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SYNCHRONOUS DATA PROCESSING IN MULTI-CHANNEL INFORMATION MEASURING SYSTEMS OF RADIOMONITORING

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Abstract: For the synchronization problem in the application of the multi-channel distributed information-measuring system, a set of combining instruments or sensors for registering dissimilar physical parameters of radio monitoring systems are considered. A variant and algorithm for the implementation of a multichannel synchronous information-measuring warning system has been proposed.

Keywords: information-measuring systems, synchronization, synchronous data processing, subsystem applications, quantizer

I. INTRODUCTION

Modern systems put complex tasks before developers of radio monitoring systems, placing increasingly high demands on them such as simultaneous processing of several data from different sources (detector or sensors), taking into account the heterogeneity of information on physical and spectral parameters (temperature, humidity, pressure, etc.). In this case, most of the problems are associated with the implementation of heterogeneous data integration mechanisms.

The complex use of such information is associated with various problems, especially with their heterogeneity. To solve these problems, an integrated approach to the study of synchronization systems is necessary, which leads to the solving the complication of research methods or radio monitoring processes. As a result, there is a need to create multi-channel and distributed systems of data acquisition for conducting research of information - measurement in radio monitoring systems. The most complete information about the state of the observed object or area can be obtained by a comprehensive analysis of only synchronous data, so the study of the function of synchronizing the data flow in multichannel systems acquire great importance.

An important additional requirement in a multichannel system is the synchronization of incoming data. If no special measures are taken, then the synchronization errors of the counts coming through various channels increase constantly. The rate of increase of errors is equal to the derivative of the instantaneous phase difference of quantizers. It is difficult to measure the magnitude; it can only be estimated for example, by the difference in the number of reports per unit of time. The increase rate of the phase difference is not constant and depends on various parameters (temperature, humidity, pressure, etc.). Therefore, it is impossible to accurately predict the time point when the phase error exceeds the permissible quantity and the joint analysis of data from different devices becomes incorrect. Thus, long-term multi-channel measurements made with the help of many individual devices can function only if the individual devices are in synchronization mode, and the measurements themselves are synchronous.

II. LITERATURE SURVEY

The task of synchronous retrieval of heterogeneous data can be solved in two main ways: by building a universal multichannel device that implements all the necessary channels, i.e. channel bonding is performed at the level of analogue signals, or by creating an open system that provides external synchronization and the possibility of combining data streams from a set of heterogeneous devices [1].

The approach to data synchronization provides the provision of guaranteed synchronous message transmission between subsystem applications running in a geographically distributed heterogeneous environment. At the same time, management of the computational process by events with queue processing and message distribution is supported. Synchronization has become the usual way of linking operational tasks [2].

Combining only information flows from various devices, for example, by the help of using special information buses, provides only simultaneous reception of data, but does not solve the problem of synchronous pickup, since there is an increasing run-up of clock phases of individual devices. For the user, the disadvantages of the first method are obvious: universality leads, in some cases, to failure (it is very difficult to build such a system), in other cases, it leads to system redundancy, as well as the inability to use the functional groups of channels separately [3].

From the point of view of the developer of the synchronous registration system, the first approach is due to its determinacy, on the one hand, is much simpler, and on the other hand it requires the creation of a collective set of diverse functional units, which is not always possible. When implementing the second method, serious problems occur, the main reasons for which are territorial distribution and certain non-determinacy of the composition of the system [4].

The need for logical integration of devices requires the development of a specialized protocol for exchanging data and commands that exists in industrial systems. In many cases, devices are needed that act as routers or concentrators. For radio monitoring systems, there are no official standards and recommendations for the integration of heterogeneous devices into a single system, and each development team has to solve the task of interfacing different devices independently each time [5].

Existing analogues of such systems have a number of technological shortages [6-8]. For example, if an information signal is received simultaneously from various detectors or sensors in the system, distortion of received signals is observed, as well as short-term failures in the radio monitoring system (Fig. 1).

The figure 1 shows a timing diagram of the data conversion process of an unsynchronized system. The appeal of each individual sensor (U_0-U_n) is performed in a period of a certain time interval, that is, there is no provision for simultaneous reception of information from different sensors.

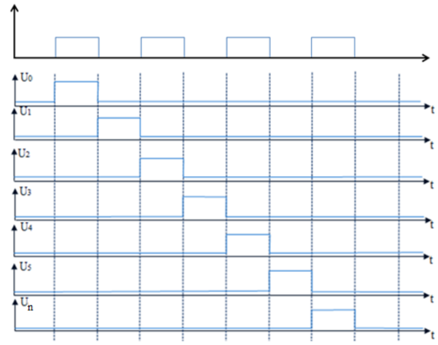

Figure 1: Timing diagram of the conversion of pulses from a variety of sources of standard systems (not synchronized).

