THE ISQL LANGUAGE
A SOFTWARE TOOL FOR THE DEVELOPMENT OF PICTORIAL INFORMATION SYSTEMS IN MEDICINE

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1. *Objectives and Problems*

From the electronic storage and management of radiographic images many advantages over management with conventional archives are expected. Some advantages of such systems, called Picture Archiving and Communication Systems (PACS) are

- Safe storage and easy retrieval of images in clinical work even in very large archives;
- Arbitrary evaluation of the archive content;
- Support of image analysis by image processing methods which are only possible with computers;
- Comparison of images from different modalities and simultaneous display;
- Linkage of textual and pictorial information in a uniform manner;
- Simultaneous access to images by several users.

While the necessary hardware gradually becomes available, there are no general software solutions for such systems.

The problem of having a large amount of images can be solved quite well by means of optical storage devices available today. The display of

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images on a medical workstation is a problem not yet solved for all possible cases, but there are some experimental prototypes of a workstation, e.g., described in Ref. 20. There are many projects which are concerned with the research and realization of the network connecting the components of a PACS (modalities, storage and workstations). Glass fiber technology will contribute substantially to solving the problem of the very high data rates for transmitting images. Publications on PACS are mainly concerned with hardware solutions. This situation is reflected by the topics of the two most important meetings[25,26] on the subject. The present situation with PACS resembles the situation of database technology 15 years ago when the development of large mass storage devices was thought of as the solution for data management problems. Only the database research, however, has provided general tools for the construction of operational information systems.

In the following a project is presented which studies a possible solution for the software problem. The concepts developed for the solution are mostly implemented in an experimental system. General ideas are discussed, a solution is outlined, and practical results are presented with some examples.

There are typical differences between a conventional database and an image database (Figure 1). In the design process of a conventional database the part of the real world to be modeled is subject to perception and abstraction and is finally transformed into database objects. In this process the level of abstraction is very high. For example a patient is represented by his name, sex, date of birth, etc.

On the contrary, with an image database the images themselves are the objects in the database, and their level of abstraction is low. So the main difference between a conventional database and an image database is due to the fact that the abstraction takes place on different levels. This fundamental difference results in two basic properties of an image database management system:

- The target information, e.g., the diagnosis, is not obtained until the user has retrieved, displayed, and interpreted an image by using additional knowledge (e.g., the experience of the radiologist). This requires means of *interaction.* After the interpretation the abstractions are added to the images by the user in an interactive manner. Therefore, the images are treated as unstructured objects the structures of which cannot be described formally. In the future a knowledge-based system can be used for image interpretation. Related problems, however, are not even solved rudimentarily for the broad field of radiologic image interpretation.

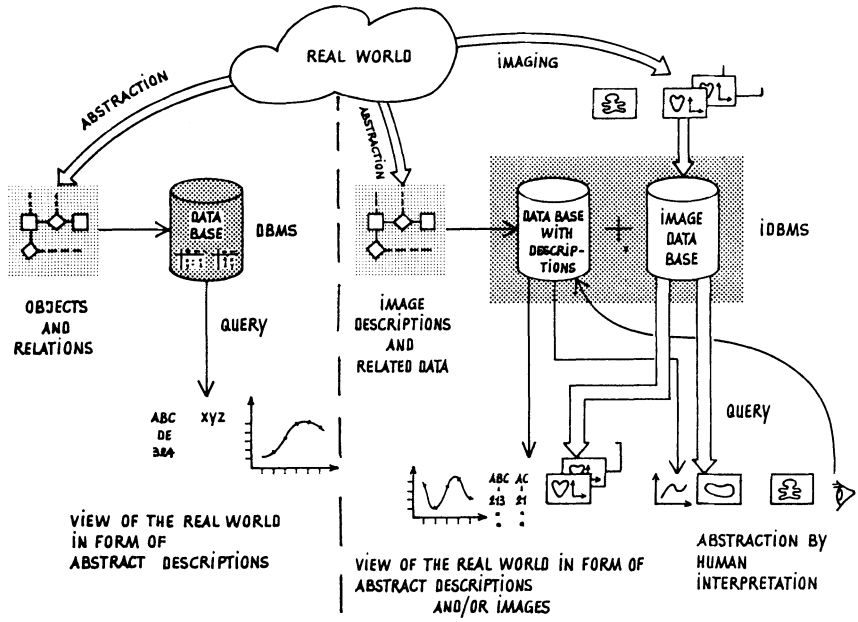

FIGURE 1. The function of a conventional database system vs. the function of an image database system

- Owing to the low degree of abstraction a variety of modes of storage, coding, and display of images is possible. Nevertheless, an object-oriented access is required, i.e., the user should be able to refer to the images irrespective of their physical properties.

The huge amount of data to be managed is not considered a software problem.

The tool for constructing conventional information systems is a database management system (DBMS) which has various possibilities for application programming. In addition, there are utilities such as application generators, report generators, and user interfaces. There are some corresponding approaches for pictorial information systems. The languages used in these approaches and the system background are briefly summarized in Table 1. Details of the languages can be found in Refs. 7, 9, 10, 11. A recent survey on commercially available systems and on research efforts is given in Ref. 12.

