Java Plugin for ProcSee - Integrating 3D Visualisation and Virtual Reality Models in Operator Displays

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Abstract

Visualisation of information on computer screens has been a research topic at the Halden Project for more than 30 years, and the Project has built up strong competence and state-of-the-art systems for 2D and 3D visualisation. The systems are, however, based on different technologies. This paper describes an ongoing activity at the Project with the specific goal of providing means for integrating 2D and 3D visualisation in order to create even stronger features and achieve synergies.

Further, implementing a Java plugin to ProcSee enables ProcSee developers to take advantage of a wide range of features provided by the rich set of Java components available as commercial or open-source code. Examples of such features include charts, spreadsheets, sound, video, instant messaging, database access, networking and much more.

The Java plugin is currently under development, so no official ProcSee version supporting this feature has been released at the moment. However, a few pilot applications have been developed for demonstration and testing purposes. The pilot applications described in this paper include a 3D visualisation of a reactor core, a virtual reality model and a few examples using various open-source Java components.

The work on implementing the Java plugin will continue, and the feature will be released in future ProcSee versions. The Java plugin is also a vital component for improving the ProcSee graphics editor in future releases.

1. BACKGROUND

ProcSee [1] is the Halden Project's software tool for developing and displaying dynamic graphical user interfaces. It is used extensively by HRP and by HRP member organisations and is also provided as a product to external customers. ProcSee offers unique flexibility in building customised operator interfaces, and have been implemented on screen sizes ranging from small handheld devices, via traditional operator screens to large wall-mounted overview screens. ProcSee was previously known as Picasso, and its history dates back to the early 1980's.

Since 1998, virtual reality and visualisation of 3D models have been parts of the Halden Project's research programme [2]. Due to different needs, the technologies used in these activities have been different from those used in the development of ProcSee/Picasso. In 2000 HRP decided to use Java 3D [3] as the primary technology platform for the activities on virtual reality and visualisation of 3D models, after using proprietary technologies from different vendors for some years. The decision was based on requirements for open standard file formats, platform independence, and a desire to avoid run-time licence costs.

Strong competence and state-of-the-art technology for 2D as well as 3D visualisation within the same organisational unit makes it natural to see how these technologies can be combined to create even stronger features and achieve synergies from integrating the two technologies. The integration should preferably be a two-way integration: 3D models should be available from ProcSee-based operator displays, and ProcSee displays should be available from within the 3D software. The Java plugin for ProcSee supports the integration of 3D models into ProcSee displays. In addition, a Java-based application programming interface (API) is currently being developed and will enable the use of ProcSee from within Java applications, including HRP's 3D model software.

Technologically, ProcSee and Java have similarities. The core component in both technologies is a virtual machine that compiles and executes code provided by the application developer. Two major advantages from using a virtual machine are platform independence and the ability to add, remove and modify code at any time, even at run-time during end-users interaction with the application.

2. MOTIVATION – WHY ADD A JAVA PLUGIN TO PROCSEE?

Implementing a Java plugin to ProcSee opens up for several new possibilities as discussed in the following sub-sections.

2.1 3D visualisation

Using 2D displays has for many years proven to be an efficient way of presenting process information to operators. New innovative HSI designs have demonstrated how careful use of graphics techniques can improve operators' performance by presenting information in ways more perceivable to the operators. HSI design research has been an activity on HRP's research programme for many years, and the flexibility offered by ProcSee has been a key factor to success for this research.

However, information regarding physical phenomena that by nature are three-dimensional may be better presented to the operator using 3D visualisations. Obvious examples include information regarding temperature or pressure in a reactor core.

Java 3D is a scene graph based 3D application programming interface for the Java platform. It encapsulates the graphics programming using a real, object-oriented concept. By implementing a Java plugin to ProcSee, ProcSee developers can use the features of Java 3D to enable 3D visualisations within 2D displays.

2.2 VR-models

Since 2000 HRP's virtual reality activities have been based on the Java 3D platform. So, implementing a Java plugin to ProcSee will enable the integration of IFE/HRP VR-models into the ProcSee displays.

