

SOUNDS OF MUSIC

A PROJECT REPORT

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BONA FIDE CERTIFICATE

Certified that this project report titled Sounds of Music is the bona fide work of Abirami R, Thupalli Hethana, and Vibha Alaguraj who carried out project work under my supervision. Certified further that to the best of my knowledge and belief, the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or an award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Our web application helps a beginner how to learn playing music using sheet music in instruments like the guitar or violin. In this web application, a scanned image of the sheet music is uploaded by the user which will be converted to recognize the alphabet notation from the notes. Two images will be given to users. One will be a new image with the pitch notation written in sheet and the other image will contain the ABC notation written in music sheet. The pitch notation will be used later for the feedback module while the ABC notation will help the user know how to play the note. This helps the user to easily recognize what the note stands for from the sheet music image and makes learning how to play an instrument more simple.

The user will then be provided a visual representation on how to play a particular note in an instrument. After learning the finger position and chords correctly, the user is all set to play. Finally, the user will play the instrument and based on the understanding of the notation and notes, it will display on screen with the pitch that the user is playing. User can use the given feedback to make modifications to how they are playing the note to make sure the pitch is matched with note from the pitch image.

ACKNOWLEDGEMENT

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LIST OF SYMBOLS AND ABBREVIATIONS

\neg, \neg, \sim	Negation operator
$+, \vee, \cup$	Disjunction operator
X, \wedge	Conjunction operator
\rightarrow	Conditional operator
\leftrightarrow	Biconditional operator
\diamond	Future tense modal operator
α	Action

CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

For beginner instrument users, learning how to read sheet music will be like learning how to read a whole new language. On top of this, distinguishing themselves what each note stands for and how to play that note would be a tough task that could discourage them from continuing to play the instrument. If they are learning individually, it would also be hard to recognize if the notes they are playing are correct without any feedback to correct.

1.2 PROPOSED SOLUTION

We plan to create a web application that allows users to take a picture of sheet music and convert the music sheet into two images. One with ABC notation to easily read the note and another image with pitch notation that will be helpful for the feedback phase. Help will be provided by showing a visual representation of how to play the notes based on the instrument chosen. User then plays a note from their instrument and the app will listen, with microphone permission, to give feedback of what pitch is being played. The user can modify their finger position to make sure they are playing the correct pitch and note.

1.3 SUSTAINABILITY GOALS

Our Creative and Innovative Project is aimed to work on 2 (Goal 3 and 4) of the 17 Sustainable Development Goals (SDGs) set by the United Nations, Department of Economic and Social Affairs.

1.3.1 Goal 3: Mental Health and Well Being

There are many articles and research papers that suggest learning to play an instrument helps improve mental health and cognitive skills. One such reference here: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6368928/>

1.3.2 Goal 4: Quality Education

Our app will help beginners learn how to play music notes and give feedback to help them play correctly. This is helpful because users can play an instrument without the need of a tutor making the process more accessible to all. The users can learn at their own pace.

1.4 TECHNOLOGIES USED

1.4.1 OpenCV

It is a huge open-source library platform used for computer vision and machine learning application. It is used in applications like image processing and object detection. We uses OpenCV to detect the music sheet page and for Blob Detection. Blob stands for Binary Large Object and it is a group of connected pixels. We consider the music note as a Blob to detect where it lies in the staff position.

1.4.2 NumPy

NumPy is a python library that adds support for large, multi-dimensional arrays and matrices. It also has a large collection of high-level mathematical functions to operate on those arrays.

1.4.3 Django

Django is a high-level open-source Python Web framework that is used for the creation of complex, database-driven websites. It emphasizes on re-usability of code components and quicker development of applications.

1.4.4 SQLite3

SQLite3 is a relational database management system for SQL. It is not a client server database engine but is embedded into the end program creating databases that are faster to work with.

1.5 WHY MUSIC IS IMPORTANT

Music does wonders for your health. Many pieces of research have shown that playing music helps in lowering your blood pressure, reduces stress and anxiety levels. It can even strengthen your immunological response and keeps your mind active. Learning to play an instrument makes you smarter. It turns out that learning music at an older age can do wonders for your mind as well. In a study at the University of South Florida, adults aged between 60 and 85 were given piano lessons. Six months later, they exhibited improved memory, verbal fluency, information processing skills, and other cognitive functions. It can help build confidence. Learning music gives you opportunities to put yourself in potentially uncomfortable performance situations and learn to overcome anxiety. Music enhances creativity. According to Microsoft co-founder, Paul Allen, music lets you “look beyond what currently exists and express yourself in a new way”. Music is all about understanding basic rules and then expressing yourself in the form of sound. Writing your songs, improvising solos, and re-performing existing songs are all ways that musicians create something out

of nothing. Music is an amazing stress reliever. We all have busy lives, and there will be times when we feel like our heads are going to explode from everything that's happening. Playing music is an amazing way to get your mind off things. It doesn't hurt your health, it allows you to release your frustrations.

1.6 MUSIC SHEET NOTATION

Since this application deals with Music Notations, here are some general information on some basic sheet symbols mean.

- Staff - set of five horizontal lines and four spaces that each represent a different musical pitch
- Pitch - perceptual property of sounds that allows their ordering on a frequency-related scale

The Letters of the Music Sheet: Since this is a simple staff (the treble symbol on left is without any flats or sharps) the sheet is considered to be in the key of C Major.



Figure 1.1: Music Sheet

The Strings of the Guitar - Used for TAB Notation. The smallest string is the top e string while the largest string is the bottom E string. Each Vertical column there indicates new fret which in tab notation will be given in number.

String names

e Ears	1st				Top string
B Big	2nd				
G Grow	3rd				
D Donkeys	4th				
A And	5th				
E Elephants	6th				Bottom string

Figure 1.2: Guitar Position

CHAPTER 2

REFERENCES

2.1 Citation of Websites

The websites cited are shown in this Reference [1], [2], [3], and [4].

2.2 Citation of Videos

The videos cited are shown in this Reference [5], [6], and [7].

CHAPTER 3

DESIGN OF YOUR WORK

3.1 MODULES

We have 3 modules in our web app. The First Module is the User Module. The Second module is converting the music sheet to include pitch notation and tabs/or finger position notation. This uses image processing techniques. The Third module is retrieving the images on how to play the notes and then displaying the frequency where user can check his/her performance.

3.1.1 User Module

- Login/Sign in
- View Lessons
- Upload Music Sheet - Use Notation Conversion Module
- Use Feedback Module

Flow Diagram of the Upload Music Sheet is shown in Figure 4.1.

3.1.2 Notation Conversion Module

This modules returns two images back to user:

- Image with Pitch Notation Written in Music Sheet

- Image with Hand Notation or TABS Notation written in Music Sheet

Flow Diagram of the Notation Conversion Module 2 is shown in 4.2.

3.1.3 Feedback Module

Users plays instrument and based on what note is playing, pitch will be displayed. User can use the pitch as feedback to make sure they are playing the note correctly.

Flow Diagram of the Feedback Module 3 is shown in Figure 4.3.

