Extreme Control at Current Moment

Introduction

It is obvious that all natural events and phenomena (hereinafter - *phenomena*) occur only at the **current time**. And to be absolutely precise - at the current moment in time (hereinafter - **current moment**). No other is given. The values of the parameters that qualitatively and quantitatively characterize the aforementioned *phenomena*, the control goal and the operating characteristics of an industrial facility (hereinafter - *object*) at the **current moment** are constantly changing. Therefore, these *phenomena*, goal and operating characteristics, as well as the parameters characterizing these, are called current.

It is also obvious that the subject controls the *object* at the same **current moment**, when he receives a **set** of current parameters necessary for this control. There is no time to use this **set**. Therefore, the subject controls the *object* at any **current moment** based on the parameters received in the **past time**.

We have created a technology that almost completely compensates for the objective impossibility of applying a **set** of **current parameters** for control at the **current moment**. It is called the **Technology of Forecast Calculation in the PRESENT**[1] (TFCP).

TFCP predicts at the **current moment** the value of each **current parameter** that characterizes the current *phenomenon*. The error in predicting the values of the required parameters at the **current moment** using this technology is an order of magnitude less than the error of the instruments used to measure these.

The study of the set of definitions of the concept of "**optimal control**" has shown that in each case we are talking either about the extremum of any one criterion of control quality, or about a compromise between the extrema of several criteria. And the term "optimal" shows that developers fail to achieve the desired extreme or compromise. We have developed and tested in real multidimensional objects the **Extreme Control Technology** (ECT), which provides extreme modes of their operation.

The Control Action Implementation Technology (TICA) is applied to implement the current control actions at the **current moment**. TICA changes the positions of the executive bodies of the regulators through given speeds. ECT calculates a **set** of trends of these speeds for TICA exactly at the beginning of their execution at the **current moment**.

A new control method has emerged from the merger of TFCP, ECT and TICA. It has been called **Extreme Control at Current Moment** (EC&CM).

EC&CM was developed and tested in real objects in the development of the **Noologistic Control Technology**[1] (NCT). The name NCT is formed using the ancient Greek words νόος - noo (mind) and λογιτσιχη - logistics (the art of calculation).

Brief description of EC&CM

1. Terminology of EC&CM

The terminology of the EC&CM is similar to the terminology of the forecasting theory[3] because its mathematical apparatus and algorithms are borrowed.

Objects have one regulator are classified as one-dimensional control *objects*. An example of a one-dimensional *object* is a heater with a temperature regulator, a pump with a capacity regulator, an electric motor with a speed regulator, a steam turbine stage with a steam extraction regulator, etc.

Multidimensional control *objects* include *objects* consisting of a multiplicity of interconnected one-dimensional *objects*. One-dimensional *objects* are interconnected into a multidimensional *object* by a single technological process. They may be connected to each other in any way, for example mechanically, electrically, hydraulically, chemically, etc. Examples of multidimensional control *objects* are gas supply, water supply, power supply, heat supply grids, chemical plants, and other similar complex objects in all industries.

Current time is an objective process of successive transformation of **future time** into **past time**.

The **current moment** is the objective boundary between **future time** and **past time**, at which all future *phenomena*, goals and actions of the subject, when controlling an *object*, turn into **past** ones.

For comparison: the term "**PRESENT**" in forecasting theory (analogous to the term "**current moment**" in EC&CM) is the moment in time at which the **FUTURE** turns into the **PAST**.

Future time is a single time scale of trends predicted by the subject relative to the **current moment**, including the trends of *phenomena*, goals and actions of the subject in managing the *object*.

For comparison: the term "**FUTURE**" according to forecasting theory (analogous to the term "**future time**" in the EC&CM) is a **set** of expected values of parameters that characterize the *phenomena* at the moments of forecasting time.

A **future moment** in time is a point on a single time scale of trends predicted by the subject relative to the **current moment**, including trends in *phenomena*, goals and actions when managing an *object*.

The **past time** is a unified scale for recording the time of *phenomena* relative to the **current moment**, as well as the goals and actions of the subject, performed while managing the *object*.

For comparison: the term "**PAST**" according to forecasting theory (analogous to the term "**past time**" in the EC&CM) is a **set** of parameter values that characterize the *phenomena* at the **past moments** in time.

