Visual Information Retrieval System for Ethnological Research

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INTRODUCTION

The National Museum of Ethnology keeps many kinds of cultural materials with various types of information for ethnological research. Materials such as books, cards or memoranda, that have character information, are known as character materials. Pictures, photographs, motion films, and video tapes that have image information, are called image materials. For these visual materials, databases of abstracts list their attributes. Researchers can retrieve such abstracts, not the primary material itself. To obtain more detailed information, they must go to its storage place and check the actual material itself.

For both image and character materials, we are planning to construct an image database. Once it is constructed and combined with corresponding databases of abstracts, researchers will be able to retrieve visual information regarding cultural materials from terminals, without handling the materials themselves. The visually retrieved information will speed up selection of the desired materials.

While the problems of storing, processing and retrieving ethnological materials are fundamentally the same all over the world, solving them in Japan has an extra dimension which may turn out to be a major advantage. The Japanese language, unlike most others, is written in what was historically (and still is to a major extent) a pictographic mode. Looking at a written word, a Japanese has very few clues to its pronunciation but often sees a strong visual association with a thing, an action or a concept. As a consequence, computer processing of Japanese-language materials is much more like image processing than the same operation is when the data are encoded in an alphabet. While the latter has the advantage that a small number of phonetic characters have been organized into a standard order, the relative closeness of the Japanese writing system to other visual representations may afford special advantages for developing an information retrieval system for ethnology, where data must be stored as both characters and images.

INFORMATION RETRIEVAL IN ETHNOLOGICAL RESEARCH

The discipline of ethnology includes very wide research fields. From those traditional fields of social anthropology or linguistic anthropology to the modern urban anthropology or medical anthropology, ethnological research covers almost all human activities. Some fields, such as ecological anthropology and ethno-technology, treat human groups as masses and focus on the interaction between the man and the physical or ecological environment, others try to clarify influences of social system on the personal world of conception, as seen in psychological anthropology. Thus, ethnology seems to be more extensive and profound than many other disciplines.

According to this inherent breadth and depth, the information to be dealt with in ethnological research has several unique features compared with that of the natural sciences. First, some ethnological information, *e.g.*, psychological questions such as the degree of likes and dislikes, is not fit for quantitative representation. Second, ethnological information on cultural systems is sometimes interrelated in a highly complicated fashion. For example, a marriage system does not stand alone, rather it relates to many other systems of economical, political, religious and ritual affairs. The analysis method of separating and extracting a part of the system as closed from others, which is commonly used in natural science, is not directly applicable to ethnological research. Third, different researchers may sometimes take different interests in the same ethnological information. When given a picture of bamboo basket, for example, one researcher may be interested mainly in its size and color, another in its weaving, and the other in its use. Owing to these features of ethnological information, it is difficult to construct its common model structure or to represent it in a definite form.

Next, let us consider the research activity concerned with such ethnological information. Fig. 1 shows a simplified model of the ethnological research process.

Since ethnology aims at total understanding of culture, ethnological researchers must deal with all aspects of human activity, or its product. Through field work, information is collected and recorded as various styles of character, image, or sound. These records we may call *primary material.* They are used for analyzing human culture in an iterative process of trial and error. Included in the analysis are information retrieval from the primary materials, modification or transformation, and

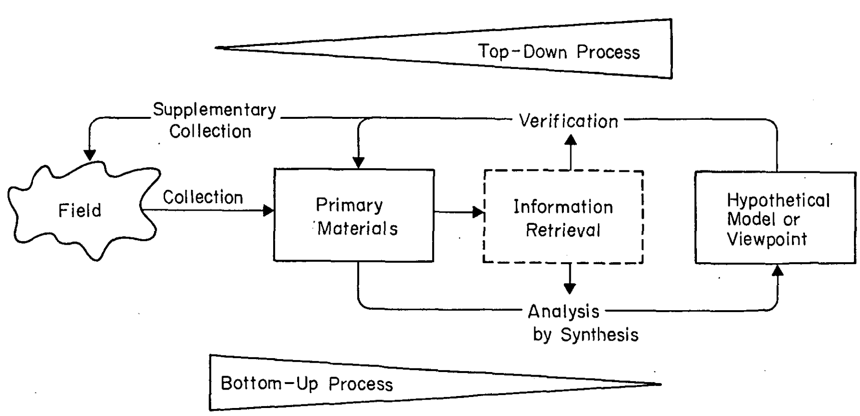

Figure 1. A Model of Ethnological Research Process

comparison of retrieved information. Finally, based on the analysis, hypothetical models are constructed for an aspect of culture. In this synthesis information is abstracted from the analyst's perspective.

