INTELLECTUAL SEISMOACOUSTIC TELEMETRIC STATION

Ali Abbasov[1], Telman Aliyev[2], Akif Ali-zada[3], Gurban Etirmishli[4], Gambar Guluyev[5], Fahrad Pashayev[6]

[1]Institute of Information Technology of ANAS, Baku, Azerbaijan
[2,5,6]Institute of Cybernetics of ANAS, Baku, Azerbaijan
[3]Institute of Geology of ANAS, Baku, Azerbaijan
[4]Republican seismic survey center of ANAS, Baku, Azerbaijan
[1]*sesh@mincom.gov.az*, [2]*telmancyber@rambler.ru*, [3]*gia@azdata.net*,
[4]*seys@azeurotel.com*, [5]*scb_06@mail.ru*, [6]*pasha.farhad@gmail.com*

1. Introduction.

The forecast of earthquakes is the most important and difficult problem of the seismological science in which scientists in many countries of the world are engaged. Two opposite opinions express prospects of the forecast of the development of seismic processes: the forecast is impossible, and small probabilities of the forecast for the given period are capable to bring a damage not less than from the earthquake; the forecast of earthquakes is necessary and creation of means for the reliable forecast is possible.

Now the search of new methods, technologies and means remains actual [1,2]. In this connection one of the possible variants of solving this problem is suggested below.

2. Statement of the problem.

The urgency and complexity of the problem demands integrated approach to solving the problem. There was a necessity of the solution of the following problems:

- To create intellectual seismic acoustic telemetric station (fig.1) in which seismic accelerometers, acoustic microphones and hydrophones are combined, the seismic acoustic information is interrogated and processed in parallel.
- Development of hybrid algorithms of processing of seismic acoustic information from deep layers of the ground.
- Creation of methods and technologies of the analysis of noisy seismic acoustic signals, in view of specificity of their formation in the different periods of time of formation of abnormal seismic processes.

3. Means of intellectual seismic acoustic telemetric station.

The carried out researches have shown that the suggested technical structure of station is optimal and reliable:

Seismic accelerometer CMG-5T

- Low-noise components for precision and dynamic range
- Full-scale sensitivity from 0.1 to 4.0 *g*
- Additional high gain outputs
- Low pass corner from 50 to 100 Hz
- Amplitude linearity > 80 dB
- Isolated power supply for 10 – 36 V operation
- Robust and waterproof

Outdoor Microphone Types 4952 and 4952-A

Outdoor Microphones Types 4952 and 4952-A are suitable for long periods of unattended outdoor use. Their exterior housing is made of a chemical resistant polymer that provides extremely high protection against corrosion.

- Measurement to EN/IEC 61672 Type 1 and ANSI S 1.40 1984
- Sensitivity 30 mV/Pa
- Frequency response ±2dB from 8Hz to 12.5kHz with linearization
- Wide dynamic range from 15 to 146 dB
- Built-in preamplifier with TEDS - IEEE 1451.4
- Protected against the effects of wind, rain, and perching birds

Hydrophone type 8106

- Sensitivity 2.24 mV/Pa;
- Frequency response 3Hz to 80 Hz;
- Operational upper limit 10^7 Pa (1000m);
- Built-in, high quality, low-noise 10 Db preamplifier;
- Operational temperature range -10^0 C to $+60^0$ C;
- Dimensions length 182mm, body diameter 32 mm;

