International Journal of Mechanical Engineering and Applications
2015; 3(3-1): 34-39
Published online April 11, 2015 (http://www.sciencepublishinggroup.com/j/ijmea)
doi: 10.11648/j.ijmea.s.2015030301.16
ISSN: 2330-023X (Print); ISSN: 2330-0248 (Online)

A Statement of Problems of the Ship Control in the Head-on Navigation

Nguyen Xuan Phuong[1], Vu Ngoc Bich[2]

[1]Faculty of Navigation, Ho Chi Minh City University of Transport, Ho Chi Minh city, Vietnam
[2]Department of Science Technology – Research and Development, Ho Chi Minh City University of Transport, Ho Chi Minh city, Vietnam

Email address:
Phuongnx1968@gmail.com (N. X Phuong), vubich@hcmutrans.edu.vn (Vu N. B.)

To cite this article:
Nguyen Xuan Phuong, Vu Ngoc Bich. A Statement of Problems of the Ship Control in the Head-on Navigation. *nternational Journal of Mechanical Engineering and Applications.*Special Issue: Transportation Engineering Technology — part II.
Vol. 3, No. 3-1, 2015, pp. 34-39. doi: 10.11648/j.ijmea.s.2015030301.16

Abstract: Navigation is an object of control. The studies are effect when they have found the features of vessels and given the navigation technologies and control algorithms. This paper devotes the statement of problems of the control by a meeting of movements on a sailing vessel.

Keywords: Head-on Navigation, Interaction of Vessels, Mathematical Models of Vessel

1. Introduction

Now in Vietnam, certain work on increase in depths of waterways in connection with growth of load-carrying capacity and deposits of transport units is spent. The Uniform deepwater system of Vietnam where the guaranteed depth makes from 4 to 4.5 m.Now is created the question on use of the given system by foreign port and in particular by the countries of Indochina peninsula for transportation of cargoes to Cambodia, Thailand, Laos, Myanmar and China and back is solved [3, 4].

Despite this, the dimensions of the waterway to secure the effective and positions do not meet modern traffic requirements. High saturation trails transport vessels, geometric dimensions are comparable with the dimensions of the fairway, leading to a decrease in bandwidth and hence delays in the delivery of goods to the recipient, or in the worst cases, more accidents and therefore to loss of life or damage to these goods.

All this required the crews more serious qualification on the basis of current knowledge, the best psychological and physical capabilities.Under these conditions, necessary studies aimed primarily at ensuring safety, increase productivity in water transport on the basis of resource and accurate schedules.Studies will be effective when they will be opened previously unknown characteristics of ships, ship power plants (SPP) , proposed new motion technology and EMS work and new algorithms for their control [2, 5, 11].

2. Interaction of Vessels in Navigation

In the environment from which the given concrete vessel co-operates, there can be similar vessels, channels, sluices, ports, dispatching device [6, 7, 10]. Such set of co-operating systems forms super system, having the functional, morphological and information description. The behavior of given own vessel is defined by operation modes of its diesel power installation (DPI), the movement purpose, criteria of control and restrictions. For own vessel in formed system the purposes, criteria and restrictions which are set by the system which is at higher hierarchical level are defining.

For this purpose we will break the systems entering interactions among themselves, into two classes. To the first class we will carry those which co-ordinates practically do not change in time. Coastal radar stations, channels with the central posts of management (CPM), CPM port, filling stations, CPM a ship canal, natural both artificial waterways and etc. can be them. To the second class we will carry the systems which co-ordinates change in time. Those are, first of all, transport vessels, passenger vessels, vessels of technical fleet [6, 7, 9].

Let's consider most often meeting variant at vessel movement on the channel having some subpart (channels) when vessel traffic control is consecutive or it is simultaneously carried out by dispatchers of channels. On a vessel the information on the input beginning - an exit in the channel (from the channel), transition time from one of its subpart to another, operation modes DPI on separate sites of the channel depending on swimming conditions is given [10, 11, 15].

