DESIGNING AND EVALUATING OF CREW ACTIVITY ALGORITHMS ON INITIAL STAGE OF DESIGNING OF ANTHROPOCENTRIC OBJECT

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Abstract: For reaching the goals of designing the system-forming kernel of modern anthropocentric object, algorithms of crew activity have to be designed already on the initial stage of its development. Technology of designing of crew activity algorithms and evaluating of time expenses for their realization is described.

1. Introduction

Development of algorithms specifications of onboard digital computing systems (ODCS) and crew activity algorithms (CAA) of anthropocentric object (AO) includes following technical documents:

- An original-language technical document: "Logic of functioning of the “crew-onboard equipment” system". Text of this document is usually structured by typical situations (TS) of designed object functioning and their problematic sub situations (PsS);
- ODCS-algorithms and CAA specifications structured by TS and their PsS;
- Realizability estimation of designed onboard algorithms: ODCS-algorithms for onboard digital computing system and CAA for crew;
- Efficiency estimation of designed onboard algorithms.

2. Macro model of anthropocentric object for onboard algorithms specifications development

AO model consists of three global control levels (OGCL):

I - Operative choice of purpose of current functioning (the purpose choice level).

II - Choice of a rational way of achievement of appointed purpose.

III - Realization of chosen actions.

The model of AO functioning includes: set of the general functioning purposes that is appointed for algorithmization; representation of each general purpose through a semantic network of TS; representation of each TS through a semantic network of PsS; OGCL level I and II problems are solved at system-forming kernel of AO.

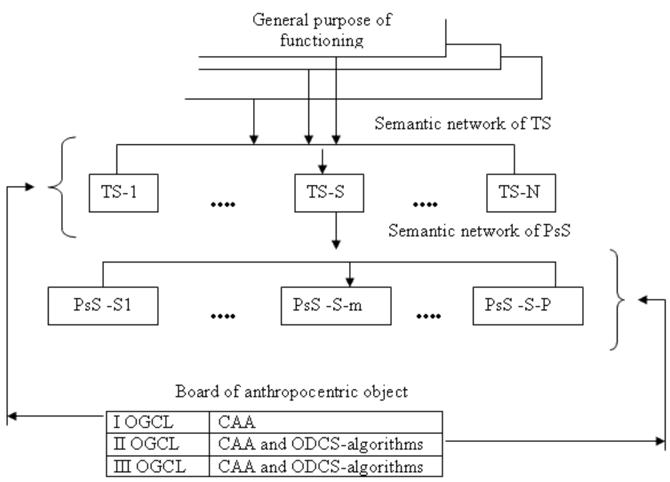

Figure 1. Macro model of anthropocentric object

2.1 Crew member (operator) model of onboard algorithms specifications development

Activity structure of operator of AO includes: decisions appointment processes; participation of the operator in processes of tracking as a part of tracking system; realization of a chosen decision. During development of CAA specifications the screens of information on the cabin indicators, structure of voice messages, lists of controls of an informational-control field of a cabin of crew are created. Decisions made by operator in a functioning process are divided in three types: π – perceptive-identificational decisions that do not demand any time to think over; ρ – speech-thought decisions that can be divided into several elementary acts of making decision; π-ρ – heuristic decisions.

Time expenses for making a π-decision are the time for reaction on signals of the cabin informational field: acoustical or light irritation, recognition of conventional signs on indicators etc. The corresponding average data about time of reaction on various irritations can be found in the literature on subject psychology or by experimental way.

For ρ-decisions it is necessary to take into account the time to think over the situation besides similar reactions expenses. Elementary acts of making decision (EAMD) are elementary logical operations which operator algorithm of making decisions, based on data from corresponding devices can be divided to. For example: simple arithmetic calculation, comparison of digital or literal signs, check of a logic condition and/or. The corresponding average data about time spent for EAMD can be found in the literature on subject psychology or by experimental way.

Time expenses for π-ρ-decisions can only be found by experimental way.

If there is a project of an operator cabin at a design stage of onboard algorithms specifications, the way of realization of the made decision (manual operations) and time spent for it are calculated on the basis of an arrangement and type of devices in a cabin. Manual operations are represented through elementary acts.

Operations of tracking are estimated on time expenses which are spent by the operator for elimination of a mistake of the tracking which have collected during the operator distraction from process of tracking. Discretely-continuous model of tracking is used. For calculation of time expenses for process of tracking, experimental distraction time dependence of mistake elimination time during a tracking process is determined. A possible arrangement of tracking updating points is placed on CAA earl by a design-engineer. For an estimation of CAA earl realizability optimum arrangement of tracking updating points gets out among all possible.

