Online Dental Information Database for Dental Identification System

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Abstract—Dental cast models along with dental identification data have been extensively applied in cephalometric analysis and dental identification. However, the lack of database to handle both dental cast models along with dental identification data has prevent the researchers and dentists from making an access into the dental information for further dental researches. The solution is to create the online dental model database to collect both 2D and 3D dental cast images with the search function from the information of both dentists who collect the dental model images and other dentists who are database users. Furthermore, the online dental database has facilities to record the dental identification data from individual teeth and the overall dental structure in details useful for dealing with the missing persons by matching the postmortem dental artifacts with the dental records from dental model and dental identification data.

I. INTRODUCTION

Dental Model Analysis is a part of orthodontic treatment plans [1]. In the past, the measurements for each individual tooth have to be done by manual method using a veneer as shown in Fig. 1(A) [2] which is tedious method. The later development is to make a measurement of dental model on the digital photographs of dental cast model before performing using dental model analysis program such as Dental Model Analysis Module of CephSmile V2.0 as shown in Fig. 1(B) [3]. The further development is the 3D dental model analysis program such as AnaDent3D Viewer [4] which can perform 3D dental model analysis on 3D dental model file in STL format obtained from either an Optical 3D Scanner or a Cone-beam CT Scan as shown in Fig. 2.

Furthermore, there are a few applications of dental model analysis for the forensic science application [5] which has been done from the post mortem cross bite traces collected from the cadavers [6].

However, the long term storage of dental cast has to be held at least 5 years according to the 3rd section of the 35th article in “Medical Premises Act BE 2541[7] and the ministerial regulation has extended the storage period for dental casts to 10 years [8], increasing a longer period to access and search the accumulated dental model data.
Furthermore, there are extensive applications of dental information for the forensic dental identification which require to record the dental data for each individual tooth in the Dental Chart with an odontogram and the oral data along with overall dental condition in the Dental Record as shown in Fig. 3.

However, the records of dental data for dental identification have several shortcomings including [9],

1) No standardization of the dental forensic document system and the computer program to record the dental data for forensic applications.
2) Incompleteness of recorded dental data for forensic applications.
3) Redundant documents that delay the process time and cause error during data procession.
4) Shortage of personnel with forensic expertise to handle dental information for forensic applications.

There are several researches on the program to handle dental forensic data for dental identification including ExcelDent by Canadian researchers [10] and IDIS® for dental identification by Thikhamporn in 2005 [11]. However, there is no dental database to handle the dental model analysis information as well as the dental information for the forensic dental identification. This paper will mention about the dental database development to handle the dental model analyses information and dental information for the forensic identification.

II. DENTAL MODEL DATABASE

Dental Model Database in this paper consisted of the following 5 sections including:
1) Register section
2) Patient Information section
3) Dental model images in 2D and 3D.
4) Dental model analysis results from 3D dental model.
5) Records of dental data for identification.

This paper would focus on the section about the records of dental data for identification while the rest would be mentioned in concise manners.

A. Register section
Register section consists of the following information to comply with the Computer Crime Act BE 2550 [12].
1) User Name for the members to login the database.
2) Password with 4-8 digits to access into the database.
3) Confirm Password with 4-8 digits to confirm the identity of the user.
4) E-Mail address of the user for activating the account as the measurement for user authentication.
5) Photo for member photograph
6) First-name of the user
7) Surname of the user
8) Sex of the user
9) Birthday the birth date (day/month/year) of the user
10) Nationality of the user
11) ID Card No., the 13-digit of user's national ID card.
12) Dental License No., beginning with “Tor” and follow by a 3-5 digit number issued by the Dental Council of Thailand according to the Dental Profession Act BE 2537 [13].
13) Address, the user’s address for the delivery of DVD containing scanned dental model file in 2D and 3D from the Optical 3D scan.
14) Tel, a telephone/mobile phone number to allow the contact between webmaster and user
15) Education, the highest education level of the user
16) Hospital, the working office for the user which functions as the alternative address in the case of returned DVD.
17) Clinic, a dental clinic outside the hospital for the user if the user is working in both hospital and dental clinic which functions as the alternative address in the case of returned DVD.

