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A NOVEL INSTRUMENT FOR PERIODONTAL TOOL SHARPENING

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Abstract - *Nowadays dentists face much problem as the instruments they use for treating the patients become blunt after prolonged use. Dentists have to sharpen their instrument manually which is time consuming and tedious task to perform. Thus there is need of a system which can sharpen periodontal tools automatically and effectively. This paper presents an automatic system which electronically determines whether the tool is sharp and sharpens the tool if it is blunt. The entire process is controlled by a microcontroller. The novel, low cost system described herein has been thoroughly analyzed and tested for achieving better performance. To the best of our knowledge, the system described here is first of its kind.*

1.INTRODUCTION 1.2

Periodontal tools plays vital role in treatment of oral diseases. Repetitive use of tools results in wear and tear and dentists can reuse such costly tools if they prefer to sharpen it manually or discard it. The effectiveness and efficiency of instrumentation depends on the quality of instruments. Hence, keeping curettes and scalars sharp is an essential part of hand instrument maintenance [1].

A sharp periodontal instrument results in better tactile sensitivity, improves quality of dental treatment and causes less fatigue during treatment.

1.1 Determining the sharpness of instruments

There are different ways to determine if an instrument in use is Sharp or blunt.

1.1.1. Glare Test:
If a periodontal tool is subjected to a light source then reflected light can indicate if instrument is sharp or blunt. A sharp cutting edge does not reflect light while blunt one does. This means if light is reflecting from the cutting edge, the instrument is blunt.

1.1.2.Acrylic Test Stick:
In this test, the stick is held firmly in the non-dominant hand. The instrument is held in a modified pen grasp and placed against the acrylic with the face between 80 and 90 degrees to the long-axis of the stick. The cutting edge is first pulled gently in toward the stick and then an attempt is made to pull the instrument up the stick. If the cutting edge bites into the acrylic, the instrument is sharp. If the instrument does not bite in but slides along the acrylic, the instrument is dull [1].

This paper describes a novel test, hereby named as passage of light test, which is fairly similar to the well-known glare test with modifications. In this test, it is not necessary to observe light reflected. Instead, a light passed from source to detector is analysed and on the basis of light intensity falling on the detector, instrument sharpness can be predicted. A sharp edge passes almost all the light that falls on it while a blunt edge (because of the irregularities) would absorb/reflect some light and pass the remaining. This facilitates automatic detection of sharpness of tools.

1.2 Techniques for Sharpening Periodontal Equipments

For sharpening periodontal tools, following techniques have been discussed in reviewed literature.

1.2.1 Moving Stone Technique

In this technique, the stone is kept rotating while edge of periodontal tool is resting on it. This is manual process in which, generally, the practitioners hold an instrument in non-dominant hand and the stone is handled with dominant hand .

1.2.2 Stationary Stone Technique

In this technique, the stone is stationary while tool is in motion. The instrument is rubbed on stone surface for sharpening. This is manual process in which, generally, the practitioners hold stone firmly in non-dominant hand and instrument in dominant hand .

Both techniques mentioned above are manual in nature and are time consuming and tedious. This paper proposes automatic technique which determines need for sharpening tool and electronically sharpens it using technique similar to moving stone technique described above.

2. PASSAGE OF LIGHT TEST

Passage of Light is a novel technique, proposed by this paper, to determine the sharpness of periodontal tools such as curettes, scalars etc. This technique makes use of Laser diode and photo transistor detector to detect sharpness of

tool. A laser beam if passed through edges of sharp tool, maximum light falls on the detector transistor. While blunt tool obstruct most of the light before it reaches the detector. This concept has been verified using Malus law apparatus. The Malus Law Apparatus is an instrument that helps to understand polarization properties of light. Further paragraphs discuss experimentations performed using Malus law apparatus.[2]

2.1 Malus Law Apparatus

Malus law Apparatus consist of a light source, polarizer , analyzer and a detector. The specifications are as given in table 1.

Table 1: Specifications of Malus law apparatus

Source(LASER)	
Wavelength	650 nm
Optical power	3 mW
Detector	
Sensor type	Phototransistor
Display	7 segment, 3 ½ digit
Range	0-199 milli/micro Amperes

In order to determine effectiveness of laser diode - phototransistor combination for sharpness detection, the tool is positioned between source and detector (analyzer and polarizer of equipment were not used). The laser light source emits coherent beam of light while detector is a phototransistor which converts light into electric current. On the basis of the output current obtained at the phototransistor one can determine whether the tool is sharp or blunt. If the current obtained is high, the tool is sharp. Malus Law Apparatus is shown in Fig.1

Fig-1: Malus Law Apparatus

2.1.1 Results of experiment performed on Malus law Apparatus

Detector output current obtained for different tools is specified in table 2 .Detector output current when there is no obstacle [I=20.8 mA (Full scale reading)].

