TECHNION – Israel Institute of Technology
Department of Electrical Engineering
The Physiological Signal Processing Laboratory

Objective VS Subjective Pain Assessment

By

Dvorkin Michael
Fux Ilya

Supervised by
Dr. Danny Lange

Spring 2003

Abstract

To date, there is no specific and accurate method or algorithm for objective pain measurement. However, the need for such system is great. A reliable pain measurement system would be useful in modern medicine, and surely could become another significant diagnostic tool.

This project implements an objective pain report tool, based on an electro-physiological pain phenomenon. The implemented system uses an electrical activity observation from a few sites on the subject's forehead. The electrical signal passes through a processing algorithm, producing an objective pain report. This report is compared with a subjective patient evaluation. The system is calibrated empirically (enabling an operative generalization) by using pain evaluations (objective and subjective) of a considerable group of patients. The final result is an objective pain measurement tool.

Background

The pain is an alert system our body uses to defend itself from destructive processes that occur from time to time. The reason for such processes can be external or internal (for instance a scratch or a headache). The pain is an unpleasant sensation, ranges from slight discomfort to severe suffering. However, it is impossible to get an accurate oral pain report from the subject itself. Self report is subjective by definition, and influenced by variety of aspects that can't be taken into consideration. Moreover, sometimes it is impossible to get even the subjects oral report (cases in which the subject is not communicative). Nevertheless, accurate pain assessment is a basic medical tool, which every physician would like to have.

Previous efforts made in this field, didn’t lead to sufficient results. Some different physiological phenomena (heart rate, blood pressure, skin conductance etc.), were used, and found to have some relation to pain. But, no phenomena specific only to pain, were found. Consequently, all these methods, found to be inadequate for objective pain measurement.

Basic Approach

At the beginning of the project, five steps of performance were defined. These steps guided us during the entire work till its successful finish. Here are these steps:

1. Developing a tool that functions as a subjective pain reporter.
2. Choosing a proper measurement system.
3. Planning and actual performance of pain experiments.
4. Signal processing stage.
5. Results analysis and conclusions.

1. The subjective report tool was implemented in Visual Basic 6.

The patient reports about the felt pain, using the slider. The report is saved as a vector of numbers matching the signal observed on the patient's forehead. In the next stage the data is transferred to Matlab for processing and comparison.

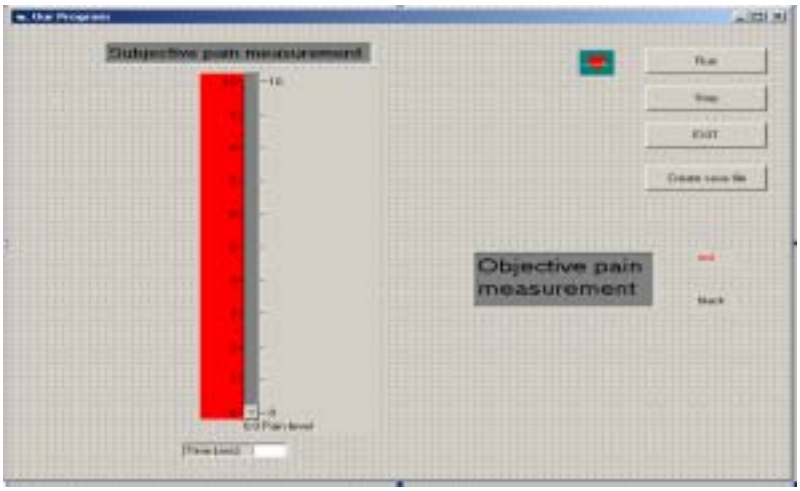

Figure 1 – The report tool

2. The next step was locating an appropriate measurement device for obtaining an objective signal. The relevant ranges for the phenomena mentioned above, are 0.5-5 Hz for frequency, and 0-5mV for the magnitude. We chose an existing device used for ECG signals measurement (Norav PCECG 1200S). After a line of tests the device was found suitable for our needs.

