Model of Computer-Aided Design Environment for UAV Projects

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***Abstract*—Presented computer-aided design system for unmanned aerial vehicles with an integrated environment introduces a new approach to managing the design process. Used in the proposed medium scenario design can greatly simplify the work of the designer. Available in medium monitor provides the flexibility of design processes with a flexible structure description of design procedures in the scenario design.**

Keywords—unmanned aerial vehicles*; *dynamic integration; computer-aided design; integrated environment; design

I. Introduction

Nowadays unmanned aerial vehicles (UAV) have become an essential part in every aspect of over lives.UAV are used in all sectors of production. In addition, more than 50 countries are using them. Due to the high demand for such devices, it is necessary to develop new methods for designing drones. New approach will decrease time used to develop new UAV sand significantly reduce the cost of the final product.

The design process is always the specific actions add-in on pre-defined parameters with given boundary conditions [1]. And this statement is true, both in the initial and the final design stage. Any design process of UAVs begins with the processing of the project task on the parameters of which is based the initial stage of creation of the UAV which satisfies the boundary conditions inherited in the task.

Let us consider the process of creating an UAV. The design assignment is represented as the following components [4]:

- Technical specification – detailed description of requirements.
- Preliminary design:
  - technical specifications (MS Office, Libra Office, Flow Vision, Ansys);
  - strength properties (MathCAD, Matlab);
  - calculation of electrical systems (Altium Designer, OrCAD, AutoCAD Electrical, Electronics Workbench).
- Draft project– drawing of UAV (AutoCAD, Kompas 3D, Catia, Pardox).
- Technical project:
  - development of project documentation;
  - production and testing of models (Scilab, Maxima, Flow Vision, 3DCrafter).
- Detail design - based on master geometry all the details are designed in 3D with the real sizes (Catia, NX, 3DCrafter, 3DVIA shape).

II. Problem statement

At the initial stage the project task design process is performed. Designer selects the priority method for describing the project (graphic, text, table or analytical calculations). Usually the graphical way of describing the project is preferred. This means that in the process of designing the first steps at each stage of the design will be performed on the graphics data of the project. Then depending on the given task the operations on the data of other aspects of the performance are made.

The next stage of UAV design is a direct modification of the design data. Then the change of the project graphic image is held [2]. For example a single object is added. Now you need to specify the correct installation of the new object. For example, if this object is the default, you must specify its dimensions in the reference table and make the appropriate changes on the drawing. Next, you need to make an entry about installing a new object in the explanatory note to the project and specify some of its characteristics [4]. Now you want to bind the new object to existing objects and design task. For this you need to perform some calculations depending on the complexity and purpose of the object, which change the shape and properties of the object or the place of its installation. The calculations are recorded in the explanatory note. Next is the adaptation of the modified object to the terms of the project.

Let’s say you want to change the object which is in close relation with other objects. After changing some characteristics of this object designer will need to perform all the above operations for each object associated with the changes to restore the logical connectedness of object. If a project has a set of interconnected objects, the designer practically has to re-perform the design, taking into account all of the binds.

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Dynamic data integration of different aspects of the performance is realized during the automated design of control actions on the elements of the environment-aided design [5]. Proposed in the thesis method for dynamic data integration is a method of modeling the interaction of components of the environment of CAD, i.e. a method for dynamic data integration is part of the information model of the environment of CAD.

So it is necessary to create an information model of computer-aided design environment.

III. Information Model Structure of Computer-Aided Design Environment

Information model of environment of computer-aided design, consisting of a control processor (CP), thematic coprocessors and executing processors is suggested (Fig. 1).