All DBMS underlying the above-mentioned languages are based on the relational data model. All applications originate from geography or related fields and have been developed on this background. All languages assume that the images are structured objects, i.e., there exists a structure

TABLE 1
Approaches to Picture Query Languages

Feature	Language								
	ADM	AQL	ARES	GADS	GRAIN	IDAMS	IDMS	IQ	QPE
Type of language	Extension of SEQUEL2 + commands	Extension of APL	N/A	Retrieval language	Commands		Extension of SEQUEL2	Very simple commands	Two-dimensional
Storage of images	?	?	?	?	?	?	Matrix	Files, tapes 64 × 64 blocks	UNIX-files
Types of images	Gray tone, sets (?) binary images	?	?	Polygons	?	Vectors	All conventional + PICTURE	Satellite	
DB operations	SEQUEL2 (?)	AQL	Retrieval only	EXTRACT only	GET only	Retrieval only	All, UPDATE is INSERT + DELETE	None	All
Implementation	Partially implemented	APL	Associative processor			APL	N/A	PDP 11/45 RATFOR FORTRAN	PDP 11/45 UNIX, C
Display of images	?	?	?	?	SHOW command	Graphics	Concept of DEVICE	DISPLAY for 1 image	?
DBMS	SYSTEM/R	AQL (?)	N/A	GADS	GRAIN	?	?	IMDS	IMAID
Remarks	partially implemented images are aggregates	No display		Decision support system for geographically related data		Open system collection of APL procedures	General approach some ideas on image coding	Implemented in 1977	Special operators for geographical operations
Reference	(27)	(1)	(16)	(19)	(11)	(20)	(28)	(18)	(11)

Legend:
? cannot be clarified by means of the reference
(?) uncertain
N/A not applicable

which can be described formally. The languages are planned rather for image processing by a set of functions tailored to the specific needs of a particular application than for easy handling of images. Frequently, the implementation is an extension of APL. The only general approach seen is IDMS, for which unfortunately no implementation has been published.

For the problem in question, namely, the construction of pictorial information systems in medicine, the image database languages mentioned are scarcely suitable. For the reasons mentioned above, they are very specific and do not pay regard to special image types, such as image sequences, which are quite common in medicine (angiography). There are no concepts seen for easy handling of images and image display. At best the user interface is on a command level. The systems mentioned are described as image databases but genuine database operations are only designed in IDMS. It is worth mentioning that some language approaches have the idea of a set of APL procedures which can be augmented by user-written procedures, which allows an open and flexible system. More recent approaches to image databases and query languages are described as PICDMS[13] and PSQL.[23]

There are three hardware-oriented approaches for an image database system: PICCOLO[30], the system designed by Yamamura,[31] which shall also be used for medical applications, and the system designed by Feng.[14] The references describe hardware relevant aspects only, so that one cannot judge on their suitability as a tool for the construction of pictorial information systems. There is an approach published for the management of higher descriptions for the analysis of image sequences which is based on the relational data model.[6]

2. *The* ISQL Approach

Having in mind the ideas described above, we have used the following approach for the development of tools for the construction of pictorial information systems in medicine:

Using a *scenario*[4] of a department of radiology *PACS-functions* are determined; then *concepts* for their realization are proposed and tools for their implementation are developed. Afterwards, *applications* use these tools. At that time *results* can be judged and *problems* still to be solved can be recognized.

For the investigation of this approach a relational conventional DBMS with the database language SQL has been used. It has been extended by database functions for structures and operations with images. The system has been tested with various applications. A datatype "Image" has been

realized with an extended data dictionary (DD). The operations are implemented by the extension of the database language SQL to the image database language ISQL (*I*mage-SQL). A description of the language and first experiences can be found in Refs. 2 and 3. The syntax of the language is described in the Appendix. Figure 2 shows the overall design of the system.

The prototype of the image database system has been implemented with a VAX 11/780 under VMS, the DBMS ORACLE and its Host-Language-Interface (HLI), and PASCAL. At the moment some 5000 physical and logical images are stored together with their descriptions. The images are mostly computer tomograms. About 1600 images are stored on on-line devices. As image processing system a COMTAL VISION ONE/20 with two independent work stations is used. Figure 3 shows the laboratory work station for research on image database management systems and human–computer interaction.

3. *PACS-Functions, Concepts, and Realization with the Tool* ISQL

In the following those functions of a PACS are described which can be realized by the concepts and tools of the described approach. For an overview Table 2 lists functions, concepts, realization in the prototype, and remaining problems. The table also describes the present state of the prototype system.

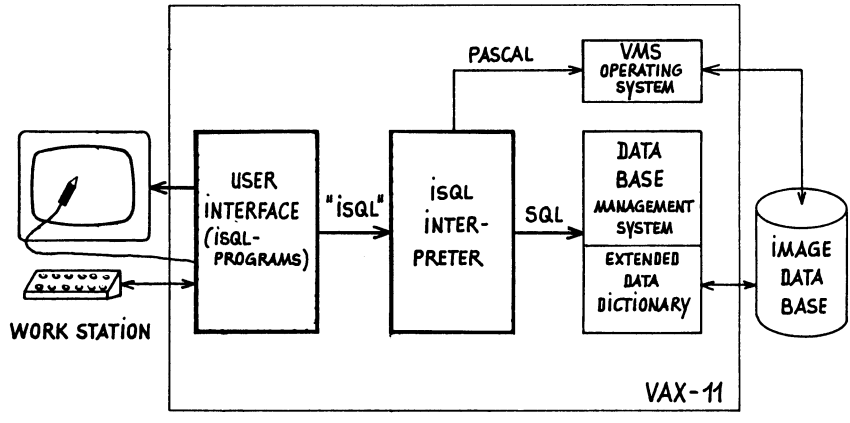

FIGURE 2. Overview of the software concept of the ISQL project.

