INPROV - an environment for stress analysis of aeronautical structures

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Abstract: *The main objective of this paper is to develop a set of tools and integrate techniques in a software package dedicated to stress analysis of aeronautical structures.*

Key Words: stress analysis, aeronautical structures, 3D visualization, interface.

1. INTRODUCTION

In this paper we develop a new stage of the CNMP-INPROV project. Its general aim is to provide a set of tools and techniques, integrated in an interface, dedicated to stress analysis of aeronautical structures, taking into account the national experience consolidated with the most advanced specific methods.

The final result of this project is a complex system of integrated codes dedicated to the stress analysis of aeronautical structures, a system needed in order to develop and optimize new aeronautical projects.

2. DESCRIPTION

The three main components of this project are the CAD objects, the specific programs and the interface.

The structure and content diversity of the informatical objects operated by the INPROV applications impose the creation of a friendly interface. This interface allows the user to launch specific or standard applications (EXCEL, MSWord, MATLAB, IE) and functions for the management of objects (data structures, files, models, or display windows).

The applications (programs) of the INPROV project developed with different software products are independent from the project interface made in Visual Basic Windows.

The INPROV interface contains a standard VB form with the structure presented in Figure 1.

The source code includes: the extension of the class INPROV_Entry; the definition of the controls; the source of the methods which define the behavior during different events. The definition of any control contains: the membership to a class, settlement in the current class (here INPROV_Entry) and properties (name, position, dimensions).

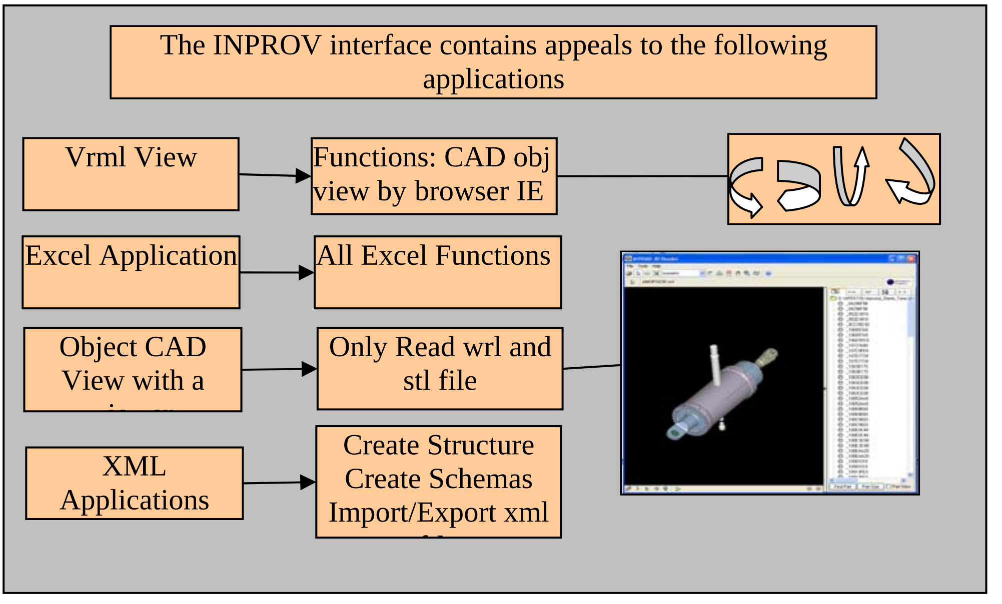

Figure 1. The standard form of the interface.

In Figure 2 we present a window of the INPROV interface with its controls.

Each of these control buttons has its precise role (Launching of a ViewerCAD, exploration of a database, launching of MSExcel, XML and Matlab applications).

