

A User Vocal Interface for the Intra-Operative Staging

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Abstract -- In this paper the Authors present the prototype of a vocal interface for the storing in real time of intra-operative staging informations into a knowledge base of an expert system and, at the same time, into a medical record of a database integrated with it. A brief discussion about the medical problem (the pancreatic cancer) is made, and the acquisition of the staging informations by voice is presented. Finally, the vocal query language is discussed, and an example by visual representation of a partial result of the staging is shown.

I. INTRODUCTION.

In this paper the authors discuss the problem of interacting with the computer using mainly a vocal interface for the storing in real time of intra-operative staging informations into a knowledge base of an expert system and, at the same time, into a medical record of a database integrated with it. They also present a prototype implemented on a personal computer, which, by a user friendly multimedial interface, manages the above data and knowledge bases in order to solve the problem to store into a computer information without using the hands (i.e., keyboard or mouse) when the user has own hands engaged in other activities (for example, because he is a surgeon that is operating in an operative theatre). After a brief discussion about the medical problem, the authors present the project in progress and, in particular, the part regarding the acquisition of the staging informations by voice to store into the expert system knowledge base of the system. Finally, the vocal query language is presented, as well as its main commands, and a screen with the graphical representation of a partial result of the staging is shown.

II. THE SURGICAL PROBLEM OF THE PANCREATIC CANCER AND THE S.P.E.S. PROJECT

Surgery is "a complex treatment system" that is integrated with other therapies much more frequently than other treatment systems. The help of a consultant acquires a stronger relevance in the operative room, where the decisional time is at the most of some minutes. Medical experience is less formally described than medical knowledge, but it appears to be the leading factor in treating patients. An expert system oriented towards the real need of the surgeon, appears, then, much more complex than systems developed in other medical areas [1]. The phases which characterize a surgical act consist essentially of the following points: a) choice of the surgical procedure and starting phases of the operation; b) staging; c) confirmation of the surgical procedure and its execution.

The disease considered in this paper is the pancreatic cancer. Today the cancer of the pancreas is the fourth biggest cause of death by tumor in the world. The operations are not carried out very frequently (and therefore there are few expert surgeons), the organ is deep in the abdomen (and therefore difficult to reach) and complications during the operating phase are frequent and varied. In order to help the surgeon that has a little expertise in this type of operation, the authors designed and implemented an expert system, called Spes-2, which supports both the operative risk evaluation and the choice of the surgical procedure depending on the operative risk and the diagnosis, obtained by another expert system integrated with Spes-2 and called Spes-1), and the starting phases of the operation and the staging, and, finally, the description (by a stack of pictures) of the surgical act chosen. These expert systems are part of the SPES (Surgical Pancreatic Expert Systems) project [2] which regards the early (pre-operative) differential diagnosis of the primitive exocrine cancer of the pancreas and the intra-operative phases evaluation of the operative risk and choice of the surgical procedure, staging, help to the surgeon during the surgical procedure).

The Spes-2 expert system, instead, refers to the different phases of the surgical procedure [1]. In particular, in this paper the authors suppose that the operative risk [3] has already been evaluated, the choice of the surgical procedure made (considering both the operative risk and the diagnosis of Spes-1) and the starting phases of the surgical procedure are carried out. So, for the staging phase, the surgeon sees the pancreas both really (in the abdomen of the patient) and, at the same time, as picture on the screen of the computer. The difficulties to use the conventional tools (mouse, key-board) to store the informations deriving from this activity suggested to the authors the use of a microphone by which to replace the above tools. For this reason the authors defined and implemented a *vocal query language*, which, using the modern technology supported by efficient tools, is able to understand commands, key-words, etc. given by voice.

III. THE MULTI-MEDIA USER FRIENDLY INTERFACE

Controlled by a Controller Module, the system developed is able to answer, asking a confirmation of what it understood, and to show on the screen the (commented) images of the different phases of the surgical act selected previously. The Controller Module plays a key role in the human interface. The main functions carried out by this module are: (a) to interpret the sequences of words received by the vocal interface; (b) to issue the commands for other modules (expert