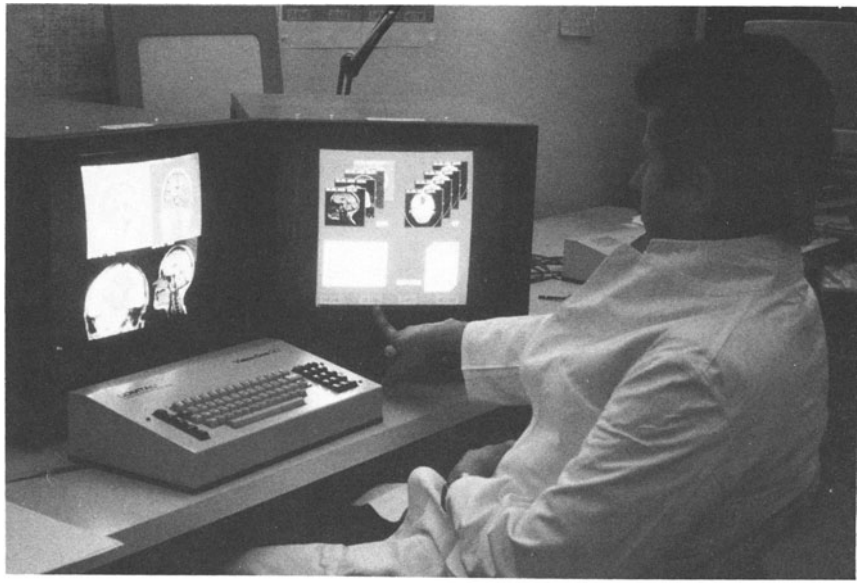

FIGURE 3. Laboratory work station.

3.1. Integration into the Departmental or Hospital Organization

Certainly, an image database in medicine only makes sense if it is integrated into a hospital organization. For this purpose a conventional DBMS is suitable. Using a DBMS, all functions which are not specific to images can be carried out. Already existing tools can be used such as a database language, a transaction concept, data security and privacy, and utilities. Therefore, the prototype has been realized with the DBMS ORACLE. Standard applications can be programmed very easily with its standard tools. The examples depicted in Figures 4 and 5 show a patient data entry screen and a histogram which have been generated by means of the application generator (IAF) and the user friendly interface (UFI), respectively, of ORACLE.

The underlying relational model of data has many advantages, such as flexibility, well-understood mathematical background, and simplicity, which makes the software part of the construction of a departmental information system, with all due respect, a relatively easy task. There are, however, performance problems even with the conventional use of a relational DBMS.

TABLE 2
Functions, Concepts, and Realization with the Tool ISQL

Required Function	Concept	Realization	Example	Problem
Integration of the image data base into a departmental information system (conventional storage and retrieval)	Use of a conventional DBMS with • Database language • Transaction concept • Data security and privacy • Utilities	DBMS ORACLE	Data entry screen, histogram, Figures 4, 5	Performance
In addition: display and storage of images	Extension of a conventional DBMS	Extension of the data dictionary, operations: • SELECT IMAGE • DISPLAY • UPDATE IMAGE • INSERT IMAGE • DELETE IMAGE	Display of MR-images, CT-image directory, Figures 6, 7	
User-friendly interaction	Maintenance of a pictorial context Various levels of communication	Introduction of current objects Application generators SQL, ISQL, images used as icons	Interaction via icons to produce a screen of MR-images and display of the image with full resolution, Figures 8, 9, 10	

Easy adaption to a specific surrounding (hospital, radiologist)	Generator for user environment	Set of parameters, defaults		
		Constructs for user interfaces in language		
Optical display of nonimage data	Extension of the data dictionary by attributes	Extension of ISQL for the display of optical attributes	Not yet implemented	
Image processing operations	implementation of image processing algorithms	Extension of ISQL for image processing operations	Not yet implemented	
Storage of derived data	Extension of the DBMS	- UPDATE IMAGE	Under development	Consistency
Distribution of work-stations	Distributed DBMS	No decision yet		
	Multi user operations	ORACLE and ISQL are multi user systems		
Reproduction of documents	Interactive editing of images and textual data	Document editor	Not yet implemented	
Retrieval by templates and feature extraction	Complex data structures, pattern recognition	Knowledge base is integrated into the data base	Not to be started in the near future	
Computer assisted diagnosis	Knowledge based system	Knowledge base is managed by ORACLE + AI-concepts	No decision yet	