3. Specification development technology

For development of an original-language technical document "Function logic of the crew and onboard equipment system" and onboard algorithms specifications, the group of plenipotentiaries of organizations participating in development of AO is created. This document is structured by OGCL, TS, PsS and usually consists of several books: one book of "Function logic of the crew and onboard equipment system" of the 1'st level of OGCL and several books (in the number of TS) of "Function logic of the crew and onboard equipment system" for concrete TS.

Using the text of each book the generalized earl is designed as ordered by causally investigatory attitude the set of TS and the set of PsS.

Formal completeness of texts of these books is estimated by members of plenipotentiaries with the help of the "Logic-Text-Analysis" (LoTA) computer system. For each TS and its set of PsS the scheme of onboard algorithms (SOA) will be made. These algorithms are realizated on ODCS. The operator decision earl (ODE) has to be made either. ODE is structured by causally investigatory attitude set of CAA that includes:

- decision making processes;
- participation of the operator in processes of tracking as a part of tracking system;
- realization of the chosen decision.

A possible arrangement of tracking updating points is placed on ODE by a design-engineer manually and the optimal arrangement is calculated. The design process of coordinated ODE and SOA is supported by "Bort" computer system.

3.1 CAA specifications design computer system "BORT"

The computer system "Bort-ADE" is crew activity algorithms specifications development computer system. It is a part of the "Bort" computer system named above. It is designed for plenipotentiaries group members and support development of ODE of selected PsS in appointed TS. The initial information for development includes:

- texts of "Function logic of the crew and onboard equipment system";
- set of recommended signs for information representation to the operator on the cabin displays;
- hardware-semantic shape of the crew cabin informational-control field including set and arrangement of control devices, types of operator inputs into ODCS, etc.

"Bort-ADE" system supports designers while constructing ODE of TS for selected PsS:

- finding fragments of selected PsS in texts of "Function logic of the crew and onboard equipment system" and in generalized earl;
- selecting next problem in this fragment;
- detalisation of operator accessible information of the informational-control field needed for solving selected problem of the current moment of AO functioning;
- decision type identification (π, ρ or π-ρ);
- introducing of accessible information using allowed symbols to the operator;
- verbal describing of operator solving decision of the selected problem;
- collecting the set and semantic features of ODCS-algorithms forming information for the operator to solve selected problem;
- representation of the CAA set of PsS as ODE;
- forming the possible arrangement of tracking updating points;
- determining the distraction time dependence of mistake elimination time during a tracking process using experimental data;
- uniting ODEs of each PsS into common TSS ODE.

The "Bort-ADE" system includes databases for: recommended symbols of information representation; hardware-semantic shape of the crew cabin informational-control field; crew activity time expenses in different TSs and PsSs (is filled while ODE constructing): normal, stress etc.

4. Realizability estimation of ts CAA set computer system "GRO-OTSENKA"

"GRO-otsenka" system is intended for automatization of ODE realization estimation process. On the basis of the data entered manually by the design-engineer or received from system "Bort", the program optimally arrangements tracking updating points, time expenses for each CAA, their mean-square deviations and similar parameters for each branch the ODE and any set of CAA inside ODE branch. The system also allows changing entered data operatively, automatically determining bottlenecks of ODE. The initial information includes: operator cabin informational-control field data, voice messages for the operator, etc.

4.1 Example of designing and realizability estimation of CAA

Fragment of "Function logic of the crew and onboard equipment system" texts: "Onboard measuring devices have located objects "B1", "B2", "B3" and are showing them at a screen using Cartesian system of coordinates. Operator location is represented as object A. Operator has to order this objects by distance while taking part at a tracking process keeping directory mark "F" inside moveless round "H"."

ODE constructed using this fragment consists of:

1. Perception of the onscreen objects parameters.
2. Keeping directory mark "F" inside moveless round "H" (tracking beginning)
3. Comparison of pieces A-B1and A-B2
4. Probability of tracking mistake correction
5. Comparison of pieces A-B1and A-B3
6. Probability of tracking mistake correction
7. Comparison of pieces A-B2and A-B3
8. Probability of tracking mistake correction
9. Transferring ordering algorithms into ODCS (manual operations).
10. There is a probability of tracking mistake correction after each CAA.

