Software Requirement Specification Document for Rejuvenate Face and Body Retouching Using Image Inpainting

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Table 1: Document version history

Version	Date	Reason for Change
1.0	17-Dec-2022	SRS First version's specifications are defined.
1.1	20-Dec-2022	Updated UML Diagram & Project Plan
1.2	5-Mar-2022	Updated SRS Version
1.3	1-May-2023	Updated SRS Version

GitHub: https://github.com/SamaRostom/Rejuvenate

Contents

Abstract

In today's environment, people are becoming increasingly interested in their appearance. However, they are afraid of their unknown appearance after a plastic surgery or treatment. Accidents, burns and genetic problems such as bowing of body parts of people have a negative impact on their mental health with their appearance and this makes them feel uncomfortable and underestimated. Our approach presents a revolutionary deep learning-based image inpainting method that analyses the various picture structures and corrects damaged images. In our model, we are aiming to propose the in-painting of medical images with Stable Diffusion Inpainting method. Image inpainting is the process of reconstructing missing and damaged areas of an image is a key progress facilitated by deep neural networks. The system uses the input of the user of an image to indicate a problem, the system will then modify the image and output the fixed image, facilitating for the patient to see the final result.

1 Introduction

1.1 Purpose of this document

The purpose of this document is to detailed documentation of Rejuvenate's development process. It will describe the functional requirements as well as the expected behavior in a given environment. This document will analyze all the tools and methods used in doing this project.

1.2 Scope of this document

This document's purpose is to explain the foundation of our project so that stakeholders and developers can both understand the solution we are offering. In addition, this document provides a full explanation of Rejuvenate's functional and non-functional requirements, design constraints, data design, and basic class diagram. The document mainly covers possible performance outcomes and presents a timeline for the application.

1.3 Business Context

Plastic surgeries is a trending topic nowadays [1]. Our method will give the patient to view the postoperative outcomes of the procedure before making a decision. As a result, a greater proportion of people will be open to having these procedures. Our technology, for instance, can assist patients who have severe problems with their faces or bodies in knowing what will happen or how they will appear post surgery.

2 Similar Systems

2.1 Academic

- This research paper [2] is talking about cleft lip is a congenital abnormality that needs to be surgically fixed by an expert. To do surgery, a surgeon needs have substantial training and theoretical understanding, and an artificial intelligence (AI) method has been proposed

to assist surgeons in enhancing surgical results. Surgeons may be able to utilise artificial intelligence (AI) as an auxiliary to modify their surgical method and achieve better results if it can be used to forecast how a cleft lip repair would appear. We suggest a deep learning-based picture in-painting technique that can cover a cleft lip and produce a lip and nose without a cleft in order to test the viability of this concept while maintaining patient privacy.

- In this paper [3], the technique of "image inpainting," or fixing outdated or damaged photos, has existed for some time, but just recently has it gained increasing popularity because to advances in image processing technology. Automatic picture inpainting has found significant applications in computer vision and developed into a significant and difficult area of research in image processing as a result of the advancement of technologies for image processing and the adaptability of digital image editing. This study examines the existing image inpainting techniques, which were divided into sequential-based, CNN-based, and GAN-based approaches. A list of techniques for various types of visual distortion is also provided for each category.

- In this paper[4], The inpainted image is achieved by imitating art restoration experts and extending the inpainting information along the isophote directions. It propagates the known information at the edge of the area to be inpainted as far as possible smoothly, so that the inpainted image is closer to human visual perception. The advantages of stable-diffusion high resolution image generation for densely conditioned tasks, lower cost to run training and inference, & better scaling.

2.2 Business Applications

- BurnMed Pro this app help burn patient receive correct treatment initially [5]. The developers' goal aimed to provide a thorough 50-minute initial burn management training using a mobile device. Documenting the burnt regions and determining the total body surface area (TBSA) impacted using the Rule of Nines or a Lund-Browder Chart are two of the initial procedures in burn care. In BurnMed, the burned areas are drawn onto a 3 dimensional anatomic figure. The Treatment Guidelines summarise the key steps in early management and provide links to more data on inhalation injuries, escharotomy, and dressings.

- APECS: Body Posture Evaluation this application assists people in determining the proper position of their body parts [6]. The user should enter some images with different positions and the application will give the user the current and ideal poses. It covers full height evaluations and specific tests of various regions as back, head, neck, legs and feet, so from this app we can detect bow leg and predict the right position for the leg.

