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THE CONCEPT OF A SENSORY NETWORK MEASURING MECHANICAL QUANTITIES
КОНЦЕПЦИЯ СЕНСОРНОЙ СЕТИ ИЗМЕРЕНИЯ МЕХАНИЧЕСКИХ ВЕЛИЧИН

Summary. *In our time, the need for separate use of measuring devices has significantly decreased. This trend is characterized by two major changes in the world of electronic devices: In modern devices, sensors have ceased to be independent systems or separate devices and are part of them (in their everyday life they are tablets and smartphones, and in the production they are sensory measuring networks). Measurement systems themselves have ceased to be of interest. They are an integral part of the system, which also includes technologies for processing, measuring, storing and forecasting measurements. An example of using such technologies is "Internet of Things", which can be considered as one of the IT-technologies that improve professional interaction, due to the shared use of this or that group of people.*

Key words: *Intelligent home, sensors, microclimate, leakage protection, lighting control, fire and security alarm systems, access control systems.*

Аннотация. *В наше время потребность в отдельном использовании измерительных приборов значительно снизилась. Эта тенденция характеризуется двумя существенными изменениями в мире электронных устройств: в современных устройствах датчики перестали быть независимыми системами или отдельными устройствами и являются их частью (в повседневной жизни это планшеты и смартфоны, а в производстве они являются сенсорными измерительными сетями). Сами по себе измерительные системы тоже перестали представлять интерес. Они являются неотъемлемой частью системы, которая также включает в себя технологии для обработки, измерения, хранения и прогнозирования измерений. Примером использования таких технологий является «Интернет вещей», который можно рассматривать как одну из IT-технологий, которые улучшают профессиональное взаимодействие, благодаря совместному использованию той или иной группы людей.*

Ключевые слова: *интеллектуальный дом, датчики, микроклимат, защита от утечек, управление освещением, системы пожарной и охранной сигнализации, системы контроля доступа.*

Introduction

The subject of the study is the measuring sensor network "Internet of Things", as a kind of informational measuring system that is being solved as a system of professional interaction.

Research methods are the systematic method of analytical research, computer simulation, simulation modeling.

The purpose of the research is to analyze the problem of modern information measuring systems of mechanical quantities, to harmonize the basic concepts and terms, to analyze the concept of deployment of the sensory network "Internet of Things", to develop a basic simulation model of sensory measuring network of mechanical quantities as a means of professional interaction.

The article will analyze the problem of modern information measuring systems of mechanical quantities, will agree on the basic concepts and terms, will analyze the concept of deployment of the sensor network "Internet of Things", will develop a basic simulation model of sensory measuring network of mechanical quantities as a means of professional interaction.

Today there is a decisive transition from individual measuring instruments to intelligent measurement systems of the future generation. In such systems can simultaneously provide coordinate services, weather forecast, and calorie measurement (based on what distance people overcame and at what speed).

Analysis of recent research

A good solution for such different requirements is the computerized measurement system. They consist of geographically distributed autonomous devices and their intelligent sensors related to them: temperature, sound, vibration, time positioning, etc., they can freely compete with existing measurement systems, and also serve as an addition to any existing measurement system with a professional interactions.

The research of information-measuring systems, including the research of the technologies of modeling, control and interaction of computerized systems of measuring mechanical quantities, is devoted to the work of modern scientists such as Kvasnikov V., Ornadsky D., Osmolovsky A., as well as works by Geyer D ., Irwin J., Liery J., Roshan P., Stollings V., Harley D. et al.

Formulation of the problem

The interest in automation networks grows each year due to their low cost and relative simplicity of installation. One of the most promising areas for using these WSN networks is the automation of buildings and premises, for example, automated systems for temperature and illumination control. The number of incoming sensors (wired sensors) for climate control at someone and the intelligent house (Intelligent House) can be significant, which inevitably leads to high installation and installation costs, and even in some cases, even before the building is reconstructed for laying cable systems Therefore, an economical and efficient alternative to the CAN, BACnet, LonTalk, Ethernet, and TokenBus protocols is a modern wireless sensor network (WSN) in the "Internet of Things". The WSN wireless sensory networks with Wi-Fi and WiMAX networks, which address office communication tasks (Fig. 1), are integrated into the system.