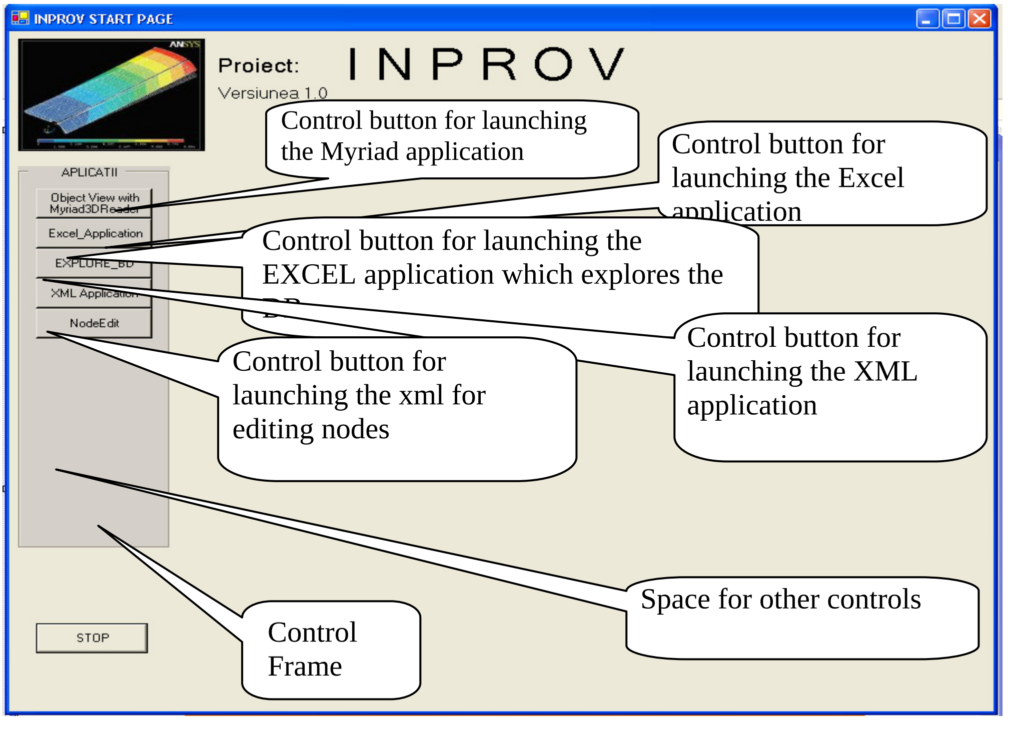

Figure 2. The INPROV interface

Mainly, we work with and on CAD objects (structures and substructures, for example a wing as a structure with its elements- spars, ribs, stings, panels, etc).

The data base (like the Knowledge Tree model) is in fact an MSExcel file with all information of the physical objects described in the project. So this pseudo data base contains for each object the CAD model, files associated with the CAD model, files containing important information about the object (physical properties, specifications, computing proceedings, standards), images (jpeg, jpg, gif), etc. The links between them at the object level are made when an object is registered. The access at the data base file is done by the buttons "Explore BD" or "Excel App".

The EXCEL application is launched by pressing the button "Excel Application". The control is taken completely by the MS Excel (EXCEL Session).

