行政院國家科學委員會補助專題研究計畫成果報告

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計畫編號：NSC　90-2511-S-039-001-
執行期間：90 年 8 月 1 日至 91 年 7 月 31 日

計畫主持人：吳 帆
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計畫參與人員：周立平等

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中　華　民　國　91 年　10 月　31 日

行政院國家科學委員會專題研究計畫成果報告

手術器械電腦輔助教學系統之製作

Computer-aided Instruction System for Surgical Instruments

計畫編號：NSC 90-2511-S-039-001-

執行期限：90 年 8 月 1 日至 91 年 7 月 31 日

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一、中文摘要

因為醫療技術驚人地發展，醫院的手術室裡擁有越來越多多樣及昂貴的設備。在過去，醫護人員中的新手必須見習整個手術過程或者在他們操作這些設備之前聽取口頭指示，但這類訓練方法在目前越來越複雜的手術室管理中顯得有些跟不上進步。本研究主要著眼於操作這些設備之醫療人員的教育問題，發展一套以網路為基礎的系統來支援這些操作人員的訓練，我們使用物件導向的方法來探索外科包盤和器械間的關係，然後為他們建立一個物件模式；這個系統的資料庫包含超過 30000 個器械記錄，並以之組成外科設備的電腦輔助教學系統。為了方便，系統提供一個網路界面，使用者能夠互動式地得到外科手術設備的規格和圖像，並在學習之後獲得測驗，系統能夠記錄受測者的表現，且測驗問題為隨機選擇，以此保持受測者的興趣。另一方面，這個系統豐富的資料和搜查功能有利於手術室的準備工作。有了這個系統，醫院能在職前教育和在職人員教育中幫助醫務輔助人員及設備支援人員的訓練，並因此改善手術的品質。

關鍵詞：手術室、器械管理、電腦輔助教學、外科手術、物件導向

Abstract

As medical technology advances staggeringly, the operating rooms in hospitals contain more and more various and costly instruments. In the past, the recruits of medical staff had to witness the operation processes or listen to the verbal instructions before they operate these instruments. This training lags behind currently increasingly sophisticated operating room management. This project primarily focuses upon the educational issues for the medical staff who operates the instruments, developing a web-based system to support the teaching and training of the operators. We use Object-Oriented (OO) method to explore the relationship among the surgical packages and instruments and then build an object model for them. The database of this system encompasses more than 30000 records of instruments to make up a CAI system of surgical instruments. For the sake of convenience, the system provides a web interface. The user can interactively get the specification and image of the surgical instruments and can get an exam after learning. The system can record the testers' performance and the test questions are chosen at random to keep the tester's interest. On the other side, abundant data and searching function of this system facilitate the preparation of operation room. With this system, hospitals are able to assist paramedics and instrument supplying personnel in pre-vocational education and on-the-job education to improve the quality of operations.

Keywords: Operating room, instrument management, Computer Aided Instruction (CAI), Surgery, Object-Orientation.

2、Background and Goal

Surgery has been playing a vital role in the medical care. Well-prepared instruments hold the key to a successful operation. Only the operating rooms with immediacy and quality of medical care can meet the challenge of increasingly innovated medical

instruments and demands for quality of medical care. Such the requirements apparently cannot be achieved solely by senior medical workers' familiarity with the instruments. The cyber educational system can open the door to good learning for the recruits, raise the efficiency of learning and evaluate users' performances. In addition, the system can go even further to escalate the quality of medical services and function of medical management and prevent artificial negligence.

Previously, medical workers paid more attentions upon the outcome of the medical treatment and nursing care than the general medicine management and training. The operating rooms, growing out of the original anatomical rooms, contain more and more various instruments. For ease of management and preparation, hospitals put a group of instruments together, called *package*, for a specified operation. The package, congruent with relative operations, is the basic unit to prepare, practice and wash. When a surgeon makes an operation order, the staff should prepare the suitable packages for it. Obviously the staff needs to be familiar to the relationship between the operation and packages and the relationship between the package and instruments.

