Models and Resources for Analysis and Accuracy of Instruments for Measurement of Parameters on Moving Objects

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Abstract - **In the report are presented basic models, which are supposed to investigate of dynamical error, mistakes by measuring devices, determent parameters of movable objects. Developed are schemes and settlements for experimental determination of basic characteristics of dynamical error. By virtue of package Sim-Mechanics from the program complex Matlab and on the base of developed structural schemes are modulated necessarily mechanical systems for theoretical investigation of dynamic accuracy. Structural schemes is presented, stend apparatus for investigate metrological accuracy of measuring instruments was used. On the base of structural schemes was developed. Software for automatically engineering projects Solid-Works was used. Consumer user interface was involved for connection are complete in LabVIEW domain.**

Keyword s- **imitation model, modeling, dynamical error.**

I. INTRODUCTION

The contemporary stage in development of the measuring techniques is characteristic with the fast transition of instruments, measuring static quantity to measuring devises, reacting to dynamic of real quantities. Measurement of quantity in the proper dynamic gives the possibility to measure better to determine characteristics of the quantity, in there to dynamic and to establish more-considerable properties and condition of the objects.

All that require though established of the measuring resources and methods of measuring in two directions. The first is connected with the development of new measurement instrumentation like technical modules possessing broad early convenience at the first opportunity for following and measuring its dynamics. In the contemporary, that direction is extremely and developed extremely, rapidly, thanks to the nanotechnology, microprocessors and computer technique. The second direction is connected with improving accuracy of measurement. The improving of that indicator is increasing reliability of the results, give possibility for precise management and control of the processes. The quantity indicator of the accuracy of measurement is the total error, accented in the measurement process.

The basic share by formation of the recapitulation of the error is occupied from the dynamic component. The last is a consequence of operation, plenty of factories, but not all of them are connected with the coordinate of the time. For example, inertial component of dynamical error is owed to the second derivate of measured quantity or perplexity influences against the time.

Theoretical and experimental investigation of the dynamical error is connected with rank of difficulty. From one side to the present moment do not exists sufficient etalons for measurement for measuring of dynamical quantity, from anode- theoretical argumentation of the dynamical error do not response to the contemporary request in the engineering science and need of perfection. In that direction is the purpose of the present work, namely to present the basic structures scams for analysis of the dynamical error, its programs models for theoretical investigation, to produce measuring apparatus with metrological regulation of standards, with normalized indicator for investigation of dynamical accuracy characteristics by measuring instruments and system for measuring of kern and different on ships' vessel.

II. STRUCTURAL SCHEMES FOR INVESTIGATION OF THE DYNAMICAL ERROR

In the ground of theoretical and experimental investigation of dynamical accuracy is the pawnbroker's the model of Fig. 1.for formation of the error. On that bases could be create different structural schemas for analysis of dynamical error dependant of the kind of the measuring instrument, characteristics of the transmission function, metrological qualitative and quantitive displayed of the instrument, all-embracing of the exploration characteristics and so forth.

By some cases the more successful use of models with open structural schemes to define and investigation of dynamical error. Such a schema is presented on Fig. 1. The last is a structure on the base on generator for etalon signal. In that case, the metrological chain is relatively short; this diminishes possibly sources of distortion of the signal.

The scheme on Fig. 2 an etalon measuring device is placed on the same condition, to the investigated measuring instrument. By the dynamical measurements, however for small part of the quantities have been created etalon for checking and calibration, which in considerable degree it embarrass the implementation of that scheme.

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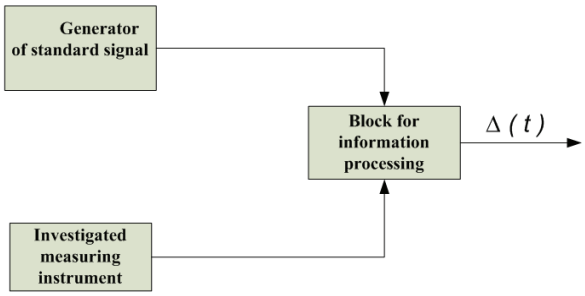

Fig. 1. Open structural schema for generator of etalon signal

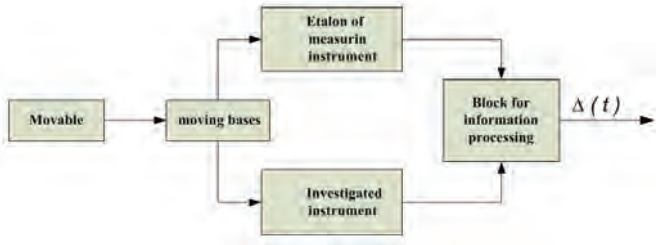

Fig. 2. Structural schema with etalon of measuring instrument

With the development of the micro processing and computer technique, and appearing of programmed instruments like LabVIEW, Matlab as well, which offer broadly possibility for automation of physical investigation, become possible to exceed the limit to closed schemes for determination and investigation of the dynamical error. Those kinds of schemes are shown on Fig. 3 and Fig. 4.

