PACS (Picture Archiving Communication System) for Dentistry

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Abstract **This paper proposes PACS (Picture Archiving Communication System) to manage and transfer information for dental field focusing on 2 main fields as follows. First application was to open Digital Imaging and Communications in Medicine (DICOM) files of patients inside the database via Local Area Network (LAN) and Hypertext Transfer Protocol [HTTP]. Second application was to pass patient's personal data and treatment data on the network by applying MySQL database [4] with Graphic User Interface (GUI) implement using Borland C++ Builder**[TM]**.**

I. INTRODUCTION

Presently in general practice, dentists need to fill in patients' information in the paper form and keep it in the filing. Also in order to make a diagnosis, dentists will have to view the DICOM [1] image one by one, from the X-Ray films. This process consumes plenty of time, which many hamper the treatment.

Therefore, the computer program that can manage patients' information with fast and accuracy would be highly preferable for dentists in this research. These days, computer network has become a significant part for handling data, the program is developed using this tool to handle several type of data, such as patient's information, medical data, treatment plans, result and data retrieval from remote area.

In addition, PACS [2] will support dentists and other health professionals able to perform their roles with modern technology to pursue advanced twenty-first century healthcare service.

In this paper we explain the design and development of PACS, the system architecture. Then we will describe the components of PACS, data management and DICOM viewer. After that function of system and evaluation of PACS are explained later.

II. DESIGN AND DEVELOPMENT OF PACS FOR DENTISTRY

A. Overview of PACS

This system is separated to 2 sites, the site of server site and client site [3] connected by LAN [4] shown in figure 1.
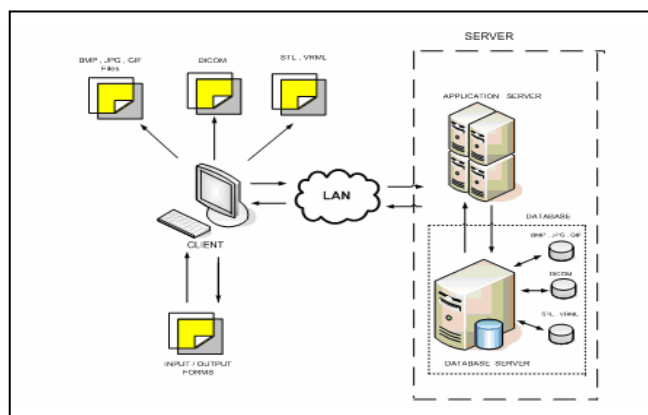
First, DICOM Viewer used to open DICOM files. Second, medical data in both text and image files such as patient's information, treatment data. PACS has clients there are no special software for clients. Clients should install the PACS installer and then set the ODBC connection for connect to the database from server site. Client system is using client GUI in retrieving data from a server, through LAN.

Figure 1 PACS architecture

B. DICOM viewer

DICOM viewer, which is the program that developed in house to open DICOM file and to use in dental implant planning and surgery, GUI in DICOM viewer is implemented using Borland C++ Builder[TM] [5].DICOM viewer can manage the DICOM files---the image file from Computed Tomography-Scanner (CT-Scan) for example, opening file, single view, examining in 3 views (axial view, coronal view, sagittal view) call multiple view, instancing between points, saving file, printing file, creating panoramic view along with dental information in both text and images via networks with efficiency.

III. PACS FOR DENTISTRY FUNCTIONS

The First application is DICOM viewer

A. Opening file

The DICOM viewer is able to be opening file. DICOM file can be opened in two ways; from single file or directory file. Single file opening is open one by one DICOM images and directory file opening is open directory of DICOM images. DICOM viewer displays image in three views relate to x plane, Y plane and Z plane (coronal view, axial view and sagittal view). It can display in single view shown in figure 2 and multiple view shown in figure 3 which depicted in four view images, coronal view, axial view, sagittal view and STL [6] view.

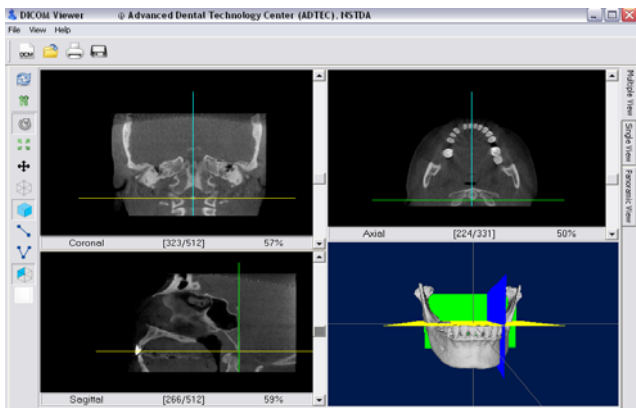
Figure 2 DICOM viewer with single view

Figure 3 DICOM viewer with multiple view

B. STL view

STL view is a capability of DICOM viewer for demonstration STL model. STL view can be see in figure 4 is the 3D data.
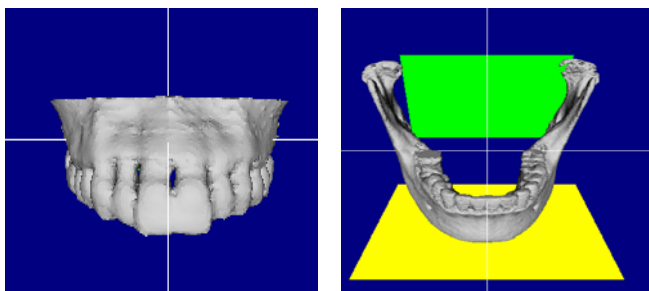

Figure 4 STL File of maxilla and mandible section.