In a HAMMLAB experiment in 2004 called Extended Teamwork [4], the Halden Project demonstrated how the use of virtual reality models and manikins could improve control room operators' awareness of field-operators' present location and improve team communication.

With the new Java plugin, the integration of VR-models into the operators' interface is straight-forward. Further, when controlled from the same master application, operators will conceive the interface as much more uniform.

2.3 Java components

A Java plugin to ProcSee enables the use of other Java components as well. Numerous Java components exist, commercial and open-source, that can now be used directly in ProcSee displays. Examples of such components include:

- Standard user interface components like buttons, lists, and task-specific dialogs
- Spreadsheets and charts
- Sound and speech
- Video and camera
- Instant messaging
- Maps
- Database access
- Network programming

The list above is by no means complete. Java components exist for numerous tasks, and application developers now have the option of inserting such components directly into ProcSee displays.

ProcSee version 3.0 introduced similar features for the Microsoft Windows platform by supporting the use of COM and ActiveX components. Now, the Java plugin enables these features on all platforms and in a way that ensures that applications developed on one platform can run on all other platforms supported by ProcSee.

2.4 Platform independence

Platform independence has always been a major concern in the development of ProcSee. We believe that this is important for generic, long-living software products. ProcSee was originally developed on a set of UNIX platforms and now runs on UNIX (HP, Sun), Linux, Microsoft Windows and Mac OS X.

Java is widely recognised as very well suited when developing applications for a heterogeneous mixture of platforms, and the set of platforms supported by Java is far more comprehensive than ProcSee's. Thus, ProcSee's Java plugin enables ProcSee developers on all platforms to take advantage of the new features. Further, ProcSee-based applications using Java features can operate on all platforms supported by ProcSee.

3. PILOT APPLICATIONS

3.1 3D visualisation of reactor core with VNEM data

Work carried out at the Halden Project during early spring 2008 shows how the new Java plugin for ProcSee and a generic, configurable 3D-model can be used to present detailed information calculated by the VNEM code [5]. VNEM is a nodal expansion method to solve neutron transport equations, developed to increase the accuracy of 3-dimensional light-water reactor core analysis. The user can toggle between visualisation of power, burn-up and xenon, all calculated by VNEM.

The VNEM calculations of a scenario takes several hours, and VNEM is configured to store the results in a series of files, each file containing the complete set of values for a specific moment in time. The ProcSee/Java application can then replay a scenario by reading the files one by one, using the files' timestamp to control the progress. Replays can be faster or slower than

real-time, and may be stopped and resumed. A slider indicates the progress, and the user can jump back and forth in a scenario by moving the slider.

A reactor core consists of a number of fuel assemblies arranged in a grid. Each fuel assembly is typically 360 to 370 cm high. Within each fuel assembly, a number of fuel rods are arranged in a grid. When calculating, VNEM divides the vertical axis into a number of segments. The 3D model is constructed at system start-up, and the number of fuel assemblies, number of fuel-rods pr assembly and number of vertical segments are configuration parameters to the system. A typical example can be 15x15 fuel assemblies with 17x17 fuel rods pr assembly and 24 vertical segments; leading to a total number of more than 1.5 million data points each for power, burn-up and xenon. In the visualisation, colour-coding is used to present the data as shown in the figure below.

