Design of Neural Predictor for Performance Analysis of Experimental Automated System in Oral Photography of Dental Treatment

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Abstract: - Recently, in spite of advanced and high technology, there is still some problems for positioning head and chin of dental patients treatment for getting photographs of teeths. Furthermore, it is very important to get previous head and shoulder positions of dental patients for comparison present head position and chin of dental patients. In this study, a new designed system method is introduced for complex through collection of standardized oral photographs and computerassisted measurement of reproducible data. However, PLC based fully automated a photograpic device for fully automated oral photography and standart protocol for the esthetic of the crown-mucoginvigal complex is also presented. However, the proposed fully automated system is consited of camara equipment with two directions and head supporting linear sliding mechanism with two directions of Z axes and X axes. On the other hand, to test the proposed system a neural network was used to predict real time measured values.

Key-Words: -PLC, dental patients, oral photographs, photograpic device, neural networks

1 Introduction

This use offers advantages such as lower voltage drop when turned on and the ability to control motors and other equipment with a virtually unity power factor [1]. Few papers were published concerning dc machines controlled by PLCs. They have reported both the implementation of the fuzzy method for speed control of a DC motor/generator set using a PLC to change the armature voltage [2], and the incorporation of an adaptive controller based on the self-tuning regulator technology into an existing industrial PLC [3]. Also, other types of machines were interfaced with PLCs. Thereby, an industrial PLC was used for controlling stepper motors in a five-axis rotor position, direction and speed, reducing the number of circuit components, lowering the cost, and enhancing reliability [4]. For switched reluctance motors as a possible alternative to adjustable speed ac and dc drives, a single chip logic controller for controlling torque and speed uses a PLC to implement the digital logic coupled with a power controller [5]. Other reported application concerns a linear induction motor for passenger elevators with a PLC achieving the control of the drive system and the data acquisition [6]. To monitor power quality and identify the disturbances that disrupt production of an electric plant, two PLCs were used to determine the sensitivity of the equipment [7].

Since there are more prone to gum edge, fine; It is important to think of the Phenotype in the planning of treatment [8, 9]. This situation primarily dental implant after [10], less stable in the long term of the gum margin related to dating [11, 12]. Also, the thin edge of the gums periodontal treatment post higher withdrawal rate [13] and restoration shows less stability in relation to the edges [14, 15]. Healthy periodontal tissue clinical image shows a structure that varies from person to person [10]. The natural tooth Crown length extension after "thick-flat" gum biotype in patients with "thin-curvy" biotype shows more soft tissue generation according to patients [13].

2 PLC Based Morphometric Measurement System

Nowadays, human operated systems are used to make position of head of dental patiens. As can beseen in Figure 1, there is plenty of disadavantages for exact positioning of phographing patiens chin on the system. For that reason, in this section, the proposed fully automated and standarized oral phtography system is described. The proposed and designed system is consisted of two main positioning apparatus. The first one, the patient is sitting or standing position and puts his/her head in a head holader. The chin is placed on a chin rest and the forehead rests against a traversal forehead holder. The chin rest height can be adusted fully automatically from patient's pervious positions (see Figure 2(a)).

Second one, the camara is fixed to stands with quick mount attachment and can be moved along a circumferential quide rail at a range of 180^0 arround virtual center in the patient's mount by a servo motor and driver equipment. On the other hand, for eccentric and lateral ptotographs with mirror the camara poisition can be changed, recorded and seen at a scala undermeat the camara stand by a servo motor and driver using PLC. In addition to these developments, by using PLC based automation, height and rotation of camara position as well camara object distance can be changed automatically as previous measurements. The images are to be held on the measurements of clinical records by comparison with measurements of "reliability", repeated measurements with measurements on the display "consistency" to be tested. Bone morphology will be analyzed the relationship between radiographic measurements in the case of gum disease and healthy alveolar . In addition, observer variation in determining deviation of repeated measurements is to be calculated, and these variances which occurred in the area of the teeth will be analyzed (see Figure 2(b)).

