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OralMate: Intelligent Brushing Monitoring Using a Smart Toothbrush

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Abstract: *Tooth Brushes are the most commonly used oral hygiene aids. Dental plaque, a sticky, colourless film of bacteria build-up and covers the enamel of the teeth and can cause tooth decay, gum disease, and dental disease. So, it is very important to remove dental plaque to keep teeth clean and healthy. OralMate is an IOT enabled smart toothbrush. OralMate helps in monitoring the pressure while brushing teeth, keeps check of the duration of the brushing and monitors the intensity of brushing. OralMate comes with an application that keeps a record of the brushing sessions and related parameters. The main aim is to help people to maintain their oral health. OralMate is an effective way to help people develop a proper brushing method to keep their teeth healthy. A proper brushing method includes many factors, like the pressure applied on the teeth, the number of brush strokes, and the time duration for which the brushing is done. These factors fulfilled individually might not be enough and must be fulfilled as a whole.*

Keywords: *Oral hygiene, HC05 Bluetooth module, Internet of Things, etc.*

I. INTRODUCTION

OralMate is a combination of hardware and software majorly focusing on improving people's oral health and includes a tooth brush and a mobile app to keep a record of their brushing activity. The toothbrush includes an accelerometer, a Bluetooth, a force sensor and an LCD display to interact with the user.

The mobile app starts with a sign-In page for registered users then from there you can either sign-In with your registered email and password or if you are not registered you can go to the registration page with the button provided at the end of the sign-In page. The registration page consists of user image, user name, email, password, when all the fields are filled properly and then clicked on the submit button the user is sent to the homepage of the app where they can access all the features provided by the product. Now, the user is required to connect the toothbrush with their mobile app via Bluetooth.

Then the user needs to press the start brushing button in the mobile app. The toothbrush sends the count of the brush strokes made and the force applied on the teeth by the toothbrush to the mobile app. This data is then analyzed and stored in the database and recommendations are made accordingly for the user to improve their brushing method. The toothbrush case allows you to use different toothbrush head attachment according to your bristle requirements.

According to studies, the optimal pressure which must be applied on the teeth for proper plaque removal is around 250 gm to 280 gm. The optimal time period for which the brushing should be done is 2 minutes. According to these numbers, the number of brush strokes to be made within this 2-minute time period was found around 200 to 220. The platform used for CAD designs is SolidWorks.

II. LITERATURE SURVEY

The study on "Toothbrushing behavior in children" by Sundell and Klein in the year '2019' is about the patterns of people of different age groups, majorly focusing on parameters like stroke frequency and pressure applied on the teeth while brushing.

The outcome of the study puts light on the difference in the brushing patterns of people of different age groups. The results obtained by observing children of two different age groups of 7 years old and 11 years old shows that 57.8% of the younger children made irregular strokes and applied less pressure while 75% of the older children made regular strokes with more pressure. The study concludes that it is crucial to adjust Oral hygiene instructions in a child's development stage to develop better motor skills and variations in the toothbrushing abilities. [1]

III. MOTIVATION

Dental problems are increasing day by day due to the change in food lifestyle. From children of 4-5 years to adults, all are suffering from dental diseases. Dental problems like tooth decay, Gingivitis, sensitive teeth, enamel erosion etc. are common nowadays. Tooth Brushes are most commonly used by the people for cleaning purpose. Dental plaque can cause tooth decay, gum disease, and other dental diseases.

So, it is very important to remove dental plaque to keep teeth clean and healthy. But manual brushing is only effective if they are used properly. Sometimes, we brush our teeth so hard that they can cause potential damage to our teeth and gums. Also, due to a hectic lifestyle, we sometimes forget to brush our teeth twice a day and this is a major reason due to which people suffers from tooth decay and gum disease. So, brushing teeth twice a day is very important.

IV. PROBLEM FORMULATION

Poor oral hygiene is common nowadays due to change in eating lifestyle. It not only affects the oral health but also the overall health of the body. It builds up the plaque which may cause gum infection/disease and tooth decay resulting in tooth loss.