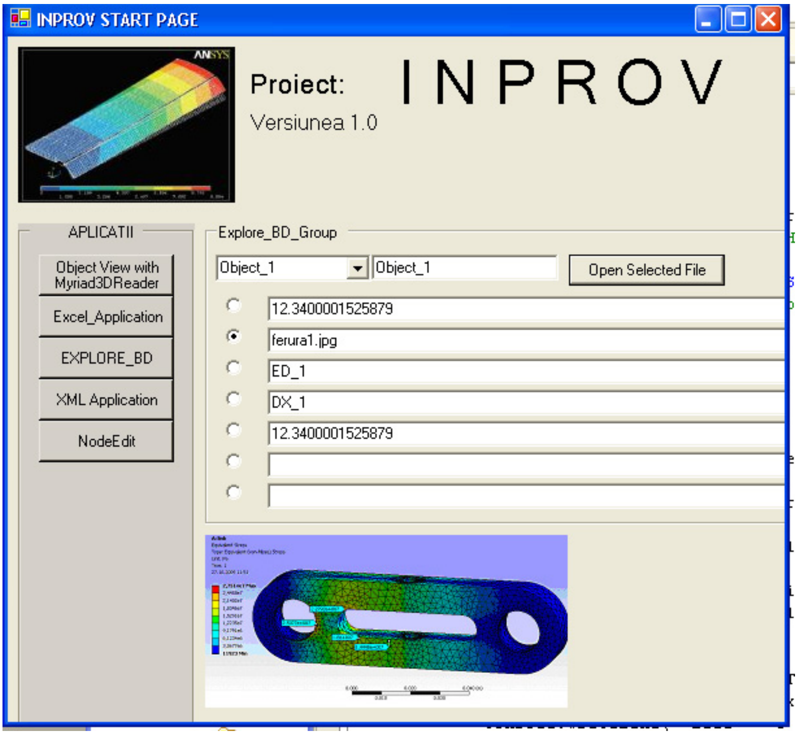

Fig. 3 Exploring the Data Base

A session begins accessing an EXCEL file which contains the names of the physical objects whose characteristics are described in the set of files. From a list of files of Combo type one chooses the physical object. As in figure 3 the names of the files which describe this object are displayed: the meta file, the draw file, the EXCEL file, the XML file, or others. Choosing the control DB one chooses the file that will be explored. The application is attached to this file. In Figure 6 the draw file is attached and the sketch of object becomes visible.

The button OpenFileDialog is utilized to open files.

Utilized functions:

Object_ComboBox_SelectedIndexChanged
ExtractObjectData
xlsBook = xlsApp.Workbooks.Open()
xlsSheet = xlsBook.ActiveSheet
xlsSheet.Range(   ).Value

For the moment we wrote EXCEL applications to calculate [3], [4], [5], [6]: moments of inertia, beam buckling; crippling, panel buckling, lugs (figure 4).

As future work we intend to integrate other codes (for example a code for calculation of the structural load from the aero dynamical pressures, or complex proceedings developed by using commercial codes as NASTRAN, PATRAN, ANSYS).

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Figure 4 EXCEL Window from the lug application

The visualization of the CAD objects contribute to a better understanding by the stress specialist that was not directly involved in the design process or has not access to the CAD soft.

The stress specialist can visualize the CAD objects from the data base as .wrl files, visible by using an IE browser with a Cortona or something similar. A better viewer is Myriad reader.

A viewer (here MYRIAD Reader) is a system designed to visualize and to publish problems associated to the distribution of the 3D CAD forms on the web for those with no access to the original files. It allows the conversion of the CAD models in a compressed format 3DF.

The files are published with visualization permission protected with a password, protection for printing and other options for publishing.

The 3DF formats can be visualized with MYRIAD 3D Reader without the copying or modifying option.

The dimension of these files is much smaller then for the 3D models and they are displayed in a very short time.

This viewer does not need an open session, the information can be transmitted through mail or sharing or other ways.

The installation of MYRIAD 3D Reader is easy as a desktop application or using a Web explorer.

Remarks:

It is no need to synchronize the tasks. The control is turn to the Myriad application.

This application allows only the visualization. No intervention on the CAD objects is allowed.

Myriad Reader has its own interface Myriad Reader (figure 4 and 5). The viewer MYRIAD 3D Reader allows the visualization of whole ensemble with rotation, pan and zoom possibilities, selections and identifications of components.

It also allows navigation and dynamic operations Orbit/Zoom/Pan on a 3D object, 2D measurements and offers the possibility to burn the executed measurements.