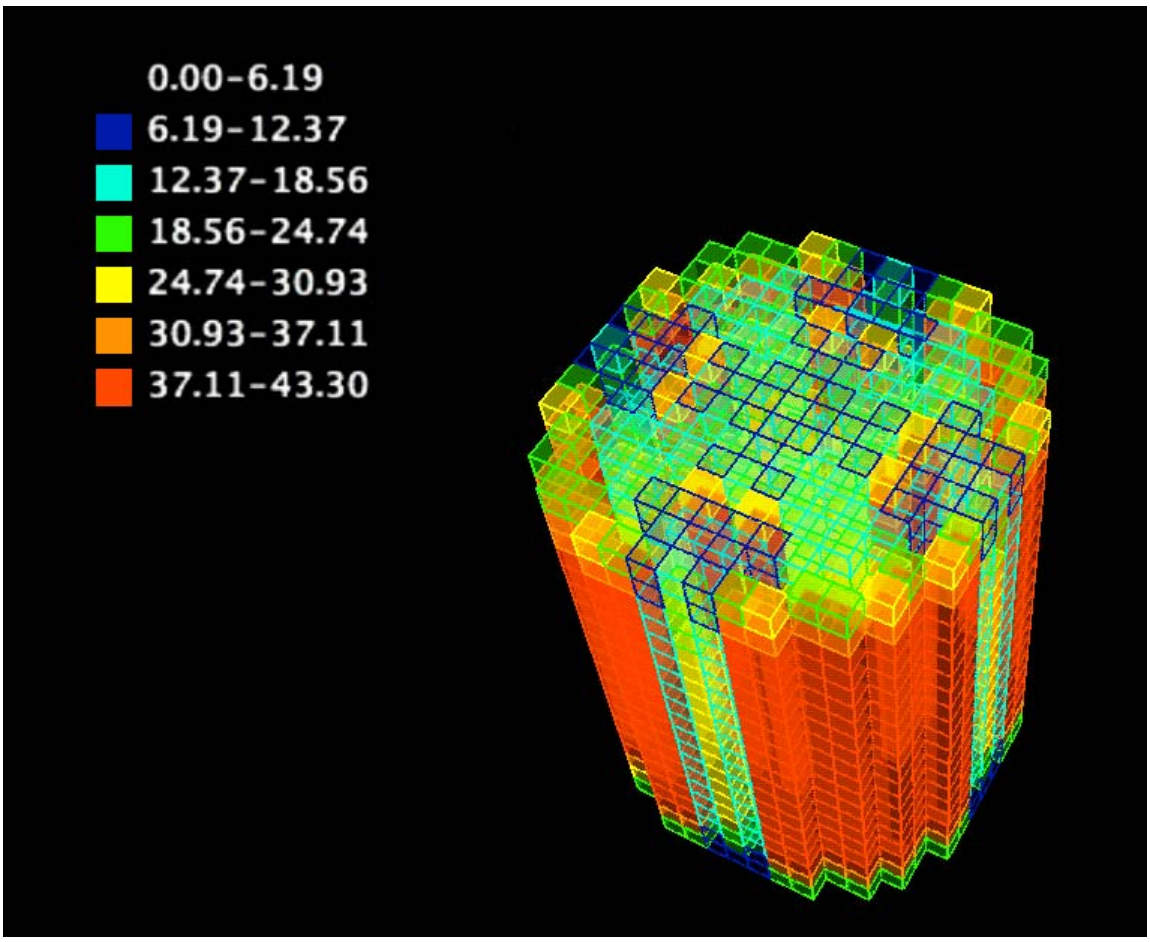

Figure 1: 3D visualisation of fuel rod burn-up in reactor core

During a scenario, users can rotate the 3D model and zoom in to points of interest to study details. Further, users can specify horizontal and/or vertical cross sections to study internals of the model.

3.2 Visualising VR-models of the operators' plant

As a proof-of-concept for integrating VR-models with operator displays, HRP's VR-model of the Halden reactor has been integrated into a HAMMLAB display. Although the VR-model

represents a totally different reactor, the demonstrator shows how operators can view and navigate the VR-model from initial navigation points selected by the operator.