Usually, the Center of Supply Room (CSR) and the operating room are the venue to teach and demonstrate the context of the usage of the instruments. The teaching to be familiar to the instruments is becoming a heavy loading for the resident surgeon and the preceptor in the surgical education. The factors, such as the cost for bedside teaching, is increasing but the insurance payment for health care is no more increasing, exerts the pressure on surgery training. Various efforts have been undertaken to surgical education and training to meet the pressure. Several investigator developed methods to evaluate the surgical skills [1-3], intending to narrow down the variance of learning and then cutting the cost of teaching. On the other side, introducing computer-assisted instruction with advanced image technology has become increasingly utilized in hospital [4-8]. The computer-aided instruction can share the load of preceptor and then decreases the education cost. For the surgical instruction, some articles focus on the education [6-12]. A lots of researchers developed simulator systems, such as endoscopic investigations [15], surgical planning [16, 17] and neurosurgery [18]. However, little literature discussed the education of the instruments and packages. We know that well-prepared instruments hold the key to a successful operation. Only the operating rooms with immediacy and quality of medical care can meet the challenge of increasingly innovated medical instruments and demands for quality of medical care.

We investigated the environment of the operating room and found there are some problems, such as 1). the operation administration does not have an effect method to reduce the heavy loads of teaching; 2). apprentices master the technological processes and acquire instrument information from experienced paramedics only for text, no diagrams; 3). there is no an efficiently evaluating system to get over new employed persons' learning condition.

三、Method and Result

We put the system into action by involving the researchers in the processes of system exploration and application. In the implementation, the system does not only induce the practical experiences but also adopt bibliography of development of information system of instrument management.

We use Microsoft Internet Explore (IE) as the platform of the client sides and Active Server Page (ASP) as the developing language in the server side. The images for the instruments are captured with noise reduction and edge sharpening filters and finally stored in SQL server. The database encompasses more than 30,000 records of instruments from National Cheng Kung University (NCKU) Hospital to make up the system.

In collecting the information on the instrument management, we adopt the methodology of object-oriented method [13, 14]. We explore the relationship between surgery and package and the relationship of the package and instrument and then build an object model for them. For the former, a surgery will need at least one package in the preparing sheet; one package can appear in different preparing sheets for different

surgeries. For the latter, a package normally contains more than one instrument; the same type of instrument can be contained in different packages. Therefore we get their relationships, as is shown in Figure 1.

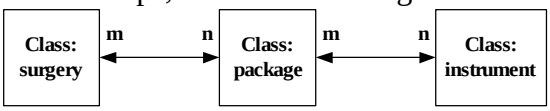

Fig. 1 The cardinality relationship among the surgery, package and instrument.

For each class in Figure 1, they contain a lot of attributes. For the surgery class, it contains the attributes: its name, subject, the number of packages and the corresponding package number and so on. For the package class, it contains the attributes: package number, package name, package character, number of instruments and the corresponding instrument numbers, as is shown in Figure 2. Note that the instrument's number may have several tuples, since in the object model for surgery and package classes are not normalized yet. As for the instrument class, it contains its all specifications as its attributes.

Packages class
Package number
Package name
Package character
Quantity of instruments
Instrument's number

Fig. 2 Attributes of the package class (unnormalized).

We use diagrams of class as support tools to build the system. The proceeding steps are:

1. Qualification the class: find the class;
2. Affirming the attribute of the class;
3. Finding the relationship among the classes;
4. Normalizing the attributes of each class; Building up the database schema for each class.

The system provides a convenient environments to practice and train the medical staff, where staffs can practice repeatedly as needed but with low cost. The system also provides a systematic evaluation of the trainee performance. The evaluation can be a closed loop interaction. The staff can have an exam any time during his learning and backs to the learning state when he decides to give up the exam or finishes the exam. Figure 3 shows how the user learns the knowledge of the packages and instruments. The system provides two types of questions (yes-or-no and multiple-choice questions), and these questions are selected at random. Fig. 4 demonstrates the process the user takes the exam in multiple-choice questions. After the exam, we can look over the statistical records of the exam so as to evaluate trainees' learning conditions. The system provides a consistent way of learning as well as a mean of evaluation. By making use of our random generated test system, we enhance the degree of accuracy and credibility of our computer-aided instruction system.

