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DEVELOPMENT OF AN INTELLIGENT GAS ANALYZER BASEDON THE IR-SPECTROMETRY METHOD

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ABSTRACT

The paper considers the process of obtaining the measurement result using an intelligent IR gas analyzer. The unclear intelligence of "Adjusters" and "operators" is excluded, which reduces the probability of measurement errors. Making devices smart improves their metrological characteristics and reduces the likelihood of errors during operation. There are various approaches to designing intelligent measuring equipment. One of them is considered on the example of an automatic gas analyzer that uses infrared spectrometry for analysis.

KEYWORDS: *Spectrophotometer, IR Gas Analyzer, Intelligence, Probability, Error, Devices, Procedure, Properties, Beam Splitter, Compensator, Detector, Interferometer*

INTRODUCTION

The main purpose of IR spectrophotometers is to obtain the vibrational spectrum of the compound under study. Various designs of spectral instruments have been developed. IR spectrophotometers, in which information about the spectral intervals cut out by the slit is recorded sequentially in time, are called scanning. As each such spectral interval is scanned, the widthof which is determined by the spectral width of the slit, the radiation energy is perceivedby a single-channel receiver. Devices with spatial separation usingmultichannel receivers are practically not used in the middle IR region, as opposed to the visibleone. An example of a multichannel instrument for the visible region is a spectrographthat registers the radiation spectrum on a photographic plate. Multichannel spectrometers are devices in which the receiver simultaneously receives many signals correspondingto different parts of the spectrum. These signals are decrypted in such a way that they provide information abouteach individual spectral element. Since the IR region is characterized by low energy, thedesign of IR spectrophotometers is aimed at maximizing the energy passingthrough the device and reaching the receiver. For his part, the user must remember this limitation and choose, especially in the case of quantitative measurements, the optimal operating modes and methods of sample preparation from an energy point of view.

In the course of a classical spectroscopic experiment, polychromatic radiation (white light) entering a prism or lattice monochromator is divided into an infinitenumber of monochromatic beams. The spectrum is obtained by spatial separationof beams with different wavelengths coming out of the prism. A diffraction grating worksin the same way, except that the number of beams is equal to the number of bars of the grating and foreach wavelength at the output, more than one maximum is obtained. Different orders of the spectrumthat overlap must be separated. The resolution achieved in the spectrometeris determined by the width of the slit that defines the band of wavelengths that falls on the photodetector andthe order of the spectrum.

One of the rapidly developing areas of computer application is the emulation of human behavior in evaluating information and making decisions. Systems with similar properties that simulate the mechanism of human thinking are considered intelligent, and it is assumed that the presence of these properties gives them a new quality. The division between intelligent and" conventional " devices is unclear, but a computer playing chess with a world champion, an optical device that recognizes shapes, and robotic systems are no longer called a computer or machine, although they work according to certain and understandable algorithms. This is not just a fashion statement. Expanding the requirements to"smartness" of the device allows you to look at problems differently, develop the theoretical base and find new design solutions. This process objectively does not depend on the fact that the standard of "intellectuality" - a person functions according to some complex and poorly formalizedprograms.

MAIN PART

There are many definitions of system intelligence, starting with non-specific ones that appeal to intuitive understanding. In General, the characteristic features of smart devices include the ability to learn, generalize, accumulate knowledge, adapt to changing conditions in the decision process [1]. The intelligent system evaluates the situation based on both previously accumulated data and analysis of the current situation, recognizes the situation, and makes an action plan to achieve the goal based on existing information bases and rules.

At the moment, with the development of the theory of artificial intelligence, with the appearance of applications for creating practical systems, a new point of view on the use of artificial intelligence methods has emerged. It consists in the fact that these methods, designed as special technologies, must be used notonlyat the strategic level, but also at other levels of the system hierarchy. At the same time, the so-called basic intelligent technologies are specifically defined [2]. An intelligent system is one that uses these technologies as a means to combat environmental uncertainty. It is proposed to use a hierarchical gradation of system intelligence by level, i.e. for small-scale intelligence, it is sufficient to have a minimum set of intelligent technologies in the system.

