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MUNDARIJA | ОГЛАВЛЕНИЕ | TABLE OF CONTENTS

Muxtarov Farrux Muhammadovich, TARMOQ TRAFIGI ANOMALIYALARINI IDENTIFIKATSIYA QILISHNING STATIK USULI	4-7
Daliyev Baxtiyor Sirojiddinovich, Abelning umumlashgan integral tenglamasini yechish uchun Sobolev fazosida optimal kvadratur formulalar	8-14
Umarov Shuxratjon Azizjonovich, KRIPTOBARDOSHLI KRIPTOGRAFIK TIZIMLAR VA ULARNING KLASSIFIKATSIYASI	15-21
Zulunov Ravshanbek Mamatovich, PYTHONDA NEYRON TARMOQNI QURISH VA BASHORAT QILISH	22-26
Djalilov Mamatisa Latibdjanovich, IKKI QATLAMLI NOELASTIK PLASTINKANING KO'NDALANG TEBRANISHI UMUMIY TENGLAMASINI TAHLIL QILISH	27-30
Erkin Uljaev, Azizjon Abdulkhamidov, Utkirjon Ubaydullayev, A Convolutional Neural Network For Classification Cotton Boll Opening Degree	31-36
Seytov Aybek Jumabayevich, Xusanov Azimjon Mamadaliyevich, Magistral kanallarda suv resurslarini boshqarish jarayonlarini modellashtirish algoritmini ishlab chiqish	37-43
Abdullayev Temurbek Marufjonovich, Algorithm of functioning of intellectual information-measuring system	44-49
Odinakhon Sadikovna Rayimjanova, Usmonali Umarovich Iskandarov, Reaserch of highly sensitive deformation semiconductor sensors based on AFV	50-53
S.S.Radjabov, G.R.Mirzayeva, A.O.Tillavoldiyev, J.A.Allayorov, BARG TASVIRI BO'YICHA MADANIY O'SIMLIKLARNING FITOSANITAR HOLATINI ANIQLASH ALGORITMLARI	54-59
Эргашев Отабек Мирзапулатович, Интеллектуальный оптоэлектронный прибор для учета и контроля расходом воды в открытых каналах	60-65
Xomidov Xushnudbek Rapiqjon o'g'li, Nurmatov Sardorbek Xasanboy o'g'li, Yo'ldashev Bilol Iqboljon o'g'li, O'lmasov Farrux Yorqinjion o'g'li, Konus setkali chang tozalovchi qurilma uchun chang namunalarning dispers tarkibi tahlili	66-69
Akhundjanov Umidjon Yunus ugli, VERIFICATION OF STATIC SIGNATURE USING CONVOLUTIONAL NEURAL NETWORK	70-74
Лазарева Марина Викторовна, Горовик Александр Альфредович, Цифровизация и цифровой менеджмент в современном управлении	75-81
D.X.Tojimatov, KIBERTAHDIDLARNI OLDINI OLIHDA KIBERRAZVEDKA AMALIYOTI VA UNING USTUVOR VAZIFALARI	82-85
Muxtarov Farrux Muhammadovich, Rasulov Akbarali Maxamatovich, Ibroximov Nodirbek Ikromjonovich, Kompyuter eksperimenti orqali kam atomli mis klasterlarining geometrik tuzilishini o'rganish	86-89
Umurzakova Dilnoza Maxamadjanovna, BOSHQARISH QONUNLARINI ADAPTATSIYALASH ALGORITMLARINI ISHLAB CHIQLASH	90-94
Muxamedieva Dildora Kabilovna, Muxtarov Farrux Muhammadovich, Sotvoldiev Dilshodbek Marifjonovich, JAMOAT TRANSPORTI MARSHRUTLARINI QURISH INTELLEKTUAL ALGORITMLARI	95-103
Нурдинова Разияхон Абдихаликовна, Перспективы применения элементов с аномальными фотовольтаическими напряжениями	104-108
Bozarov Baxromjon Pjxomovich, UCH O'LCHOVLI FAZODAGI SFERADAANIQLANGAN FUNKSIYALARNI TAQRIBIY INTEGRALLASH UCHUN OPTIMAL KUBATUR FORMULALAR	109-113
Улжаев Эркин, Худойбердиев Элёр Фахриддин угли, Нарзуллаев Шохрух Нурали угли, РАЗРАБОТКА КОНСТРУКЦИИ И ФУНКЦИОНАЛЬНОЙ СХЕМЫ ПОЛУЦИЛИНДРИЧЕСКОГО ЁМКОСТНОГО ПОТОЧНОГО ВЛАГОМЕРА	114-122
Mamirov Uktam Farkhodovich, Buronov Bunyod Mamurjon ugli, ALGORITHMS FOR FORMATION OF CONTROL EFFECTS IN CONDITIONS OF UNOBSERVABLE DISTURBANCES	123-127
Sharibayev Nosirjon Yusubjanovich, Jabborov Anvar Mansurjonovich, YURAK-QON TOMIR KASALLIKLARI DIAGNOSTIKASI UCHUN TEXNOLOGIYALAR, ALGORITMLAR VA VOSITALAR	128-136
Marina Lazareva, Estimating development time and complexity of programs	137-141
Asrayev Muhammadmullo, ONLINE HANDWRITING RECOGNITION	142-146
Norinov Muhammadyunus Usibjonovich, SPEKTR ZONALI TASVIRLARGA INTELLEKTUAL ISHLOV BERISH USULLARI TAHLILI	147-152
Xudoynazarov Umidjon Umarjon o'g'li, PARAMETRLI ALGEBRAGA ASOSLANGAN EL-GAMAL SHIFRLASH ALGORITMLARINI GOMOMORFIK XUSUSIYATINI TADQIQ ETISH	153-157
D.M.Okhunov, M.Okhunov, THE ERA OF THE DIGITAL ECONOMY IS AN ERA OF NEW OPPORTUNITIES AND PROSPECTS FOR BUSINESS DEVELOPMENT BASED ON CROWDSOURCING TECHNOLOGIES	158-165

