TOWARDS THE ACCURACY IN MEDICAL INSTRUMENT

Udit Narayan Bera[1], Bhavesh B Kunbi[2], Pragya Banarjee[3]

[1,2]Mechatronics, IIITDM Jabalpur, MP, (India)

[3]Student, Hithkarni Dental College.Jabalpur,MP, (India)

ABSTRACT

The objective of this paper is to eliminate the human error in the measurement of distance between human jaws during the teeth replacement procedure. A pair of ultrasonic sensor controlled by Arduino is incorporated with this work. A computer is used as display. End product has been examined and tested on patients and we have found that it has the potential to compete with conventional measurement method with the accuracy up to ± 0.5% of the total range.

Keywords: Displacement Measurement, Medical Instrument, Ultrasonic Sensor

I. INTRODUCTION

Teeth replacement was a common word in countries of Europe and America. In recent years India includes its name in the same. There are many reasons behind teeth replacement. In this process the initial and former step is precise and accurate measurement of the distance between upper and lower jaw. The conventional method followed normally is use of a Vernier caliper for the purpose. It is done manually so that all the data and information depends on the observer or medical instructor present there. Therefore error comes to the picture resulting worse replacement of teeth. In this context we have come up with a new proposal to reduce the human error in the measurement.

An ultrasonic sensor is well known for its accuracy, preciseness and repeatability. Medical ultrasonic transducers (probes) come in a variety of different shapes and sizes for use in making pictures of different parts of the body. The transducer may be passed over the surface of the body or inserted into a body opening such as the rectum, vagina and jaw. Clinicians who perform ultrasound-guided procedures often use a probe positioning system to hold the ultrasonic transducer. Arduino can be used to display the data obtained from the sensor and help to analyze them dynamically.

Figure 1: Proposed Measurement System

In this paper we have proposed a system containing a pair of ultrasonic sensor and Arduino controller to measure the distance between upper and lower jaw with great accuracy and precession so that human error can be eliminated partially or fully. A proposed model with sensors and mechanical structure has shown in Fig.1 during testing on a patient.

II. TECHNICAL APPROACH

A typical vernier scale has shown in Fig.2. It shows sort of manual error during measurement. To eliminate that a new electromechanical model has been proposed containing sensors, controller and computer display.

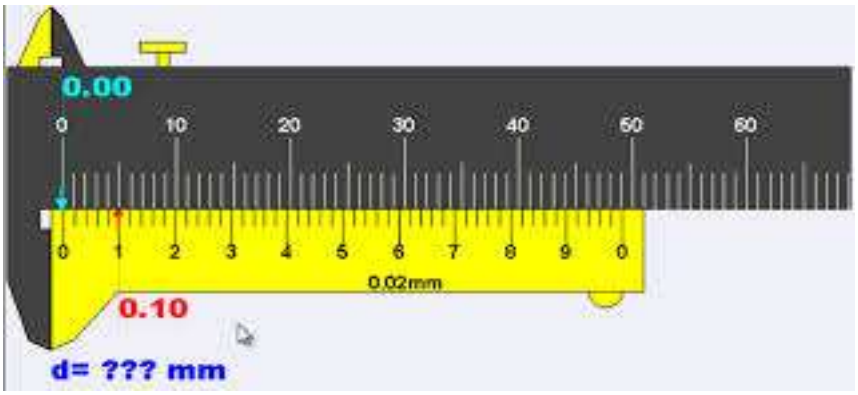

Figure 2: Typical Vernier Scale

In this work first we have pointed two spot on human face and place our system according to that. Then the patient is instructed to open his or her mouth fully so that we can get the maximum distance between that. Fig.3 shows the initial marking spot during measurement. Once the maximum range is obtained the patient has to repeat the same procedure at least three to four times such that the optimized distance between two jaws can be found. Also this repetition helps to achieve highest accuracy in the measurement. Arduino controller is used to interface between computer and ultrasonic sensor.

Figure 3: Measurement Procedure

III. MACHINE AND MECHANISM

Once the instrument is set with the marked point on patient face and patient open up his or her mouth fully the distance between ultrasonic sensor and reflector will be displayed on the computer. The sensor used in this work has shown in Fig.4.

