SJ Engineering Africa
Vol. 1 No. 1 (2024): January 2024 Issue
https://doi.org/10.51168/k6z3kb17
Original Article

# AN IMPROVED PORTABLE MOUTH GAG ESSENTIAL IN DENTISTRY.

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## ABSTRACT

**Background**

Despite World Health Organization's efforts to promote oral health, there has been lots of failures as the leaving standards per now where sugar consumption, tobacco use and so forth have become a culture increasing the risk of getting the dental caries, gum disease, oral cancer etc.

In an interview we made with dentists in Mwesigwa dental clinic, it was revealed that for every patient there is need to keep the mouth open for some time during examination, diagnosis and treatment.

With the above mentioned we realized an increasing need for improving visibility of the oral cavity as a requirement during diagnosis because of the need to better dental services. This report is the record of what we did that includes identification of a real life problem and an innovative solution to the problem .This was covered between February and August.

**Public health needs**

Covers public health needs and impact which includes an introduction of the need, problem statement, and current solutions to needs, their impacts and gaps, and the project objectives

**Concept of innovation**

Conception of the innovation and this includes; introduction of the innovation, product design specification/criteria for success, project idea generation and project idea selection.

**Engineering analysis**

Engineering analysis of the proposed solution, its principle and mechanism of operation and the material analysis and simulation of the proposed solution

**Prototyping and testing** covers the budgeting of the selected materials and components, budget justification, prototyping and prospects for the project.

**Project management**

Goes to introduce a multi-disciplinary project team and respective responsibilities, project work plan, project management tools, financial management and a summary of meeting minutes for the project

*Keywords: Mouth gag, Dentistry, Oral care*
*Submitted: 2023-12-18 Accepted: 2024-01-15*

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## Background

Dentistry is a branch of medicine focused on teeth, gums, and mouth where it consists of the study, diagnosis, prevention management and treatment of oral based diseases, disorders and conditions of the mouth.

Dental related problems having become a problem worldwide which is due to a range of modified risk factors common to non-communicable diseases including sugar consumption, tobacco use, alcohol use and poor oral hygiene bring a rise in the need to improve accessibility and visibility of the oral cavity during dental procedures. Improved accessibility and visibility of the mouth cavity is a global health demand need that should be taken critically into consideration.

In a survey carried out by the Centers for Disease Control and prevention in the United States, more than 1 in 4 adults equivalent to 26% suffer dental carries. In addition, nearly half that is, 46% of the adults 30 and older have signs of gum disease, and 13% of the youth ages 5 to 19 have untreated tooth decay.

Worldwide, untreated cavities (also called carries) are the most common oral health issue, affecting more than 2 billion people and severe gum disease affects about 1 billion people, according to the new report on oral health from the World health organization

Calling the global situation alarming WHO officials say nearly half of the world's population has untreated oral disease, and that these illnesses affect more people worldwide than mental disorders, cardiovascular disease, diabetes, chronic respiratory disease, diabetes, chronic respiratory disease and cancers combined.

Around 44% of the population in the African region suffer from oral disease, while the region has experienced the steepest rise globally in oral diseases over the last three decade. Oral health remains a low priority in many African countries, leading to inadequate financial and technical investment which in turn undermines prevention

and care services as well as oral health promotion (Dr. Moeti)

The African region has experienced an increase of more than 257 million in oral disease cases over the last years, affecting people from early life to old age. The growing burden of oral diseases such as dental caries, gum diseases and tooth loss disproportionately impacts marginalized groups, reflecting wider inequalities in access to health services.an example is the persisting prevalence of Noma, a disease that occurs in the contexts of extreme poverty and is primarily found in sub-Saharan Africa. Noma destroys the mouth and face of mostly young children. If left untreated, it is fatal in 90% of cases.

According to a study carried out in Kampala it was stated that dental caries was recorded in 40% of the children and 62.5% of the adults. Carries was significantly more severe in female as compared to males, in children while in adults, there was no significant gender difference.

Kampala had significantly higher mean DMFT (decayed, missing due to carries, and filled teeth) score compared to the other districts in all age groups.

under a survey that was taken in Mwesigwa dental clinic it was confirmed that out of the 20patients attended to daily, 15 required dental surgeries, 3 required dental examination and the 2 were for reviews for all these to be done, the doctor has to be able to see clearly and access clearly the affected area, this therefore calls for the urgent need to solve the problem of limited access and visibility of the mouth cavity because for all the above mentioned conditions whose victims grow daily, at one point the mouth cavity has to be viewed

## Problem Statement

Dentistry is the branch of medicine focused on teeth, gums and the mouth where it consists of the study diagnosis, prevention, management and treatment of oral based diseases, disorders and conditions of the mouth. Dental related problems having become a big problem worldwide this comes due to a range of modifiable factors common to many no communicable diseases including sugarcane consumption, tobacco use, alcohol use and poor hygiene.

For any action to be taken in diagnosis, or treatment of any dental medical conditions, automatically the first step to success is to ensure that the mouth of the patient is open. Before any action or measure is taken, the dentist has to have a clear view of the affected area and this calls for the need to eliminate any obstacles to the visibility and accessibility of the mouth cavity. When patients cannot open their mouth very well, it is of a disadvantage because every millimeter saved for operating space counts.

Limited access and visibility of the oral cavity can lengthen the procedural time. When the patient cannot keep their mouth open during the procedure, there the chances of ingestion of foreign bodies as they accidentally close in response to stimuli and this can bring about more adverse conditions. There are also chances of the dentist making blunders because he or she cannot see the affected area well.

And for every dental condition it's definite that the oral cavity be opened and for some cases it may be kept open longer depending on the intensity of the condition and the treatment method opted for.

A survey was carried at Mwesigwa Dental Clinic where Dr. Katende affirmed that they face a challenge when it comes to keeping the patient open during operative dental procedures yet is most highly required. But this is hard to achieve as patients get fatigue, hence affecting his efficiency.