MUNDARIJA | ОГЛАВЛЕНИЕ | TABLE OF CONTENTS

Солиев Бахромжон Набиджонович, Путеводитель по построению веб-API на Django - Шаг за шагом с Django REST framework — от моделей до проверки работоспособности	166-171
Sevinov Jasur Usmonovich, Boborayimov Okhunjon Khushmurod ogli, ALGORITHMS FOR SYNTHESIS OF ADAPTIVE CONTROL SYSTEMS WITH IMPLICIT REFERENCE MODELS BASED ON THE SPEED GRADIENT METHOD	172-176
Mamatov Narzullo Solidjonovich, Jalelova Malika Moyatdin qizi, Tojiboyeva Shaxzoda Xoldorjon qizi, Samijonov Boymirzo Narzullo o'g'li, SUN'IY YO'LDOSHDAN OLINGAN TASVIRDAGI DALA MAYDONI CHEGARALARINI ANIQLASH USULLARI	177-181
Обухов Вадим Анатольевич, Криптография на основе эллиптических кривых (ECC)	182-188
Turdimatov Mamirjon Mirzayevich, Sadirova Xursanoy Xusanboy qizi, AXBOROTNI HIMOYALASHDA CHETLAB O'TISHNING MUMKIN BO'LGAN EHTIMOLLIK XOLATINI BAHOLASH USULLARI	189-193
Musayev Xurshid Sharifjonovich, TRIKOTAJ MAHSULOTLARIDA NUQSONLI TO'QIMALARNING ANIQLASHNING MATEMATIK MODELI VA UNING ALGORITMLARI	194-196
Kodirov Ahkhmadkhon, Umarov Abdumukhtar, Rozaliyev Abdumalikjon, ANALYSIS OF FACIAL RECOGNITION ALGORITHMS IN THE PYTHON PROGRAMMING LANGUAGE	197-205
Suyumov Jorabek Yunusalievich, METHODOLOGICAL PROBLEMS OF QUALIMETRY IN CONDUCT OF PEDAGOGICAL EXPERIMENT-EXAMINATION	206-211
Хаджаев Саидакбар Исмоил угли, АКТУАЛЬНОСТЬ ПРОБЛЕМЫ ЗАЩИТЫ ИНФОРМАЦИОННЫХ СИСТЕМ МАЛОГО И СРЕДНЕГО БИЗНЕСА ОТ КИБЕРАТАК	212-217
M.M.Khalilov, Effect of Heat Treatment on the Photosensitivity of Polycrystalline PbTe Films AND PbS	218-221
Тажибаев Илхом Бахтиёрвич, ПОЛНОСТЬЮ ВОЛОКОННЫЙ СЕНСОР, ОСНОВАННЫЙ НА КОНСТРУКЦИИ ИЗ МАЛОМОДОВОГО ВОЛОКОННОГО СМЕЩЕНИЯ С КАСКАДНЫМ СОЕДИНЕНИЕМ ВОЛОКОННОЙ РЕШЕТКИ С БОЛЬШИМ ИНТЕРВАЛОМ, ИСПОЛЬЗУЕТСЯ ДЛЯ ОПРЕДЕЛЕНИЯ ИСКРИВЛЕНИЯ И ПРОВЕДЕНИЯ АКУСТИЧЕСКИХ ИЗМЕРЕНИЙ	222-225
Sharibaev Nosir Yusubjanovich, Djuraev Sherzod Sobirjanovich, To'xtasinov Davronbek Xoshimjon o'g'li, PRIORITIES IN DETERMINING ELECTRIC MOTOR VIBRATION WITH ADXL345 ACCELEROMETER SENSOR	226-230