system, video and audio modules, vocal interface); (c) to receive commands from the expert system; (d) to allow other types of input (keyboard and mouse); (e) to control the vocal interface according to the user current "position" in the application. The Vocal Interface is divided in two modules: an *Answer Module* and a *Listen Module*. Both of these modules work on the Spes-1 interface (retrieval of the medical record in the database, storing of the informations in it, request of the opinion about the diagnosis, etc.) and on the Spes-2 interface (again the previous retrieval and storing, staging, guide by voice and images to perform the surgical operation suggested, etc.) The function of the Answer Module is to pronounce predefined messages in order to guide the user through the system and to help the comprehension between him and the machine. The function of the Listen Module is to receive the user's words and to send them to the Controller Module for the next actions. In particular, in the staging that the surgeon carries out in the operative theatre on the computer in real time and the storing into the database and the knowledge base of the Spes-2 system. The staging phase is made by means of the voice and of a representation of the pancreas on the screen, so that the surgeon sees on it duplicated the real situation.

A. The Staging by the Vocal Interface

When the staging phase is selected, the screen of Figure 1 (without the buttons *H 1*, *H 2*, ...) appears to the user. If he clicks on the button *manual*, the message "mark the part(s) of the pancreas with methastases" and an hand appears on the screen. By the mouse the user can click on a general part (e.g., the button "head"), or directly on the picture of the pancreas. This last action will select a little zone of the pancreas which will appear darker. This information will be stored at the end of the section in the knowledge base and in the database of the system. Clicking on *next* the user can store other eventual anomalous situations (methastases) regarding other organs interested, from the nearest to the farthest (the methastases on these last organs can be discovered by instrumental examinations).

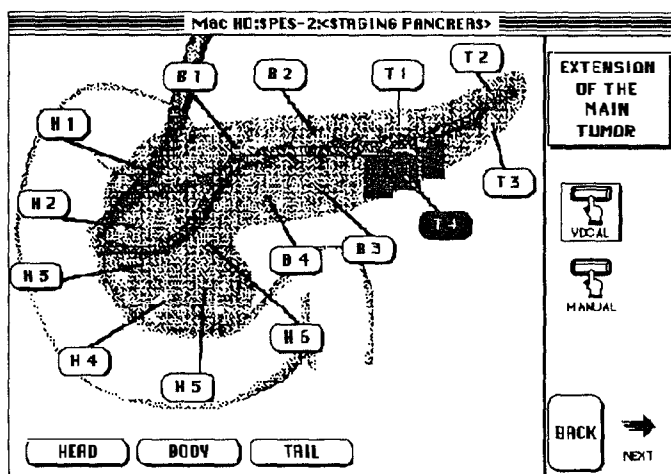


Figure 1

Instead, if the user chooses the modality *Vocal*, he will say "vocal" to the system by a wireless microphone of which he is provided (or will click on the button *vocal*) and the screen of Figure 1 will appear to him. Note that the different areas of the pancreas are marked by different buttons (where H means

head, etc.). By the vocal dictionary the user can choose what organ is interested in the staging phase (for each organ a suitable screen exists). Moreover, each organ (e.g., the pancreas) is divided in general areas and sub-zones (for example, "head" and H 1, H 2, ... respectively). By the vocal commands *next* and *back* the user can browse from the main organ (the pancreas) to the others and store the real situation of the patient.

The *vocal key-words* are divided into different groups, according to the situation, or context, in which they can be met. Note that, generally, in a normal conversation, that is our brain excludes those meanings that do not relate to the subject of the conversation. It is planned (and its implementation is in progress) the vocal managing of the help for the surgeon during the surgical operation. It consists on a vocal dictionary which allows to request on the screen the pictures of a particular phase (or the complete operation) commented by voice.

A set of compatibility rules is associated at each word of the vocabulary (i.e. after the word/command *play* only few words are allowed to be uttered by the user; they are: *escape*, *confirm*, *stop*). These rules define for the *Controller Module* what are the next commands that can be expected by the system.

A database is linked to these systems in order to retrieve the medical record of the patient, to update or to modify it and to print, at the dismissal, a final report about the health situation of him/her.

IV. CONCLUSIONS AND FUTURE DEVELOPMENTS

In this paper a user friendly interface, based on a Vocal Query Language, by which to store informations deriving from the staging phase of a surgical operation, is described.

Different expert systems could be fruitfully implemented in the medical area, for diagnosis or for therapy planning, but at present there is no system known designed to be used in the operating room.

As future developing the authors plan the implementation of the staging and the main different types of surgical operations, proposed by a graphical user friendly interface, in which stacks of images are commented by a voice that explains the different, more significant phases of the surgical procedure.

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