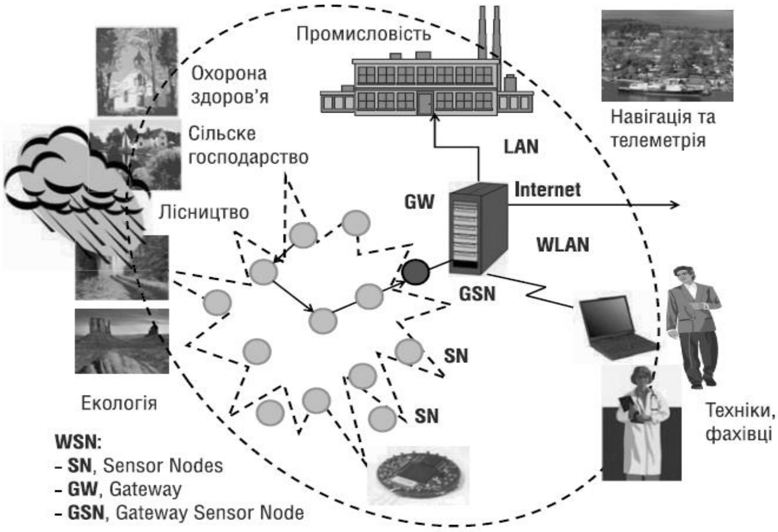

Fig. 1. Areas of application of sensory pawns WSN

On the whole, the WSN's coasts are composed of spatially-allocated autonomous units (SN, Sensor Nodes) that communicate with the purpose of joint monitoring of physical parameters or ambient conditions such as air temperature, sound, vibration, and pressure, movement of parts during structural assembly or diffusion of pollutants into the air. The model and parameters without a proximity sensor are shown in Fig. 2

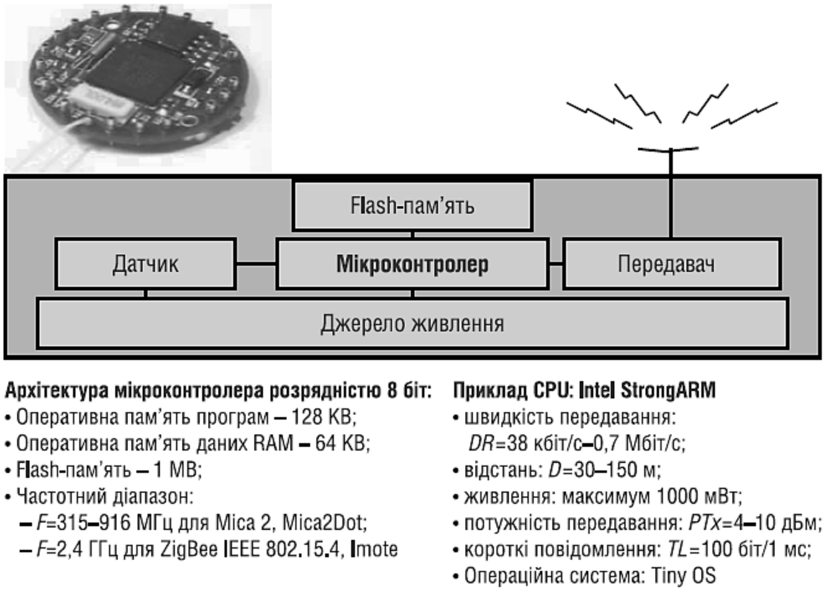

Fig. 2. Model and parameters of the wireless sensor

In most pockets, microcontrollers installed in nodes are implemented in 8-bit Harvard architecture with an average RAM (128-Kb) and 64 kb data. For the most part, the transmission frequency is in the range of F = 315 ... 916 MHz (Mica2, Mica2Dot) or F = 2.4 GHz (ZigBee IEEE 802.15.4, Imote). The data transfer speed of DR is usually small and ranges from 38 kBits / s to 0.7 MB / s. The radius of the sensor is in the range of 30 to 150 m. The energy consumption is determined by the sensor operation phase and is up to 1,000 mW for data transmission and reception, 100 mW for Idle Mode and up to 0.05 mW for partial mode Sleep Mode. The average transmit power is PTx = 4-10 dBm. To provide Real Time Requirements in the WSN automation outings, only short messages that are called telegrams are allowed (TL ~ 100 bits) with relatively small headers (overhead, OH).

