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Application Design with the Intuitive Tools

– Two Case Studies

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Application Design with the Intuitve Tools – Two Case Studies

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Abstract

This report describes the first prototype implementation of the Intuitive tools and experiences of applying the Intuitive Tools in application building. Two prototype implementations are described and the implications on the user interface are discussed. User feedback is also reported.

Contents

1. Introduction

This report is the third in a series of reports from the Intuitive Project. The Intuitive Project is an ESPRIT III project in which SISU is a participant. The objective (of the Intuitive project) is to provide efficient and easy to use solutions for end-users to access heterogeneous information sources.

The reports document the work carried out by SISU during the first year of the Intuitive Project. Two other SISU reports are available at the moment. Rosengren et al describe the fundamental concepts of the Intuitive system [Rosengren93]. As Rosengren et al explain, the four end-user tools are central to the Intuitive system. Wingstedt et al detail the requirements with regard to these end-user tools including their internal architecture [Wingstedt93].

The aim of the end-user tools is to make it possible to use multimedia information stored in a set of databases. The four main objectives to be met by the these tools are:

- Provide overview and understanding of available information.
- Provide a short mental distance between users' information needs and how to express a query with the tools.
- Help users understand and interpret the results from queries to the databases.
- Provide a seamless interaction allowing users to switch between different operations in a non-obtrusive way.

As is explained by Wingstedt et al, the Tools will support users in the following information retrieval tasks:

- *Selection.* Users will be given support for formulating queries that select a set of information entities.
- *Navigation.* Users will be provided with an overview of available information resources at a conceptual level.
- *Browsing.* Users will be assisted in seeking information by inspecting information entities at the instance level.
- *Presentation.* Users will be supported in understanding and interpreting the result brought to them from a search in the information resources.

The support for these tasks may be implemented in various ways, using different methods, dependent on what is found to be the most suitable implementation for a given task.

To support the user in the above tasks four types of end-user tools will be implemented:

- Selector
- Navigator
- Browser
- Presenter

These tools will be general tools. This means that they can be applied in different applications for a different set of databases without reprogramming.

The different tools will provide a seamless way of interaction where the user can switch between different subtasks of the information retrieval process. The tools will have specific graphical interfaces and can be controlled by mouse, voice, and keyboard. In addition, they can also be controlled by other software modules of the Intuitive system such as the Dialogue Manager. In this way Intuitive will provide a *mixed initiative* style of interaction, i.e. the tools may be controlled by either the user or the system.

This report describes the first prototype implementation of the Intuitive Tools and our experiences of applying the Intuitive Tools in application building. The report is organised as follows: first an overview of the prototype work is given in Chapter 2 as well as a presentation of common elements in the prototypes. Chapter 3 describes a generic prototype that has been built to validate our approach. Comments and feedback from demonstrating the prototype for users are presented. Chapter 4 then describes how the graphical interface for a medical application has been produced from the generic prototype. This leads into Chapter 5 which explains how multimodality, i.e. combining speech and graphics, has been added to the graphical interface. In Chapter 6 we discuss application design issues. Chapter 7, finally, describes our future work.

2. Overview of Prototype Work

During year 1 of the Intuitive Project three prototypes were developed:

- A generic prototype called "The SISU Knowledge Base".
- From the generic prototype, the user interface was tailored to produce a Medical Demonstrator with a graphical interface.
- Multimodal interaction, with speech and pointing, was added to produce a multimodal Medical Demonstrator.

All three prototypes are developed around the same architecture. The common elements in all prototypes are:

- Four end-user tools
- SQL database
- ODBC (Open Database Connectivity)
- Conceptual dictionary
- Multimedia data

The four tools - *Navigator*, *Selector*, *Browser* and *Presenter* run under Microsoft Windows 3.1 and have been developed using Visual Basic.

The database used is an SQL database called QuadBase. The tools communicate with the database through the ODBC protocol. All meta information the tools need, i.e. conceptual maps, mappings between conceptual map and database schema, data types, the default graphical layout of the conceptual maps, is stored in a dictionary [Rosengren93]. The Dictionary has been implemented as a set of relational tables in the database. The structure of the dictionary is described in the following model:

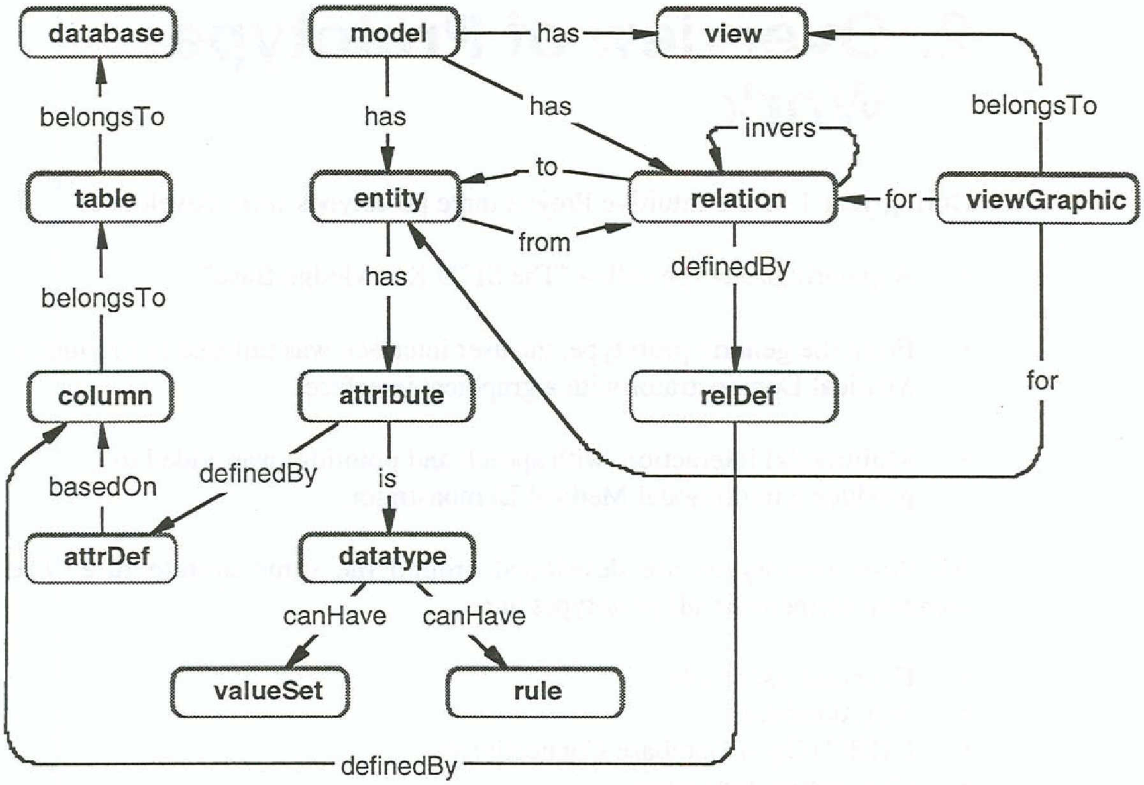

Figure 2.1 The Dictionary Structure used in all prototypes.

Multimedia data, e.g documents, x-rays, and pictures, are stored as ordinary PC files with pointers from database fields to the files.

3. Generic Prototype

The generic prototype shows the four end-user tools in their default mode. The database chosen as an application for the generic prototype is a database with information about SISU. The application is called "The SISU Knowledge Base". The intended user is someone working at SISU or a person working at one of our sponsoring companies.

The database contains information about our research projects such as SISU reports, project descriptions, project deliverables, project documentation, literature overviews, video seminars etc. We have also encoded information about the employees at SISU, their work, their expertise and interest and how to contact them.

Here are some examples of what we know users would like to query the database about.

- In which projects are SISU currently participating?
- Do SISU and Cap Gemini Innovation have any ongoing collaborative projects?
- Which people at SISU work with HCI issues?
- Give me the report about tools for graphical user interface design.
- Give me the video of the seminar "Business Design".
- Has anyone from my organisation participated in a project together with SISU?

There is also a need to make more fuzzy searches, for instance free text search over all documents in the system or keyword searches over all multimedia information, irrespective of the type:

- What does SISU know about business process re-engineering?
- Does the database contain anything on visual languages?

We expect that the users of this system will use it infrequently. This implies that it must be easy to learn and easy to remember how to use. The overview of the available information is crucial, therefore the design of the Navigator is of utmost importance.

The prototype consists of four end-user tools - Navigator, Selector, Browser and Presenter. The Navigator gives the user an overview of the information available within the databases. Figure 3.1 shows one way of visualising the information structure, in which icons are used to illustrate important concepts.

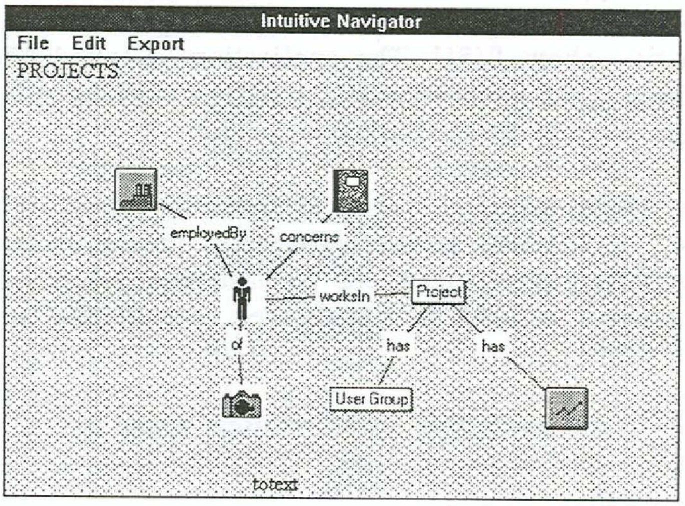

Figure 3.1 Navigator map visualised with icons.