## Existing Technologies

Even though the challenges remain prevailing in the health centers, many solutions have been developed to improve the accessibility and visibility of the oral cavity during dental treatment procedures. Some of them include;

a) Micro surgical mirrors

These are generally used during endodontic microsurgery to view into hard to reach areas. They are designed at a much smaller size than typical dental mirrors because they are used in such small places. They are fabricated from stainless steel and should be fully autoclavable


*Figure 1 shows microsurgical mirror*

b) Electronic apex locator

This is a device used for taking radiographs in patients who can't open their mouths easily. It is an electronic device used in endodontic to determine the position of the apical constriction and thus determine the length of the root canal space.

Figure 2 shows an electronic apex locator

b) Dental bite blocks These are tiny devices that the orthodontist attaches in front or the back of your teeth, and this helps prevent the teeth from

coming into contact with each other when you bite down.

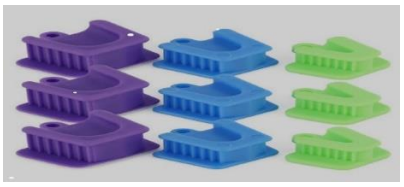

*Figure 3 shows dental bite blocks*

d) Molt mouth gag

It has pivotal pads which allow to compensate movements in surgery without dislocation. These pivotal pads give a stable and better fixation to the teeth, to the edentulous jaws and enable also to fixate other instruments like tongue plates. The large handles at the back also somewhat work as an obstacle hence reducing working space. It has still failed to address the issue of slipping off during the operation.

*Figure 4 shows a Molt mouth gag*

(e) Denhardt Hoefort mouth gag

It features a ratchet mechanism that allows the mouth to remain open during the surgery. It still has failed to address the issue of slipping off during the procedure.

*Figure 5 shows a Denhardt mouth gag*

## Objectives

- To design an affordable and easily accessible device.
- To design a reliable device that eliminates the concern of sliding and slipping off during dental procedures.
- To come up with a working prototype of the solution.
- To eliminate the risk of swallowing a foreign body when the patient accidentally closes the mouth.
- To eliminate mouth muscle fatigue due to prolonged opening.
- To improve visibility of the oral cavity.

## Criteria for Success/Concept of Innovation

The solution suggested for the delayed and inefficient service offered to the dental patients as a result of limited access and visibility of the oral cavity was a strong mouth holding device. For these devices to perform an intended function, we formulated a criterion for the project success considering the factors for the design process, innovation and implementation process. They were summarized as follows;

### Reliability

The device should offer a better and simpler and safer alternative to keep the mouth of the patient open during dental procedures. It should be patient friendly as well as solve and address the problems doctors face as well. Therefore problems like sliding and slipping off will be solved. The device will be comfortable for use on both children and adult patients.

### Maintenance

It will be made of material that is easy to clean and disinfect by simple disinfection methods to prevent cross infection.

The device will be easy to service by hospital engineers. It will have a relatively long operation life with simple servicing procedures.

### Non toxic

The material of the device should not present or cause any damages or harm to both the patient and the doctor.

### Size and weight

The device should be very small in size and light weighing about 100grams.

## Low-cost

The device should be easily affordable by all health facilities.

**Operation**

The device will be easy to operate. It will be put in the mouth in-between the lower and upper jaw. With the teeth having a firm grip onto the rubber. The adjuster ring will then be rotated to adjust the width between the jaws of the device in accordance with the size of the mouth of the patient also that required by the dentist for proper operation.

## Power consumption;

The device will have a low power consumption.

## Concept Generation

After studying the problem in detail and considering the criteria for success, the team met multiple times to come up with the appropriate solutions. We had multiple stages of the ideation and brainstorming sessions managed and facilitated by the members. The following are the resolutions we came up with to satisfy the criterion for success.

**Solution 1**; Designing a device with a small hand mirror to give a reflection of the inside

**Solution 2**; Designing a light device of small size with a rubber portion onto which the teeth grip firmly to prevent slipping off and sliding off during operation.

