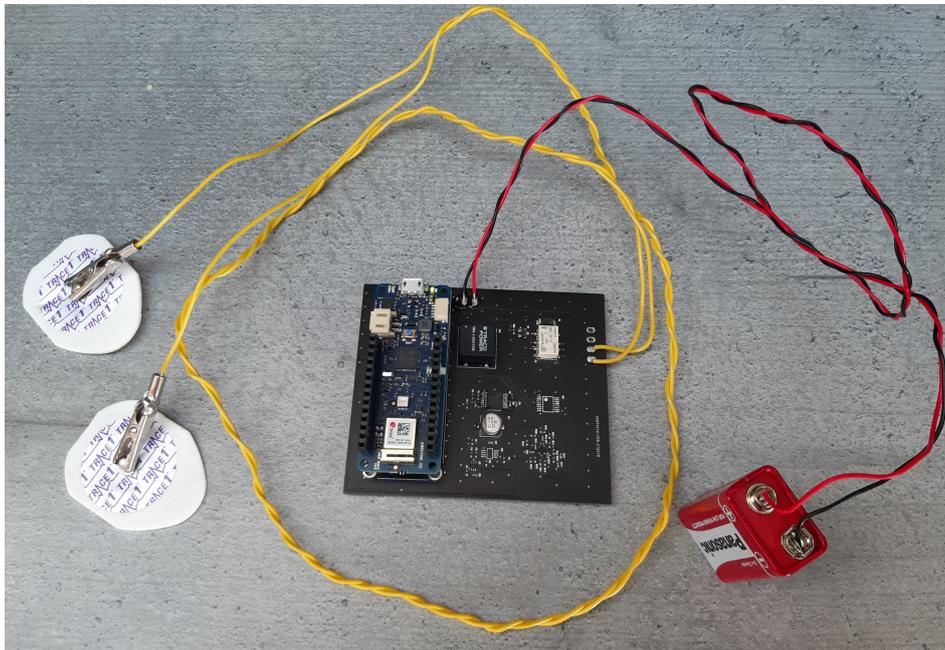


Figure 3: Circuit used to acquire ECG activity

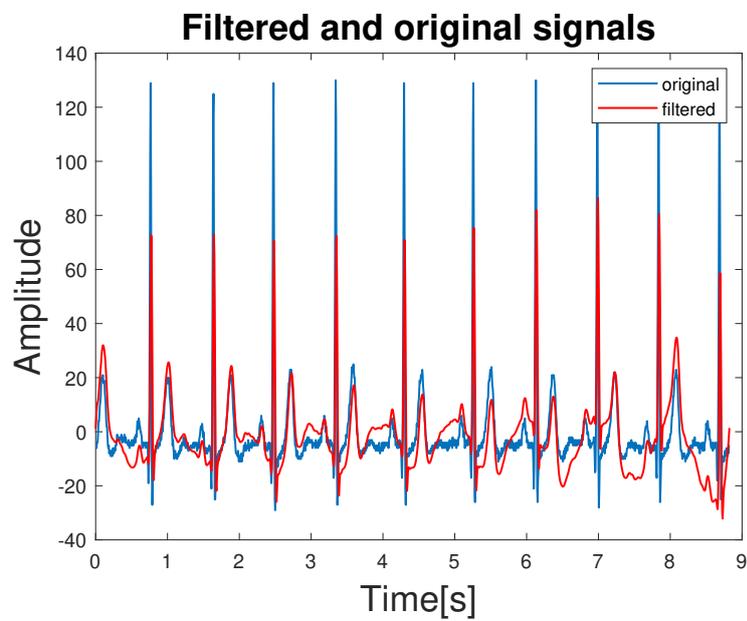


Figure 4: Recording using a 9VDC battery