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# **System Requirements Specification**

**for**

# **Digitized Rhinoplasty**

**Version 1.3 approved**

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## Revision History

Version	Name	Date	Reason for Changes
v1.0	P.C., M.C., J.C., M.K., A.O.	16 September 2021	Formatted template, added introduction
v1.1	P.C., M.C., J.C., M.K., A.O.	28 September 2021	Completed introduction, added references.
v1.2	P.C.,J.C., M.K, M.C, A.O.	26 October 2021	Added document conventions, added overall description, reformatted document
v1.3	P.C.,J.C., M.K,M.C,A.O.	30 November 2021	Refined system requirements, Modified system descriptions

# **1.Introduction**

## **1.1. Purpose**

The software requirements specification for Digitized Rhinoplasty v1.3 covers the general system requirements, scope of the project, and intended use for all applicable audiences.

## **1.2. Document Conventions**

We did not use any document conventions while writing this System Requirements Specification.

## **1.3. Intended Audience and Reading Suggestions**

This document is intended for developers, users, testers, customers, and product owners alike to provide insight into the specifications and scope of the project. The suggested sequence for reading the document is beginning with the overall description and overview sections then proceeding through the sections that are most pertinent to the user.

## **1.4. Product Scope**

The product being designed is software that will have the capability to take in the 3-D input of a client's face and add that to a database. It will then use an algorithm that will give the client a desired amount of options for potential modifications that can be made to their face. This will be done by setting anchor points on the clients face that can move these specified areas around to generate several looks. When the client chooses an option, the selection will be sent to Blender. Blender will then output a 3-D image of the new face completely and compare both the old and new versions. If the client likes and confirms their decision, the relevant data that Rhinoplasty Surgeons would need will be output for their use so they can make the exact changes necessary.

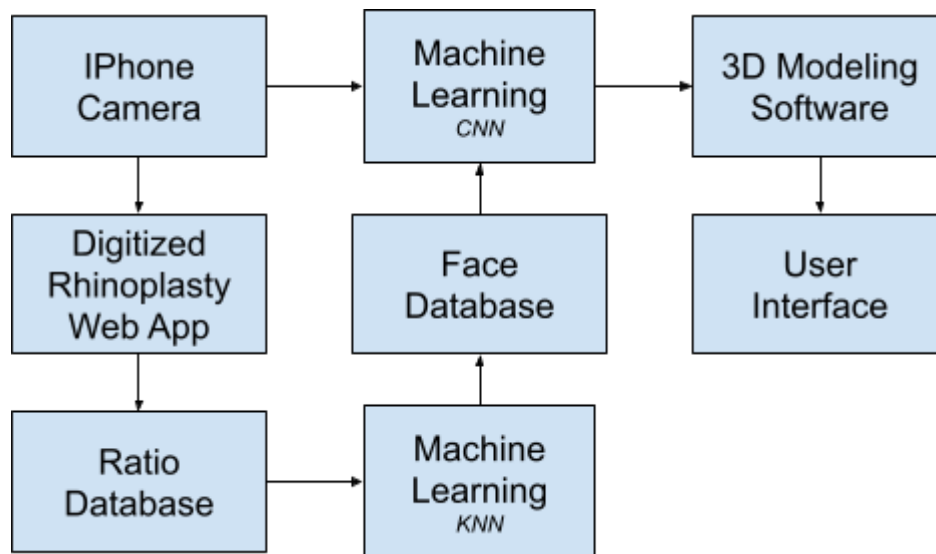
## **1.5. References**

- I. "Digitized Rhinoplasty." *Digitalization of Rhinoplasty Research*, <https://digitized-rhinoplasty.com/>.
  - A. This is a web application intended to digitize the rhinoplasty by novel methodologies for pre-surgery planning, intraoperative guidance, and post-surgery evaluations.

## 2.Overall Description

### 2.1. Product Perspective

Digitized Rhinoplasty is a system designed to aid surgeons and patients who are about to undergo rhinoplasty surgery. It is an update to the previously developed Nova Initia system, which presented similar functionality in allowing users to preview desired facial surgeries. This system requires some hardware and multiple pieces of software in order to function, which is modeled below. The iPhone camera is initially utilized to scan the user's face, which is then uploaded into the Digitized Rhinoplasty website. A JSON file is then uploaded into the database. Then, through the use of the selected machine learning models, the user is presented with different selections and options in potential facial modifications. The machine learning models implemented in this system include, but are not limited to, the convolutional neural network (CNN) model and K-Nearest Neighbors (KNN) model.