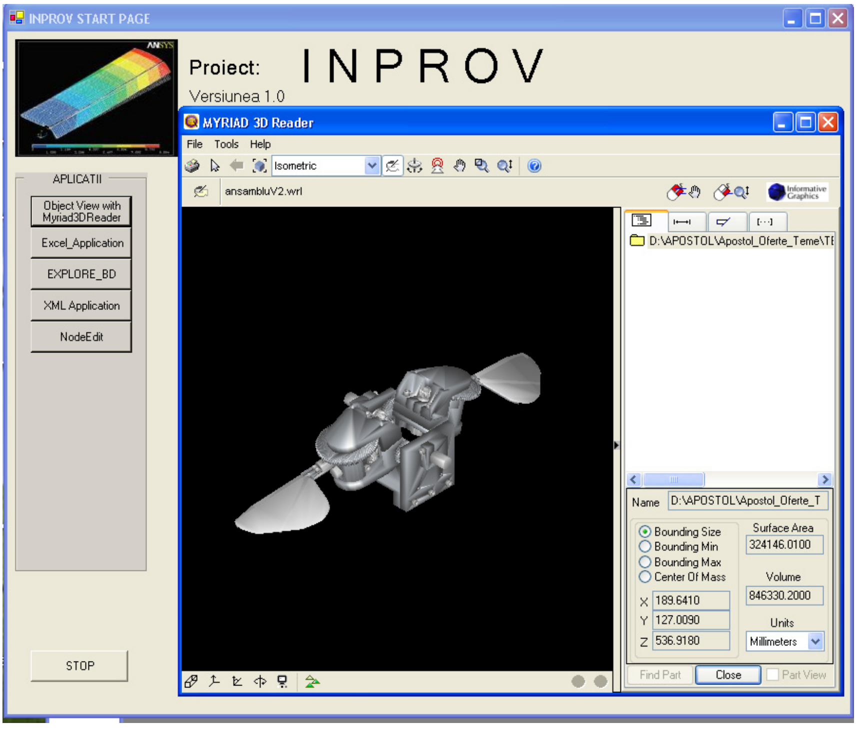

Figure 5. The viewer interface

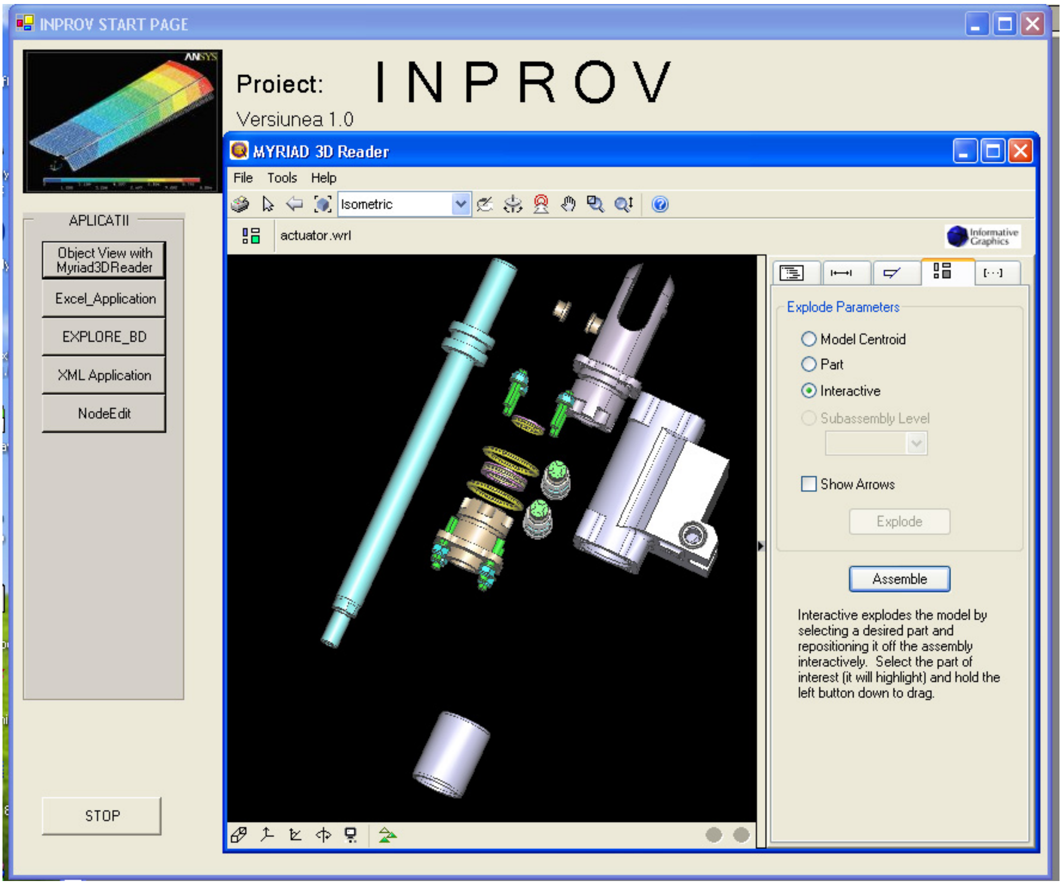

Figure 6. The viewer capabilities.

