The Second International Conference "Problems of Cybernetics and Informatics"
September 10-12, 2008, Baku, Azerbaijan. Section #3 "Modeling and Identification"
www.pci2008.science.az/3/14.pdf

SYSTEM OF MONITORING HIGH-ALTITUDE BUILDINGS WITH INTELLECTUAL BLOCK OF IDENTIFICATION OF ABNORMAL SEISMIC PROCESSES

Naila Musayeva[1], Elchin Aliyev[2], Rauf Gadimov[3], Dilara Mastaliyeva[4], Ulkar Rzayeva[5]

Institute of Cybernetics of ANAS, Baku, Azerbaijan
[1]*musana@rambler.ru*, [2]*elchin@sinam.net*, [3]*rauf_qadimov@mail.ru*,
[4]*dilara.mestelieva@gmail.com*, [5]*ulker.rzaeva@gmail.com*

The terrestrial surface is shaken constantly with earthquakes. Besides, ground and underground transport as well as a different sort of construction work create effect of the terrestrial surface fluctuations. All these and other fluctuations of the terrestrial surface are instantly and reliably registered by seismic stations located in seismically active zones as well as far beyond these zones.

In connection with designing and building in large cities of high-altitude buildings there was a necessity for additional seismological information. Sharp increase of rates of industrial and civil construction last years dictates the creation of a system of monitoring which includes technical, ecological and resource aspects.

By means of this system precautions against damaging buildings caused by the following natural and man-caused loads: industrial dynamics, wind actions, changes in grounds and bases, in the Earth's interior are taken. The main problem of the safety of the operation of high-altitude buildings is the control of strained-deformed condition of carrying designs [1].

For monitoring the mentioned above condition of buildings, sensors for registering fluctuations of building, their rollings, etc., are established on carrying designs. In places of the centralized gathering of information this information is gathered, processed and analyzed. Similar systems of monitoring allow providing diagnostics of the change of the strained-deformed conditions of designs at an early stage, locating places of a change like that, finding out the reasons of changes, determining the degree of the danger connected with such changes, and if necessary making provisions for eliminating the revealed negative tendencies.

In the present work the intellectual system of identification of abnormal seismic processes is realized on the basis of existing system of monitoring. With this purpose the intellectual block of abnormal phenomena is connected to the system of monitoring.

The intellectual system of identification of abnormal seismic processes consists of measuring items $1,2,\ldots,n$ established on each building I, consists of places of the centralized processing of information II, standard seismic equipment III, and the intellectual block of identification of abnormal seismic processes IV (Fig. 1).

The measuring items supplied with sensors are established on various sites of carrying designs of a high-altitude building depending on its configuration, and also in the bottom underground floor of a high-building for registering its rolls. Signals from these sensors come in the place of the centralized gathering of the information II. Here besides the traditional processing of the information the noise analysis of noise signals according to the following algorithms is realized:

First, in places of centralized processing of information the value of robustness $\Lambda^R(\mu)$ of each signal $g(i\Delta t)$ coming from measuring points and consisting of the useful signal $x(i\Delta t)$ and noise $\varepsilon(i\Delta t)$ is calculated according to the following expressions [2,3]:

$$\Lambda^R(\mu)=\left[N_{\circ}^{+}(\mu)-N_{\circ}^{-}(\mu)\right]\Delta\lambda(\mu=\Delta t), \tag{1}$$

where

$$\Delta\lambda(\mu=\Delta t)=\lambda(\mu=\Delta t)/N_{\circ}^{-}(\mu=\Delta t);\ \left|R_{gg}(\mu)-R_{\underset{g\,g}{\circ\,\circ}}(\mu)\right|=\lambda(\mu); \tag{2}$$

$$R_{\overset{\circ}{g}\overset{\circ}{g}}(\mu)=\frac{1}{N}\sum_{i=1}^{N}\overset{\circ}{g}(i\Delta t)\overset{\circ}{g}((i+\mu)\Delta t);\ R_{gg}(\mu)=\frac{1}{N}\sum_{i=1}^{N}g(i\Delta t)g((i+\mu)\Delta t)-m_g^2; \quad (3)$$

$N_{\circ}^{+}(\mu)$ and $N_{\circ}^{-}(\mu)$ are the number of positive and negative products $\overset{\circ}{g}(i\Delta t)\overset{\circ}{g}((i+\mu)\Delta t)$, and the time shift is μ.

