



Bilkent University

Department of Computer Engineering

# CS 491 Senior Design Project

Analysis Report

## *Sum of Sounds*

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# 1. Introduction

Nowadays speech synthesis technologies are very popular. They are mostly used for translating text information into audio information and in applications that use voice-enabled services and mobile applications. Apart from this, speech synthesis is also used in assistive technology for helping vision-impaired individuals in reading text content [1].

There are people with visual impairments who do research in mathematics or physics and need to read scientific articles and books that cannot be read using text-to-speech applications. One of them is Vitaliy Vertogradov - Doctor of Science, who researches in the field of black holes and gravitational collapse. He was looking for volunteers who can read a book with formulas [2]. His post motivated our team to develop an application that could voice the mathematical formulas and equations. Such a project can be useful for both developers of text-to-speech applications and people with vision problems.

## 2. Current System

There are lots of text-to-speech applications on the market now, such as an Intelligent Speaker and Natural Reader that read plain texts without any problems, but when there are mathematical formulas in the text almost all of such text-to-speech applications have trouble with voicing the formulas. For example, when Natural Reader meets mathematical formulas it just ignores them and continues reading the next plain text. Apart from this deficiency in reading formulas, the existing systems have user friendly interfaces, give users the option to change reading voices and more. However, most have limitations and charge a premium to use the majority of their features.

## **3. Proposed System**

### **3.1 Overview**

The application will be a web app that can be accessed from a modern browser with its URL. Users will be greeted with a simple interface which allows them to enter source LaTeX, or upload a file to the system. If the user chooses to enter source LaTeX,

### **3.2 Functional Requirements**

- The application will be able to read formulas from documents or images.
- The user will be able to upload files in PDF, LaTeX, and supported image formats.
- The user will be able to enter source LaTeX into a text box on the web app rather than uploading a file.
- The user will be able to control the audio playback using play, pause and stop buttons.
- The user will be able to select the part of the document they want to be voiced out.
- The user will be able to choose between two reading voices, one male and one female.
- The user will be able to adjust the reading pace to suit their requirements.
- The user will be able to change themes to customize the size, font and color of the display of the text being read.
- The user will be able to download the audio output as an MP3 file.
- The application will limit the number of characters that a user can have voiced out. This limit excludes characters generated to voice out formulas.

## **3.3 Nonfunctional Requirements**

### **3.3.1 Usability**

- The application will have a user-friendly interface that will allow users to navigate through it easily without difficulty.
- The application will not be flooded with a lot of functionalities that may overwhelm the user.

### **3.3.2 Extensibility**

- The application will be made such that new features can be added easily.
- As there is always room for improvement, the application will be updatable.

### **3.3.3 Reliability**

- The application will not alter any files uploaded to voice out formulas.
- The application will not store users' information or track their activities in the browser.
- The formulas in users' documents will be identified and converted to LaTeX format, if not already in LaTeX, which will then be voiced out accurately.

### **3.3.4 Availability**

- The application can be accessed on the web by anyone with access to the link.

### **3.3.5 Efficiency**

- The application will be able to identify formulas in texts in a few seconds and voice them out without intermittent delay or breaks.

## **3.4 Pseudo Requirements**

## **3.5 System Models**

### **3.5.1 Scenarios**

#### **Scenario 1**

**Use Case Name:** Upload document

**Actor:** User

**Entry Conditions:**

- User must be on homepage screen of the app

**Exit Conditions:**

- File is uploaded

**Main flow of events:**

1. User selects upload button from the screen
2. User is redirected to choose a file to upload

#### **Scenario 2**

**Use Case Name:** Select part to voice

**Actor:** User

**Entry Conditions:**

- User uploads a document and decides to voice a part

**Exit Conditions:**

- Selected part has been voiced

**Main flow of events:**

1. User highlights part of the document to voice
2. Highlighted part is voiced out

#### **Scenario 3**

**Use Case Name:** Enter LaTeX string

**Actor:** User

**Entry Conditions:**

- User is on homepage screen

**Exit Conditions:**

- User has entered the LaTeX string

**Main flow of events:**

1. User clicks on 'Enter LaTeX string' button from homepage screen
2. User enters the LaTeX string

#### **Scenario 4**

**Use Case Name:** Customize settings

**Actor:** User

**Entry Conditions:**

- User is on homepage screen

**Exit Conditions:**

- User goes back to homepage screen

**Main flow of events:**

- User clicks on the 'customize settings' button from homepage screen
- User is redirected to settings menu to change settings