**Solution 3**; Designing a small device with a light emitting diode that flashes light into the mouth during operations

Figure 6

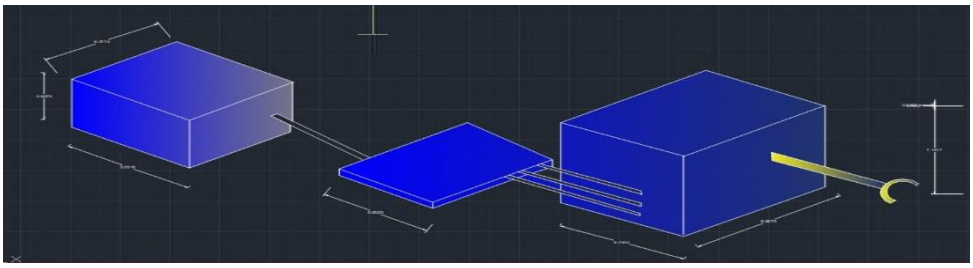

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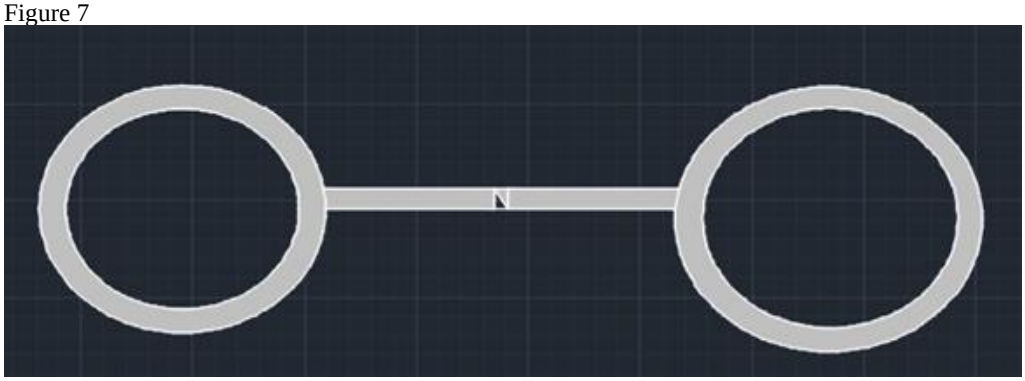
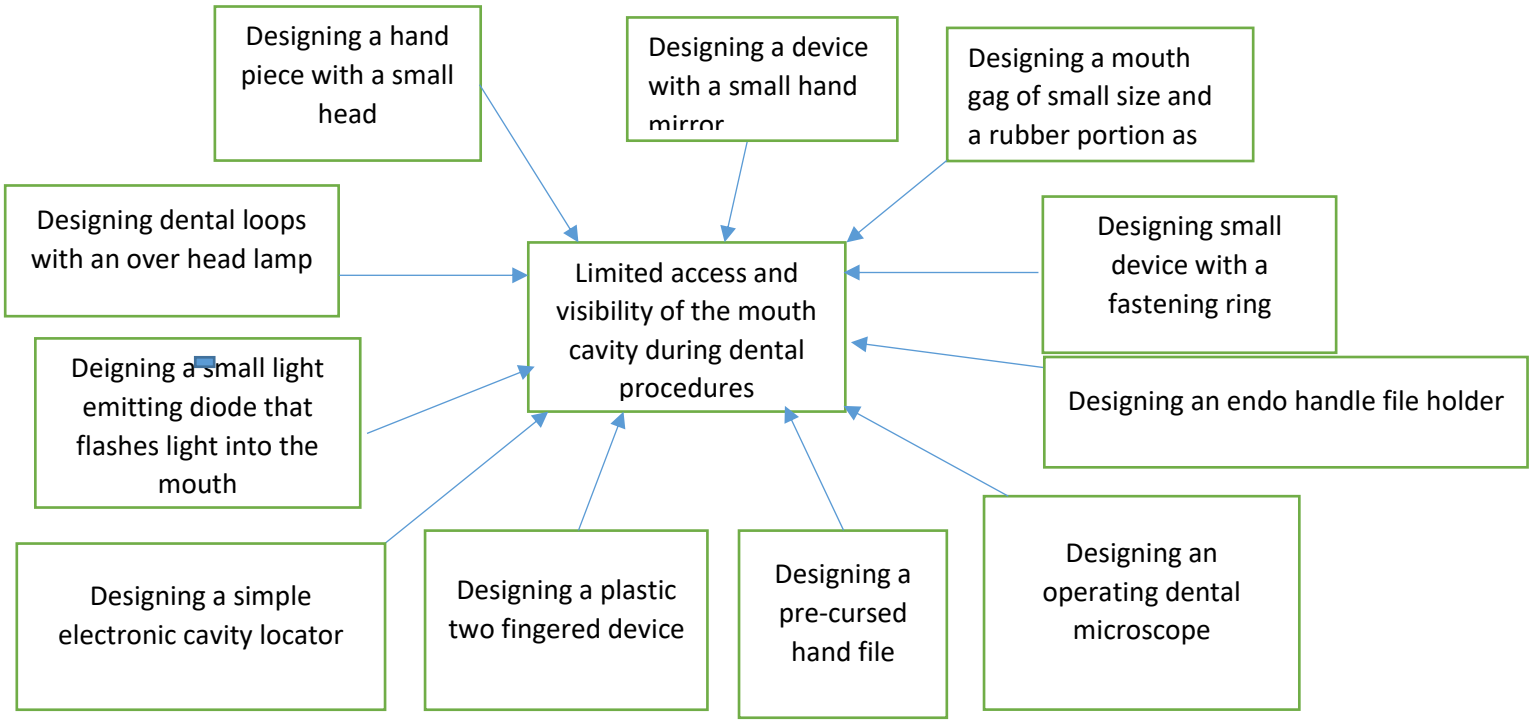
Figure 7



Below are the solutions from which the three best were chosen.



| Specification | Rank | Solution 1 | Solution 2 | Solution 3 |
|---|---|---|---|---|
| Reliability | 8 | 2 | 5 | 3 |
| Weight | 5.5 | 5 | 4 | 4 |
| Size | 5.5 | 4 | 5 | 3 |
| Non toxic | 1 | 5 | 5 | 5 |
| Reusability | 2 | 5 | 5 | 5 |
| Maintenance | 3 | 3 | 4 | 3 |
| Low cost | 4 | 4 | 5 | 2.5 |
| Low power consumption | 7 | 5 | 5 | 1 |
| Total | | 33 | 38 | 26.5 |

*Table 1 showing the criteria for idea selection*

## Project Idea Selection

From the three solutions, the team sat and followed the criteria below to come up with the most appropriate for achieving our desired objectives.

- Excellent- 5
- Very good-4
- Good-3
- Fair-2
- Poor-1

W1=1-((i-0.5)/n)

N-number of specification

## Conclusion

Basing on the weighted criteria, the team decided to take up the small automatically adjustable device with a rubber portion as the best way to solve the problem of limited visibility and accessibility to the oral cavity during dental procedures as it satisfies the objective.

## Selected Innovation

## Working principle

Mouth opening using this device is based on the principle that for whichever adjustment of the servo motor is made, the prongs fixed into the mouth move and the jaws are caused to move at a certain degree thus opening the mouth. The servo motor is adjusted to the point desired by the dentist and can be withstood by the patient. Without reverse adjustment of the mouth gag, the mouth will be kept open. To close the mouth and have it back in its position, there will be reverse action to the opening

## Servo Motor

A servo motor is an electric motor that allows for precise control of angular or linear position, speed and torque. It consists of a suitable motor coupled to a sensor for position feedback and a controller that regulates the motors movement according to the desired set point.

How a servo motor brings about opening and closing.

It consists of three parts:

1. Controlled device
2. Feedback loop
3. Output system

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as

the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

Servo motor diagram


*Figure 6 shows a servomotor*

## Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name. The working principle of the potentiometer is that the voltage drop across any part of the uniform resistive wire is directly proportional to the length of the wire if a constant electric current is flowing through the resistive wire. Hence, no electric current will flow through the circuit if there is zero potential difference between any two parts of the wire. In the potentiometer, the input voltage is applied to the whole length of the resistive wire, and the output voltage is measured between the sliding contact and the fixed end of the circuit as shown in figure-1. The position of the jockey (sliding contact) is varied across the length of the uniform resistive wire to find the null position.