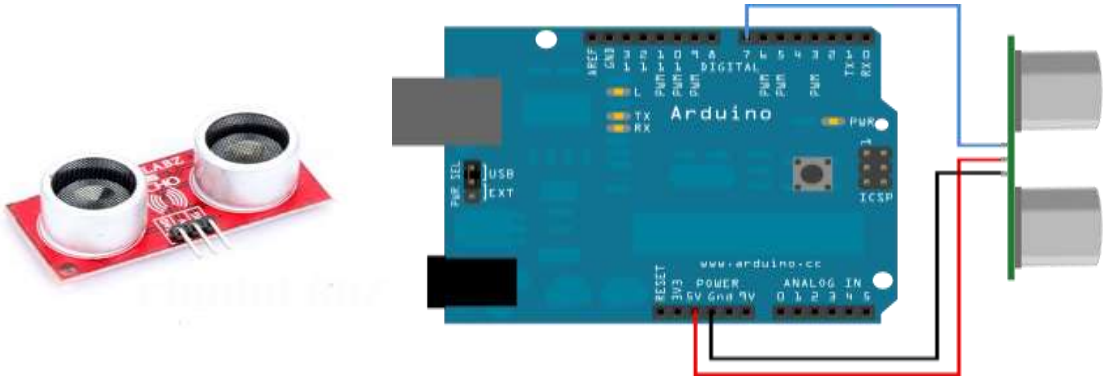

Figure 4: Ultrasonic Sensor and its Schematic Interface with Arduino Controller

A Rhydolabz's "ECHO" Ultrasonic Distance Sensor with ASCII serial O/P is an amazing product that provides very short to long-range detection and ranging. The sensor provides precise, stable non-contact distance measurements from about 2cm to 4 meters with very high accuracy. Its compact size, higher range and easy usability make it a handy sensor for distance measurement and mapping. The board can easily be interfaced to microcontrollers RX pin (USART) . At every 50ms sensor transmits an ultrasonic burst and send out ASCII value of distance that corresponds to the time required for the burst echo to return to the sensor. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Naturally, robotics applications are very popular but you'll also find this product to be useful in security systems or as an infrared replacement if so desired. Since it is very stable, the "ECHO" Ultrasonic sensor module can be used for Micro-mouse application instead of IR sensor. Fig.5 shows schematic electronic connection between sensor and controller.

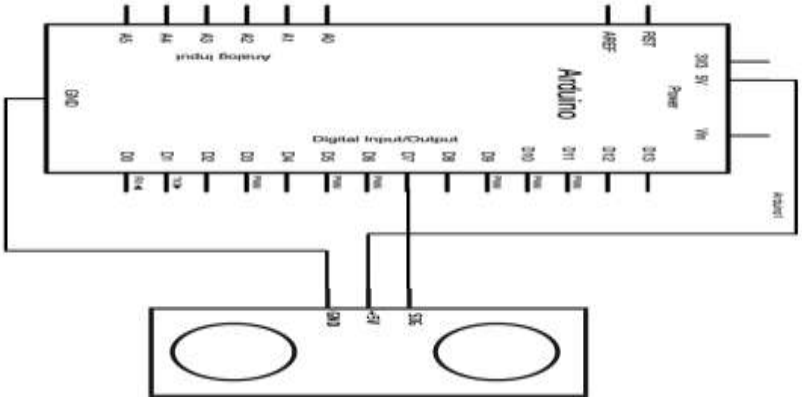

Figure 5: Electronic Connection

IV. RESULT

Distance between two jaws were measured using both the methods; conventional using Vernier scale and proposed system, and Fig. 6 explains the comparison between actual, proposed and conventional data. It is clearly showing that measurement using proposed system is more accurate and precise than that of the conventional measuring system.