3 System Description

3.1 Problem Statement

Our project addresses critical issues that many patients face. Patients have no idea how they will look after plastic surgery, and not all plastic surgeries are aimed to be for fun. There are many

serious surgeries are being done to cases with congenital conditions such as cleft lip problem. Some patients and their parents may panic if they do not know how they or their children will look after a surgery, so our system will help them overcome their apprehension. Furthermore, some doctors are unable to explain to their patients what will happen during the surgery, the outcome, and whether it will leave scars or not. Our system is willing to fix the issue by taking a picture of the patient's problem, regardless if it is a cleft lip and presenting the result before having the surgery.

4 System Overview

As shown in **Figure 1**, it depicts the project flow from obtaining the dataset to getting it suitable for use in the model. Firstly, system user should select the problem of the patient which is cleft lip. Secondly, entering the input image. Thirdly, the system moves through the preprocessing stage; which is converting the image to 'RGB' & resize the image to (512, 512) and make the image clear enough to prepare it to fit the model and be easy for the next stage. Fourthly, applying the mask generation. Then, applying the image in-painting approach. In our system we are willing to use stable-diffusion image inpainting [4] to get the best result which makes the output image as real as possible. Stable Diffusion generates data that looks similar to original data. Finally, the model presents the output, and clarifies the appearance of the patient post-surgery.

4.1 System Scope

The system aims to:

1. Surgeon shall select the patient's issue.
2. System shall take the pictures of patients to let the surgeon examine it.
3. In the pre-processing stage, images will be converted to 'RGB', then will be resized to (512, 512) pixels.
4. Surgeon shall decide the wanted part from the image to start working on it.
5. Images shall be edited to meet the requirements of the patient.
6. Patient shall preview his/her appearance before the plastic surgery and giving their comments on it.

4.2 System Context

As shown in **Figure 2**, they will be able to choose the problem the patient is suffering from. Next,the user will be able to upload an image of the problem they want to fix. If the system recognizes the problem from the entered image, the system will start applying the image inpainting approach to repair the issue.