The **past moment** in time is a point on a single scale for registering the time of *phenomena* relative to the **current moment**, as well as the goals and actions of the subject, performed while managing the *object*.

The current parameter is the name of a quantity that qualitatively or quantitatively characterizes the rate of change of the parameter at the **current moment**. This concept is absent in forecasting theory.

The **current operating mode** of the *object* is a **set** of values of the **current parameters** that characterize the operation of the control *object* at the **current moment**.

The **current control action** is the value of the rate of forced change in the state of the executive element of the controller of a one-dimensional *object* at the **current moment**. Further - the **control action**.

A **set** is an aggregate of parameter values that completely provides a solution to the control problem by means of EC&CM.

Control in the mode of the current moment is the process of changing the positions of the executive elements of the regulators at the **current moment** in accordance with the trends of **control actions** that correspond to current needs, goals, management experience and to objective *phenomena*. The main content of this process is transformation of:

- the **current parameters** of the subject's needs into the **current parameters** of the management goal;
- the **current parameters** of the subject's needs, goals, environment, management decisions, **control actions**, modes of operation of one-dimensional *objects* - into the management experience;
- the **current parameters** of the environment, performance characteristics of the controlled *object*, goals and experience of management - into the **current parameters** of the management decision;
- the **current parameters** of the management decision - into the **current parameters** of the control actions;
- the **current parameters** of control actions - into the **current parameters** of the operating mode of the *object*.

The rest of the concepts used in this article are special, technical and / or generally accepted. They are described in the relevant literature, dictionaries and instructions for the respective equipment.

2. Main function of TFCP in EC&CM

The main function of TFCP is to calculate the trend of the magnitude of one **current parameter**, characterizing the current *phenomenon*, relative to the **current moment**. This parameter may be the temperature of the atmosphere, its pressure, etc. TFCP calculates this trend sequentially in sections. A universal calculation EC&CM cycle is used for each i^{th} section - see Fig. 1. It is borrowed from the forecasting theory[3]. We applied in EC&CM the usual mathematical apparatus and prediction algorithm used, for example, in EXCEL spreadsheets.

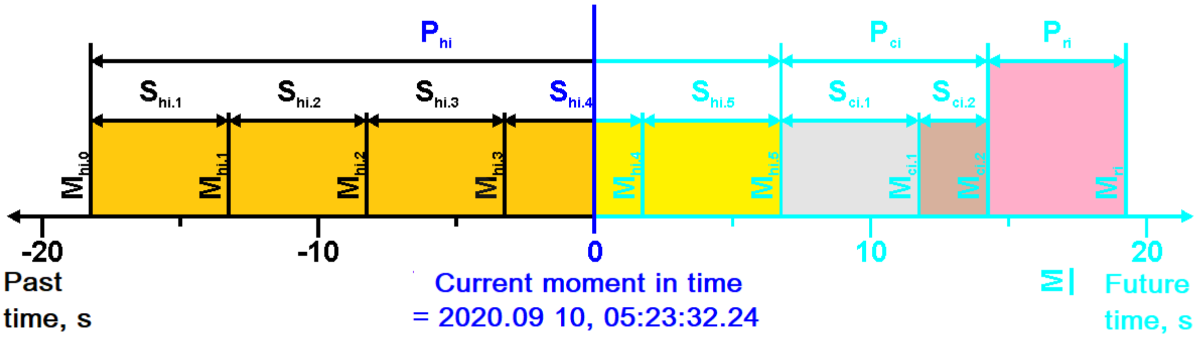

Fig. 1

In fig. 1 the following conventions are adopted:

- The designation 2020.09.10, 05: 23: 32.24 corresponds to the **current time** on September 10, 2020 05 hours 23 minutes 32.24 s.
- Everything that is shown to the left of the **current moment** refers to the **past time**;
- Everything that is shown to the right of the **current moment** refers to the **future time**;
- $\mathbf{S_{hi.1}}$, $\mathbf{S_{hi.2}}$, $\mathbf{S_{hi.3}}$, ..., $\mathbf{S_{hi.j}}$, ..., $\mathbf{S_{hi.J}}$ – these are the steps of forming the history of changes in the value of the predicted parameter;
- $\mathbf{S_{ci.1}}$ is the end of the TFCP cycle. It calculates the trend of the predicted parameter for the period $\mathbf{P_{ri}}$;
- $\mathbf{S_{ci.2}}$ and $\mathbf{P_{ri}}$ - these periods are described in ECT and TICA - see below fig. 2. Their duration is taken into account when calculating the TFCP trend in the $\mathbf{S_{ci.1}}$ period;
- Symbol i in the subscript is the number of the calculated section of the trend;
- Symbol j in the subscript is the step number of the history of changes in the value of the predicted parameter in the $\mathbf{P_{hi}}$ period.