Various variants represent interaction of ship complexes for traffic conditions in a system, for example, on artificial waterways under the set schedule, behind a tow, a vessel - the pilot for pushing conditions one pusher some barges, to movement coupled side by side courts [5].

The considered variants of interaction of systems are connected directly with a meeting of movements of moving objects; interaction will be possible, if some parameters of their movements coincide. For example, speeds of longitudinal movement will be leveled, coincidence of a direction of movement is provided, objects can be in zones of mutual radar-tracking supervision and a radio communication, and objects can be in immediate proximity from each other. Besides meetings of movements are possible in our understanding for mobile object with motionless when the mooring problem, locking, an input in an operative range of radar station, an input in a zone of work of radio stations dares.

In the course of a meeting of movements following problems of control and operation can be solved: passage of channel to the limited water spaces, fuelling and refueling for ship power installations, acceptance aboard the foodstuffs, potable water, transfer of cargo from one transport unit on another, rendering assistance to a vessel suffering disaster, maintenance of radar-tracking conducting of a vessel on artificial waterways [2, 5, 11].

3. Mathematical Models of Vessel in Head-on Navigation

The differential equations widely known in a general view in hydrodynamics of a vessel are put in a basis of mathematical models of a meeting of movements. The concrete definition of forces operating on a ship complex and the moments, executed further with the help interpolation, has allowed receiving the mathematical models considering action of lateral and longitudinal movement for work DPI [6, 8, 10].

We use following systems of co-ordinates:

Terrestrial - $O^{н}, Z^{н}, x^{н}, y^{н}$

Connected - O, Z, x, y

High-speed- O, x^{0}, Z^{0}, y^{0}

$O^{н}, Z^{н}, x^{н}, y^{н}$ It is possible to consider system inertial as speed of movement of a vessel is much less, than circular speed of the earth.

The equations of a ship complex with DPI will be such:

$$\left.\begin{aligned}
&(m+\lambda_{11})\frac{dU_x}{dt}-(m+\lambda_{22})U_y\Theta_z-\lambda_{26}\Theta_z^2=F_x\\
&(m+\lambda_{22})\frac{dU_y}{dt}+(m+\lambda_{11})U_x\Theta_x+\lambda_{66}\frac{d\Theta_z}{dt}=F_y\\
&(I_z+\lambda_{26})\frac{d\Theta_z}{dt}+(\lambda_{22}-\lambda_{11})U_xU_y+\lambda_{26}U_x\Theta_z+\lambda_{26}\frac{dU_y}{dt}=M_z\\
&(I_i+\lambda_i)\frac{d\omega_i}{dt}=M_{g_i}-M_{c_i},\quad i=1,\dots,n
\end{aligned}\right\}\quad(1)$$

Here such designations are entered:

m - Weight of a vessel;

λ_{11} - The attached weight of water at movement on axis X;

λ_{22} - The attached weight of water at movement on a y axis;

λ_i - The attached moment of inertia of weight of water;

λ_{66} - The attached moment of inertia of water at rotation of a vessel round axis Z;

U_x, U_y - Speeds at movement on axes X and Y;

Θ_z - Angular rotational speed of a vessel round the vertical axis passing through the center of gravity;

ω_i - Angular rotational speed of i_{th} rowing screw;

λ_{26} - The attached static moment;

F_x - Projection of the forces operating on a vessel, to axis X;

F_y - Projection of the forces operating on a vessel, to a y axis;

M_z - The moments operating on a vessel, concerning axis Z;

M_{g_i} - The moment developed by an i-diesel engine;

M_{c_i} - The moment of resistance to i-diesel engine;

I_i - The moment of inertia of rotating parts of i_{th} engine and the screw.

