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Contents

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Research Articles

SENSORDEVICES 2010:

The First International Conference
on Sensor Device Technologies and Applications

July 18 - 25, 2010 - Venice, Italy

IARIA

The inaugural event SENSORDEVICES 2010, The First International Conference on Sensor Device Technologies and Applications, initiates a series of events focusing on sensor devices themselves, the technology-capturing style of sensors, special technologies, signal control and interfaces, and particularly sensors-oriented applications. The evolution of the nano- and microtechnologies, nanomaterials, and the new business services make the sensor device industry and research on sensor-themselves very challenging.

Conference tracks

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Sensor device technologies
Sensors signal conditioning and interfacing circuits
Medical devices and sensors applications
Sensors domain-oriented devices, technologies, and applications
Sensor-based localization and tracking technologies

Important dates

Submission (full paper):	February 20, 2010
Notification:	March 25, 2010
Registration:	April 15, 2010
Camera ready:	April 20, 2010

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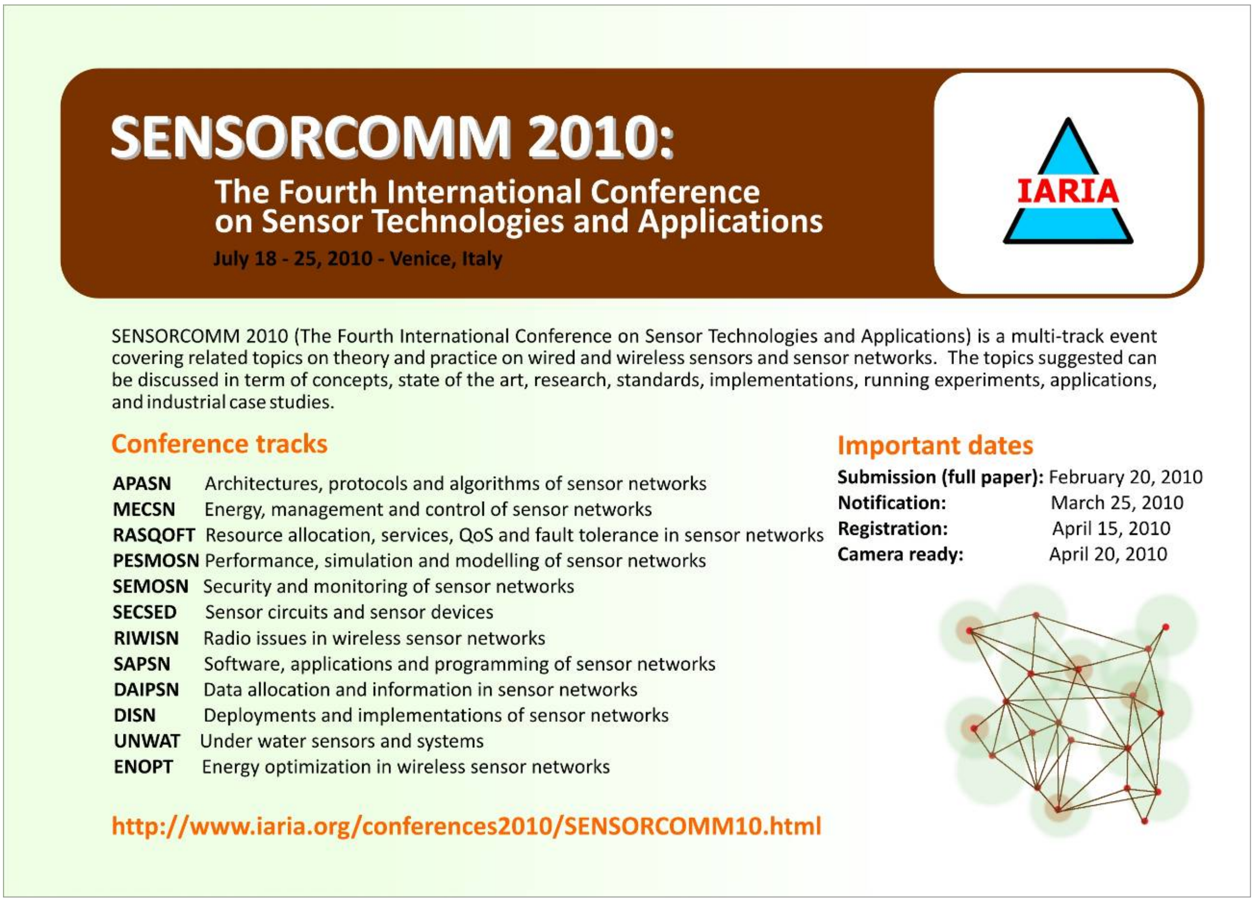