Following this *bottom-up* process, from primary materials to an abstract model, corresponding *top-down* process will verify the validity of the hypothetical model. In some cases supplementary data collection from the field will be required.

The iteration of these two processes, one bottom-up and the other top-down, establishes new axiomatic models for any cultural aspect. This method of iterative *analysis by synthesis* is also used in natural science research, where *confidence* asserted by a researcher is verified to form the basis of *relief*, which is again verified to gain general acceptance as *truth* [COATS and PARKIN 1977]. In other words, rather general hypothesis at the lowest stage in the process *evolves* into a rigid model at the final and highest stage.

In both processes of analysis and verification information retrieval plays an important role, whether the research field is ethnology or a natural science.

As to the role of information retrieval, however, there is a noticeable difference between the disciplines. In natural science research information retrieval is directed under the researcher's perspective, which has already a definite form from the first stage in the process. In ethnology, on the other hand, the researcher sometimes cannot definitely express his perspective at that stage. Rather, he sometimes derives his intuition, "flash" or association from the information retrieved. That is to say, information retrieval in ethnological research triggers insights that associate a researcher's knowledge with the information to obtain a perspective on or an insight about his research.

Therefore, for supporting the research, it would be most desirable to design an information retrieval system that willingly utilizes or incorporates the above mentioned *brainware* of a researcher with hardware and software, as shown in Fig. 2. One of the best strategies for fully utilizing brainware is to supply the researcher with unabstracted and unprocessed *raw* information *exhaustively* and *quickly*. The *fresher* the information is, that is to say, the closer it is to what is contained in the original raw material, the more valuable it will be, since abstracting or processing information may sometimes hinder the full operation of brainware.

According to the complexity of the task, Martin has classified information

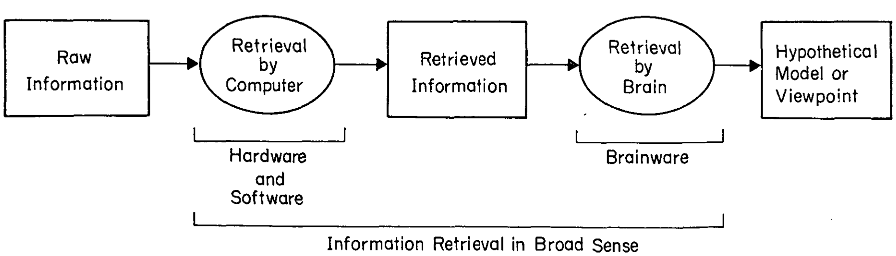

Figure 2. Information Retrieval in Ethnological Research

	TASK	CODING	MESSAGE	PROCESS
TABLE LOOKUP	What is the telephone number for the Golden Bull restaurant?	The name Golden Bull serves as a relatively unique identifier.	A single record name, address, and number··· is desired.	The record retrieved is the record contributed.
DOCUMENT RETRIEVAL	What reports deal with higher education in Australia?	Descriptors like universities and Australia narrow the description.	A number of records···title, author, book location···are desired.	The record retrieved is the record contributed.
DECISION SUPPORT	What percentage of students have grade point averages above 3.0?	The category grade point average is used to order student records.	An answer is constructed from information in the record.	Information from the database is retrieved.
QUESTION ANSWERING	What route do I take from my hotel to the restaurant?	Knowledge about the situation is used to determine which hotel, which restaurant, and which means of travel are implied.	An answer is constructed from a map of the city.	Many different types of information from multiple databases are combined.

Figure 3. Classification of Information Retrieval by Martin [MARTIN 1980]

retrieval into four types, as shown in Fig. 3 [MARTIN 1980]. The task becomes more complicated from top to bottom in the figure. As the key for retrieval becomes more sensitive to the data, additional processing is required. The *table lookup* is a simple task because each query contains a unique identifier to one desired record. In *document retrieval* certain set operations are required for extracting desired records. In *decision support* the system must perform several computations on retrieved records, and then synthesize the answer from the resultant information. In *question answering*, the most complicated task, the system must analyze the query by referring to some knowledge about multiple databases, resolve it into several keys to appropriate databases, gather the results and finally synthesize the proper answer in a proper form.