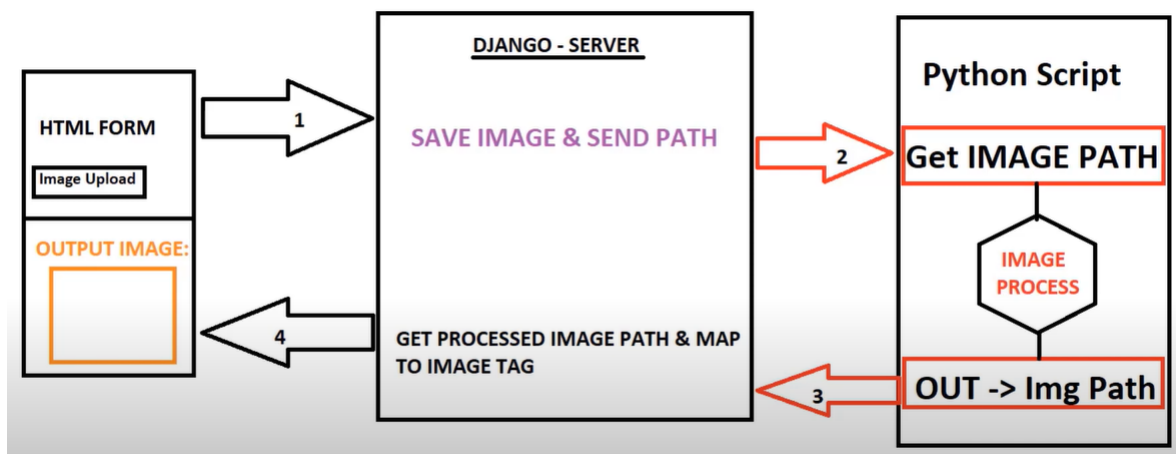


Figure 3.1: Upload Music Sheet

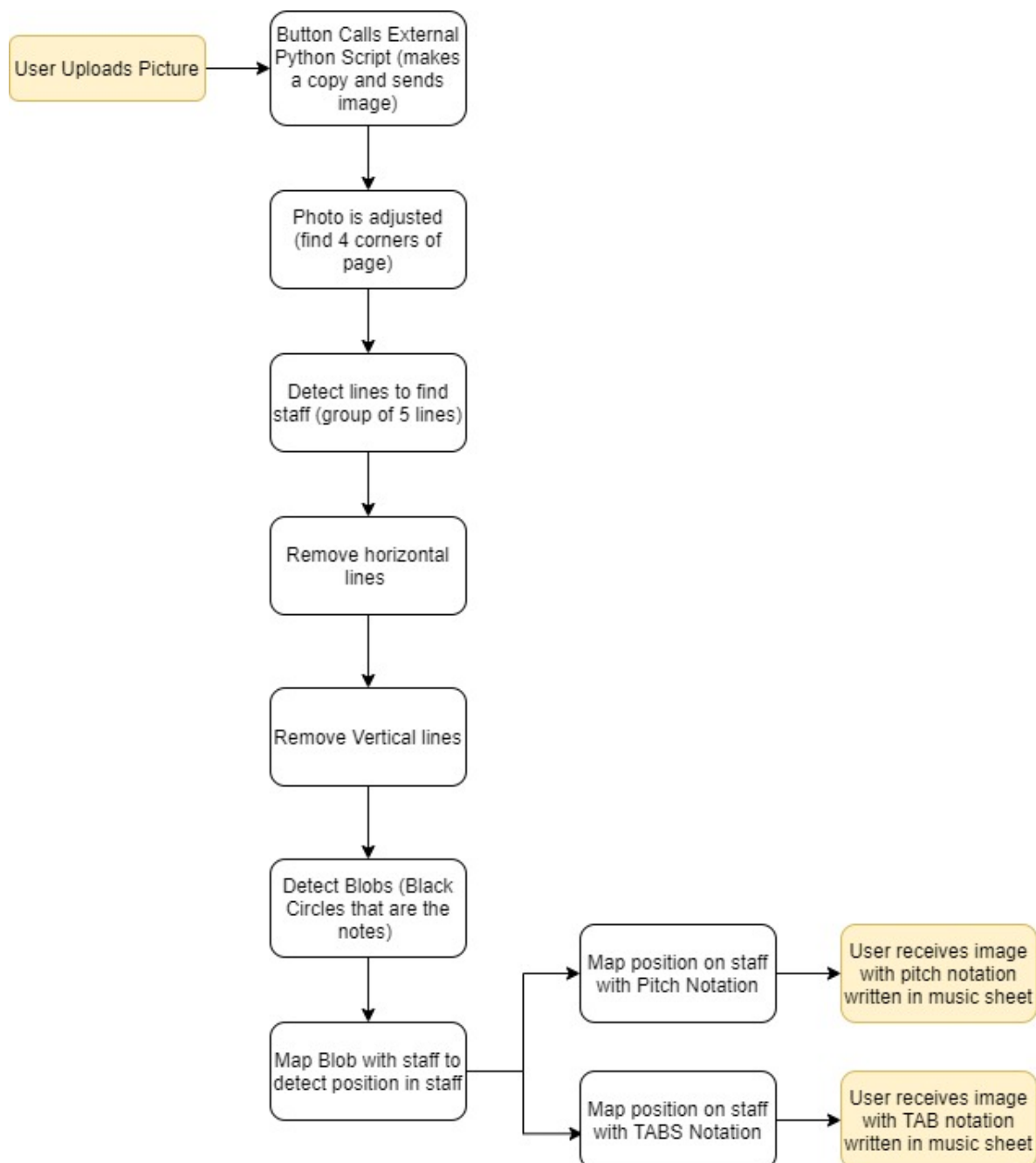


Figure 3.2: Notation Conversion Module Flow Diagram

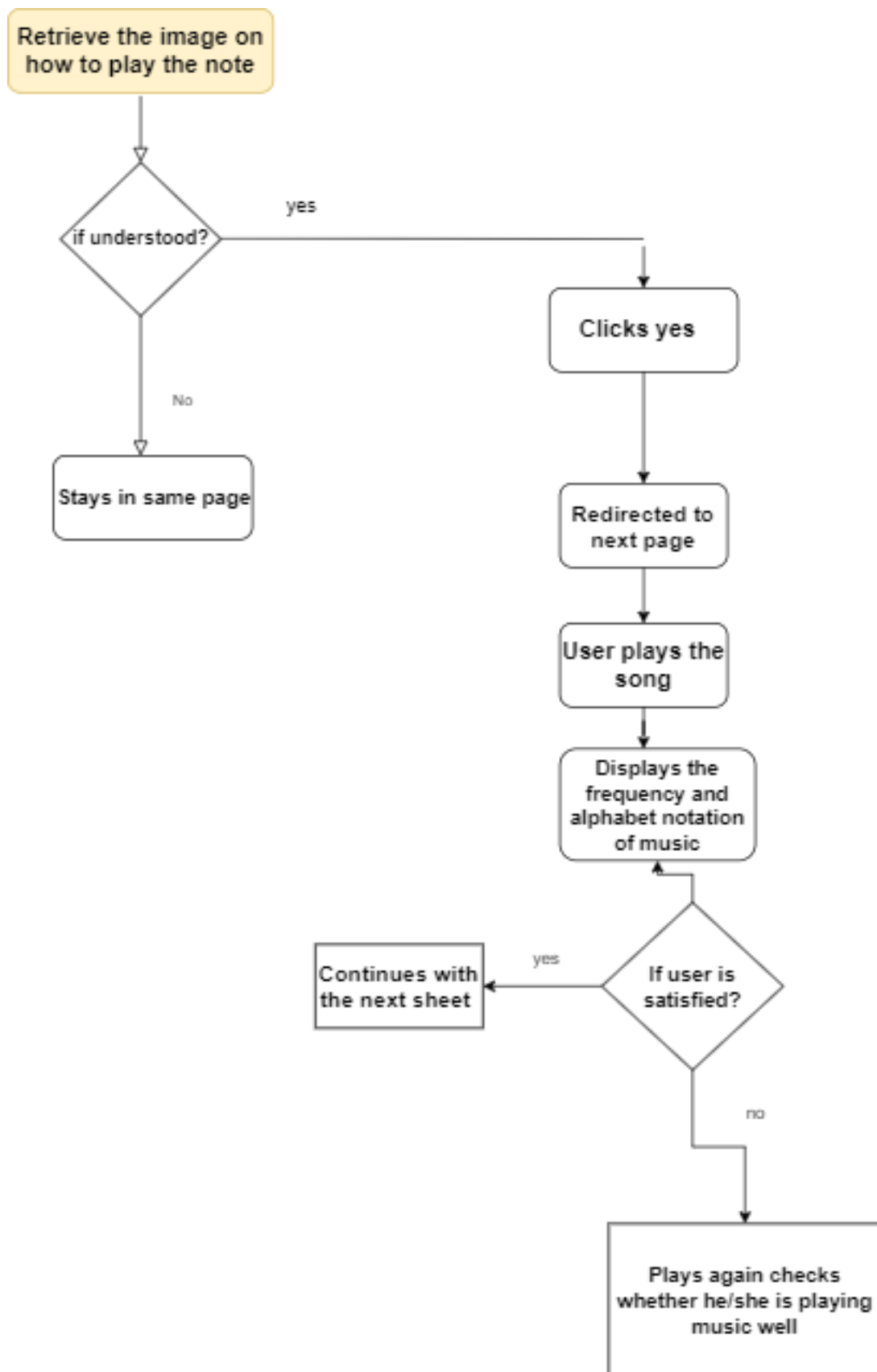


Figure 3.3: Feedback Module Flow Diagram

CHAPTER 4

IMPLEMENTATION

4.1 CONVERSION MODULE

This Module is part of the back-end process. User will be able to upload an image of the music sheet and select which instrument its is for. The following steps are taken to process the image and return an output to the user.

4.1.1 Adjusting Photo

Change the user uploaded image to gray-scale then blur with the Gaussian blur function to smooth the picture and reduce detail. Use the Canny method to then detect edges in the image and Douglas-Peucker Algorithm to reduce the number of points in the curve. Calculate the max width and length of the sheet along with the 4 points. Using the four points in `getPerspectiveTransform` to find the edges of the page and scale the image with `WarpPerspective`. With this the an image with contours then an adjusted image of just the music sheet can be produced

OUTPUT:

- Image with Gray-Scale - 4.2
- Image with Gaussian Blur - 4.3
- Image with Canny - 4.4
- Image with Contour - 4.5

- Image with Adjusted Ends - Music Sheet - 4.6

4.1.2 Getting Lines

Next, we detect lines present in the picture. This will be used to find staff position later. To do this, convert image back to color and use Hough-Transform function to detect horizontal lines. Return a list of horizontal lines

OUTPUT: Image with red lines drawn - 4.7

4.1.3 Detect Staff

To get Staff, calculate the approximate positions of the separate lines in the staff. Using the list of horizontal lines (from before) to count, if position between each 5 lines is close, it is considered a Staff. Otherwise, not enough lines or uneven distance between the 5 lines are treated as anomaly and discarded. A List is made of tuples and with beginnings and ends of staffs detected. It returns a List of Staffs (location points) .

OUTPUT: Image with staff detected (in yellow) - 4.8

4.1.4 Detect Blobs

The Music Notes are black circles so we can consider them as a blob. To find them, we remove the horizontal lines and remove vertical lines using the morphologyEx Function. Now only the blobs remain and are detected using SimpleBlobDetector (default parameters used). More info on this can be found in: <https://learnopencv.com/blob-detection-using-opencv-python-c/> . The Blobs are then numbered with staff line (based on location in sheet and List of Staff)