SENSORCOMM 2010:

The Fourth International Conference
on Sensor Technologies and Applications

July 18 - 25, 2010 - Venice, Italy

IARIA

SENSORCOMM 2010 (The Fourth International Conference on Sensor Technologies and Applications) is a multi-track event covering related topics on theory and practice on wired and wireless sensors and sensor networks. The topics suggested can be discussed in term of concepts, state of the art, research, standards, implementations, running experiments, applications, and industrial case studies.

Conference tracks

APASN	Architectures, protocols and algorithms of sensor networks
MECSN	Energy, management and control of sensor networks
RASQOFT	Resource allocation, services, QoS and fault tolerance in sensor networks
PESMOSN	Performance, simulation and modelling of sensor networks
SEMOSN	Security and monitoring of sensor networks
SECSED	Sensor circuits and sensor devices
RIWISN	Radio issues in wireless sensor networks
SAPSN	Software, applications and programming of sensor networks
DAIPSN	Data allocation and information in sensor networks
DISN	Deployments and implementations of sensor networks
UNWAT	Under water sensors and systems
ENOPT	Energy optimization in wireless sensor networks

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Dynamically Functioning Structure and Problem of Measurements of Rapidly Time-Varying Processes: Dream or Reality

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Abstract: It is shown that rapidly proceeding time-varying mechanical processes can change full dynamic characteristics of a measuring transducer, and that many dynamic tests and measurements are based on a changing measurement equation, and that internal and external loads on the same structure may change presentation about the physical structure. Several arguments are considered which may change or increase new vision into dynamic measurements. *Copyright © 2010 IFSA.*

Keywords: Dynamic measurements, ‘Bad’ posed problems, Changing dynamic characteristics of measuring transducer under specific loads, Metering dynamic errors

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1. Introduction: Why Everyone Has to Proceed the Economic Reasons

World industry is undergoing changes in response to global forces of economy. Certainly, industry trends are shaping for a new future- one where high-value, knowledge- intensive, highly- customized products and processes will be the new cornerstones for growth and prosperity [1]. In labor- intensive commodity sectors, industry currently faces substantial competitive and cost disadvantages. To remain competitive and promote growth, the industry must adapt to new challenges and markets demands that require more complex and individually customized products with improved quality, functionality, and performance. New policy initiatives seek to make realistic gains for U.S. manufacturers, while recognizing the budget realities of the federal government. Many believe that our vision for the manufacturing sector - to be sustainable and globally competitive - can be achieved by increasing the return on US public investment dollars by making manufacturing-related federal policies and programs more effective.

What place is taken away for dynamic measurements in hierarchy of economy? It is not an obvious fact that dynamic measurement technologies play one of the preventive roles in the creation of economy. At a time of great technical and economic changes, dynamic measurement technologies are in a position of multiple applications to the real world. Dynamic measurement technologies (DMT) play one of key roles in contemporary stages of boost of economic potential in the world: they determine to a large extent successes and failures. The DMT also play an important role in common structure of creation and the perfecting of new techniques and technologies, metrological provision from creation of models or processes, testing, … to certification of the finished product.

It is important to understand how to organize and carry out the dynamic tests and measurements in order to receive conceptually correct and accurate results corresponding to putting up with the problem. There is a correctly framed problem and optimal well-founded measurement possibilities as one of the ways to reach minimum certainty, identify actual non-linear behaviour of a dynamic structure, or processes.