#### **Scenario 5**

**Use Case Name:** Download mp3

**Actor:** User

**Entry Conditions:**

- User has uploaded a document and selected the part to voice
- User has entered a LaTeX string

**Exit Conditions:**

- User downloads mp3 file

**Main flow of events:**

1. User clicks on the 'Download mp3' button
2. The mp3 file is downloaded

**Scenario 6**

**Use Case Name:** Play mp3

**Actor:** User

**Entry Conditions:**

- User has uploaded a document and selected the part to voice
- User has entered a LaTeX string

**Exit Conditions:**

- The mp3 file is played

**Main flow of events:**

1. User clicks on the 'play mp3' button
2. The mp3 audio is played

**Scenario 7**

**Use Case Name:** Change play speed

**Actor:** User

**Entry Conditions:**

- User has started playing the selected part to voice

**Exit Conditions:**

- User chooses speed
- Selected part which is being voiced reaches the end

**Main flow of events:**

1. User clicks on 'change play speed' button
2. User chooses the speed to change

**Scenario 8**



Use Case Name: Change reader

Actor: User

**Entry Conditions:**

- User has entered 'Customize settings' menu

**Exit Conditions:**

- User chooses the reader

**Main flow of events:**

1. User clicks on 'Change reader' button
2. User chooses reader

**Scenario 9**

**Use Case Name:** Change theme

**Actor:** User

**Entry Conditions:**

- User has entered 'Customize settings' menu

**Exit Conditions:**

- User chooses theme

**Main flow of events:**

1. User clicks on 'Change theme' button
2. User chooses theme

### 3.5.2 Use Case Model

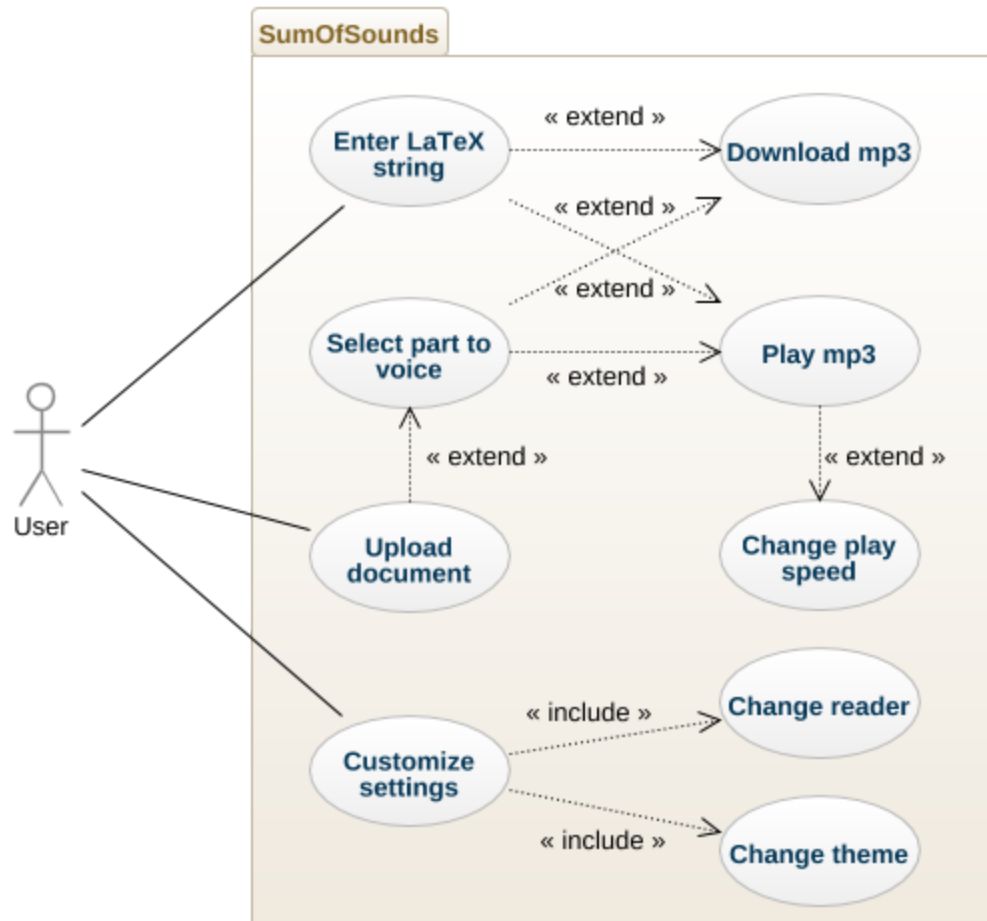


Figure 1. Use case diagram

### 3.5.3 Object and Class Model

### 3.5.4 Dynamic Models

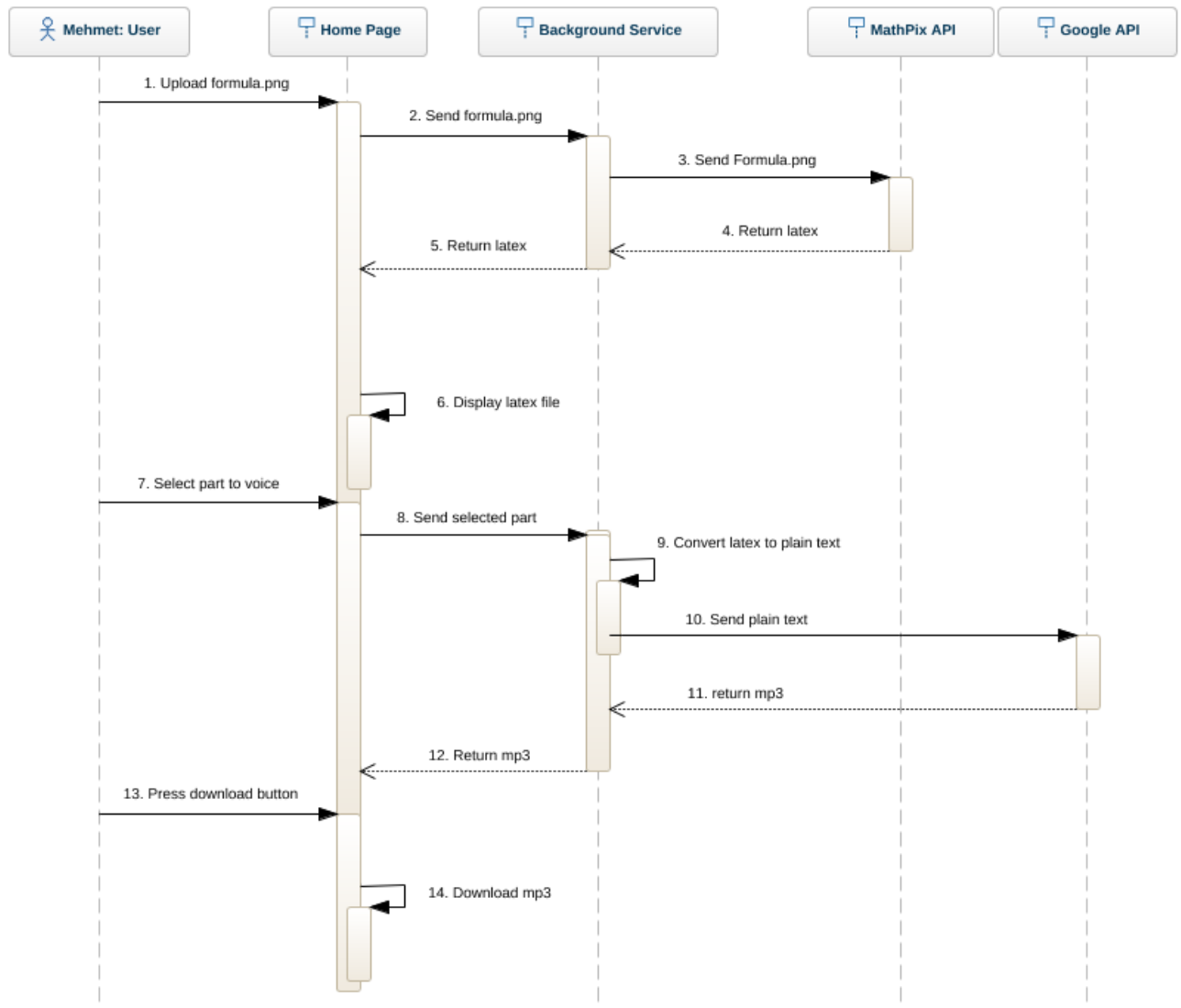


Figure X. Sequence diagram

User uploads the PNG file and downloads it.

