SIMULATOR FOR MOVEMENTS ACCOMPANYING THE EMERGENCY ELECTROCARDIOGRAM RECORDINGS

Ivan Dotsinsky, Irena Jekova, Ivaylo Christov
Centre of Biomedical Engineering - Bulgarian Academy of Sciences
Technical University of Sofia
E-mail for correspondence: iadoc@argo.bas.bg

Summary: In case of emergency like monitoring before defibrillation, the electrocardiographic signals are often corrupted by disturbances caused by movements. We elaborated a simulator containing set of appropriate disturbances that may be used by programmers in elaborating and debugging algorithms for movement detection.

Introduction

Very often the recordings of electrocardiographic (ECG) signals in case of emergency, like monitoring before and after defibrillation, are corrupted by patient involuntary movements or by contacts provoked by the life-saving people. A simulator containing set of appropriate movement disturbances will be useful in testing algorithms and programs for crucial situation detection.
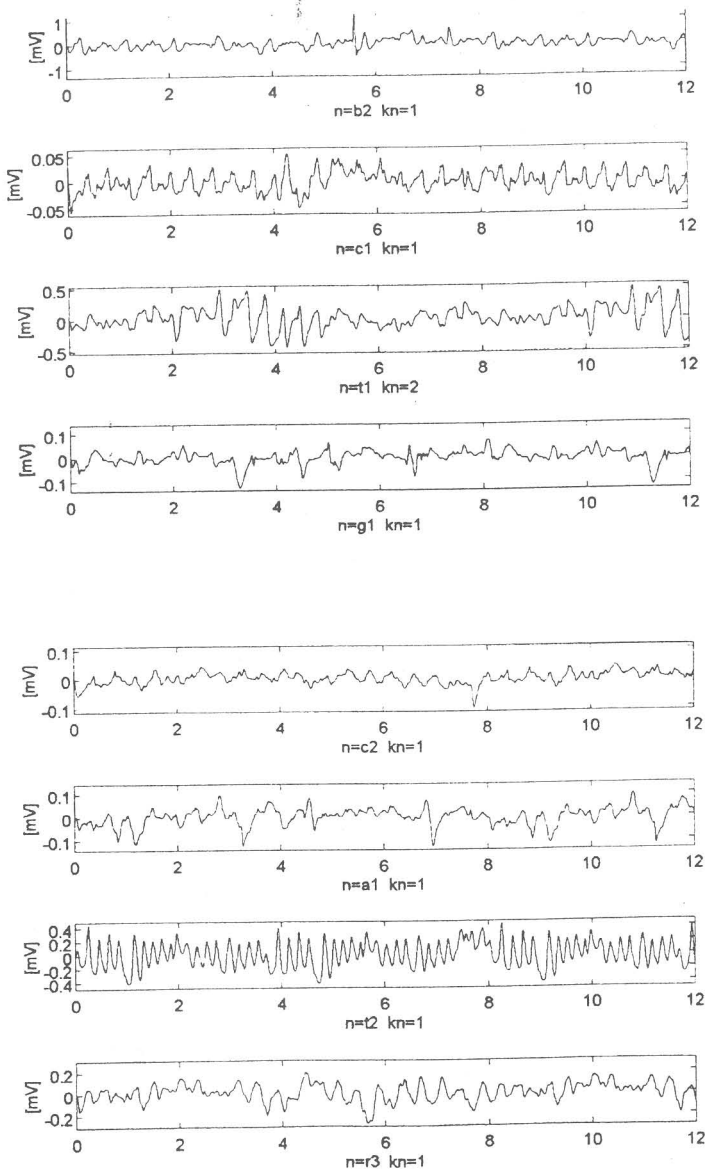
Materials and simulator