and a copy of the detected blobs page is made to enumerate the blobs(to count number of notes). The return a List of Blobs which will be used to make Note Object.

OUTPUT:

- Image with horizontal lines removed - 4.9
- Image with vertical lines removed - 4.10
- Image with detected blobs - 4.11
- Image with numbered detected blobs (number of notes) - 4.12
- Image with Blob and numbered Staff - 4.13


4.1.5 Extract Note from Blob

We represent a single note based on blob location and staff lines location. This is done by first generating a range of 3 upper lines and 3 lower lines for each beginning and end of staff (for notes that are outside of the traditional 5 lines. If blob is equal distance from two lines, it is considered as a note in center between the lines but if notes is closer to one line than other line then is considered as note on line's center. Each note, based on location in line is mapped to pitch notation (violin, guitar, etc) as well as the TABs or hand notation.


OUTPUT:

- Image with Pitch Notation - 5.5
- Image with TABs or Hand Notation - 4.15

Twinkle Twinkle Little Star

Go to www.guitarnick.com 
lots of free guitar tabs & video lessons

Tablited by
Nicola Mandorino (2011)




G C G C G D7 G

C G D7 G C G D7


G C G C G D7 G

Figure 4.1: Original Image

Twinkle Twinkle Little Star

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Tablited by
Nicola Mandorino (2011)



G C G C G D7 G

C G D7 G C G D7

G C G C G D7 G

Figure 4.2: Image with Gray-Scale

Twinkle Twinkle Little Star

Go to www.guitarnick.com
lots of free guitar tabs & video lessons

Tablited by
Nicola Mandorino (2011)

The image shows a musical score for the song 'Twinkle Twinkle Little Star' in 4/4 time. It consists of three staves of music. Above each staff are guitar chords: G, C, G, C, G, D7, G for the first staff; C, G, D7, G, C, G, D7 for the second staff; and G, C, G, C, G, D7, G for the third staff. The music is written in treble clef with a key signature of one sharp (F#). A watermark 'Guitarnick.com' is visible across the middle of the image.

Figure 4.3: Image with Gaussian Blur

Twinkle Twinkle Little Star


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Tablited by
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This image is a processed version of the musical score from Figure 4.3, applying a canny edge detection effect. The background is black, and the musical notes, staff lines, and chord labels are rendered in white. The layout is identical to Figure 4.3, showing three staves of music with the same chords and watermark.

Figure 4.4: Image with canny

Twinkle Twinkle Little Star

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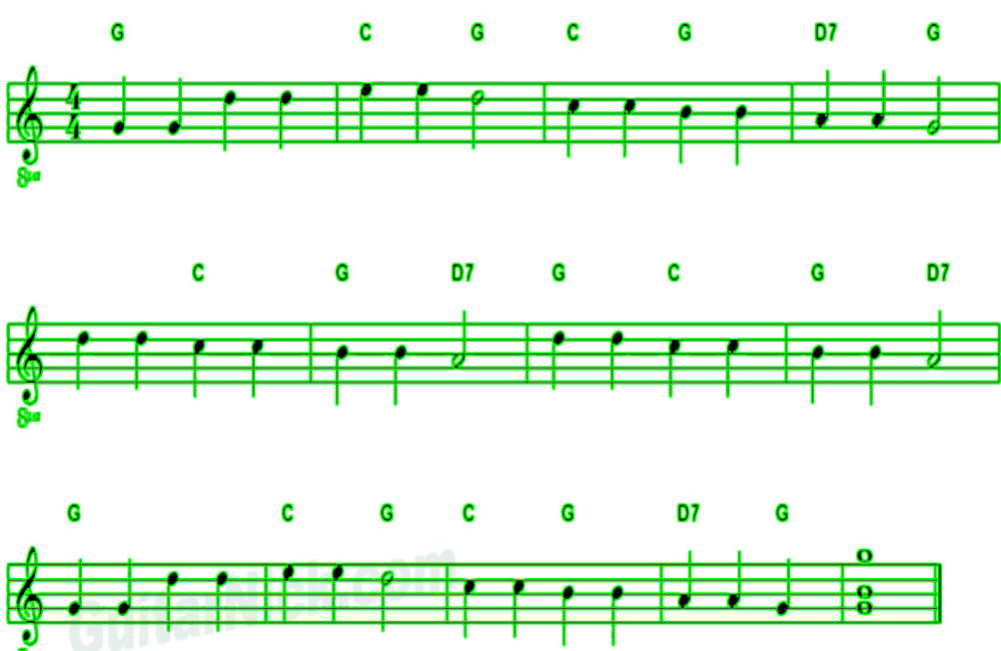