If to accept that vessel contours are symmetric concerning a plane midsection, i.e. concerning plane OXY the size λ_{26} can be neglected [6, 8]:

$$\left.\begin{aligned}
&(m+\lambda_{11})\frac{dU_x}{dt}=(m+\lambda_{22})U_y\Theta_z+F_x\\
&(m+\lambda_{22})\frac{dU_y}{dt}=-(m+\lambda_{11})U_x\Theta_z+F_y\\
&(I_z+\lambda_{66})\frac{d\Theta_z}{dt}=(\lambda_{11}+\lambda_{22})U_xU_y+M_z\\
&(I_i+\lambda_i)\frac{d\omega_i}{dt}=M_{g_i}-M_{c_i},\quad i=1,\dots,n
\end{aligned}\right\}\quad(2)$$

As forces and the moments are considered in high-speed system of co-ordinates their projections to axes of the connected system will be such [6]:

$$\left.\begin{aligned} F_x &= \sum_{i=1}^{n} P_{e_i} + A\sin\alpha - R\cos\alpha \\ F_y &= R\sin\alpha + A\cos\alpha \\ M_z &= M + \sum_{q=1}^{m} M_q + \sum_{i=1}^{n} M_{н_i} \end{aligned}\right\} \tag{3}$$

Where α - a drift corner;

P_{e_i} - i an emphasis of i_{th} screw;

And - force of drift;

R - Force of resistance to vessel movement;

M - The moment of the hydro mechanical forces operating on the case of a vessel concerning axis Z;

M_q - The moment q cross-section force;

$M_{н_i}$ - The moment concerning axis Z, ith rowing screw arising from action.

The moment from q cross-section force is defined so:

$$M_q = \Theta_q l_q \tag{4}$$

Here l_q - distance between an axis ofrudder and the center of gravity.

Equation (1) describes the motion of the ship in the longitudinal and lateral directions. By lateral direction shall mean the rotational motion around the axis Z, passing through the center of gravity and translational movement along axis Y. By longitudinal movement understand translational movement along the axis X.

Ideal lateral movement is possible only if the drift angleequals $+-\frac{\pi}{2}$. If the drift angle is within $|\alpha| < \frac{\pi}{2}$, that occura mixed traffic (lateral and longitudinal). When $\alpha \cong 0$,the longitudinal motion will be occurred.

To use equation (1) in the synthesis of control systems need to define the model. It consists in discovering dependencies forces and moments on the hydrodynamic parameters and the phase variables.

The resistance force of the vessel can be represented as follows:

$$R = R(U, \alpha, \beta, \Theta, \rho, D, \psi) \tag{5}$$

Where

β - Rudder angle as the control action;

ρ - Density of the water;

D - The displacement volume of the vessel;

ψ - generalized parameter characterizing the strength of the wind, currents, depth and width of the fairway;

The force of the drift seems so:

$$A = A(U, \alpha, \beta, \Theta, \rho, D, \psi) \tag{6}$$

Force of i^{th}rowing screw:

$$P_{e_i} = P_{e_i}(U, \alpha, \beta, \Theta, \rho, D, \psi, \omega_i) \tag{7}$$

Moment of hydrodynamic force:

$$M = M(U, \alpha, \beta, \Theta, \rho, D, \psi) \tag{8}$$

Shearing force:

$$\Theta_q = \Theta_q(U, \alpha, \beta, \Theta, \rho, D, \psi, \omega_i) \tag{9}$$

Moment arising from the difference betweenscrewforce and shearing force:

$$M_{н_i} = M_{н_i}(P_i, \Theta_q) \tag{10}$$

Moment developed by i^{th} diesel:

$$M_{g_i} = M_{g_i}(h_i, \omega_i) \tag{11}$$

h_i - Moving of rack of fuel pumps of i^{th} diesel

Resistance moment of rotation of i^{th}screw:

$$M_{c_i} = M_{c_i}(U, \alpha, \beta, \Theta, \rho, D, \psi, \omega_i) \tag{12}$$

Expressions (5 - 12) simplified if the movement of the vessel seen in the fluid with density ρ = constant and unchanged for a selected period of time.