Then the values of variances $D^*(\varepsilon)$ of noises $\varepsilon(i\Delta t)$ of each signal $g(i\Delta t)$ are calculated according to the following expressions [2,3]:

$$D^*(\varepsilon)=R_{\overset{\circ}{g}\overset{\circ}{g}}(0)-2R_{\overset{\circ}{g}\overset{\circ}{g}}(\mu=1\Delta t)+R_{\overset{\circ}{g}\overset{\circ}{g}}(\mu=2\Delta t). \quad (4)$$

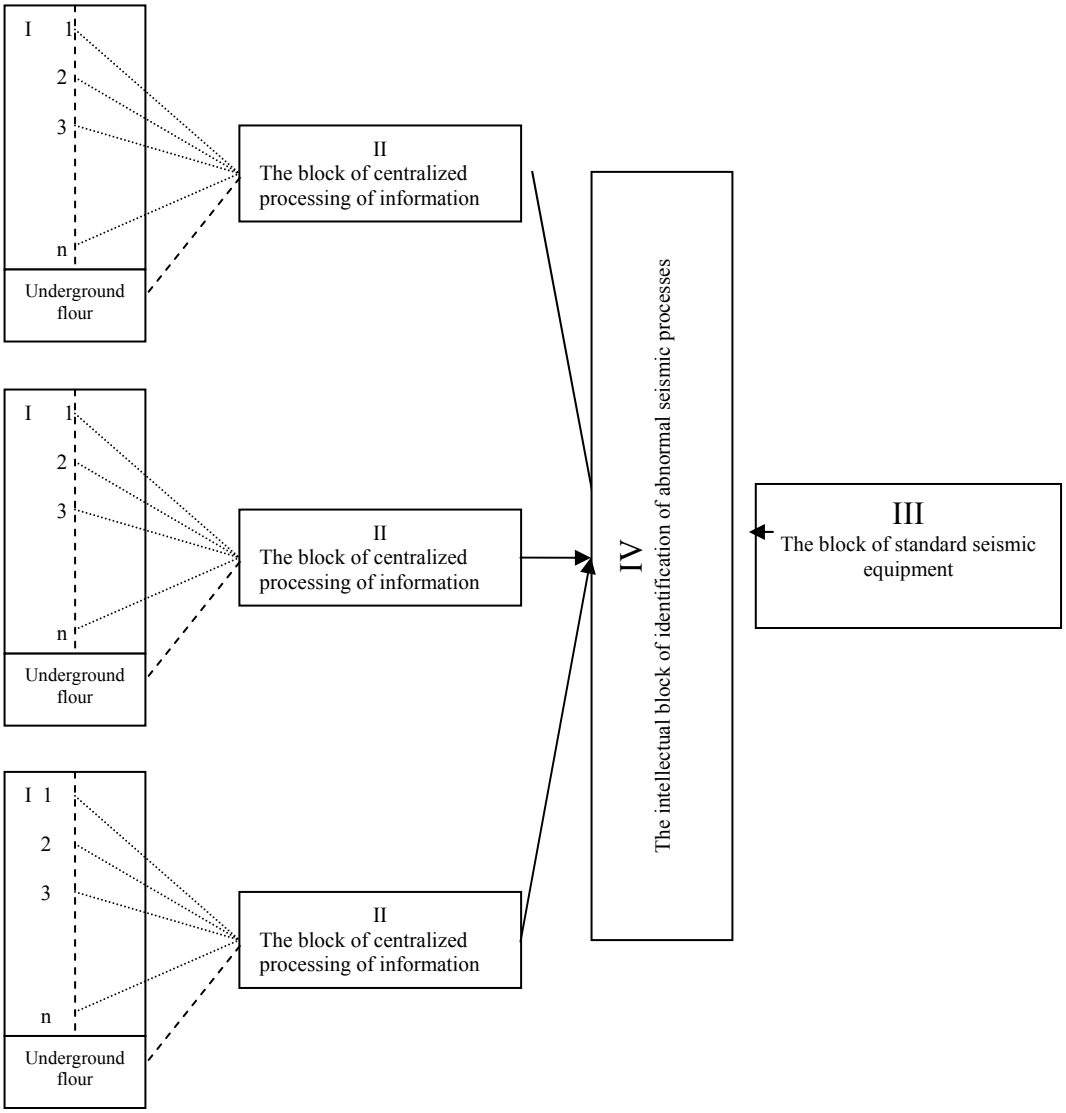

Fig. 1

The results of the noise analysis of noise signals according to algorithms (1)-(4) from the places of centralized processing of information of each building come into intellectual block of identification of abnormal seismic processes IV. The signals fixed in the block of standard seismic equipment III come here. In the block of standard seismic equipment the force of seismic fluctuations is also preliminary estimated. This information comes into the intellectual block with some delay. Intellectual block of identification of abnormal seismic processes functions as follows.

For each signal according to the results of comparison of the results of processing of measurements of real abnormal seismic processes with the calculated estimations of values of robustness $\Lambda^R(\mu)$ and noise variances $D^*(\varepsilon)$, the appropriate ranges $\Lambda^R(\mu)_{\min}$, $\Lambda^R(\mu)_{norm}$, $\Lambda^R(\mu)_{\max}$, $D^*(\varepsilon)_{\min}$, $D^*(\varepsilon)_{norm}$, $D^*(\varepsilon)_{\max}$ are established. Then in the intellectual block of identification of abnormal seismic processes training is carried out. According to the received informative attributes for a long time when there are no abnormal seismic processes in the intellectual block the appropriate standard sets are formed and remembered. In the block of standard seismic equipment seismic processes are marked as normal because they do not surpass the given threshold level.

According to them appropriate standard sets are formed. On further work of system according to the analysis results, the received current estimations are compared to the standard sets. If their difference does not surpass the established ranges, it is considered that they do not differ from standard ones, and their number is fixed. This process proceeds up to the moment when the current estimations of signals received from appropriate sensors differ from values of estimations of standard sets by the values which are more than the established ranges. Here the time is fixed.