Figure 4.5: Image with contours

Twinkle Twinkle Little Star

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Figure 4.6: Image with adjusted photo - Music Sheet

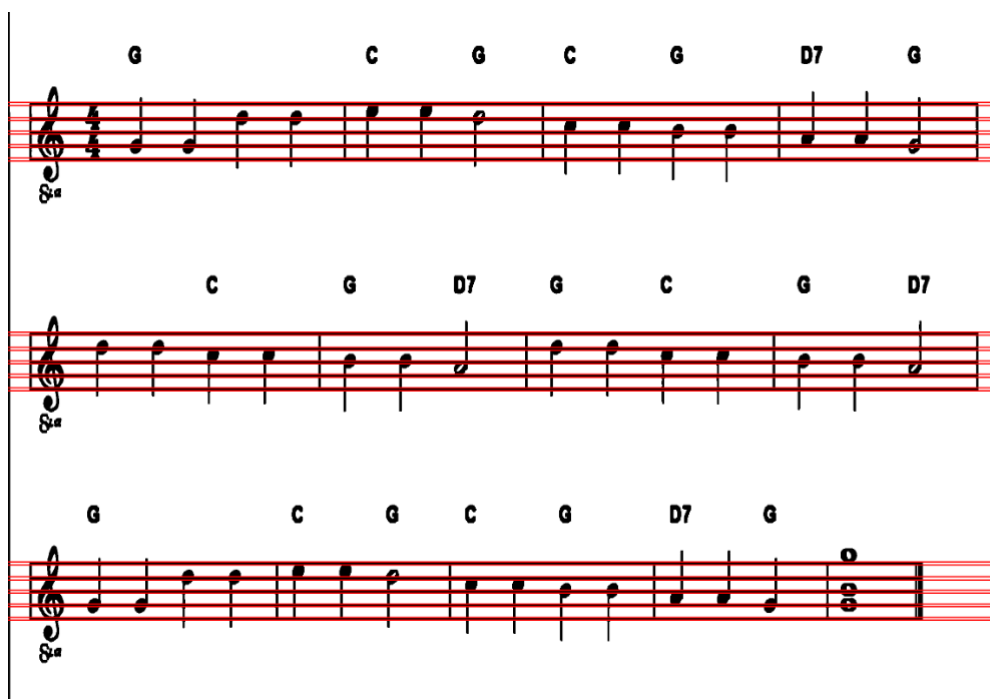


Figure 4.7: Image with Lines Detected

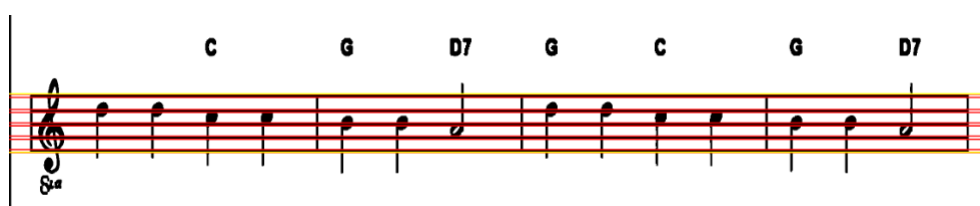


Figure 4.8: Image with Staff Detected - Yellow Lines

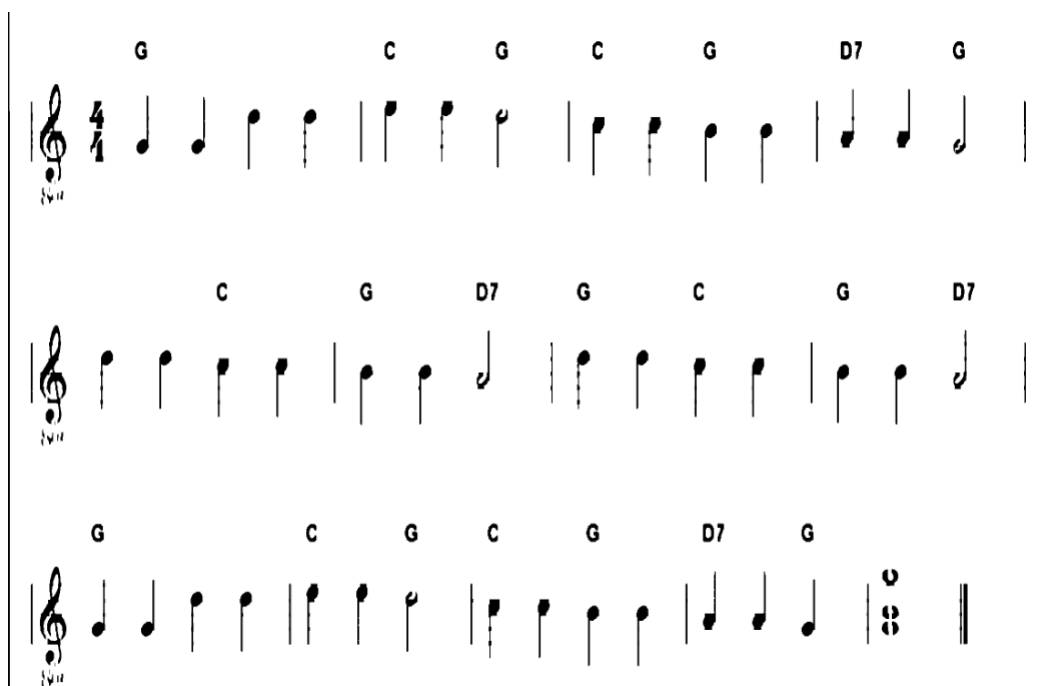


Figure 4.9: Image with Horizontal Lines Removed

