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A Computer Aided Measurement and Analysis System for Orthodontics Mould

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Abstract: A computer aided measurement and analysis system is put out to avoid the problem caused by Orthodontics Mould (Teeth Die) manual measurement of the possible measurement errors in this study. Orthodontics Mould's digital image may be collected by using digital CCD camera's information acquisition technology and achieved by means of a computer-aided measurement system of the Orthodontics Mould's digital image. Digital image processing of the Orthodontics Mould, makes it easy to process and analyse the measurement data from the mould. The system based on the Windows platform, Visual C++ 6.0 tools and MS SQL server database technology completes Orthodontics Mould-image data measurement, processing, maintenance and management. The system based on the arch form's measurement and analysis includes 3 subsystems, namely, Orthodontics Mould's medical records management system, measurement systems and analysis system. The results show that the digital measurement data of Orthodontics Mould's image can be developed for clinical doctor-assisted oral treatment options for reference, which has a strong clinical value.

Key words: Oral orthodontics, orthodontics mould measurement, CCD digital cameras, computer-aided measurement

INTRODUCTION

Dental deformities have always been an important factor affecting people's appearance. With the continuous improvement of living standards, the world pay more attention to one's own appearance, which makes the measurement of orthodontic mould (edentulous mould) image widely used in orthodontic surgery. Therefore, a fast and accurate measurement of Orthodontics (Orthodontics) mould image has become one of the most important common subjects in the oral areas (Johnm and Brentley, 1981; Gu Min and Pu, 2003). However, compared with some developed countries, there are still significant gaps in Orthodontic level: our Orthodontics in measurement methods and equipment parameters of such areas is still quite backward. For a long time, the use of the accuracy of 0.02 mm vernier caliper, the regulations for manual measurement tools such as dental mould (Orthodontics Mould) is the most commonly used measurement method, which is not only time-consuming, laborious and prone to error (Wang and Yu, 1999) and thus, greatly affectes the work efficiency of the oral orthodontics. In particular, in the development of oral treatment options, developing treatment programmes, according to a rough measurement of personal medical data and experience, not only hardly convinces patients and often causes a lot of errors and sometimes even brings about irreparable mistakes, which results in a serious impact on orthodontic cause of China's healthy and rapid development and the improvement of one's spiritual life. With the development of information technology, some of the traditional oral treatment methods and means are also engaged in the transformation of information (Verstreken, 1995; Ganz, 2001; Hu Wei *et al*., 2000; Lu Shuyuan and Lu, 2003). However, some diagnostic systems of Orthodontic field at home and abroad, still don't yet take full advantage of computer technology, especially network resources. It is not possible to provide help for the diagnosis classification and orthodontic treatment programmes. And with the wireless network technology developing, the mould image edentulous orthodontic system based on the wireless network technology allows long-distance diagnosis possible.

Compared with the traditional manual measurement, the research for the computer-aided measurement system of orthodontic model, based on CCD (Charge Coupled Device) digital camera and a image acquisition card, will

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enable measurement and analysis of orthodontic mould achieve a better precision and accuracy. At the same time, the computer itself has a powerful data storage and processing capacity, which is convenient to handle the large statistical sample. This is conducive not only to store and enquiry for the results of measurement, which is more conducive to statistical measurement data, processing and analysis (Robert, 1998; Burston, 1979), but also reduces the dependence on foreign technology, lowers cost of application and can be used to guide clinical work and breaks the shackles of mode of measurement of the old Orthodontic mould and help to promote oral repair techniques and the development of relevant industries. And in the development of China's Orthodontic cause there is a breakthrough in the role and significance.

PRINCIPLE AND FUNCTION OF SYSTEM

Orthodontics Mould image is received by the CCD image sensor, image resolution of 1024×1024, which can meet the precise measurement request of orthodontics mould, the system measuring principle as shown in Fig. 1.

Measurement and analysis system of Orthodontics Mould image consists of three subsystems, which are medical records management system, the measurement system and diagnostic analysis system. System based on arch shape measurement and analysis is designed for orthodontic clinical diagnosis and clinical operations. Features include arch width measurement, arch length measurement, Spee's curve distance, the degree of overcrowding, the angle measurement, bolton index analysis, tweed analysis, measurement and analysis of mixed dentition period, Moyers's probability-table analysis, analytical methods of dental morphology and so on. The functional modules diagram is shown in Fig. 2. This study uses RPE rate calculation mould and teeth-mould analysis of drawing Bonwill-Hawley ideal standard arch mould. This is because the human form of arch belongs to a geometry problem. Using a pure mathematical reasoning, colleting the local values of the mathematical mould and then drawing the varables relations among arch arc length, arch width and arch length, from not only quantitative but also qualitative point of view, reveals the internal laws of the treatment of RPE (Lin Zhu *et al*., 1997; Stanley *et al*., 1998). Its derivation formula is:

$$W = \frac{(L^2 - D^2)\ln[(L + 2D)/(L - 2D)]}{4D} \quad (1)$$

W = The arch width.
L = The arch length.
D = The arch depth.