If the subsequent estimations also differ from estimations of standard sets by the value which is more than the given range, in the intellectual block it is marked as the beginning of abnormal seismic processes.

Besides, if the change of results of noise analysis is observed for one high-altitude building, it testifies to the change of strained deformed conditions of the building caused by the changes of technical characteristics of the design, for example, impact of the lift, initial defect in armature, etc. If the changes of the strained-deformed condition of carrying designs are observed simultaneously in several close located high-altitude buildings, it testifies to the action of such natural loads as wind influence, changes in the ground, etc. If the changes of the strained –deformed condition of carrying designs are observed simultaneously in plenty of high-altitude buildings located on a significant distance from each other, it testifies to changes in bowels of the ground.

Thus, according to the value of the noise signaling received simultaneously from plenty of high-altitude buildings and to the indications of standard seismic equipment after some time interval one can form intellectual model of identification by training. While in operation in each current moment when receiving simultaneously noise signals from the set of high-altitude buildings by means of the mentioned model one can perform the prediction of readings of standard seismic equipment that is equal to a short-time forecast of abnormal seismic processes.

References

1. Guryev V.V., Dorofeev V.M. Features of diagnostics of technical condition of carrying designs of high-altitude buildings // Unique and special technologies in construction, №1, 2004, www.dom6.ru/documents/show/2005/Safe/materials/10.doc
2. Telman Aliev, Digital Noise Monitoring of Defect Origin, Springer, New York, 2007, 223 p.
3. Musaeva N.F. Technology for determining the magnitude of robustness as an estimate of statistical characteristic of noisy signal // Automatic Control and Computer Sciences. Allerton Press. Inc., New York, No. 5, 2005, pp. 53-62.