C. Panoramic View

DICOM viewer can create panoramic view, which is developed from axial view. The panoramic view is created from panoramic line. User can define the landmarks for the path along the teeth then program generates the panoramic line to view shown in figure 5.

D. Cross sectional view

Cross sectional view is from sectioning each tooth in selected panoramic view shown in figure 6.

E. measure the distance

DICOM viewer is able to calculate distance between points in 2D and 3D, the measurement can demonstrate in millimeters. Additionally, it's able to measure the angle in 2D and 3D that shown in figure 7.
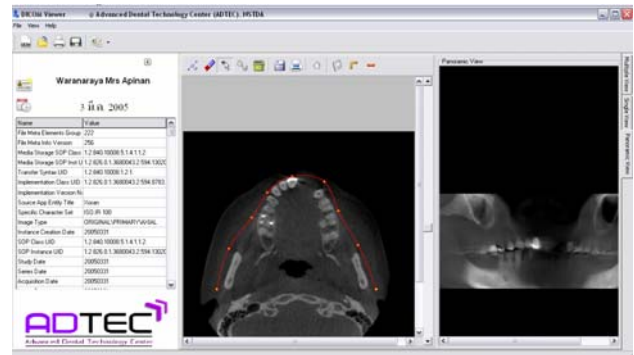

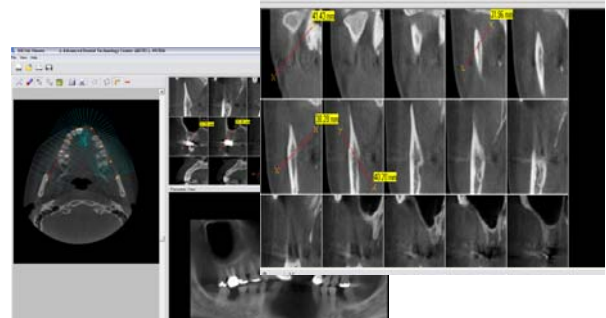Figure 5 DICOM viewer produces a panoramic view of an image.

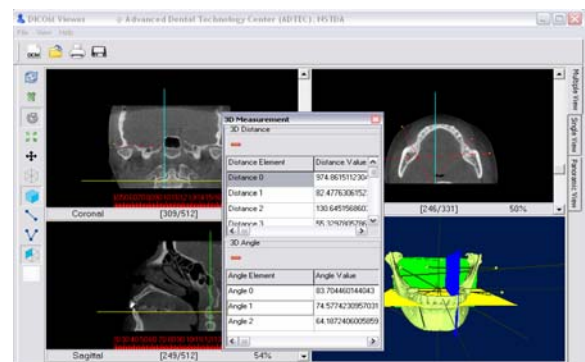Figure 6 DICOM viewer, cross sectional view

Figure 7 Measurement the distance and measurement the angle.

F. Adjustment brightness and contrast

DICOM viewer is adjusted brightness and contrast value at the menu adjustments shown in figure 8. It can adjust brightness and contrast value of the image for clearer and better vision.

G. Save files

DICOM viewer is able to save DICOM files and panoramic files with BMP type into your computer, PC, laptop or notebook.

H. Print files

DICOM viewer is able to printout DICOM view and panoramic view with description to use into diagnosis of implant treatment and other treatment.
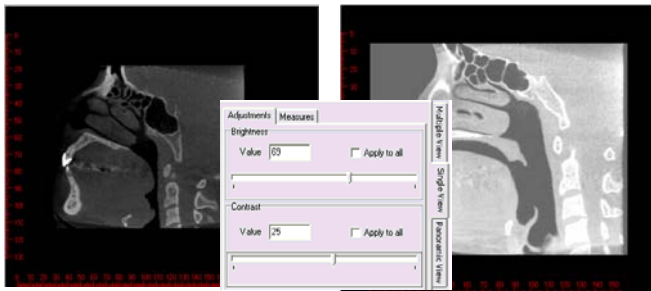

Figure 8 Adjustment brightness and contrast value at the menu adjustments.

The second application is the data management

The implementation of the PACS architecture is base on client/server architecture. Using the PACS program, when we open the program we'll see main page. Then go to Log-in page to type username and password in order to get into the system. When we are authorized into the system, we'll be able to use any PACS functions. For example, archiving, retrieving, rectifying patient's information and creating an appointment.