One way to obtain dependencies of forces and moments in an explicit form is the representation of expressions (5 - 12) through one of the defining variables and the corresponding coefficient C and the coefficient is a function of other independent variables. Expressions (5 - 12) in this case will have the following form [6, 8]:

$$R = C_\omega U^2 \tag{13}$$

$$A = C_\alpha U^2 \tag{14}$$

$$P_{e_i} = C_{p_i} \omega_i^2 \tag{15}$$

$$M = C_m U^2 \tag{16}$$

$$\Theta_q = C_q U^2 \tag{17}$$

$$M_{g_i} = C_{d_i} h_i \tag{18}$$

$$M_{c_i} = C_{f_i} \omega_i^2 \tag{19}$$

If the moment which rotates the vessel created by the difference of propeller force, it is determined on the basis of the following formula [6, 8]:

$$M_н^{'} = \sum_{j=1}^{q} P_{e_j} r_j - \sum_{к}^{d} P_{e_к} r_к, \quad q + d = n \tag{20}$$

Where $r_j, r_к$ - the distance between the center plane and *j* or *k* screws.

When the moment generated by the difference screw force and shearing force, then the equation for it is as follows:

$$M_н = \sum_{j=1}^{q} P_{e_j} r_j - \sum_{к}^{d} P_{e_к} r_к + \sum_{i=1}^{n} Q_i l_i \quad (21)$$

Each of the coefficients of (13 - 19) is a function of many variables. These coefficients can be expanded in powers of the independent variables. And as a graphical dependence of the coefficients of the independent variables are sufficiently linear, then the expansion can restrict ourselves to linear terms in the expansion [6, 8, 16]:

$$\left.\begin{aligned}
C_\omega &= C_\omega^o + C_\omega^\alpha \alpha + C_\omega^\beta \beta + C_\omega^\Theta \Theta + C_\omega^\psi \psi \\
C_\alpha &= C_\alpha^o + C_\alpha^\alpha \alpha + C_\alpha^\beta \beta + C_\alpha^\Theta \Theta + C_\alpha^\psi \psi \\
C_\omega &= C_{p_i}^o + C_{p_i}^\alpha \alpha + C_{p_i}^\beta \beta + C_{p_i}^\Theta \Theta + C_{p_i}^\psi \psi \\
C_m &= C_m^o + C_m^\alpha \alpha + C_m^\beta \beta + C_m^\Theta \Theta + C_m^\psi \psi \\
C_q &= C_q^o + C_q^\alpha \alpha + C_q^\beta \beta + C_q^\Theta \Theta + C_q^\psi \psi \\
C_{d_i} &= C_{d_i}^o + C_{d_i}^\omega \omega \\
C_{f_i} &= C_{f_o}^o + C_{f_i}^U U + C_{f_i}^\alpha \alpha + C_{f_i}^\beta \beta + C_{f_i}^\Theta \Theta + C_{f_i}^\psi \psi
\end{aligned}\right\} \quad (22)$$

The index "0" corresponds to the longitudinal movement without lateral movement. Therefore, longitudinal motion for such;

$$C_\alpha^o = C_m^o = C_q^o = 0$$

On the basis of equations (13 - 22), we write the differential equations of motion of the ship in the associated coordinate system:

$$\left.\begin{aligned}
&\frac{dU_x}{dt} = a_1 U_y \Theta_z + a_2 \sum_{i=1}^{n} C_{p_i} \omega_i^2 + \\
&+ a_3 U^2 \sin\alpha + a_4 U^2 \cos\alpha \\
&\frac{dU_y}{dt} = b_1 U_x \Theta_z + b_2 U^2 \sin\alpha + b_3 U^2 \cos\alpha \\
&\frac{d\Theta_z}{dt} = C_1 U_x U_y + C_2 U^2 + C_3 \sum_{q=1}^{m,n} C_q U_i^2 l_q + \\
&+ C_4 \left[\sum_{j=1}^{q} P_{e_i} r_i - \sum_{к=1}^{d} P_{e_к} r_к \right], \quad d + q = n \\
&\frac{d\omega_i}{dt} = \eta_{1i} h_i + \eta_{2i} \omega_i^2, \quad i = 1, \dots, n
\end{aligned}\right\} \quad (23)$$