By means the structural schemes from Fig. 3 could be investigated the influence of the constitute of the generalization additive influence *G(t)* on the input of the investigated measuring instrument. For the purpose of foreseeing possibility for moving-on the ground, towards the basic coordinate, diversion from the measured one. By projection of stand apparatus of that kind should realize factual compatibility in constrictive, program and metrological attitude with the compound modules.

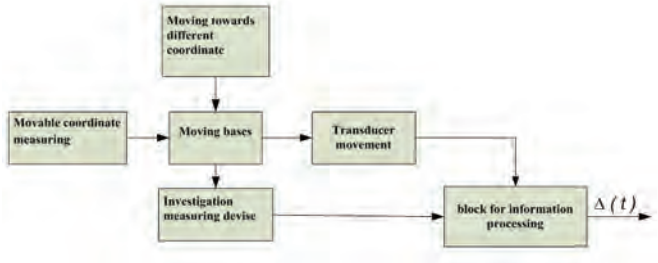

Fig.3. Locked structural scheme

Investigation of the influences on the divergence of nominal sensibility and compatibility of the generalization disturbance *U(t)* the output of the instrument could realise by scheme decision on Fig. 4.

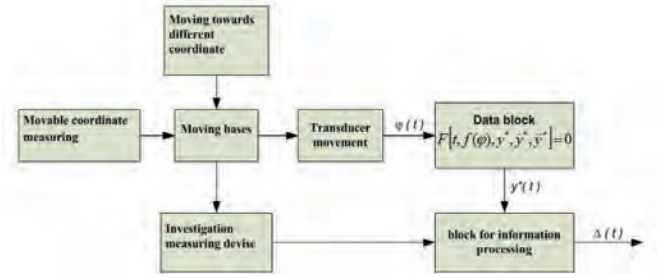

Fig.4. Locked structural scheme with computation block

Computing block is constructed on the base of mathematical model of the measuring instrument. Usually dynamic of the instrument is define by means of non-homogeneous differential equation of the kind of $F\left[t, f(\varphi), y^*, \dot{y}^*, \ddot{y}^*\right] = 0$. The right part of the differential equation is function with generalize coordinate of φ , which is receiving in real time from the transducer, registration shifting of the stand towards measuring coordinate.

III. Modeling of a System for Investigation of the Dynamical Accuracy

The construction and investigation of concrete system for investigation dynamical accuracy is impossibility without mathematical model, adequately decrypting functionality; property and characteristics. The process of constitute the mathematical models simplify to considerably degree with use of such a powerfully contemporary programs complexes lice MatLab.

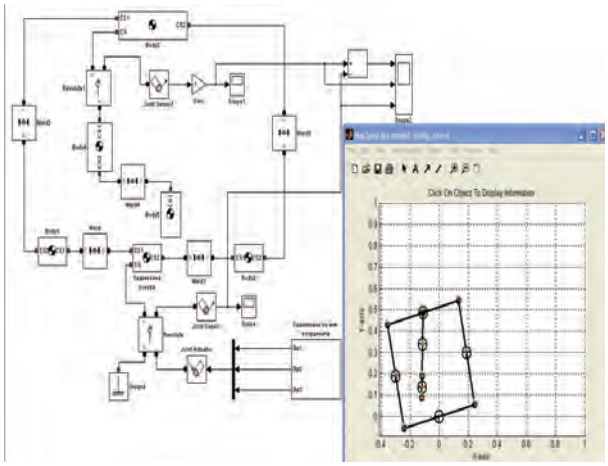

Fig.5. Sim-Mechanics model

In fact, that case it is expressional useful for implication of so cold imitation modeling by introducing SimMechanics package. Imitation model is a formal description of the logic of functionality of the system and interaction of the initial elements in time, give an account the most essential causatively-inquest connection, inherent to the system and ensure conduct of statistical experiment.