Mukhammadjonov A.G., ANALYSIS OF AUTOMATION THROUGH SENSORS OF HEAT AND HUMIDITY OF DIFFERENT DIRECTIONS	231-236
Эрматова Зарина Кахрамоновна, АКТУАЛЬНОСТЬ ПРЕПОДАВАНИЯ ЯЗЫКА ПРОГРАММИРОВАНИЯ C++ В ВЫСШИХ УЧЕБНЫХ ЗАВЕДЕНИЯХ	237-241
Saparbaev Rakhmon, ANALOG TO DIGITAL CONVERSION PROCESS BY MATLAB SIMULINK	242-245
Садикова М.А., Авазова Н.К., САМООБУЧЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА, БАЗОВЫЕ ПРИНЦИПЫ РАБОТЫ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА НА ПРОСТОМ ПРИМЕРЕ	246-250
Abduhafizov Tohirjon Ubaydullo o'g'li, Abdurasulova Dilnoza Botirali kizi, DEVELOPMENT OF ALGORITHMS IN THE ANALYSIS OF DEMAND AND SUPPLY PROCESSES IN ECONOMIC SYSTEMS	251-256
Kayumov Ahror Muminjonovich, CREATING MATHEMATICAL MODELS TO IDENTIFY DEFECTS IN TEXTILE MACHINERY FABRIC	257-261
Mirzakarimov Baxtiyor Abdusalomovich, Xayitov Azizjon Mo'minjon o'g'li, BIOMETRIC METHODS SECURE COMPUTER DATA FROM UNAUTHORIZED ACCESS	262-266
Soliyev B., Odilov A., Abdurasulova Sh., Leveraging Python for Enhanced Excel Functionality: A Practical Exploration	267-271
Жураев Нурмахамад Маматович, Системы Электроснабжения Оборудования Предприятий Связи: Надежность и Эффективность	272-276
Rasulova Feruzaxon Xoshimjon qizi, Isroilov Sharobiddin Mahammadyusufovich, OLIY TA'LIM MUASSASALARIDA MUTAXASSISILIK FANLARINI O'QITISHDA MULTIMEDIALI MOBIL ILOVADANDAN FOYDALANISHNING STATISTIK TAHLILI	277-280
Muxtarov Farrux Muxammadovich, Toshpulatov Sherali Muxamadaliyevich, SUN'IY INTELLEKT YORDAMIDA IJTIMOYIY TARMOQ MONITORINGI TIZIMINI YARATISH, AFZALLIKLARI VA MUHIM JIXATLARI	281-285
Sadikova Munira Alisherovna, APPLICATION OF ARTIFICIAL INTELLIGENCE DEVICES IN MANUFACTURING	286-290
Mamatov Narzullo Solidjonovich, Ibroximov Sanjar Rustam o'g'li, Fayziyev Voxid Orzumurod o'g'li, Samijonov Abdurashid Narzullo o'g'li, SUN'IY INTELLEKT VOSITALARINI TA'LIMNI NAZORAT QILISH VA BAHOLASHDA QO'LLASH	291-297