Once the user has navigated around the information structure and found the parts of the map in which he is interested, he selects the part of the map he wants for further querying. The submap is exported to the Selector where the user can add further constraints to restrict his querying, for instance to add that he is only interested in pictures of persons working in companies in Stockholm. The Selector is shown in figure 3.2.

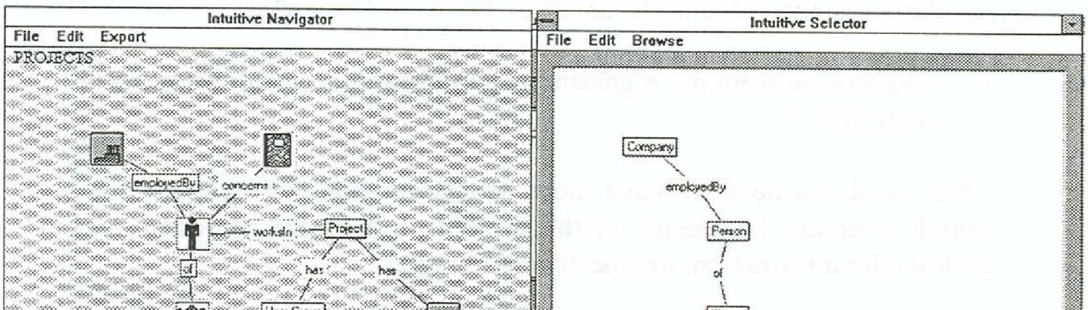

Figure 3.2 User formulates his query with a Selector.

The query is sent to the database. In the prototype we use Quadbase, an SQL database for Windows. The result is retrieved and displayed in the Browser. The Browser works in a synchronised manner [Wingstedt93]. Pictures are indicated with camera icons. If the user double clicks on the column with camera icons, the corresponding pictures are displayed as miniatures, called thumbnails, see figure 3.3.

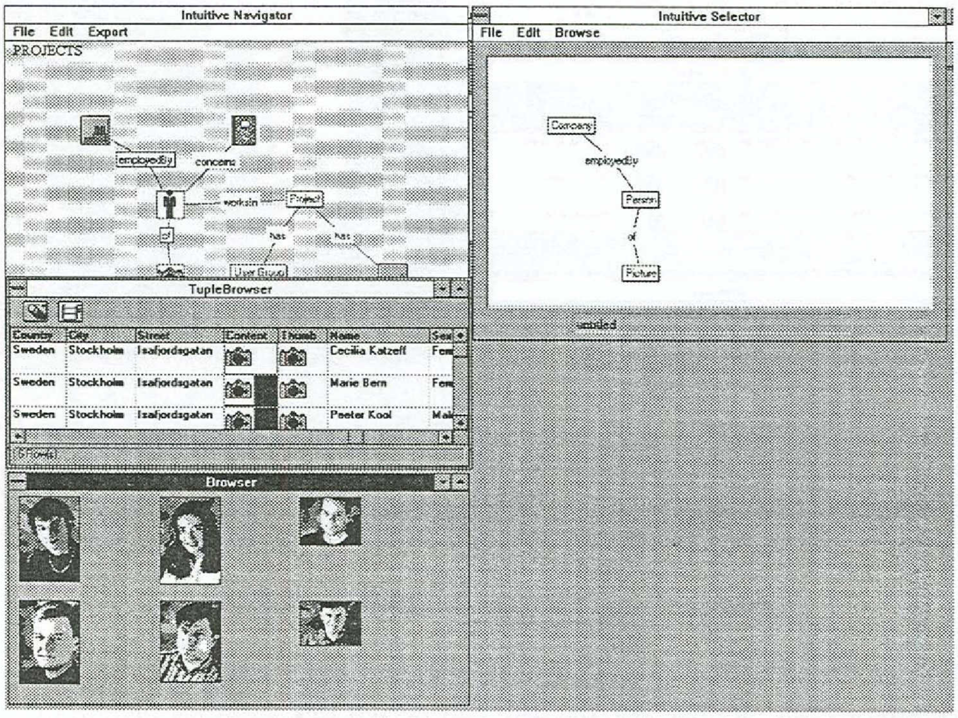

Figure 3.3 The result of a query can be viewed in different browsers.

If the user wants to see a picture in full resolution he double clicks on a thumbnail. The picture is then displayed in the Presenter, see figure 3.4.