Table 2: Results obtained on Malus Law apparatus for different tools

Experiment on different curettes	Blunt edge current	Sharp edge current
curettes Tool 1	1.8 mA	3.1 mA
curettes Tool 2	1.9 mA	3.1 mA
curettes Tool 3	1.84 mA	3.0 mA
curettes Tool 4	0.92 mA	3.15 mA

Difference in current for blunt and sharp edge in above observations is found to be [approx 1.16-2.23mA]

The encouraging results obtained using Malus Law apparatus resulted in design and development of apparatus for sharpness detection and sharpening of periodontal tools, proposed in this paper.

3. PROPOSED SYSTEM

The proposed system as indicated in Fig-3 is so designed that the tool always rests at an angle of 70-80 degrees on stone. Laser and Phototransistor pair is used for sharpness detection .In this system, a DC motor and Stepper motor is used. The DC motor is used for rotation of Arkansas Stone while, Stepper motor is used to control movement of periodontal tool. Buzzer is used to indicate completion of process. Arduino UNO board is used as controller. LM339 comparator IC compares phototransistor output voltage obtained for a tool with set reference voltage and informs controller whether tool is sharp or blunt. Motor regulator IC L293D is used to drive both motors as it gives constant required supply voltage.

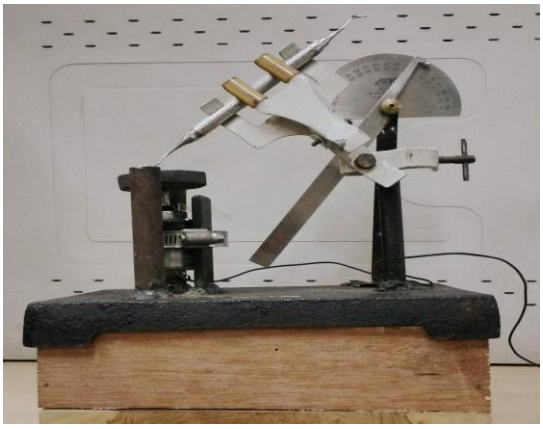

Fig-2: Proposed system

Interfacing of peripherals such as DC motor ,stepper motor, IC L293D, IC LM339 with Arduino UNO board is shown in Fig-3.

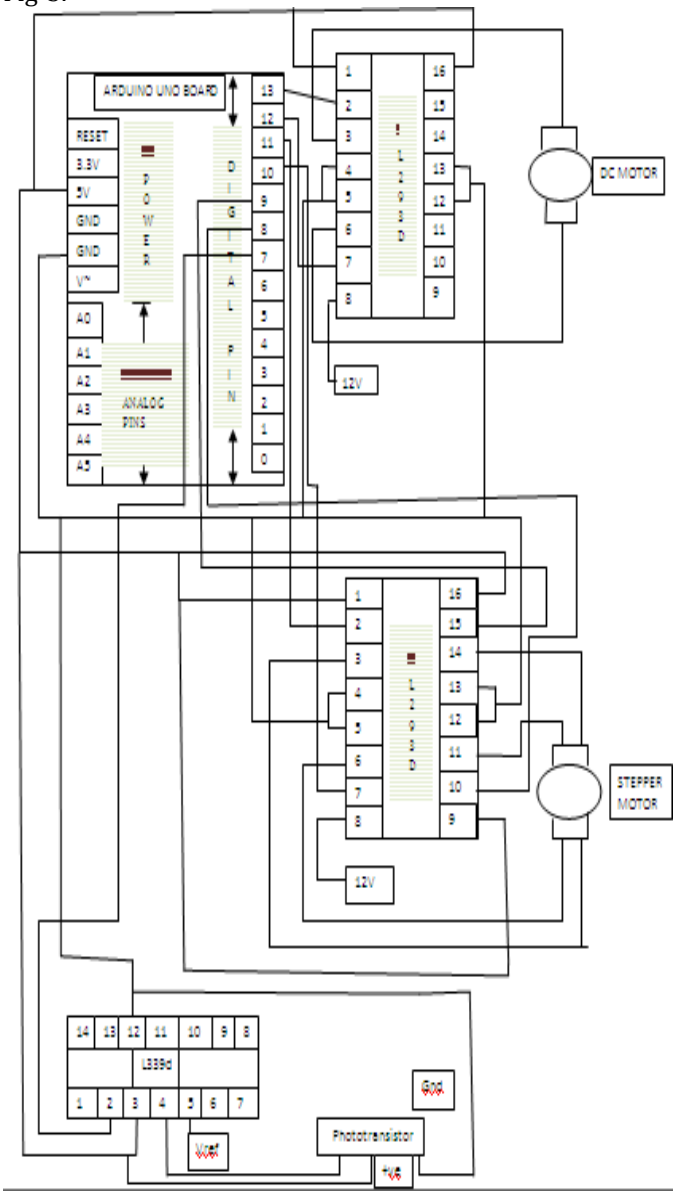

Fig-3: Interfacing of various peripherals with Arduino UNO

The specifications of components used in proposed system are illustrated in table 3