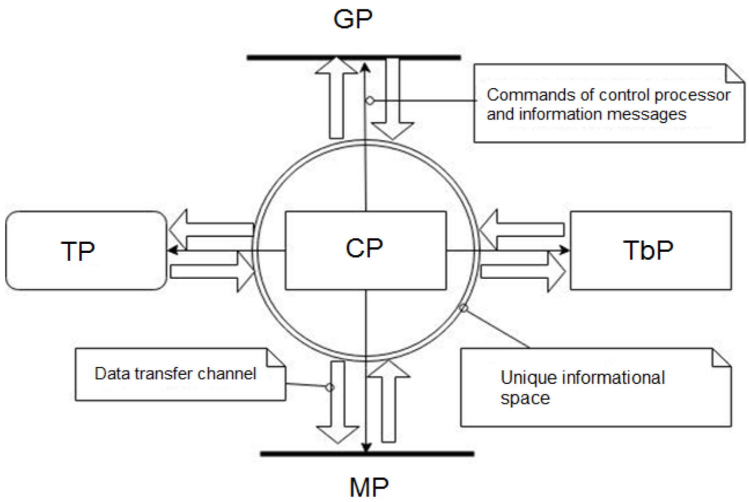

Fig. 1. The scheme of processors control in the information model

The control processor controls the behavior of all thematic coprocessors that implement dynamic data integration in the environment of computer-aided design. The thematic coprocessors include: Graphics coprocessor (GP), Table coprocessor (TbP), Text coprocessor (TP) and a Math coprocessor (MP). Thematic coprocessors receive and process commands from the CP and transmit them to the executive processor. Executive processors are software tools that implement the data of one aspect of the presentation. For example, they are: AutoCAD, FreeCAD, Catia, NX, 3DCrafter, dBase, Paradox, MS Word, MathCAD, etc. This information model reproduces real software interaction in a simulated environment of CAD.

Each thematic coprocessor performs certain actions:

- graphics coprocessor automates the procedures of processing the information presented in the form of images and supports appropriate data structures for its storing;
- table coprocessor automates the processing procedures of the information presented in tables and supports the relevant data structures for its storing;
- text coprocessor automates the processing procedures of the information presented in the form of textual descriptions and maintains appropriate data structures for its storing;
- mathematical coprocessor automates the procedure of calculation of the necessary parameters and maintains appropriate data structures for its storing;
- control processor automates the procedures for managing the design process and coordinates the interaction of all thematic coprocessor included in the environment of CAD.

The design process is the execution of certain actions on the data, demonstrating various aspects of the performance. To achieve private design decisions required to perform multiple actions (or commands of CAD). Therefore, the set of commands that are performed to obtain private design solutions is a complex operation. In the design process there are similar complex operations that have the same set of commands and differ only by used data.

Concepts

1) Project is a related description of the design object represented as generic operations performed in the sequence recommended by the design scenario. The project also includes separate commands of thematic coprocessors which are not included in the set of generic operations. The project is carried out manually by the designer using generic operations from the operations library.

2) Generic operation is a set of commands for one or more thematic coprocessors. Coprocessor commands are the procedural component (T) of the design data, connected with each other by K operators. Generalized operation is intended to perform a specific sequence of actions specified by the designer. Generic operations can be connected together using operators for performing connection between different commands from different generic operations.

3) Design scenario is a set of interrelated generic operations recommended for designer. The design scenario specifies the execution sequence of generic operations in the formation of the finished project.

4) The monitor is a tool of CP that monitors the status of the project. The monitor reflects the state of the project as a sequence of thematic processors commands executed. The monitor displays the executed commands and the connection between them and allows editing executed generic operations and overriding the connection between the commands.

IV. Design Scenario

This information model provides the ability to create and develop a design scenario that includes the generic operations that are performed in the design process. The result of the generalized operation is the implementation of specific design stage. Generalized operation may consist of commands both from one and from several processors. For example, in the design process you want to open the reference tables, where the data for a specific object is obtained. In this generalized operation the following steps are performed:

- the type of the object is determined;
- the name of the database file containing the directory is determined;
- the parameters for data retrieval keyword is determined;
- the search of the required entries in the database for a specific object is performed.

In design scenarios the sequence of actions performed by the designer are reflected. The presence of the script allows you to minimize repetitive actions. For example, it is necessary to place and describe a number of similar objects. To do this, the designer once holds the entire sequence of actions, using the entire arsenal of available generic operations, and by identifying this part of the script he may use it again, changing only the input parameters.

Each of the thematic coprocessor processes the data of the aspect representation for operations with which it is intended. If he needs the data processed by other thematic coprocessor, he will send an informational message to the control processor. That, in turn, interrupts the first coprocessor and gives the command to the appropriate coprocessor to provide the necessary data in a single information space. After receiving notification of readiness data control processor sends the command to the first coprocessor to continue working. Thematic coprocessors can't apply the same coprocessor directly, for this purpose control processor is used.

Thematic coprocessors can submit only information messages, and receive only commands. Control processor receives only messages and gives commands only. Thematic coprocessors, referring to the control processor, receive from him the command to abort, and continue its work only after receiving the appropriate command from control processor [2]. The use of such model allows controlling actions (Fig. 2).