What is the difference among posed problems? Well in most of cases, one overlooks the methodical component of the metering dynamic errors- this creates a full complex of problems. Often, there is a small cause to pervasive misunderstanding of consequences.

However, the correct approach requires additional expenses for ‘additional’ investigations of methodical correctness of measuring technologies. Main examples are considered in this paper.

2. Background and Problem Definition

The objective in this section is to demonstrate a problem, which is always presented in dynamic measuring technologies for dynamically complicationly functioning structures from aerospace, aircraft, and energetic, as well as machine-building, ship building industry. In reality, a process of destruction is identical physically with some variations. Indeed, generators of influences to structures may be different (it is nonlinearity, quickly- proceeding processes and so on) and destruction takes place at different zones of a structure and displays as different processes, or, so clearly, transmitting medium changes of configuration of characteristics of a measuring channel being by component of a measurement channel, and physical properties delivering different energy as a function of time, as well as penetrates the zones, where a measuring transducer is placed. Consequently, different information on destruction or on a rapidly changing non-linear structure condition acts into a measuring channel of an information-measuring system. Let us mark that an experimenter has to build your conceptions based on understanding of non-linearity and chaotic influences no idealized of a problem. In a real structure, non-linearity and chaos are ordinary natural phenomena and they are very egoistically individualistic. Main sources of non-linearity, on which the conventional paradigm between tests, measurements and analysis of structure behavior are based, are presented in a number of fundamental research endeavors; it may be known for readers. Non-linearity of objects has direct relation to a structure of a measuring channel and to ways of information processing in intelligent smart systems [2].

It is known that an inclusion of some mechanisms of non-linearity generates changes in common dynamics of a structure. Non-linearity gives rise to complex dynamic phenomena, including jumps, bifurcation, and chaos. Any attempt to apply traditional linear analysis is certain to fail. There will be situations where non-linearity, if not accounted for, introduces a threat of a ‘catastrophe’. Why it is to pay attention to written.

The basic setup and compound elements of considered approach are given in Fig. 1.

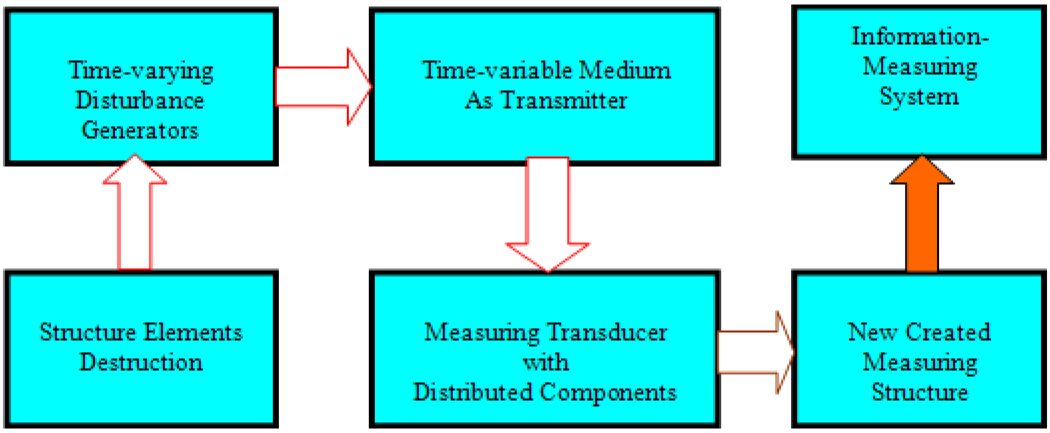

Fig. 1. Structural scheme of physical processes related to measuring procedures.

This demonstrates that such dynamic measurements are not direct. The typical ill-posed problem is, too. Therefore, creation and development of new measuring techniques and technologies requires of development of insight towards fields of knowledge tied to new approaches to dynamic measurements of dynamic processes and behaviour of dynamically functioning structures, or systems such as non-linear, hybrid, time-variations, or distributed dynamic systems. Signal always is. What kind of nature of signal is?