ALGORITHMS FOR FORMATION OF CONTROL EFFECTS IN CONDITIONS OF UNOBSERVABLE DISTURBANCES

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Abstract: this article develops an algorithm for synthesizing a complex-shaped command-tracking system based on modal considerations by compensating for interference signals when there is an effect of unknown unobservable disturbances on the control object. In this case, the control signal is selected in such a way that the output of the object must accurately and inertibly monitor each command signal. By predicting the future character of the object when the state of the system can be measured directly, we can ensure the observation of command signals using linear feedback to the state. Using Cauchy's formula, the matrix obtained by zeroing the co-head due to the galaiions in the equation representing the exact output of the object is an poor-conditioned matrix. A modified Greville's constructive algorithm was used to determine these pseudo-inverse matrices. The structure of the resulting tracking system is built. Its main elements are the identifier of the command signal, the identifier of the interrupts and the state of the object. If the matrices in the identifiers are selected correctly, the system provides high-precision tracking of command signals even in the presence of any interference.

Keywords: non-measurable disturbances, indirect measurement, object condition estimation, combined control systems, and disturbance compensation.

I. Introduction

On the basis of modal considerations, we will consider the synthesis of systems that track commands of complex form in the presence of unknown and unmeasurable disturbances. We consider the unknown disturbance signal and the command signal as the output of some identifiable dynamical system with a known structure and an arbitrary initial state. Then we see a monitoring system for the ideal state, we assume that the ideal state is as follows: we can accurately measure the states of a fictitious (imaginary) dynamic system whose outputs coincide with the interference and command signals at any time, and then we construct the state identity of these dynamic systems, in which the ideal in state formulas, we replace the state with its value, these values are obtained at the output

of the identifier, thereby forming a physically realized construction of the monitoring system.

Let some controlled and identifiable object be represented by the following equations:

$$\begin{cases} \dot{x}(t) = Ax(t) + Bu(t) + \Gamma w(t), \\ y(t) = Cx(t), \end{cases} \quad (1)$$

Where $x(t) \in R^n$ – state vector, $u(t) \in R^m$ – vector of input effects, $y(t) \in R^p$ – vector of outputs, $w(t) \in R^r$ – vector of external disturbances, A, B, Γ, C – invariant matrices. If the outputs of objects are linearly independent, then $rank C = p$. The problem of controlling the object is as follows: the input $u(t)$ should be selected in such a way that the output of the object is equal to the previously given command



signals of size $y(t)$ is equal to the previously given p -sized command signals $y_k(t)$. In addition, it should be possible to provide monitoring of command signals when the object is affected by unknown external interference $w(t)$.

Suppose that the command signal $y_k(t)$ is the output of an imaginary dynamic system

$$\begin{cases} \dot{r}(t) = Rr(t), \\ y_k(t) = Gr(t), \end{cases} \quad (2)$$

it is possible to measure directly where $y_k(t)$. R, G matrices are known, v -dimensional vector $r(t)$ refers to the state of the command process, which can change at any instant of time when the initial conditions change. The external disturbance $w(t)$ appears at the output of the imaginary dynamic system

$$\begin{cases} \dot{z}(t) = Dz(t), \\ w(t) = Hz(t), \end{cases} \quad (3)$$

where $w(t)$ is assumed to be impossible to measure directly, D, H matrices are given, the state of the p -dimensional $z(t)$ vector disturbance process, the initial conditions in (3) are unknown and may change at arbitrary time instants. Here, the functions $y_k(t)$ and $w(t)$ can be continuous due to changes in the initial conditions. (2) and (3) dynamic processes can be used to model many types of realistic interference and command signals.

