11º COLAOB
11º Latin American Congress of Artificial Organs and Biomaterials
17th Congress of Lantin American Society of Artificial Organs, Biomaterials, and Tissue Engineering

ALGORITHM TO RECONSTRUCTION OF TIME SIGNALS THAT INDICATE PRESENCE OR ABSENCE OF THROMBUS ON VENTRICULAR ASSIST DEVICE AND USE OF ARTIFICIAL NEURAL NETWORK TO CLASSIFY THESE SIGNALS

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SUMMARY

Affecting millions of people around the world, the cardiovascular diseases (CDs) are responsible for the first cause of hospitalization and death in many countries, being a serious public health problem (1). Many patients affected with some cardiovascular diseases and not eligible for hearth transplantation, receive a kind of circulatory device for life support known as Ventricular Assist Device (VAD) (2).

The VADs show some kind of problems, among of them the thrombogenesis, which is a kind of natural coagulation when blood comes in contact to any surface not covered by endothelium. The thrombus formation on VAD can result in its disablement or even cause patient's death (2,3). To prevent this kind of scenario, the thrombolytic therapy needs to start as soon as possible. However, a previous and not invasive diagnostic is relative complex. Because of this, the use of predictive maintenance techniques (e.g. signal analysis) together machine learning can be an alternative to detect the thrombus formation in its beginning or even, predict its formation before its occur, which can enable both patient and physician have time to take some preventive action. On study of (4) was showed a way to detect thrombus presence or absence using vibration signal analysis with Microelectromechanical systems (MEMS) accelerometer.

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The objective of this work is to develop a Python algorithm to reproduce signals that indicate presence and absence of thrombus showed on (4). These signals were used to train a neural network to classify absence/presence of thrombus.

Using the results of (4), a dataset in Python was created from reconstruction of voltage signal as a function of time. The graphs showed in that work provide data as maximum voltage amplitude for determinate frequency, noise and sampling rate. With these data, cosine signals with same amplitudes were created. After creation of "clean signal", a background noise with Gaussian distribution was added with goal to have the simulated signal similar to the real one. The Fast Fourier Transform was applied to each one of the created signals and these results were plotted. This methodology was applied to all results of the work referenced in this section.

Figure 1 shows a comparison between the graph extract from (4) and simulated signals graph. These show the information about thrombus presence in the rotor base of VAD for 1800 rpm velocity. In that work is informed that the presence or absence of thrombus is characterized by occurrence of peaks in determinate frequencies. The red arrows on José Sobrinho graphs indicates an imbalance caused by thrombus presence.

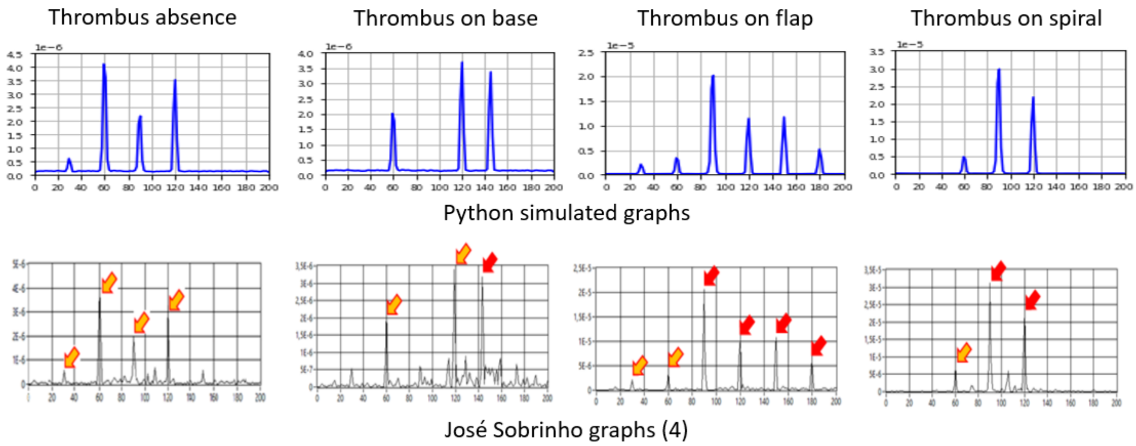

Figure 1. Comparation of results for 1800 rpm rotor velocity.

It was found that with the created algorithm was possible reproduce with certain similarity the same signals that (4) obtained in its work. Thereby, new time signals can be easily "synthesized", for example, a mix of signals of presence and absence of one or more thrombus, signals with amplitude and any spectral noise distribution or other interesting characteristics. The neural network obtained an accuracy around 91% to classify thrombus absence, thrombus on base, spiral and flap of rotor.

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