Improved accuracy of measurements

When solving many practical problems arising in instrument making, as well as in conducting research, there is a shortage of information due to the nature of the measurement of the function of the state and other factors. The specified deficit is replenished by solving the problems of controlling distributed systems that are part of the Internet of Things network such as mathematical modeling, estimating the state and parameters of stochastic processes, minimizing the number of measuring points and optimizing their location in the spatial domain.

Formulation of the problem. Consider the case of measuring (estimating) the vector information parameter under the influence of the additive interference with the non-Gaussian probability distribution density in the "Internet of Things" sensory network.

The random process selection $X_h = X(t_h)$, $h=1,\ldots,H$, is a mixture of the useful signal $S(\lambda,t_h)$, that carries information about the measurement information parameters $\lambda=\{\lambda_1,\ldots,\lambda_m\}$, and additive generally non-Gaussian noise n_h [1; 3; 4]

$$X(i_h)=S(\lambda, t_h)+n_h.$$

We believe that the results of measurement of mechanical quantities are functions of sufficient statistics and have asymptotic properties of sufficiency, instability and normality, as well as the regularity conditions are fulfilled. We believe that additive interference and measurement parameters are independent.

The task of determining the optimal filtering of the random process of measuring mechanical quantities is to convert a signal ξ to the target as the most accurate reproducing S. The distribution density $p(x/\lambda)$ depends on the vector parameter $\lambda=\{\lambda_1,\ldots,\lambda_s\}$, $p \geq 2$. To obtain a timetable in a power polynomial relative x

$$\ln p_s(x/\lambda) = \int_a^{\lambda} \sum_{i=1}^{s} k_i(t)\left[x^i - m_i(t)\right] dt + c_s(x) \qquad (1)$$

where $c_s(x)$ – he function that does not depend on λ, and for the convergence in x sequence $\{ln\, p_s(x/\lambda)\}$ to the logarithm of the distribution density $ln\, p(x/\lambda)$ at $s \to \infty$ need to $k_i(\lambda)$ are determined from the solution of the system of linear algebraic equations [1]

$$\sum_{j=1}^{s} k_j(\lambda) F_{ij}(\lambda) = \frac{d}{d\lambda} m_i(\lambda), \quad i = \overline{1,s},$$

де $F_{ij}(\lambda) = m_{i+j}(\lambda) - m_i(\lambda) m_j(\lambda)$ $i, j = \overline{1,s}$, $m_i(\lambda)$, $m_j(\lambda)$ – moments. According to the schedule (1), to find the vector parameter, the approximation of the compatible density distribution of independent sample values will have the form

$$p_{sn}(x/\lambda) = exp\left\{\sum_{i=1}^{s} h_{mi}(\lambda) \cdot t_{in} + h_0(\lambda) + c_s(x,\lambda/\lambda_m)\right\} \tag{2}$$

where the notation is introduced:

$$h_{mi}(\lambda) = \int_a^{\lambda} k_{im} dt,$$

$$h_0(\lambda) = n \int_a^{\lambda} \sum_{i=\lambda}^{s} k_i(t) b_i(t) dt,$$

$$t_{in} = \sum_{r=1}^{n} c_s(x_r),$$

But $c_s(x,\lambda/\lambda_m)$ – function independent of the composite vector parameter.

In accordance with the Cramer-Rao theorem, the variance of any unbiased estimation is determined by the inequality [1]

$$G_{\lambda}^2 \geq \left[-m\{d^2 lnW_n(\lambda)/d\lambda^2\}\right]^{-1}, \tag{3}$$

Where $W_n(\lambda)$ – function of plausibility.

We believe that the logarithm of the probability function (LFP) exists and has the form

$$B_n = \ln W_n\{X_h - S(\lambda, t_h)\}, \tag{4}$$

Where $W_n\{*\}$ - There is an additive interference.

