Information Fire Extinguishing System and the Concentrator for Its Realization

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Abstract

Information fire extinguishing system which is under construction on the basis of continual idea of process of emergence of a fire is offered. This system allows to read out signals from sensors and to transfer them to the control panel at a considerable distance from the fire. Designed the concentrator (signals of sensors) fire extinguishing system, which is a set of key and remote concentrators. Operation of the existential transformation of information (ETI) is defined as action in which scanning, measurement, information processing and delivery of operating signals is combined.

1. Basics

In the last decade, particular attention has been paid to the development of effective systems of human security and property. Particular attention is paid to the protection of structures against the occurrence and prevention of fire. For this purpose designed and developed effective systems of fire alert, information about it for a considerable distance through the information system. One of developers and manufacturers of such systems is the French firm Neutronic [http://www.neutronic.fr/]. Information fire extinguishing system is under construction on the basis of continual idea of process of emergence of a fire. It is supposed that emergence of a fire happens locally in one or several places and is characterized by level of smoke of the room at the expense of increase of concentration of products of burning indoors. At achievement of concentration of products of burning of a certain level work the corresponding sensors signals with which are transmitted to the control panel. Continuous systems (CS) are formed on the basis of continuous media (physical fields), whose properties are determined by the physics of the processes and in general they perform an operation of space-time signal conversion function.

Operation of the existential transformation of information (ETI) can be defined as action in which scanning, measurement, information processing and delivery of operating signals is combined.

On this case, the output shows the spatial distribution of the characteristics of the field concentrations of the products of combustion.

2. The paper’s objective

The concentrator development for creation the information fire extinguishing system.

3. The materials and results of the research

Development of the direction of information fire extinguishing systems is based on use of continual and quasicontinual physical systems of transformation of information [1]. It is connected with complication of tasks which are set for information systems and transition to algorithms of adaptation and self-organization. Structure of space-time systems, in particular, and sprinkler systems are represented as a set of basic analog integrated cross-coupled devices. This takes into account the physical features of a transformative environment [2]:

$$ U = \{A,F,X\} \quad (1) $$

where U - control field, formed under the influence of a medium in the conversion operator A and having a spatial-temporal dispersion, F - operator of external influence on the environment, X - a signal indicative of the state of the object.

If the device interacting with object of potential emergence of a fire to present in a look shown in fig.1, it can be presented in the form of the following flowchart:

![Fig. 1 The model of interaction with the object of continual control medium.](image-url)
Here the control signal \( U \) could be presented as:

\[
U_i(k, \omega) = \sum_{j=1}^{n} A_{ij}(k, \omega)X_j(k, \omega)
\]

(2)

where \( A_{ij} \) – Fourier’s transformation from a matrix kernel of the operator of the operating environment.

Thus we consider that external influence of \( F \) is absent, and \( X_j(k, \omega) \) and \( U_i(k, \omega) \) can be presented in the form of Fourier’s multidimensional integrals:

\[
x_i(k, \omega) = \int x_i(r, t) e^{-j2\pi \omega t} dr dt
\]

(3)

\[
u_i(k, \omega) = \int u_i(r, t) e^{-j2\pi \omega t} dr dt
\]

(4)

If now to write down expression for a management signal in originals, we will receive:

\[
u_i(r, t) = \sum_{j=1}^{n} \int_Q q_{ij}(r - r_2, t - t_2) x_j(r_2, t_2) dr_2 dt_2
\]

where \( S \) – some area of an existential continuum.

The matrix \( A_{ij} \), for the operating continual environment, has to be subordinated to requirements, physical feasibility of management by fire extinguishing process.

The class of functions \( A_{ij} \) defined by properties of natural environment and the availability of its physical realization of the synthesis, and it is connected with the technological capabilities and limitations imposed by the applicable component parts [3].

Consider a fire information system, consisting of medium fire, considered as a continuous system, sensors, fire alarm control unit (SCP) computer information processing unit and control unit fire extinguishing system.

The electro technical part of an automatic fire extinguishing system (ASPT) consists of the devices combining the PKPP functions and a monitor by fire extinguishing. PKPP is intended, for reception of information of the notification of a fire, sensors of manual start-up, sensors of blocking of start-up, transformation and an assessment of this information, formation of signals of the notification at emergence of a fire or malfunction, further signaling and delivery of commands for other devices, and also managements of installations of powder, aerosol, gas fire extinguishing and systems of removal of a smoke.

ASPT divided by the fire extinguishing agent used:

- gas fire extinguishing (argon, nitrogen);
- powder fire extinguishing (powders of a special chemical composition);
- aerosol fire extinguishing systems (are similar to powders, but it is 10 times less particle by the sizes);
- water fire extinguishing (water);
- foamy fire extinguishing and water-foamy fire extinguishing (water with frothers);
- systems of sprayed water (TRV).

The concentrator developed in our university, which represents a complex of the universal modules designed so that they can work as independently, and in a multilevel expanded fire extinguishing system, the security alarm system or as a part of Clever House (Smart Home) system. The example of use of the concentrator is represented in figure 2. It represents information system.