3. The following flow chart fully explains the pain experiment:

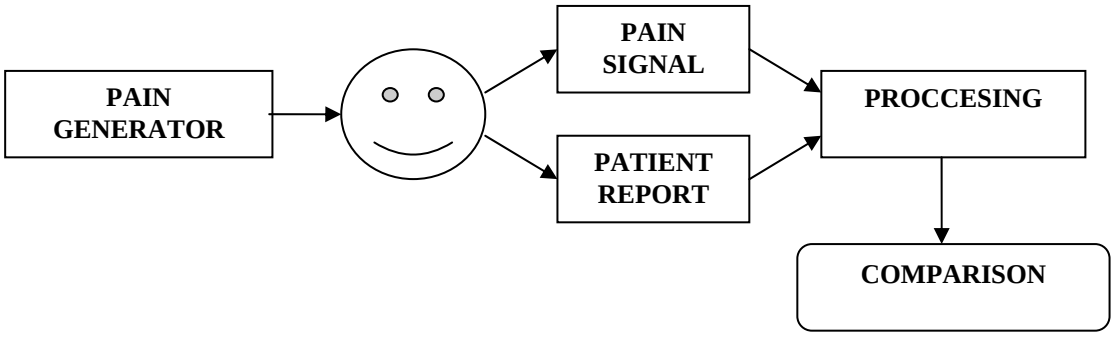

Figure 2 – Experiment flow chart

The pain feeling was generated by locating the subject's finger in a glass with hot water (~50 ^{o}C) for a known time period (mostly for 60 sec).

4. The most significant and complicated step, the signal processing, was performed using Matlab 6.5 application. The basic idea is comparing between two signal channels, computing the signals power, and then producing with the help of these two parameters, the final objective pain report. The processing algorithm itself is unclosed and can be done in several ways.

5. In most cases, the final results matched our expectations. However, we found that some people don't respond to such type of measuring (they don't produce any electrical signal during the pain process). For those who showed a good sensitivity, we got stable and reliable results. A typical pain signal (before and after the process) and the comparison to the subjective report are shown below:

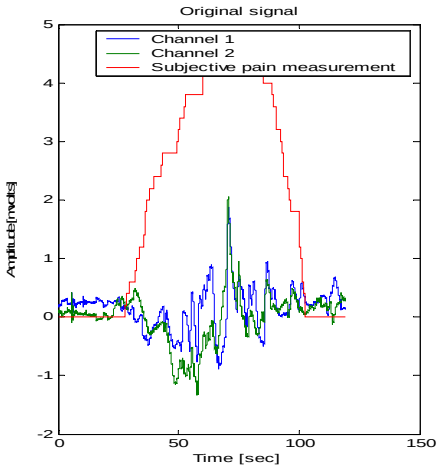

Figure 3.a – Original signals (objective and subjective)

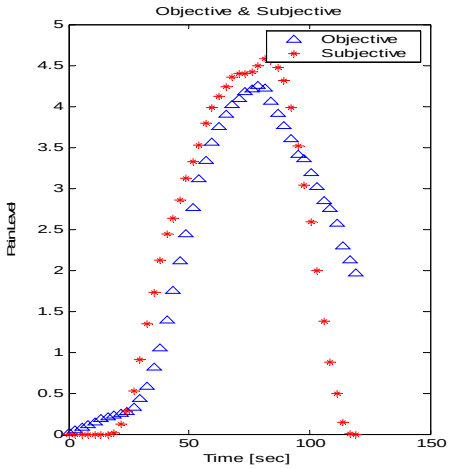

Figure 3.b – Signals after processing

Conclusions

In conclusion, we can say that the new conception of pain measurement, implemented here, had proved itself. There is no doubt that this new technique of pain measuring can be very useful in modern medicine. However, for getting more accurate and stable results, we advise to perform similar experiments in more medical and scientific manner. It is clear, that high level of generalization and reliability can be obtained only by a model calibration based on evaluations of a large and not homogeneous group of patients. Of course, we couldn't make this calibration properly, using a small (20) amount of pain reports.

Acknowledgement

We are grateful to our project supervisor Dr. Danny Lange for his help and guidance throughout this work.
We would like to thank Johanan Erez and the rest of the staff of the PSPL lab, for their support.
We are very grateful to the students that agreed to become our patients.
We are also grateful to the Ollendorf Minerva Center for supporting this project.