3. Real Approaches to Extraction of Information about Behavior of a Structure: Investigation and Processing

Typically, one aspires to create a measurement system or a measuring channel on the idealized approaches. As a rule, ‘classical’ dynamic information-processing measuring technologies consider sources of disturbances for comparatively stable transmitting medium and for “stable” measuring channels. One bases on knowledge that a measuring transducer and a measuring channel do not change their dynamic characteristics during their relationships with a physical structure or a process. Such vision does not distort the condition of measuring processes (in framework of the concretized accuracy, when information flows do not change).

An unfolded example of dynamic measurements relating to an idealized measuring problem of the considering type is presented in Fig. 2 [3].

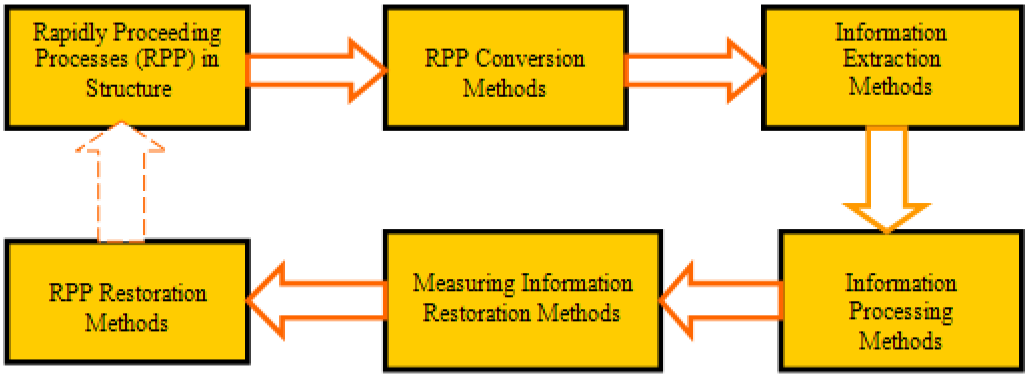

Fig. 2. Block- scheme of information processing for classical measuring solutions.

In development of considered approach, classical measurements of structure reaction or its elements to random excitation are directed to foresee the behavior of a physical structure in other conditions of functioning. This approach is known and is based on understanding of model behavior. It is presented in Fig. 3 [4]:

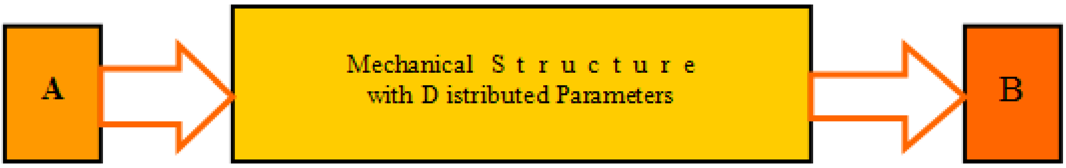

Fig. 3. Scheme of complex testing; **A** is excitation, **B-** Response.

Considered approach was applied as one of the most powerful instruments, which helped to solve numerous problems during several decades.

So called 'random processes' are the oscillations of a physical structure subjected to a shock temporally, and perhaps spatially, randomly varying internal, external dynamic environments. Let us underline, one traditionally assumes that a transmitting medium changes its physical characteristics inessential. Mathematical, physic, and experimental study is particularly important because practically all real physical structures are subjected to random dynamic environments at some time during their lives, and many physical structures fail due to the effects of these exposures. These studies of random processes have historically been pursued to explain observed phenomena, predict the characteristics of structure responses to unrealized environments, aid in the design of mechanical structures and systems, isolate them, and demonstrate the survivability and response character of physical systems. As information-processing or signal processing instrument, spectral density has been the *de facto* fundamental quantitative descriptor of stationary random processes.

Of cause, a comprehensive theory of random excitation and measurements was needed not only to accurately predict structural response but extract information about possible destruction [4]. The possible caveat is that considered approach carries integral appraisal. Many analytical solutions have been used for this class of problems.