### 2.2. Product Functions

- 2.2.1. Interpret 3D scan of a user's face.
- 2.2.2. Compare the 3D scan of a user's face to a database of other 3D Face Scans.
- 2.2.3. Use machine learning to choose similar faces and suggest changes to the nose.
- 2.2.4. Allow a user to open and edit a 3D model of a face in Blender.
- 2.2.5. Export new nose mesh.

### 2.3. User Classes and Characteristics

- Surgeon
  - Requires full access to the database, with the ability to read from and add to the data.
  - Requires Python and Blender to be installed on their machine.

- Requires access to the digitized rhinoplasty web application.
  - Requires access to Bellus3D iPhone application.
  - Should be able to view a patient's face in Blender.
  - Should be able to make changes to the user's nose in Blender.
  - Should be able to export the patient's altered face/nose.
- Patient
  - Requires access to Bellus3D iPhone application.
  - Requires access to Digitized Rhinoplasty website
  - Should be able to view similar faces.
  - Should be able to choose face(s) with similar noses.
  - Should be able to view the changes to their face before the operation.

## **2.4. Operating Environment**

The software should operate on a computer running Windows 10 or later, or Mac OS 10.15.6 or later. This computer should have Python version 3.6 and Blender version 2.90 installed and should have access to the internet as well to ensure proper functionality.

## **2.5. Design and Implementation Constraints**

- The hardware must have Windows, Mac OS, or Linux OS installed.
- The hardware must have Python version 3.0 or later installed.
- The hardware must have Blender version 2.90 or later installed.
- The hardware must be connected to a network with internet access.
- The hardware must have access to the database of patients.
- The software must have access to Digitized Rhinoplasty website
- The software and documentation is only available in english.
- The software will require maintenance in order to work on each different machine (i.e. the file locations will need to be changed).
- The Bellus3D will be no longer available as of December 2022

## **2.6. User Documentation**

Documentation for the software is available on GitHub under the Deliverables folder and can be viewed here: <https://github.com/jcurtis664/FacialAnalyzer/tree/main/Deliverables>.

## **2.7. Assumptions and Dependencies**

- 2.7.1. The software will run on Windows 10.0 and Mac OS 10.15.6 or later operating systems.
- 2.7.2. The surgeon will access the program as a local software.
- 2.7.3. User must have Blender 2.90 or later installed on their system
- 2.7.4. User must have iPhone to scan face

2.7.5. The openpyxl module is installed to Blender's python module directory (C:\Program Files\Blender Foundation\Blender 2.90\2.90\scripts\modules). If openpyxl is not installed there is a tutorial on the github called "Installing openpyxl to Blender"

2.7.6. User must use Digitized Rhinoplasty website to obtain JSON file

## **3.External Interface Requirements**

### **3.1. Physical Environment Requirements**

- 3.1.1. The system shall only be installed in a plastic surgery clinic
- 3.1.2. The user shall have version 3.6 of Python installed
- 3.1.3. The user shall have version 3.0.9 of openpyxl installed in their Python site-packages
- 3.1.4. The user shall have at least 2.90.1 version of Blender installed
- 3.1.5. The user shall have version 3.0.9 of openpyxl installed in their Blender modules

### **3.2. Interface Requirements**

- 3.2.1. The system shall display a login screen
- 3.2.2. The system shall display a home screen
- 3.2.3. The system shall display a preview a 3D face with facial points
- 3.2.4. The system shall allow input of new patient data
- 3.2.5. The system shall output new user data to database
- 3.2.6. The system shall execute Blender for manual face manipulation
- 3.2.7. The system shall execute the KNN algorithm to build database of face images
- 3.2.8. The system shall execute the CNN algorithm when prompted by the user
- 3.2.9. The system shall allow the user to input images
- 3.2.10. The system shall output the patient "before image" to Blender

### **3.3. Functional Requirements**

- 3.3.1. The system shall create a 3D image of the new nose on the patient's scanned face.
- 3.3.2. The system shall display the 3D image of the patient's face with a new nose.
- 3.3.3. The surgeon shall mark points on the patient's face upon upload using the rhinoplasty web application.
- 3.3.4. The system shall use the KNN algorithm to group the most similar faces
- 3.3.5. The system shall display k options for the patient to choose from.
- 3.3.6. The system shall generate more suggestions based on the patient's request.
- 3.3.7. The system shall send the patient's choice to Blender.
- 3.3.8. The system shall create the patient's new face in Blender.

### **3.4. Documentation Requirements**

- 3.4.1. The documentation will be online through the application's GitHub.
- 3.4.2. The intended audience shall be surgeons and patients.
- 3.4.3. Physicians shall have previous background in surgical procedures.
- 3.4.4. The patient shall receive the same feedback as the doctor as well as a blended image of their expected output.

