

SYSTEM FOR SYNCHRONIZED EEG RECORDING AND SLEEP MOVEMENT MONITORING

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ABSTRACT

Some years ago we started to evolve system which enable recording of the synchronized EEG signals with video recording of sleeping patient. We tried many ways and many possibilities and finally we have developed system which contains two personal computers with special measurement cards, digital video camera, and analog EEG system.

1 INTRODUCTION

Our development started with EEG sleeping laboratory (Brno - Bohunice Hospital) cooperation and our goal was to improve the sleeping laboratory.

This laboratory is situated to one room which is for staff, apparatuses and for patients too. Drapes should evoke intimacy. Although the laboratory is not equally equipped, it is sufficient for diagnostics of some sleep disorders.

Sleep laboratories often don't have equipment for video-monitoring of sleeping patients. This equipment is always in special laboratories for epilepsy diagnostics. Sleep laboratories, which dispose of video-monitoring can use thermal cameras. This cameras make staff possible to observe patient also at dark environment. For most of the hospitals and clinics is this expensive equipment inaccessible.

At the beginning we started to evolve system for synchronized video of sleeping patient with EEG data. This laboratory equipment contains a high-quality system for EEG recording Galileo. But this system itself is not sufficient for sleeping laboratories. The sleeping laboratories standard equipment is EEG recording system and video-recording system especially for recording in dark environment. For this reason the laboratories use IR video cameras.

As we continued our research, we realized that the problem was more difficult then we assumed at the beginning. Our first idea was to add to existing system some apparatus which is able to record sleeping patient to VHS cassette and is able to generate and record synchronizing signal.

We developed system which was able to EEG monitoring of sleeping patient, recording video signal in dark room and apparatus for synchronization of EEG and video recorder.

This system appeared a bit complicated for physicians work. In present situation and the full working capacity of physicians and sleeping laboratories it is impossible to use this system. Every record must be vet by physician and vetting EEG and video signal saved on different medias. This appears as very time-consuming.

After that we left this idea (recording of video data on VHS cassette and EEG data to PC) and we started to evolve other system which would be able to save only digital data and show EEG signals and video record together.

2 A SYSTEM FOR SYNCHRONIZED RECORDING

For the new system for synchronized EEG and video recording we used a personal computer with special measurement cards, an analog EEG recorder, a multiplexer and a video camera.

In a few months we had to change our conception once more because the computer was not able to execute video processing and recording and also EEG recording. We have a problem to keep the sampling frequency of EEG signal (128Hz) and acceptable shotting frequency of video signal.

Then we trayed out system with two personal computers, special measurement card for EEG recording, a multiplexer, an analog EEG and a video camera. The block scheme of our system is in Figure 1.

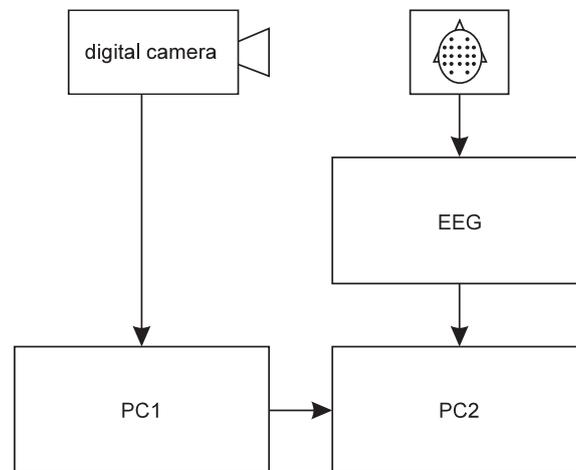


Figure 1: System for Synchronized EEG Recording and Sleep Movement Monitoring

2.1 CONTROL SYSTEM COMPUTER

The main control computer (in Figure 1 sign as PC1) is focused on the video recording and control of the whole system. The video camera is connected in the PC1 by the USB port and PC2 is connected by the parallel port LPT1. The parallel port LPT1 is used for the control signals between the PC1 and PC2. The communication between the PC1 and PC2

is above all the start and the end of the recording. Otherwise both computers work utterly independently.

2.2 A VIDEO CAMERA

The video camera which is used for the video recording is a standard digital cam-corder Sony TRV 240. This camera enables to work in scotopic mode according to the accommodating terms for sleeping laboratory.