In addition, in the development of data processing systems for the development of data, the following problems cannot be denied:

- There is no application software for processing heterogeneous data that is configured for a specific area of implementation.
- No well-defined data processing and integration algorithm has been developed.

III. PROPOSED MODEL

In order to ensure synchronization of flows from different sensor or sensors, the following functioning algorithm is proposed (Fig. 2).

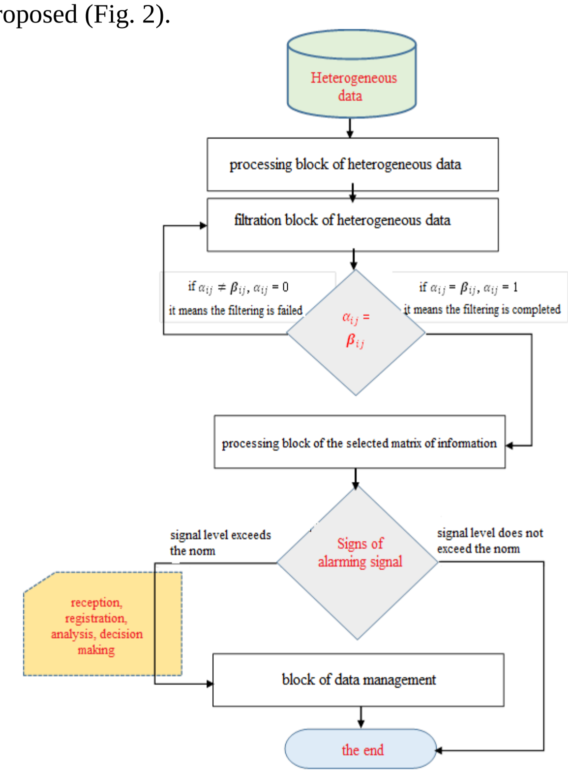

Figure 2: Algorithm of multichannel information-measuring system.

The data processing unit receives heterogeneous data with different physical and spectral characteristics. The data filtering unit receives a plan for the selection of the required data types with the appropriate characteristics.

In cases where there are multiple channels of information processing, the total time of passage of information is calculated using the following formula [8]:

$$t_{total} = max_{i=1}^{m} \frac{V_i}{q_i} \quad (1)$$

V_i– Sources of information;
q_i– Multiple communication channels;
t_{total} – Total time of information passage.

The more data sources from disparate sources, the longer is the queue of information passing through the channel, besides this, the processing time of the data increases. The total amount of heterogeneous data (array of information) can be calculated by the formula (2) [8]:

$$V_i = \sum_{j=1}^{n} \alpha_{ji} \quad (2)$$

n – The length of the element matrix;
$\sum_{j=1}^{n} \alpha_{ji}$ – The sum of all the elements of the data array;
V_i –The volume of information transferred to the - **n** data source.

For further data processing, it is necessary to calculate individual characteristics of data from the general information flow, that is, to determine where exactly to direct the type of filtered information. The mathematical basis for filtering the type of information is solved by the following condition (3.4) [8]:

$$t_{total}^{*} = \frac{\sum_{i=1}^{m} V_i^{*}}{q}, \quad (3)$$

$$V_i^{*} = \min \sum_{i=1}^{n} \alpha_{ij}, \quad (4)$$

Provided that $\alpha_{ij} = \beta_{ij}$,
V_i^{*}– The minimum value of the area;
α_{ij} – Signs of the necessary selected data;
β_{ij} –The criteria for determining the characteristics of the data to be selected.

The process of filtering the necessary information includes the following steps:

1. Pre-determination of conditions / criteria for determining the characteristics of the desired information - β_{ij}. Criteria β_{ij} are set on the basis of the goals of applied tasks.

2. The data is filtered. The stage is carried out according to a predetermined condition / criterionβ_{ij}.

- if$\alpha_{ij} \neq \beta_{ij}$, then the condition is considered not to be fulfilled and zero value is assigned to the elements of the data matrix (α_{ij} = 0), respectively, this type of information does not enter the corresponding processing stage;
- if $\alpha_{ij} = \beta_{ij}$, then the condition is considered to be fulfilled and these elements will be determined as corresponding to one or another criteria of data type, then they are followed by further processing.