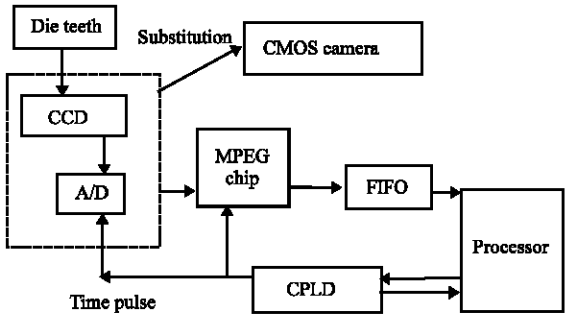

Fig. 1: Block diagram of orthodontics model image

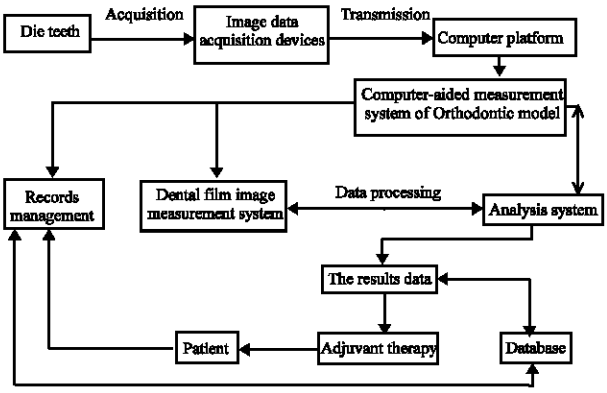

Fig. 2: Block diagram of function module

RPE margin calculations, can be used not only as the forecast of RPE treatmenton based on the mathematical mould, but also can be used to narrow the arch and anti-bite, a bite cases, such as researches. In particular, the parameters needed in the method can be measured simply and easily. It can also replace the row of teeth on the test mould for the prediction analysis.

As the arch with larger changes in the size, using the ideal bow as a unified standard is obviously inappropriate. Therefore, bending the first bend sequence of the ideal bow should be personalized based on the accuracy. Using Bonwill-Hawley's method to produce each of maps of the arch basic form is an important step to wire appliance technology (Yamauchi *et al*., 2002). With Beta equation, using the first tooth crown width from input to map Bonwill-Hawley individual ideal standard bow. On the basis of this, bending orthodontic arch wire provides a relatively simple approach for the clinical application of the individual ideal standards arch.

REALIZATION OF SYSTEM

The acquisition of CCD Teeth-image is in JPEG format. Taking the measuring range of standard yardstick