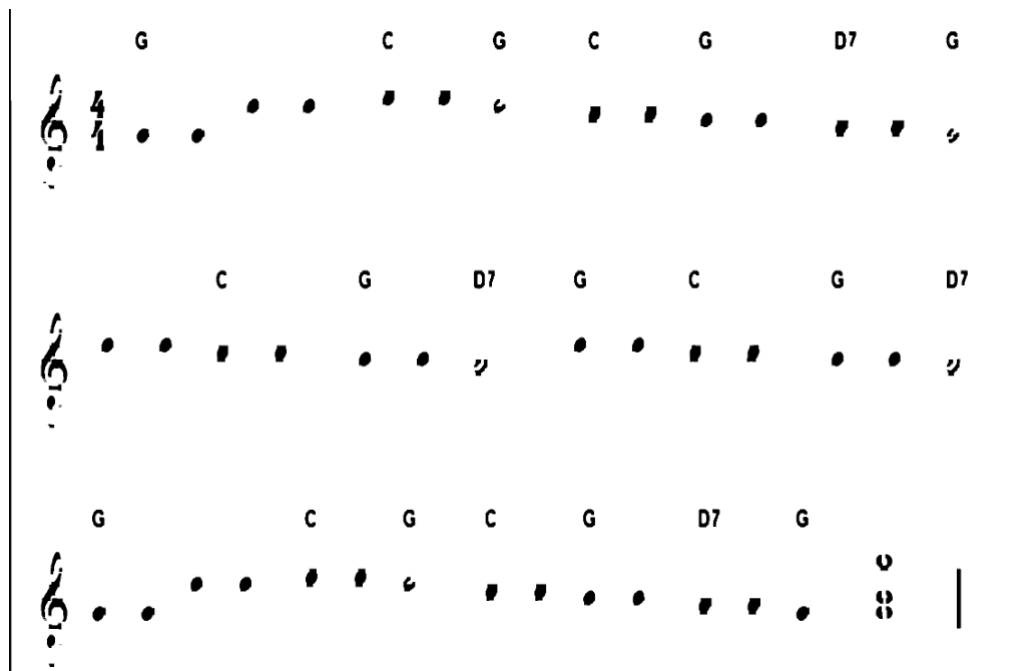


Figure 4.10: Image with Vertical Lines Removed

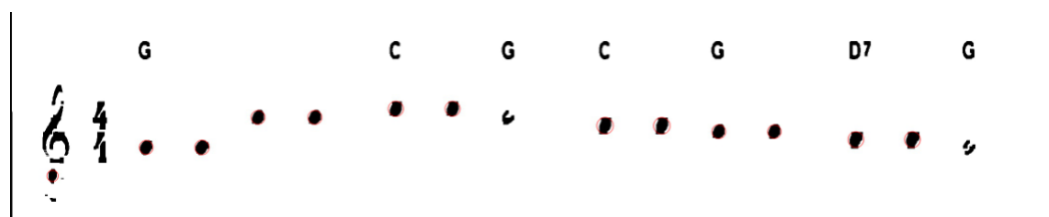


Figure 4.11: Image with Lines Detected



Figure 4.12: Image with Blobs Numbered

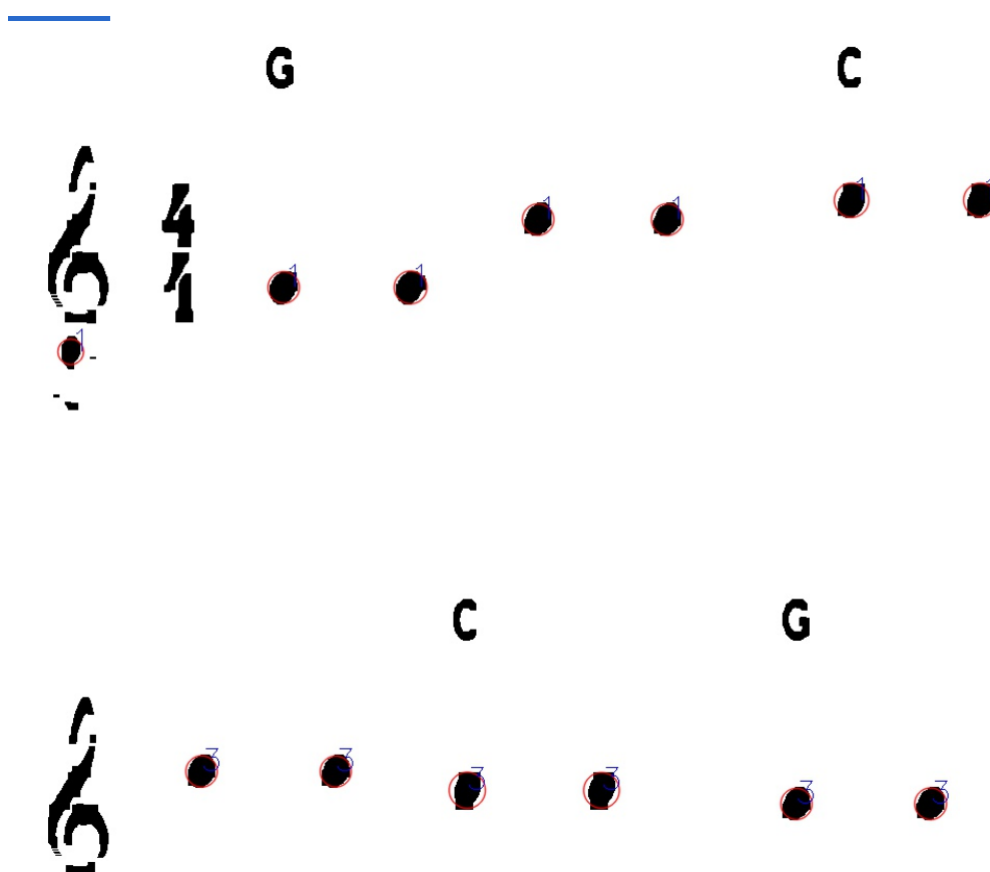


Figure 4.13: Image of Blobs with Staff Numbers

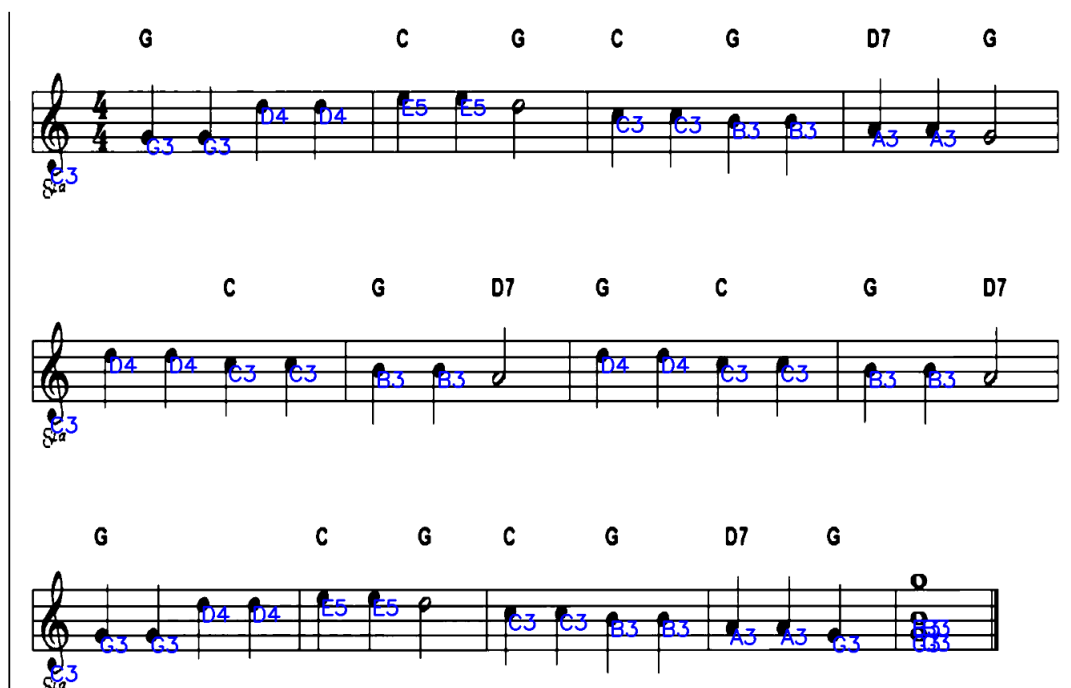
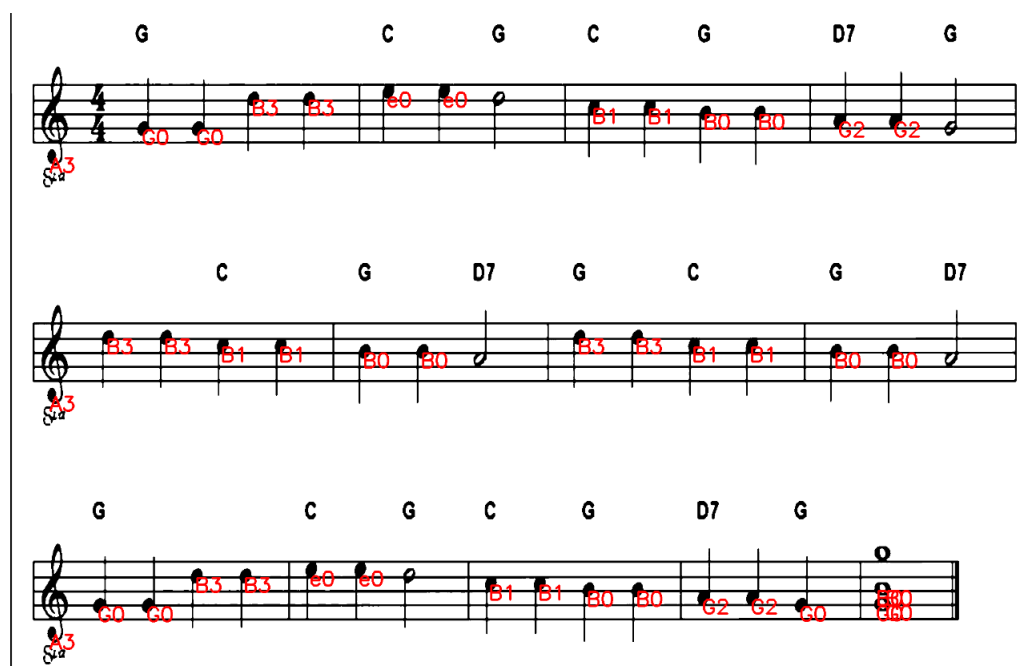