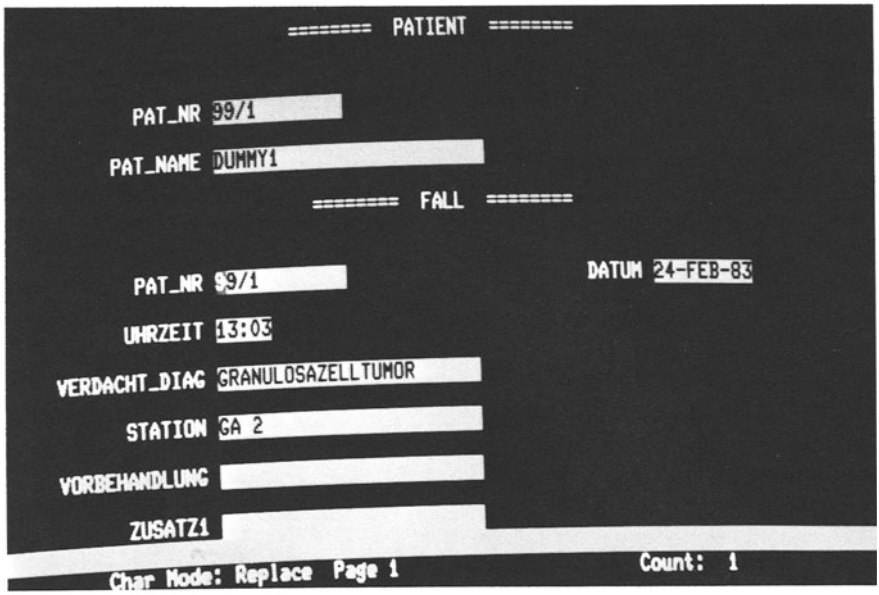

FIGURE 4. Patient data entry screen as designed with the standard tools of the DBMS.

```
  3  select distinct dosis, lpad ('*',round(dosis/10),'*') X
  4  from herkunft_ct
  5  where dosis is not null
  6* order by dosis
UFI> start histo

     DOSIS                          Histogramm
---------- ------------------------------------------------------------
         0
        40 ****
        57 ******
        81 ********
       115 ************
       153 ***************
       163 ****************
       230 ************************
       300 ******************************
       460 ***********************************************
       600 ************************************************************

11 records selected.

UFI>
```

FIGURE 5. Query for a histogram of x-ray doses in CT together with the result as an example of the use of standard DBMS tools.

3.2. Management of Images

For the construction of a pictorial information system the conventional DBMS has to be extended for the additional functions of storage, management, retrieval, and display of images. Because of the low level of abstraction image presentation is one of the most prominent aspects. To consider all possibilities sufficiently the display has to be independent of specific hardware devices and peculiarities of images such as physical storage, coding, and pixel depth. To meet these requirements all descriptions are stored in relations with the management facilities of ORACLE. The descriptions represent an extended data dictionary. With the help of these relations a set of language constructs has been realized which represents the ISQL operations. With these operations all image management can be performed independently of the peculiarities of image display devices and image formats. These operations are as follows:

SELECT IMAGE . . . DISPLAY AS . . . WITH. . . . This operation is used to retrieve images from the image database and to display them in the desired appearance. The images may be ordered or scaled down or displayed in any desired fashion as there is a display operation for each type of image (described in the extended DD). Not only images may be retrieved, but also text will be displayed with the images in a way the user can choose. He simply indicates the text or the names of the columns the text is stored in.

Some images in the image database have properties, e.g., "no diagnosis," which should be understood at once when the image is displayed. These properties can be assigned to the images as attributes and get displayed with the images as optical attributes. For this purpose the data dictionary has to be extended for these attributes and ISQL must provide a display operation for this kind of display. This concept has been realized in the spatial data management project for alphanumerical data.[15]

INSERT IMAGE. This operation is used to insert an image into the image database. This can be performed either by including the descriptions column by column or the descriptions may be read from a file with a set of descriptions.

DELETE IMAGE. This operation deletes an image from the image database by deleting its descriptions. An image may be deleted only by authorized personnel.

UPDATE IMAGE. At the moment an update on an image is considered to be the insertion of images which have been derived from the original image or textual data which is related to the image to be updated. The original image is the image which has been inserted in an earlier state of the image database.

As an example of how to perform database operations with ISQL Figure 6 shows the retrieval and display of a set of MR-images for a certain patient. This figure shows how images and text such as the patient's name and the date when the images were taken can be retrieved and displayed with one command.

Figure 7 shows how a directory of images of a certain day can be generated.

3.3. Human Computer Communication

Leaving traditional archives and working habits of the radiologist behind and going to electronic archives, computer-assisted radiology could cause new problems for the user. This is due to the fact that in a fully electronic system more powerful and complex operations with images are possible. This complexity, however, must not be passed on to the user. Therefore, there have been implemented concepts for the easy access to the pictorial information system.

```
SELECT IMAGE pat_name,date
WHERE modality = 'NMR' AND
      pat_name = 'DUMMY5'
  DISPLAY WITH SCALE = 2;
```

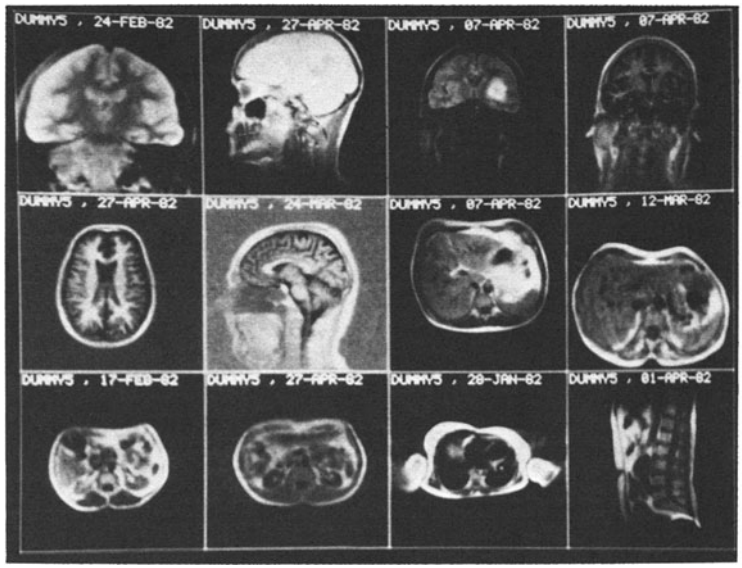

FIGURE 6. Query for all MR images of a patient and the corresponding result screen.

```
SELECT IMAGE
WHERE date = '07-SEP-82'
ORDER BY pat_name
   DISPLAY WITH SCALE = 4;
```