It is an obvious observation that different shifts are directed to create and adsorb of information about any processes. In these conditions they cannot give reliable results in spite of all creator efforts of information processing technologies directed to eliminate the root of problem thinness. There is analysis both redistricted and proceeded data when a medium changes its properties, as an example. The dynamic measurements are considered as direct measurements for one measuring channel.

4. Some Particularities of Dynamic Behaviour of Measuring Channel in Medium of Rapidly Time-varying Processes

Methodical peculiarities of the measuring technology for dynamic measurements of complicated time-varying processes and behavior of distributed physical structures are partly based on 'behavior' of the *measurement equation* [5], and partly- on the equation of measuring processes [6]. In simplifying approach, a measurement equation does not change in framework of the setting error. Ideologies of solutions of the measuring problem are known for such event; this is habitual approach and it calls any doubts.

Nevertheless, a measurement equation can change doing of the dynamic metering error by time dependent function. It has not to astonish. Where could it happen? This may occur in a result of interaction of a measuring transducer (MT) with by a part of the dynamically- functioning structure or during dynamic measurements of dynamic processes, as well as to be by a result of changing of dynamics of a functioning structure and it elements, as one of examples- [7]. It is may be a known class of errors and uncertainties, for instance, presented in [8]. As a result, received data do not reflect real behavior of a structure; measuring information does not illuminate it in the result of indirect measurements.

One traditionally may be assured that the calibrated in ideal conditions MT never changes its dynamic characteristics during its applications for investigations of complicated functioning structures with strong nonlinearity and chaos. This is not so. It is not obvious that a measurable physical structure with by *'swimming'* dynamic characteristics may be created. In a real medium, the loads differ from 'ideally' simulated loads. Indeed, a new measuring structure appears. A new measuring structure consists from of the MT and of a part of an investigating structure, and it (a new measuring structure) has *other metrological characteristics* in comporting with by a single MT. One thinks that metrological characteristics of the MT do not change and they are the same as in a result of the dynamic calibration in condition of idealized simulated impact. Therefore, this always does not happen that dynamic measurements can predict the behavior of physical structures and their functioning with a necessary level of accuracy.

The problem of dynamic measurements, when the full dynamic characteristic of the MT changes in fixed environment in dependence with as the MT is located on the structure, is difficult for perception: the new measuring structure may be formed, but, 'what structure'. One of the examples is presented in Fig. 4. Here are presented the results of experimental investigations of accelerometers. Due to a location is limited and high stress rate in the zone is possible, where the accelerometer is placed, however, the accelerometer has to be located in the area where stress's gradient of a process is severe. It is known that a level of acceleration in the zone of its location can reach tens of thousand **g** during in time less then 1.0×10^{-6} s. Here the conditions are considered when gradient of energy flow transfers to different structure elements. As a result, a sort-time metering dynamic error of a measuring channel becomes higher than relative contribution of the changes conditioned by a changing measurement equation. Changing of a measurement equation is motivated by nonlinearity of behavior of the structure, and by changing characteristics of measuring channels. Consequently, this part of metering dynamic error exerts influence.

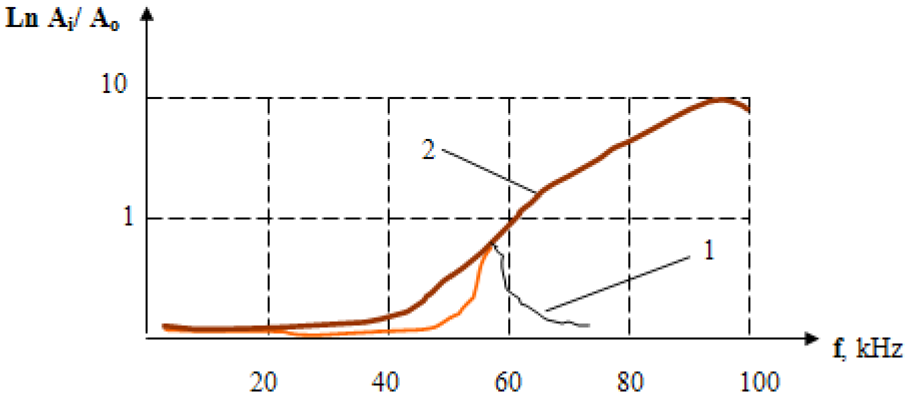

Fig. 4. The accelerometer calibrated characteristic (curve 1) in ideal conditions of simulated impact, and real characteristic of the new measuring structure (curve 2) formed by the accelerometer and by the part of the investigating physical structure (the curve 2 is received from experiments, based on [8]).

