OPEN HYBRID SYSTEM FOR GEOMETRICAL MODELING

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Abstract: Architecture and possible stages in developing of an open, flexible, distributed, multi-user, hybrid system for geometric modeling are considered in the following article. System requirements and its possible applications are also discussed.
Key words: Geometric Modeling, F-Rep, Hybrid System

1. INTRODUCTION

It is a fact that one of the most frequently used representation schemes in geometric modeling is the Boundary Representation (B-Rep). For this scheme are created a lot of algorithms, which mainly use its special features and conveniences. There are many program systems and libraries that are based on this method for describing geometric information (CAD/CAM, research systems, games etc.). Hardware accomplishments were developed in order to help the fastest visualization.

Research work in the field of a new representation scheme, named Function Representation (F-Rep) [4], started growing and developing intensively during the last 10 years. It is based on the description of the objects included in the scene with the help of explicit functions, R-functions etc. Theoretically it is not so new and could be found in V. Rvachev’s work in the 60s [1, 2]. This scheme allows easy integration with the elements of other well-known representation schemes like CSG, B-Rep etc. The only, really serious reason for limiting F-Rep wide spread usage till now is the necessity of performing a large number of calculations needed to receive accurate algorithms’ results. Such examples are the visualization algorithms. However the advantages of the scheme are much more than its disadvantages and with the fast growth in computing power this drawback starts losing its importance. Practice shows that priorities of the different representation schemes mutually supplement each other in the hybrid schemes of geometric modeling. It is clear that such scheme should be open to the representation schemes, which have already been used. This characteristic would lead to its bigger applicability, compatibility with the existing wide spread schemes, easy adaptation and future expansion with newly appeared representation schemes.

2. GOALS

The main goal of the following article is to consider the possibility to create a hybrid system for geometric modeling, which could help to examine different aspects of F-Rep and its relations with the other representation schemes.

Starting from the goal defined above the system should have the following characteristics:

- To be open one (Openness) – opportunity to be expanded in one or more directions;
- To be hybrid one (Hybrid) – availability and possibility for co-working with more than one inner representation;
- Flexibility – easy adaptable in accordance with different applications;
- To be distributive (Distributiveness) – simultaneous work of the system parts on different computer systems;
- Multiuser – possibility for parallel (or/and simultaneous) work of many system users. Main aspects of the multiuser work are independent or/and mutual work of more users.

All this features are influential on the system architecture.

Secondly, system architecture should allow creating it by stages. Which means that system creation should be:

- By stages – constructing the system by separate sequential stages and after finishing each of them it is efficient for the level according to the particular stage. There are three stages in system development – system, application and user stage;
- Most of the developers (teams) achieve this characteristic through: weak connection among the subsystems, clearly described ideology for development, documenting, constructing the system in open source etc.;
- PL (Programming Language) or OS (Operating System) should not be of any importance – system architecture and its implementation should not be based on means and technologies linked with a particular OS or PL.

All this problems could be solved by the usage of contemporary means and programming techniques (methods).

Finally, the aimed system should be able to be used on the following purposes:

- Research;
- Application;
- Educational;

This requirements influence both the architecture and the stages in accomplishment of the system.

3. ARCHITECTURE OF THE SYSTEM

Firstly, we will consider different aspects of the architecture caused by the defined main requirements.

<u>Openness</u>

Through analyzing of the declared goals and by having in mind the specification of the systems for geometric modeling we could conclude that for achieving satisfying openness of the system the following directions are sufficient:

- Inclusion of new representations;
- Addition of converters between representations, called converters;
- Addition of logical input, output and input-output system elements, called Sources, Targets, Storages;
- Inclusion of application elements in the system – elements which functioning is not linked to or it is not of a great importance for the base functionality of the system;
- Inclusion of compound elements (subsystems) as elements of the system;
- Inclusion of communication elements in the system – new types of inter-element communications.

To achieve openness of the system in these directions it is necessary registration-elements to be included for each one of them. In addition a configuration-element is needed to set (adjust) and include new elements and/or subsystems. The above directions form the base functionality of the system and their fulfillment should be differentiated in the architecture as a system core.

<u>Hybrid (in accordance with the representation schemes)</u>

What makes the system hybrid is the possibility to include unspecified number representations and converters (subset of the set of transformation-elements).

As the both classical schemes for conversion (shown on Fig 1) on principle are impossible [3] it follows that the chosen architecture allows the usage of a no fixed scheme for conversing between formats (representations).

In addition this method of approach gives the possibility to support, not only some converters (with different qualities/features) between to representations, but also several representations for one and the same representation scheme.