Based on this approach and considering the existing practice, it can be noted that if, for example, the "capabilities" of an intelligent aspirator (liquid sampling device) [3] are not clear, then other devices more closely correspond to this definition. For example, intelligent electric [4], controlled via the Internet, or smart gas stove, incorporating gas sensors, which, through "education", "summarizing" the data sensors in the process and "analyzing" using fuzzy logic "makes decisions" about the presence of a gas leak from a specific burner. Although in the conventional sense, they are hardly more intelligent than an amoeba. But such plates are more reliable, more convenient, safer than" non-intellectual " plates, and this is already a positive achievement of applying the concept of "intellectuality".

There is no doubt that both the concept of intelligence level and the concept of intelligent basic technologies will be adjusted, but the approach associated with the distribution of intelligence by levels provides new opportunities for device design.

Measuring procedures are an important aspect of human intellectual activity. It is logical to recognize measuring devices as possible objects of application of intelligent technologies [5-8]. Given the difference of views on the problem, it is interesting to consider the specific goals and techniquesof intellectualization of measuring technology.

Here are the considerations underlying the experimental development of an intelligent gas analyzer based on a method for measuring absorption spectra in the infrared region (IR-gas analyzer). The main goal of device intellectualization was not to solve the problem of configuring measuring circuits or self-calibration of the device [5-10], but to exclude human intellectual activity from the measurement process as a potential source of errors. It is assumed that obtaining the measurement result with traditional instruments is provided by at least two specially trained parties — conditionally "Adjuster" and "operator", who work with a specific device design.

"Adjuster" on the basis of the developed plan and programs calibrates the device using reference mixtures and builds a scale model, determines the ranges and accuracy of the device for the measured product. If necessary, it repeats all operations taking into account interfering influences— humidity, temperature, etc. It takes into account the specifics of getting information about them: accuracy and the time delay for getting it. Develops an updated model, taking into account the interfering factors. Since over time there are processes of degradation of the device, after some time the "Adjuster" verifies the device, repeating all these procedures and correcting the scale or changing the scale model. This procedure is repeated with a certain frequency. Note that these procedures can be interpreted as training and experience accumulation.

When performing a measurement, the device displays certain numbers in accordance with the built-in model. The" operator " who performs the measurement decides whether the measurement conditions meet the conditions for developing the instrument scale model, and accepts (or rejects) the result. In case of ambiguity,the "operator" independently decides, based on the developed programs or experience, what the displayedvalues correspond to.

From this brief review, it can be seen, firstof all, that for devices of even one design version, the measurement result depends on the specific intellectual properties of the "Adjuster" and "operator", as well as their error-free operation. Secondly, a number of aspects of the intellectual work of the "Adjuster" and "operator" can be implemented by modern microprocessor technology directly in measuring instruments. Moreover, these methods are classified as intelligent and are used in intelligent systems for analyzing and recognizing figurative information, systems for planning and analyzing experiments, and modeling systems. With this implementation, the device receives all the main signs of intelligence, and since it makes its own decision, its characteristics are standardized and no longer depend on the properties of the "Adjuster" or "operator". As a result, the measurement process of an intelligent gas analyzer based on IR spectrometry is constructeddifferently.

The original procedure for constructing the scale is organized as a training and does not require a special "Adjuster". In the course of training, the consumer presents the gas analyzer with a list of products that need to be measured. The device uses its built-in experimental planning programs and knowledge bases to request the necessary reference mixtures with the necessary influence factors. The user provides the mechanistic side of the gas analyzer training process by feeding the desired gas mixtures to the input. Based on the information received, the device, using known methods, independently develops a multi-factor model of its scale for selected products. If the training was not completed in full — for example, due to the lack of necessary gas mixtures, the inability to create all kinds of interfering influences, or other reasons — the analyzer uses the existing knowledge base, including the spectra of substances, models of the deformation of spectra when they interact in a mixture. The completeness of the set of knowledge determines the qualityof the scale model [6-13].

At the next verification, the device independently suggests its program. Calibration results allow the device to gain experience and build a degradation model, taking into account which increases the measurement accuracy between the verification interval.