To evaluate the accuracy of the measurement of the vector information parameter, we shall consider, for example, the random vibrational processes that occur when the foundation is fluctuating in flexible production systems and frequency measurement - ω, frequency derivative - ω' and phase - φ of the useful signal of the sensors

$$S(\lambda, t_h) = U_{mh} \cos[(\omega + 0{,}2\omega' t_h) t_h + \varphi]. \qquad (5)$$

Let's represent a useful signal (2) $S(\lambda, t_h)$ in the form

$$S(\lambda, t_h) = U_{mh} \cos(\lambda_1 + \lambda_2 t_h + \lambda_3 t_h^2), \qquad (6)$$

де $\lambda_1 = \varphi$; $\lambda_2 = \omega'$; $\lambda_3 = \omega$.

For a measuring signal we define the derivatives:

$$S'_{\lambda i}(\lambda, t_h) = U_{mh} t_h^{i-1} \sin(\hat{\lambda}_1 + \hat{\lambda}_2 t_h + \hat{\lambda}_3 t_h^2); \; i = 1, 2, 3. \qquad (7)$$

In estimating the information parameters for the maximum of the a posteriori density of probability distribution (ASSR), three equations are fulfilled:

$$\frac{d}{d\lambda_1} \ln W_y(\lambda) \Big|_{\lambda_1 = \hat{\lambda}} = 0; \qquad \frac{d}{d\lambda_2} \ln W_y(\lambda) \Big|_{\lambda_2 = \hat{\lambda}} = 0; \qquad (8)$$
$$\frac{d}{d\lambda_3} \ln W_y(\lambda) \Big|_{\lambda_3 = \hat{\lambda}} = 0.$$

References

1. Kvasnikov V. P. Kontseptsiya povirky koordynatno-vymiryuval'nykh mashyn cherez Internet / V. P. Kvasnikov, T. M. Khaeyn // Metrolohiya ta prylady. – 2013 . – №6. – S. 48–53. http://ua.amu.in.ua/journal1
2. Kvasnikov V. P. Nova metodyka rozrakhunku datchyka deformatsiy / V. P. Kvasnikov, T. I. Hanyeva // Vymiryuval'na ta obchyslyuval'na tekhnika v tekhnolohichnykh protsesakh – 2015. - №3 (52). – S. 169-173. http://inmad.vntu.edu.ua/portal/static/41E185F3-5121-491D-84A7-F1E92DE5FB6E.pdf
3. Kvasnikov V.P. Method of measurement of stress in loaded structures / V.P. Kvasnikov, T.I.Ganeva // Scientific and technical journal «Metallurgical and Mining Industry». Founder: «Ukrmetallurginform «Scientific and Technical Agency», Ltd, №7. – 2015. - p. 340-343.
4. Kvasnikov V.P. Rozrobka ta doslidzhennya intelektual'noyi systemy dlya analizu ymovirnisnykh kharakterystyk vypadkovykh protsesiv

mekhanichnykh velychyn / V.P. Kvasnikov, Yu.P. Leshchenko // Tekhnolohycheskyy audyt y rezervы proyzvodstva. – 2015. - № 5/3 (25). – S. 100-102.

5. Ornatskij D.P. Optimizacija analogovogo interfejsa informacionno-izmeritel'nyh sistem dlja distancionnyh izmerenij mehanicheskih velichin / D.P. Ornatskij, V.P. Kvasnikov, A.I. Osmolovskij // Vostochno-Evropejskij zhurnal peredovyh tehnologij. – 2014. – №4 (70). – S. 31-37. http://cyberleninka.ru/article/n/optimizatsiya-analogovogo-interfeysa-informatsionno-izmeritelnyh-sistem-dlya-distantsionnyh-izmereniy-mehanicheskih-velichin
6. Stukhlyak P.D. Teoriya informatsiyi (informatsiyno-vymiryuvalʹni systemy, pokhybky, identyfikatsiya) / P.D. Stukhlyak, O.V. Ivanchenko, A.V. Buketov, M.A. Dolhov / Navchalʹnyy posibnyk. — Kherson: Aylant, 2011. — 371 s.