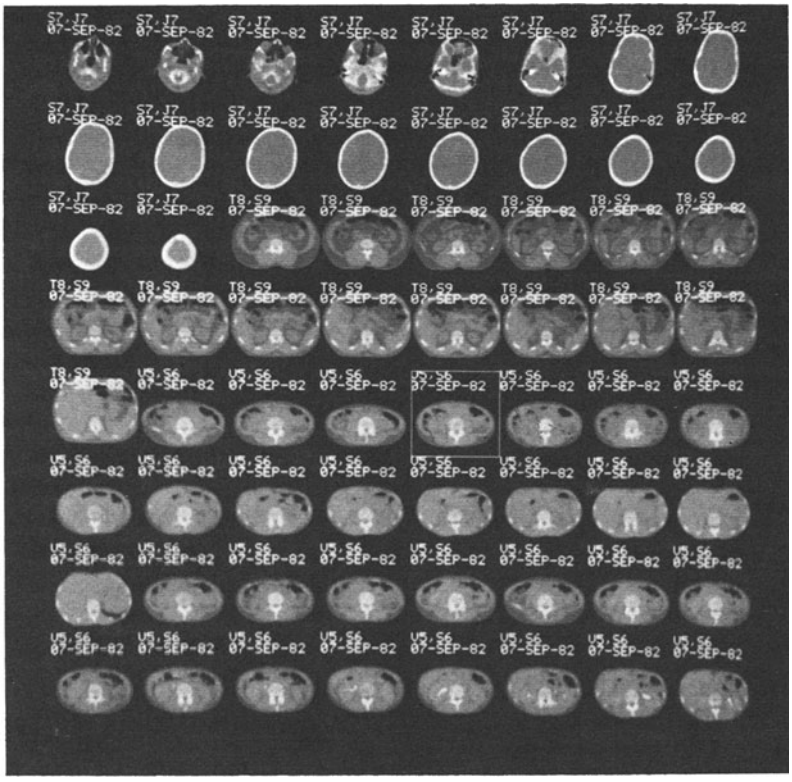

FIGURE 7. Request for a directory of all images of a specific day with the first 64 resulting images on screen. The image surrounded by a frame is the "current image." The text to be displayed with the images is defined by default values.

Choice of Communication Level. Experience with earlier projects[8] has shown that there should be a choice for the level of communication with the image database to reflect the fact that there are different users with different levels of knowledge about how to use a computer. A language like ISQL is a suitable means.

The *application programmer* interacts with the image database via SQL for nonimage operations and uses ISQL for image operations or mixed operations (image and nonimage).

The *motivated user* (e.g., a specially interested radiologist) may use (after some practice) ISQL as well. For operating in routine, however, ISQL itself is not suited.

For *users in routine* the application programmer can write programs in ISQL which create an interface to the image database which is adapted to the needs and requests of the radiologist. For easy communication icons can be produced with ISQL. There is a special display operation (DISPLAY AS SOFTKEY) integrated in ISQL to perform the operation which is connected to the icon. The operation to be performed is a parameter of SOFTKEY. It is a special feature of ISQL that any image in the image database may function as an icon. Figure 8 gives an example of how to program a user interface with icons by means of ISQL. Figure 9 shows an ISQL program which is activated by the icon. The ISQL program shown retrieves MRI images of a patient.

Context Management. When viewing images the radiologist has already built up a certain environment: the image actually under consideration, the sequence of images on the lightbox, or the pile of jackets to be viewed later. Operations that are trivial in this environment like "what is the tentative finding for the image on the lightbox" are very complex in an electronic system unless appropriate means to access the information about previous manipulations are provided. In the prototype this problem is solved by introducing "current objects." Presently, two are implemented: the current image and a set of current images, the current database. By default the current image is the image most recently displayed on the screen. One can refer to that image, e.g., in order to get additional information concerning that particular image, by just making reference to the "current image." The image database system then traces down to the required information with no other explicit description of how to access this information. Similarly, the current database can be defined as the set of current images which have been retrieved by a previous query. In this way, the above-mentioned pile of jackets may be modeled by the current database. The concept of a current image database in ISQL implements a local store for the images of a specific user but is restricted to retrieval and display. The current database is a snapshot of the database contents at a certain instant. Therefore it may be inconsistent on a global level. The concept of current objects is discussed in detail in Ref. 21. Figure 10 demonstrates how powerful the concept of current images may be used. To implement an operation like "show this image in full resolution" only a one line ISQL-command has to be coded. It is not necessary to reference the image explicitly by some kind of identification.