These types of information retrieval are useful for ethnological research. But it also seems desirable to introduce another type, which we may call *primary browse*, where the researcher can inspect a set of primary materials containing *fresh* information, in order to obtain his first-level insight or viewpoint. This type of information retrieval will be especially valuable for image materials, because visual information can convey as much raw information as is contained in the original materials, and because our well-developed two- and three-dimensionally oriented eye-brain pattern recognition mechanism allows us to perceive and process many types of information rapidly and efficiently, if the information is represented visually.

Thus it may be concluded that an image database, accompanied by a retrieval system that enables researchers to browse visual information exhaustively and quickly, is indispensable for supporting ethnological research.

USE OF VISUAL INFORMATION IN ETHNOLOGICAL RESEARCH

Visual information plays a very important role in ethnological research. Viewed from the perspective of computer manipulation, the processing of visual information is twofold; *image processing* and *computer graphics.* Accordingly, representation of image data within a computer is classified into two types; *raster image*, based on pixel-by-pixel representation, and *graphical image*, based on vector representation. Here let us discuss the effective use of visual information in ethnological research, regardless of this classification. From its support role in the research the use of visual information may be classified into four categories; image processing for analysis and encoding of visual pattern, visualization of originally non-visual information, image database, and visual man-machine interface.

In the first category many ethnological materials are awaiting image processing by computer. Much research, such as the analysis of remotely sensed images or the measurement and classification of artifact images, has been launched already in the National Museum of Ethnology. The encoding of human motion as nonverbal communication, or the encoding of such pictographs as Mayan glyphs, is another challenging field of application in image processing.

From the technical perspective of image processing, sophisticated technique of pattern recognition is rarely required in ethnological research, rather, application of such simple techniques as geometrical transformation and image editing seems sufficient to inspire a researcher's brainware.

The visualization of non-visual information, which seems to be one of the most rewarding applications of computer graphics, is also useful for ethnological research. Geographical information processing, such as *computer mapping*, is a straightforward example. More complicated or abstract information can be visualized so that the researcher can discover relationships among it. For example, such applications as generating pedigree representing kinship, or representing sound data or psychological data in three-dimensional or a more multi-dimensional form, may be of great use in social anthropology, ethnomusicology or psychological anthropology, respectively. Implementation of such systems are eagerly awaited in these fields. Generally speaking, any relationship can be visualized if an appropriate mapping function is defined to transform it into some distance-like relationship.

As mentioned before, the third topic of image database, the central issue of this paper, is indispensable for ethnological research. All visual data, whether raster image or graphical image, can be so organized as to form image database. Pictures of artifacts, color slides taken during field work, field notes containing handwritten characters and sketches, texts taken from books, are our present targets for constructing an image database.

In addition there are several visual materials whose image database is expected to help research greatly. A database of patterns drawn on artifacts or textile fabrics will be useful for comparative study in ethno-technology. For several undeciphered scripts such as Mayan glyphs, image database may contribute to their decipherment.

Map database is a typical and attractive example of image database, into which much research has already been conducted in fields other than ethnology. The map is treated by computer in two ways, as raster image and as graphical image: the former may be called *image map* and the latter *graphical map*. Unlike other fields, ethnological research needs database of both types. Database of topographic image map is particularly useful for human geographical research.

Visual representation is also a powerful means of enhancing man-machine communication. As will be discussed later, *user-friendly* man-machine interface is indispensable to ethnological researchers unfamiliar with operating computer systems. Symbolic representation of both system's status and menu, like *icon*, found in the modern engineering work-stations, serves the researchers as an especially helpful guide.

Among these topics, image database for ethnological research is mainly discussed in the remainder of this paper, touching on visual man-machine communication.

IMPORTANCE OF IMAGE DATABASE IN ETHNOLOGICAL RESEARCH

The recent remarkable progress in image processing and computer graphics makes it possible in various fields to manipulate visual information by computer. With the progress of this research the volume of visual data produced or to be manipulated in their application fields is increasing rapidly. Consequently, much attention has been paid to establish the method of structuring and retrieving visual data. On the other hand, owing to the rapid technological advancement of image inputting, outputting and storing devices, it becomes easier to produce cheaper hardware systems capable of managing voluminous visual data.

Based on these needs and seeds, many image databases are now being developed or already implemented in various fields. Therefore, it would not be amiss to survey applications of image database in other fields, to grasp trends and to obtain hints from them for constructing image database to support ethnological research.

Overview of Image Database in Various Fields

Typical applications of image database are broadly classified into four categories; map database, medical database, database in office, and database in broadcasting or education [BLASER 1980; KIDODE 1986].