An important component of the INPROV project is that dedicated to create and manipulate the XML files.

The XML files allow the transfer of the unstructured data between different applications.

Beside the proper data they contain markers. A processor analyzes the data and the markers and sends them to the proper application.

To access a component a window is opened. In this window we can define and build a XML scheme that formally describes the XML document.

This document is created and validated in the same time with the scheme. Technically a XML scheme is an abstract collection of metadata consisting in a set of scheme components written in an .xsd file.

Usually a XML scheme can be graphically represented as a graph with a tree structure composed of nodes and subnodes (as the VRML technology requires).

The component developed in INPROV allows to edit such a tree structure and then to visualize it in a graphic format.

Attributes are associated to nodes and subnodes.

Each attribute is accompanied by alphanumeric values. Nodes and subnodes can not be copied but they can be deleted.

The XML application is launched by pressing the button “XML Application”. In Figure 6 a XML window is presented.

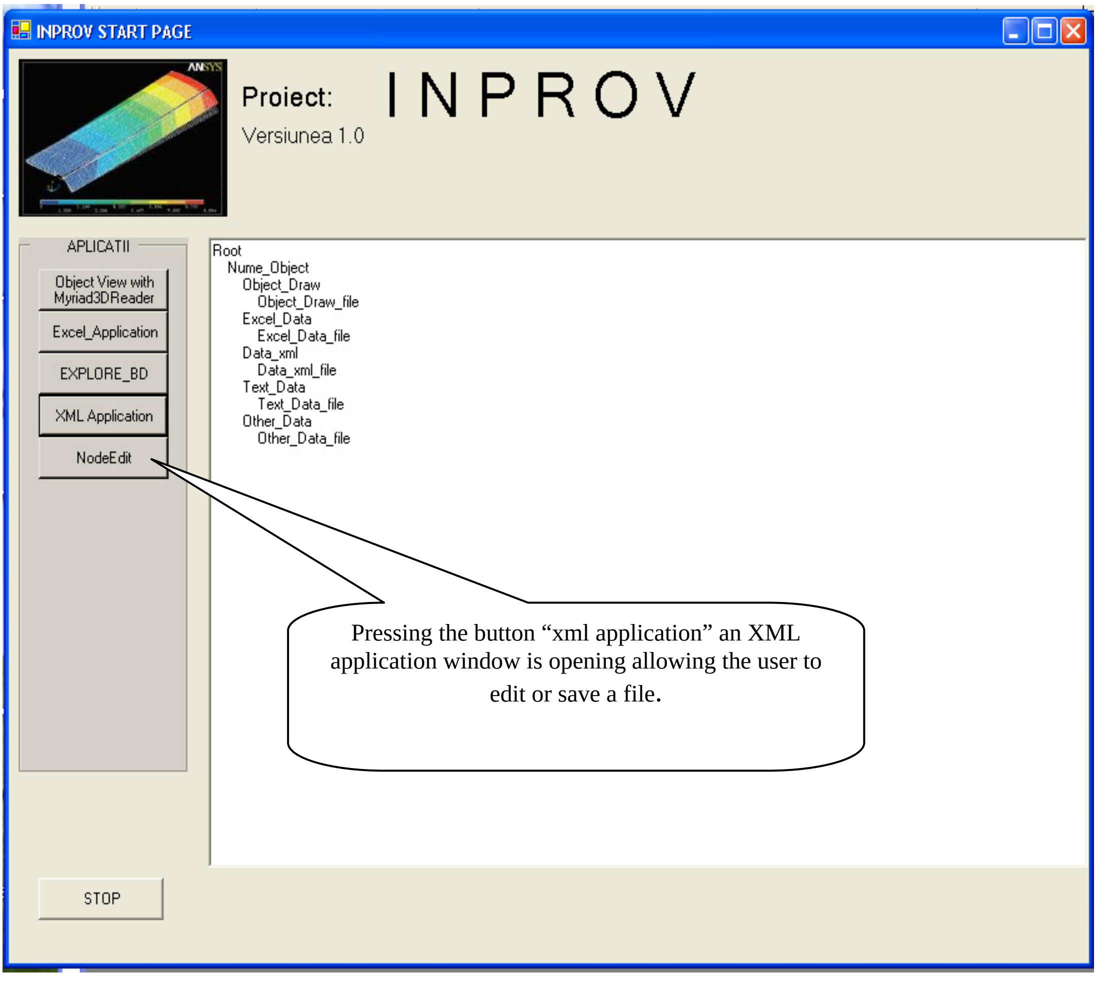

Figure 7 XML window

To define nodes and elements for a FEM analysis using ANSYS for example, the XML application can be used to edit tree structures, as in the following example:

Another important section of the INPROV project is that which connects the XML applications with MATLAB, using the MATLAB functions and MATLAB XML Toolbox to convert Matlab data structures in XML structures and reverses.

Thus, the results of the engineering applications are retained as XML structures and exported to other applications.

Future Work

- Adding new columns in the Data (generating at a request radio type buttons and text box buttons, capturing and offering the xls cell information);
- Registration of new data in the visualization (axes, forces, etc);
- Capturing the visualization space in order to distribute it.

Edited Structure Graphical Scheme

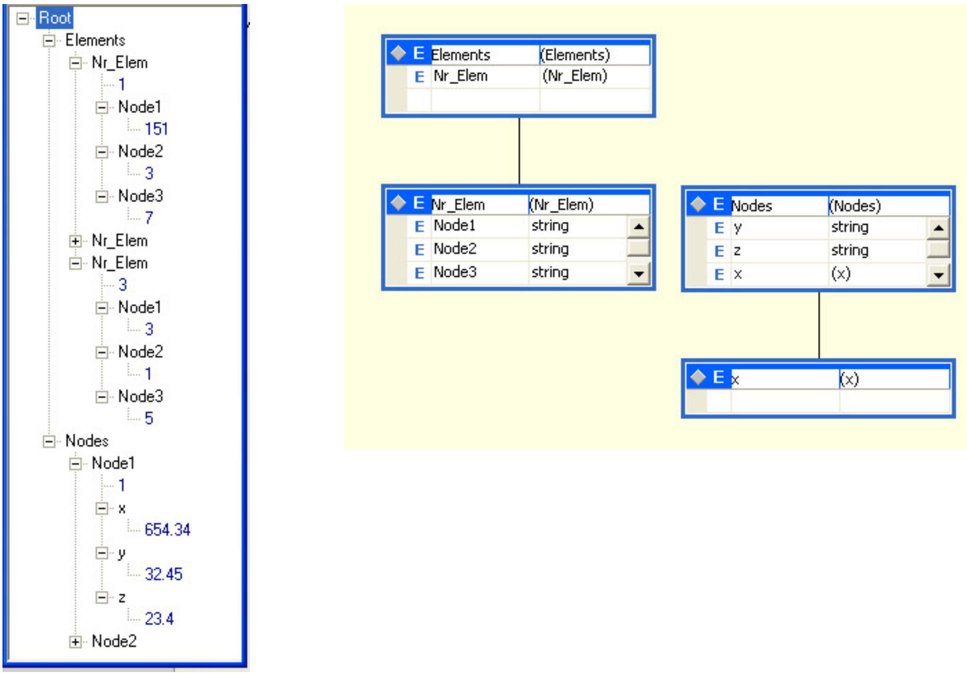

Fig.8 Node editing

3. CONCLUSION

The techniques and tools integrated in the proposed system allow to reduce the number of experiments made for the analysis of the aeronautical structures and therefore this leads to the optimization of the product design.

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