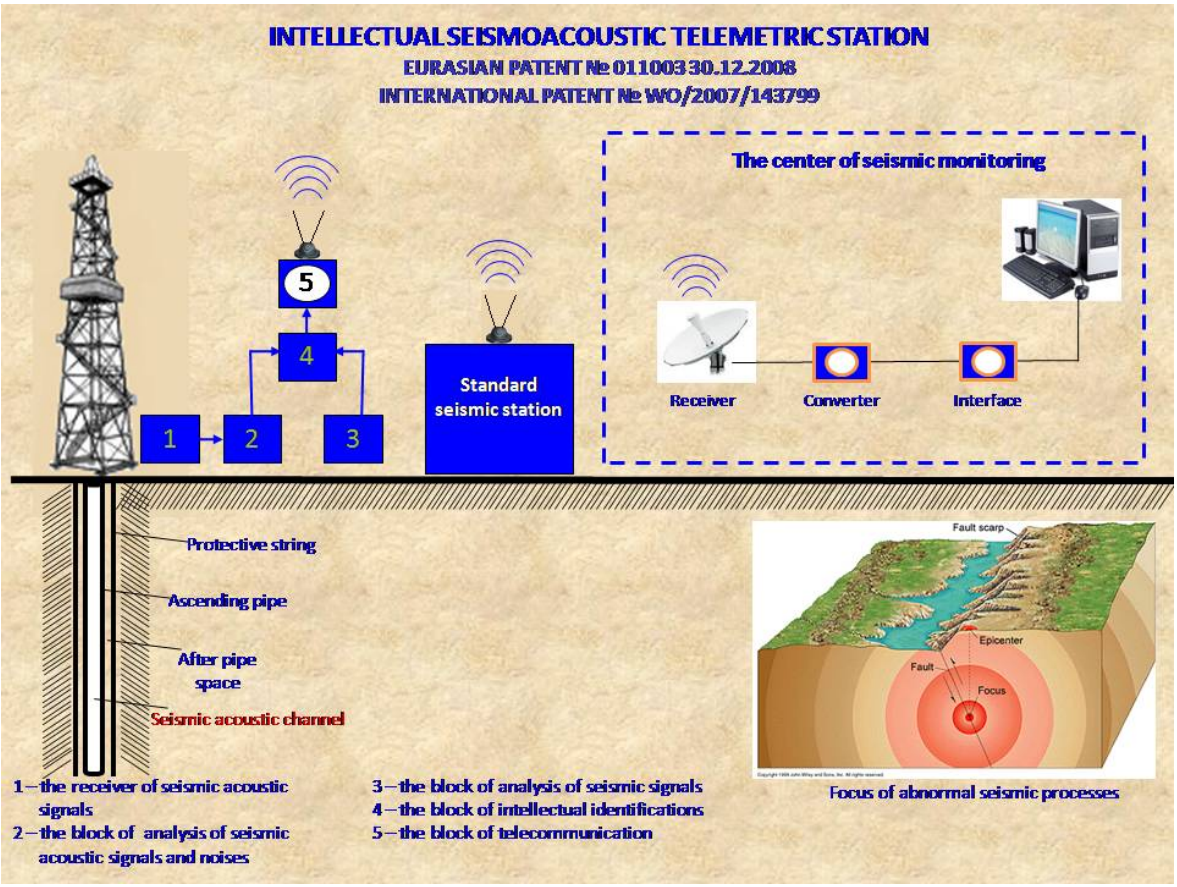

Figure 1. Intellectual seismoacoustic telemetric station

Information from specified accelerometers, microphones and hydrophones is normalized and with the help of the appropriate controller it is transferred in the system block for initial processing.

4. Hybrid processing of seismoacoustic signals

The system block, accepting signals, processes them in the hybrid algorithm blocks (fig.2). On the output of each block the appropriate attributes of seismoacoustic signals are determined.

