



# Automatic Toothbrush for Specially-Abled Patients

Sandeep Singh, P. S. Rao, Sanjeev Verma

**Abstract:** *The project generally relates to teeth cleaning devices, and more specially to motorized teeth cleaning devices. A hand-free simultaneous Whole-mouth cleaner is disclosed for brushing a user's teeth all at once, without requiring manual manipulation, thereby enabling the whole mouth cleaner include top and bottom brush trays which include tooth brushing material such as bristles for contacting the users teeth, motor housed within a motor case located in the space formed by the brush trays and a switch or actuating the motor. In some embodiments the hands free simultaneous whole mouth cleaner includes a handle for easy insertion and a removal. In some embodiments, the tooth brushing material is capable of contacting all the sides of a user's teeth, as well as the gum line. Other embodiments include an external surface capable of providing non-irritating frictional contact to soft tissue of a user's mouth.*

**Keywords:** *Automatic toothbrush, Thermoplastic Polyurethane, Polylactic acid.*

## I. INTRODUCTION

Taking good care of your mouth, teeth and gums is a worthy goal in and of itself. Good oral and dental hygiene can help prevent bad breath, tooth decay and gum disease-and can help you keep your teeth as you get older.To carry forward this aim of being hygienic various methods came into force. Removal of mechanical plaque(an infectious disease) with a manual toothbrush is the primary method used for maintaining good oral hygiene. When manual brushing is performed with adequate duration of time, it is highly effective. However, for some patients these criteria cannot fulfill their desire of being hygiene. Manual brushes had bristled head attached to its handle which is only capable of cleaning small area one at a time.

To overcome the limitations arising due to manual brushing system there comes need to develop mechanical brushing device. These automatically toothbrush provides a brush head capable of driving various motions driven by a power source. The main objective of this research was to explore the

effectiveness of automated toothbrush in minimizing plaque by manual users with various brushing technique in a single brushing design. This research focuses on fundamental studies of toothbrush action which leads to the development of an automatically driving brushing system with precisely controlled, high speed, short stroke motion for easier use hard as well as soft oral tissues. Over time these automated toothbrushes have become a valuable alternative to manual methods of brushing system. From this study; it has been proved that automated toothbrush is an effective instrument for dental care with many advantages such as it can be used both on teeth and gingival.

However, there are many people who lack the ability or do not have the patience to follow up the dental advisory for more than a period. These improper and insufficient teeth brushing habits sometimes results in ineffective cleaning and poor or bad oral hygiene. Individuals, such as elderly people or disabled, do not have the ability to regularly clean their teeth with manual toothbrush, thus resulting in shorter brushing sessions that fail to adequately remove plaque from surfaces. The teeth of these individuals are not brushed by themselves so usually in such cases their health workers do so.

It is very often that providing an effective cleaning of the teeth in order to maintain proper hygiene might be difficult or time consuming for these health workers using manual toothbrushes. And also there are few children who cannot effectively manipulate the bristles of the toothbrush and hence they face difficulty in brushing with the manual toothbrush. Similarly, there are children and other disabled bodies who literally fail to perform adequate brushing activity may experience several problems or diseases like tooth decay, plaque or gum diseases.

Therefore, to prevail over these inability or flaws a U-shaped automatic tooth brushing system has been developed which consists of a mouthpiece having a vibrating or reciprocating brushes for easier and flexible movement. This brush performs back and forth motion commonly used with manual toothbrush. It usually covers all the recommended area because its bristles make an angle of 45° against the gum line. It is soft enough so that the pressure generated removes plaque easily without damaging gums.

Regardless, whether the individual is disabled, a person may be too tired or in a rush or physically or mentally impaired to spend recommended time to brush his teeth, for such persons automated brushing system has been developed so that they do not carry any dental problem like oral hygiene, gum decay.

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\* Correspondence Author

**Sandeep Singh\***, Mechanical Engineering (Manufacturing Technology), National Institute of Technical Teachers Training & Research, Chandigarh, India.

**P. S. Rao**, Mechanical Engineering (Manufacturing Technology), National Institute of Technical Teachers Training & Research, Chandigarh, India.

**Sanjeev Verma**, Senior Principal Scientist, Biomedical department CSIO-CSIR Chandigarh, India.

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## II. OBJECTIVES

Following are objectives of the research:

- A. To study the existing automatic tooth brushes for disabled persons..
- B. Design and analysis of new mechanism for automatic tooth brush for improving dental to health to higher extent
- C. Validation of new automatic toothbrush and evaluation of cleansing action.
- D. To make feasible and affordable toothbrush for middle class.