Figure 4.14: Image with Pitch Notation



CHAPTER 5

OUTPUT AND RESULTS

5.1 HOME PAGE

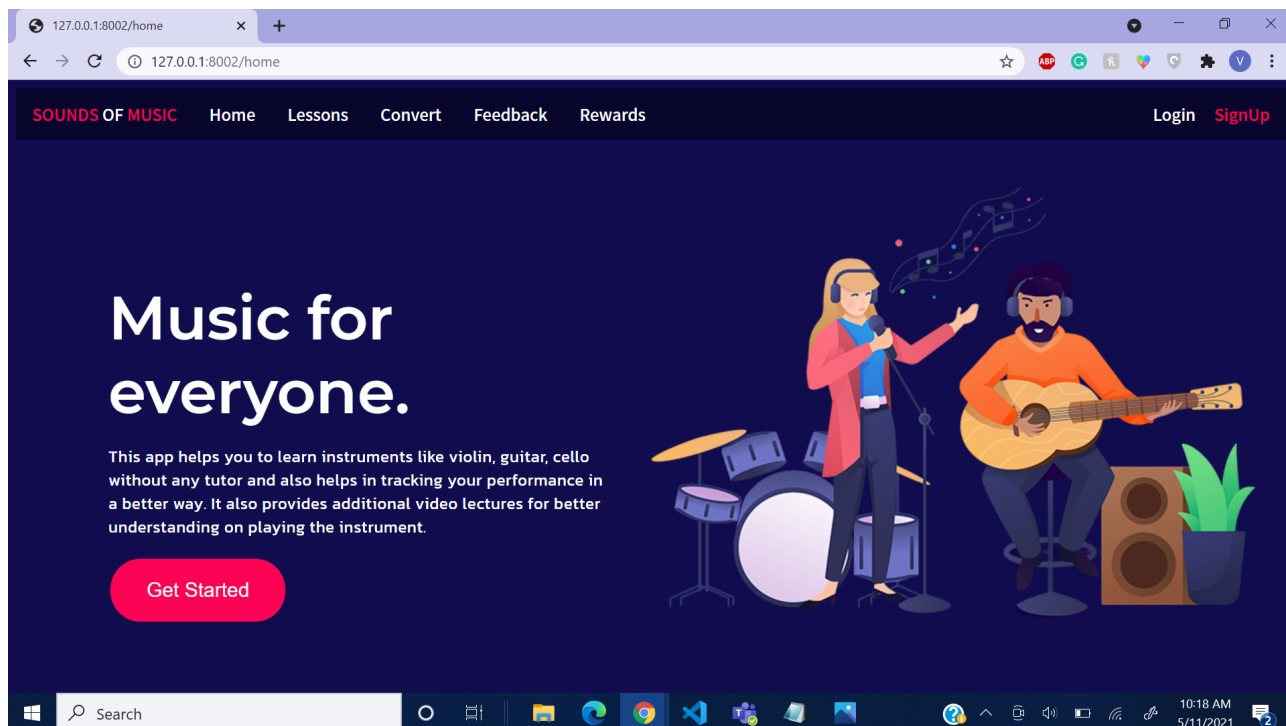


Figure 5.1: Home Page

5.2 SIGN UP

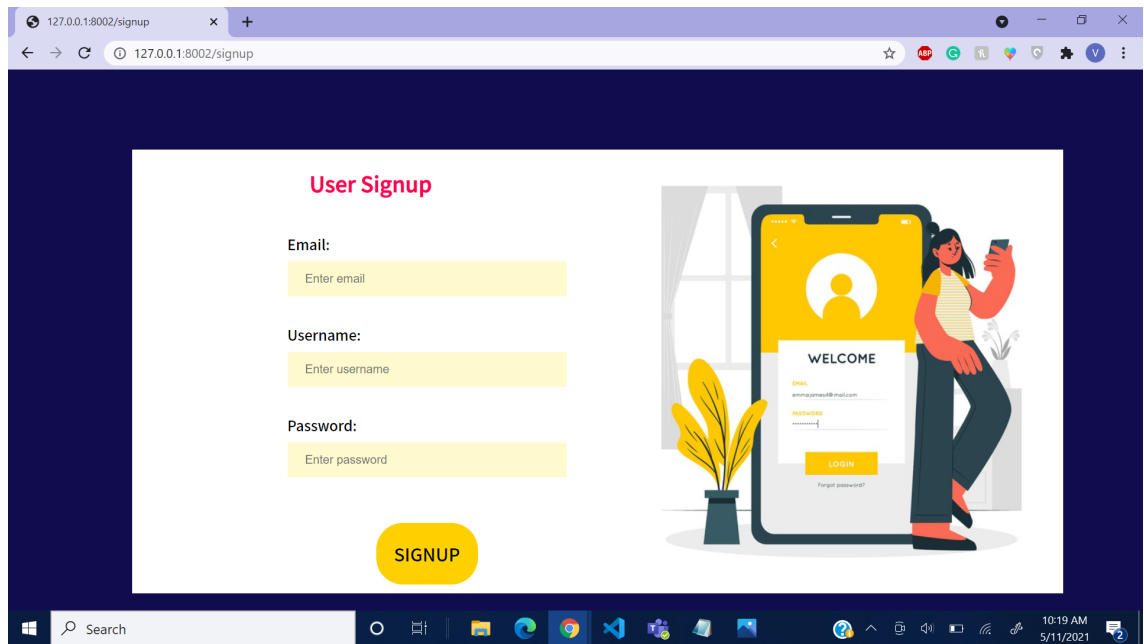


Figure 5.2: Sign Up Page

5.3 LOGIN

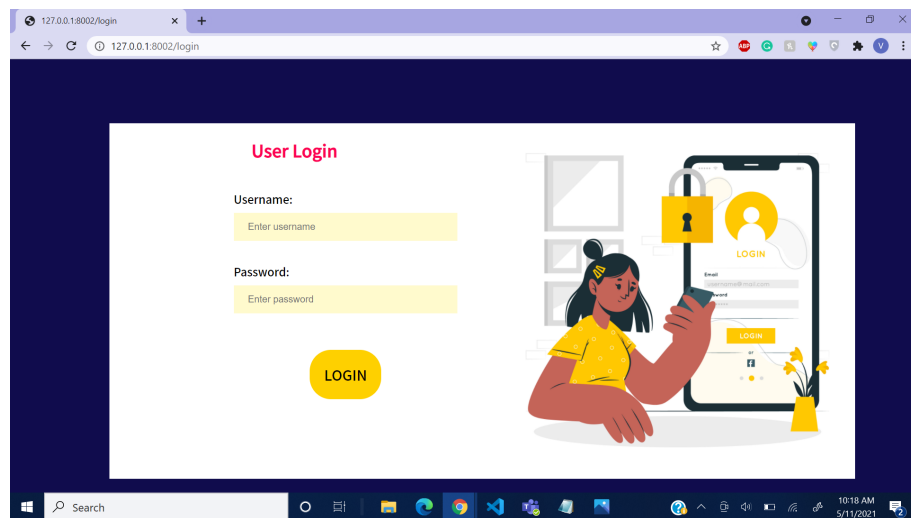


Figure 5.3: Login Page

5.4 CONVERT

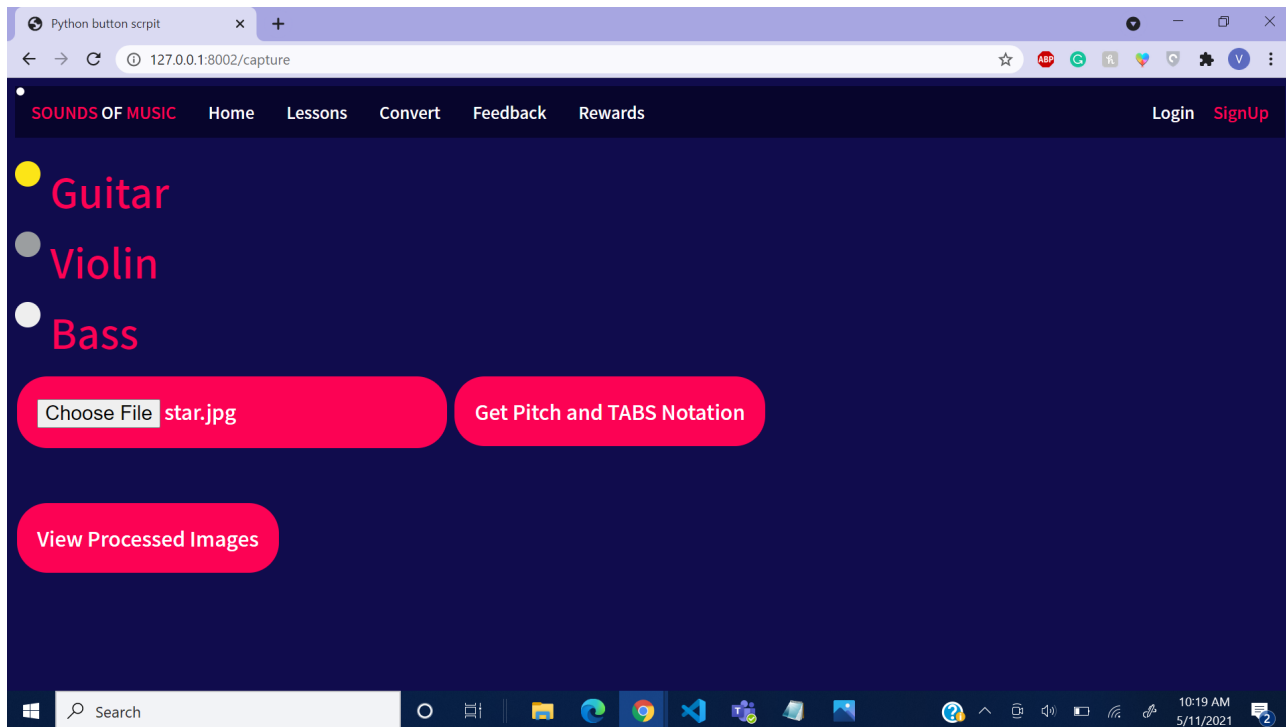


Figure 5.4: Convert Page

5.5 CONVERT OUPUT

The screenshot shows a web browser window with the address bar displaying '127.0.0.1:8002/output'. The page title is 'Music Sheet with Pitch Notation'. The main content is a music sheet for the song 'Twinkle Twinkle Little Star'. The sheet includes two staves of music in 4/4 time. Above the first staff are the chords G, C, G, C, G, D7, and G. Above the second staff are the chords C, G, D7, G, C, G, and D7. The notes on the staves are labeled with pitch