UDC 681.5.015 (045)

[1]V. M. Syneglazov,
[2]A. P. Godny

IMPROVING EFFICIENCY OF AUTOMATED DESIGNING OF UAV

National Aviation University, Kyiv, Ukraine
E-mails: [1]svm@nau.edu.ua, [2]andrewgodny@gmail.com

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.*

Index Terms—Unmanned aerial vehicles; dynamic integration; computer-aided design; integrated environment; design.

I. INTRODUCTION

Unmanned aerial vehicles (UAVs) have long been part of our lives, affecting all aspects of it. UAVs are used in all areas of production and are intended to perform various functions as a civil and military nature. Current methods of UAVs design and production are no longer able to meet the rapidly growing demands and requirements. It is therefore necessary to consider new approaches to the UAV design process with the object of maximizing automation and optimization. The approach described in this article allows you to significantly speed up the design process of the UAV, which in turn saves you money resources.

II. PROBLEM DEFINITION

The development of the UAV is a complex and time-consuming process, which consists of many stages. At various stages of design different automated systems are used for implementation of their tasks (MathCAD, Matlab, AltiumDesigner, AutoCAD, Kompas 3D, Catia). Despite the fact that the majority of computer-aided design (CAD) systems can be used at several stages of the design, none of them is able to fully meet the needs of engineers. Today, therefore, a set of CADs is used for the development of the UAV, which imposes certain restrictions on the ability of engineers and greatly increases the UAV engineering time [2]. Using different CADs leads to working with many different kinds of data, which need to be transmitted from one computer aided design system to another. It is necessary to create a system that will bring together all required CAD systems into a single system and automates the process of data transfer between the individual components.

III. CAD SYSTEMS REVIEW

Let us consider the most common CAD software systems that are used in the UAV design at different stages. Let's also describe the flow of information in the design process to create a unified information environment of computer-aided CAD design [1]. For the analysis of requirements we chose 3 most popular CAD systems on the market:

– CATIA;
– Matlab;
– AltiumDesigner.

CATIA is a CAD from the French company Dassault Systemes [5].

It is a comprehensive CAD, computer-aided manufacturing (CAM) and computer-aided engineering (CAE) system, which includes advanced three-dimensional modeling tools, software complex processes simulation subsystem, advanced analysis tools and unified database of textual and graphical information. Main components:

– CATIA – Assembly Design – assemblies modeling allows to simplify assemblies creation and structure management [5];

– geometric modeling kernel is designed to meet the challenges of three-dimensional design and construction of parts for all branches of engineering and to ensure their use for engineering, process engineering, graphic documentation and other problems of machine-building enterprises;

– CATIA – Team PDM – data management system for CATIA users command provides a solution to the basic problems of the project management;

– CATIA – Generative Part Structural Analysis is designed for rapid preliminary structural strength analysis;

– CATIA–CADAM Interface – data exchange interface enables existing CADAM system users to work in the same space with the CATIA system users as well as using a uniform format of drawing data. To do this, the migration of drafting standards from CADAM to CATIA is provided [5].

Matlab is a high-level language and interactive environment for programming, numerical calculations and visualization of results [3]. With

Matlab, you can analyze data, develop algorithms, create models and applications.

Key features:

– platform-independent high-level programming language oriented to matrix calculation and development of algorithms;

– interactive environment for developing code, managing files and data;

– linear algebra and statistics functions, Fourier analysis, differential equations solution, etc.;

– rich visualization tools, 2D and 3D graphics;

– built-in user interface design tools for creating complete applications in Matlab;

– C/C++ integration tools, code inheritance, ActiveX technology.

Main components:

– Aerospace Toolbox is a package that contains special tools for analysis and modeling of air, space, jet and turbojet systems.

– Aerospace Blockset is a library of Simulink-blocks containing special tools for modeling, simulation and integration of air, space, jet and turbojet systems.

– Simulink is a graphical simulation modeling environment that allows by means of block diagrams in the form of directed graphs build dynamic models, including discrete, continuous and hybrid, non-linear and discontinuous system.

– Robust Control Toolbox is a package for the development of management systems for objects with uncertainties and nonlinearities of various types.

– Signal Processing Toolbox is a Matlab expansion pack, which contains a set of standard functions for digital and analog signal processing;

– SimEvents is a Simulink library for simulation of discrete state systems, which uses queues theory and queuing systems.

– Computer Vision System Toolbox (set of computer vision systems design tools) contains algorithms and tools for the design and simulation of, computer vision and video processing systems.

Altium Designer is an end-to-end computer-aided printed circuit boards design system [1]. Altium Designer contains all essential tools for the design, simulation and tracking PCBs and programmable devices. This provides a full electronic components development cycle – from concept to start of production. Project management in this CAD system is carried out by a unified shell called Design Explorer. Functional features of the Altium Designer.

– Multilayer circuit boards routing.

– Mixed signals modeling.

– Support of the OrCAD Capture CIS (Component Information Systems) library interface.

– Pins swapping at the level of integrated PCD (Programmable Logic Device) projects and circuit boards.