Control $u(t)$ should be selected in such a way that the output $y(t)$ of the object follows each command signal $y_k(t)$ precisely and without inertia. $y_k(t)$, (2) can occur when there is any interference at the output of the system (3) that the system produces, $w(t)$ cannot be measured. In addition, control $u(t)$ must be physically implemented in the form of feedback on the output, i.e. $u(t) = (y(t), y_k(t))$.

We assume that the state of systems (1), (2), (3) can be directly measured, and we have all the information necessary to predict the future behavior of the object, and thereby define arbitrary good dynamics for tracking command signals using linear feedback on

the state. We can ride. In this case, the control that solves the problem consists of two joiners

$$u(t) = u_n(t) + u_k(t), \quad (4)$$

Where $u_n(t)$ interrupt compensates for the effect of $w(t)$ on the object, and is a command signal when there is no interference $u_k(t)$ and in the absence of interference, the command signal $y_k(t)$ is observed.

II. Methods of evaluation of non-measurable disturbances

We insert object control (4) into equation (1) and using the Cauchy formula put $w(t) = Hz(t)$ in place and exit $y(t)$ the exact expression for can be written as [1].

$$y(t; x_0, t_0, z(t)) = Ce^{A(t-t_0)}x_0 + C \int_{t_0}^t e^{A(t-\tau)}Bu_k(\tau)d\tau + C \int_{t_0}^t e^{A(t-\tau)}[Bu_n(\tau) + \Gamma Hz(\tau)]d\tau \quad (5)$$

So that the output $y(t)$ does not depend on the interference $w(t)$ the last addend in (5) must be zero.

In order to completely eliminate the effect of the disturbance $w(t)$ on the output $y(t)$ of object (1), we find a constant matrix Λ that satisfies the following condition

$$Ce^{A(t-\tau)}[B\Lambda + \Gamma H] = 0 \quad \text{all } t_0 \leq \tau, t \leq \infty. \quad (6)$$

In this case, the display of control will be $u_n(t) = \Lambda z(t)$. From (6), it seems to correspond to:

$$C[\hat{B}, A\hat{B}, A^2\hat{B}, \dots, A^{n-1}\hat{B}] = 0, \quad \hat{B} = B\Lambda + FH, \quad (7)$$

which in turn gives rise to the following system of equations:

$$CA[B\Lambda + \Gamma H] = 0 \quad \text{when } s = 0, 1, 2, \dots, n-1.$$

If we consider the following matrix as well, its degree is equal to n because the pair of identifying matrices is $\{A, C\}$ condition (7) can be written as follows $\text{rank}[W^T, B, \Gamma H] = \text{rank}[W^T, B]$.

we use the following formula to calculate the matrix Λ

$$\Lambda = -(W^T B)^+ W^T \Gamma H + [I - (W^T B)^+ W^T B] Q_\Lambda,$$



here Q_Λ – arbitrary parametric matrix, I – unity matrix, W – n dimensional matrix $W = [C^T, A^T C^T \dots]$.

In the case when the matrix F is not a full-rank matrix, then the problem under consideration is ill-posed. To give numerical stability to the procedure of pseudo-inversion of the F matrix, it is advisable to use the concepts of regular methods [2, 3, 5].

Let's consider some of the most constructive algorithms for determining pseudoinverse matrices [6, 7-14, 15].