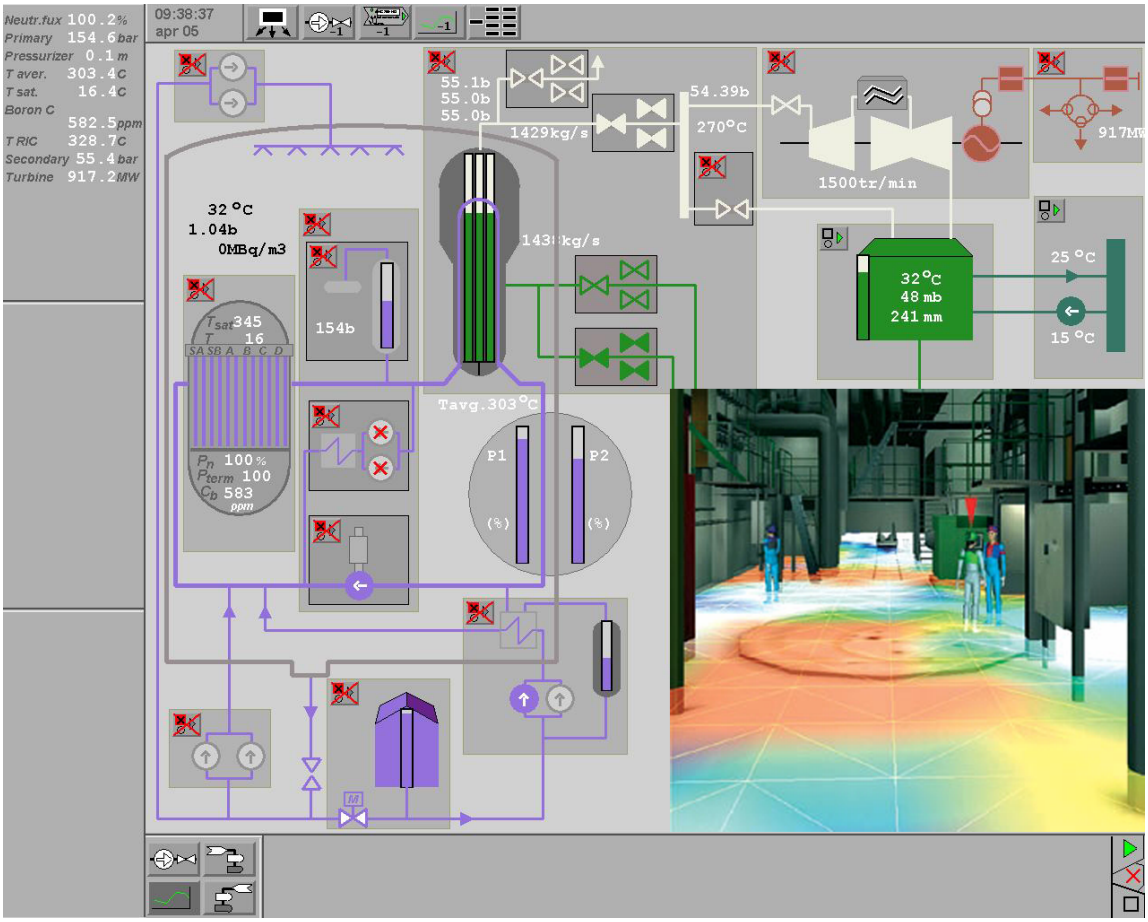

Figure 2: Virtual reality model of the Halden reactor integrated in a HAMMLAB display

Similarly, videos from surveillance cameras could be integrated into the displays.

3.3 Demonstrating the use of Java components

For demonstration and test purposes, a number of open-source Java components have been inserted into ProcSee displays. The picture below shows a few examples.