*Figure 7.potentiometer*

## Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010. The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It has the same microcontroller as the Arduino Nano board, and the same headers as the Leonardo board. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.


*Figure 8 shows an arduino UNO*

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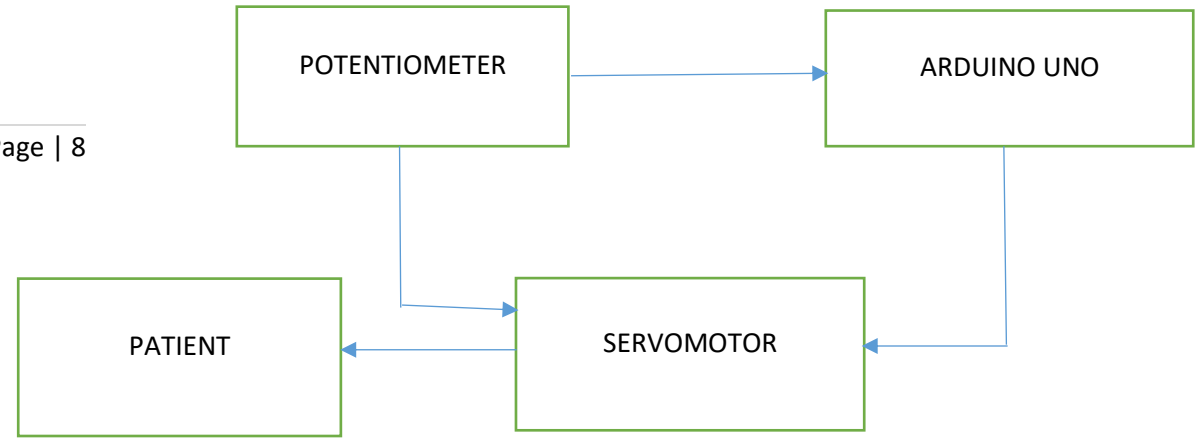
## Block diagram




**Working mechanism**

A potentiometer also known as a pot or potmeter is defined as a 3 terminal variable resistor in which the resistance is manually varied to control the flow of electric current. A potentiometer acts as an adjustable voltage divider. Using a potentiometer attached to the rotating shaft through the arduino board, servomotor senses position. The incoming pulse is measured, which then applies current to the motor to turn the shaft until the potentiometer indicates that the position corresponds to the incoming pulse width. This is a form of feedback control.

## Engineering calculations

Given:

- Angle of mouth opening:40degrees
- Average resistance force of jaw muscles:10 Newtons

Calculation

Force=resistance force/sin (angle)

$$Force = \frac{10}{\sin(40°)}$$

Force=13.421

So I would need a mechanism that can apply around 15.24Newtons of force to comfortably hold the mouth open at a 40-degree angle and tNhis calls for material stress analysis.

**Material stress analysis**

Let's analyze the stress on stainless stress

Given:

- Stainless steel tensile strength:500MPa(500N/mm$^2$)
- If Cross-sectional area of the mouth gag arm is 5mm$^2$

$$stress = \frac{force}{area}$$

Taking force to be 15.24

$$stress = \frac{13.421}{5}$$

$$stress = 2.684 Nmm^{-2}$$

Since the calculated stress (2.684N$mm^{-2)}$ is much lower than the tensile strength of stainless steel (500N$mm^{-2}$), the material should be able to withstand the forces without failing.

## Material analysis and justification

## Stainless steel as casing for the mouth gag

Stainless steel, also known as inox or Corrosion Resistant (Stainless) Steel (CRES), is an alloy of iron that is resistant to rusting and corrosion. It contains at least 10.5% chromium, usually nickel, and may also contain other elements, such as carbon, to obtain the desired properties. Stainless steel's resistance to corrosion results from the chromium, which forms a passive film that can protect the material and self-heal in the presence of oxygen.

The alloy's properties, such as luster and resistance to corrosion, are useful in many applications. Stainless steel can be rolled into sheets, plates, bars, wire, and tubing.

These can be used in cookware, cutlery, surgical instruments, major appliances, vehicles, construction material in large buildings, industrial equipment (e.g., in paper mills, chemical plants, water treatment), and storage tanks and tankers for chemicals and food products.

The biological clean ability of stainless steel is superior to both aluminium and copper, and comparable to glass. Its clean ability, strength, and corrosion resistance have prompted the use of stainless steel.

## Properties

## Conductivity

Stainless steels are relatively poor conductors of electricity, with significantly lower electrical conductivities than copper. In particular, the non-electrical contact resistance (ECR) of stainless steel arises as a result of the dense protective oxide layer and limits its functionality in applications as electrical connectors. Copper alloys and nickel-coated connectors tend to exhibit lower ECR values, and are preferred materials for such applications. Nevertheless, stainless steel connectors are employed in situations where ECR poses a lower design criteria and corrosion resistance is required, for example in high temperatures and oxidizing environments.

## Hardness

Stainless steel is a highly durable metal known for its impressive hardness. This quality is primarily due to the presence of two key components: chromium and nickel. Chromium forms an oxide layer on the metal's surface, protecting it from corrosion and wear. Meanwhile, nickel contributes to the metal's strength and ductility, enhancing its overall hardness. Stainless steel can also be hardened through heat treatment processes such as annealing or quenching, further improving its hardness.

## Thermal conduction

The thermal conductivity of stainless steel depends on its composition and structure. Typically, stainless steel has a thermal conductivity ranging from 15 to 20 W/mK (watts per meter Kelvin). Due to this, it keeps more energy that stabilizes the surrounding temperature.

## Magnetism

Martensitic, duplex and ferritic stainless steels are magnetic, while austenitic stainless steel is usually non-magnetic. Ferritic steel owes its magnetism to its body-centered cubic crystal structure, in which iron atoms are arranged in cubes (with one iron atom at each corner) and an additional iron atom in the center. This central iron atom is responsible for ferritic steel's magnetic properties. Austenitic stainless steels, which are usually non-magnetic, can be made slightly magnetic through work hardening.