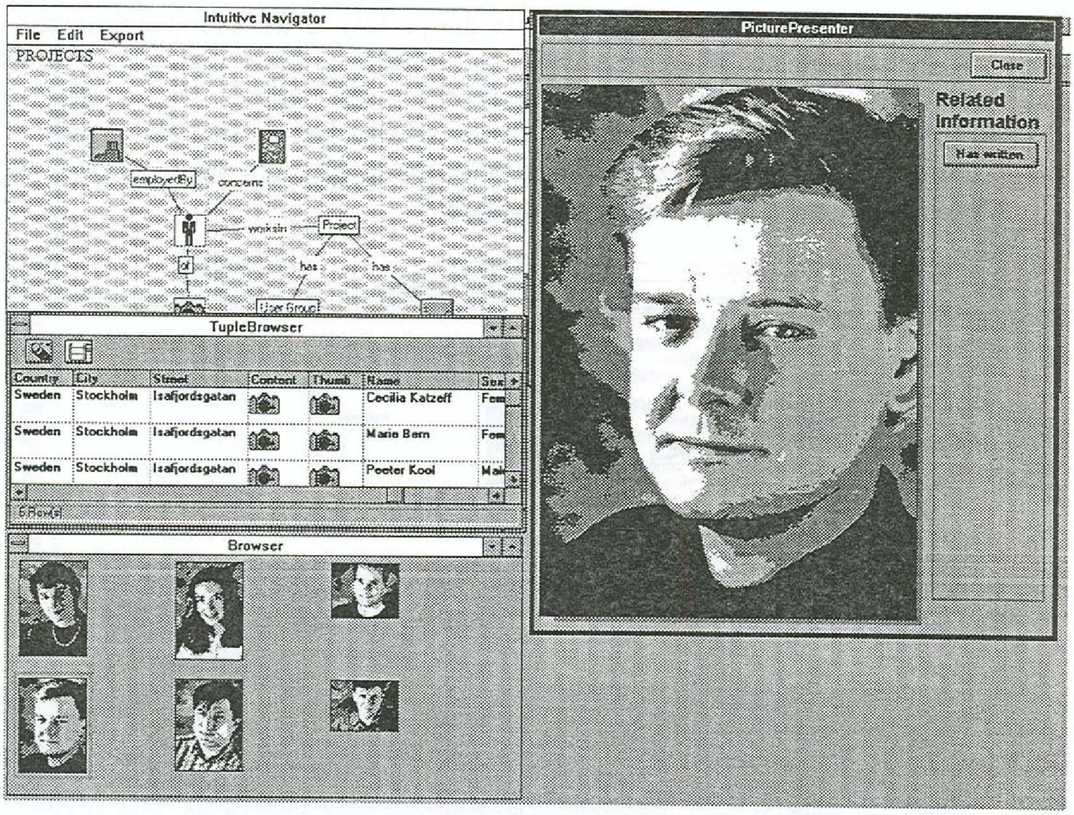

Figure 3.4 Data items can be viewed in full detail.

Buttons for accessing any related information will be displayed together with the picture. In this case the user followed a link from the picture to a related document. This document can be exported to Word or any other word processor by clicking on the button "Show in external", see figure 3.5.

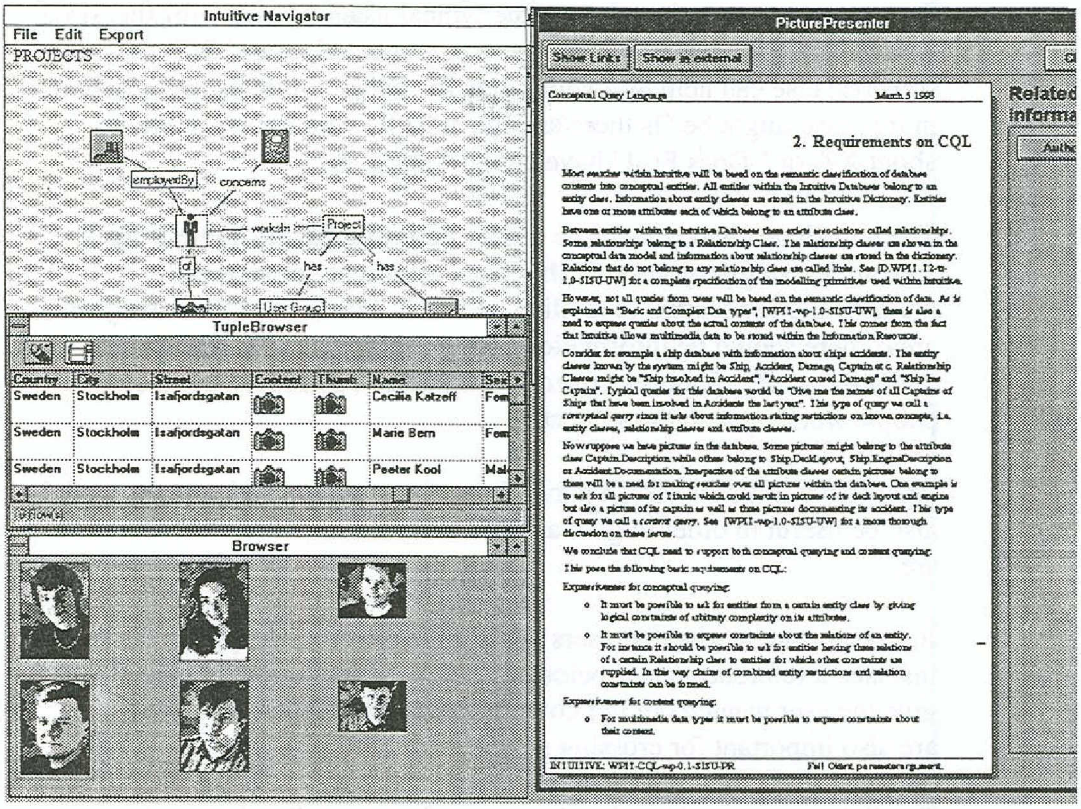

Figure 3.5 The user followed a link from a picture which led him to a related document.