In the equations (23), the coefficients a_i, b_i, c_i, η_i have the following meanings:

$$\left.\begin{aligned}
&a_1 = \frac{m + \lambda_{22}}{m + \lambda_{11}}, \; a_2 = \frac{1}{m + \lambda_{11}}, \\
&a_3 = \frac{c_\alpha}{m + \lambda_{11}}, \; a_4 = \frac{c_\omega}{m + \lambda_{11}} \\
&b_1 = \frac{m + \lambda_{22}}{m + \lambda_{11}}, b_2 = \frac{c_\omega}{m + \lambda_{22}}, \; b_3 = \frac{c_\alpha}{m + \lambda_{22}} \\
&c_1 = \frac{\lambda_{11} + \lambda_{22}}{I_z + \lambda_{66}}, c_2 = \frac{c_m}{I_z + \lambda_{66}}, \\
&c_3 = \frac{\lambda_{26}}{I_z + \lambda_{66}}, c_4 = \frac{1}{I_z + \lambda_{66}} \\
&\eta_{1i} = \frac{c_{\alpha i}}{I_i + \lambda_i}, \; \eta_{2i} = \frac{c_{fi}}{I_i + \lambda_i}
\end{aligned}\right\} \quad (24)$$

In high-speed coordinate system of equations (23) would be:

$$\left.\begin{aligned}
&\cos\alpha \frac{dU}{dt} = a_1 U_y \Theta_z + a_2 \sum_{i=1}^{n} c_{p_i} \omega_i^2 + a_3 U^2 + a_4 U^2 \\
&\sin\alpha \frac{dU}{dt} = b_1 U_x \Theta_z + b_2 U^2 + b_3 U^2 \\
&\frac{d\Theta_z}{dt} = c_1 U_x U_y + c_2 U^2 + c_3 \sum_{q=1}^{m,n} c_q U^2 l_q + \\
&+ c_4 \left[\sum_{j=1}^{q} P_{e_i} r_j - \sum_{к=1}^{d} P_{e_к} r_к \right], \quad q + d = n \\
&\frac{d\omega_i}{dt} = \eta_{1i} h_i + \eta_{2i} \omega_i^2, \quad i = 1, \dots, n
\end{aligned}\right\} \quad (25)$$

In the longitudinal direction, movement of a ship described by the following system of equations in a coupled system of coordinates[6, 8, 16]:

$$\left.\begin{aligned}
&\frac{dU_x}{dt} = a_2 \sum_{i=1}^{n} c_{p_i} \omega_i^2 + a_3 U^2 \sin\alpha + a_4 U^2 \cos\alpha \\
&\frac{d\omega_i}{dt} = \eta_{1i} h_i + \eta_{2i} \omega_i^2, \quad i = 1, \dots, n
\end{aligned}\right\} \quad (26)$$

In the lateral direction, movement of a ship described by the following system of equations in a coupled system of coordinates:

$$\left.\begin{aligned}
&\frac{dU_y}{dt} = b_1 U \cos\alpha \Theta_z + b_2 U^2 \sin\alpha + b_3 U^2 \cos\alpha \\
&\frac{d\Theta_z}{dt} = c_2 U^2 + c_3 \sum_{\substack{q=1 \\ i=1}}^{m,n} c_q U_i^2 l_q + \\
&+ c_4 \left[\sum_{j=1}^{q} P_{e_j} r_j - \sum_{к=1}^{d} P_{e_к} r_к \right], q + d = n \\
&\frac{d\omega_i}{dt} = \eta_{1i} h_i + \eta_{2i} \omega_i^2, \quad i = 1, \dots, n
\end{aligned}\right\} \quad (27)$$