Failing to brush the teeth twice a day may convert the soft plaque into hard plaque known as calculus or tartar that cannot be further removed by brushing. Hence, proper dental care is required to maintain oral hygiene. So, there is a need for a smart toothbrush which must be cost-effective and provides features to help users in promoting their oral health.

V. HARDWARE AND SOFTWARE COMPONENTS

A. Hardware Components

1. Arduino Nano: Arduino Nano (Figure 1) is an open-source microcontroller. It consists of 30 male I/O headers. The board requires a power supply of 9V, which can either be supplied by a battery or a type-B mini-USB cable.

   The board operates at a voltage of 5V and is capable of handling an input voltage of 5 to 20 volts. Out of these 30 pins, 14 are digital I/O pins out of which 6 spins, if required, may work as PWM outputs.

   Further, the board contains 8 analog, a 32KB flash memory and 2KB of SRAM and has a clock speed of 16MHz. [2]

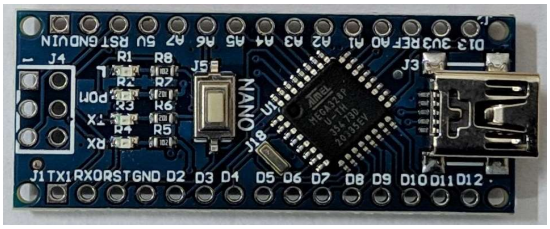

Figure 1: Arduino Nano

2. 16x2 LCD display: The LCD display (Figure 2) used in this project is RG1602A 16x2 Alphanumeric LCD Green. It is an electronic display and is widely utilized in many embedded projects because it's cheap, easily available and user friendly.

Figure 2: 16x2 LCD display

3. MPU6050 accelerometer: MPU6050 (Figure 3) is a type of Micro Electro-mechanical system (MEMS). The device works on 6 axes, out of which, three- axes are for accelerometer and three-axes are for gyroscope and hence can be used to determine velocity, acceleration, displacement, orientation and many more motion features.

Figure 3: MPU6050

4. HC05 bluetooth module: HC05 (Figure 4) is a bluetooth module designed to enable wireless communication and can be used in a master or slave configuration.

   It operates in a range of 10 meters and uses 2.45 GHz frequency band and the data transfer rate may vary up to 1Mbps. The module operates on a voltage of 3.3V and may take an input voltage of 5V which gets regulated to 3.3V. [3]

Figure 4: HC05 Bluetooth module

5. Force Sensitive Resistor/ Force sensor: The force sensor (Figure 5) helps detect physical pressure. An increase in pressure leads to more electrodes getting in contact with the semiconductor reducing the resistance. At rest the resistance is infinite hence there is a complete voltage drop across the force sensor [4].

   With the increase in pressure, the voltage across the force sensor increases. This increase in voltage is the parameter used against a constant resistance to measure the pressure applied

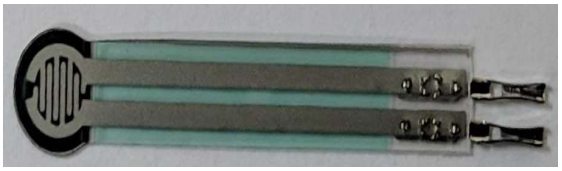

Figure 5: Force sensor

6. Piezo Electric buzzer: It is a simple electric device which produces a sound, which can be used as an alarm or notification or warning. It comes in various sizes which can produce sounds of various frequencies. The longer terminal is VCC and the shorter one is ground.

Figure 6: Piezo Buzzer

B. Software Components

1. Flutter: Flutter is an open-source framework created by Google. It is used to build natively compiled applications for mobile, web, and desktop from a single codebase.

2. Android Studio Emulator: An Android emulator is a software program that allows you to run Android apps on a computer or a device other than an Android phone or tablet.

3. Dart: Dart is a programming language developed by Google. Dart is used to build applications for the web, mobile, and desktop, and it is the language that Flutter, a popular mobile app development framework, is built with.