For this purpose, first of all, it's a high resolution inside the mouth on the photo, and open the corresponding pails cylindrical structure around positioning errors will be checked and the calibration of photographic records (Figure 3).. The next stage for the evaluation of records, have launched a clinical photographic 10 direction of teeth and gums healthy individuals (Group 1) and 10 recovered after treatment in periodontal maintenance phase, oral health in a good way that can keep patients (Group 2) determination of the alveolar bone of the groups will create morfolojis for long placed in parallel with technical digital periapical radiographs and gum health and profile, and morphology will be about clinical records. The slot for the computer-aided standardized digital photographic recording system inside the mouth of individuals in the group, both with the left and right half-jaw in the 1. Premolar teeth between each tooth for mesial and distal to the intermediate and long teeth, Central vestibule faces angles of 90 ° and 180 ° in the horizontal plane angles from the front and profile photos are withdrawn. Photographic records on the gingival morphology and parameters related to his relationship with teeth will be saved. Photography and clinical records search will be repeated with 10-15 days.

Morphologic evaluation of gingiva, biyotip and aim of the standardized, computer-aided digital photographic registration system to assess. The use of this system by setting it manually with a photographic image taken from the back of the head and positioning differences opened resulting distortions will be eliminated. If the hypothesis to be tested in our study, personal and repeatable conditions of registration that can be taken with this system after periodontal treatments and soft tissues can be evaluated more accurately.

3 Purpose of Testing Hypothesis

This section describes main hypotesis of the propose fully automated PLC based ssytem in the following;

1-Reliability: the accuracy of measurements with direction, clinical measurements with digital photographic images, computer-aided with standardized measurements will be assessed the relationship between. 2-Consistency: Photographic records are made on the measurement repeatability of measurements to be made at different times will be revealed with the determination of deviations. 3-The alveolar bone morphology (as associated with the Radiographic image analysis) with gingival morphology relationship will be evaluated. 4-Healthy gums are effective factors on morphology in the neighboring teeth, alveolar bone, inter-relationships and relationship with soft tissue keratinized gingiva, alveolar mucosa and the evaluation of the position and morphology of interdental papilledema analysis will be made. 5-Levels (in cases of Alveolar bone loss and Gingival recession) in the presence of periodontal problems exist after healing bone morphology with a relationship between the morphology and position of the gums will be evaluated. 6-Sensitivity: in particular, the data of a sensitive measurement of patient positioning and image effect technique is attaching great importance.

In the case of healthy conditions and disease tissues will be used to evaluate the relationships between computer-aided standardized digital photographic image analysis is the closest to the reality of clinical results and those results under the same conditions that may occur during repeated deviations < 0.01 mm in dimensions and future research as well as a clinic for routine applications and the difference between them in terms of the assessment of great importance. Designed and produced the fully automated patient jaw snapping, positioning the image due to the nature of the system with the system of non-invasive soft tissue by using a method associated with the gum edge thickness, including almost all of the measurements you can easily and very largely aimed at fine-tuning with hassasie. To be evaluated in the gum areas of macro photography without any angular deviation of the recording, as the photographic records received error-free and the minimum error of measurement and evaluation system that will be used to make (additional: 1, will be used as the basis of the system project details) consists of five main parts (Figure 4):

Part 1: the head and the Chin still placed, for each individual location as the original adjustable forehead and jaw snapping (jaw snapping part of vertical direction moving) parts. **Part 2**: digital camera image of the rear area of the oral cavity and can be saved in the desired angle of the mirror inside the mouth (0-180 ° angle within the limits of the width) moving in the horizontal plane rail system and offers these tracks on the vertical direction moving mirror and camera connections. **Part 3**: Jaw snapping, intraoral mirror and camera placed in the mechanisms used to control the movements of the joystick. **Part 4**: all auto mobile parts and running them with the engine table. **Part 5**: CPU and graphics processing capabilities and in our study, both photographic and digital radiographic image is to be used in the analysis of OsiriX can operate in compliance with the program and the high resolution images in the computer system even higher performance and mechanical mechanism is automatic and repeatable way to use software to function.

The proposed system's block diagram as outlined in Figure 5, will be employed with computers, Apple iMac and IOS operating system. Apple iMac, it uses the operating system stability, high resolution screens with fast processors and radiology and digital imaging is one of the preferred hardware.