Let us define a matrix of size $n \times m$, $F_m = (f_1, f_2, \dots, f_m)$ the columns of which are the vectors f_j , $j = 1, 2, \dots, m$. Using the obvious notation, this matrix can be represented as

$$F_m = (F_{m-1} \quad f_m), \quad m = 2, 3, \dots$$

Pseudo-inversions of the matrix D_1 , are obviously carried out according to the formula

$$F_1^+ = f_1^T / f_1^T f_1$$

To sequentially find the pseudo-inverse matrix D we will use the Greville method [16, 17]. From this we get

$$F_{m+1}^+ = \begin{pmatrix} F_m^+ [I - f_{m+1} k_{m+1}^T] \\ k_{m+1}^T \end{pmatrix},$$

where

$$k_{m+1} = \begin{cases} \frac{(I - F_m F_m^+) f_{m+1}}{\|(I - F_m F_m^+) f_{m+1}\|^2}, & \text{if } (I - F_m F_m^+) f_{m+1} \neq 0, \\ \frac{(F_m^+)^T F_m^+ f_{m+1}}{1 + \|(F_m^+)^T F_m^+ f_{m+1}\|^2}, & \text{in other cases} \end{cases}$$

Accurate compensation of disturbances using control $u_n(t) = \Lambda z(t)$ is suitable even for continuous function when the state of the interrupting $z(t)$ process is known. This condition is appropriate only when it is possible to accurately measure the interference signal.

Now we will pay attention to the problem of assessing the state of systems (1), (2), (3). We believe that it is possible to actually measure only two quantities, the output of the object $y(t)$ and the

command signal. When developing (constructing) the structure of the initial (zero) state adjuster, $x(t)$, $z(t)$, $r(t)$ the state vectors are obtained from the output of the identifiers, the ideal and only the measured quantities $y(t)$, $y_k(t)$ found using information about the optimal values, $\hat{x}(t)$, $\hat{z}(t)$, $\hat{r}(t)$ replacing (in the ideal case) the dynamic system as desired selection allows to build a monitoring system that can be put into practice For simplicity, we use state-estimating n -dimensional identifiers (Kalman filters). We write down the equations of the identifiers from which the estimate of the state of the object $\hat{x}(t)$ and the value of the state of interference is $\hat{z}(t)$ as follows:

$$\begin{bmatrix} \dot{\hat{x}}(t) \\ \dot{\hat{z}}(t) \end{bmatrix} = \begin{bmatrix} A + L_1 C & \Gamma H \\ L_2 C & D \end{bmatrix} \begin{bmatrix} \hat{x}(t) \\ \hat{z}(t) \end{bmatrix} - \begin{bmatrix} L_1 \\ L_2 \end{bmatrix} y(t) + \begin{bmatrix} B \\ 0 \end{bmatrix} u(t) \quad (8)$$

Where $y(t)$, $u(t)$ – are the actual output of the object and the actual input to (1), respectively. We assume L_1 , L_2 matrices are chosen so that the value $[x(t), z(t)]$ and grade $[\hat{x}(t), \hat{z}(t)]$ let the difference between asymptotically approach zero: $[\varepsilon_x(t), \varepsilon_z(t)]^T = [x(t), z(t)]^T - [\hat{x}(t), \hat{z}(t)]^T \rightarrow 0$ if $t \rightarrow \infty$.

III. Condition assessment error.

The state estimation error equation has the following form:

$$\begin{bmatrix} \dot{\varepsilon}_x(t) \\ \dot{\varepsilon}_z(t) \end{bmatrix} = \begin{bmatrix} A + L_1 C & \Gamma H \\ L_2 C & D \end{bmatrix} \begin{bmatrix} \varepsilon_x(t) \\ \varepsilon_z(t) \end{bmatrix} \quad (9)$$