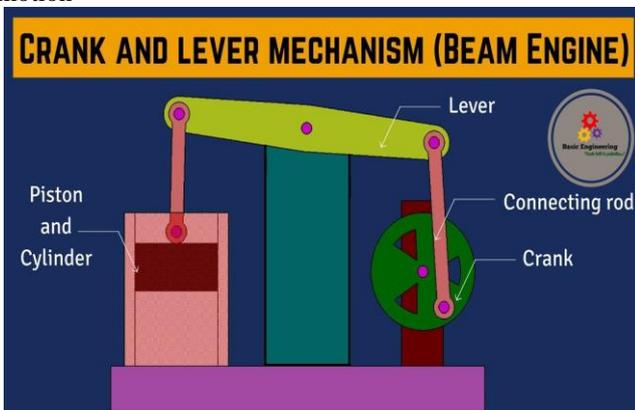
## III. METHODOLOGY

For brushing, the difficult task is the design and after the design, the complex part is the mechanism. For brushing action, circular motion or reciprocating motion is needed. According to the given design, circular brushing action is not possible, so the reciprocating motion was tried. For reciprocating motion the circular motion needs to be converted into reciprocating motion. Therefore, various mechanisms were tried which is used to convert circular motion into reciprocating motion.

Following mechanisms are tried

1. Rotary to reciprocating motion using Cam
2. Rack and pinion mechanism
3. Scotch and yoke mechanism

The above 3 mechanism did not worked for the project because of the less area in the mouthpiece and also the manufacturing of the small size of cam, Rack and pinion etc. Therefore some other mechanism were tried So at last Crank and Lever mechanism is used. the purpose of this mechanism is to convert rotary motion into reciprocating motion



(1)

This mechanism was quite useful for the project. In the beginning Crank and Lever is roughly designed and saw whether the motion was possible or not.

## IV. DESCRIPTION OF MODEL

### A. Components details

There are different sizes of the human jaws. Different people have different teeth structure and due to this, size of jaws varies people to people. Therefore, the jaw was designed to fit according to the different sizes of the teeth. In the jaw for restricting the motion of the strip, a support was designed for the strip. In the design of the jaw, proper care has to be given to the path on which the strip was moving because if the path will not be clear motion cannot take place properly.

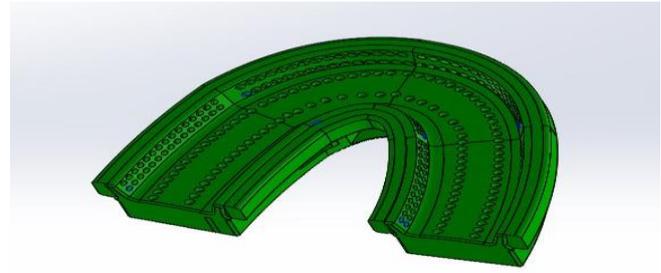


Fig.1. Mouthpiece

### B. Casing

In design of casing, distance plays an important role. In this, firstly all the dimension of the motor, pump and battery were measured then after design, the motor casing according to the dimension.

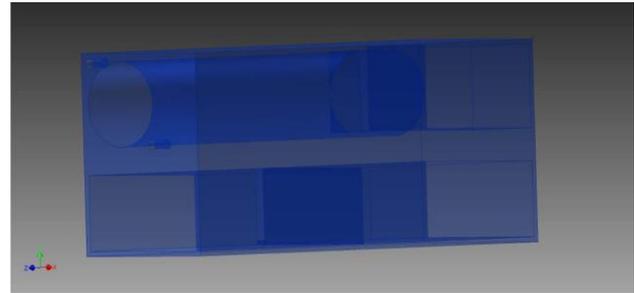


Fig.2. Casing

### C. Motor Specification

#### • COMBINATION GEAR

Planetary Gear head GP 16 A  $\Theta$  16 mm, 0.1 – 0.3 Nm, Metal Version, Sleeve Bearing

#### • MOTOR

RE 16  $\Theta$  16 mm, Graphite Brushes, 4.5 Watt

#### • SENSOR

Encoder MR, Type M, 128 CPT, 3 Channels, with Line Driver

### D. Battery Specification

9 volt battery is used as power supply for pump and motor. For brushing, the difficult task is the design and after the design, the complex part is the mechanism. For brushing action, circular motion or reciprocating motion is needed. According to the given design, circular brushing action is not possible, so the reciprocating motion was tried. For reciprocating motion, the circular motion needs to be converted into reciprocating motion. Therefore, various mechanisms were studied to find out the fitting mechanism which is used to convert circular motion into reciprocating motion.