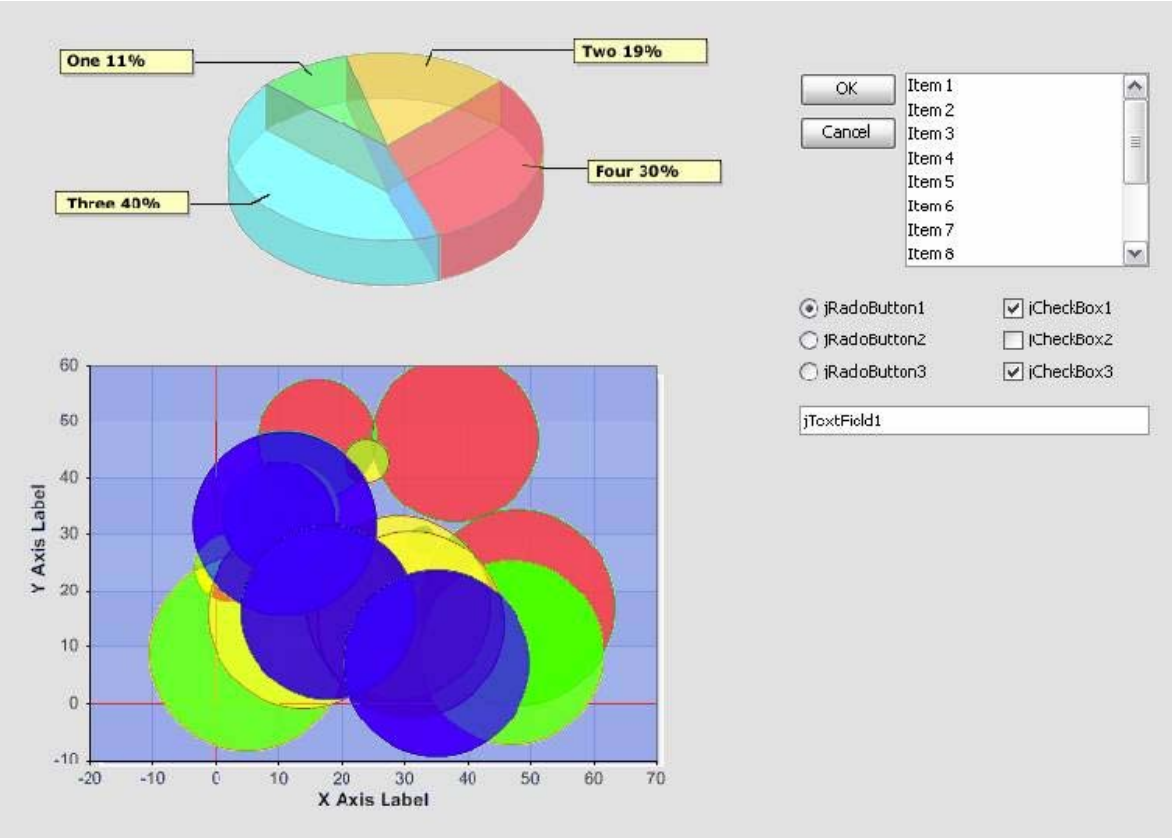

Figure 3: Various Java components in a ProcSee display

4. LIMITATIONS

Only Java classes conforming to the JavaBeans [6] conventions will in the longer term be fully supported by ProcSee. To be called a Java Bean, a Java class must obey certain rules about naming, construction and behaviour. Java classes not conforming to these conventions may experience reduced functionality when used in ProcSee, or even be completely rejected.

The first version of the Java plugin will have limitations that will be gradually fixed in future versions. By now the following limitations are foreseen in the first version:

- Functions with identical names but different argument lists will be renamed instead of overloaded
- Arrays of Java objects will not be supported
- Multi-dimensional arrays will not be supported
- The Java datatype long, i.e. a 64-bit integer, will not be supported.

5. CONCLUSIONS

The Java plugin for ProcSee is an enabling technology for integrating the 2D and 3D visualisation activities carried out at the Halden Project. Using the plugin, 3D visualisation and virtual reality models can be presented within ProcSee-based operator displays. On the other hand, a new Java-based API for ProcSee will enable the use of ProcSee displays from within 3D and VR-models.

In general, the Java plugin is attractive for application developers because it enables the use of a large number of commercial and open-source components with advanced functionality directly from within ProcSee operator displays.

A few pilot applications have been developed to test and demonstrate the functionality.

6. REFERENCES

[1] ProcSee is presented on the web at www.ife.no/procsee

[2] The Halden Project's activities on virtual reality and 3D visualisation is presented on the web at www.ife.no/vr

[3] Java and Java 3D is presented on the web at java.sun.com/

[4] A.B.Skjerve et al.: "The Extended Teamwork 2004/2005 Exploratory Study. Preliminary Results", HWR-812, Presented at the Enlarged Halden Programme Group Meeting, Lillehammer, Norway, October 2005.

[5] M.Tsuiki, W.H.Beere: "A variational nodal transport method for pressurized water reactor core calculations", Proceedings of M&C Avignon, 12-15 September 2005, Avignon, France.

[6] Sun's JavaBeans product page: java.sun.com/javase/technologies/desktop/javabeans