## Corrosion

The addition of nitrogen also improves resistance to pitting corrosion and increases mechanical strength. Thus, there are numerous grades of stainless steel with varying chromium and molybdenum contents to suit the environment the alloy must endure. Corrosion resistance can be increased further by the following means, increasing chromium content to more than 11%, adding nickel to at least 8%, adding molybdenum which also improves resistance to pitting corrosion.

## Wear

Galling, sometimes called cold welding, is a form of severe adhesive wear, which can occur when two metal surfaces are in relative motion to each other and under heavy pressure. Austenitic stainless steel fasteners are particularly susceptible to thread galling, though other alloys that self-generate a protective oxide surface film, such as aluminum and titanium, are also susceptible. Under high contact-force sliding, this oxide can be deformed, broken, and removed from parts of the component, exposing the bare reactive metal. When the two surfaces are of the same material, these exposed surfaces can easily fuse. Separation of the two surfaces can result in surface tearing and even complete seizure of metal components or fasteners. Galling can be mitigated by the use of dissimilar materials (bronze against stainless steel) or using different stainless steels (martensitic against austenitic). Additionally, threaded joints may be lubricated to provide a film between the two parts and prevent galling. Nitronic 60, made by selective alloying with manganese, silicon, and nitrogen, has demonstrated a reduced tendency to gall.

## Density

The density of stainless steel can be somewhere between 7,500kg/m3 to 8,000kg/m3 depending on the alloy.

## Rubber as the grip part

Rubber is a natural polymer of isoprene (polyisoprene), and an elastomer (a stretchy polymer). Polymers are simply chains of molecules that can be linked together. Rubber is one of the few naturally occurring polymers and prized for its high stretch ratio, resilience, and water-proof properties.

**Tensile strength;**

Tensile strength is the amount of force needed to tear apart a rubber specimen until it breaks. It is also known as ultimate tensile strength. The tensile strength is a key factor for designers and buyers as it signifies the point of failure resulting from the stretching of rubber.

**Hardness;**

The chemical structure of the elastomers provides them with an inherent hardness that can be altered. The modified hardness is then measured in terms of durometer (duro) on a Shore scale. Shore A is used for a soft to medium-hard rubber.

**Resilience;**

Resilience, also known as rebound, is the ability of rubber to return to its original size and shape following a temporary deformation, such as contact with a metal surface. Resilience is critical in dynamic seals that serve as a barrier between stationary and moving surfaces. It is necessary to take into account resilience for applications that require weather-stripping between a door frame and a door.

**Tear resistance;**

Tear resistance is the resistance of an elastomer to the development of a cut or nick when tension is applied. This property, also called tear strength.

**Abrasion resistance;**

Abrasion resistance is the resistance of rubber to abrasion by scraping or rubbing.