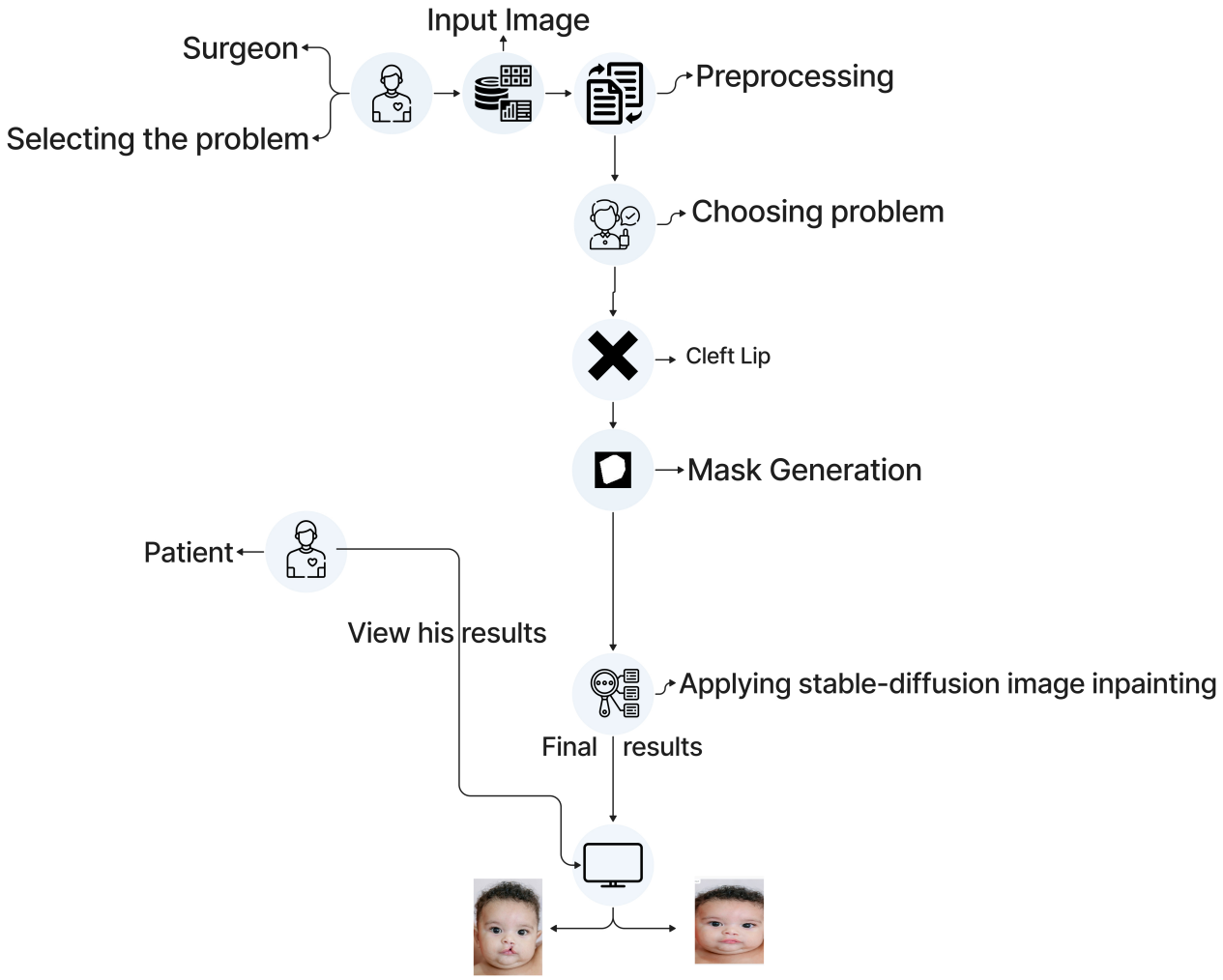

Figure 1: System Overview Diagram

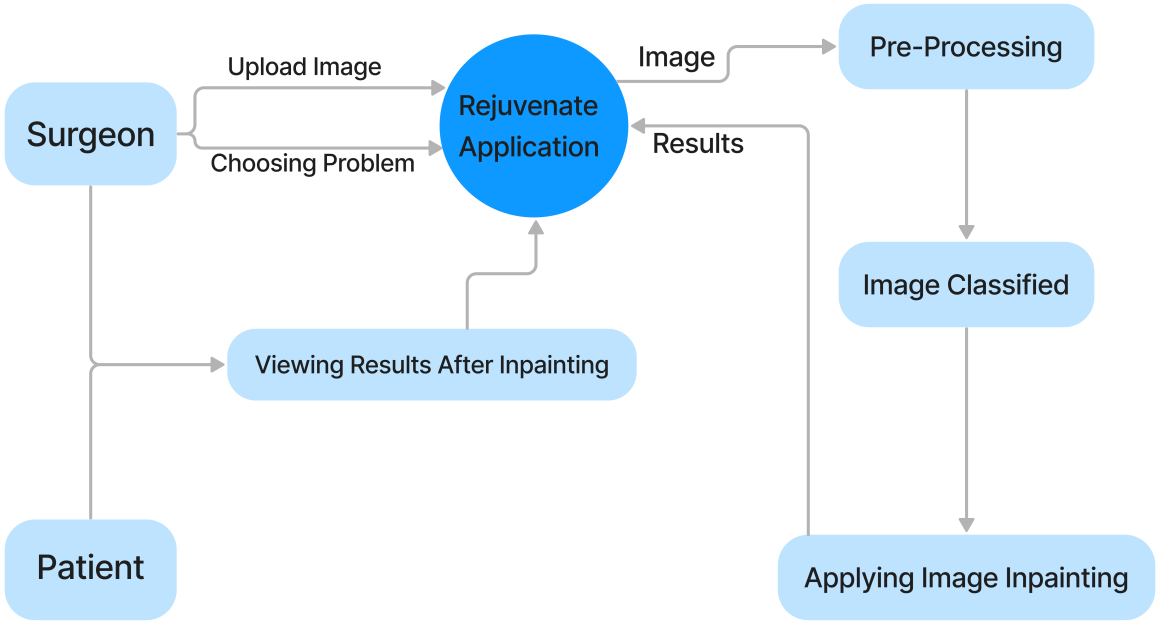

Figure 2: Context Diagram

4.3 Objectives

The main goals for Rejuvenate:

1. Improve trust between patients and surgeons.
2. Let patients see their appearance post-surgery.
3. If there more than one stage to reach the best result, it will be determined.