## **4.System Features**

Section 4 details a more specific list as put forward in section 2.2.

Services of the product: Output similar faces using CNN, render 3D model of user face, output the new model after changes have been made to the nose.

### **4.1. Output similar faces using CNN**

#### **4.1.1. Description and Priority**

A user should provide a 2D JPEG of their 3D face, which will be used as the input for a convolutional neural network (CNN). The output of the CNN algorithm will provide the user with a grouping of faces that look similar to their own. This feature is of high priority to the functionality of the system.

#### **4.1.2. Stimulus/Response Sequences**

First the user will utilize the Bellus3D iPhone application to generate a 3D scan of the face to generate an obj file, a jpg file, and an mtl file, which should be saved in a folder with the naming convention "<Patient Name>" in the database's Scaninfo folder. These files should then be uploaded to the digitized rhinoplasty web application (<https://digitized-rhinoplasty.com>) to generate a 3D model of the face, where the doctor will choose the 50 significant landmarks. Once the landmarks are selected, the user should export the JSON file and save it in the database's JSON folder with the naming convention "<Patient Name>.JSON". The user should then utilize the python file "read\_in.py" found on the GitHub page (<https://github.com/jcurtis664/FacialAnalyzer>) to upload the patient's data into the database, then again to set the current patient. Next, the user should run the python file "match\_faces\_cnn.py" to be presented with a grouping of faces similar to their own.

#### **4.1.3. Functional Requirements**

- REQ-1: The user must have an Apple device
- REQ-2: The user must download the Bellus3D software to the Apple device
- REQ-3: The user must also have a computer with Windows, Mac OS, or Linux
- REQ-4: The computer must have access to the internet
- REQ-5: The computer must have python installed



## **4.2. Render 3D Face of Patient**

### **4.2.1. Description and Priority**

A user should provide a 3D obj file, a jpg file, and an mtl file of their face, as well as a JSON file of the 50 significant landmarks, which will be loaded into Blender to display a model of the patient's face. This feature is of high priority to the functionality of the system.

### **4.2.2. Stimulus/Response Sequences**

First the user will utilize the Bellus3D iPhone application to generate a 3D scan of the face to generate an obj file, a jpg file, and an mtl file, which should be saved in a folder with the naming convention "<Patient Name>" in the database's Scaninfo folder. These files should then be uploaded to the digitized rhinoplasty web application (<https://digitized-rhinoplasty.com>) to generate a 3D model of the face, where the doctor will choose the 50 significant landmarks. Once the landmarks are selected, the user should export the JSON file and save it in the database's JSON folder with the naming convention "<Patient Name>.JSON". The Blender file 'NovaInitia2.blend' should then be opened and the script 'NovaInitiav2' should be run, which will prompt the user to choose four files (dataPointsFile\_path, newDataPointsFile\_path, faceObjectFile\_path, and meshFile\_path)

### **4.2.3. Functional Requirements**

REQ-1: The user must have an Apple device

REQ-2: The user must download the Bellus3D software to the Apple device

REQ-3: The user must also have a computer with Windows, Mac OS, or Linux

REQ-4: The computer must have access to the internet

REQ-5: The computer must have Blender installed

REQ-6: The user must install openpyxl into the Blender modules folder

## **5. Other Nonfunctional Requirements**

### **5.1. Performance Requirements**

Section 5 details the current known requirements and regulations associated with this product of the Initial Release, Version 1.3.

### **5.2. Safety Requirements**

There are no safety requirements for this system.

### **5.3. Security Requirements**

- 5.3.1. The system shall only allow access to authorized users.
- 5.3.2. The system shall save patient data in a secure database.
- 5.3.3. The system shall isolate patient data from each individual patient file
- 5.3.4. The system shall backup every time new patient data is uploaded.

### **5.4. Software Quality Attributes**

There are no additional software quality attributes for the product. They were listed above in section 3.

### **5.5. Business Rules**

- 5.5.1. Business Requirements
  - 5.5.1.1 The system shall only accept a certified surgeon that specializes in rhinoplasty as a user.
  - 5.5.1.2 The patient shall be over the age of 18.
  - 5.5.1.3 The patient shall have the consent of a parent or guardian if under the age of 18.

## **6. Other Requirements**

- 6.1 A patient should sign a document to allow the use of their face in the database.

## **Appendix A: Glossary**

KNN - K-Nearest Neighbor, machine learning algorithm used to find points for 3D modeling software

CNN - Convolutional Neural Network, machine learning algorithm used to find similarity between jpg files of patients

JPEG - Joint Photographic Experts Group, taken from Bellus3D and uploaded to Digitized Rhinoplasty website