It is a consequence of the relational approach that from the current image any item related to the image can be retrieved without the need of

```
    :
    :
    :
SET SCREENLEN 10
    :
SELECT STANDARD_ICON , 'MRI'
DISPLAY AS SOFTKEY (START mri_images)
WITH XPOSITION = 0, YPOSITION = 0
    :
    :
```

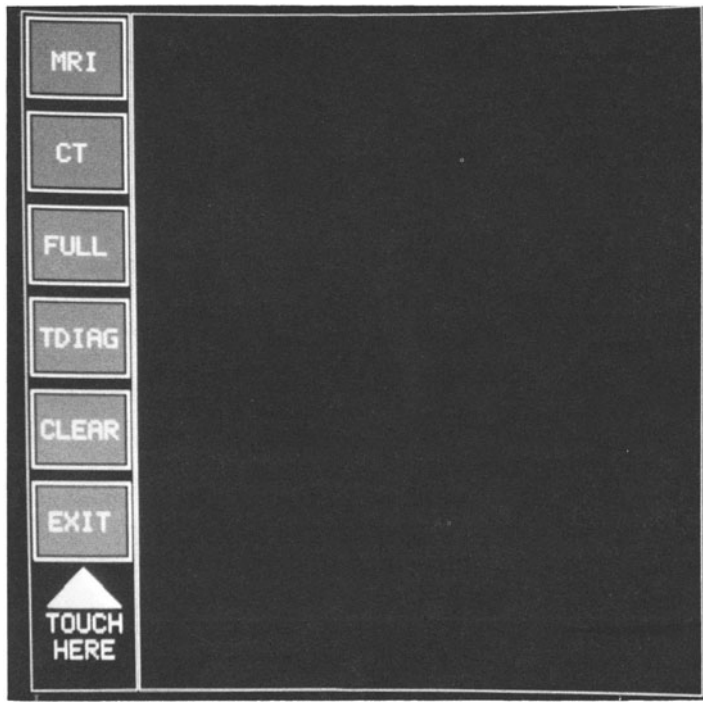

FIGURE 8. Part of an ISQL program to producing the icon "MRI" of the column of icons shown on the screen. The STANDARD_ICON is an image file.

describing the access path. Thus also textual data such as the tentative diagnosis can be retrieved as shown in Figure 11.

3.4. User Environments

It is desirable to be able to adapt the pictorial information system to specific peculiarities of the environment of an image database, e.g., the

hospital, the department, or preferences of a radiologist. This can be accomplished by creating a user environment which may be generated according to the requirements. In ISQL, there are two tools for this purpose: *parameters* for static properties such as color, size, and position of the text to be displayed with the images and ISQL *procedures* generating the

```
INQUIRE &pat_name Please type the
        name of the patient:
SELECT IMAGE
WHERE pat_name = &pat_name
AND modality = 'NMR'
DISPLAY WITH XPOSITION = 195,
            YPOSITION = 0,
            YINCREMENT = 25,
            XINCREMENT = -20,
            SCALE = 2;
```

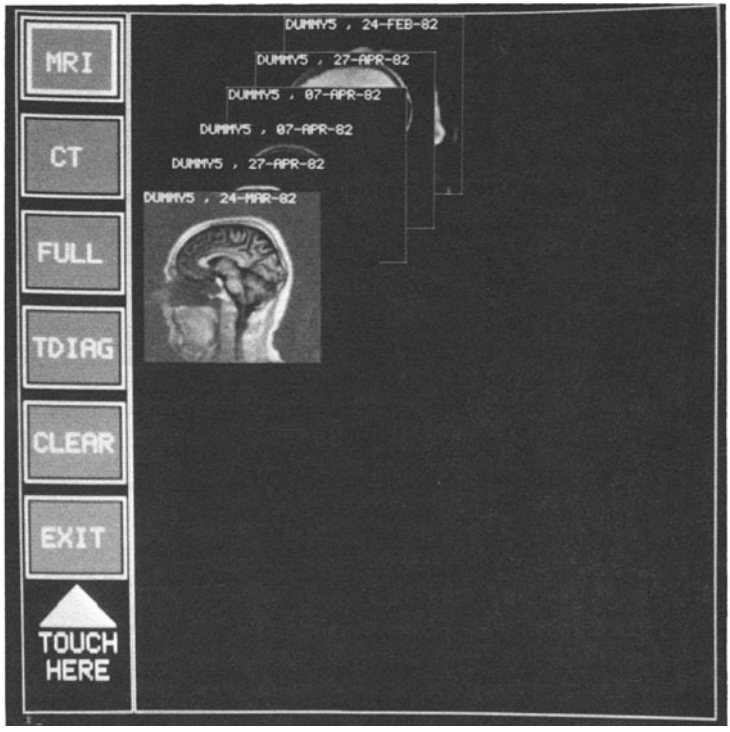

FIGURE 9. Program activated by the icon "MRI" (Figure 8). It retrieves the MR images of a patient and displays them on the screen (right). The user is prompted for the name of the patient.

```
SELECT IMAGE
WHERE image_id = :CURRENT_ID;
```