4. Firebase: Firebase is a mobile and web application development platform developed by Google. It provides a range of tools and services for building and maintaining applications, including tools for cloud storage, real-time database, authentication, analytics, and more.

VI. PROPOSED METHODOLOGY

A. Block Diagram

Figure 7 shows the block diagram of data transmission across the hardware and software

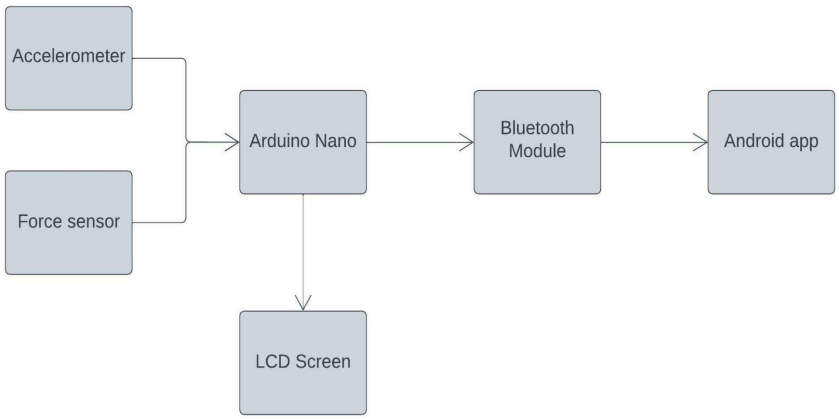

Figure 7: Block diagram of data transmission across the hardware and software

B. Circuit Design

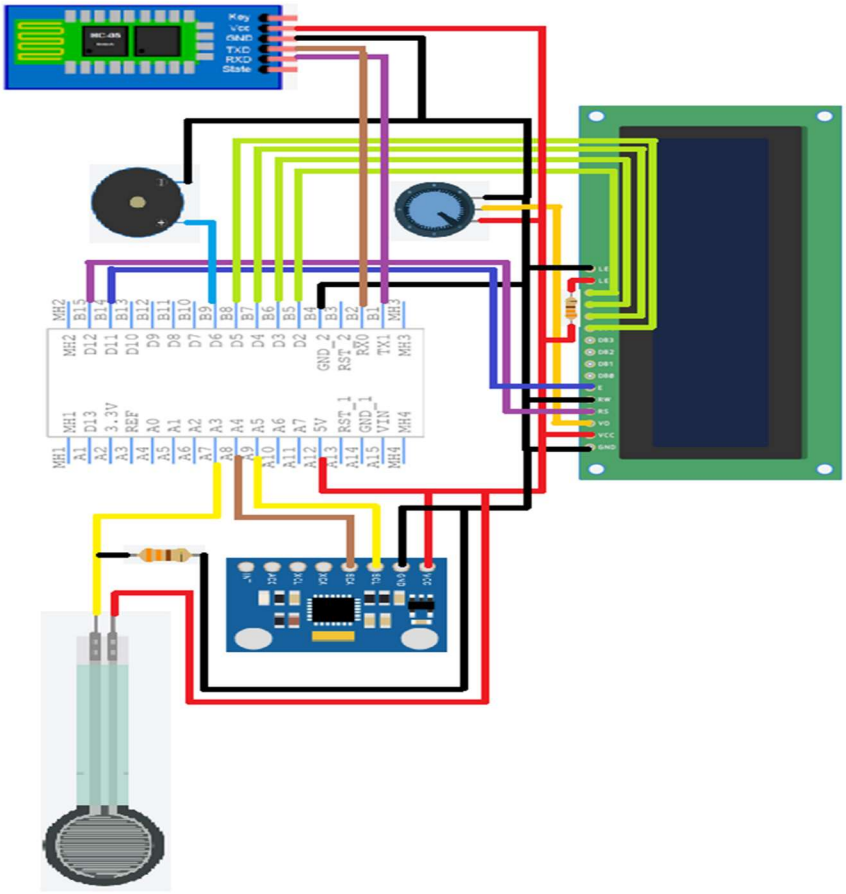

Figure 8: Circuit Design