Every map database is combined with additional code database to form a part of GIS (Geographical Information System). Maps of specific objects, such as public infrastructure (*e.g.*, piping of gas or water, electric wiring), tourist spots, or real estate, are organized into database and now widely used as a geographical guide system in their respective fields. Most of these maps fall under the category of *graphical map*. The representative of the *image map* database is database of remotely sensed image. It is utilized at various levels of government, from small city to large country, to analyze and plan the use of earth resources, land use and environmental protection. It is hoped to standardize the format of map data, whether raster image or graphical image, now being set individually in these fields.

Image database also attracts much attention from medical scientists. For such image data as microphotograph, X-ray photograph or CT (Computer Tomography) image, which are produced in large quantity from daily examinations, database construction will facilitate medical diagnosis, remedy and research.

Image database in office work is intended mainly for two purposes; *design-base* and *document filing*. In the former application every kind of design pattern for fashion, interior design, advertisement, and manufacturing is being structured into image database, which allows the designer to retrieve and *reuse* existing designs adding modification to them, or to check infringement of design registration. In most cases these design-bases work as a component of CAD (Computer Aided Design) or CAM (Computer Aided Manufacturing) systems of respective fields. The document filing system, combined with mail function, contributes to office automation. Since most documents can be treated as bi-level raster image data, some data compression techniques are applicable, which leads to the saving of image storing media.

Image database is useful in broadcasting. A start has been made in developing database of fixed still images used for routine daily or urgent broadcasting. The topical *videotex* system cannot do without image database. Image database also plays an important role in audiovisual education in elementary or secondary schools, especially in CAI (Computer Assisted Instruction). In the question-answering system, the function of image generation from graphical components will be necessary.

From the above overview, it can be seen that most present image databases focus on *reusing* artificial graphical images, as in the guide map system, design-base, or broadcast. By contrast, image database for ethnological research has a somewhat different purpose. As was mentioned before, the principal aim of our plan is to provide the researcher with information close to what is contained in the raw materials, and thus to inspire his brain work to derive his own insights or viewpoints. Therefore, it is essential to develop an image database capable of offering the researcher fine color raster images as rapidly as possible.

Benefits of Constructing Ethnological Image Database

The National Museum of Ethnology houses a large amount of primary materials, broadly classified into four types; character material, image material, sound material, and artifact. For each of these, database of conventional coded data, *i.e.*, numbers and character strings, has been already developed, but only at the level of abstracted descriptions of attributes. We are planning to construct an image database to reduce the gap between this abstract information and full character or image information, by storing it in on-line user-accessible storage. The benefits of constructing such an image database may be summarized as follows:

(1) Image retrieval, the main reason for constructing the image database, is easily achieved by combining code database with image storage;

(2) Uniform management of image data can be achieved regardless of both its source material and storage media;
(3) Space needed for maintaining voluminous paper materials can be saved by electronic image storage media;
(4) Meaningful two-dimensional information on character materials, *e.g.*, layout of character strings or shape of the writer's hand in handwritten documents, can be retained by treating them as image data;
(5) Transformation of analog image data, recorded on media which may cause discoloration into appropriate digitized code, will serve to conserve original color information; and
(6) Image data sharing among researchers will be easily realized in the near future by way of computer network, which is expected to promote not only intra- but also inter-museum research.

TOWARD CONSTRUCTING ETHNOLOGICAL IMAGE DATABASE

Outline of an Ethnological Image Database

Our plan is to construct an integrated database system for character and image materials, a rough sketch of which is given in Fig. 4. It comprises three image sub-databases corresponding to each set of primary materials (*i.e.*, *artifact library, visual material library,* and *ethnography library*), a database integrator, several image retrieval work-stations, and a LAN (Local Area Network) connecting these components.

Each image sub-database is composed of an image file server and a corresponding code database of abstracted attributes. The artifact library allows the researcher to retrieve artifact pictures, which are being taken by the existing *image input and automatic measuring system for artifacts*. The visual material library is intended for both handwritten character materials, such as field notes, memoranda or cards, and image materials, such as slides, video tapes or cinefilms. This library will facilitate circulation of these materials now being used only personally. The ethnography library enables the researcher to retrieve page images of ethnographic texts by key words attached to each page.