This phenomenon has not to astonish everyone from readers; it illustrated in Fig.4 routine error is a result of transformation the accelerometer to the measuring structure having concrete relationships with the investigating physical structure.

Next, it is important to underline that the MT always cannot be and have not to be by the MT with concentrated parameters. Confirming examples are written in [9-17]. In development of understanding of dynamic measurement's particulars, this is expedient to consider a component of the metering dynamic error created by transformation of the ordinary MT to the MT with distributed components and parameters.

As this was shown, the measurable dynamic rapidly time-varying processes change the full dynamic characteristics of the MT. The nature of these changes is stipulated by wave processes, i.e., symbiosis of different wave processes in physical system 'the MT- the Structure'. One implication is that the MT possesses other properties such as the high sensitivity, the wide dynamic range, the high correlation signal/noise, the high reliability, and the ability to operate under difficult conditions. Nevertheless, they have relation to transformation of the MT. As consequence, dynamic characteristics of the MT change. It will be shown below.

There is an obvious fact, the MT receives not only measuring quantity information about occurring rapidly changing processes but also information about other effects, which are physically destabilizing factors: they accompany measuring processes. Altogether, measured quantity and secondary effects influence on the MT, which is a part of a measuring channel and 'use' as an optimal basis in any monitoring, diagnostic, prognosis, and control's systems.

One of the ways is considered to divide information received from a structure on information, which one wants to receive and information generated by secondary effects. The use of mathematical models of the MT as the MT with distributed components and parameters, when wave effects are taken into consideration as real factor, gives possibility to do it. For example, the solution of the problem can be realized in the form of traveling or standing waves. For one of types of piezoelectric sensors, the solution is given in [9].

In Fig. 5, one of results of interaction of the piezoelectric sensor and of the process is shown. Thus, the full dynamic characteristic of the piezoelectric sensor changes in conditions when the piezoelectric sensor gets by the MT with distributed parameters or components.

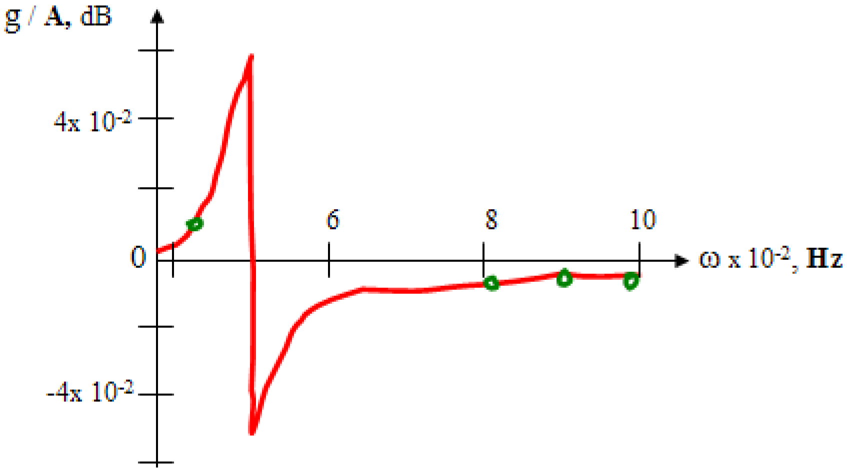

Fig. 5. A calculated amplitude- frequency characteristic of the MT: the circles represent the experiment data [9]. The **A** is the response of the piezoelectric sensor.

The piezoelectric sensor operates in the semi- resonance mode under aforementioned conditions. As one of examples, illustrating how the model of the MT is optimized, is considered in [11, 14] and shown in Fig. 6; here also is reflection of the information flow during successive steps. Such work contributes analysis-test correlation and model validation as well as assesses efficiency of metrics for analysis-test correlation. Users of measurement technologies can utilize software packages together as tools for analysis of regarding problem, see [14] as example where is such offering.

