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UID 12149
Spé SCIA
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Last year internship report abstract

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Company : ESPCI electronics laboratory / ELA Medical

internship supervisors :

Gérard Dreyfus (laboratory's director)
Brigitte Quenet (internship supervisor)
Yves Faisandier (co-supervisor)
Rémi Dubois (thesis student)

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Presentation of the company

The internship was carried out in an original context : as I choose to continue my scholarship after EPITA with a DEA diploma, this internship was carrier out in both a research laboratory (ESPCI's electronics laboratory) and, in order to keep in touch with industry's realities, in co-tutoring with a company (ELA Medical).

ELA Medical provides patients who suffer from cardiac rhythm disorders with a proprietary range of innovative, reliable and highly physiological systems. ELA Medical manufactures implantable pacemakers, implantable defibrillators, leads and Holter monitoring systems.

The ESPCI's electronics laboratory is specialized in modeling and machine learning : in the field of engineering, the research projects of the laboratory have led to new theoretical and methodological results related to the design of nonlinear models (static or dynamic) through machine learning ; furthermore, the laboratory investigates the information coding mechanisms in nervous systems.

Presentation of the general function of the service

The group I worked with was directed by Pr. Gérard Dreyfus (ESPCI's electronics laboratory's director) and composed of : an assistant professor, a research director, a thesis student and a student of ESPCI.

My internship supervisors were :

- Brigitte Quenet, PhD from the ESPCI's electronics laboratory, assistant professor at ESPCI
- Rémi Dubois, PhD student.
- Yves Faisandier, MD and project responsible from ELA Medical (research director).

Description of the work you were asked to carry out

The recording of the cardiac signal ECG on long durations (Holter recording) is a non invasive exam, frequently used in cardiology, which helps the medical diagnosis. But, as it takes too much time, the analysis of this huge quantity of information is rarely done in an exhaustive way by a physician. We had to develop a method which allows to track down and to name various constituents of the signal usually identified by experts. The use of Hidden Markov Models (HMM) was choosed to realize this identification because it takes advantageously into account an *a priori* knowledge of the electrophysiological behavior of the heart. During this work, the robustness of this automatic identification in a context of noise (of multiple frequencies and types) was the main goal.

Description of the existing state of affairs

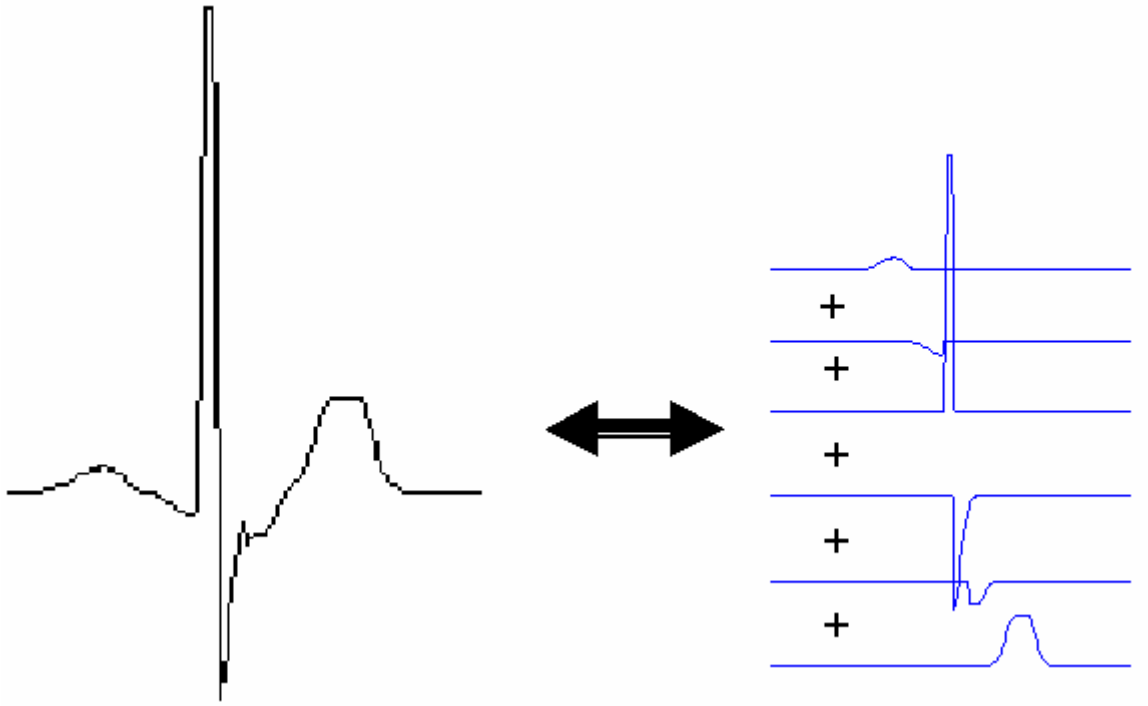

Figure 1 : analytical splitting of a heart beat.

Specific tools (reconstruction of the signal by learning) had already been developed in the electronics laboratory, during a long-term project in association with ELA Medical. An analytical splitting of the signal (Figure 1) enabled the relevant information of the signal to be revealed. The object of my internship was the exploitation of this analytical model.

Timeline of the project

Period	**Task**
from 01/10/01 to 15/01/02	Study of the HMM in electrocardiography
from 16/01/02 to 10/02/02	Implementation of a HMM module: limits and capabilities
from 10/ 02/02 to 07/03/02	Settling of a method of labeling (for cardiologic waves)
from 08/03/02 to 30/05/02	Attempts of classification normal – anomalous cardiac beats
from 01/05/02 to 07/06/02	Finalisations and reporting

General appreciation of the work

My working conditions were quite pleasant, but of course I earned no money (as a DEA internship, I worked as trainee, not employee). Also, my work team insertion was easy, and will result on a thesis work next year in the same laboratory. As a matter of fact, my general appreciation would be : a nice internship, a good experience.

engineering skills acquired

- Research skills: finding a novel solution, solving algorithmic problems.
- Experimental skills: leading an experiment, a study.
- Technical skills: modelling, HMM, neural networks.
- Interpersonnal skills: team work.

Conclusion

We worked out a computer model of the cardiologic interpretation. By using the Hidden Markov Models (HMM) formalism, a physiological meaning is given to a vector of descriptors dependent on time. This meaning is a labeling of heart waves, which allows us to interpret the signal in terms of pathologies: as an exemple the detection of the P and T waves, which so far had no solution and is very valuable for the physician. Thanks to the developed model, this information of position and shape of the waves is accessible. This information can thus be used to assist the cardiologist for his diagnosis.

The obtained labeling is robust against noise, but meets problems with particular cases. The management of these particular cases seems to be the next challenge to assert the validity of the labeling. A study has already been carried out to improve the modelling of the distributions of probability of observations. A classification of anomalous beats was worked out from this labeling, the results of which seem promising.