B. Patient information section
After the registration, the user can fill up the patient info as the patient record
1) Identified to indicate whether this patient is known or otherwise for dental forensic information
2) Picture of the patient
3) First-name of the patient
4) Surname of the patient
5) E-Mail address of the patient if available
6) Sex of the patient or the artifacts which require forensic analysis to identify the gender.
7) Birthday the birth date (day/month/year) of the patient
8) Nationality of the patient if available.
9) ID Card No., the 13-digit of patient's national ID card if available.
10) Blood Type of blood for the patient if available.
11) Address, the patient’s address if available.
C. Dental Model Images in 2D and 3D

The section for the dental model images in 2D consists of the following information to be filled.

1) Photograph date, the date (day/month/year) when taking a photograph of a dental model.

2) Dental Images which can be either separated maxillary and mandibular photograph or the photograph with both maxilla and mandible shown as a thumbnail icon shown in Fig. 4(A). After clicking the thumbnail icon of dental model photograph, the display result will be as shown in Fig. 4(B).

3) Other image information, the information about the dental image records including, lateral image, frontal image, smiling image, the image of post mortem dental artifacts radiographic images and panoramic images.

4) Comment, the further record about the dental images.

The section for the dental model images in 3D in either VRML for displaying on the web browsers or STL obtained by scanning with the optical 3D scanner or a cone-beam CT machine will be as shown in Fig. 5(A) while the display result of the dental model in VRML by Internet Explorer® after installing Cortona3D driver program will be as shown in Fig. 5(B). [14]
space analysis result will be as shown in Fig. 6(C) and the result of the Bolton Analysis will show the list of ideal sums of maxillary and mandibular lengths compared with the actual results as shown in Fig. 6(D).

<table>
<thead>
<tr>
<th>Model Space Analysis</th>
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<tbody>
<tr>
<td>Arch Perimeter</td>
</tr>
<tr>
<td>Maxilla Actual (mm)</td>
</tr>
<tr>
<td>Maxilla Ideal (mm)</td>
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<tr>
<td>Mandibular Actual (mm)</td>
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<tr>
<td>Mandibular Ideal (mm)</td>
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<tr>
<td>Anterior Arch Width</td>
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<td>44.22</td>
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<td>43.57</td>
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<tr>
<td>16.25</td>
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<tr>
<td>16.79</td>
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<tr>
<td>11.43</td>
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</tbody>
</table>

(A) Model Arch Perimeter Analysis

(B) Model Space Analysis

E. Record for Dental Data for Identification

There are two main sections for the records of dental data for identification, Dental ID and Dental Rec with the reference to the image of the dental chart and dental record shown in Fig. 3 with the details described below.

Dental ID for Recording Information of the Individual Teeth

This section will follow the example of the program for dental identification for the individual teeth WinID3: Dental Identification System [15] while the codes in the program would follow the standard codes established by ABFO [16] which consists of two main sections including:

**Primary Codes:** The dental data code for the individual teeth to be mandatory recorded such as

1) M for Mesial Surface
2) O for Occlusal Surface
3) D for Distal Surface
4) F for Facial Surface
5) L for Lingual Surface
6) I for Incisal Surface
7) C for Dental Crown
8) U for Unerupted
9) V for Virgin Tooth
10) X for extracted tooth
11) J for missing tooth after post mortem
12) # for not available data.

**Secondary Codes:** The optional dental data code to be recorded following the if available such as

1) A for Abnormal Tooth which requires further records
2) E for Dental Filing with Resin
3) G for Dental Filing with Gold
4) H for Dental Filing with Porcelain
5) K for Temporary filing
6) N for Dental Filing with cheap medical grade steel.
7) P for Pontic after following X (Missing Tooth)
8) Q for Removable Crown at least ¾ of the tooth
9) R for Root Canal filing
10) S for Silver Amalgam filing
11) T for Denture, after following X (Missing Tooth)
12) Z for Decayed tooth broken tooth, impacted tooth without filing

The way to record dental data for the individual teeth would follow these examples.