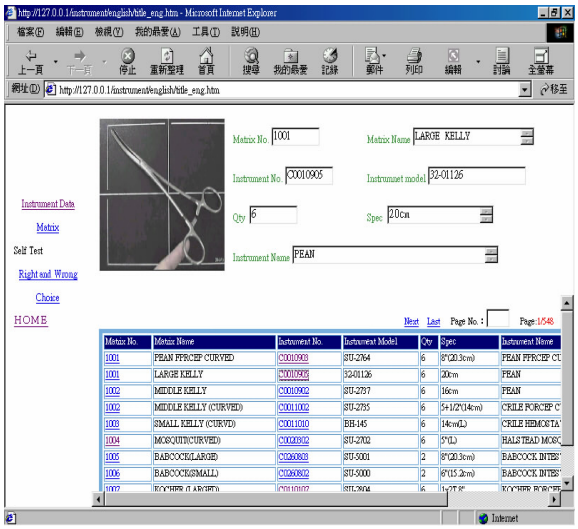

Fig.3 Education of the package and instrument.

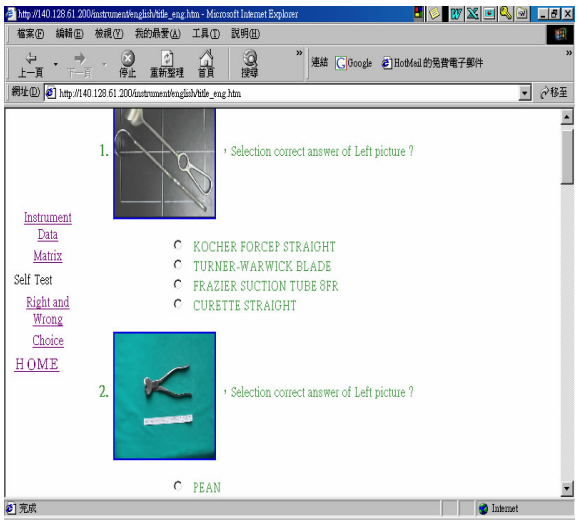

Fig.4 Test of multiple-choice questions.

This system contains three features:

1. Provide detail data on surgical instruments that can teach the users detail knowledge of surgical instruments;
2. Provide detail data on surgical packages that can teach the user not only the items contained in each package but also the relationship between the type of operations and package;
3. Provide two types (true-or-false and multiple-choice questions) of random generated test system.

After the hospital in the project put the system into actions, we can find the facilitation of operation processes, the escalation of efficiency of personnel of operating room, the positive response from apprentices in training and the diminished errors of preparations. The system achieves three general requirements for CAI system: accurate model of teaching, closed loop interaction and easy device to practice.

The system has not provided a variety of levels for public, trainee and experienced staff. The combination of this system and the Hospital Information System (HIS) has not yet finished. Both are our next goals. However, the virtual reality about the usage of the instruments is depended on the type of surgeries. This task is the domain of surgical simulations and is beyond the scope of the system.

四、Conclusion and Suggestion

Providing training systems on the web has a lot of advantages for the staff. Though the training demand high communication (internet) capacity. The exponential rate of computer development and improvement can support the demand in the near future. The reduce of the loading and the performance of the learning can compensate for the investment cost in computer.

The bibliography has shown the object-oriented model can well performed in constructing medical records. From our system, we show the object-oriented model can also be expended into the surgical instrument management. In the system, abundant data and searching function facilitate the preparation for pre-operation instruments. The system also supports that computerized educational system can curb the time for adaptation by recruits, relieve the heavy loads of teaching on paramedics and raise the efficiency of surgical personnel.

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