THE PROCESSING OF HETEROGENEOUS DATA FOR MULTISENSOR SYSTEMS OF TECHNICAL VISION ON THE EXAMPLE OF ANALYSIS OF TEMPERATURE AND GAS CONCENTRATION

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Introduction

In circumstances that prevent visibility for underwater robots operating near the bottom, when the movement of the robot causes precipitation and water turbidity; in extreme cases in a smoke-free environment; when the workplace is polluted in the workplace and other circumstances, supervisory control is often applied, which is reduced to the periodic task of the operator performing the next elementary operation that is performed only after the visibility is restored, resulting in the problem of qualitative data acquisition. In such cases it is advisable to use multi-sensory vision systems (STV), where attention is focused on the quality of the data obtained. Successful solution of this problem will lead to significant progress in a wide range of applied problems due to increasing the accuracy, efficiency and reliability of such systems.

One of the actual tasks that can be solved using STV methods in robotics, using specialized sensors, is the determination of the temperature and concentration of gases in an enclosed space. Determination of the source of leakage of a number of gases has a high value in the elimination of accidents. Theoretical methods of this study are based on:

- digital image processing;
- pattern recognition;
- discrete transformations;
- system analysis.

The heterogeneous and multiscale data obtained from the gas analyzer contain information on the composition of the gas sweep of various gases, the amount of these data increases with the number of the sensors themselves, as a result, for the experiment in question, the gas concentrations were obtained at each of the ten key points. In turn, the data obtained from the thermal imager have graphical information and information on the nature of temperature changes at key points.

The following hypothesis is suggested: the data obtained from the gas analyzer should have a linear dependence on the heat distribution, which follows from the properties of the gas whose physical state is directly influenced by its temperature indexes.

Within the framework of this work, an experiment was conducted to determine the relationship between the thermal imager and the gas analyzer in real time. On the basis of a comparison of the experimental data obtained, an algorithm is proposed for determining the thermal losses of a gas in a gaseous mixture of arbitrary composition in a closed region due to thermal conductivity and thermal radiation from temperature and concentration sensors.

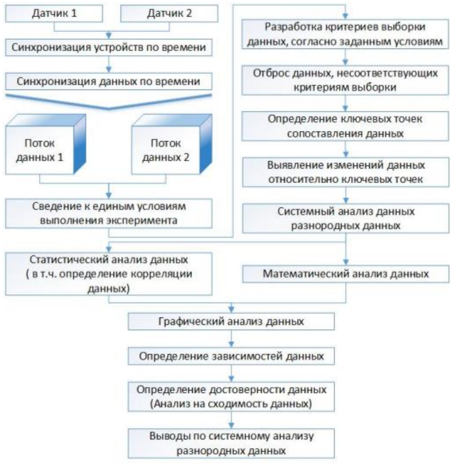

Fig. 1. Algorithm for processing heterogeneous data for a multi-sensory system of technical vision.

For the experiment, a prerequisite was the condition for setting up synchronization and calibration of two sensors (gas analyzer and thermal imager), determining the type of data and sample size, and classifying the data. 10 measurements were made in 50 time intervals to track the dynamics of the state changes, the grouping of the obtained data was carried out by time slices. The temperature spread is from 25 ° C to 140 ° C corresponding to the gas state of NO_2.

In areas with insufficient data from the analyzer carried approximation conventional central difference scheme of the "cross" and the decision to have defined an iterative method of Gauss-Seidel. In this case, the approximation is used to bring the data to a single common scale. The key values of the data from the gas analyzer were compared with the image obtained from the thermal imager by imposition of images.

Existing methods for calculating the heat transfer of different gases operate only with information obtained from one sensor and a priori knowledge (gas mixture composition, heat capacity, fractional component ratio). In contrast, the developed algorithm uses heterogeneous information flows from two time-synchronized sensors and makes it possible to draw a conclusion about the characteristics of the analyzed gas already on the basis of statistical analysis in real time. All sensors are static, one thermal imager and ten sensors with a gas analyzer. The thermal imager is suspended in the center of the room under the ceiling, for maximum coverage of the room. Gas alarm sensors are placed evenly over the entire surface of the ceiling. The measurement interval is 15 seconds. Measurement range NO_2 - 1000 ppm. Reduced measurement error (except for O_2) - 5%; According to the data obtained in the course of the experiment, a direct correlation of the readings of the temperature and concentration sensors was revealed, which indicates a diffusion process close to isothermal.

The validity of the conclusions regarding the effectiveness of the proposed system is confirmed by statistical modeling and experimental-methodological processing of real results. The verification of this simulation model was carried out by experiment.

Conclusion

An algorithm has been developed that uses heterogeneous information flows from two time synchronized devices that allows us to make a conclusion about the characteristics of the analyzed gas already on the basis of statistical analysis in real time, in contrast to existing traditional methods that operate on information obtained from one sensor and a priori knowledge.

It was found that the correlation coefficient between the readings of the concentration and temperature sensors reflects losses of NO_2 by thermal conductivity and thermal radiation in the gas mixture, these heat losses are equal to 12% of the initial heat quantity for the data obtained during the experiment. This confirms the proposed hypothesis about the possibility of calculating the thermal losses from the data of the temperature and concentration sensors of the gas mixture.

The results of the research are applicable in the field of monitoring and processing of heterogeneous data to improve the efficiency of work performed with the help of STV, in modeling situations requiring rapid response, such as: accident elimination, modeling of evacuation of people from buildings in emergency situations, simulating situations in terrorist attacks.

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