![Fig. 2 Concentrator, as multilevel complex of universal modules.](image)

Such concentrator of a fire extinguishing system is intended for collecting, processing of signals from 16 various sensors and devices, and also information transfer on remote devices (repeaters). It consists of the input device; processing devices and managements, and also output device. The input device contains 16 discrete channels. It is intended for a filtration of signals and protection of the equipment against influence of a high voltage. The processing device and managements carries out a number of functions:

1) the analysis and processing of entrance information (a task of temporary delays for operation fixing on entrances, inverting of separate entrances);

2) task of temporary delays for turning on of output devices, light and sound alarm system;

3) control of existence of the main source of power supply and charging of a reserve source (battery);

4) automatic restart (restart) of the operating microcontroller in case of "lag" at operation in the conditions of industrial hindrances;

5) data collection about a condition of other concentrators, in a case when the system consists more than from one device (to 4 concentrators can work in parallel);

6) self-diagnostics mode;
7) in case remote repeaters are connected to the concentrator (to 4 devices), it provides exchange of information with them on CAN-to the interface on distance information with them on CAN-to the interface on distance to 1 km;

8) automatic recovery of the data transferred to remote repeaters in case of loss of communication, switching off and repeated turning on of the main concentrators or remote repeaters;

9) automatic configuration after food giving. Each concentrator defines the place in system (if their more than one) and is adjusted on the corresponding operating mode.

Figure 3 illustrates a structure of the hub in information system concentrators unite in complexes.

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**Fig. 3. Concentrator structure.**

In figure 4 the structure of the complex is consisting of four concentrators and four remote repeaters is represented.

It is possible to carry to distinctive features of this concentrator: universality, the expansibility, increased reliability and fault tolerance. Universality consists that the concentrator allows the operator to adjust and configure operation of the device under various types of entrance sensors and output executive devices. During the work in a complex with several additional concentrators each of them automatically defines the appointment at start and is configured.

Expansibility consists in possibility of parallel connection, both the main concentrators, and remote repeaters to 4 units. Exchange of information between parallel modules is carried out on the I2C interface. Data exchange happens to remote repeaters on the highly reliable noise proof field tire CAN. Increased reliability and fault tolerance is caused by use of the modern high-performance PIC24F microcontroller of "their" data and ignoring the rest. The exchange Microchip firm (USA); built-in system of self-testing; original circuit decisions and effective software.

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**Fig. 4. Structure of the complex consisting of four concentrators and four remote repeaters.**

A more detailed look at how the system is the transfer of information from the sensors of the lower level to the upper levels with high reliability.

The task of ensuring high reliability achieved both on hardware and in software. At the hardware level, the goal is achieved using a stand-alone transceiver ISO1050 interface CAN (Controller Area Network). The ISO1050 combines innovative CAN interface and isolation technology Texas Instruments, which helps reduce the number of required components, such as at least 2 times and simplifies the design of circuit boards for industrial automation device ISO1050 reduces power consumption at the system level by 38% in comparison with the solutions for opto-isolation.

The case 6,1 mm wide reduces the installation area on a payment by 30% that is the extremely important for the high-voltage appendices demanding the minimum gap. In addition to it ultralow level of the electromagnetic radiation (EME) allows to use the device in sensitive analog appendices, for example, industrial sensors. According to the logic of the organization of data exchange of CAN differs from traditional interfaces. The other nodes "listen" line and analyze the identifiers transmitted messages, taking only organization – event focused. It means that as soon as the knot receives the message on an event, on which it is necessary to inform other knots of system (taking into account described above arbitration procedure), it begins broadcasting transfer of the message. Such procedure is carried out without program poll, interruptions and without
the controller operating an exchange. As a result, survivability of the system increases: even after being divided into two parts, it maintains the viability of each of them. In this case, the two subsystems will be able to function independently.

Another consequence of the equality of all components is saving time for delivery of the message to the recipient by the decentralization of the system.

As already noted, the CAN protocol, the concept of "e" is absent and there is the concept of "ID", which is actually the transmission of location registration (knots CAN interface software is not available for writing receiving registers). Each identifier is rigidly connected to an array of data which can be transmitted to the transmission line at the initiation of the respective node. The data can simultaneously receive multiple nodes. This greatly speeds up the operation of the interface by eliminating duplication of transmission of the same data to different sites. Procedure of request of data is organically included in event focused logic of operation of the interface. If it were required to knot the data formed by other knot, it sends the message with request of these data, specifying in it the identifier. In reply knot the holder of data transfers the corresponding message.

The event which has caused in data, initiates their delivery. Those, CAN interface use in systems of safety allows:
1. To lower load of a network since all messages transferred in system, are event and are accepted at once by all devices of system.
2. To provide the high speed of reaction of system.
3. To define communication problems and failure of devices of system, using a mode of confirmation of messages and the mode of self-diagnostics based on the mechanism of clock impulses of "on bus".
4. To keep operability of system at a rupture of the communication line.
5. To connect and disconnect devices without change-over of other knots of system.
6. To increase reliability of system because of possibility of simplification of architecture of a network and reduction of number of backbone components.
7. To increase survivability of system of safety at the expense of reliable interaction of devices of system irrespective of a condition and existence the master of devices, possibilities of creation of the communication line of the ring, radial and mixed architecture without use of any additional blocks.
8. To achieve reduction of cost of systems of protection of objects as a result of application of the simplified structure functioning without continuous presence of the control panel in the structure.

The flexibility of distributed networks based on CAN-bus technology allows for modular construction method of design layout systems.

4. Conclusions

In this work the fire information system was proposed, which is based on the idea of the process of continual fire. This system allows us to read the signals from sensors and transmit them to the control panel at a considerable distance from the fire. Designed Hub (sensor signals) fire extinguishing system, which is a set of key and remote concentrators.

The operation of space-time transformation of information (PVPI) is defined as an action in which the combined scanning, measurement, data processing and issuing control signals. It is shown how the system is the transfer of information from the sensors of the lower level to the upper levels with high reliability. The task of ensuring high reliability achieved both on hardware and in software.

Bibliography


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