Equations (26) and (27) can be simplified if we assume that part of the regime of the ship are such that the angle of drift is less than 15^0– 20^0,then sinα≅α,cosα=1. From equation (26) will be [6, 8]:

$$\left.\begin{aligned}\frac{dU_x}{dt} &= a_2\sum_{i=1}^{n} c_{p_i}\omega_i^2 + a_3U^2\alpha + a_4U^2\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2, \quad i = 1, ..., n\end{aligned}\right\} \tag{28}$$

Equations (27) will be as follows:

$$\left.\begin{aligned}\frac{dU_y}{dt} &= b_1U\cos\alpha\Theta_z + b_2U^2\alpha + b_3U^2\\ \frac{d\Theta_z}{dt} &= c_2U^2 + c_3\sum_{\substack{q=1\\ i=1}}^{m,n} c_qU_i^2l_q +\\ &+c_4\left[\sum_{j=1}^{q} P_{e_j}r_j - \sum_{\kappa=1}^{d} P_{e_\kappa}r_\kappa\right], \quad q+d=n\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2, \quad i = 1, ..., n\end{aligned}\right\} \tag{29}$$

In the high-speed system of coordinates the equation of longitudinal movement will be as follows[6, 8]:

$$\left.\begin{aligned}\frac{dU}{dt} &= a_2\sum_{i=1}^{n} c_{p_i}\omega_i^2 + a_3U^2 + a_4U^2\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2, \quad i = 1, ..., n\end{aligned}\right\} \tag{30}$$

In the same coordinate system, the equation of lateral motion;

$$\left.\begin{aligned}\frac{dU}{dt} &= b_1U\cos\alpha\Theta_z + b_2U^2 + b_3U^2\\ \frac{d\Theta_z}{dt} &= c_2U^2 + c_3\sum_{\substack{q=1\\ i=1}}^{m,n} c_qU_i^2l_q +\\ &+c_4\left[\sum_{j=1}^{q} P_{e_j}r_j - \sum_{\kappa=1}^{d} P_{e_\kappa}r_\kappa\right], \quad q+d=n\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2, \quad i = 1, ..., n\end{aligned}\right\} \tag{31}$$

At small angles of drift, equation (30) can be written as:

$$\left.\begin{aligned}\frac{dU}{dt} &= a_2\sum_{i=1}^{n} c_{p_i}\omega_i^2 + a_3U^2 + a_4U^2\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2, \quad i = 1, ..., n\end{aligned}\right\} \tag{32}$$

Equations (31) can be respectively written in such a way:

$$\left.\begin{aligned}\frac{dU}{dt} &= b_1U\Theta_z + b_2U^2 + b_3U^2\\ \frac{d\Theta_z}{dt} &= c_2U^2 + c_3\sum_{\substack{q=1\\ i=1}}^{m,n} c_qU_i^2l_q +\\ &+c_4\left[\sum_{j=1}^{q} P_{e_j}r_j - \sum_{\kappa=1}^{d} P_{e_\kappa}r_\kappa\right], \quad q+d=n\\ \frac{d\omega_i}{dt} &= \eta_{1i}h_i + \eta_{2i}\omega_i^2\end{aligned}\right\} \tag{33}$$

The considered equations are nonlinear mathematical models of ship complexes, as objects of control. Use of these equations for the analysis and synthesis of algorithms of management encounters considerable difficulties. As a rule, the given equations linearized by means of classical ways or by means of multidimensional extrapolation [1, 6, 10, 12].

4. Conclusion

Formulation and solution of problems of head-on navigation can be carried out. Problem with free right and left ends, for example, when the ship is moored to the pier and mooring place fastening devices or on the first vessel, or the second is not strictly specified. A problem with fixed right end and free left (or vice versa) ends, for example, the entrance of the vessel into the zone of action of radars. Fixed problem of the left and right ends when refueling is this object to another. From the above, we have the following result:

- Performed the analysis of transport processes, have a look through the characteristics and location of its role in Water way of Vietnam;
- Having reviewed the possible options in the interactive activities of the object fixed to mobile and can thus consider the plan moves inversely to meet in a broader sense as is shown in the existing technical literature;
- Following the introduction of a mathematical model of the ship complexes, thereby ensuring the basis for mathematics and algorithms for motion control system to meet the opposite direction;
- Gave the conditions of application of the mathematical model is obtained in the form of linear and non-linear;
- Completed the analysis of a set moving in the opposite problem when met and cited examples of similar problems.