### E. Designing of Prototypes

Evidently, 3D printing occurs as one of the most pertinent technological innovations that have and continue to elicit an intense debate across various settings all around the globe. Speaking of 3D printing, this connotes to the process of creating physical items from a three-dimensional digital model.

In early 1980's, 3D printing was an unrealistic concept that only existed in the dreams of famous scientists such as Engineer Chuck Hall. However, its evolution into reality has demonstrated that indeed 3D printing is a game-changer. In fact, 3D printing possesses a remarkable capability that could change the world in a number of ways. The design was made on a CAD Software and was then converted the stereolithography (STL) and was then was imported in aslicing software and converted the G-codes for the printer. The printer was feed with the material called PLA(Poly-Lactic Acid) which is a Thermoplastic with a very good boiling point and can also resist higher than 3 times the room temperature. The extruder was heated up till 215 degrees and the build plate was heated till 60 degrees for better grip of the prototype's lower layer to the build plate.

**F. Bristle**

*Materials Used in Toothbrush Bristles*

Modern toothbrushes are typically outfitted in either nylon or nylon-polyester blend bristles. The first nylon bristled brush was introduced in 1938 and was produced with nylon yarn. Today, nylon bristled brushes come in a variety of shapes, sizes, textures and densities. Whether one requires and extra-soft to a firm bristled brush, one is sure to find a brush to suit in the nylon variety.

*The settings which were used to print mouthpiece and other parts:*

**Layer height:** 0.02mm;

Higher values produce faster prints but in lower resolution and lower value produce prints in higher resolution, but in slow speed.

**Infill Density:**50%

This value adjusts the value of infill of the print. Lower the value of infill will provide less strength to the model but will print faster and higher the value will print in higher resolution but will take extra time to print each layer.

**Print Speed**

The print speed was set to 60 mm/s and was deliberately kept slower for better quality print, The infill speed was kept at 80mm/s

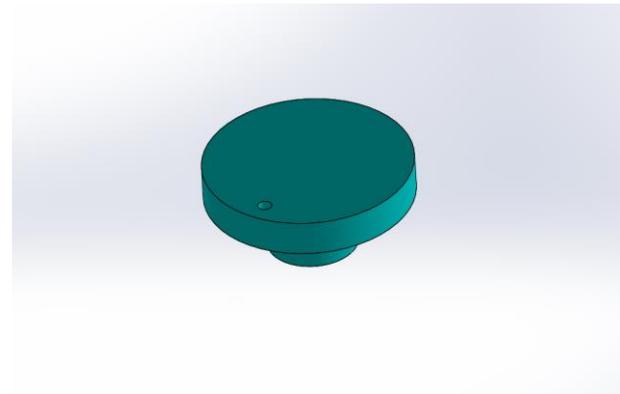
**Support Material**

It generates structures to support parts of the model which have overhangs. Without these structures, such parts would collapse during printing.

**Enabled Print cooling fans**

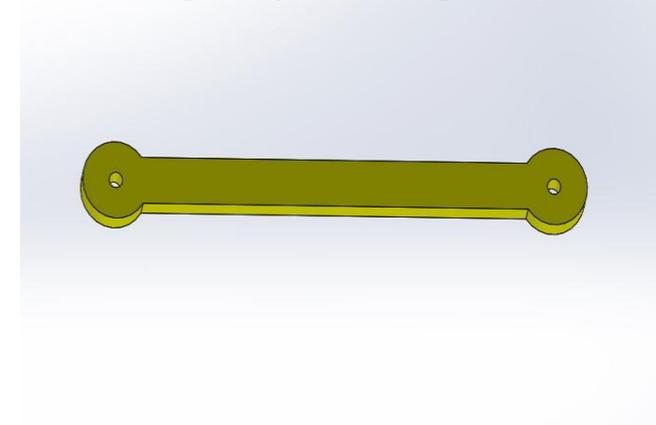
Enabled Print cooling fans while printing. The fans improve print quality on layers with short layer times and bringing/overhangs.