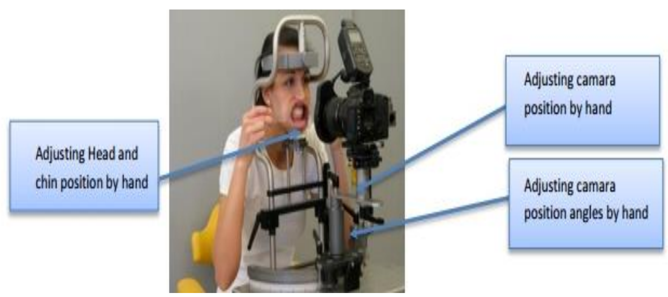


Fig.1. View of manually positioning system and description

Fig.2 (a). General view of the proposed system

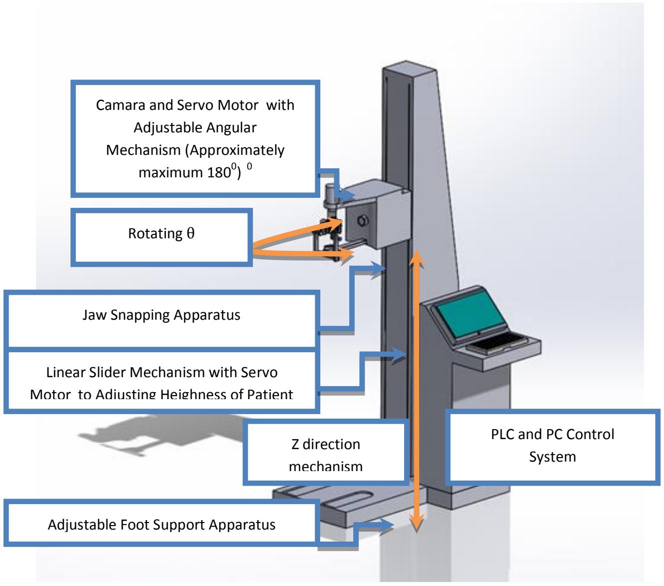


Fig. 2 (b). The proposed fully automated system and main elements

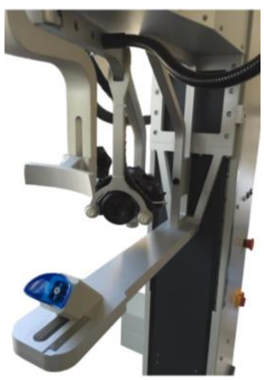


Fig. 3. Camara and chin position apparatus

Fig.4. Maximum postioning of camara by PLC

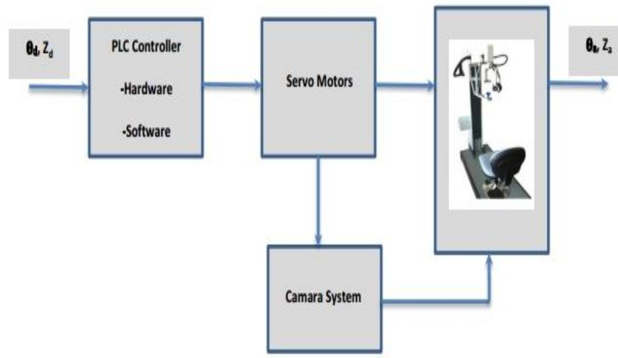


Fig.5. Block diagram of position control process

4 The Proposed Neural Network

A network is specialized to implement different functions by varying the connection topology and the values of the connecting weights. Complex functions can be implemented by connecting units together with appropriate weights. In fact, it has been shown that a sufficiently large network with an appropriate structure and property chosen weights can approximate with arbitrary accuracy any function satisfying certain broad constraints.

Usually, the processing units have responses like ;

$$y = f\left(\sum_i u_i\right) \qquad (1)$$

where u_i are the output signals of hidden layer to output layer, f(.) is a simple nonlinear function such as the sigmoid, or logistic function. This unit computes a weighted linear combination of its inputs and passes this through the nonlinearity to produce a scalar output. In general, it is a bounded no decreasing nonlinear function; the logistic function is a common choice.

This model is, of course, a drastically simplified approximation of real nervous systems. The intent is to capture the major characteristics important in the information processing functions of real networks without varying too much about physical constraints imposed by biology.