**Schematic diagram**

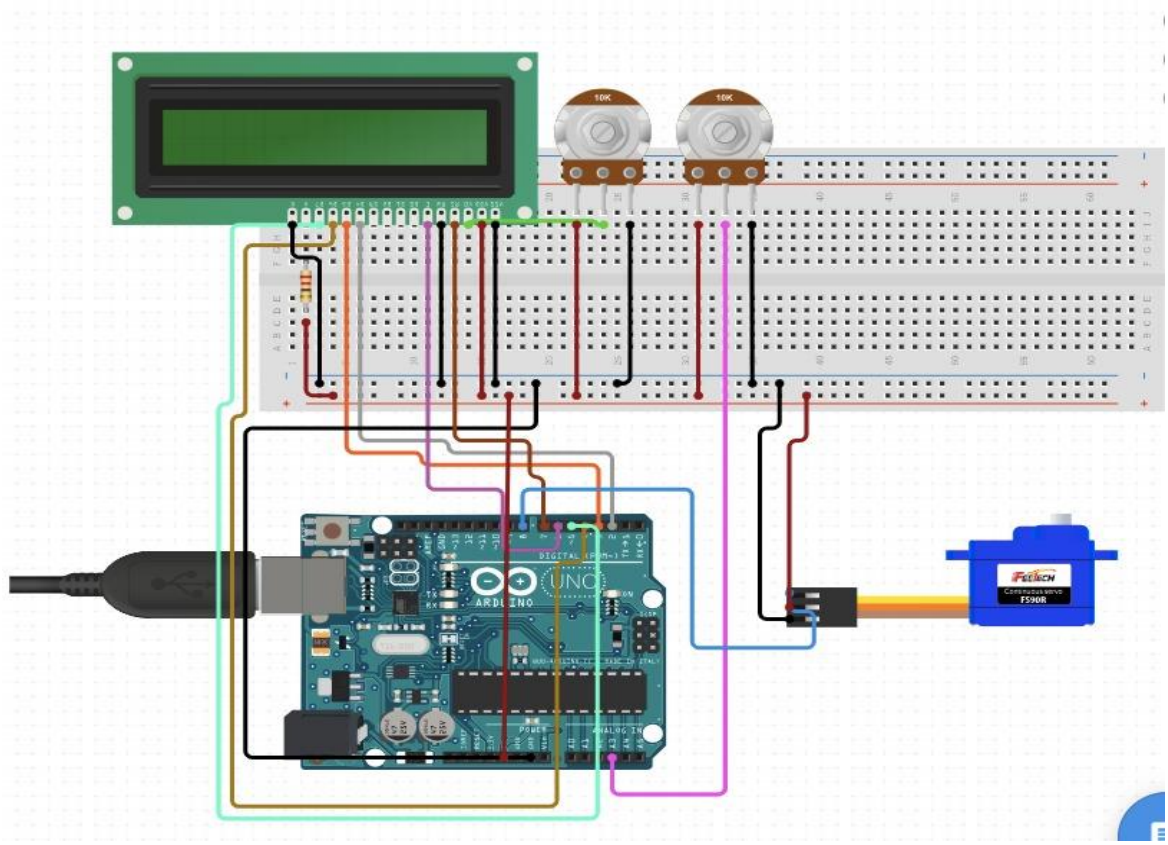


*Figure 9shows the schematic diagram of the prototype circuitry*

**Prototyping**

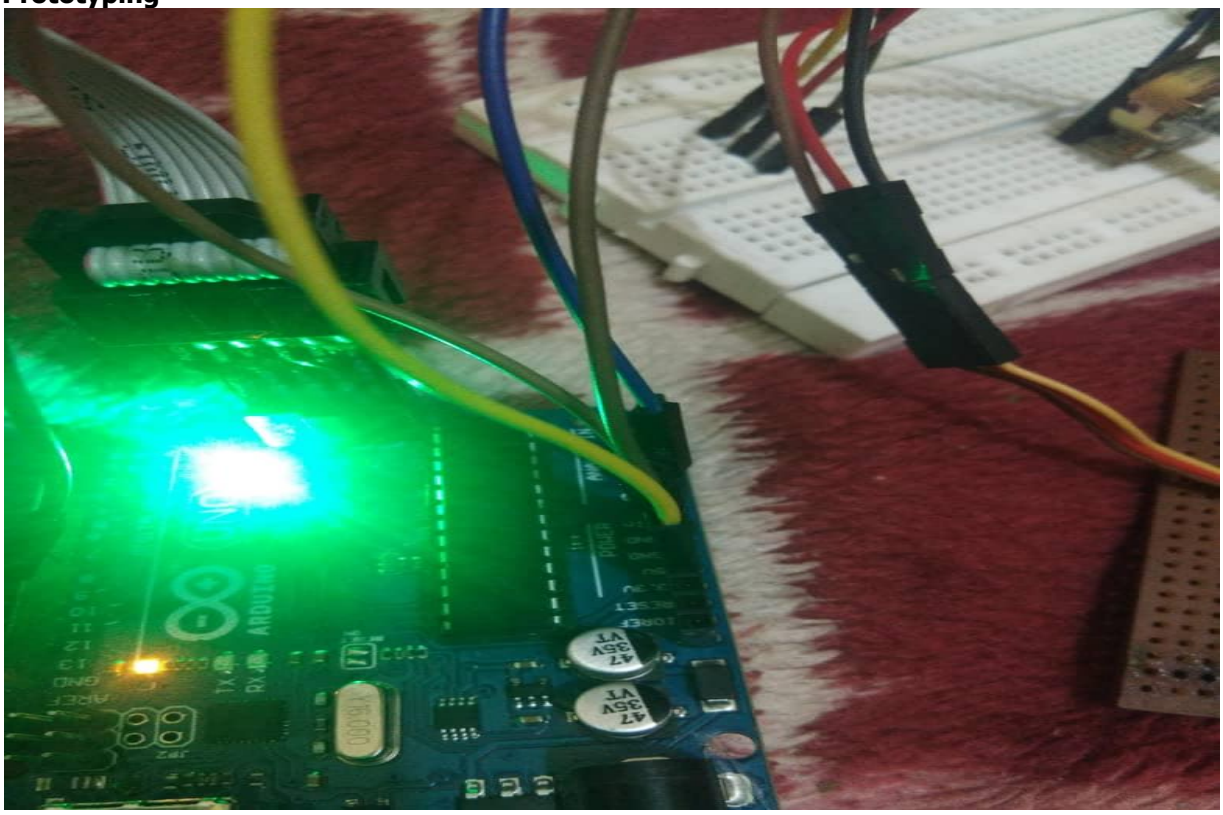


*Figure 10 is an image of the prototyping process*

**Prototyping image**

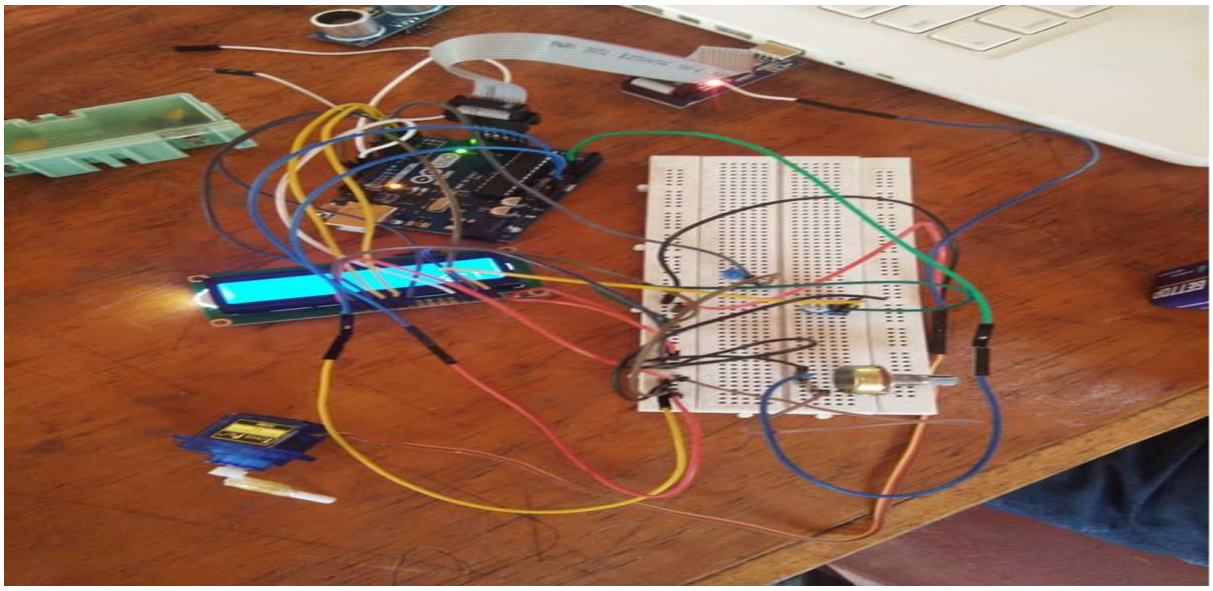


*Figure 11 prototyping image*

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**Finished Prototype**

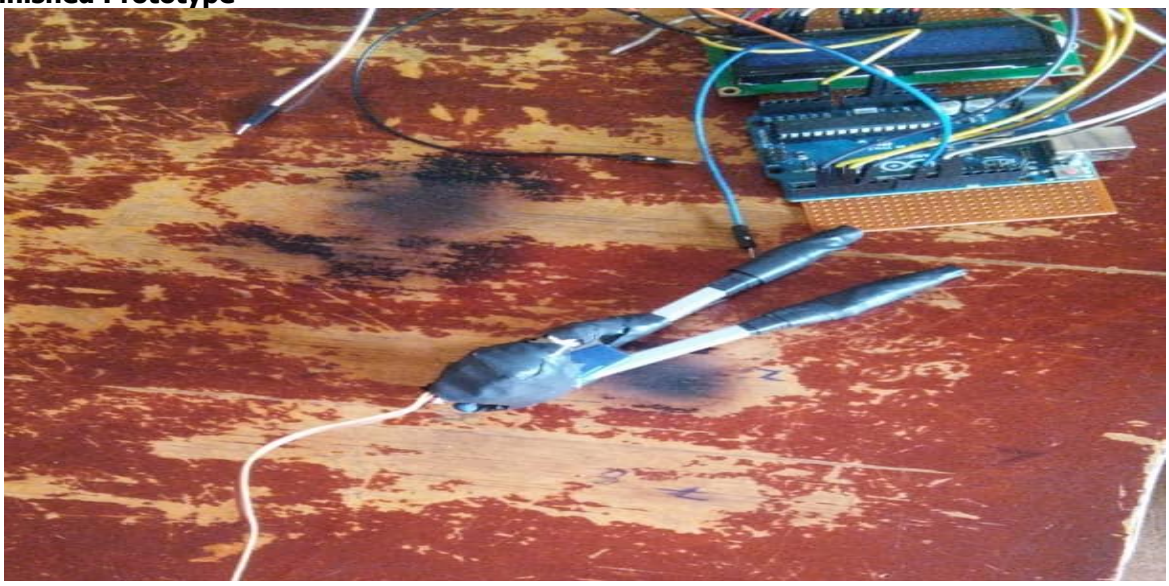

*Figure 12 shows the complete prototype*

## Prototype Testing

- Functionality test

We assessed how well the prototype achieves its intended purpose such as keeping and maintaining the mouth open for dental procedures. And the test was positive.

- Adjustability test

We checked if the prototype can be easily adjusted considering the various mouth sizes, shapes and patient ages while maintaining a secure fit as well has its integrity.

- Comfort test

We had a volunteer wear the prototype for an extended period of time and asked her to provide feedback on the comfort, pressure points and any discomforts experienced.

- Fit test

We measured the prototype's fit on various mouth sizes to ensure it accommodates a wide range of mouth sizes and various age brackets can make use of it.

- Durability test

We subjected the prototype to repeated opening and closing actions to gauge its durability and potential for wear and tear.

- Hygiene test

We subjected the prototype to this test to find out how easily it could be to clean, disinfect and maintain to ensure proper hygiene for reuse. And the best cleaning method is to use disinfectants because sterilization may have a negative impact on the rubber portion by weakening it.

- Breathing test

We assessed whether the prototype allows for normal breathing and any potential breathing obstructions. This is because the reason for this prototype is to improve healthcare services in the field of dentistry so not at any one point should affect or worsen a patient's health condition.

- Pressure test

We tried finding out whether the pressure applied by the prototype on the mouth and the surrounding areas falls within the limits to ensure safety of the patient.

## Precautions

## Safety precautions

Ensure to note that maximal mouth opening varies for each gender and age bracket. The dentist should ensure that they command the device properly to prevent conditions like Temporomandibular Joint dislocation (TMJ) and trismus.

Mouth opening is a clinical parameter, which we encounter routinely in our daily practice. Maximal mouth opening (MMO) has been defined as the maximal intercristal distance. A known normal range of mouth opening is necessary to enable the clinician conduct a thorough oral examination conveniently.

**Table showing the mean maximal mouth openings considering gender and age**

| CONSIDERATIONS | MEAN MMO |
|---|---|
| CHILDREN | Generally is 44mm |