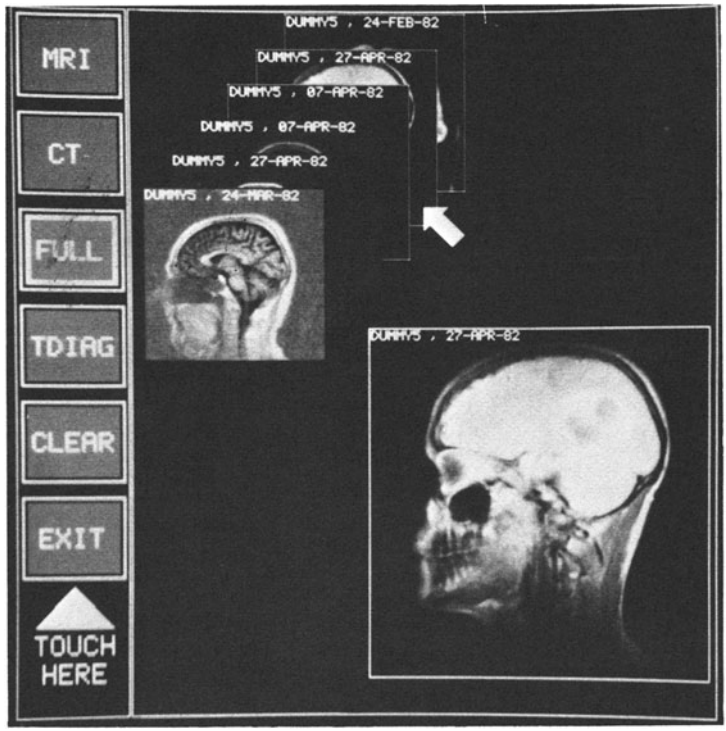

FIGURE 10. Retrieval of a full scale version of the current image which has been marked by the user with the arrow. The command shown above is performed by activating the icon "FULL."

user surface. Values for the parameters may either be given by specifying them explicitly with the SET command or they may take over predefined default values. These values are valid until specified otherwise.

More important is the possibility of creating special user interfaces via ISQL procedures easily. As shown in Figures 8 and 9, these are very simple and can be implemented rapidly. Mnemonic naming of commands and parameters makes ISQL procedures self-explaining. This not only facilitates the creation of the user interface but also supports maintenance and documentation. This is a decisive property if, e.g., one system has to be adapted to many hospitals with different users.

It is a consequence of the approach that any image in the database can be used as an icon. In the prototype, images from the conventional

```
SELECT pat_name, ward,
       tentative_diagnosis
FROM IMAGE_DB
WHERE image_id = :CURRENT_ID;
```

```
ISQL> l
  1* :  select pat_name, verdacht_diag
  2  :  from image_db
  3  :  where bild_id = :current_id

ISQL> r
PAT_NAME                  VERDACHT_DIAG
------------------------  ------------------------

DUMMY5                    ASTROCYTOMA

1  records selected

ISQL>
```

FIGURE 11. Example of the retrieval of nonimage information related to the current image. Here the tentative diagnosis is retrieved without specifying any explicit identification.

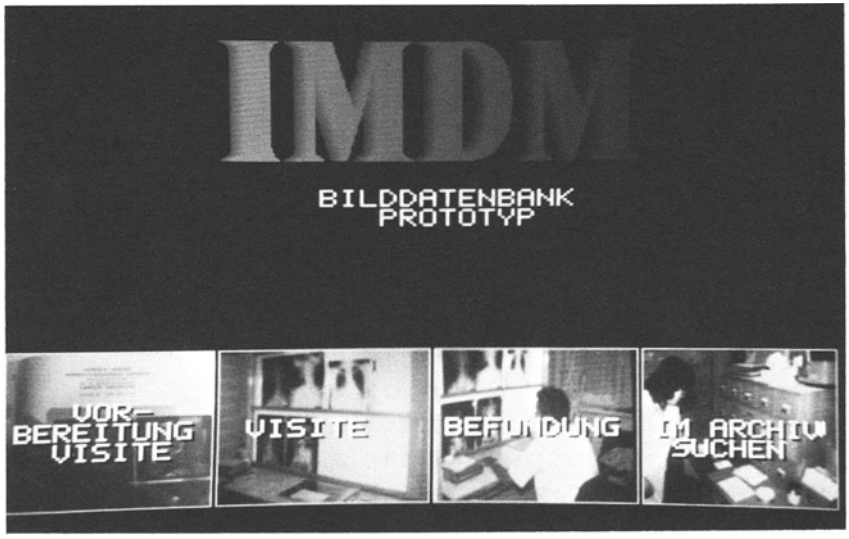

FIGURE 12. Initial screen of the image data base prototype showing real world images as icons for functions related to film reading.

film reading environment have been used as icons (see Figure 12) in order to facilitate the access to the system for the radiologist. At the moment, this feature is being tested for its acceptance. Preliminary experience has shown that it helps the casual user to understand the system functions. It is not likely that it can decisively support routine utilization. There might, however, be applications we have not thought of yet.

3.5. Further Developments

Integration of Image-Processing Operations. One of the new possibilities in computer-assisted radiology is image processing. Image-processing capabilities should be an integral part of a pictorial information system. One way of integrating these capabilities is to extend the image database language by such operations. As a consequence different structures (e.g., pyramides and octrees[22]) according to the appropriate algorithms will have to be provided. For the management of these structures a relational DBMS seems to be suitable. These structures and operations have not been implemented yet in the prototype. Presently, the processing of images is performed separately. Subsequently the appropriate data are included in the image database by means of the UPDATE IMAGE command. For the time being, the update on an image is not well understood and will be subject to further discussion and research, e.g., on transaction concepts and concurrency.