Our approach of dividing the user interface into four distinct tools and presenting them to the user as tiled windows has similarities with the InfoGrid system [Rao92]. However, that system is not intended for ER databases, but focuses instead on document retrieval. Also, InfoGrid does not have any module that corresponds to a Navigator.

In the user interface we have tiled windows for several reasons; they save screen real estate but are also advantageous from a usability perspective since they give the user an overview of system status.

3.1 User Feedback

User feedback on demonstrations has so far been promising. The overview provided by the ER schema visualisation in the Navigator and the hyperlink facilities for exploratory searching have especially been pointed out as attractive features.

The following is a summary of the users' comments (slightly edited) which were noted during a meeting with the Swedish User Group for Intuitive:

- The representatives thought that the typical usage scenario for the SISU Knowledge Base would be that the user wants to know if SISU or someone else can help him with a specific subject. Interesting questions in this case might be "Is there anyone at SISU who knows anything about X?" or " Does SISU have a report about X?".

- The knowledge base should be organised into different subject areas. Instead of using projects etc., the focus should be for instance multimedia, conceptual modelling and HCI. For each of these subject areas there should be information about ongoing and finished projects, compilation of references covering the subject, seminars, courses and people working with the subject.

- Apart from this structure, a parallel one for seminars and courses would also be useful in order to give a quick overview of what activities there are.

- It is important to give the users possibilities to cross subject areas (for instance a reference could belong to many subject areas) in order to give the user wanted but unknown information. Hypertext-style links are also important for crossing subject areas.

- The links were considered an important feature. A link history list was considered necessary in order to give a useful system.

- An interface for creating links easily should be developed to allow the user to define new links in run-time. These links should possibly be private for the user and not directly available for others.

- The system should stimulate the user to discover and retrieve more than his primary need. This is taken care of by a good link structure, but is perhaps not enough. A "What's On" and an open bulletin board could be useful as a complement. This "extra" information that users occasionally find is added value.

- All users must easily realise how to find information, but people behave and think differently which implies that there must also be alternative ways of finding it. If someone wants to know more about HCI, the system must give him the opportunity of finding it through different kinds of links from, for instance, Mr Rosengren, the "Electronic Course Catalogue" or documents on the subject.

4. Graphical Medical Demonstrator

The application area for the medical demonstrator is radiological examinations at a Spanish hospital. The primary users are *radiologists* who use the system to prepare reports about radiological examinations to be sent to requesting physicians. Examples of information they need to include in a report are radiological images, i.e. X-Rays, computed tomography, magnetic resonance, patient identifications and text reports.

The characteristics of the medical demonstrator compared with the generic prototype are:

1. The database schema is small with a non-complex structure.

2. The users' information needs are well-known. Only 8-9 different queries are needed.

3. When presenting information to the user several sources need to be combined.

4. Information retrieval takes place as part of a larger task, in this case the preparation of a report.

These four points have the following implications for the user interface compared to the generic demonstrator:

1. There will be no problems with overview of the information space and understanding of the information structure. This implies that we can use a *simplified Navigator*.

2. There is no need for a general query language, which implies we can use a *specialised Selector*.

3. We need *advanced presentation planning*.

4. The Intuitive system must be able to communicate with external modules.

In the following we will see how these implications are manifested in the user interfaces.