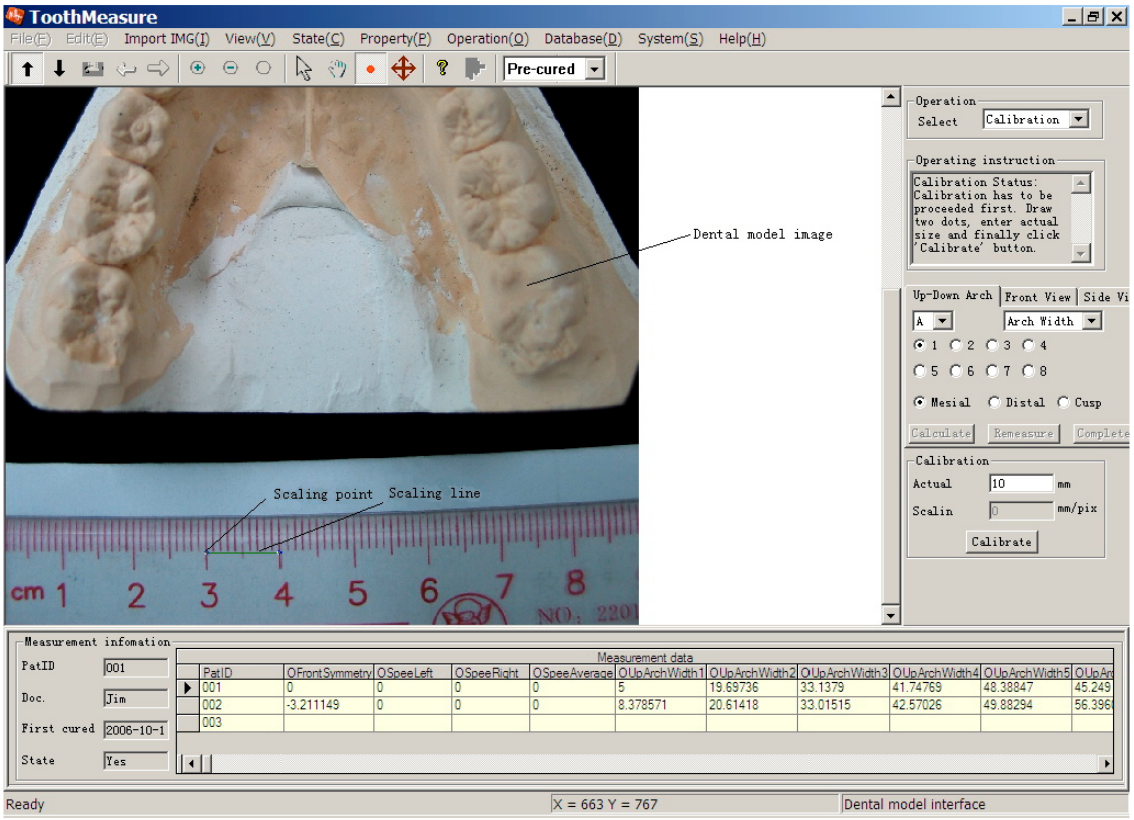

Fig. 3: A window for realization of system

into account, it can be limited to between 0.1 and 100 cm, as shown in Fig. 3. If the actual length doctors input is not within in this range, the system considers that doctors enter incorrectly and allows doctors to re-enter, which can reduce the probability doctors mistakenly enter to a certain extent.

The calibration is a must before the teeth-image measurement which can be completed by setting up a calibration flag. After calibrating successfully, flag is TRUE; calibration failed or undetermined superscript, Flag is FALSE. After the user makes zoom operation on teeth-image and so on. Flag changes into FALSE and prompts the user to re-calibration, otherwise the measured operation can not be carried out. Due to the difference of measurement parameters of the teeth-image, the system is divided into pages on the mandibular measured, positive jaw measurement pages and pages about the side jaw measurements 3 pages in the measurement pages of toolbox, choosing to adopt which measurement pages by the user's teeth-read images. In the lower measurement pages, including A, B, C and D, 4 anterior and associated 8 teeth points. For example, A1 refers to the upper left side of the first tooth, that is, in the upper left incisor. Since each tooth has 3 points for measurement, they are near, far and in the cusp. Therefore, A1 plus one of the three can be targeted to certain of the exact location of teeth. A 8×3 of 2-dimensional array is needed for positioning measurement points in the design process. Measurement parameters include: arch length, width arch, arch gradient, the actual arch perimeter, theory arch perimeter, crowded, the whole tooth Bolton index and the anterior Bolton index. Users select corresponding measurement parameters, then can define measurement points in the teeth-image and make the appropriate measurement, shown in Fig. 4.

The design of analysis system includes data export, data import and error analysis 3 aspects. Data export is that the data will be kept to the background database after the end of measurement and physician makes data export order. Data import is that when a patient referral, physicians do not need to re-survey, only to have the teeth in the database-image data into the measurement of the current measurement interface and then further measurement or analysis. Under the system tips, first of mandibular plans, dental plans left, the right dental plans, dental plans positive. Through the measurement of this