Query from any work-station is first transferred to the database integrator, which decomposes the query into sub-queries for the appropriate libraries. Each library is responsible for generating sub-answers and transmitting corresponding images. The retrieved images are transmitted to the work-stations through the LAN. The LAN consists of several data links with different transmission speeds. Image data is transmitted through high-speed digital link, whereas coded data is transmitted through relatively low-speed digital link. Video signal is transmitted by analog link. To allow the researcher a *quick-look* at retrieved images analog link may be preferable, since high-speed transmission is required. Some work-stations are connected to both analog and digital links.

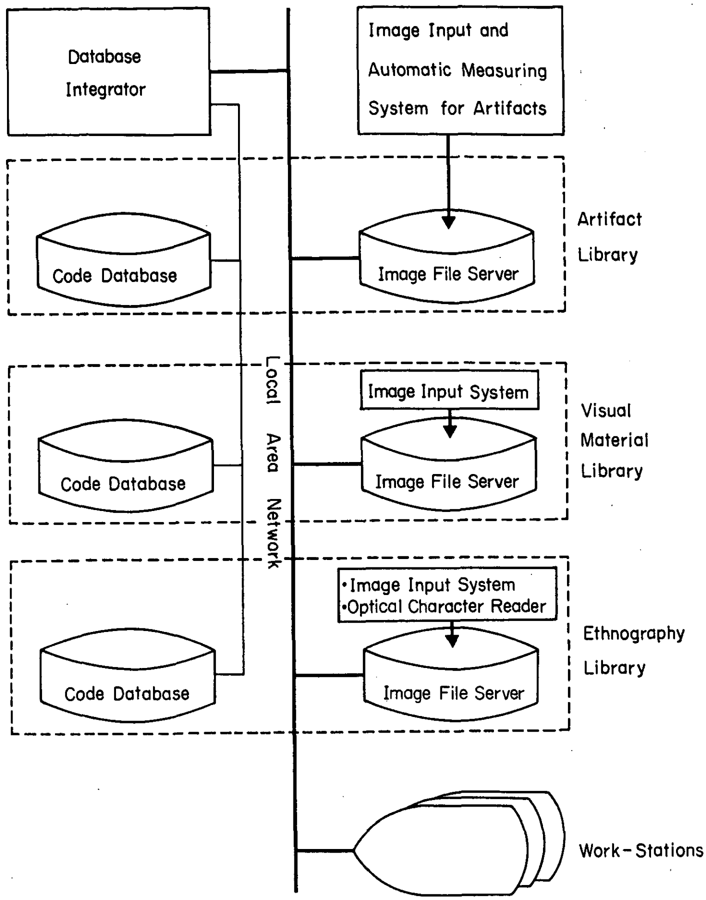

Figure 4. Rough Sketch of Our Ethnological Image Database

Technological Problems for Constructing Ethnological Image Database

To construct that ethnological image database we must solve the several technological problems described below.

Media for Storing Visual Information

On-line accessible storage with very large capacity is indispensable for retaining image data. The recently available optical disk is a promising candidate for storing images of both bi-level character materials and color image materials. From the viewpoint of cost/performance it seems a wise strategy to adopt the following combinations of media and material:

(a) Off-line and digital media for all image materials which need permanent maintenance;
(b) On-line and analog storage for materials which will be retrieved only for quick-look and where a little noise is permissible; and

(c) On-line and digital storage for a small amount of special materials to which on-line image processing will be applied.

To meet the requirement of high-speed image retrieval the problem of data compression must also be considered. Several data compression methods are widely used for bi-level images, but they are not directly applicable to color images. We must seek the best method for compressing full-color raster images from two viewpoints, size reduction and color encoding.

IMAGE DATA TRANSMISSION

The time required to transfer image data from storage to work-station is a key factor to realize high-speed image retrieval. Even the recently available optical LAN systems are unsatisfactory in the speed for transmitting the finest color image (*e.g.*, resolution of 1024×1024, depth of 24 bits) in our museum. Awaited is a breakthrough in the technology of transmitting a large block of image data. One method for saving time may be to omit overrigid error checking when loading and storing image data, since a small margin of error is permissible in raster image data.

Another theme is *virtual* image transmission. Transmission of any kind of image data, regardless of its size and depth, can be uniformly managed if an appropriate mechanism is prepared within both image sender and receiver.

DATABASE INTEGRATION

Our image database may be called *distributed image database*, since each library, *i.e.*, image sub-database, is located separately. As shown in Fig. 5, distributed database is generally composed of component sub-databases and a database integrator, whose role is to manage all sub-databases together, thus to give the user a virtual view as if he could use one database.