4.1 Feedforward Neural Networks

In feedforward neural networks artificial neurons (also called nodes or processing units) are arranged in a feedforward manner (usually in the form of layers, i.e. each neuron may receive an input from the external environment and/or from other neurons, but no feedback is formed. A standard feedforward neural network consists of simple processing units (without dynamic elements). A feedforward network computes an output pattern in response to some input pattern. Once trained (with fixed connection weights) the output response to a given input pattern will be the same regardless of any previous network activity. This means that the feedforward neural network does not exhibit any real dynamics, and there are no stability problems in such networks. For feedforward networks the dynamics are often simplified to a single instantaneous nonlinear mapping. Some learning algorithm of the ANN can be described in the following [16, 17] ;

4.1.1 Quickpropagation (QP) learning algorithm

QP is another training method based on the following assumptions, E(w) for each weight can be approximated by a parabola that opens upward and the change in slope E(w) fort his weight is not affected by other weights that change at the same time. The weight update rule is;

$$\Delta w(t) = \frac{S(t)}{S(t-1)-S(t)}\Delta w(t-1) - \eta\, S(t) \qquad (2)$$

Where $S(t-1)-S(t)$ The numerator is the derivative of the error with respect to the weight and is a finite difference approximation of the second derivative. Together these approximate Newton's method for minimizing a one-dimensional function . To avoid an infinite backward step, or a backward uphill step, a maximum growth factor parameter μ is introduced. No weight change is allowed to be larger than μ times the previous weight change. Furthermore, QP has a fixed learning parameters, η ,that needs to e chosed to suit the problem.

4.1.2 Delta–Bar-Delta (DBD) learning algorithm

An adaptive learning rate method in which every weight has its own learning rate. The learning rates are updated based on the sign of the gradient does not change signs on successive iterations then the step size is increased linearly. If the gradient changes signs, the learning rate is decreased exponentially. In some cases this method seems to learn much faster than non-adaptive methods. Learning rates (t), are updated as follows;

$$\Delta_{ij}\begin{cases}\kappa & if\ \delta'(t-1)\,\delta(t) > 0\\ -\phi\boldsymbol{\eta}(\mathbf{t}) & if\ \delta'(t-1)\,\delta(t) < 0\\ 0 & else\end{cases} \qquad (3)$$

Where δ(t)= $\frac{\delta E}{\delta w}$ at time t and δ is the exponential average of past values of δ. δ'(t)=(1-θ) δ(t)+ θ δ'(t-1)

5 Experimental and Simulation Results

Simulation study has been carried out for predicting measurement of length of teeth of two patients using neural network predcitors. In this section describes, two types approaches. First approach is related to experimetal work with the proposed fully automated camara based measuring system. Two patients' teeth poistions are photograped at two stages firt and second times. However, Table 1. shows training, structural and RMSE (root mean square error) parameteres of the neural network for the cases of 1-4. The results of this stage is shown for patient 1 in Figures 6(a) and for patient 2 (b). As can be seen from figures, there is some errors between first stage measurement and second stage measurement. However, this problems has been accured by chin supporting equipment.

Fig. 6 (a). First patient teeth positons with two photos match (Cases 1-2)

Fig.6 (b). Second patient teeth positons with two photos match (Cases 3-4)

On the second approach is consisted simulation based neural netwoks (NNs) results for both patients. Two types of neural network based algorithms were employed to predict each patients length of teeths variations. Furthermore, Quick-Propagation Neural Network (QP-NN) and Delta Bar Delta Neural Network were used to predict two patients' length of teeths variations for first and second stages measuremets.

Table 1. Strucrural, training and RMSEs of the proposed neural network with two algorithms

Cases	NN type	Learning rate	Training numbers	Algorithms	RMSE (First Stage)	RMSE (Second Stage)
Case 1	1-10-1	0.01	100.000	QP	0.2144	0.0410
Case 2	1-10-1	0.01	100.000	DBD	0.2348	0.1649
Case 3	1-10-1	0.01	100.000	QP	0.0545	0.0508
Case 4	1-10-1	0.01	100.000	DBD	0.0774	0.0637

QP-NN approach for patient 1's lengh of teeth variations is represented in Fig.7. As can bee seen on the figure, measuring points 3 and 4 hase some errors to predict. Fig. 8 shows the results of NN-DBD for patient's 1 teeth length measurement of first satge. However, the results are similat to the results of Fig.7.