| ➢ Male | 44.5mm |
| ➢ Female | 43.5mm |
| ADULTS | Generally is 52.0mm |
| ➢ Males | 54.18mm |
| ➢ Female | 49.62mm |

*Table 2 showing the MMO*

Ensure that the patients' teeth firmly grip onto the rubber portion to avoid slipping of the gag. Sliding off can cause accidents to both the patient and doctor for example that abrupt closure of the mouth may be followed by ingestion of foreign bodies that may be harmful.

## Care and maintenance

Always ensure that the pivot is firm to prevent collapsing of the gag during the procedure.

Ensure to disinfect the device every after or before use to avoid spreading germs from one patient to another.

Ensure to store the device in a cool dry place to eliminate risks of rusting.

Ensure the device well dried before storage if initially exposed to any liquid.

## Future prospects

The device opening by a motor will be controlled using a remote meaning there will be no need of attaching any wires.

The device will have electrodes to be attached to the patient's jaws to detect any strains and to alert the doctor about the maximal mouth opening of each patient.

The device shall have a lighting system to accompany the opening with light so as to achieve the best of visibility.

The device shall also be equipped with a small mirror to give a reflection of the hidden details in the mouth.

## Project Management

### Multi-disciplinary project team and responsibilities

| NAME | POSITION | RESPONSIBILITY |
|---|---|---|
| Eng. Nantongo Sumayah | Project supervisor | ➢ Supervision of all activities related to the project.<br>➢ She has also been providing guidance wherever needed. |
| Dr. Katende | Client | ➢ He is affected by the problem and was able to disclose to us the issue.<br>➢ He is willing to receive the solution as per the stated need. |
| Mr. Ewaru Emmanuel | Programmer | ➢ He helped in the selection of the components we would need to have a working prototype.<br>➢ He did all the programming work necessary to get the solution to the need working properly. |
| Acwe Tracy Aisling | Coordinator | ➢ She has been coordinating and ensuring all the activities aimed at producing a solution to the need move on smoothly and successfully.<br>➢ She has also ensured to get all the paper work required for the project together and ready.<br>➢ She has also taken part in financing the project. |
| Ssekamatte Frank | Coordinator | ➢ He has been ensuring that all the resources required for prototyping are gathered.<br>➢ He also effortlessly ensured that they are put together so as suitable solution would result.<br>➢ Also actively took part in financing the project. |

*Table 3 showing the project team and their responsibilities*

## Challenges faced

There was no one-stop shop from which we could purchase components that were used during the process of prototyping so we had to move multiple times, making it a tiresome process.