When analyzing a multicomponent mixture, the device analyzes the spectrum of the mixture and determines the products and their concentration, using additional information from the sensors. A probabilistic decision about the measurement result is made based on the knowledge base about spectra, training results, and a set of information.

Thus, the unclear intelligence of "Adjusters" and "operators" is eliminated from the process of obtaining the measurement result with the help of an intelligent IR gas analyzer, which reduces the probability of measurement errors.

Having a flexible training procedure allows you to implement it for different products. By transferring programs from one device to another of similar design, we can talk about the exchange of experience. This exchange is possible both as it accumulates, and as a result of the development of planning and modeling methods. In other words, a particular device can continuously improve its consumer properties.

With this approach, all the problems of ensuring the quality of measurements are transferred to the level of designing intelligent measuring devices: the development of programs and algorithms, knowledge bases, the correct choice of a set of sensors, the information from which would be necessary and sufficient to solve the problem. The solution to these problems is left to the device developer.

A schematic diagram of the Michelson interferometer is shown in Fig.1. Following is a brief description of his work.

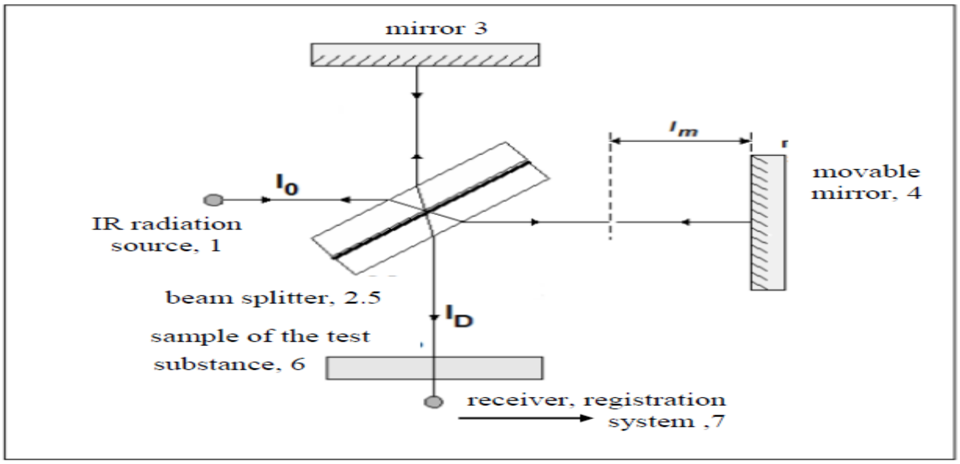

Fig 1 Scheme of the Michelson interferometer

1. The source of infrared radiation,
2. Beam splitter,
3. Fixed mirror,
4. A movable mirror,
5. Compensator,
6. Sample of the test substance,
7. The detector of the infrared radiation.

The light coming from the radiation source 1 (I_0) is divided by a semi – transparent plane-parallel mirror-beam splitter 2 into two coherent beams. The materials used to make the beam splitter (and the compensating plate 5) are selected depending on the studied spectrum region. One beam is directed to the stationary plane mirror 3 and reflected from it to the beam splitter, the other goes to the plane mirror 4 and also returns; on the beam splitter they are connected. These two coherent beams interfere with each other, so that they can either amplify or weaken each other depending on the difference in travel between them. Interference bands appear in the focal plane of the lens, which can be observed visually or recorded in some way (detector 7). Mirror 4 makes a reciprocating movement along the beam. The displacement of this mirror occurs relative to the zero position, in which the optical path difference in the arms of the interferometer is equal to zero. The largest mirror displacements are $\pm l_{m.}$ When moving mirror 4 is shifted by a quarter of the wavelength, the light bands in the interferogram are replaced with dark ones and Vice versa.

Detector 7 registers an interferogram- the dependence of the intensity of the light output from the interferometer on the optical path difference, which can be different – from centimeters to meters. The interferogram contains complete information about the spectral composition of radiation coming from the source.