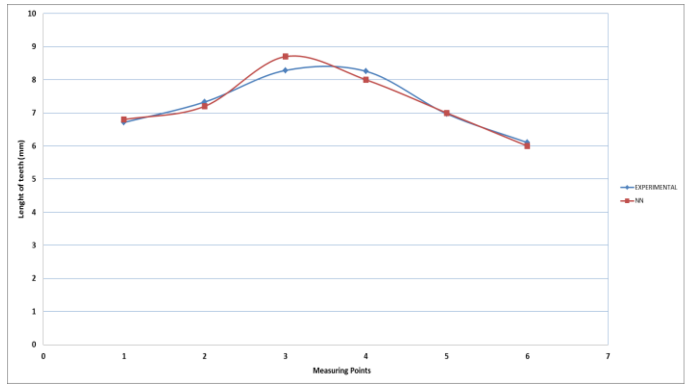


Fig.7. First stage measurement of patient 1's teeth length variations with QP-NN

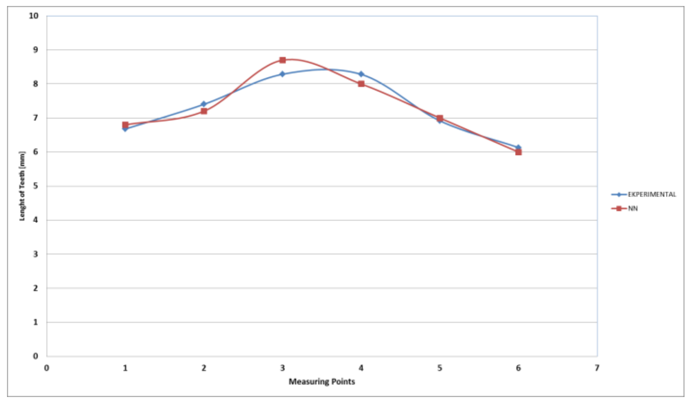


Fig.8. First stage measurement of patient 1's teeth length variations with DBD-NN

Fig. 9, is indicated the results of the second stage of patient 1 with QP-NN. The results showed that the proposed NN perdictor has good performance to predict experimental results. Furthermore, Fig.10 shows the results of the second stage of patient 1 with DBD-NN.

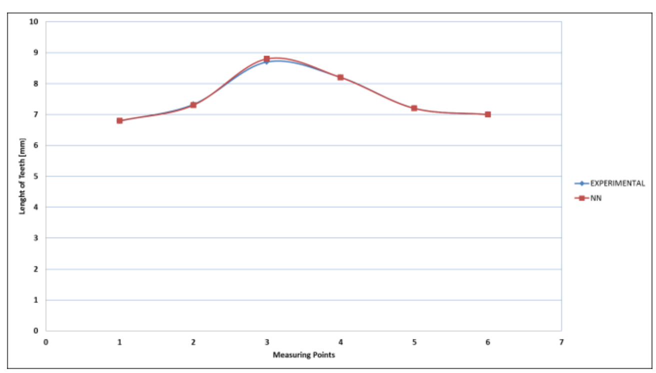


Fig.9. Second stage measurement of patient 1's teeth length variations with QP-

NN

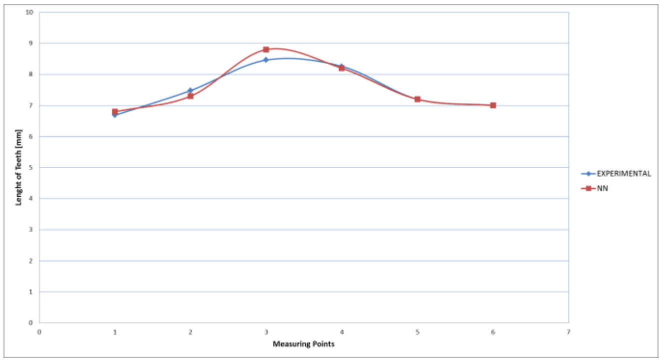


Fig. 10. Second stage measurement of patient 1's teeth length variations with DBD-NN

As can be seen Fig. 11, QP-NN approach has good performance to adapt experimetal results of patint 2's teeth length variations. Furthermore, on the same case the DBD-NN predictor has follows experimetal results of patint 2's teeth length variations with some errors on Fig. 12.