In our case, since each sub-database of coded data is already constructed on the

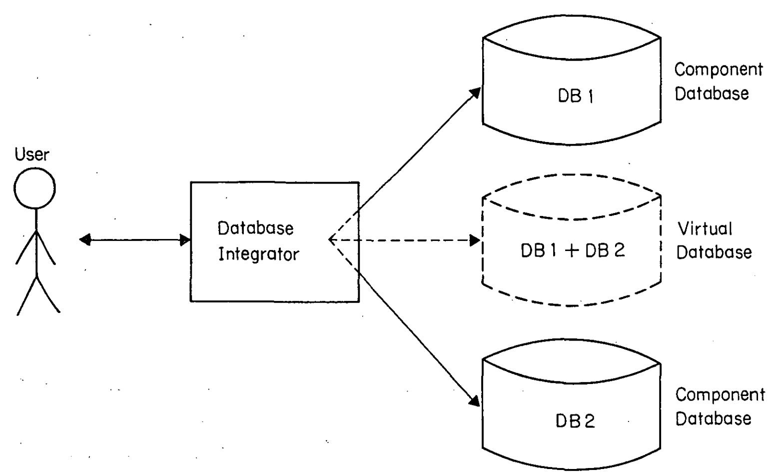

Figure 5. Concept of Distributed Database

main system, it is appropriate to locate the database integrator on the main system also. A conceptual diagram of our distributed image database is illustrated in Fig. 6. The database integrator decomposes a query from work-station into sub-queries, and transfers them to appropriate libraries. Each library comprises code database and image file server. Receiving a query, the former generates its answer, and if necessary, commands the latter to transmit the desired image data to the work-station which issued the query. Sub-answers from libraries are merged into an appropriate answer by the database integrator, then transferred to the work-station. The LAN conveys both image and coded data.

The image file server should have a mechanism for allowing the code database to point out any image data not by its physical location on a storage device but by its logical name, in order to localize within the image file server the influence of location change due to error recovery or replacement of storage device.

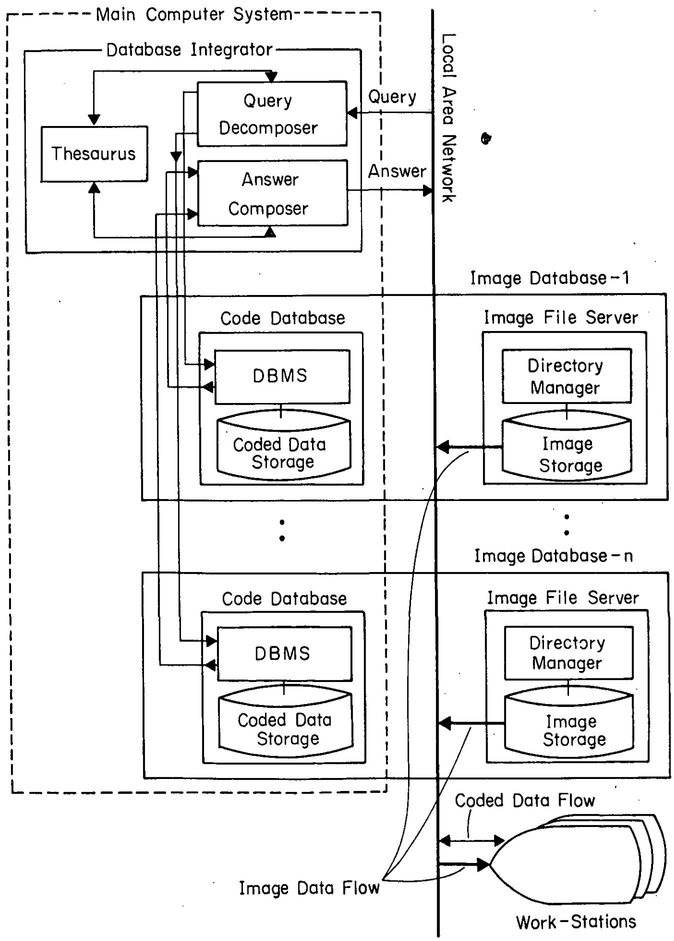

Figure 6. Conceptual Diagram of Our Ethnological Image Database

THESAURUS

Allowing the researcher to retrieve cultural information through the familiar *free key word* requires a thesaurus based on *cultural elements*. As shown in Fig. 7, the general form of a thesaurus is a hierarchy of categorized word lists representing five concepts, *i.e.*, broader term, narrower term, synonym, antonym, and related term. The thesaurus thus serves as a kind of *knowledge base* or *semantic network* for ethnological terms.