The interferogram is the result of the interferometer's working cycle - scanning ("scan") along the l-axis from 0 to lm - one-sided scanning, or from - lm to + lm - two-sided scanning. As the mirror 4 moves, a light beam hits the receiver, the intensity of which in the case of a monochromatic source changes according to the cosine law. If - I (x) is the intensity of the light falling on the receiver, x is the displacement of the mirror 4 in centimeters, B (ν) is the intensity of the source as a function of the wavenumber ν in cm-1, then the signal intensity for a monochromatic source ν1 changes according to the law:

$$I(x) = B(v_1)\cos(2\pi v_1 x)$$

CONCLUSION

1. The fuzzy intelligence of "adapters" and "operators" in the process of obtaining a measurement result using an intelligent IR gas analyzer has been eliminated, which reduces the likelihood of measurement errors.
2. The flexible learning process made it possible to implement it for a variety of products.

LIST OF REFERENCES

1. Yusupbekov, N., Adilov, F., Ergashev, F. Development and improvement of systems of automation and management of technological processes and manufactures // Journal of Automation, Mobile Robotics and Intelligent Systems 11(3), c. 53-57. DOI: 10.14313/JAMRIS_3-2017/28

2. Yusupbekov, N.R., Marahimov, A.R., Gulyamov, Sh.M.,Igamberdiev, H.Z. APC fuzzy model of estimation of cost of switches at designing and modernizations of data-computing networks / 4th International Conference on Application of Information and Communication Technologies, AICT2010, 5612015, DOI: 10.1109/ICAICT.2010.5612015

3. Yusupbekov, N.R., Yusupov, A.A. Review and comparative analysis of modern devices for level gauging in checking system and industrial processing control // International Journal of Advanced Science and Technology 29(9 Special Issue), c. 5370-5380

4. I.Kh.Siddikov,M.A.Anarbaev,A.A.Abdumalikov, A.B.Abubakirov,M.T.Maxsudov, I.M.Xonturaev.«Modelling of transducers of nonsymmetrical signals of electrical nets» // International Conference On Information Science And Communications Technologies Applications, Trends And Opportunities //Publication Year: 2019, Page(s): 1–6. http://WWW.ICISCT2019.Org

5. A.B.Abubakirov. «Research of the electromagnetic transducers for control of current of three phases nets»// European science review, Scientific journal № 5–6 Виенна, Австрия. 2018. с 269-273.

6. I.X.Siddikov, A.B.Abubakirov, A.J.Allanazarova, R.M.Tanatarov, Sh.B.Kuatova // Modeling the secondary strengthening process and the sensor of multiphase primary currents of reactive power of renewable electro energy supply // Solid State Technology, Volume: 63 Issue: 6, Publication Year: 2020, pp: 13143-13148.

7. Abubakirov A.B., Yo'ldashev A.A., Baymuratov I.Q.,Sharipov M.T.,Utemisov A.D. «Study of conversion circuits and design of the electromagnetic primary current and voltage transducer of monitoring andcontrol systems» // EPRA International Journal of Research and Development. Volume: 5 India. 2020. - C. 214-218. (SJIF Impact Factor: 6.260| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)).

8. N. Juraeva,O.Nazarov, S.Urolov, A.Djalilov. Intellectual system for water flow and water level control in water management/1st International Conference on Energetics Civil and Agricultural Engineering 2020 October 14th – 16th 2020, Tashkent, Uzbekistan. IOP Conf. Series: Earth and Environmental Science 614 (2020) 012044.

9. Баратов Р.Ж., Чуллиев Я.Э.,ДжалиловА.У. Low power smart system development for water flow measurement and level controls in open canals// International Journal of Advanced Research in Science, Engineering and technology. – India, 2019. – Vol.6. Issue 12 – pp. 12240-12246. http://www.ijarset.com/upload/2019/december/55-rbatov-80.pdf. http://www.ijarset.com/volume-6-issue-12.html.

10. Management in the conditions of uncertainty / Ed. by A. E. Gorodetsky.SPb.:SPbSTU, 2002, 398p. (in Russian)

11. Intelligent automatic control systems / I. M. Makarov, V. M. Lokhin, Moscow: Fizmatlit, 2001, 576 p. (in Russian)c.

12. http://trimm.ru/

13. http://www.tmio.com/