All elements of the cycle shown in Fig. 1 move from right to left in accordance the **current time**. They continuously “flow” from the **future time** through the **current moment** into the **past time**.

The real EC&CM cycle is more complicated than the cycle described above due to the application of verification of the collected information, selection of the best dynamic series from the set of known ones, calibration of calculation results, etc. It provides a forecast error by an order of magnitude less than any device for measuring the values of the corresponding parameter. The duration of the calculation is a fraction of a second. Microchips may be used to implement TFCP. For more details on TFCP, see the book The Noo Logistics[1].

3. Main function of ECT in EC&CM

The main function of ECT is to calculate an extreme **set** of values of control actions to all one-dimensional objects of a multidimensional *object*. This **set** provides an extremum of the total value of a given control criterion in the entire multidimensional *object*. This extremum may be the maximum productivity, minimum costs, minimum CO_2 emissions, etc.

ECT calculates the above set of actions based on the performance characteristics of one-dimensional *objects*, mathematical dependencies and algorithms from the relevant sciences, as well as the parameters of the phenomena, the goal, the allowed modes, etc. The calculation is performed in one step without the use of statistical information, iterations, searching for options and choosing from several solutions. The duration of the calculation is fractions of a second, regardless of the scale and complexity of the multidimensional object, subject to all permitted work limits. Microchips may be used to implement ECT.

ECT calculates the several extreme sets of control action values in parallel, if the control goal states a compromise between the extrema of several criteria. The ECT then establishes a compromise between the extremes in accordance to the goal. ECT is described in more detail in the patent[2] and the book The Noo Logistics[1].

ECT uses trend sections from TFCP in its calculations when it works as part of EC&CM. ECT uses trend sections from TFCP in its calculations when it operates as part of EC&CM. Therefore, the result of the calculation is the sections of trends in the values of control actions on the object. The period of ECT operation in the EC&CM cycle in Fig. 1 is shown by the $\mathbf{S_{ci.2}}$ section. The synchronization of EC&CM cycles each other relative to the **current point** is shown in Fig. 2 below.

4. Main function of TICA in EC&CM

The main function of TICA is to execute an extreme **set** of trends in the values of **control actions** on all one-dimensional *objects* of a multidimensional *object*. TICA controls the synchronous movement of actuators in all controllers for one-dimensional objects. The speed of movement of each of these at the **current moment** corresponds to the trend calculated above using ECT.

TICA cascades the EC&CM cycles from fig. 1 for continuous control - see fig. 2.