- MODFL-S - A Permanent Tooth restored with amalgam at Mesial, Occlusal, Distal, Facial, Lingual section of the tooth.
- MO-SB - Mesial Occlusal Silver Amalgam in Deciduous Tooth
- MI-E us Mesial and Incisal section of the tooth filled with Resin
- X - an extracted tooth
- X-PN - an extracted tooth replaced with steel crown
- MO-AZ Mesial Occlusal of the tooth went wrong with abnormal teeth including tooth decay and an impacted tooth

Dental Rec for Recording Information of the Overall Dental Conditions

This overall dental record consists of two main sections including:

**Dental Record:** The overall dental data condition to be mandatory recorded such as

1) Extensive Dental Work - Wearing the whole set of denture
2) Lower Denture – Wearing a Denture fore the missing mandibular teeth
3) Upper Denture – Wearing a Denture fore the missing maxillary teeth
4) Partial Plate – Wearing a partial denture plate.
5) Dental X-Ray - Radiographic images of teeth.
6) No teeth – for the case of a Patient without teeth.
7) Has most teeth – Having almost all teeth
8) Brace – Have a dental brace in the oral cavity
9) Bridge – Have a dental bridge in the oral cavity
10) Other (Please specify) – Other particularities to be specified

Other Dental Record: The overall dental data condition to be recorded if available such as

1) Tilted mesially, distally, buccally (including protruding anterior teeth), lingually or palatally – dental tilt directions including
2) Functional appliances e.g. bionator and palate expander, etc – dental instrument within an oral cavity
3) Root canal therapy completed, or not completed – Information about the root canal treatment for the case that has a record about root canal therapy
4) Excessive wear due to tooth brushing, excessive occlusal wear (Bruxism) – record about the excessive dental wear due to any circumstances.
5) Metal post in canal or retentive pins – record about the existing dental pins
6) Severe bone loss, soft tissue pocketing, or recession – extreme jaw bone and dental loss
7) Rotated – record about the existence of rotated teeth
8) Pariapical pathology (granuloma, cyst, etc.) - dental disease within jaw including cysts, and the trace of an oral infection
9) Supranumerally tooth or Retained root tip – Number of teeth over 32 or the protruding dental root
10) Intrinsic staining e.g. mottling, tetracycline, etc. – intrinsic stain on the teeth due the circumstance including tetracycline or so.
11) Overhang of restoration at gingival margin – dental support on the gingival areas if exists.
12) Torus mandibularis or palatines (other exostosis) – excessively protruding mandibular jaw bone to under the lingual area or protruding jaw bone
13) Retained amalgam or metal fragments embedded in tissue adjacent to the affected tooth or tooth vicinity – record about the existence of amalgam embedded within oral cavity
14) Blade implant or individual tooth implant (Metal implant, ceramic, etc) – record about the existing of metal ceramic implant
15) Shovel-shaped incisor – incisor with abnormal shape
16) Implant superperiosteal – dental implant stuck deep into the mandibular bone
17) Diastema – Excessive space between individual teeth
18) Chipped – the broken teeth within oral cavity
19) Orthodontic band on tooth, archwire – report about the existing of orthodontic treatment instruments in band shape or orthodontic wire.
20) Surgically Placed wired, e.g. fracture repair procedures – report about the existing of the wire which keep cracked or broken teeth during the oral surgery together.

F. The Design of Dental Identification Database

![Fig. 7. Information Loading for Data ID](image)

For the design of the dental database for identification, the authors have designed the Dental ID section for recording dental data as shown in Fig. 7(A) consisted of dental image and keywords to be filled up with the information about the individual teeth by the user started while Fig 7(B) is showing the result after choosing the right maxillary incisor (Tooth #11). The use can select whether the chosen tooth is either a permanent tooth or a deciduous tooth by pressing the Permanent tooth radio button for the case of a permanent tooth or the Deciduous tooth radio button for the case of a deciduous tooth. After that, the user can fill up the Primary code along with the Secondary code if the dental model set or dental images have information exited in the secondary codes. After finishing the record of the individual teeth, the user can save the data by pressing Save button to record the dental data for personal identification.

The dental information record on both Dental Rec section for required dental records and Other Dental Information for optioned dental information record been designed as seen in Fig. 8.
The result from recording Dental ID for dental identification by the information from the individual teeth will be as shown in Fig. 9. The example shown in Fig. 9 is showing the case of mixed dentition with a deciduous tooth at the second right mandibular incisor (Teeth #72) shown in pink while the permanent teeth in this example will be shown as the azure teeth. The user can correct the information by pressing the Correction button.

### IV. SOME COMMON MISTAKES

The development of dental model database for identification has finished to one level. However, this system needs further advice from dental specialist on dental identification to make further improvement of database system. More dental model examples are in need for the statistical assessment. The developer may consider for the development of dental analysis system for the application of the dental identification as a Web Application with the capacity of performing Automated Dental Identification System (ADIS) as Fahmy et. al. [17] have been trying to do so.

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### REFERENCES


