System Design Document

For

Nova Initia

CS 491/SE 451

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Sarai Toloza

Jacob Gattuso

Hailey DeNys

Yara AlRashidi

Emily Nunez

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TABLE OF CONTENT

SYSTEM DESIGN DOCUMENT

Overview

The System Design Document describes the system requirements, operating environment, system and subsystem architecture, files and database design, input formats, output layouts, human-machine interfaces, detailed design, processing logic, and external interfaces for Nova Initia.

1 INTRODUCTION

1.1 Purpose and Scope

The System Design Document describes the system requirements, operating environment, system and subsystem architecture, files and database design, input formats, output layouts, human-machine interfaces, detailed design, KNN algorithm, and external interfaces for Nova Initia.

1.2 Project Executive Summary

This section describes the Nova Initia system from a management perspective and an overview of the framework within which the conceptual system design was prepared.

1.2.1 System Overview

The goal for the Nova Initia system is to provide a patient with three nose options given by the k nearest neighbors (KNN) algorithm. The three images that the algorithm outputs are the three closest people that have similar facial structure as the patient and the patient will choose a nose that they like the most. The patient will be able to see a 3D image of their face with their current nose, and then after their measurements go through the algorithm, they will be able to see a 3D image of the new nose on their face with the help of the Blender application. Plus, the system also aids the surgeon in giving them average accuracy during the procedure into giving the patient their new beginning.

The following diagram (Figure 1) gives an overview of the data flow of the system:

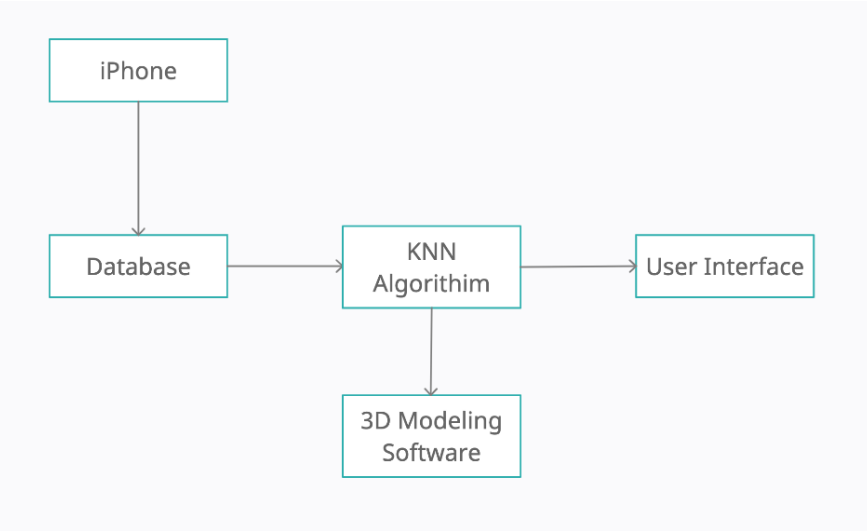

Figure 1: Overview of the data flow of the entire system

1.2.2 Design Constraints

There are regulatory constraints that the system must conform to. Meaning it will need certifications in order to be used in a medical clinic. The system will require a certificate from the FDA; because the system promises a medical-grade result to the patient, it needs to be approved by the FDA for surgeons to upload the design into their clinics. Being FDA approved will mean that this surgical "equipment" is reliable and compliant. We also need a patient's permission to scan their faces to improve our database of faces.

There is a hardware assumption that we make which is that the surgeon has an iPhone of any kind in order to download the scanning application.

1.3 Document Organization

This document is designed to give the reader the idea of the system design of Nova Initia. The following sections will provide information on the system's external and user interfaces, the system's architecture, software designs, and its integrity.

1.4 Glossary

FDA - Food and Drug Association

KNN- K Nearest Neighbors

2 SYSTEM ARCHITECTURE

2.1 System Software Architecture

2.1.1 User Interface

- The user interface will consist of a login page and main page to navigate various enhancements to the app. This will be written in HTML, CSS and Javascript.
- This interface will use React API to implement microservices that will be used to display files from blender.
- The landing page will have a navigation bar, a container for the 3D model, and a form for the user to input patient information and upload a scanned image to the application
- Upon uploading a 3D scan for the new patient, the user will be prompted to execute the algorithm and a 3D model from Blender will appear in the left container.
- The interface will include a calendar for scheduling rhinoplasty procedures, as well as an archive of previous patients with their before and after results.
- The interface will be accessible through a webpage in order to be implemented into the original rhinoplasty application created by the customer.

2.1.2 Database

- The iPhone is used to download Bellus3D, the scanning application, from the App Store.
- The application is then used to scan the patients' and volunteers' faces to create a database. The scan is then sent as an object file to the Digitized Rhinoplasty web application.
- The Digitized Rhinoplasty Application is used to plot the needed points on the patients'/volunteers' faces. After positioning the specified points on the nose the JSON files are exported from the application.
- The JSON files are read by read_in.py using Pandas, after the code is run the user is prompted to enter the file name on the console. After entering the file name of the desired file, the program creates data frames and generates a .CSV file of the final data frame into the same directory where the file is being run from. The naming convention used will be "FirstNameLastInitial_df.csv".