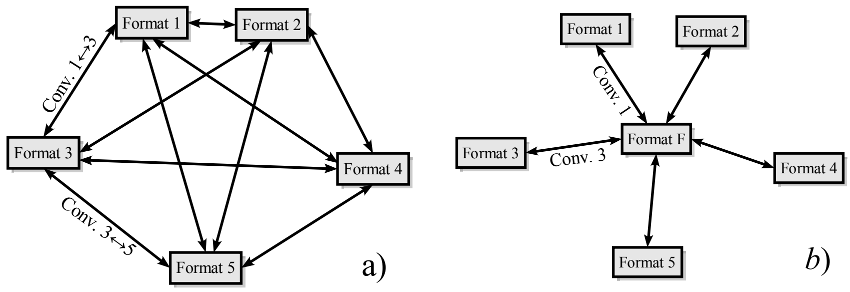

Fig 1 Hybrid system: a) with full set converters; b) with intermediate format

<u>Flexibility</u>

Flexibility is a direct consequence of the system openness. Through its adjustment functions the configuration-element gives the aimed adaptation in accordance with the applications.

<u>Distributiveness</u>

The possibility to differentiate subsystems and communication-elements makes likely the simultaneous work of separate parts of the system of different computer system. Another aspect of the distributiveness is the possibility to stratify system vertically and each layer can be accomplished as a software stage, hardware stage or mixture of them both.

<u>Multiuser</u>

Multiuser state of work includes two main aspects – independent and mutual work. Independent work means simultaneous protected access to the total elements of the system. Mutual work means simultaneous access to the common elements. This state of work is achieved through specific accomplishment of the core-elements, in particular communication-elements and storages.

<u>Many developers</u>

This characteristic is achieved by high modules accomplishment, openness of the system and usage of the instrument object interface in contemporary PL.

<u>Platforms</u>

The main idea about the system from this feature's viewpoint is that it should initially be developed on one PL and later to include in it specialized transformation-elements which to transfer the system into other platforms (OS/PL). This does not conflicting the ideology of the system because its source code could be considered as a specific representation of an object. This transformation-elements will facilitate its change if more platform accomplishments exist.

As a side effect translation of the system to one of Microsoft .net technology languages (C# for example) will give the possibility to use the advantages of this technologies as: easy transfer among the OS, development of the programming system at the same time on more than one PL etc.

System elements coming from the above reasoning could be considered on three abstract levels: logical, conceptual and physical. They are shown in Table 1.

		Logical level	***Conceptual level***	***Physical level***
System	Members	System members	Core+Configurator, Extension modules	Program units, Objects, Programs
		Subsystem members	Extension module(s) / Plug ins	Dynamic Libraries (.DLL, . SO и др.), Objects
			Element	
		Atomic subsystem	Services set (Element)	Objects, Object interfaces
	Stru.	Relations	Inter-element communications (Application)	Objects + Configuration + Communication

Table 1 Correspondence among the parts of the system on different level of abstraction

The general scheme (*Fig 2*) of the system architecture consists of three layers: core, expansion modules (plug ins) and applications.

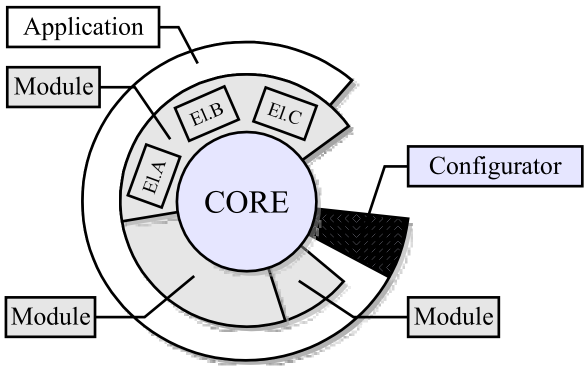

Fig 2 Structure of an open system for geometric modeling

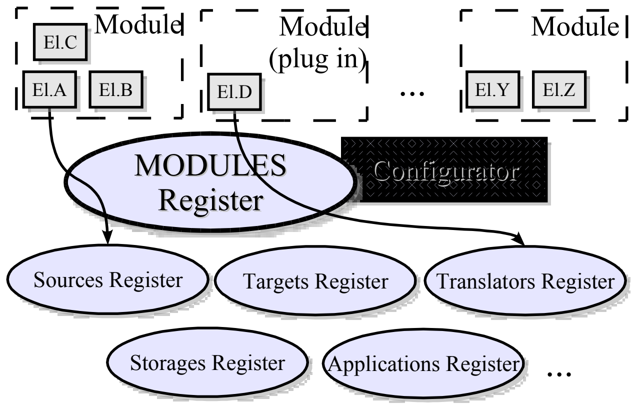

Fig 3 Registration of the elements in the system

Main kinds (types/classes) elements of the system (*Fig 3*) in accordance with their functions in it are: sources, targets, transformation-elements, system-core, registration-elements, and configuration-elements etc.