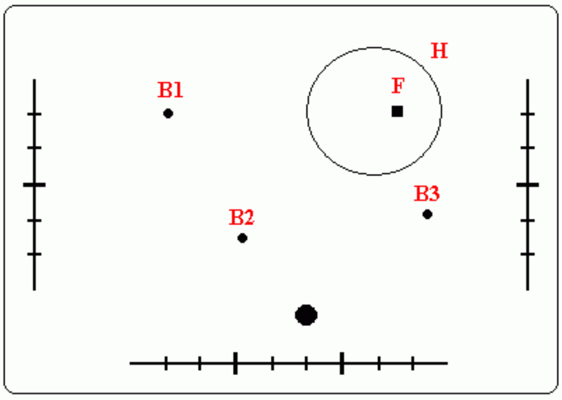

Figure 2. Onboard indicating screen example

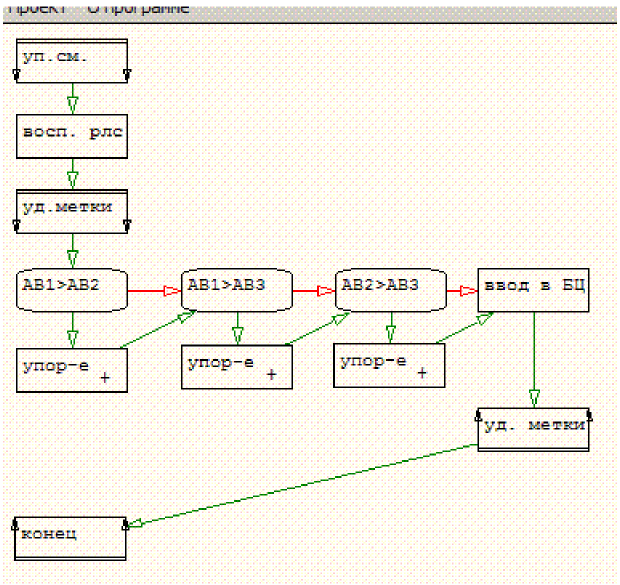

Figure 3. Example of ODE made with "Bort" system

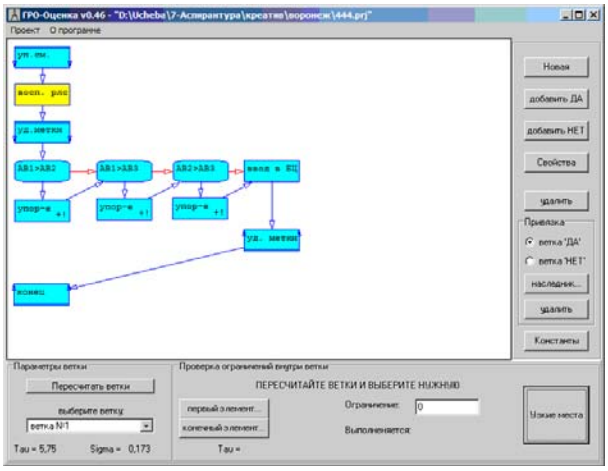

Figure 4. Example of "GRO-otsenka" results

4.2 ODE realization time expenses estimation

For realization time expenses estimation of this ODE fragment group of plenipotentiaries uses "GRO-otsenka" system. Time expenses and their mean-square deviations are calculated for each CAA and for whole ODE. Probable arrangement of tracking updating points and bottlenecks of ODE are determined automatically. The final result of the estimation stands out.

4.3 Example of estimation result report

I part

Branch №0
time: 5,75
deviation: 0,173
список САА ветки:

САА №1восп. рлс
time= 3,51
deviation= 0,1
comment=

САА №2уд.метки
time= 0
deviation= 0
comment=

САА №3АВ1>АВ2
time= 0
deviation= 0
comment=

II part

САА №4упор-е
time= 0,7
deviation= 0,1
comment=

САА №5АВ1>АВ3
time= 0
deviation= 0
comment=

САА №6упор-е
time= 0,7
deviation= 0,1
comment=

САА №7АВ2>АВ3
time= 0
deviation= 0
comment=

III part

САА №8упор-е
time= 0
deviation= 0
comment=

САА №9ввод в БЦ
time= 0
deviation= 0
comment=

САА №10уд. метки
time= 0
deviation= 0
comment=

САА №11конец
time= 0
deviation= 0

5. Conclusion

Design of crew activity algorithms set is necessary for solving problems of the system-forming kernel of anthropocentric object already on the initial stages of its development and directed on:

- determining of the information set shown to operator during typical problem situations;
- specification of control devices at the cabin;
- tentative estimation of loading of the operator problems decisions.

There are many inconsistencies between crew activity and onboard digital computing system algorithms development in the existing practice. Assistance of a computer support system covering all design stages, will raise quality of a product and will reduce expenses for its creat ion.

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