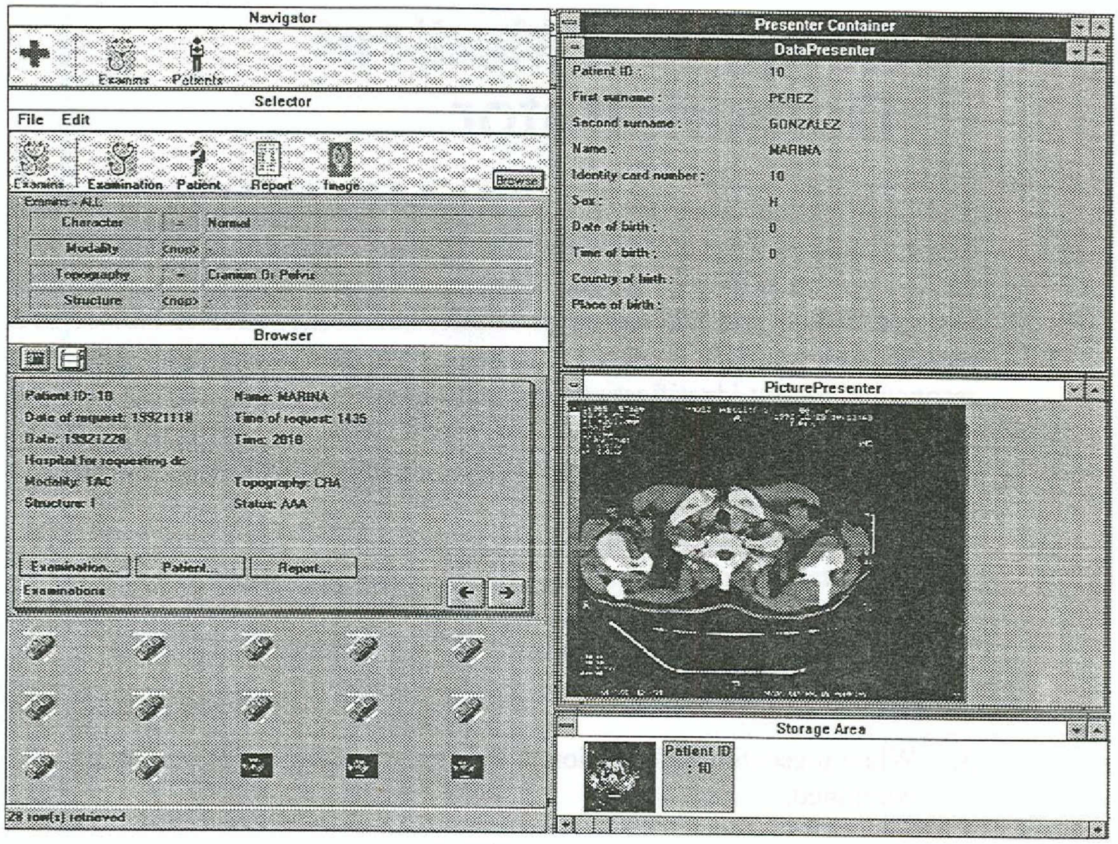

Figure 4.1 The medical demonstrator.

Figure 4.1 shows the overall layout of the graphical medical demonstrator. Each tool has been tailored for this specific application. In the following we will discuss how the Tools user interface differs from the generic prototype:

- The Navigator contains only two icons each of which represents a predefined underlying database view (Fig 4.2). If a user clicks on one of the icons, the database view is automatically exported to the Selector.

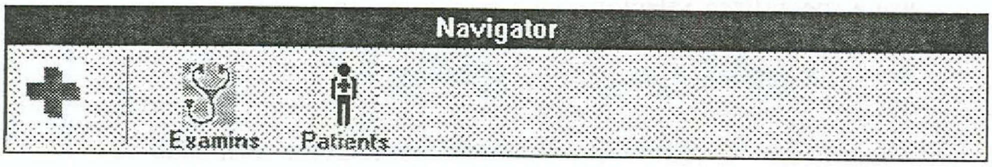

Figure 4.2 Simplified Navigator

- The Selector is tailored in that it only shows the attributes that can be restricted. More advanced methods of entering search criteria in the Selector are another feature. In the figure below the user can enter values for the attribute "topography" by clicking on a skeleton (Fig 4.3).

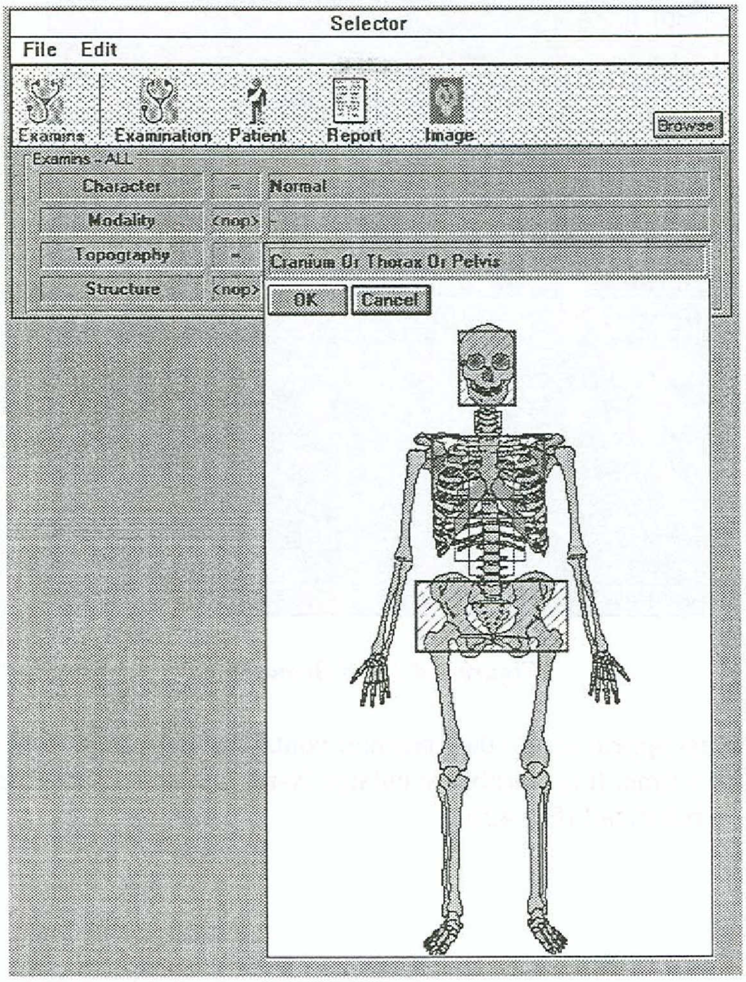

Figure 4.3 Specialised Selector

It should be noted that this feature is general. It can be applied to any value domain where the values correspond to a spatial position in an image, for instance city locations in a geographical map. Information about the value domain and its corresponding image is stored in the Intuitive dictionary.