Highlighting of the selected information, therefore, will lead to a reduction in the processing of the newly appearing matrix. The calculation is made according to the formula (5) [8]:

$$t = \frac{\sum_{i=1}^{m} V_i^{*}}{q} \quad (5)$$

Further, by the above principle, filtering happens. After the type of information is determined, it enters the processing unit of the selected matrix of information. Another stage of making decision is a comparison of the signal parameters with the initial indicators, that is, the comparison of the level with the initial level. If there is no change among indicators, the cycle ends and it implies that there is no synchronization signal [9].
Systems based on data acquisition boards, due to their versatility, require additional input converters that perform signal preprocessing, such as amplification and filtering, as well as specific transformations, the implementation of which in digital form is impractical.
This article proposes to apply such technology to develop methods for monitoring the state of the earth soils along a slope based on fiber-optic sensors. The system is installed along particularly dangerous slopes; the peaks of which landslide processes can occur.
The general principle is as follows (fig.3): sensors determine the movement along the site and the modem collects, summarizes the signals from the sensors. For the reception and transmission of information, wireless communication channels are used. The information processing unit integrates data coming from the multi-channel information-measuring system.

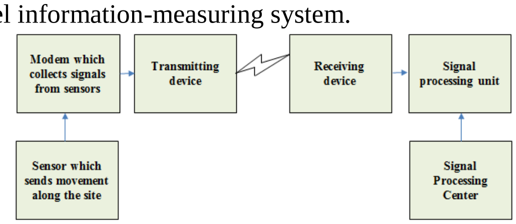

Figure 3. Block diagram of the information-measuring system

The figure 4 shows the principle of operation of the device for monitoring the states of mountain landslide processes.

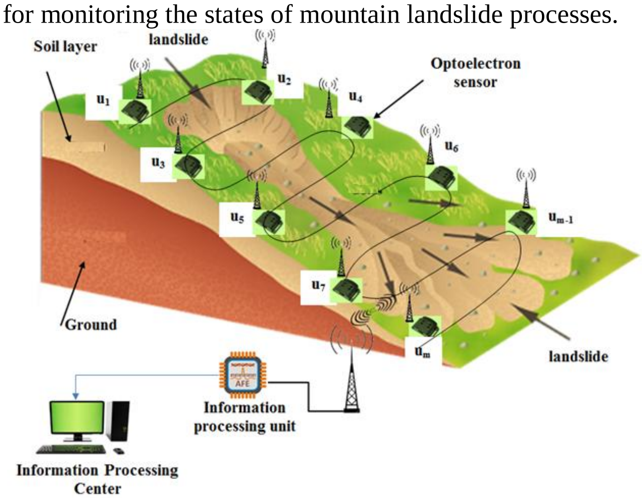

Figure 4: The principle of operation of the device for monitoring the states of mountain landslide processes.

Figure shows the experimental layout of the ground monitoring system on the slope. This device is adopted to determine the location of cracks or accidents along the ground. An automated optoelectronic system for detecting and recording fatigue cracks and the condition of the earth's soil consists of a laser diode (LD) unit, an alarm, indication and monitoring unit (AIM), and a set of sensors [10].

The main task of the U_1-U_n sensors is to determine the displacement of the earth's soil. Sensors that are on the one hand, illuminated by an incandescent laser (IL), on the other hand, are connected to individual photo-detectors (AIM unit) are fixed on any part of the slope. If a process begins to take place on the surface to be monitored, then there occurs a destruction of a sensor and, consequently, a sharp weakening of the intensity of the light flux supplied to the photo-detector. The electronic device processes the signals from the photo-detectors and implements an audible alarm about the moment of destruction, an indication of the number of the deformed sensor, as well as the operational shutdown of the external device [11-12].

The task is achieved by the fact that the channel numbers from U_1 to U_n correspond to the measuring channels, and the reference channel number corresponds to the zero level in the absence of signals on all optical channels of the device and the data on the reference channel are used to monitor the correct operation of the receiving-amplifying path and the analog-digital converter [12]

The measuring system locates in advance the occurrence of landslide processes with an accuracy of 20-30 mm.

A distinctive feature of the innovative work is that the process of monitoring the state of the earth soils along the slope will be based on fiber-optic sensors, which will undoubtedly lead to an improvement and reliability of the results.

IV. CONCLUSION

The proposed approach to solving problems of integrating heterogeneous information in various subject areas requires an adaptation of the proposed model, both in terms of the used data and in terms of the functioning of the integration systems. The proposed structure can be adopted when creating similar models in other areas working with heterogeneous data.

Such systems are preferable to use especially in places or objects where it is necessary to take into account the different physical characteristics of alarm systems. For example, the object of observation, where it is necessary to monitor the values of air pressure, temperature, humidity and mechanical damage to individual elements of special purpose.

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