4.4 User Characteristics

- The user must be a plastic surgeon.
- The user can be of any age group.
- The user must have and know how to use a modern mobile phones or tablets.

5 Functional Requirements

5.1 System Functions

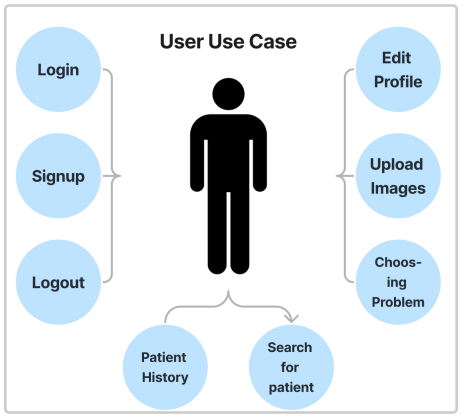

Figure 3: User Use Case Diagram

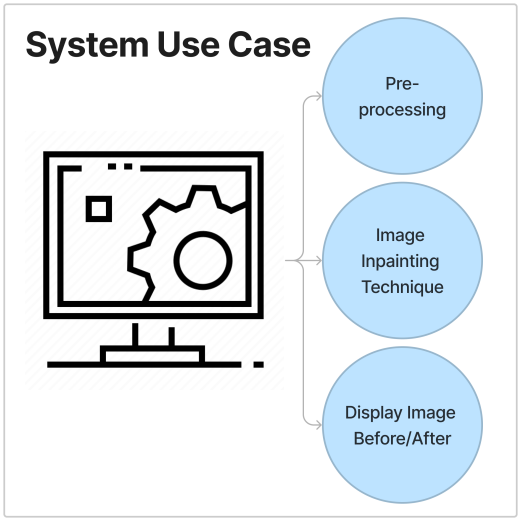

Figure 4: System Use Case Diagram

Table 2: Functional Requirements

FR01	Users shall be able to sign up with their emails and passwords.
FR02	User shall be able to login with their assigned email and password.
FR03	User shall be able to logout.
FR04	Surgeon shall select which problem the patient is suffering from.
FR05	Surgeon shall upload the input image with the problem.
FR06	The system shall be able to preform Advanced Deep learning Technique on the entered images by the user.
FR07	The system shall display the expected final result post-surgery.
FR08	Surgeon shall view all patients.
FR09	Patients and Surgeons shall view final results.

5.2 Detailed Functional Specification

Table 3: Pre-processing on image

Name	Pre-processing on image
Code	FR06
Priority	High
Critical	The user must enters the input image first and the system should catch any noise or unclear part in the image.
Description	Removing the noise from the image, cropping the required part from the original image and make the image clear enough.
Input	Input image with the chosen problem the patient is experiencing.
Output	A prepared image to fit the model and be ready for the next stage.
Pre-condition	The user should select one from the displayed issues and enters an image before the surgery.
Post-condition	The image after the pre-processing stage.
Dependency	None
Risk	Displaying an image that is not fully prepared, such as it may still contain noise.

Table 4: Applying In-painting Method

Name	Applying In-painting Method
Code	FR08
Priority	High
Critical	None
Description	Applying image inpainting approach using deep learning method called "Stable Diffusion" [4] to get best result with the best accuracy and makes the image looks as much as real.
Input	A clear and well prepared input image after relating it to which class during the classification stage.
Output	An image containing the final appearance of the patient post-surgery.
Pre-condition	Entering a clear image pre-processed.
Post-condition	Redirect the final result of the process.
Dependency	FR06 & FR07
Risk	It doesn't give the same expected result.

Table 5: Displaying the final result

Name	Displaying the final result
Code	FR09
Priority	High
Critical	None
Description	Displaying the patient's appearance before and after surgery.
Input	Image after applying image inpainting method.
Output	Displaying the patient's appearance before and after surgery.
Pre-condition	Apply image inpainting technique.
Post-condition	None
Dependency	FR08
Risk	It doesn't give the same expected result.

6 Design Constraints

6.1 Standards Compliance

The Rejuvenate mobile application runs on Android operating system.

7 Non-functional Requirements

7.1 Security

In the registration process, the password will be hashed to provide a high level of security and privacy.

7.2 Usability

The application will provide a user-friendly interface with a professional UX design.