Since the pairs of matrices $\{A, C\}$ and $\{D, H\}$ are identifiers, it is possible to choose the corresponding matrices L_1 , L_2 in such a way that the desired dynamics can be achieved, ensuring that the error of the identification state tends to zero. The following formulas can be used to construct the physically constructible state identifier $r(t)$ from the dimensions $y_k(t)$:

$$\dot{\hat{r}}(t) = [R + NG] \hat{r}(t) - N y_k(t), \quad (10)$$



where, R, G (2) is given in, N – is the matrix, which provides the rate of error tending to zero, which is chosen by the designer. The estimation error $\varepsilon_r(t) = r(t) - \hat{r}(t)$ satisfies the following equation:

$$\varepsilon_r(t) = [R + NG]\hat{\varepsilon}_r(t). \quad (11)$$

$t \rightarrow \infty$ da $\varepsilon_r(t) \rightarrow 0$ the matrix can always be chosen since the pair is identifiable if the dynamic of the pursuit is given.

Let's copy and write the equation of the observing system that can be physically implemented.

To do this, we replace the $u_n(t) = \Lambda z(t)$, $u_k(t) = K_1 x(t) + K_2 r(t)$ in the $\{z(t), x(t), r(t)\}$ formulas with their values $\{\hat{z}(t), \hat{x}(t), \hat{r}(t)\}$ and create a physically implemented control with the following appearance:

$$\hat{u}(t) = u_n(t) + u_k(t) = \Lambda \hat{z}(t) + K_1 \hat{x}(t) + K_2 \hat{r}(t). \quad (12)$$

It can be shown that this control is actually a control that allows monitoring the signal appearing at the output of (2). In this case, we consider the dynamic behavior $\varepsilon_y(t) = y_k(t) - y(t)$ of the actual error of observation in the control (12) in the presence of arbitrary external disturbances produced by the system (3). For this, we put (12) into (1) and from the following expressions:

$$\hat{x}(t) = x(t) - \varepsilon_x(t),$$

$$\hat{z}(t) = z(t) - \varepsilon_z(t), \quad \hat{r}(t) = r(t) - \varepsilon_r(t),$$

using we get the following:

$$\dot{\hat{x}}(t) = [A + BK_1]x(t) + [B\Lambda + \Gamma H]z(t) + BK_2 r(t) + B[\Lambda \varepsilon_x(t) - K_1 \varepsilon_x(t) - K_2 \varepsilon_r(t)] \quad (13)$$

When a real object is affected by perturbations $w(t)$ and it is controlled in the form of feedback (12), the movement of the object is described by equation (13). Using the above, it is possible to consider the change of state variable $\zeta(t)$ given by expression (10).

Using (13), the equation for $\zeta(t)$ will have the following form:

$$\dot{\zeta}(t) = [A + BK_1]\zeta(t) - Vr(t) - \hat{B}z(t) + B[K_1 \varepsilon_x(t) - K_2 \varepsilon_r(t)] \quad (14)$$

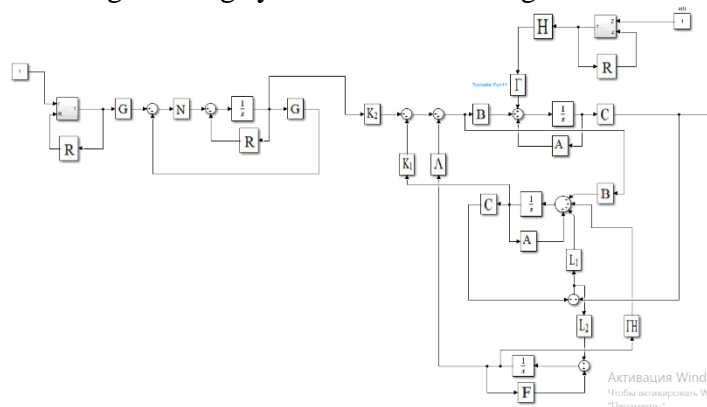
If the, K_1, K_2, N matrices in the identifiers are chosen correctly, the errors, $\varepsilon_x(t), \varepsilon_z(t), \varepsilon_r(t)$ tend to zero, and the variable $\zeta(t)$ (2) jumps of the system between the initial conditions can be determined from the following formula:

$$\dot{\zeta}(t) = [A + BK_1]\zeta(t) - Vr(t) - \hat{B}z(t),$$

this is exactly consistent with equation (13).