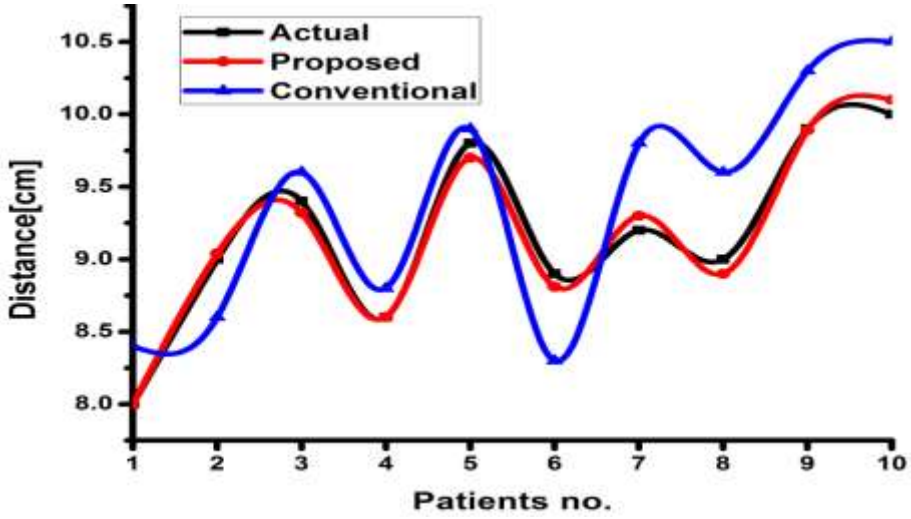

Figure 6: Comparison Among Actual Data, Data from Proposed Model and Data From Conventional Vernier Caliper Method

V. CONCLUSION

We have successfully implemented this work with hardware set up. Proposed system has been tested on number of patient. Inclusion of electronics in the measurement system has shown great improvement in accuracy. Also this suggested method has operated faithfully during dynamic measurement system. Although total system costs a bit more than conventional vernier caliper method, mass production will be effective where human body is concern.

VI. ACKNOWLEDGEMENT

This work is supported by Hithkarni Dental College and ELECTRA-8, IIIT Jabalpur

REFERENCES

[1] Y. Nagashima and S. Yuta, ‘‘Ultrasonic sensing for a mobile robot to recognize an environment — Measuring the normal direction of walls—,’’ Proc. IEEE/RSJ Int. Conf. Intelligent Robots and Systems, Raleigh, NC, U.S.A., Vol. 2, pp. 805–812, July (1992).

[2] K. W. Jorg and M. Berg, ‘‘Sophisticated mobile robot sonar sensing with pseudo-random codes,’’ Robotics Auton. Syst., 25, 241–251 (1998).

[3] J. Klahold, J. Rautenberg and U. Ruckert, ‘‘Continuous sonar sensing for mobile mini-robots,’’ Proc. 2002 IEEE Int. Conf. Robotics and Automation, Washington, DC, U.S.A., Vol. 1, pp. 323–328, May (2002).

[4] D. Marioli, E. Sardini and A. Taroni, ‘‘Ultrasonic distance measurement for linear and angular position control,’’ IEEE Trans. Instrum. Meas., 37, 578–581 (1988).

[5] D. Marioli, C. Narduzzi, C. Offelli, D. Petri, E. Sardini and A. Taroni, ‘‘Digital time-of-flight measurement for ultrasonic sensors,’’ IEEE Trans. Instrum. Meas., 41, 93–97 (1992).

[6] M. Pollakowski and H. Ermert, ‘‘Chirp signal matching and signal power optimization in pulse-echo mode ultrasonic nondestructive testing,’’ IEEE Trans. Ultrason. Ferroelectr. Freq. Control, 41, 655–659 (1994).

[7] H. Matsuo, T. Yamaguchi and H. Hachiya, ‘‘Target detectability using coded acoustic signal in indoor environments,’’ Jpn. J. Appl. Phys., 47, 4325–4328 (2008).

[8] T. Fukui, M. Segawa, M. Kurosawa, K. Oka and T. Higuchi, ‘‘A control system with single-bit digital signal processing,’’ Proc. 4th Int. Conf. Control, Automation Robotics and Vision, Singapore, pp. 1992–1996 Dec., (1996).

[9] S. R. Norsworthy, R. Schreier and G. C. Temes, Delta-Sigma Data Converters Theory, Design, and Simulation (IEEE Press, Piscataway, N.J., 1997).

[10] S. Hirata, M. K. Kurosawa and T. Katagiri, ‘‘Cross-correlation by single-bit signal processing for ultrasonic distance measurement,’’ IEICE Trans. Fundam., E91-A, 1031–1037 (2008).