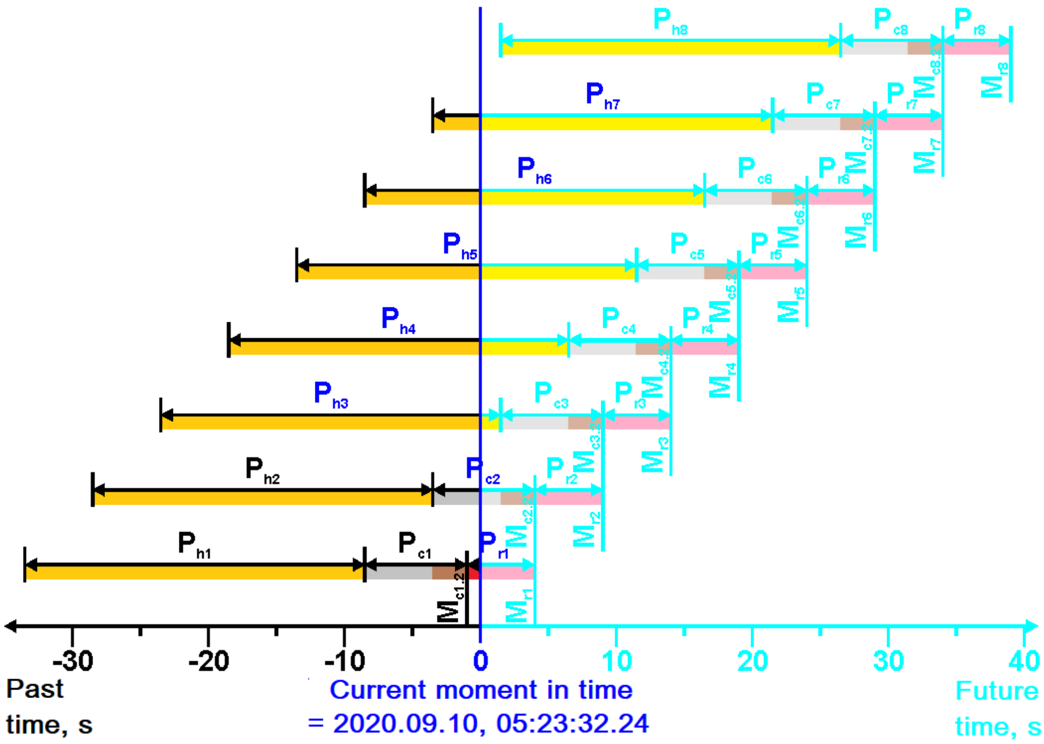

Fig. 2

In fig. 2 the following conventions are adopted:

- the periods of formation by means of TFCP of the history of changes in the values of the parameters characterizing the current phenomena in the **future time**;

- the periods of formation by means of TFCP of the history of measuring the values of parameters characterizing the current phenomena in the **past time**;

- the periods of calculation by means of TFCP of **sets** of trends in the values of the parameters characterizing the current *phenomena* in the **future time**;

- the periods of calculation by means of TFCP of **sets** of trends in the values of the parameters characterizing the current *phenomena* in the **past time**;

- the periods of calculation by means of ECT **sets** of trends in the values of control actions on one-dimensional objects in the **future time**;

- the periods of calculation by means of ECT **sets** of trends in the values of control actions on one-dimensional objects in the **past time**;

- the periods of execution by means of TICA of **sets** of trends in the magnitudes of control actions to one-dimensional *objects* in the **future time**;

- the periods of execution by means of TICA of **sets** of trends in the magnitudes of control actions to one-dimensional *objects* in the **past time**;

the rest - see above.

The **current moment** in Fig. 1 correspond exactly to the **current moment** of the 4th EC&CM cycle in Fig. 2. The remaining EC&CM cycles (1^{st}, 2^{nd}, 3^{rd}, 5^{th}, 6^{th}, 7^{th} and 8^{th}) are synchronized so that the beginning of the next $\mathbf{P_{r(i+1)}}$ period at the **current moment** is the end of the previous $\mathbf{P_{ri}}$ period.

Implementation of TICA is possible by any existing technical means.

Conclusions

This article is the first in the world to describe the method of **Extreme Control at Current Moment** (EC&CM). It combines **Extreme Control** and **Control at Current Moment**.

Extreme Control has undeniable advantages over **Optimal Control** - see our articles **Noologistic Control Technology** and **Boxed software of the Noologistic Control System for multidimensional branch facilities**. And its combination to the Control at Current Moment provides accurate synchronization of the execution of extreme control actions to the current parameters of the goal and objective *phenomena*. In other words, EC&CM provides accurate synchronization of extreme control the *object* to all other processes affecting it at the **current moment**. It is impossible to surpass the accuracy of achieving the set goal by means of EC&CM.

In contrast to the generally accepted exact concept of "current moment of time", the generally accepted exact concept of "real time" does not exist. Therefore, the combination of ineffective **Optimal Control** and inaccurate real time will always be worse compared to EC&CM.

Thus, EC&CM began the era of technologies and systems of **Extreme Control at Current Moment** and ended the era of technologies and systems of **Optimal Control** in real time. Companies that shall persevere product the systems of Real-time Optimal Control run the risk of repeating the fate of Nokia.

[1] Valery V. Matveev, Vladimir V. Matveev The Noo Logistics . – Kaliningrad. 2018. – 440 p.
[2] Valery V. Matveev Gas pipeline regulation method. RF patent No. 1755000 F 17 d 1/00, 1987
[3] Бестужев-Лада И. В. Поисковое социальное прогнозирование: перспективные проблемы общества: опыт систематизации / Москва : Наука, 1984. 271 с.

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