

Converting EEG, ECG and other paper legated biomedical maps into digital signals

A. R. Gomes e Silva, H.M. de Oliveira, R.D. Lins

Departamento de Eletrônica e Sistemas, UFPE, Recife – PE, BRAZIL

E-mail:{hmo, rdl}@ufpe.br

Abstract

This paper presents a digital signal processing tool developed using Matlab™, which provides a very low-cost and effective strategy for analog-to-digital conversion of legated paper biomedical maps without requiring dedicated hardware. This software-based approach is particularly helpful for digitalizing biomedical signals acquired from analogical devices equipped with a plotter. Albeit signals used in biomedical diagnosis are the primary concern, this imaging processing tool is suitable to modernize facilities in a non-expensive way. Legated paper ECG and EEG charts can be fast and efficiently digitalized in order to be added in existing up-to-date medical data banks, improving the follow-up of patients.

Keywords: analog-to-digital converter, digitalization of medical maps, digital ECG, digital EEG.

1 Introduction

Digital equipments are nowadays largely preferred to analogical ones especially due to their high-quality and flexibility of working with their output. Medical equipments that use digital technology have emerged as a true revolution in signal acquisition, analysis and diagnosis. Today, electrocardiograms, electroencephalograms, electromyogram and other biomedical signals are all digital. Digital signals allow very high signal processing capabilities, easy storage, transmission and retrieval of information [3]. The well-recognized advantages of digital technology turns it the first- choice.

One of the limiting factors of adopting the digital technology is the high cost of some modern digital equipment, overall some medical ones. This is a serious barrier to be crossed by those who already have a working analogical device and/or face budget limitations. An alternative to device replacement is adopting an A/D-converter and a suitable interface to a digital microcomputer or laptop. This would also allow digitizing legated analogical data, something of paramount importance in many areas, overall in medicine as the history of patients would be kept and case studies may be correlated, etc.

A number of laboratories, medical institutes and hospitals have only available analogical equipments, particularly those equipped with plotters. The storage of these signals is rather inefficient and the data processing unfeasible. In this challenging scenario, a substantial advance can be performed by designing acquisition cards with interface to microcomputers, instead of purchasing sophisticated high-cost computerized equipments. This kind of up-grade can be beneficial to small laboratories with modest resources. Nevertheless, it is not a trivial task to assemble or to design a set-box to convert signals. This study describes the development of a software tool intended to convert a version of signals and/or spectra digitalized by a scanner (files of the extension .jpg .tif .bmp etc.) to a data file, which can be efficiently processed and stored. It deals with an alternative approach to the classical A/D conversion without requiring any specific hardware.

2 An image-to-data conversion algorithm

Many relevant but old data are only available in a chart-format and the appending new data may be suitable. The steps proposed algorithm description below is strongly based on ECG, but it can easily be adapted to other signals, either biological or not. An implementation of the A/D platform on MATLABTM [2] is presented, exhibiting a few cases to illustrate the lines of the procedure.

- S1. Digitalization of the paper strip
- S2. Image binarization
- S3. Skew correction
- S4. Salt-and-pepper filtering
- S5. Axis identification
- S6. Pixel-to-vector conversion
- S7. Removing the header and trailer of the acquired signal (used for device tuning)
- S8. Splitting the ECG chart and re-assembling it.

Figure 1 below shows in part (a) section of an electrocardiogram strip obtained from reference [1] and the resulting plotting in part (b) after processing using the algorithm above.

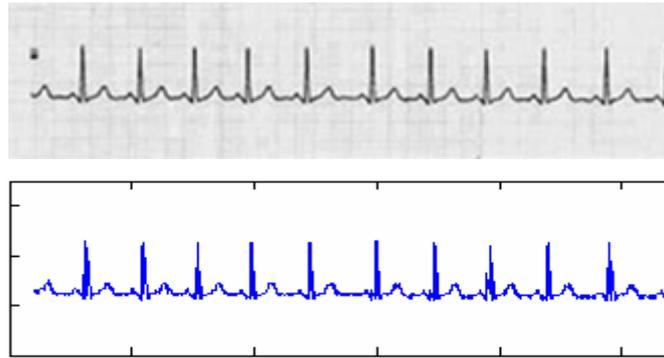


Fig. 1 – An ECG with no axis: (a) original scanned ECG, (b) MatlabTM plotting of the ECG from the retrieved data.

References

- [1] Data bank of Electrocardiograms, Available: <http://www.ecglibrary.com>
- [2] E.W. Kamen and B.S. Heck, *Fundamentals of Signals and Systems Using Matlab*. Prentice Hall, 1997.
- [3] E.N. Bruce, *Biomedical Signal Processing and Signal Modelling*, Wiley, 2001.