Retrieval by Feature Extraction and Templates. Presently, image database retrieval can be done only by making use of descriptions already existing in the database. Retrieval by descriptions not yet existing in the image database would require the application of image understanding algorithms. Such algorithms would be a necessary part of the search strategies of the image database management system. For the near future operational solutions are not expected. Although the retrieval by templates (e.g., "retrieve all images with kidneys which look like the one in the example") seems to be an easier task, it still is an unsolved problem.

Assistance for Diagnosis. Although an automatic interpretation of radiological images, if ever possible, is in the far future, knowledge-based systems could be a substantial help. Therefore, they should be taken into consideration during the design process of a pictorial information system. In the prototype the relational DBMS could be used as a tool for the management of knowledge. Databases and expert systems are discussed in several papers, e.g., in Ref. 5.

Support of a Distributed System. Image workstations will be spread over a radiological department or even a hospital. This requires management of images at many sites in parallel. Basically, the same problems occur as

with conventional distributed DBMS. There are no conventional distributed DBMS seen which are more than a prototype implementation. There are conventional DBMS, however, where several local data bases may communicate with a central database. The problem of distribution of data among different computer sites is even more complicated with a distributed image database as the objects of a transaction are images. The special case of only reading images by several sites seems to be a minor problem as far as a subsequent update is not to be performed by more than one site. In a PACS, images are distributed over many sites, e.g., there is a local store in the modalities. The retrieval of any image from an arbitrary site requires global management of a distributed image database, which will not be available in the near future. A multiuser system for a central image database is no major problem. An implementation with ISQL will be available soon.

Document Editing. In order to be able to communicate with institutions outside the hospital and for documentation purposes it is still necessary to provide means for the production of documents. A database that integrates images and text lends itself to the production of documents that combine images and text. As a software solution one could think of a document editing facility based on ISQL. No efforts have been made in this direction yet.

3.6. Software Properties of the Tool ISQL

In order to keep the tool independent of any peculiarities of hardware and software and thus make it a general tool, it should be *portable.* In ISQL, this is achieved by making use of standardized languages, i.e., the database language SQL and the programming language PASCAL.

Pictorial information systems should be able to be constructed with *little programming effort* and *uniform tools.* A high-level approach like ISQL is a suitable method.

A general requirement for pictorial information systems is the independence of any properties of special hardware, e.g., the display system. This independence can be achieved by managing all necessary descriptions with a DBMS.

There must be, of course, *rapid access* to any image in the image database. This can be accomplished by making use of a storage hierarchy for the images: according to the response time required to retrieve, the images are stored on storage means which reflect these requirements, i.e., images which have to be retrieved within a very short response time are stored on disks and others may be stored on an optical disk, etc. No efforts have been made yet in this direction with ISQL.

The software properties of the tool ISQL are summarized in the table below:

Required property	Approach	Realization
Portability	Use of standardized software tools	SQL, PASCAL
Little programming effort, uniform tools	High-level language approach	ISQL + utilities
Hardware independence	Descriptions are stored in the data base (DD)	ISQL structures
Short response time with retrieval of images	Hierarchy of storage devices	Not yet implemented

4. *Conclusion*

In a prototype system a software solution for the implementation of pictorial information systems has been described. It is based on the extension of a conventional relational DBMS. We have shown that most of the functions typical for a PACS can be implemented with the tool ISQL. These functions include, besides conventional database operations, access to image data independent of the peculiarities of physical storage or display devices, support of human–computer interaction, and easy generation of user surfaces and environments. It is demonstrated that a high-level tool not only speeds up PACS software development but also helps in keeping up with the complexity of pictorial information systems. The production version of ISQL will be portable as it is implemented with the standardized languages SQL and PASCAL.

Some of the desirable functions still have to be implemented. So image-processing features are not yet included in ISQL. Also the management of storage hierarchies is a problem to be worked on. Finally it should be pointed out that our approach is a good basis for research on advanced topics such as knowledge-based systems for image retrieval and interpretation.

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Appendix: Overview of the Syntax of ISQL

```
SELECT IMAGE [, colnam1, colnam2, . . . ]
[FROM CURRENT-DB]
[WHERE where-clause]
[ORDER BY colnam]
  [DISPLAY [AS opnam[(par1, par2, . . .)]]]
    [WITH [DEV=devnam] [,FRAME=n] [,SCALE=n] [,LOW=n]
    [,HIGH=n] [,IMAGENO=n]
    [XPOSITION=n]    [,YPOSITION=n]    [,XINCREMENT=n]
[YINCREMENT=n]]];

DELETE IMAGE WHERE BILD-ID = {number | :CURRENT-ID};

INSERT IMAGE FROM filnam;                    or
INSERT IMAGE (colnam1,colnam2, . . . )
          VALUES(val1,val2, . . . );

UPDATE IMAGE SET colnam1 =val1 [,colnam2 =val2] [, . . .]]
        [WHERE BILD-ID = {number | :CURRENT-ID}];
```

The extentions to SQL are underlined.

Presently implemented operations:

STANDARD:	display of the images in the standard format
MINI:	display of miniaturized images
FILM:	display of images as a film
SOFTKEY:	display of an image as an icon

Please note that there exists a display program for each image type described in the image database and for every display device. The name of the display operation, however, is the same for all types and devices. ISQL automatically does the necessary mapping according to the descriptions in the extended data dictionary.

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