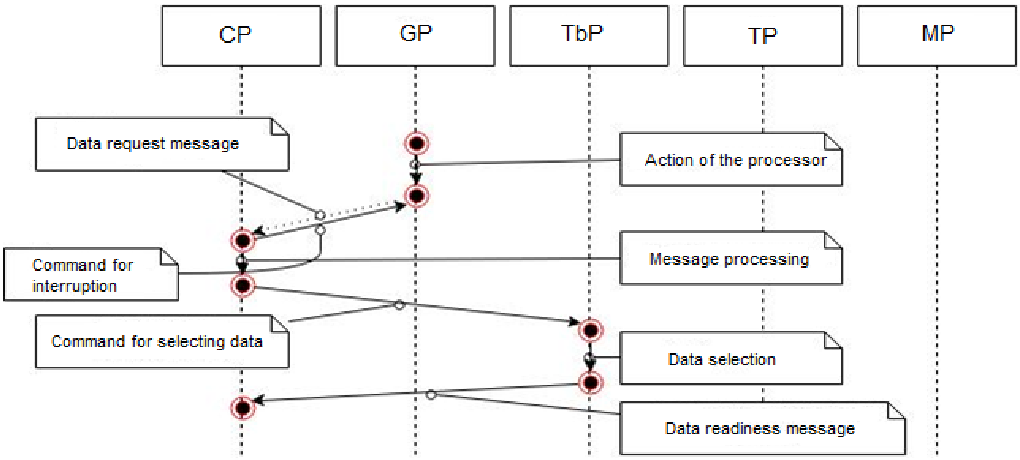

Fig. 2. The scheme of interaction of thematic coprocessors and the CP.

Each coprocessor at any point in time provides the designer the possibility to adjust the implementation of the actions of the design scenario. Thematic coprocessors have a number of properties and functions of a service nature. They manage the process of issuing informational messages and respond to commands from the control processor. These functions are particularly important for maintaining the dynamic integration of all processes in the system.

One of the main features of thematic coprocessors is the registration of all actions made by the designer. This makes it possible to create your own generic operations and create certain stages of the design scenario generated by the designer's discretion. To support interaction of all processes occurring in the environment of computer-aided design, theme coprocessors use command processing and parameters transformation. The parameters are converted to an understandable form for every thematic coprocessor included in the environment of CAD, and transmitted in a single information space. The inverse transform of data derived from a single information space allows you to perform actions on objects in accordance with data received from other thematic coprocessors. To support interaction with each other thematic coprocessors have commands transmission of the processed data in a single information space and extract data taken from other coprocessors. Each thematic coprocessor is designed only to perform their strictly defined actions.

Graphics coprocessor performs actions only on graphics [4]. In the process of designing graphics coprocessor occupies an important place, because the drawings are an important part of any design solution. Graphics processor allows you to perform the drawings and to edit existing graphics.

Table coprocessor performs actions only on table data. In the design process it is sometimes difficult to do without table data because the table is aconvenient form of hosting large numbers of similar data. Table coprocessor implements the table data by creating and using a database. The designer is constantly accesses the reference data of different nature, which are often presented in table form. One of the results of design are tables of calculated parameters, equipment tables, specifications, etc.

In the process of the project documentation developing text coprocessor is constantly used. It performs actions only on text data. For full performance of the designed object in the project documentation explanatory note is required. To do this, in the design process the designer must constantly create new and amend existing texts.

In the process of creating the project the math coprocessor can be used, as in project activities mathematical calculations are often required. Mostly the work of the working math coprocessor is invisible. Mathematical formulas and expressions bind numerical values of the commands parameters of various thematic coprocessors. But in situations requiring the choice of a particular method of calculation, math coprocessor provides the designer the ability to control mathematical calculations [2].

The information model allows combining the control actions of the designer, which allows dynamic integration of data in the generalized operations, consisting of commands of various thematic cooperating with one set of declarative information. Such generic operations (created by the designer or available in the library), you can automate dynamic data integration. For the formation of generic operations it is necessary to identify common patterns of connections between procedural data of different (or the same aspects of the presentation).

V. Conclusions

It is proved the necessity of integrated computer-aided design systems for UAV design process. The information model of computer-aided design environment is considered. It is researched the different aspects of this problem.

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