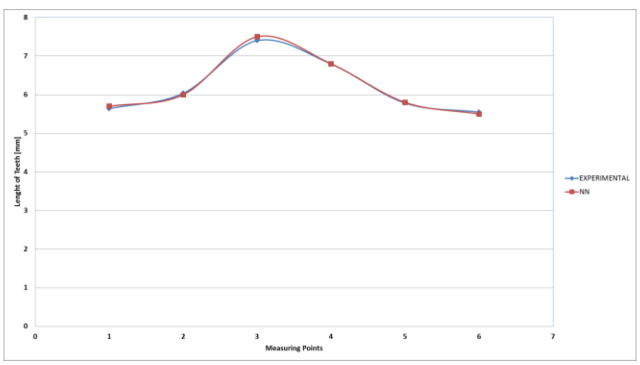
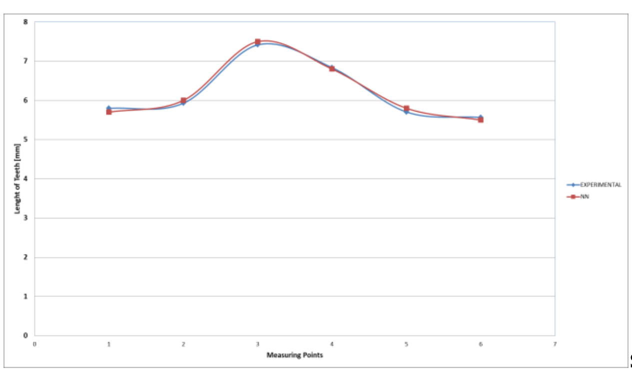


Fig. 11. First stage measurement of patient 2's teeth length variation



s

with QP-NN

Fig. 12. First stage measurement of patient 2's teeth length variations with DBD-NN

Figs. 13-14 show the cases of 3-4 for patient 2's teeth length variations. QP-NN and DBD-NN have similar results to predict for both cases.

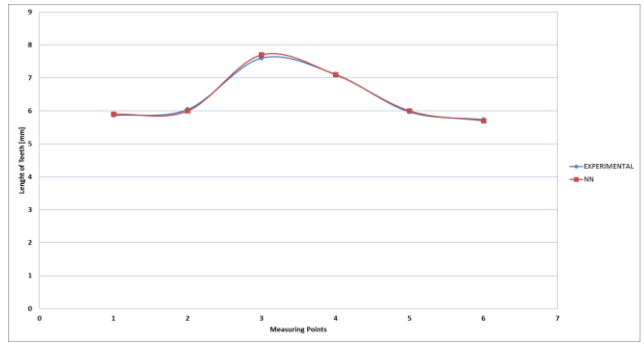


Fig. 13. Second stage measurement of patient 2's teeth length variations with QP-NN

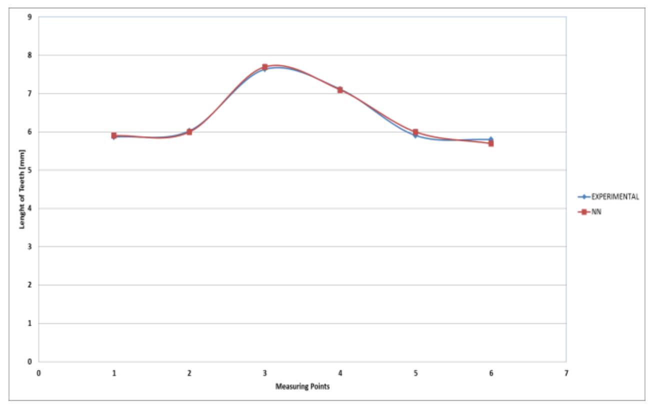


Fig. 14. Second stage measurement of patient 2's teeth length variations with DBD-NN

6 Conclusions and Discussion

Hand setting when shooting with, 1. with 2. and even framing your shift occurred in the next shoot pictures taken from being difficult or even impossible to be taken for evaluation and measurement of becoming. Device, joystick and forwarded to the desired angle and a photo with machine inspection appropriate frame provides the setting. Digital camera is to be used when the desired angle of the image because it can not be both the camera screen and in the system can be controlled from the value of the angle on the Rails. This adjustment during the frame line and location information recorded in the computer through touch screen and the next shot from the same individual according to the values that made the shooting for standarizasyon are provided.

The main outcome expected from this designed system, computer aided aesthetic and photographic records, standardized phonetic problem as important as periodontal disease will be held in the area inside the mouth front assessments. It can be made as close to the truth, and most clinical investigations and surgical treatment to be applied routinely in both the results of accurate and repeatable way.

On the other hand, two types of neural predictors were employed to predict experimatal results of four cases. However, the proposed QP-NN has superior performance to adapt the experimetal results of the fully automated dental patient chin positioning system. Finally, the neural netwok based predictors can be employed this kind of system as intelligent measuring and poistioning systems.

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