7.3 Portability

The system shall be published on the play store. It can be accessed on any smartphone.

7.4 Availability

The system shall be available at all times, so that the user can use it at anytime.

8 Data Design

Medical datasets for Cleft Lip is not published anywhere on the internet due to the privacy of patients. However, we started collecting a dataset as a sample divided into train and test with a ratio of 70% (training) to 30% (testing). The data set is still being collected from different hospitals.

Before Data Augmentation

- **Cleft Lip:** 57 images.

After Data Augmentation

- **Cleft Lip:** 334 images.

9 Preliminary Object-Oriented Domain Analysis

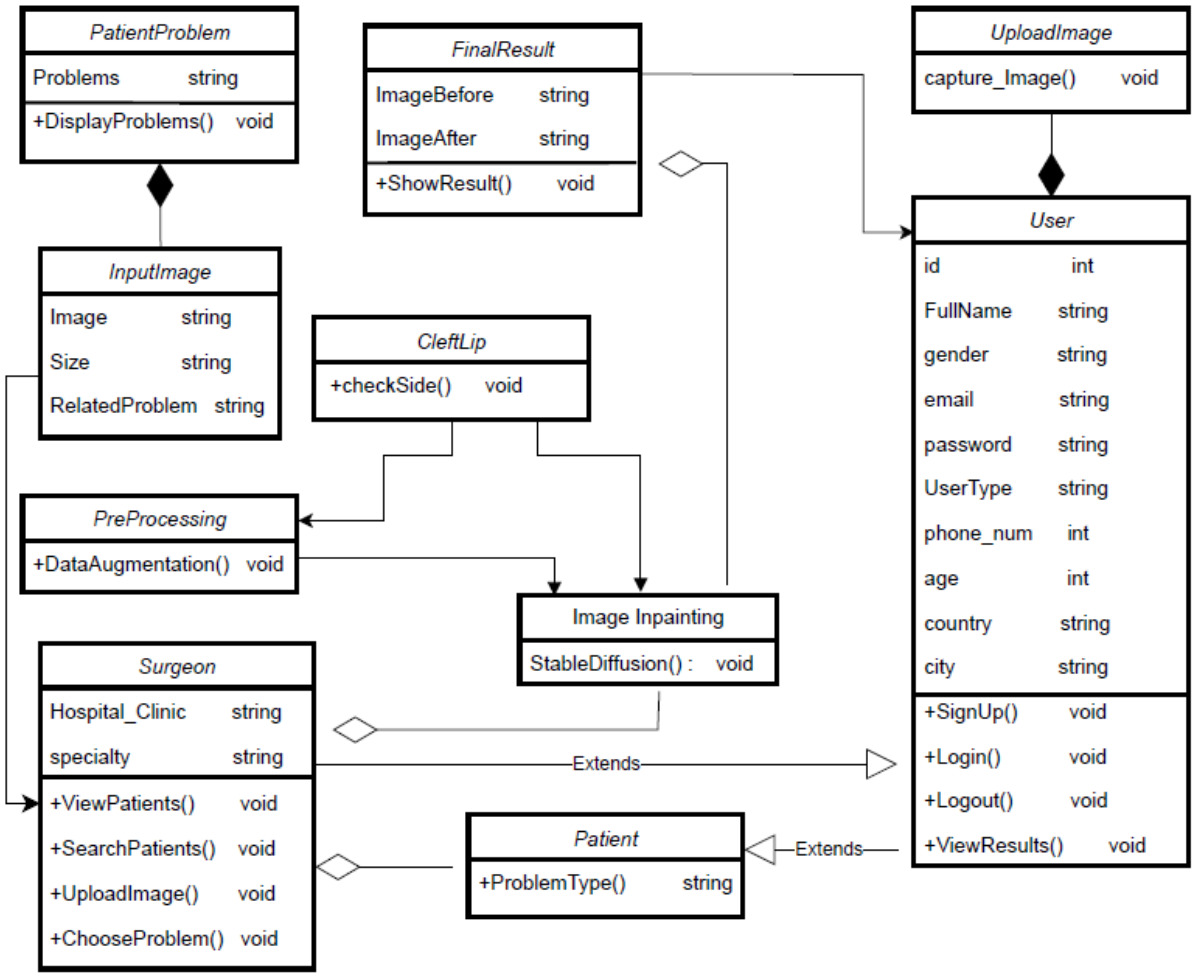

Figure 5: Class Diagram

10 Operational Scenarios

- **Scenario 1**
  The user will be able to sign up and type his data to log in successfully. He shall choose the problem that the patient is suffering from. Then, he enters the input image with the problem. After that, the system finishes the pre-processing stage to move to the following stage, then the system will be applying the image inpainting technique. Finally, it displays the final result (before and after the surgery).