To find a synonym or related word for any given key word, the index file is searched first for the category code. We think it best to adopt OCM (Outline of Cultural Materials) code system of the HRAF (Human Relations Area Files) as the basic category code for our *ethnological thesaurus*. Then, all synonyms or related terms of a given key word are gathered together, using which retrieval is carried out. The recent fruits of AI (Artificial Intelligence) research may help to automate this process. The thesaurus should be embedded in the database integrator, working with the query decomposer and answer composer.

Because a thesaurus is none other than an expression of its constructor's world view, it is questionable whether a thesaurus could gain the general acceptance of every researcher. Therefore, a loosely and flexibly structured thesaurus seems better than a rigid one. Of course, elaborate examination prior to construction is indispensable.

IMAGE RETRIEVAL

Image retrieval is made possible using key words or coded data attached to each image. Several image databases adopt straightforward application of *relational data model* to image database, just by introducing image pointer as a new data type.

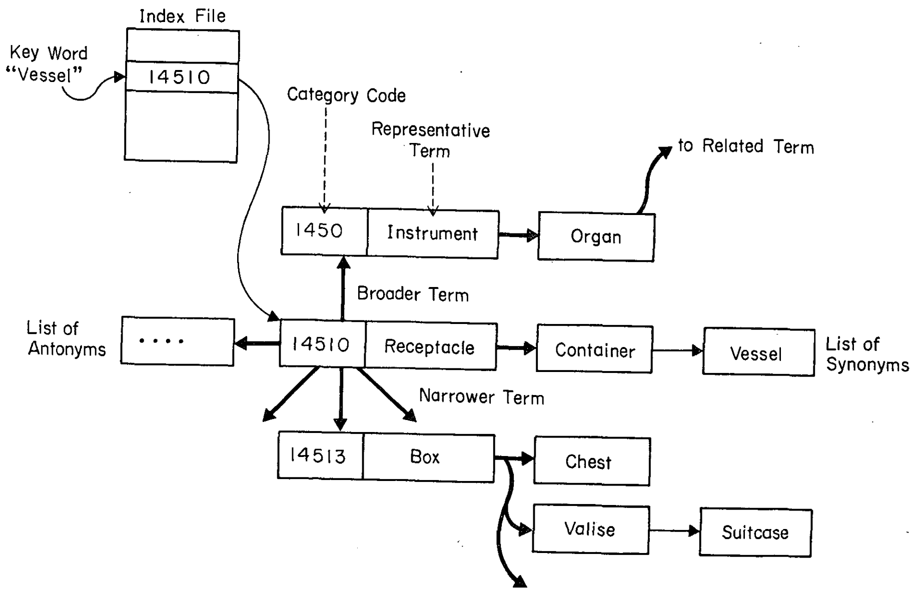

Figure 7. General Structure of Thesaurus

With this method, conventional relational database system like SQL/DS can be easily modified to manage image data [BLASER 1980].

Another retrieval method, specific to image database, is the *contents-dependent* image retrieval, *i.e.*, retrieval by image features such as color or shape, or *retrieval by similarity*. Although this sounds attractive enough to stimulate information scientists' fight for it, its practical realization requires such fast image processing at retrieval time to keep tolerable response time, that we had better leave it to the future study for the time being.

WORK-STATION

The work-station plays an important role in our image database because it is the very interface between the researcher and the system. Elaborate design in both hardware and software is necessary to fulfill the following requirements expressed by several ethnological researchers in the National Museum of Ethnology.

1) Simultaneous and integrated retrieval from multiple databases.

Such a style of retrieval allows the researcher to examine a specific ethnological object, *e.g.*, an American Indian basket, using multiple materials such as books on it, images of it, slides showing the use of it, etc. This will contribute greatly to *multi-perspective* ethnological research.

2) Image retrieval by quick browsing.

Simultaneous and quick display of roughly retrieved multiple images helps the researcher to retrieve further information from his own viewpoint.

3) Supporting classification of visual materials.

The card-based classification method such as *K–J method*, *i.e.*, a repeated process of scattering several cards on a desk, surveying, and rearranging them, is often very effective for a researcher to develop new ideas. The most desirable function of a work-station is to simulate this process on the display screen.

4) Image editing for multimedia data.