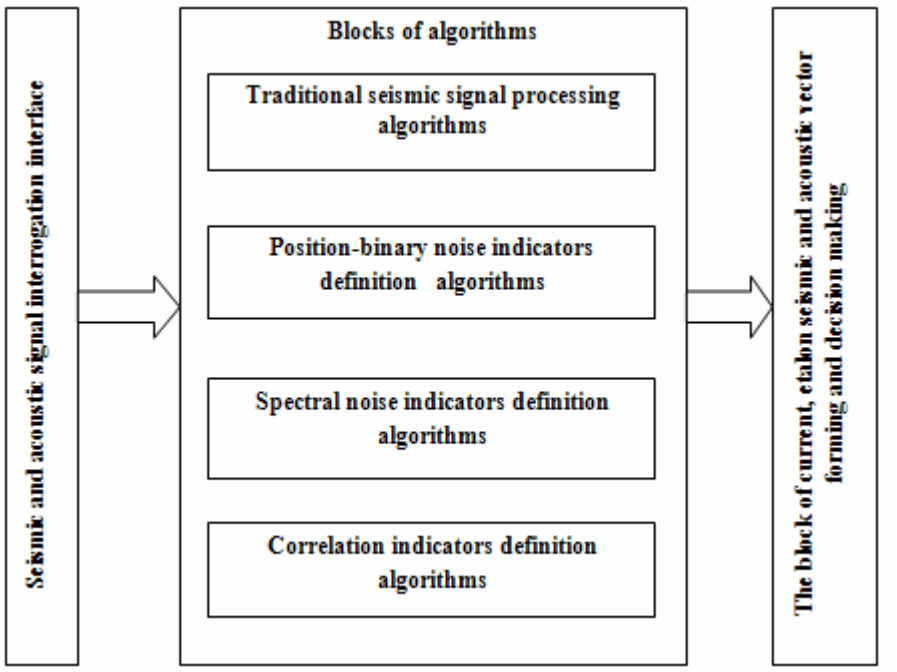

Figure 2. The blocks of hybrid algorithms.

In the block of traditional algorithms of processing of seismic and acoustic signals are determined:

- Time of fixation (receipt) P and S waves;
- A time interval between receipts P and S waves;
- Distance to the epicenter of earthquake;
- Magnitude of earth tremors;
- Time of fixation R and L waves, etc.

In the block of algorithms of positional-binary noise indicators are determined:

- Factors K_{qi}, $i=1$, 1, 2, …, reflecting the ratio of the number N_{qk} of PBIS $q_k^*(i\Delta t)$ to the total number N of samples of the signal $g(i\Delta t)$.
- Factors $K_{qi}\varepsilon$, $i=0$, 1, 2..., reflecting the ratio of the number of noises to the total number of positional-pulse signals.
- Factors $K'_{qi}\varepsilon$ reflecting the ratio the number of transitions to the total number of samples.

In the block of algorithms of determining the spectral noise indicators are determined:

- Estimations of factors of spectral decomposition of informative frequency

$$a^{++}_{\omega Ti},\ a^{--}_{\omega T_i},\ a^{+-}_{\omega T_0},\ a^{-+}_{\omega T_i},\ b^{++}_{\omega T_i},\ b^{--}_{\omega T_i},\ b^{+-}_{\omega T_i},\ b^{-+}_{\omega T_i}$$

- Estimations of sign factors of spectral decomposition of a signal

$$a'^{++}_{\omega Ti}, a'^{--}_{\omega Ti}, a'^{+-}_{\omega Ti}, a'^{-+}_{\omega Ti}, b'^{++}_{\omega Ti}, b'^{--}_{\omega Ti}, b'^{+-}_{\omega Ti}, b'^{-+}_{\omega Ti}$$

- Errors of products from the influence of noises $\lambda^*_{a\omega}$ and $\lambda^*_{b\omega}$.

In the block of algorithms of determining the correlation indicators are determined:

- Differences of estimations of autocorrelation functions between non-centered signals and centered signals $\lambda_{gg}(\mu = \mu_{\max})$.
- A difference of correlation functions of the signal and noise, and the centered signal and noise λ_{gn} [1-5].

As a result, we get the current vector of seismic acoustic signals.

5. The conclusion. The intellectual seismic acoustic telemetric station is developed and created. The experimental variant of the station is established on a mouth of nowadays invalid well №5 on the island « Gum Adasy». The seismic acoustic information (fig.3) is accepted and processed in the Institute of Cybernetics by the channel GSM.
The information for the organization of the process of training is collected.