- **Scenario 2**
  The user will be able to sign up and type his data to log in successfully. He shall choose the problem that the patient is suffering from. Then he enters the input image with the problem.

After that, the system finishes the pre-processing stage to move to the following stage, the model which stable-diffusion image inpainting.

- **Scenario 3**
  The system will check if there is any problem in the image to enhance it. If it caught an issue, then the pre-processing will be applied.

- **Scenario 4**
  The system will check if there is any problem in the image to enhance it. If there is no problem showed up, so the image will move to the next stages without passing through the pre-processing stage.

11 Project Plan

Team members will be assigned by their initials in the time plan:

- Sama Haitham (SH)
- Yara Mohamed (Y)
- Reem Abdulraouf (R)
- Salma Salah (SS)

Link Click Up: [7]

12 Appendices

12.1 Definitions, Acronyms, Abbreviations

Table 6: Appendices Table

Terms	**Stands For**
AI	Artificial Intelligence
GAN	Generative Adversarial Networks
SVM	Support Vector Machine
CNN	Convolutional Neural Network
PGGAN	Progressive Growing Generative Adversarial Networks
G-GAN	Global Generative Adversarial Networks
TBSA	Total Body Surface Area
APECS	AI Posture Evaluation & Correction System
BurnMed	Burn Medical Education

ID	Task	Start Date	End Date	Duration	Assigned To
ID01	Proposal Document	3/10/2022	20/10/2022	17 days	All
ID02	Proposal Presentation	15/10/2022	20/10/2022	5 days	R, SS
ID03	Research on SVM classifier	7/10/2022	20/10/2022	13 days	SH
ID04	Working on SRS document	30/11/2022	17/12/2022	18 days	All
ID05	Studying GAN code	25/11/2022	17/12/2022	23 days	SH, SS
ID06	Tracing inpainting code using GAN	15/11/2022	20/12/2022	5 days	SH, Y
ID07	SRS presentation	15/12/2022	20/12/2022	5 days	R, SS
ID08	Studying LAMA code	1/12/2022	17/12/2022	16 days	SH
ID09	Data Augmentation	1/12/2022	10/12/2022	10 days	SH
ID10	Collecting Dataset	15/11/2022	In Progress		All
ID11	Test & Validate	20/11/2022	15/12/2022	25 days	SH
ID12	SDD Document	6/2/2023	15/2/2023	11 days	All
ID13	Working on UI	30/1/2023	28/2/2023	30 days	All
ID14	SDD presentation	28/2/2023	3/3/2023	4 days	All
ID15	Testing Document	28/2/2023	3/3/2023	5 days	All
ID16	Studying stable diffusion code	25/2/2023	28/2/2023	4 days	All
ID17	Measurements	1/3/2023	3/3/2023	4 days	SS, SH
ID18	Mask generation	20/4/2023	1/5/2023	11 days	SH, SS
ID19	Integration python & flutter	10/4/2023	15/4/2023	5 days	SH
ID20	Updating UI	25/4/2023	2/5/2023	7 days	R, Y
ID21	Prototype Presentation	1/5/2023	2/5/2023	1 day	R