On *Fig 4* and *Fig 5* are shown cross and longitudinal section. The longitudinal section gives the

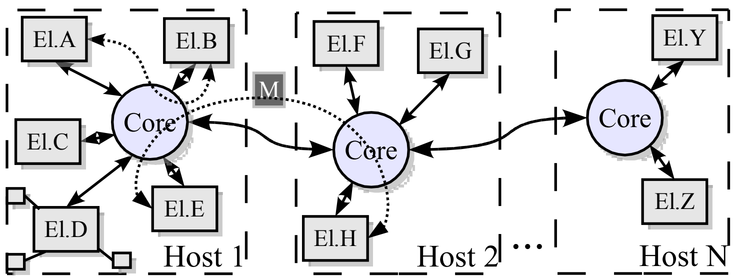

Fig 4 Longitudinal section of the architecture of a multiuser system for geometric modeling

idea of the system's multi-platformed state of work. On the separate computer systems (hosts) work copies of the core and elements which are available in the particular configuration. The cores do communication among the elements.

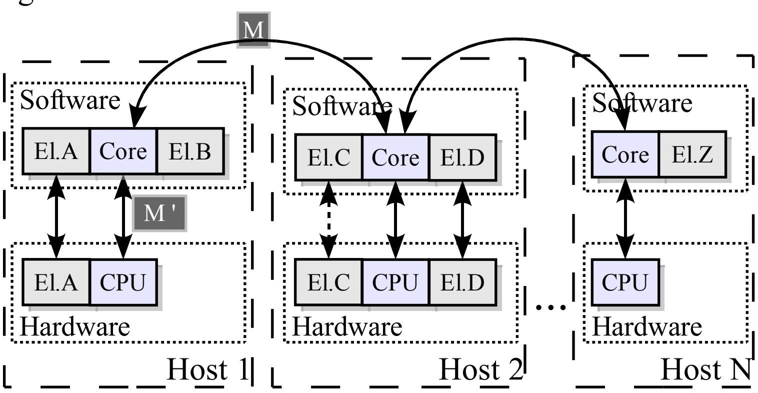

Fig 5 Cross-section of the architecture of a multiuser system for geometric modeling

This is done on the base of the available registered transfer protocols for exchange. On a computer system could work simultaneously several users and also a user could use the resources of some computer systems.

Cross-section demonstrates the possibility parts of system elements to be constructed as hardware.

4. STAGES OF ACCOMPLISHMENT

The goals determining three stages of development:

(I) System – creating of the core (registration-elements, configuration-element, communication, transformation, statistics, visualization, interactive work, storage, help subsystem etc.);

(II) Application – development of the base system elements (converters, communications etc.);

(III) User – development and usage of the system.

Each of the last two stages includes two aspects from the accomplishment viewpoint – if new possibilities are presented (system accomplishment) or already existed are adjusted and used (application accomplishment). On Fig 6 with set **A** is marked the set of system elements which expansion is a system accomplishment. Set **B** defines the system applications, which means that its expansion is application accomplishment. Set **C** consists of all potential applications, which could be accomplished through application accomplishment. System accomplishment leads to expansion of the set **C**.

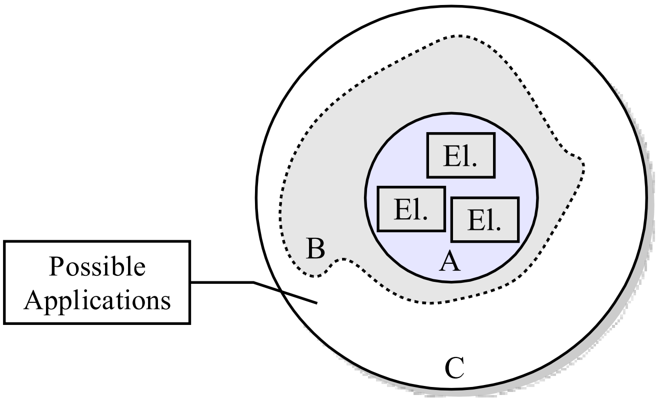

Fig 6 The space of expansions

5. CONCLUSIONS

The suggested architecture and way of building of a hybrid system for geometric modeling allows achieving a maximum openness of the system. This openness guaranties a very wide range of applicability. The most important field is outlined to be the research one. The second most important appeared to be the educational one because the accomplishment method will allow students to participate too. The last but not least in application aspect it is possible to configure effective, specialized system for geometric modeling.

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