Several examples of interaction between the MT and the measurable structure are presented in [15]. Analysis of processes proceeding inside of the MT during loading shows that the same low-speed normal pre-loading can evoke different mechanisms reflecting reactions and responses of the MT. A response during the same normal loading may appear as response on the external high-speed loading; traveling wave processes are generators of this effect.

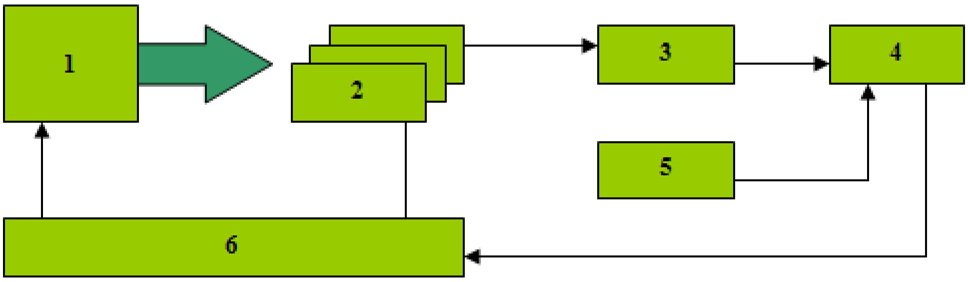

Fig. 6. The steps of measuring problem modeling, analysis and validation: 1- High-accuracy Physics- based MT's Behavior; 2- Measuring Transducer's Models; 3- Analysis for Model Optimization to Receive the Measurement Equation; 4- Test Results Model Correction; 5- Experimental Results; 6- Measurement Channel's Parameter Optimization for Given or Necessary Accuracy.

Physic-based material's (from which the MT is made) behavior plays the main role in conditions, when the level of a deformation in the MT is high during high-strain rate (due to comparatively small amplitude of loading). This is the result of interaction between the MT and a physical structure, as well as physic processes as in zone of contact as internal processes in the MT. There are no relationships the MT- Medium.

Fields of application also include condition based preventive monitoring, diagnostic, prognostics, and failure prevention, and problem of control by different structures, which cannot be solved without extensive knowledge of measuring channel possibilities and limitations. There are included identification of models and their interaction with measurement equations, suitable measurements that should correlate with developing faulty of abnormal behavior of structures, extent ability to diagnose the condition of the structure, its components or processes, and prediction of to the remaining life of the equipment. The solution of named problems requires constant adjusting of a measuring transducer and advanced measurement technologies.

However, many attempts to transfer a solution of problems to 'advanced' signal analysis techniques and technology have not been adapted successfully. It is well accepted: they may seem imperfect from the point of view of understanding of real problems.

Any considered measurements are the 'bed' measurements when conditions, in which were realized the measurements and calibration's conditions are different.

5. Conclusion

As a summary, such complicated symbiosis consisting: time-varying generators, the time-varying transmitting medium, new metrological characteristics of a measuring channel created by experiments, new measuring structures, which are by a result of dynamic interaction between a measuring transducer and a part of structure, as well as a measuring transducer as an element of a measurement channel with distributed parameters are reality.

Presented analysis does not claim that it gives exhaustive answers (only provides examples which have direct relation to practical application). Presented results confirm as it is to know all procedures of the transformation ideally- calibrated measuring transducer to the new measuring structure with characteristics which may be by the result of relationship with both a investigated dynamically-functioned time-varying physical structure and of dynamic processes. Current consideration does not affect all fields of dynamic measurements, in which a calibrated measurement transducer keep the same characteristics and in conditions it application.

The results of work can be used for solutions of metrological problems as well as for engineering applications from aerospace, automotive, machine tool, ship building, and engine industries, preventing monitoring to protect of the users from a number of inaccuracies, which could be by the basis for practical decisions including a creation of intelligent systems. They may be by a part of information processing procedures, and may use for an analysis of correct experiments.