References

[1] Athans M, Falbi P;*Optimal control*. - M.: Engineering, 1968-765 p.

[2] Nelepin R.A, Demchenko O.P, Ageev V.I, Bondarenko V.L;*Automation of ship power plants* /. - L.:Shipbuilding, 1975. – 534p.

[3] *Atlas unified deep-water system of waterways in Cuu longDelta of Vietnam. Volume 3, Waterway from Saigon to Baria - Vung Tau*. Ministry of Transport of Vietnam. Hanoi. 1980.

[4] *Atlas unified deep-water system of the North Viet nam waterways, fromRed Riverto sea*. Ministry of Transport of Vietnam. Hanoi. 1982.

[5] Basin A.M;*Propulsion and steering the ship*. - M.: Transport, 1967. -255p.

[6] Basin A.M, Anfimov V.N;*Ship hydrodynamics*. - M.: Transport, 1961. – 654p.

[7] Basin A.M, Moskvin G.I;*Coastal Vessel Traffic Management System*. – M.: Transport, 1986. – 160p.

[8] Blekhman I.I;*Synchronization of dynamic systems*. - M.: Science, 1971. – 494p.

[9] D. Drew .*The theory of traffic flow and control*. - M.: Transport, 1972. – 424p.

[10] Kulibanov YM. *Vessel as an object of multivariable control the optimal control of the main engines* // Proc. Inst: Economics and Organization of transport / LIVT. - 1966. Part I. - with 78 – 88p.

[11] Kulibanov YM, Polivanof NV, Lobarev VK; *Optimal control on fuel consumption*. In the book "Information Systems in Transport", publishing "Shipbuilding", 168-174p.

[12] Loparev VK, Markov AV, Maslov Y, Structure V; *Applied mathematics in engineering and economic calculations/* Collection of scientific papers. St. Petersburg, 2001, 58-61p.

[13] Kulibanov YM; *Dynamic model in inverse problems of traffic control*./ Collection of scientific papers "Managing transport systems " SPb.: SPGUVK, 1995, 90-97 p.

[14] Kulibanov YM; *Research and construct a mathematical model of the automatic course control for riverboat in perturbed motion* // 25 scientific and technical conference LIVT: Sat. rep. - L., 1971. - p. 256 - 265.

[15] Inose H., T. Hamar;*Traffic Control*. - M.: Transport, 1983. - 248p.

[16] Zhevnin AA, Glushko V; *Synthesis algorithm control of nonlinear, non-stationary objects on the basis of inverse dynamics*. Reports of USSR Academy of Sciences, 1981. t. 256 , № 5, p.1057 - 1061

Biography

Nguyen Xuan Phuong, (1967, Hanoi); Marine Master; PhD in Systems Analysis, Control and Information Processing, (2011, Russia). He currently is a lecturer of Navigation faculty, Ho Chi Minh City University of Transport (Vietnam). His research interests are within general linear/nonlinear control theory for maneuvering systems with applications toward guidance, navigation, and control of ocean vehicles.

Vu Ngoc BICH (1961, Haiphong), Philosophy Doctor in Automated design system (2007, Russia), Associate Professor (2013).He is Director of Science Technology – Research and Development Department at the Ho Chi Minh city University of Transport (HCMUTRANs). Main research areas are design and construction the ship, R&D, education. Former Dean of Naval Architecture and Offshore Engineering at HCMUTRANs. He has authored 6 books and 20 publications in scientific papers and presentations on national conferences.