Figure 6: Project Plan

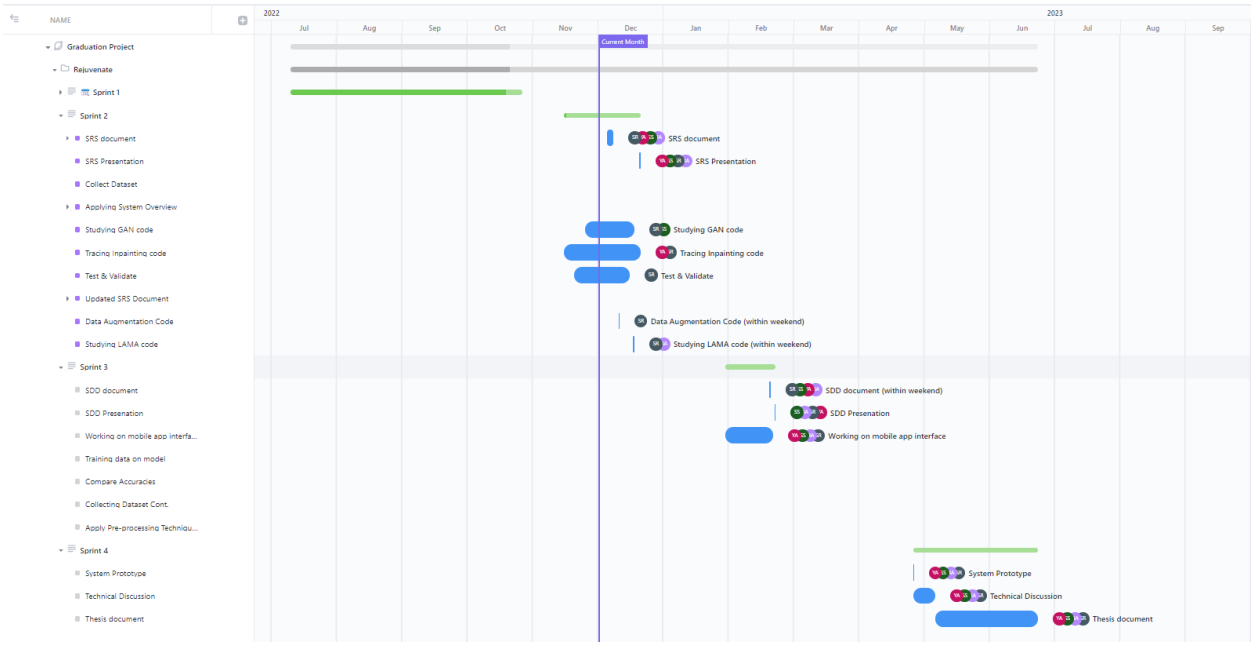

Figure 7: Project time plan

12.2 Supportive Documents

- **DELL Competition:** We have applied for the competition sponsored by DELL Technologies [8], "DELL Envision", as shown in **Figure 9**.

- **Survey:** We have made a survey to encourage our idea of developing the Rejuvenate mobile application. Here are some responses that have been gathered.

- **Dataset:** We have been to El Demerdash Hospital [9] for collecting our dataset for Cleftlip as shown in **Figure 8**.

Figure 8: Cleft Lip

Online Application	Action/Status	Submission Title	Feedback
Abstract Submission	Applied	Rejuvenate Face and Body Retouching Using Image Inpainting	