The challenges to the work like high transport costs in whenever we had to travel

We found it very hard to find microcontrollers like Arduino Uno and Arduino Nano plus the components to interface with Arduino were very expensive e.g. the 16x2 LCD.

We spent a lot in obtaining the different components of the circuitry. In this way, each member had to contribute from his or her own pockets so as to implement the project. However, the team was not able to obtain all the components thus the team did not fully get to complete the demands of the project.

It was hard to come up with the desired operation from the programming side.

## Conclusion

In many health care facilities it has been normalized that patients can keep and maintain their own mouth open during dental procedures yet there are so many problems associated with this because under normal circumstances, the muscles around the jaws and the jaws get fatigued due prolonged opening. The dental mouth gag is here to ease this work so that patients can have their dental treatments peacefully and comfortably.

## Acknowledgement

First and foremost, we would like to thank the Almighty for enabling us carry out this research project successfully. We would like to thank our lecturer **Omongo Emmanuel (BDE)** who has offered the guidance, advice and knowledge towards the compilation of this report and the overall progress of the design project. We would also like to thank **Sumayiyah Nantongo (DBE)** our supervisor who has helped and guided us right from the beginning.

We would also like to acknowledge the support of KSHS because this study would not be as qualitative as it is, without the conducive environment and resources availed to us.

To our families that supported us emotionally and financially to ensure that a device prototype was designed, we are eternally grateful, and above all, glory and honor remain to the almighty creator for the gift of life and health.

## List of Abbreviations

WHO: World Health Organization
CDC: Centers for Disease Control
UGX: Uganda Shillings
MMO: Maximal Mouth Opening
DMFT: Decayed, Missing due to carries and Filled Teeth

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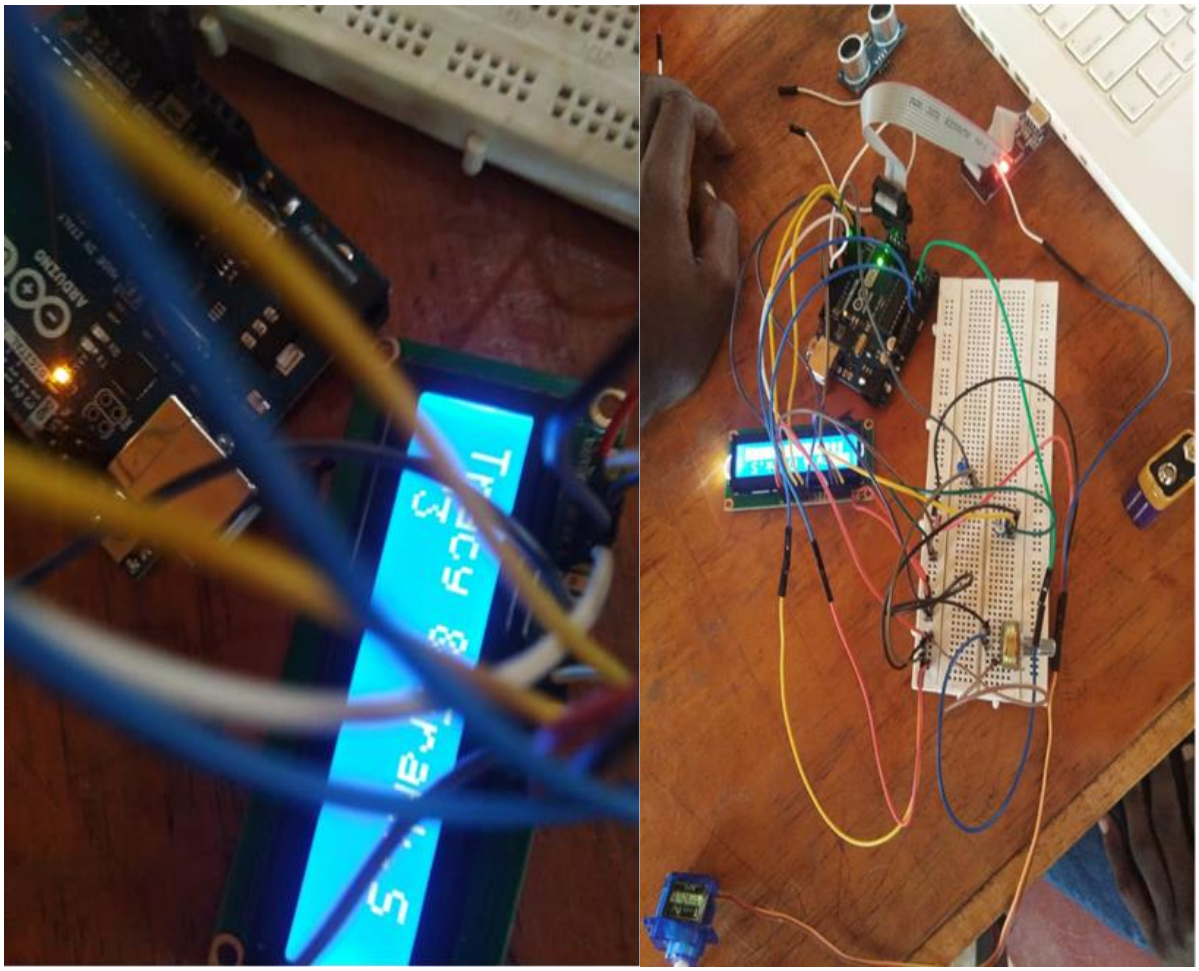
**APPENDIX**



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