- The Browser shows examinations as a stack of cards, each with a set of X-ray images. The Browser still works in a synchronised manner (Fig 4.4).

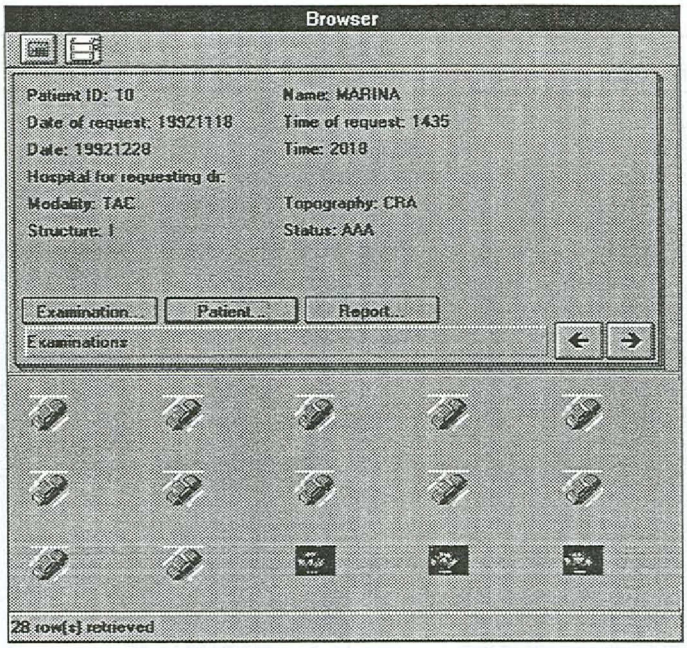

Figure 4.4 Card Browser

- Presenters appear inside the presenter container that can present several items at a time. It is possible to enlarge X-ray pictures in order to view them in full detail (Fig 4.5).

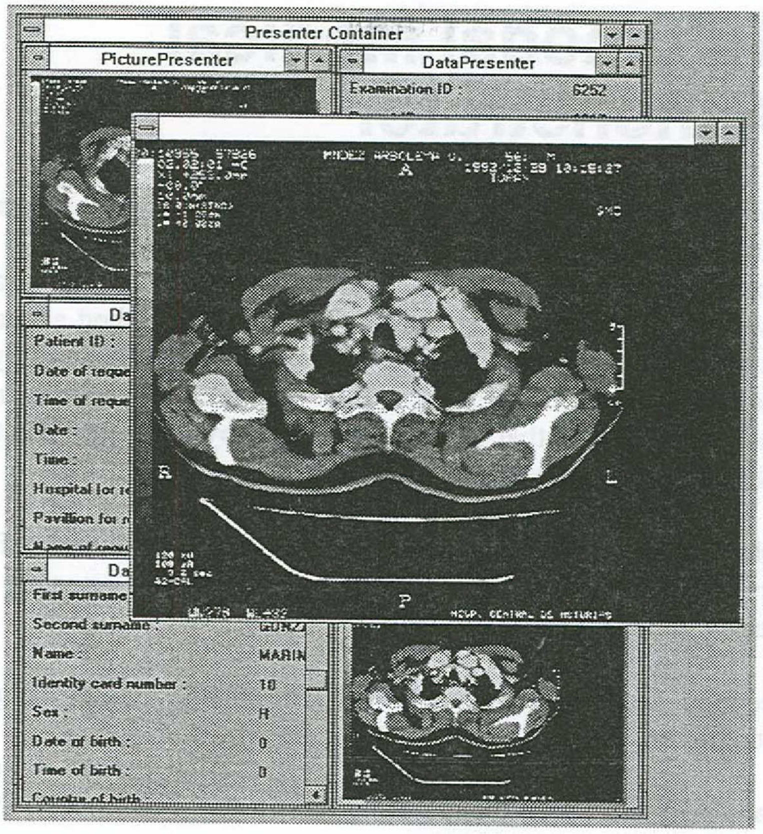

Figure 4.5 The Presenter with a full resolution presentation of one picture instance.

Another difference in the Graphical Medical Demonstrator is that a Presentation Planner dynamically constructs the Browser depending on the result retrieved.

The design of the medical demonstrator was based on requirements expressed by Spanish radiologists.

5. Multimodal Medical Demonstrator

The multimodal medical demonstrator has the same layout as the graphical medical demonstrator. The speech technology used consists of a speech recognition card (Datavox) that can handle vocabularies of 500 words. The card allows use of several vocabularies that can be switched according to current context. The card uses so-called "connect-word" technology which allows the user to speak a string of words. The speech system is speaker-dependent, which means that it must be trained by its users. The training time for the Medical Demonstrator is 30 minutes.