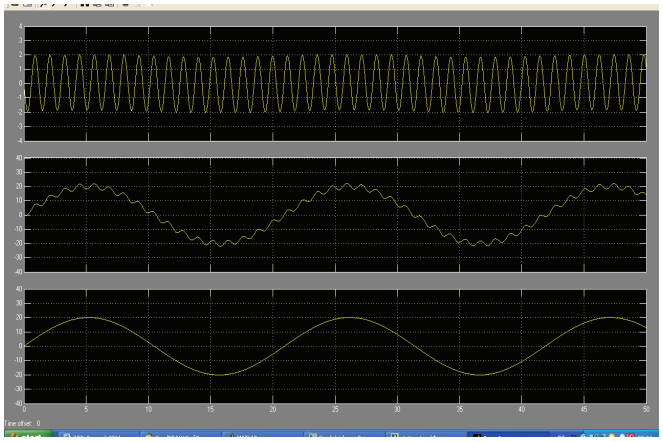

Fig.6. Numerical solutions

IV. Structural Scheme with Etalon Measuring Instrument

Structure schemes is shown on Fig. 7 is developed on the base of defined for this reason, characteristic of the investigated measuring instruments and measured from them physical quantity and structural scheme as well. It is presented in [1] for formatting and investigation of the dynamical error.

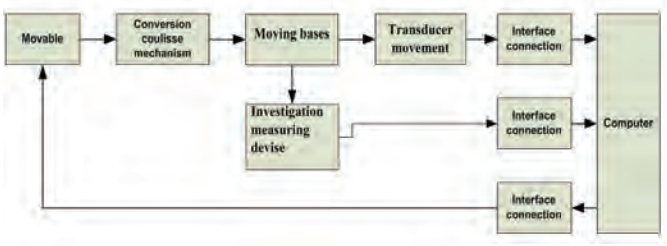

Fig.7. Structural scheme of the stand apparatus

The structural chemes is composed on three channels. The first is used for delivering of etalon information from the stand apparatus, the second is give transmission of devices of measuring information from the controlled measuring instrument, and the third channel is used for control of the parameters from the assignment of parameters from moving of the computer.

By the use of transformed sinus-function of movement on the base was controlled. The stend is following the function of rotation of the input lever, which is connecting with the transmission of the aperture. The transducer for shifting presents measuring scale with nominated metrological pointers, registration the actual angular movement of the base sinusoidal wave with frequency, which ken be given using programmable and amplitude, chancing by transforming module.

V. Apparatus Module of Stand

As far the construction attitude the stend apparatus is divided conditionally in two modules. Apparatus module included mechanical knots and elements, transducer for shifting. The second module was marked as interface and includes the interfaces for connection towards the three informational channels of structural scheme and program insurance as well using the data and to governing of the system.

In fact the constructing implementation of the apparatus module is presented on Fig. 8. By the project of that module, important task for realizing of contracture was realized. Metrological and exploitation compatibility between the initial knots and elements of the module was done.

Constricting compatibility ensure co-ordination with the constrictive parameters and mechanical and mechanical goings of separate knots and elements, by solution of measuring chains as well, influencing on instrumental accurate of the module.

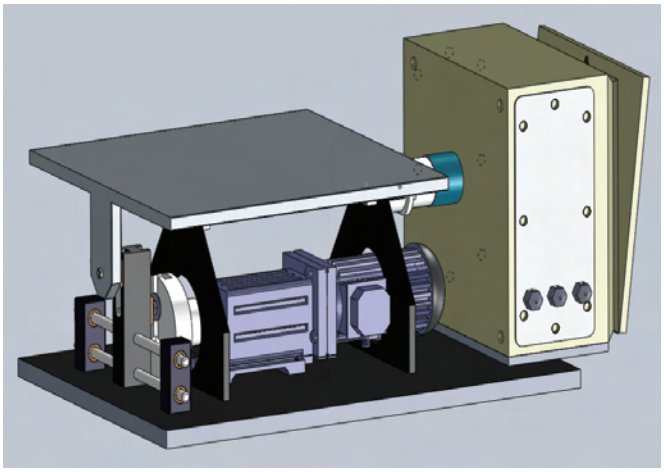

Fig.8. 3D appearance of the stend apparatus

The metrological compatibility includes recessional chose against accuracy precision characteristic and legal regulation of the metrological indicatives between separate knots and elements.

The main goal of metrological point of view by projecting and producing of the stend apparatuses is to reach accuracy, which definite with stipulation the summery error to be les then the hirer one division of the transducer for movement, which should be realize in the stipulation of the metrological compatibly. In the case transducer for movement of photo electrical raster angular transducer with 2500 imp./revolution which allowed after interpolation of 10 000 disserts per revolution.