A. Patient's information and treatment data management

The features of PACS are adding the new data, retrieving data and editing patients' information and treatment data that manage two types of file, text file and image file shown in figure 9 and figure 10. The clients connect to the server to retrieve the required data via LAN which mapping driver with server site.
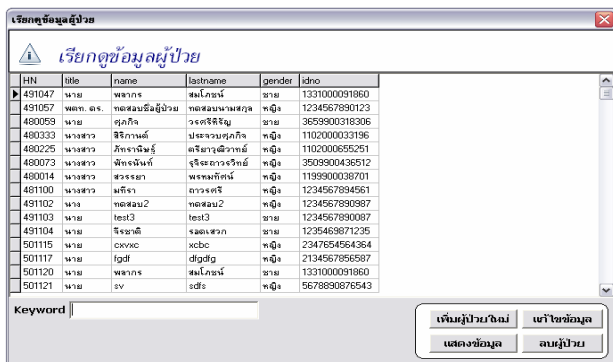

Figure 9 Retrieving patients' data.

Figure 10 Treatment data management.

B. An appointment and dentist schedule Management

PACS allows user to manage the dentist schedule and appointment with patient as illustrated in figure 11. On the input form page, they can create and add new appointments, and on this output page, they'll see list of all appointments.
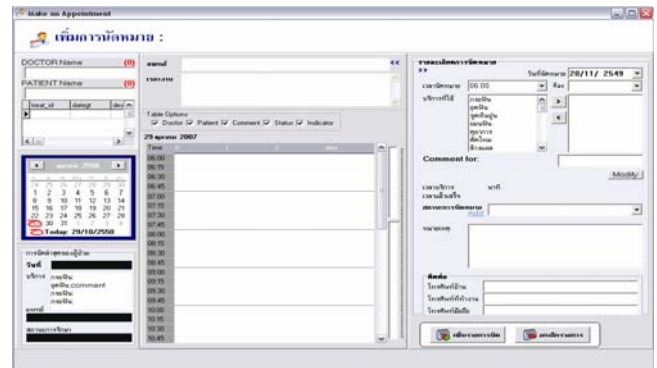

Figure 11 An appointment page.

C. Report management

The report has four types such as monthly report, total of patient report, treatment report (treatment type, treatment group), patients' information report and customize report.

IV. EVALUATION OF PACS SYSTEM

the PACS is developed in independent steps. The first step is the implementation of PACS server that is completed. Then data management and DICOM viewer are developed PACS on client/server architecture is implemented for the convenience in the data storage. Last we have used PACS program in Advanced Dental Technology Center (ADTEC) for manage the dental system and tested by dentists of ADTEC. We formed the training course for the dentist. There were 28 participants to participate this course. They underwent the test process and filling questionnaires. The result of training and evaluation of system can be depicted in Table 1 [7].

Table 1 Evaluation satisfaction

Evaluation factor	Satisfaction (%)	Modify (%)
Easy to use	86	14
Speed of using program	90	10
Overall quality of program	86	14
Error detection	80	20

We passed on testing phase and validation phase. It passed user test and user acceptance test. We validate measurement function, part of DICOM viewer by comparison between DICOM viewer measurement and manual measurement and comparison between DICOM viewer measurement and commercial software measurement. The result of DICOM viewer measurement validation is followed in table 3 and table 3 that present six landmarks measurements, the average of the distance difference and the average of the percentage difference from ten patients. According to test results, the average of the distance difference was between 0.12-1.28 millimeters and the average of the percentage difference was between 1.31-5.63 percentages. The evaluation provided the acceptable results.

Table2. The result of DICOM viewer measurement validation that comparison between DICOM Viewer and Manual measurement.

Comparison between DICOM Viewer and Manual measurement		
Point	Average of the different between DICOM viewer and manual (mm)	Average of the percentage difference between DICOM viewer and manual (%)
Width 13	0.12	1.67
Width 32	0.26	5.29
45 to 34	1.06	2.77
44 to 32	0.61	2.55
12 to 23	0.50	2.06
15 to 22	0.66	1.88

Table 3. The result of DICOM viewer measurement validation that comparison between DICOM Viewer and I-Cat software measurement.

comparison between DICOM Viewer and I-Cat software measurement		
Point	Average of the different between DICOM viewer and I-Cat software (mm)	Average of the percentage difference between DICOM viewer and I-Cat software (%)
Width 13	0.20	2.88
Width 32	0.15	2.64
45 to 34	0.49	1.31
44 to 32	0.59	2.61
12 to 23	1.28	5.63
15 to 22	1.09	3.09

V. CONCLUSION

PACS is computer system or networks dedicated to the storage, retrieval, distribution and presentation of images. It could help dentist work with patients' information, treatment data, appointment data and DICOM images. It handles images from various medical imaging instruments such as X-rays from CT-Scan. It promotes accurate diagnosis, as dentists can have variety of DICOM and panoramic views to aide implant treatment and surgery. It composes of two components, the data management and, DICOM viewer. It is easy to use and helps us have a more organized tool for patients' data and treatments which decrease the redundancy data in the database because of using a relational database management system (RDBMS), MySQL [8] database. Moreover, PACS provides the advantages for dentists and other medical fields. It is able to develop and improve the efficiency of the healthcare system.

REFERENCES

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