notation: C3, D4, E5, F#5, G5, A5, B5, and C6. The page also features a logo for 'www.guitarnick.com' and a link to 'lots of free guitar tabs & video lessons'. The browser's taskbar is visible at the bottom, showing the Windows logo, a search bar, and several application icons.

127.0.0.1:8002/output

SOUNDS OF MUSIC Home Lessons Convert Feedback Rewards

Music Sheet with Pitch Notation

Twinkle Twinkle Little Star

Go to www.guitarnick.com lots of free guitar tabs & video lessons

Tablited by Nicola Mandorino (2011)

G C G C G D7 G

C G D7 G C G D7

Search


Figure 5.5: Output with Convert Page - Pitch

127.0.0.1:8002/output x +

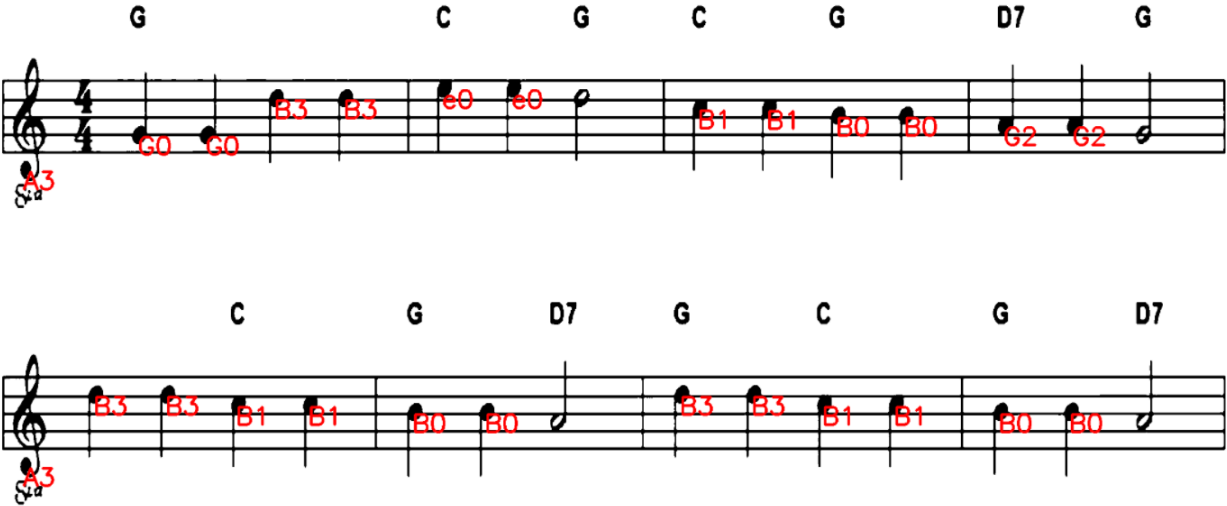
127.0.0.1:8002/output

Music Sheet with TABS Notation

Twinkle Twinkle Little Star

Go to www.guitarnick.com 
lots of free guitar tabs & video lessons

Tablited by Nicola Mandorino (2011)