**F. Multiple 3D printed parts of the toothbrush**



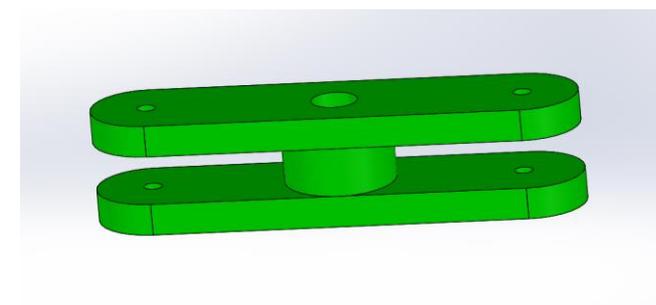
**Fig.3. Disk**

This disc is placed in the handle of toothbrush and is mounted on the motor shaft. When motor rotates this disc also rotate and transfer reciprocating motion to the pivot bar throw a rod



**Fig.4. Rod**

This rod is connected on a disc at some distance from the centre. Because of this distance from the centre the rotation motion is converted into the reciprocating motion. The more the distance from the centre the more the swinging action of pivot bar.

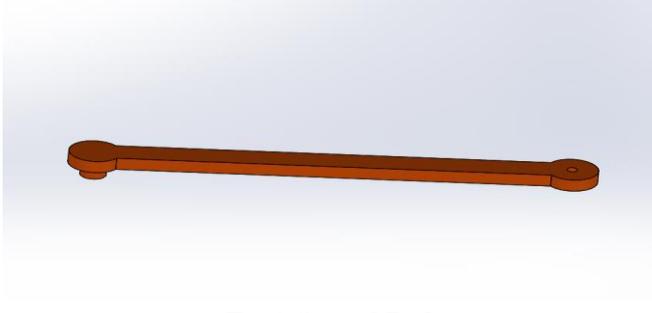


**Fig.5. Pivot Bar**

This Pivot Bar is also placed inside toothbrush handle. The pivot bar and the disc is connected together by a rod. But the center of the pivot bar is fixed and is mounted on a shaft so it can only swing and transfer the rotation of disc to swinging action of pivot bar and next this swinging action is transfer to the required motion of mouthpiece.

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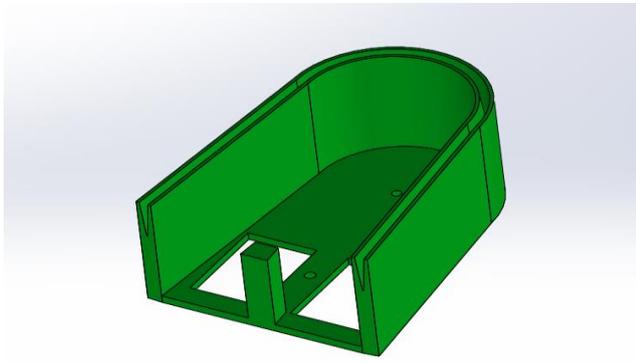
This pivot bar is connected to the mouthpiece by another rod whose dimensions are given below



**Fig.6. Second Rod**

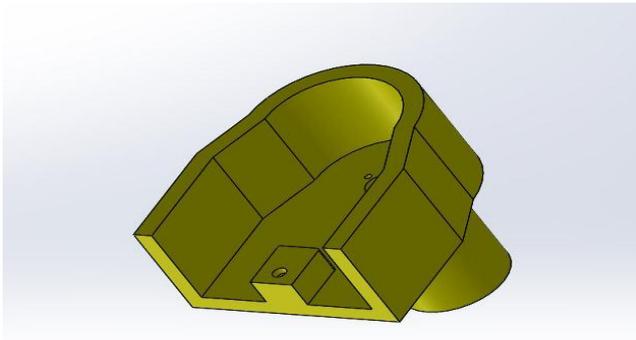
All these parts like Disc, Rod and pivot bar are housed inside the toothbrush handle. Motor is also fixed on the bottom surface of handle. Initially we design a little bigger handle just to check if it works. When it works we reduce the size of a handle, below given the detailed drawing of the handle