Table 3:Specifications

LASER	
Wavelength	650nm
Color	Red
Power rating	5mW
Supply voltage	3-5V
PHOTOTRANSISTOR	
Model name	TEPT5600
Wavelength	570nm
Power rating	100mW
Dark current	3nA
DC MOTOR	
Supply voltage	12V
Speed	300rpm
STEPPER MOTOR	
Supply voltage	12V
Step angle	7.5 degrees
MOTOR DRIVER IC	
IC name	L293d
Number of pins	16
Supply voltage	4.5V-36V
Output current per channel	600mA
DIGITAL COMPARATOR IC	
IC name	LM339
Number of pins	14
Supply voltage	2V-36V

The mechanism used for sharpness detection using Laser and photo transistor pair is shown in Fig-4. In proposed system, edge of tool is placed between photo-transistor and laser, where all the three are aligned in straight line.

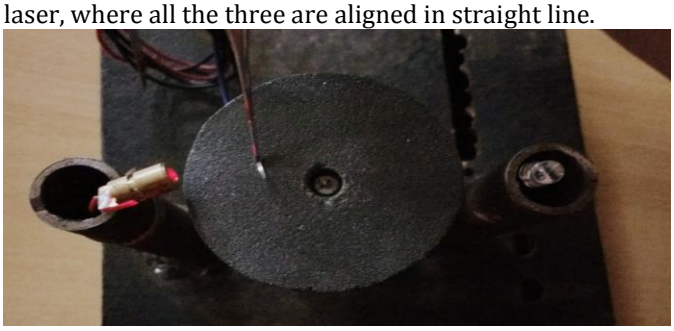

Fig-4: Laser-Phototransistor detection mechanism in proposed system

Output voltage obtained across phototransistor for different tools in proposed system is specified in table 4

Table 4: Results for sharpness detection obtained in proposed system

Alignment	Without tool	Sharp edge	Blunt Edge
Ground	5.09V	5.09V	4.96V
Proposed system(experiment1A: Atmospheric light is present)	0.44V	0.39V	0.14V
Experiment 1B:	0.46V	0.34V	0.18V
Proposed system (experiment2A: Atmospheric light is negligible)	1.22V	0.9V	0.2V
Experiment 2B:	1.35V	1.01V	0.29V

The complete flow of process is described in Fig-5

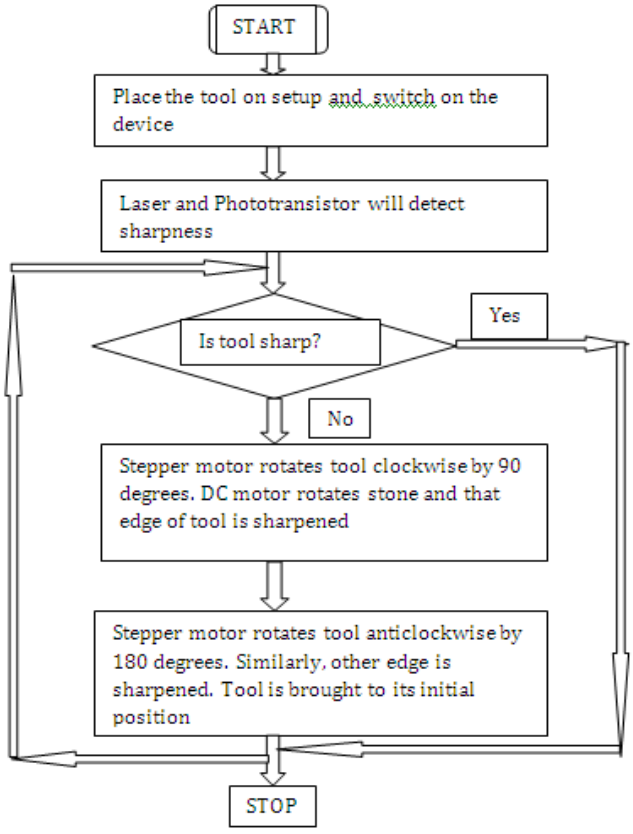

Fig-5: Flowchart

4. CONCLUSION

In this paper, three different techniques for sharpness detection of periodontal equipments are mentioned. Out of these three techniques, the passage of light test is adopted in proposed system. On the basis of experiments performed on Malus Law Apparatus, laser-phototransistor pair with corresponding specifications was finalized in proposed system. Optimal results for sharpness detection were obtained using passage of light test, giving noticeable difference (0.13V-0.72V) in output voltage of phototransistor .Precise sharpening of periodontal tool was also obtained in the proposed system. For sharpening periodontal tool, moving stone technique was implemented in the proposed system with the help of DC motor. This model gives a cost effective solution to dentists to check the sharpness of the dental tools.

5. REFERENCES

1)"Chapter9: Instrument Sharpening"pdf[Online]Available: www.toothvet.ca/VSTEP/i%20-%20**sharpening**.pdf

2) www.holmarc.com