3 HUMAN-MACHINE INTERFACE

3.1 Inputs

- Each volunteer, with assistance from a Nova Initia team member, will input their face scan into the Bellus3D application.
- The input to the Digitized Rhinoplasty application is the scanned image as an object.

- The system operator will input the patient's name, ID number, and a 3D scan of the patient's face as a JSON file.
- The Blender application takes in old and new points into Blender via .XLSX file as well as the patients 3D .OBJ file

3.2 Outputs

- The Machine Learning Algorithm will update the SQL database with the changed points of the patient's nose
- The system will then pull the .JSON files from SQL and convert them to .XLSX files so that Blender may interact with it.
- The system shall allow Blender to output the new nose .OBJ file when it finishes executing the script in Blender
- The measurements of change in nose shape are output to an XML file for the surgeon and can be displayed in the UI

4 DETAILED DESIGN

4.1 Hardware Detailed Design

The only hardware component needed for Nova Initia is an iPhone with iOS 11.0.1 or above. The Bellus3D application will only work with the stated phones to ensure the scan is high definition. Reference Figure 1 in order to see how the scanning application is connected to the Nova Initia system.

4.2 Software Detailed Design

- ernal systems, security requirements, etc.; explain any algorithms used by the module in detail
- For COTS packages, specify any call routines or bridging programs to integrate the package with the system and/or other COTS packages (for example, Dynamic Link Libraries)
- Data elements, record structures, and file structures associated with module input and output

- Graphical representation of the module processing, logic, flow of control, and algorithms, using an accepted diagramming approach (for example, structure charts, action diagrams, flowcharts, etc.)
- Data entry and data output graphics; define or reference associated data elements; if the project is large and complex or if the detailed module designs will be incorporated into a separate document, then it may be appropriate to repeat the screen information in this section
- Report layout

4.3 Internal Communications Detailed Design

If the system includes more than one component there may be a requirement for internal communications to exchange information, provide commands, or support input/output functions. This section should provide enough detailed information about the communication requirements to correctly build and/or procure the communications components for the system. Include the following information in the detailed designs (as appropriate):

- The number of servers and clients to be included on each area network
- Specifications for bus timing requirements and bus control
- Format(s) for data being exchanged between components
- Graphical representation of the connectivity between components, showing the direction of data flow (if applicable), and approximate distances between components; information should provide enough detail to support the procurement of hardware to complete the installation at a given location
- LAN topology

5 EXTERNAL INTERFACES

This section will examine the external systems that will interact with the Nova Initia system

5.1 Interface Architecture

The external system used by the Nova Initia system is an SQL server. The system communicates with the SQL server to create its database of faces. Users are able to access the face database through queries. The user will be able to execute the machine learning algorithm, compare before and after 3D models of the patient's face, and display measurements for the surgery.

5.2 Interface Detailed Design

For each system that provides information exchange with the system under development, there is a requirement for rules governing the interface. This section should provide enough detailed information about the interface requirements to

correctly format, transmit, and/or receive data across the interface. Include the following information in the detailed design for each interface (as appropriate):

- The data format requirements; if there is a need to reformat data before they are transmitted or after incoming data is received, tools and/or methods for the reformat process should be defined
- Specifications for hand-shaking protocols between the two systems; include the content and format of the information to be included in the hand-shake messages, the timing for exchanging these messages, and the steps to be taken when errors are identified
- Format(s) for error reports exchanged between the systems; should address the disposition of error reports; for example, retained in a file, sent to a printer, flag/alarm sent to the operator, etc.
- Graphical representation of the connectivity between systems, showing the direction of data flow
- Query and response descriptions

If a formal Interface Control Document (ICD) exists for a given interface, the information can be copied, or the ICD can be referenced in this section.

6 SYSTEM INTEGRITY CONTROLS

The integrity controls for this application are designed to manage the integrity of the data. The Nova Initia system will have access to the patients facial point data. The system will be allowed to save the data after the measurements have been calculated by the surgeon. Only the users with admin rights will be able to interact with the system and have access to all the data and be authorized to make modifications to the data.

To Ensure that the system is safe from common threats of modern information systems the following levels of control will be implemented:

- Input controls ensure accuracy of data entered into the application. This is implemented within the Nova Initia system or the database schema, or both, by assigning input control types, such as value limit controls, completeness controls, data validation controls, and field combination controls.

- Internal security or access controls to restrict access of sensitive data to only the surgeon.

- Ability to identify all audit information by user identification, network terminal identification, date, time, and data accessed or changed.

- Output controls are concerned with the output of the data calculated after the patient picks a nose. the output controls will appear on the display GUI.