Analysis showed as it is to understand and correctly use regarded in the paper physic differences which are specific for this class of dynamic measurements. It is important to understand how to organize and carry out the dynamic tests and measurements in order to receive conceptually correct and accurate results corresponding to putting up with the concrete problem. The question is about correctly framed problem and optimal well-founded measurement possibilities as one of the ways to reach minimum certainty and error identify actual non-linear behavior of dynamic structures, or processes.
Be careful sometimes something may happen.

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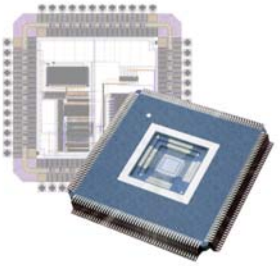

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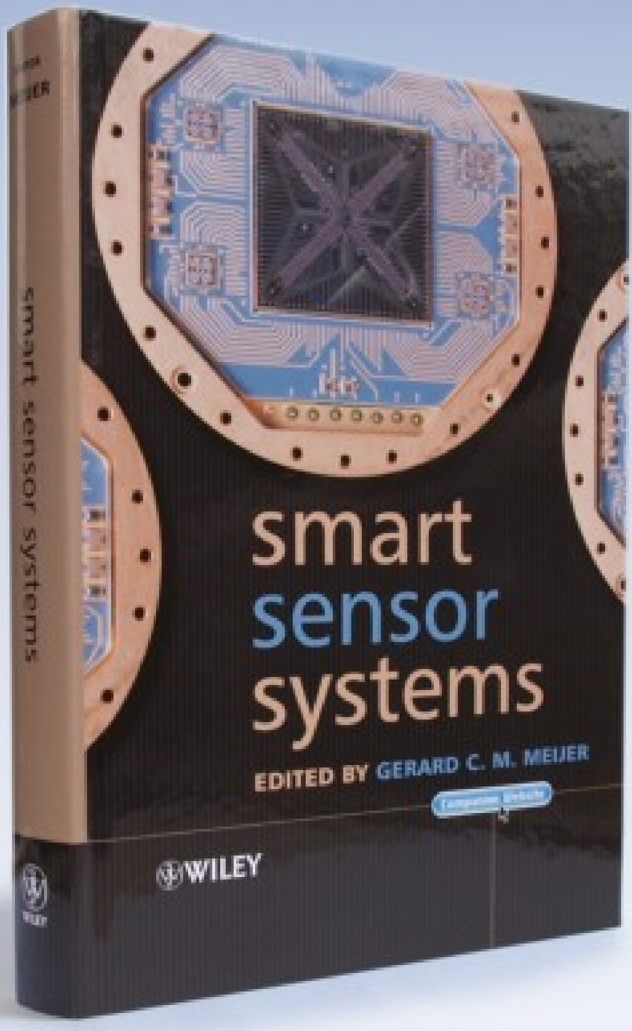
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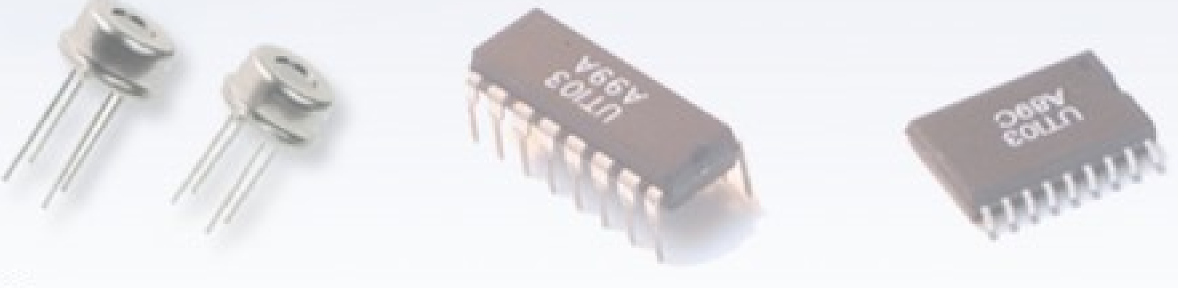
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