Figure 9: Dell Competition

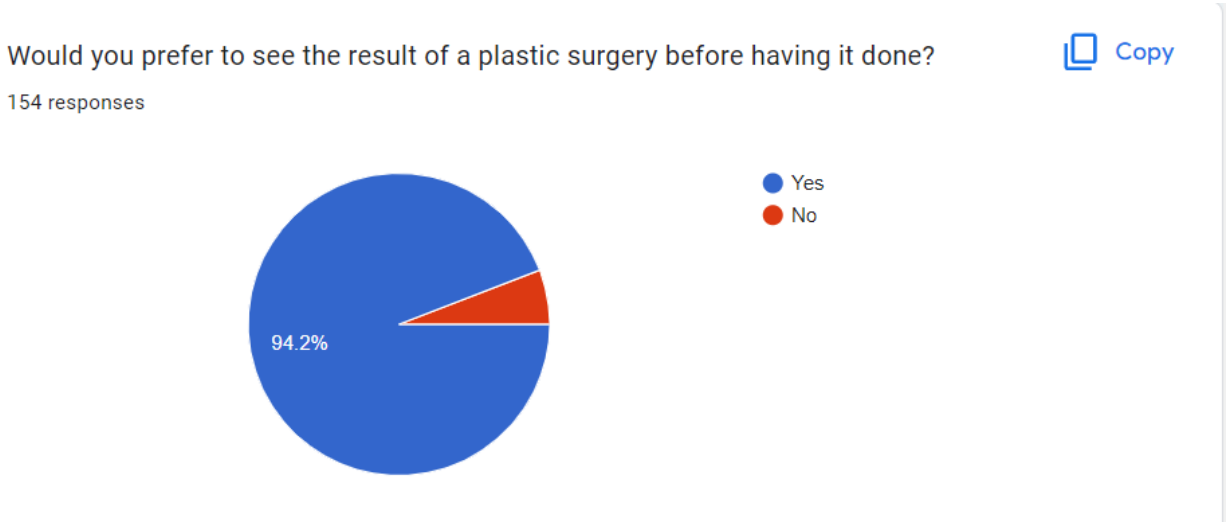

Figure 10: Statistics 1

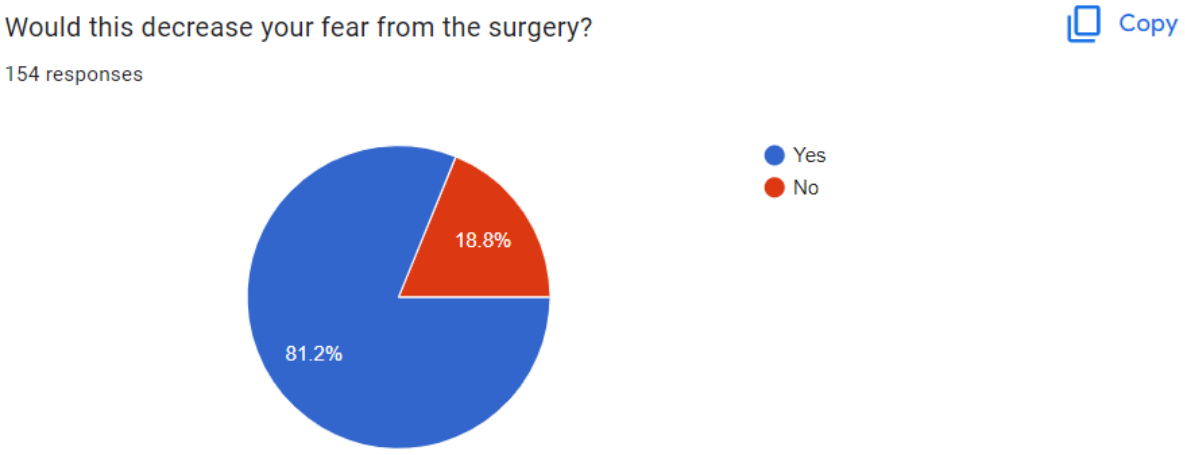

Figure 11: Statistics 2

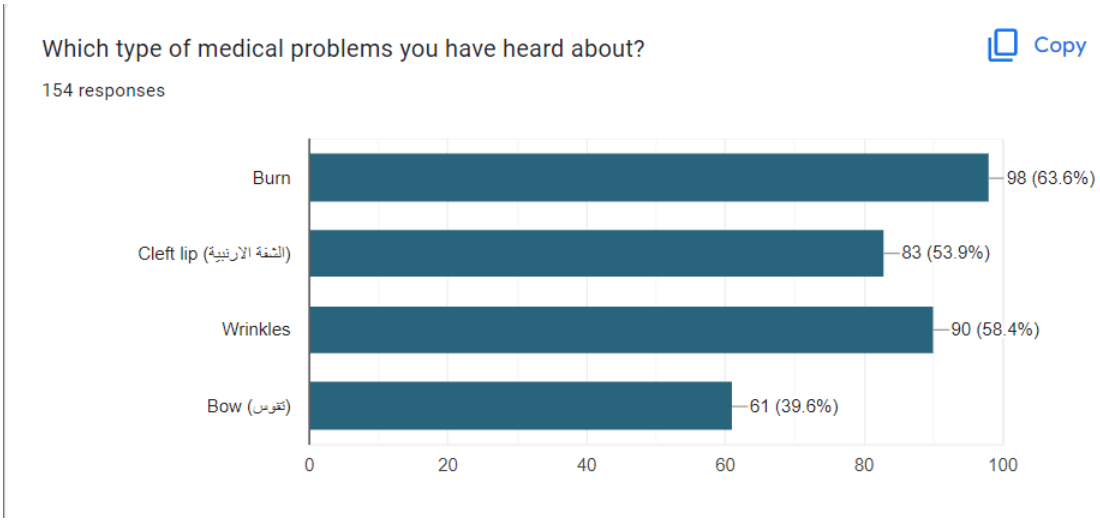

Figure 12: Statistics 3

References

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