To be able to use the speech recognition card together with the Intuitive End-User Tools the following functions have been implemented by Cap Gemini Innovation:

- Voice input module to manage the recognition and to filter the quality of recognition.
- Vocabularies can be switched during run-time.
- Speakers can be switched during run-time.

Integration of speech and direct graphical manipulation has been implemented at four levels:

- *Short commands* like "Show", "Open", "Delete" can be spoken directly by a user.
- *Window Management* functions like "Hide Window", "Close Window", "Show Window" can be controlled by voice.
- *Query Formulation* allowing the user to enter search criteria by speech.
- *Multimodality*, allowing the user to perform operations by pointing and speaking at the same time.

The multimodal features of the user interface have been developed by Cap Gemini Innovation, France.

6. Application Design

So far we have focused our discussions on how the tools look and behave from a user's point of view. But we also need to address the needs of the application designer. To give support for fast and efficient construction of highly usable ER-based information retrieval systems we need to develop a design methodology that is easy to follow for application developers. In this section we will briefly outline the various design steps an application builder has to go through in order to customise the tools for an application.

It should be clear that the tools constitute a high level toolbox for design of information retrieval applications. As Rosengren et al explain, the dictionary is the kernel of the system and in fact application building with our tools is to a large extent a matter of populating the dictionary with the correct meta information [Rosengren93].

The first step is to define a conceptual model of the information space in which the tools are to operate. This also includes choosing value domains and their representation. The description of the model and the mapping to the underlying database are stored in the dictionary.

An optional step is to define links between data items. Note that links are optional; they were used in the Generic Prototype but not in the Medical Demonstrator.

Given the conceptual model, the next step for the application builder is to decide how each tool will manage this model. Below, we will describe briefly how the Navigator and Selector can be customised.

Navigator design consists of defining different views of the conceptual model for different users and tasks and deciding on a visualisation of the conceptual model. An example of this was shown in the Medical Demonstrator. There the designer chose to collapse the entire schema into two views each visualised with one icon. The rationale for this was derived from the preceding task analysis.

Selector design involves designing the query facilities that will be available for the user. The default option for the designer is to use a query-by -example like ER-Selector, which could be seen in the Generic Prototype. This requires no extra effort from the designer since the default Selector is automatically available once the conceptual model has been defined.

If the user's task consists of queries that often are repeated the designer has the option of predefining these queries, with or without parameters. These predefined queries can be packaged into a separate Selector, as was the case in the Medical Demonstrator, or made accessible from the default Selector. This depends on what is most suitable for the task. However, our own experience has shown that it is almost impossible to foresee all possible queries users might want to ask. We believe, therefore, that users always need to have access to a general query facility like the default Selector.

7. Future work

We are currently evaluating our approach in building three different applications - a Knowledge Databank for salespersons, a multimedia repository interface and a combined customer database/file system. The experience from these will give us valuable feedback on the design of our system.

A special evaluation workpackage has been assigned within the project for this task. The methodology used for evaluation has been described by Hobday et al [Hobday93].

8. References

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Swedish Institute for Systems Development

The Swedish Institute for Systems Development, SISU, was established in 1984 jointly by the Swedish National Board for Industrial and Technical Development (NUTEK), and by a number of founding organisations. Today SISU co-operates with 40 affiliated companies, organised in the Association of Supporters of Information Systems Development in Sweden (ISVI). SISU's affiliates represent government departments, as well as public and private enterprises. The set of affiliates includes ABB, CAP Programator, Digital, Ericsson, IBM, Swedish Telecom (Telia), Sweden Post, S-E-Banken, Skandia, SKF, Statskonsult, Statskontoret, Unisys, The Swedish State Power Board and Volvo.

SISU's mission is to serve as a bridge between national and international research institutes and universities and networks, and the industrial, business and public sectors in Sweden. Hence, the primary goal of SISU is to provide an infrastructure for the development of improved competence in information systems development and use throughout the public and private sectors of the Swedish national economy.

SISU employs 40 researchers and has an annual budget of 4 MECU. The Institute is currently participating in 5 CEC R&D projects (4 ESPRIT and one within the AIM programme). These projects concern enterprise modelling, requirements engineering, conceptual modelling, multimedia databases and interoperability issues in decentralised information systems. SISU's research concerns the following R&D areas:

- Business Engineering Methods: methods and tools for business and information strategy analysis and planning, information systems planning and conceptual enterprise modelling.
- Information System Engineering: the development of methods and tools for formal description and design of information systems. CASE-shell technology, method modelling, advanced CASE functionality, experiments and assessment of CASE tools.
- Human-Computer Interaction and Communication: advanced interfaces to databases by the use of graphics and natural language, usability and cognitive aspects of hypermedia techniques. Computer supported co-operative work (CSCW). Architectures for federated information systems and interoperability issues.

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