IV. Conclusion

Therefore, the error asymptotically approaches zero, which means that the system provides high-precision tracking of command signals even in the presence of any disturbances. The structure of the resulting tracking system is shown in Fig. 1.



Its main elements are the identifier of the command signal, the identifier of the interrupts and the state of the object. The developed algorithms make it possible to synthesize a system that monitors complex commands based on modal considerations by compensating interference signals when there is an influence of unknown (unobservable) noises on the control object.

References:

1. Glad, T., & Ljung, L. (2000). Control Theory (1st ed.). CRC Press. <https://doi.org/10.1201/9781315274737>.
2. Strojic V. State Space Theory of Discrete Linear Control. IEEE Transactions on Systems, Man, and Cybernetics. Publisher: IEEE, 1982.
3. Simagina. O.V. Control theory: textbook, Novosibirsk: SibAGS publishing house, 2014.-135 p.
4. Afanasyev V.N. "Control of indefinite dynamic objects", Moscow, Fizmat-ref, 2008. – 208 p.



5. Ogarkov M.A. Methods of statistical estimation of parameters of random processes. Moscow, Energoatomizdat, 1990. 208 p.
6. Filtering and stochastic control in dynamic systems. / Ed. K. T. Leondes Trans. from English, - M.: Mir, 1980. - 407 p.
7. Pelzverger S.B. Algorithmic support of assessment processes in dynamic systems under conditions of uncertainty. -M.: Nauka, 2004. - 116 p.
8. Mamirov U.F. Regular synthesis of adaptive control systems for uncertain dynamic objects. – Tashkent: Publishing house. "Knowledge and intellectual potential", 2021. –215 p.
9. Karabutov N.N. Structural identification of static objects. -Librocom. 2011 -152 p.
10. Mamirov U.F., Azamkhonov B.S. Algorithms for stable estimation of parameters and state of nonlinear control objects // Scientific-technical journal (STJ FerPI, FarPI ITZh, NTZh FerPI, 2020, T.24, special issue No. 1). –P.274-278.
11. Kisenkova N.A., Joint estimation of object parameters and statistical characteristics of non-Gaussian disturbances, Avtomat. and Telemekh., 1991, issue 11, 71–80.
12. Mamirov U.F., Buronov B.M. Systematic analysis of methods of control of dynamic objects in conditions of non-measurable disturbances // Chemical technology control and management. 2023, No. 4 (112) pp.49-63.
13. Igamberdiev Kh.Z., Kholkhodzhaev B.A., Mamirov U.F. Formation of stable algorithms for estimating unknown input signals in dynamic control systems // Journal of Technical Sciences and Innovation. Tashkent. 2019. No. 1. -WITH. 63-67.
14. F.R.Gantmaher, "Matrix theory", Moskva, Nauka, 1988, 552 p.
15. James W., Demmel, "Applied numerical linear algebra", Berkeley, California, University of California, 1997, 184p.
16. V.M.Verzhbitsky, "Computational linear algebra", Moscow, Higher School of Economics, 2009. 351 p.
17. A.I.Zhdanov, "Introduction to methods for solving ill-posed problems", Samara, Aerospace University, 2006, –87 p.
18. Ch.Lawson, R.Henson, "Numerical solution of problems in the method of least squares", 1986, 232 p.
19. Yusupbekov, N.R., Igamberdiev, H.Z., Mamirov, U.F.: Adaptive Control System with a Multilayer Neural Network under Parametric Uncertainty Condition. In: Russian Advances in Fuzzy Systems and Soft Computing: selected contributions to the 8-th International Conference on Fuzzy Systems, Soft Computing and Intelligent Technologies (FSSCIT-2020), Vol. 2782, pp. 228-234. [CEUR Workshop Proceedings](http://ceur-ws.org/Vol-2782/paper_32.pdf), Aachen, Germany. doi: http://ceur-ws.org/Vol-2782/paper_32.pdf.