C. Block diagram of data storage and representation in mobile application

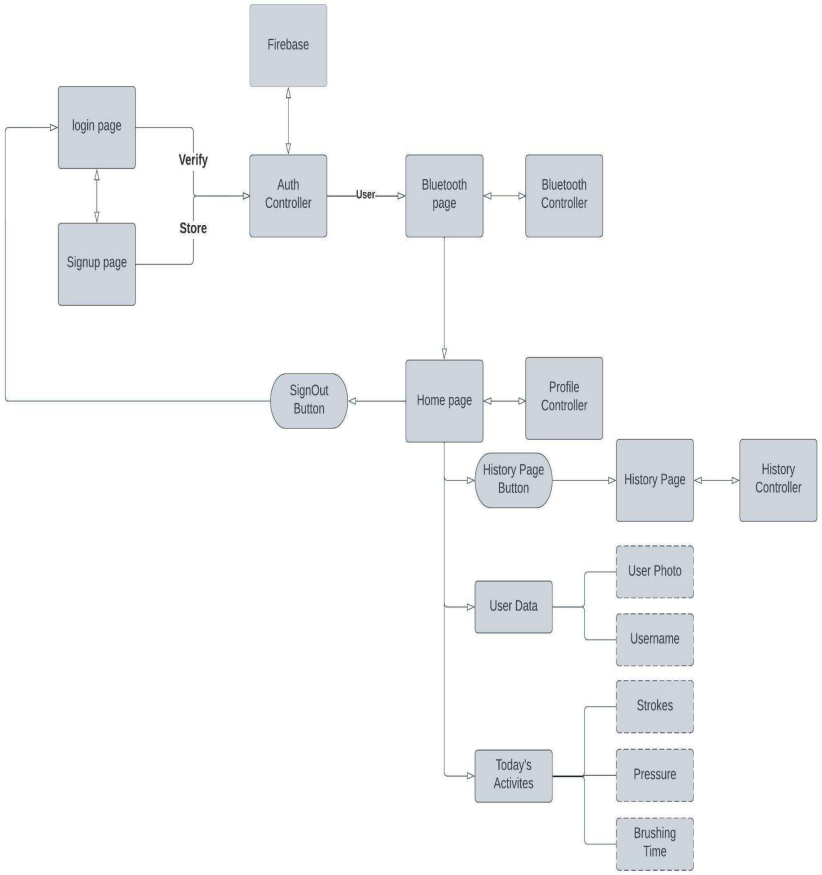

Figure 9: Block diagram of data storage and representation in mobile application

VII. RESULTS

A. Hardware (PCB Design)

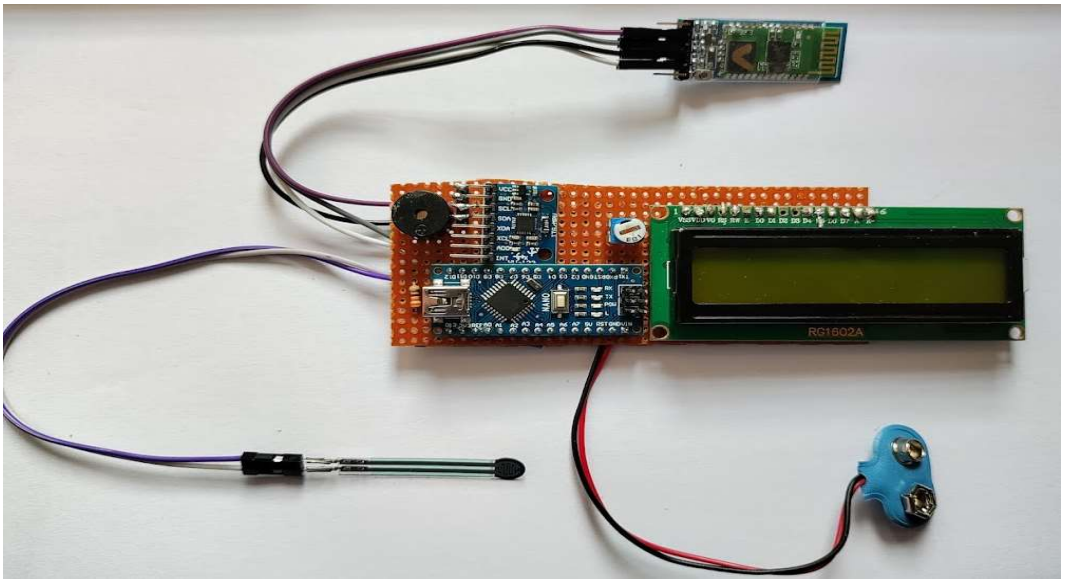

Figure 10: PCB Design

B. Software (Mobile Application)

The following figures are the snapshots of the mobile application of OralMate. The application is multipage and have various different sections. The user must complete the registration process followed by login and then they can connect to their brush via bluetooth on the pairing page. And can check their daily and monthly brushing data.