We acquired ECG signals accompanied by disturbances. They were obtained by assistance of trained patients and classified in several categories:
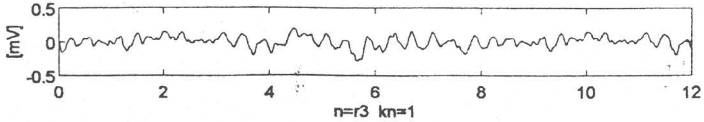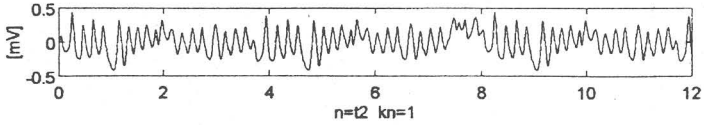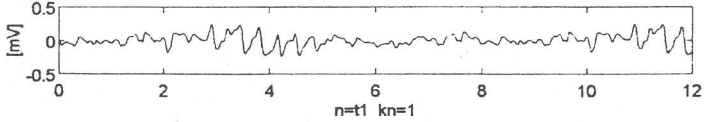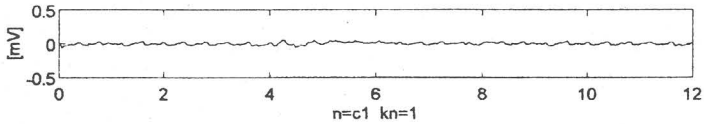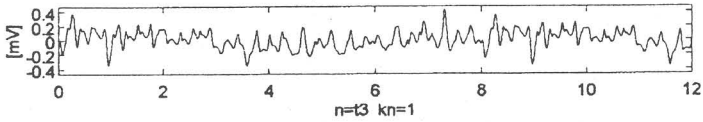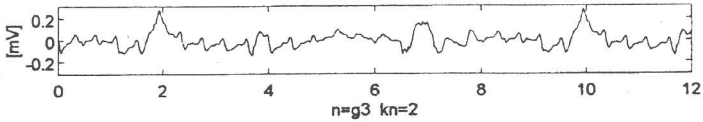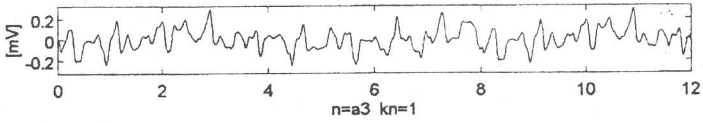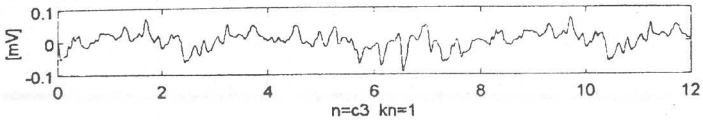
- Simulation of cardiopulmonary resuscitation (CPR) obtained by depressing rhythmically the chest marked by **t**.
- Movement of the patient cable indicated by **b**.
- Patient arms moving noted by **a**.
- Continuously body tremor and convulsive movements presented by the abbreviation **c**.
- Frequent and profound respiration (gasp) denoted by **g**.
- Quasi-rhythmic movements like disturbances provoked by car moving on an evil way marked by **r**.

The signals were fed into a PC. They were analogue-to-digital converted and memorized. Then the ECG activity was extracted by means of the software package MATLAB, after that the disturbances were down loaded in the memory of a simulator organized around a micro-controller HC11. All recordings of disturbances may be generated in loop. Their amplitude can be multiplied by 0.5, 1, 1.5, ...16, 17, ...32 and mixed with normal ECG activity or signals taken from the AHA database.

The simulator is small in size. The signals and the disturbances are stored in E^2PROM. The signal mixing is controlled by four buttons and visualized by a liquid

crystal display. Two types outputs are provided for – ones for low level amplitude in the range of mV and others for high level amplitude in the range of V.

[mV] 0.1 0 -0.1
0 2 4 6 8 10 12
n=c3 kn=1

[mV] 0.2 0 -0.2
0 2 4 6 8 10 12
n=a3 kn=1

[mV] 0.2 0 -0.2
0 2 4 6 8 10 12
n=g3 kn=2

[mV] 0.4 0.2 0 -0.2 -0.4
0 2 4 6 8 10 12
n=t3 kn=1

[mV] 0.5 0 -0.5
0 2 4 6 8 10 12
n=c1 kn=1

[mV] 0.5 0 -0.5
0 2 4 6 8 10 12
n=t1 kn=1

[mV] 0.5 0 -0.5
0 2 4 6 8 10 12
n=t2 kn=1

[mV] 0.5 0 -0.5
0 2 4 6 8 10 12
n=r3 kn=1

Results

Some of the stored in memory disturbances **n** are shown in four Figures. Since we recorded up to three different cases for each of the relatively defined categories, a number is associated to the category index **t**, **b**, etc. The first three Figures present the disturbances in automatically scaled by MATLAB ordinates. They have a coefficient of amplification **kn**=1, except for two cases **g3** and **t1** which have a gain of 2. The fourth Figure shows **c1**, **t1**, **t2** and **r3** with **kn**=1 and the same ordinate scale in order to point out the absolute ratio between their original amplitudes.

Discussion

It is very difficult to define the most important types of disturbances that may cover by their particularities all significant real cases. However, we hope we succeeded in making a useful selection.