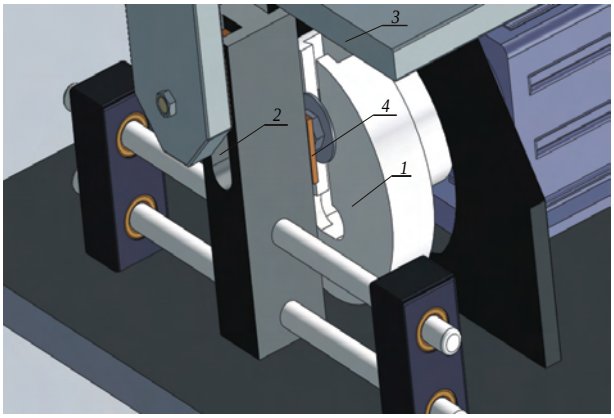

Fig. 9. Transformation block

Transformation block (Fig. 9) is fulfillment in appearance of coulisses mechanism. The last transform rotation movement of the cylindrical eccentric cam-shaft 1 in reflexive-translational movement of the coulisses mechanism 2. The base 3 is connected with coulisses mechanism 2, which formed sinusoidal angular movement on the base. The coulisses stone 4 can be faxed in different positions along the coordinate of the radial channel of the cylindrical eccentric. That gives possibility for change the amplitude of the moving by sinusoidal angular movement.

VI. Interface of Connection and Steer

The control of the stend, measuring of the parameters of investigated instruments was realized by means of the module NI USB-6211, presenting poly-punctually analog to digital devise.

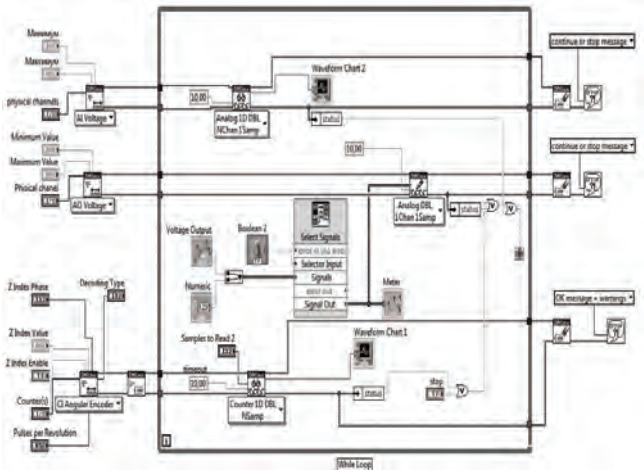

Fig.10. Block scheme of the program

By means of analogue output channel and frequency control the revolution of asynchrony electrical motor and respectively frequency of sinusoidal angular movement of the platform of the stend. Input digital channel is insurance the etalon measurement of angular translation of the base with the use of incremental transducer with 10 000 discretes per revolution. Possibility for include devices with analog output.

The program for control and measuring is realized in the LabVIEW domain, and the block scheme is shown on Fig. 10.

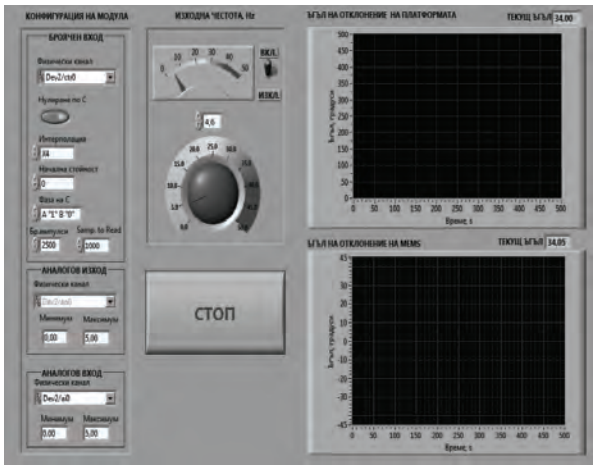

Fig.11. Panel for control and measurements

The Interface was build in effective and visible displaces forms and control elements in format “virtual panel”. The basic panel for control and measurement is presented on Fig.11. With the last one can have additional virtual instruments for information processing. In the use of additional bibliotheca in LabVIEW for analysis of measuring signals are possible.

VII. Conclusions

• Structural schemes of open and closed type for investigation of dynamical error foe instruments measuring are developed.

• By means of the package of SimMechanic is modeling systems for investigation of dynamical error of concrete type measuring devices.

• Theoretical base and imitation models allowed to be obtained optimal quantity of functional parameters to be optimized quantity of function parameters and the apparatus part as well.

• Structural scheme of measuring apparatus for investigated dynamical characteristics of instruments for parameters of movable objects.

• Constructed decision of apparatus module of the stend, for the purpose of software for the automation for engineering projects in Solid Works was done.

• On the base of program in LabVIEW domain and the module NI USB-6211, are realized with interface for connection and control in all three channels.

References

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