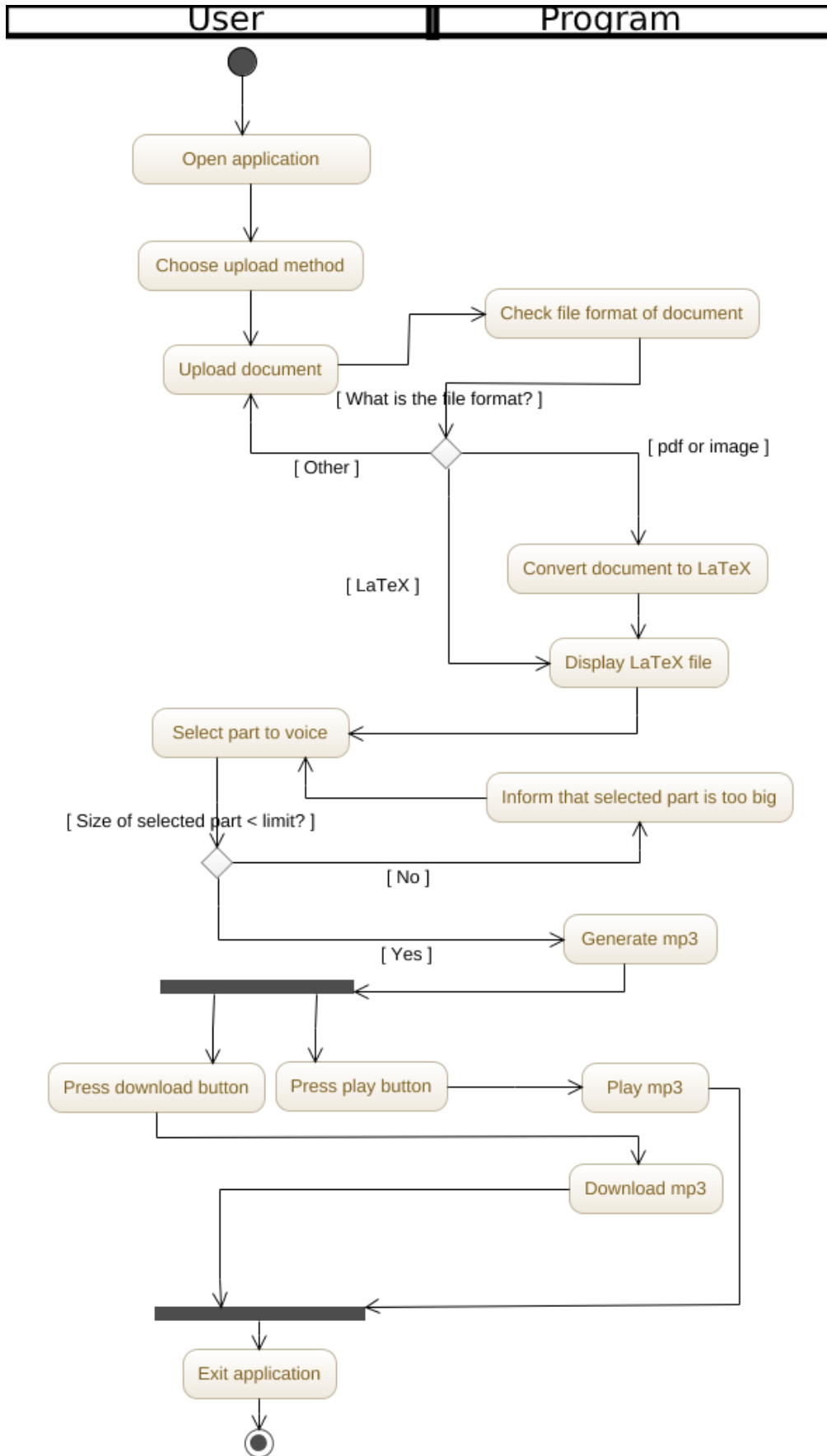


Figure X. Activity diagram

User uploads the PNG file and downloads it.

### **3.5.5 User Interface - Navigational Paths and Screen Mock-ups**

## **4. Other Analysis Elements**

### **4.1. Consideration of Various Factors**

### **4.2. Risks and Alternatives**

### **4.3. Project Plan**

### **4.4. Ensuring Proper Team-work**

### **4.5. Ethics and Professional Responsibilities**

### **4.6. New Knowledge and Learning Strategies**

## **5. Glossary**

## **6. References**