The camera can also perform in web-camera mode in which it runs by recording. Video data are transmitted by USB port to PC1 which perform the video processing and video recording.

2.3 THE EEG

We used an analog EEG recorder which is available at biomedical laboratory at Department of Biomedical Engineering FEEC, BUT for EEG recording. This analog EEG recorder is determined for paper registration of EEG signals. But we preferred only amplifiers outputs, so the paper registration circuits were disabled. The subsidiary result is, that the EEG recording is absolutely silent now.

2.4 THE MEASUREMENT CARD AND THE MULTIPLEXER

The EEG data acquisition is solved by the multifunctional measuring card TEDIA PCA-7408A. The main properties of the card are: 8 S.E. analogue inputs, 14 bit analogue inputs resolution, input ranges $\pm 10V$, $\pm 5V$, $\pm 2.5V$, $\pm 1.25V$, $\pm 0.635V$, $\pm 0.3125V$, 10 kHz sample frequency and 256 B data buffer.

The common EEG record consists of 21 channels and the external multiplexer must be used. The multiplexer OPT-832 was used for multiplication of channels as the ideal solution.

2.5 SYSTEM DESCRIPTION

The system for synchronized EEG recording and sleep movement monitoring comprise of two almost independent parts. The first one is focused for video recording and the second one for EEG recording. The control computer is PC1 as was mentioned above. Operator starts and stops measurements and sets up parameters done by this computer. The PC1 is focused on video processing and video recording too.

The second computer PC2 is focused only on EEG recording. The measurement card TEDIA PCA-7408A is placed in this computer and multiplexer OPT-832 is connected to this card. EEG signals from analog EEG recorders amplifiers outputs are joined to multiplexer. The measurement card TEDIA PCA-7408A digitalizes an inputs the analog signals by sample frequency 128Hz. Digital signals form each channel are saved as a binary files.

Every saved picture or EEG data have an information about their time position. After the measurement finishes the compression proces starts and after it is possible to use the synchronized data for expert vetting or other processing.

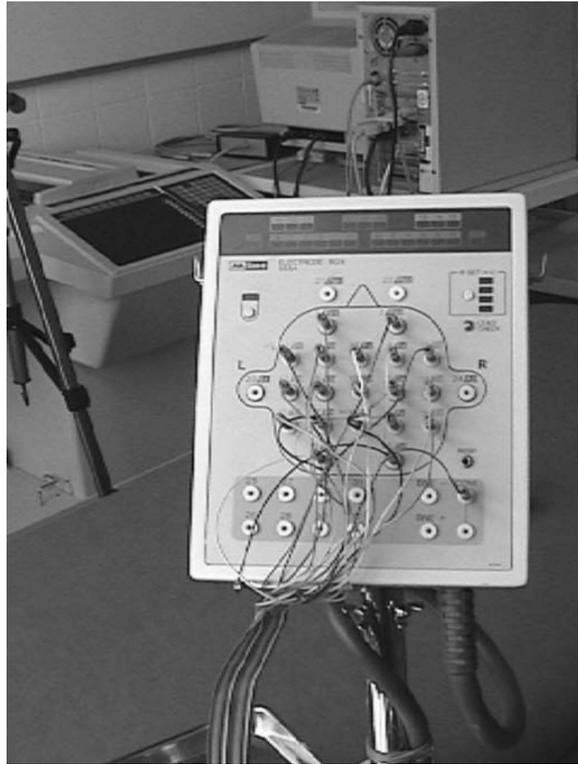


Figure 2: The sleeping laboratory at DBME, FEEC, Brno University of Technology

CONCLUSION

There is system, which we had developed especially for the synchronized EEG recording and sleep movement monitoring at the Department of Biomedical Engineering FEEC, BUT (see sleeping laboratory in Figure 2). This system is ready for operation and it is possible to use it for biomedical students education and signal processing students education and especially for sleeping disorders investigation.

Today the system is used for measuring of EEG signals by students who are working at their diploma thesis and PhD students who make an effort to find a connection between the EEG signals and hypnagogic clonus during the stage of falling asleep.

ACKNOWLEDGMENT

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