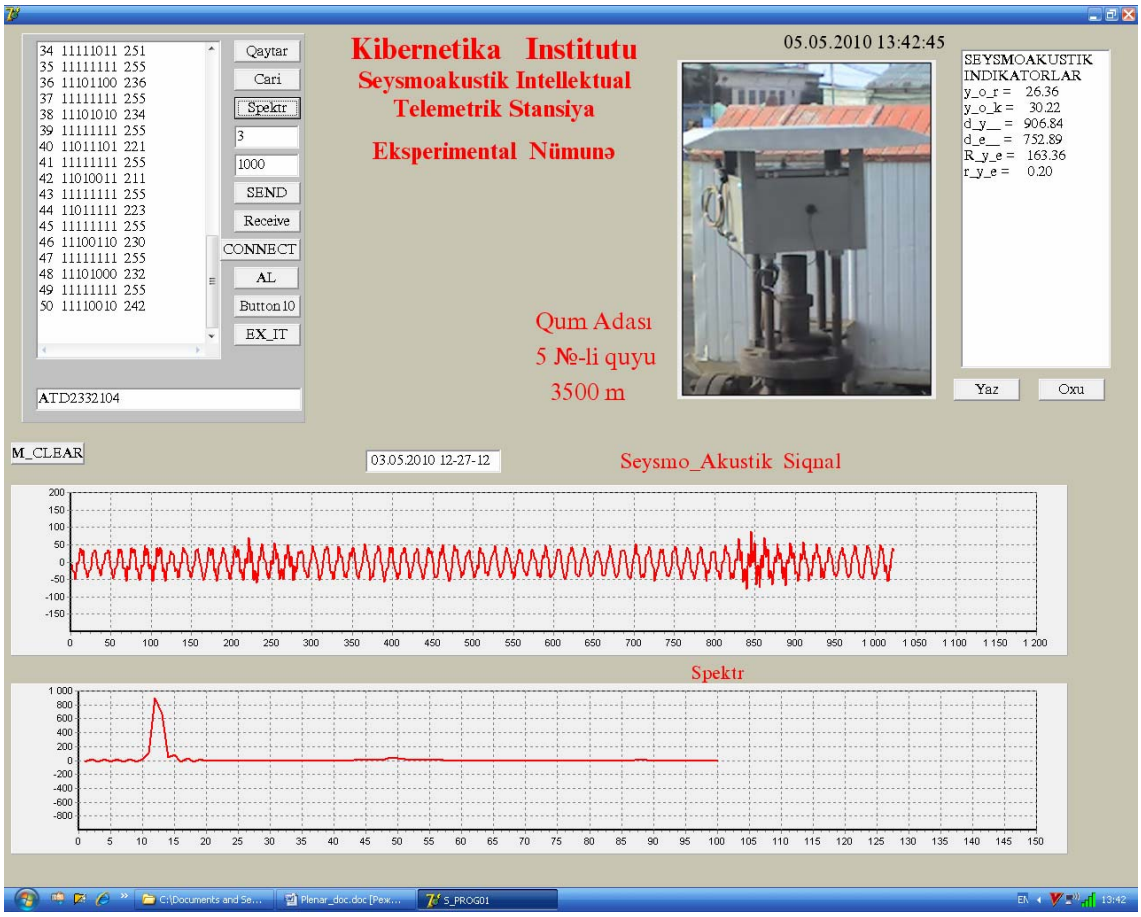

Figure 3. Seismoacoustic information from « Gum Adasy».

References

1. Telman Aliev. Digital noise monitoring of defect origin, Springer-Verlag, London, 2007, 223 p.
2. T.A.Aliev. Robust Technology with Analysis of Interference in Signal Processing, Kluwer Academic/Plenum Publishers, New York (2003), 199 p.
3. T.A.Aliev. Theoretical fundamentals of interference analysis and failure prediction. Cybernetics and Systems Analysis, Vol. 44, No. 4, Kiev, (2008).
4. T.A. Aliev, A.M. Abbasov, G.A. Guluyev, A.H. Rzayev, F.H. Pashayev. Positionally-binary and spectral indicators of microchanges in technical conditions of objects of the control. Automatic Control and Computer Sciences, Allerton Press, Inc., New York, No.3, 2009.)
5. T.A. Aliev, G.A.Guluyev, A.H. Rzayev, F.H. Pashayev. Correlated indicators of microchanges in technical states of control objects. Cybernetics and Systems Analysis, Springer New York, No.4, 2009.