– Large libraries of elements.

– Technologies of library management and report generation.

IV. DYNAMIC INTEGRATION OF CAD

This approach implies the existence of a connecting link between all modules. It manages all available components of the system and is responsible for the communication between modules, data conversion (if necessary) and quality control of the work performed.

Usage of this approach allows minimizing the cost of adding new modules and upgrading of current ones, reduces maintenance costs of the whole system, and simplifies the management of data flow in the system. The advantages of this approach are obvious, but it requires the establishment of general rules for the interaction of all components integrator and creation of a unified reporting format to simplify the processes of interaction between different CAD in the system [4]. To solve these problems, you can apply the method of dynamic data integration.

The method of dynamic data integration consists in linking into a single unit (a generalized operation) a software tool command or group of commands the result of which is the value of a specific data type, with a command of other software tools in a single information process. Besides, both considered software tools have equal rights. The order of interaction is determined by information process conditions and user requirements [1]. When using dynamic data integration, system operates with commands which are forming the object parameters, and implements objects connection directly between the commands, while providing a more flexible way of combining and "understanding" of different types of data. At the same time parameter of an object in the system should not be separated from the command. The parameter is only a formal representation of data in the system.

The completeness of the object information description in the integrated CAD environment provides a variety of information processes, implementing operations on:

– graphical aspects of the object description - a graphics processor;

– tabular aspects of the object description – a spreadsheet processor;

– textual aspects of object description - a word processor.

Considered integrated CAD environment has the following properties:

– completeness and integrity of the design object descriptions provided by integrated transformations;

– simplicity and convenience of operation of design procedures creating, provided by descriptions assembly consisting a set of alternatives - integrated design operations;

– flexibility of the design processes, provided by a flexible structure of design procedures descriptions that allows managing transitions through scripted design and modify the content of the possible reactions to the event;

– a variety of design operations classes in compliance with design tasks complexity level and end user professional skill, provided by the combination of design operations and their usage altogether;

– simplicity and combine object-oriented and subject-oriented descriptions of design processes with the ability to connect descriptions of the processes;

– support and combine object-oriented and subject-oriented descriptions of design processes with the ability to connect descriptions of the processes;

– evolutionary development, provided by feedback based on logging of user actions together with the data used and the further structuring;

– the accumulation of knowledge acquired for the subsequent synthesis of executable elements that allows developing evolutional system and configuring it to various classes of design objects;

– simplicity and convenience of management conversational interaction provides a unified operations dialog interaction kernel environment and a textual description dialogue procedures.

V. Structural Synthesis of CAD Systems

Let us consider the possibilities of developing software tools that ensure the dynamic data integration using proposed relational method in computer-aided design environment [3]. To this end, a set of software tools is developed, consisting of a control processor, subject coprocessors and executing processors. For the convenience of a software implementation, the control processor is described as a server node. Subject coprocessors are grouped as means of dynamic data integration. Auxiliary software, such as drivers, library operations and data library manager, are considered separately.

Server node of systems and software applications

Computer-aided design system which uses method of dynamic data integration is a structure consisting of a control processor (CP) and subject coprocessors: graphical coprocessor (GP), table coprocessor (TbP), math coprocessor (MP) and text coprocessor (TP). The work is ensured by execution of the design script by control processor. Design script is a set of generic operations that can be represented as a graph [2]. Generalized operation consists of several commands of subject coprocessors with a general semantic completeness.

Model of CAD environment has the structure shown in Fig. 1.

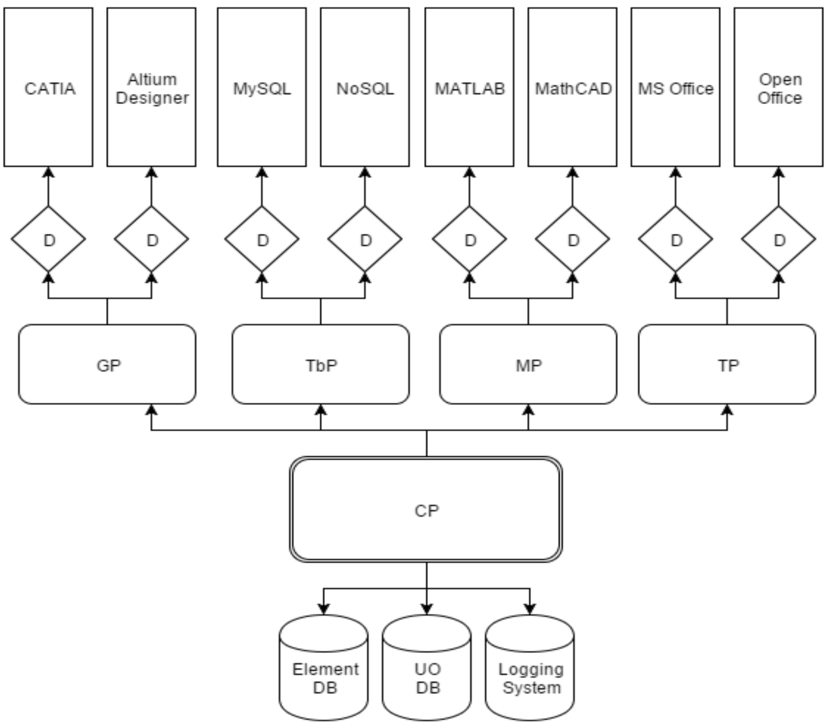

Fig. 1. Block diagram of computer-aided design environment

The proposed scheme of computer-aided design environment consists of the following modules.