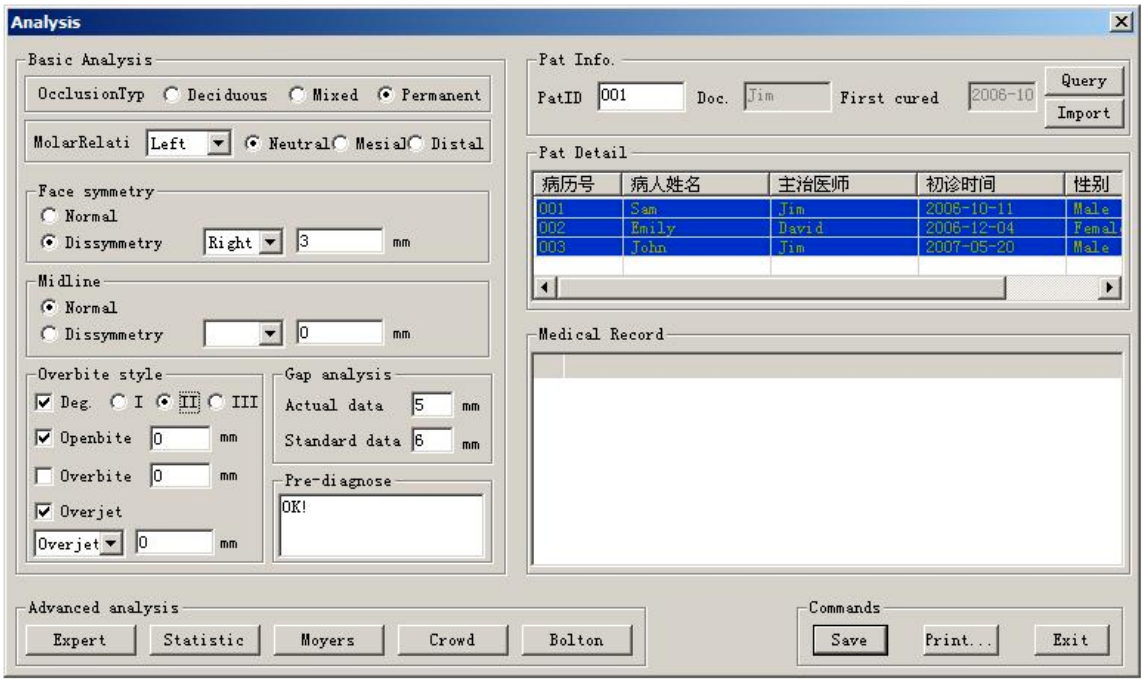

Fig. 4: Interface of measurement system

5 images, you can get different parameters for analysis and calculation. At the same time, these data will be in the right column of information displayed, at this time, you can get the dental arch-width, arch length, the center line and symmetry of the arch angle and other data, based on this, the system will automatically calculate Spee's curve distance, Bolton index of teeth and tooth gap. If it is mixed dentition period, the system also will conduct targeted data calculating.

RESULTS AND DISCUSSION

The experimental results and analysis of a dental mould, on 10 mm in length rule, as shown in Table 1. The collection data have noise or die irregular teeth in the acquisition process of edentulous model images, which distorted the dental model images, resulting in the measure inaccuracy of edentulous model images.

In the calculation of calibration measurement, there is a division operation, which is likely to get rounded middle data, making the further calculation error transfer and then cause accumulative error, resulting in inaccurate results. In addition, the error caused by human factors mainly reflected in the out of place of the selection of measurement points, the deviation of the scaling point, Experimental results show that there are no influences on the nonlinear of measurement line and so on. doctors' diagnoses as long as the scope of measurement error is ±0.2 mm. The analysis of Table 1 data as shown in Fig. 5.

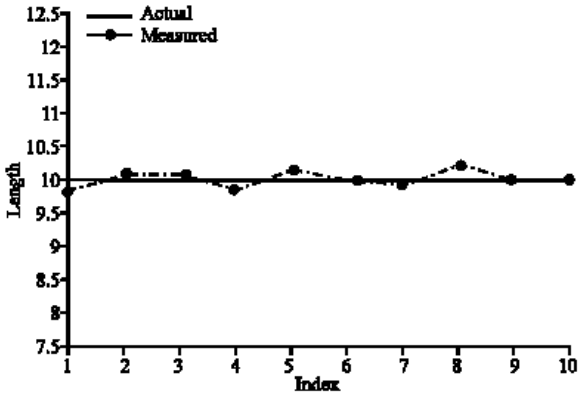

Fig. 5: Measurement data error analysis curve

Table 1: Analysis of measurement data error results

Measurement order	Actual length (mm)	Measurement length (mm)	Error (mm)
1	10	9.848488	-0.151512
2	10	10.077522	0.077522
3	10	10.077210	0.077210
4	10	9.848488	-0.151512
5	10	10.155938	0.155938
6	10	9.999704	-0.000296
7	10	9.923381	-0.076619
8	10	10.236226	0.236226
9	10	10.000000	0.000000
10	10	9.998820	-0.001180
Mean error	0.0165777 mm	**Error variance**	0.015681 mm^2

CONCLUSION

Computer-aided measurement and analysis system of edentulous mould images acquired by CCD camera to transfer oral physical mould into a multi-angle of the digital image, is conducive to the data management and data storage for mould of medicine. By means of the digital processing of the edentulous model images, it's convenient for the processing and analysis and the comparative study of the measurement data of the edentulous mould and also it reduces the measurement error caused by manual measurement. The results show that the measurement data of dental mould images can offer references to clinical doctors to assist them make oral treatment options. So, it has strong clinical value.

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