### G. Initial Handle Design



**Fig.7. Handle**

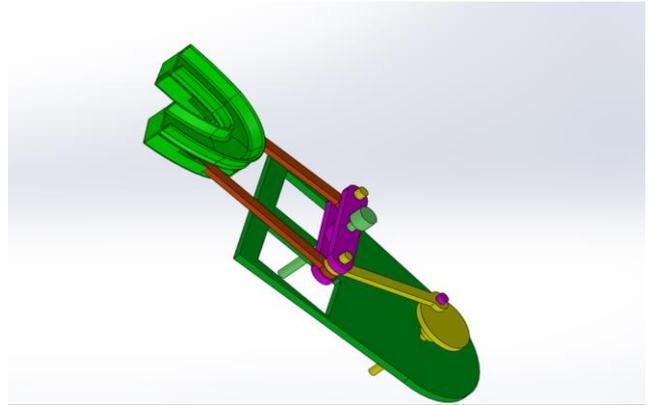
### H. Modified Handle



**Fig.8. Modified Handle**

### I. Assembly of the automatic tooth brush

In assembling, firstly the motor were fitted on the bottom surface of the handle then disk is mounted on the motor shaft and fixed properly after that all the rods are fixed on there position after this power supply was given to the motor and which has made the device to took brushing action properly.



**Fig.9. Initial assembly of automatic tooth brush**

### J. Result and Conclusion

In this study, an automatic toothbrush was developed in order to achieve maximum reduction of plaque, gum diseases and gingival bleeding diseases viruses. The process of establishing with the professional's instructions in the use of automatic toothbrush has been proved to achieve an important optimal result.

For the designing of toothbrush circular motion was need needed to be converted into reciprocating motion. There are various mechanisms which makes this conversion such as Rotary to Reciprocating motion using Cam, Rack and Pinion mechanism and Scotch and Yoke mechanism. But due to availability of limited area, Scotch and Yoke mechanism was chosen to provide reciprocating motion.

Again, to reduce some space yoke was included into strip and scotch was given counter which helped in minimizing some more space.

The automatic toothbrush is an instrument which was invented with the aim to help those people who are disabled or who are unable to give proper attention to their dental instruction.

No statistical difference has been made between manual toothbrush and automatic toothbrush. Both of them are safe and convenient to use. The only difference between the manual and automatic toothbrush is that in manual toothbrush the user need to provide the dental instructions to the toothbrush works for you. On the other hand, both the toothbrush i.e. manual and automatic toothbrush works differently but functions the same.

### K. Future Scope

Technology and its every day new invention have taken the world to the next world. Invention is the most precious product of scientific knowledge. Without technological invention and innovation, science would be just an inquiry for one's own sake, serving few and helping no one.

From the last few years, a new innovation in the field of science has emerged out in the form a toothbrush which works automatically. This newly invented automatic toothbrush has become very popular among every generation of people. It has been calculated that, there are about 30% people who are the user of this automatic toothbrush,

and due to its high demand for improving oral hygiene to a much higher level, the percentage will increase in future to a much higher extent.

In today's scenario people don't have much time; they share a very busy life. The automatic toothbrush saves a much of the time. Manual toothbrush takes about 3-4 minutes to give a complete and appropriate brushing and according to dental instructions, this must be given to the teeth while brushing which is very important to have a good oral hygiene, But with automatic toothbrush this problem has solve, now the user 's teeth can be cleaned within seconds more effectively as compared to manual toothbrush.

Even now the manufacturers of manual toothbrush have started focusing on automatic toothbrushes. They trying to improve manual toothbrush so that it can meet the appropriate dental care needs. Therefore, automatic toothbrush is the ultimate choice of the future.

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## AUTHORS PROFILE



**Sandeep Singh**, completed his Bachelor of Technology (Mechanical Engineering) from Panjab University. At present, he is pursuing Master of Engineering (Manufacturing Technology) from NITTTR, Chandigarh. His research areas are non-conventional machining, modeling and simulation, and automation



**Dr. P. Sudhakar Rao**, Assistant Professor in Mechanical Engineering Department, NITTTR, Chandigarh. He completed his Ph.D. from IIT Roorkee. Key areas of research interests include Manufacturing Technology, Engineering Design, Non-Conventional Machining, CAD/CAM/CIM, Engineering Materials, and RPT/RE.

profile which contains their education details, their publications, research work, membership, achievements, with photo that will be maximum 200-400 words.



**Mr. Sanjeev Verma**, Senior Principal Scientist in CSIR-CSIO Chandigarh, He is currently working in Biomedical department of CSIO Chandigarh. His research interests include precision manufacturing, non conducting ceramics, EDM.