– The control processor supports the execution of generalized operations according to the design script. CP instructs subject coprocessors and accepts only informational messages from them.

– Subject coprocessors are processing tools for their own data formats:

– graphic coprocessor implements the execution of graphic work of the design process and fulfills interaction between graphics processors and CP;

– tabular coprocessor implements the interaction of design process with DBMS. It supports management of internal auxiliary databases;

– math coprocessor implements the execution of calculations arising in the process of designing and maintains interaction between mathematical performing processors and CP;

– text coprocessor provides a textual description of the designed facilities, equipment used, calculations performed etc. Text coprocessor maintains interaction between performing word processors and CP.

VI. Conclusions

Possible realization of software tools which are ensuring dynamic data integration using proposed relational method for the automated UAV design system has been demonstrated.

References

[1] K. Lee. *CAD Basics (CAD/CMA/CAE)*, Peter Press, 2004.

[2] V. V. Kupriyanov, O. Y. Pechenkin and M. L. Suslov. *CAD and artificial intelligence systems*, ROSNY and IT UP: DBMS, 1995. (in Russian).

[3] G. Berezhnoj. *Problems building large IT systems*, PCworld, 1998. (in Russian).

[4] I. P. Norenkov. *Basics of computer-aided design*, Peter Press, 2002. (in Russian).

[5] Kristi *Morton. Dynamic Workload Driven Data Integration.* U. of Washington, 2012.

Received September 2, 2015.

Sineglazov Viktor. Doctor of Engineering. Professor.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine.
Education: Kyiv Polytechnic Institute, Kyiv, Ukraine (1973).
Research area: Air Navigation, Air Traffic Control, Identification of Complex Systems, Wind/Solar power plant.
Publications: more than 500 papers.
E-mail: svm@nau.edu.ua

Godny Andrew. Ph. D. Student.
Education: National Technical University of Ukraine “Kyiv Polytechnic Institute”, Kyiv, Ukraine (2014).
Research interests: systems and process control, system identification, automatic control of industrial processes.
Publications: 5.
E-mail: andrewgodny@gmail.com

В. М. Синєглазов, А. П. Годний. Підвищення ефективності автоматизованого проектування БПЛА

Представлене інтегроване середовище САПР реалізує новий підхід до керування процесом проектування. Використовуваний у запропонованому середовищі сценарій проектування дозволяє істотно спростити працю проектувальника. Наявний в середовищі монітор забезпечує гнучкість проектних процесів за допомогою гнучкої структури опису проектних процедур в сценарії проектування.

Ключові слова: динамічна інтеграція; САПР; інтегроване середовище; проектування; БПЛА.

Синєглазов Віктор Михайлович. Доктор технічних наук. Професор.
Кафедра авіаційних комп’ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Київський політехнічний інститут, Київ, Україна (1973).
Напрям наукової діяльності: аеронавігація, управління повітряним рухом, ідентифікація складних систем, вітроенергетичні установки.
Кількість публікацій: більше 500 наукових робіт.
E-mail: svm@nau.edu.ua

Годний Андрій Павлович. Аспірант.
Освіта: Національний технічний університет України «Київський Політехнічний Інститут», Україна (2014).
Напрямок наукової діяльності: ідентифікація систем управління, цифрові системи управління.
Кількість публікації: 5.
E-mail: andrewgodny@gmail.com

В. М. Синеглазов, А. П. Годний. Повышение эффективности автоматизированного проектирования БПЛА

Представленная интегрированная среда САПР реализует новый подход к управлению процессом проектирования. Используемый в предложенной среде сценарий проектирования позволяет существенно упростить труд проектировщика. Имеющийся в среде монитор обеспечивает гибкость проектных процессов с помощью гибкой структуры описания проектных процедур в сценарии проектирования.

Ключевые слова: динамическая интеграция, САПР, интегрированная среда, проектирование, БПЛА.

Синеглазов Виктор Михайлович. Доктор технических наук. Профессор.

Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.

Образование: Киевский политехнический институт, Киев, Украина (1973).

Направление научной деятельности: аэронавигация, управление воздушным движением, идентификация сложных систем, ветроэнергетические установки.

Количество публикаций: более 500 научных работ.

E-mail: svm@nau.edu.ua

Годный Андрей Павлович. Аспирант.

Образование: Национальный технический университет Украины «Киевский Политехнический Институт» (2014).

Направление научной деятельности: системы и процессы управления, идентификация, автоматизация систем управления технологическими процессами.

Количество публикаций: 5.

E-mail: andrewgodny@gmail.com