The work-station is expected to have the ability to edit uniformly every kind of visual data, *i.e.*, texts, raster images or graphical images, on the same screen by *cut and paste* method, together with such functions as word-processing, image processing, computer graphics, and high-quality printing out.

5) Personal image database.

Although a database for common use is valuable for the primary stage of research, the secondary stage often requires its modification for personal use, by attaching additional information according to individual interest. It is desirable to equip the work-station with the facility to construct a personal image database, and, inversely, to feed it back to the common database.

Although it seems too difficult at first sight to satisfy all these requirements, the recent technological development in large-scale memory, multi-window manager, image processor, and video signal processor will make them attainable in the very near future. We hope to inaugurate a new era of work-station by combining these technologies.

CONSIDERATION OF USER-FRIENDLY INTERFACE

The computer system has been called unfriendly, even to computer specialists. Especially to the ethnological researchers unfamiliar with computer systems, a user-friendly interface is essential. The unfriendliness of present computer systems may be due to the following problems:

(a) The names and syntax of commands are difficult to learn;
(b) The small display screen cannot present multiple data simultaneously;
(c) Every new job requires new programming;
(d) Users sometimes go astray in the hierarchy of a system's operation mode;
(e) System response is slow; and
(f) When a user commits an error there is no kindly guidance to recovery.

To relieve the user from such troublesome command operations, a command system must maintain simplicity, consistency and flexibility. In terms of the operation device, a programmed keyboard is preferable, where some keys are specialized for inputting frequently used commands by a single stroke.

In addition, visual aid will contribute greatly to the ease of using the command system. An ideal style of man-machine communication is conceptualized as *direct manipulation*, which means the situation where commands and their operand objects are represented by graphical symbols, instead of command language, and the effect of the command is immediately reflected in the shape or movement of these symbols [SHNEIDERMAN 1983]. Recent commercial work-stations already realize this concept. Such a graphical command system seems best for our retrieval problems.

As for the problem of multiple data presentation, multi-screen with multi-window display, together with zooming function, is desirable, so that data can be presented at any window on any screen. In the near future a large flat-panel display will come to hand, which would allow the user to view multiple data simultaneously.

Sometimes the programming load is discussed from the types of user's interaction with the computer, which may be classified into five levels; specifying algorithm, preparing program specification, utilizing a specific program package like SPSS, writing his own program, and interactive involvement with the computer program [PATTON and HOLOIEN 1981]. Based on this classification, two methods are conceivable for reducing the programming load of ethnological researcher.

1) To reduce the generality of programming language.

It is true the power of conventional programming language results from its generality, but the lower level operation of general-purpose programming language forces the programmer to specify the more detailed and complicated descriptions. On the other hand, if the programming language is tuned to a special purpose, the user's task can be specified by a small set of operators and parameters. For example, procedures for such special-purpose tasks as sorting, making KWIC (Key Word In Context) index, table generation, or statistical calculation can be made as packages with a small number of parameters. Such a set of tasks frequently required by ethnological researchers could be packaged into an *ethnological subroutine package*, to reduce the programming load.

2) Graphical programming system.

From the perspective of functional programming, any program is a sequence of instructions which mean "perform a function on the input data, then output the result." Thus a program can be imagined as a series of arcs and nodes which represent paths for data flow and function, respectively. That is to say, programming can be graphically carried out on the display screen by connecting symbols representing functions.

As for the problem of system's operation mode, graphical aid is also useful to indicate where the user resides in the hierarchy. If it is always displayed in the form of a tree with an indicator of user's current position, proper guidance to the next operation is easy.

CONCLUSION

Our plan for a visual information retrieval system for ethnological materials would serve greatly to promote ethnological research. In order to realize it, however, several problems must still be solved.

First, we must find storage media suitable for a large amount of image data. Inputting image information from primary materials into such media is another problem, since the quantity of materials is too large. Some kind of automatic input facilities must be developed.

Second, we must construct an effective thesaurus. If it is sophisticated enough to represent detailed relationships such as broader term, narrower term, synonym or antonym among ethnological terms, the range of ethnological information retrieval can be expected to expand greatly.

Third, an effective query language or command system must be designed for distributed database. Since the major attributes of primary materials are age, area, cultural element and source media, the query will be based on these categories. In implementing a command system on work-stations we must seek user-friendliness. A graphical command system would be preferable.

Close cooperation among the hardware designer, software designer and ethnological researcher will be essential to design this visual information retrieval system.

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