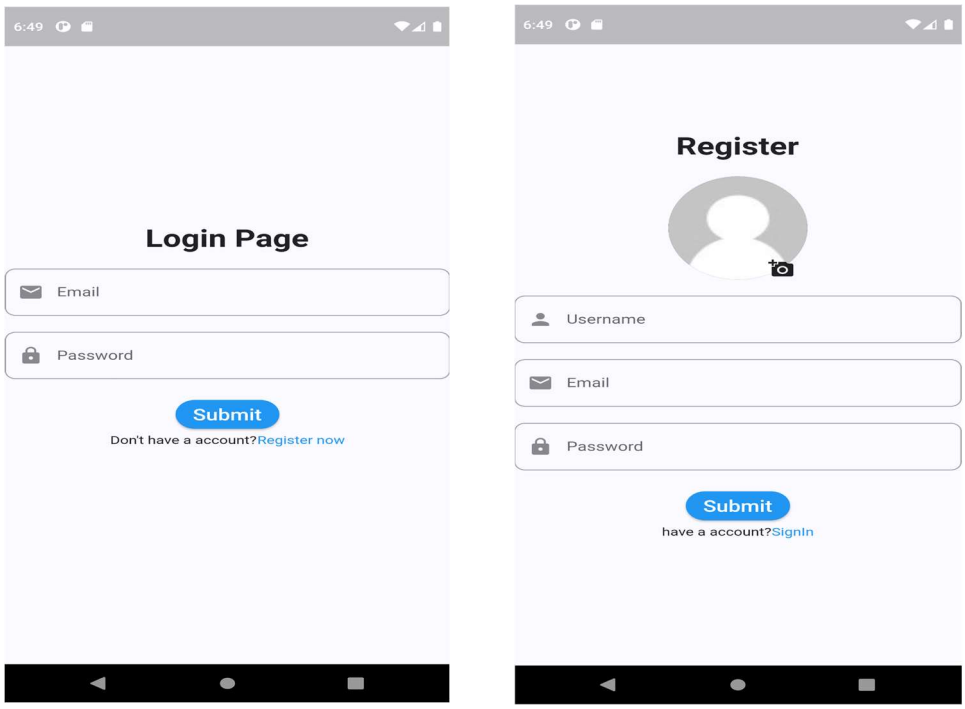

Figure 11: Login page and Registration page

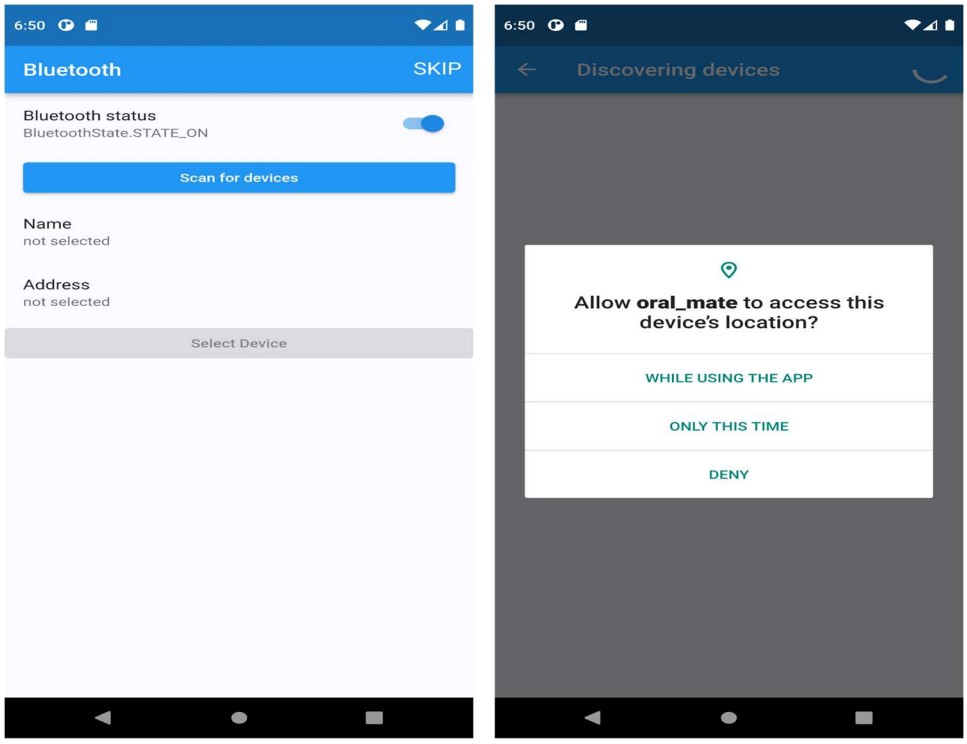

Figure 12: Bluetooth Page and Permission for accessing the device location

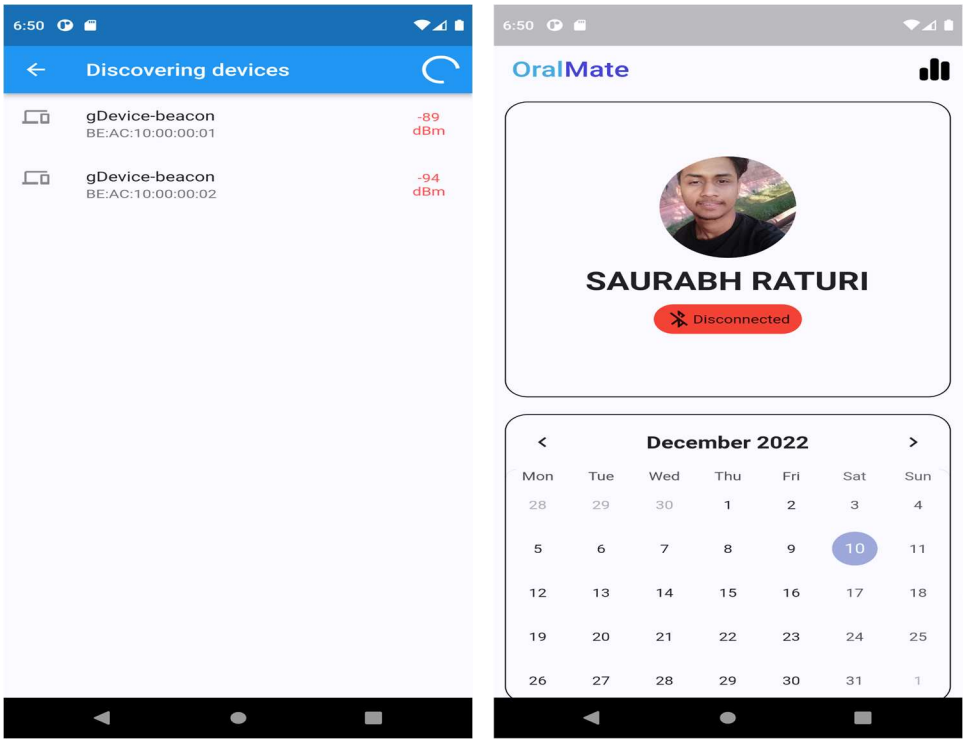

Figure 13: Bluetooth device discovery page and Home-page

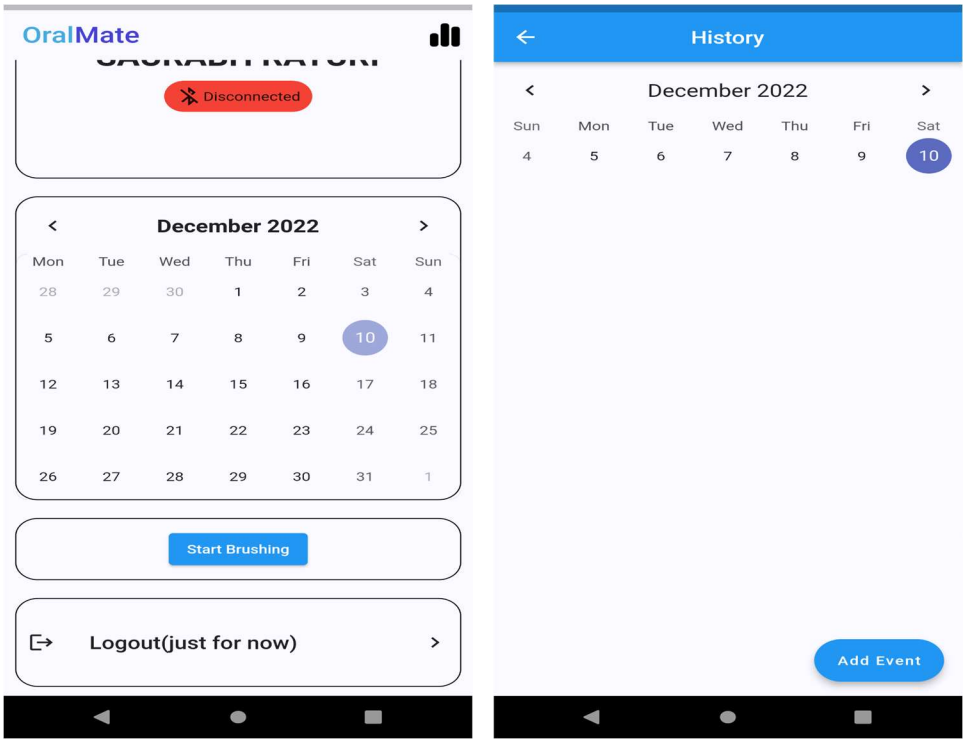

Figure 14: User brushing session calendar and history page

Figure 15: Final Model of the toothbrush

C. Final Model of 3-D Brush

The toothbrush case has been designed using Solidworks. It involves the use of various features of Solidworks to build the handle and head of the case.

VIII. CONCLUSION

There are multiple companies offering smart toothbrushes equipped with many features which help in effective brushing sessions. OralMate offers all the features in a single device and also it has an advantage over others because it shows the intensity of brushing and compares it with the required level of pressure a user should apply on his gums so that the gums stay healthy. With the help of an application connected with the brush, the user can schedule his brushing sessions and it will also remind him of his brushing time. OralMate has been found to be effective in promoting oral hygiene. It helps in daily plaque removal, thus preventing enamel and gum damage. It also helps in reducing the risk of cavities, which is now a common problem, affecting a large group of children. It also assures that there should not be any potential damage to the teeth while brushing. Oral hygiene gives a great feeling of having clean teeth and a fresh, minty taste in the mouth and also helps in smiling with confidence.

REFERENCES

[1] Toothbrushing behavior in children: a study of pressure and stroke frequency Sten O. Sundell, DDS Hortense Klein, DM PEDIATRIC DENTISTRY/Copyright © 1982 by The American Academy of Pedodontics/Vol. 4, No. 3

[2] https://www.arduino.cc/

[3] https://www.electronicwings.com/sensors-modules/bluetooth-module-hc-05-

[4] https://www.elprocus.com/force-sensor-working-principle-and-applicationa/