The image shows a guitar tab for the song 'Twinkle Twinkle Little Star'. It is presented in two lines of music. The first line contains measures 1 through 6, and the second line contains measures 7 through 12. Above each measure, the corresponding chord is written: G, C, G, C, G, D7, G for the first line, and C, G, D7, G, C, G, D7 for the second line. The notes are written on a treble clef staff in 4/4 time. Red numbers are placed below the notes to indicate fingerings: 3 for the first note of the first measure, 0 for the second and third notes of the first measure, 3 for the fourth and fifth notes of the first measure, 0 for the sixth and seventh notes of the first measure, 1 for the eighth and ninth notes of the first measure, 0 for the tenth and eleventh notes of the first measure, 2 for the twelfth and thirteenth notes of the first measure, 3 for the fourteenth note of the first measure, 3 for the first note of the second measure, 1 for the second and third notes of the second measure, 0 for the fourth and fifth notes of the second measure, 3 for the sixth and seventh notes of the second measure, 1 for the eighth and ninth notes of the second measure, 0 for the tenth and eleventh notes of the second measure, 3 for the twelfth note of the second measure, 3 for the first note of the third measure, 1 for the second and third notes of the third measure, 0 for the fourth and fifth notes of the third measure, 3 for the sixth and seventh notes of the third measure, 1 for the eighth and ninth notes of the third measure, 0 for the tenth and eleventh notes of the third measure, 3 for the twelfth note of the third measure, 3 for the first note of the fourth measure, 1 for the second and third notes of the fourth measure, 0 for the fourth and fifth notes of the fourth measure, 3 for the sixth and seventh notes of the fourth measure, 1 for the eighth and ninth notes of the fourth measure, 0 for the tenth and eleventh notes of the fourth measure, 3 for the twelfth note of the fourth measure, 3 for the first note of the fifth measure, 1 for the second and third notes of the fifth measure, 0 for the fourth and fifth notes of the fifth measure, 3 for the sixth and seventh notes of the fifth measure, 1 for the eighth and ninth notes of the fifth measure, 0 for the tenth and eleventh notes of the fifth measure, 3 for the twelfth note of the fifth measure, 3 for the first note of the sixth measure, 1 for the second and third notes of the sixth measure, 0 for the fourth and fifth notes of the sixth measure, 3 for the sixth and seventh notes of the sixth measure, 1 for the eighth and ninth notes of the sixth measure, 0 for the tenth and eleventh notes of the sixth measure, 3 for the twelfth note of the sixth measure, 3 for the first note of the seventh measure, 1 for the second and third notes of the seventh measure, 0 for the fourth and fifth notes of the seventh measure, 3 for the sixth and seventh notes of the seventh measure, 1 for the eighth and ninth notes of the seventh measure, 0 for the tenth and eleventh notes of the seventh measure, 3 for the twelfth note of the seventh measure, 3 for the first note of the eighth measure, 1 for the second and third notes of the eighth measure, 0 for the fourth and fifth notes of the eighth measure, 3 for the sixth and seventh notes of the eighth measure, 1 for the eighth and ninth notes of the eighth measure, 0 for the tenth and eleventh notes of the eighth measure, 3 for the twelfth note of the eighth measure, 3 for the first note of the ninth measure, 1 for the second and third notes of the ninth measure, 0 for the fourth and fifth notes of the ninth measure, 3 for the sixth and seventh notes of the ninth measure, 1 for the eighth and ninth notes of the ninth measure, 0 for the tenth and eleventh notes of the ninth measure, 3 for the twelfth note of the ninth measure, 3 for the first note of the tenth measure, 1 for the second and third notes of the tenth measure, 0 for the fourth and fifth notes of the tenth measure, 3 for the sixth and seventh notes of the tenth measure, 1 for the eighth and ninth notes of the tenth measure, 0 for the tenth and eleventh notes of the tenth measure, 3 for the twelfth note of the tenth measure, 3 for the first note of the eleventh measure, 1 for the second and third notes of the eleventh measure, 0 for the fourth and fifth notes of the eleventh measure, 3 for the sixth and seventh notes of the eleventh measure, 1 for the eighth and ninth notes of the eleventh measure, 0 for the tenth and eleventh notes of the eleventh measure, 3 for the twelfth note of the eleventh measure, 3 for the first note of the twelfth measure, 1 for the second and third notes of the twelfth measure, 0 for the fourth and fifth notes of the twelfth measure, 3 for the sixth and seventh notes of the twelfth measure, 1 for the eighth and ninth notes of the twelfth measure, 0 for the tenth and eleventh notes of the twelfth measure, 3 for the twelfth note of the twelfth measure.

Figure 5.6: Output with Convert Page - TAB

5.6 FEEDBACK

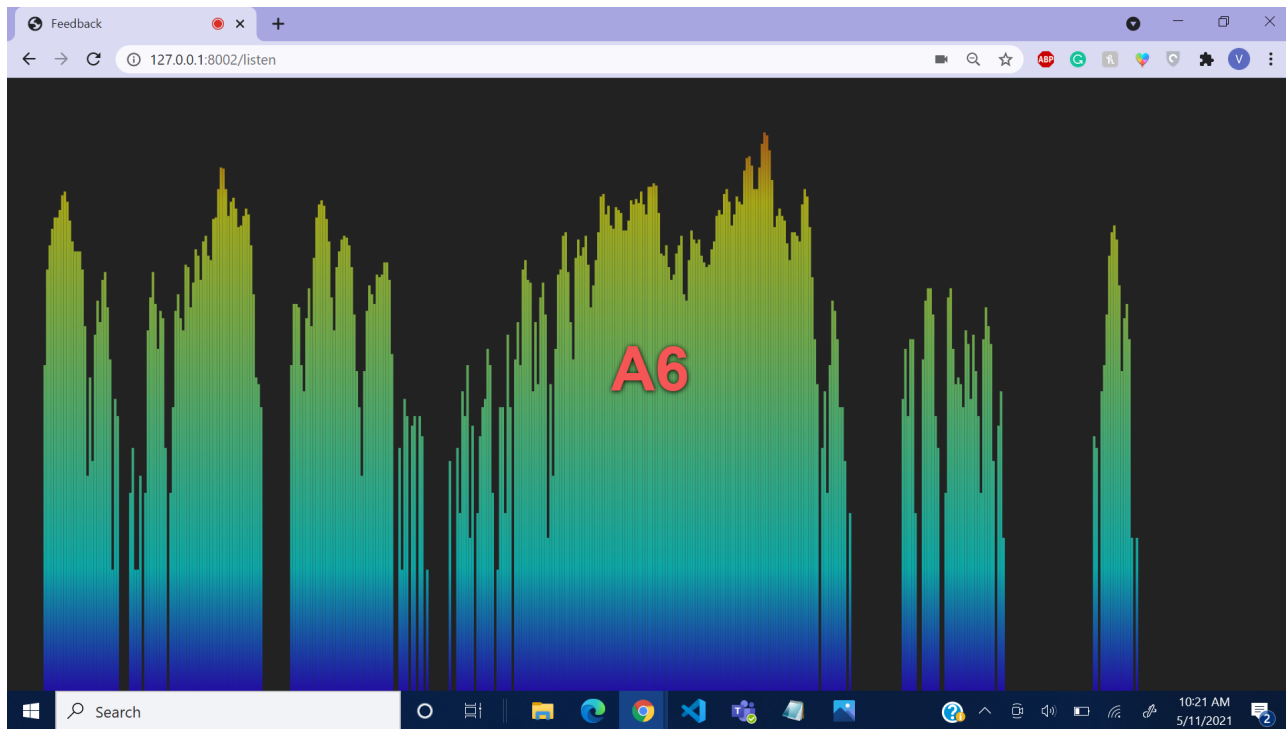


Figure 5.7: Feedback Page - Showing Pitch

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.0.1 CONCLUSION

The project work presented in the above thesis concerns with the development of an interactive web application for the instrument music learners. Using this application users can improve their efficiency in understanding the sheet music and get to know well about playing the notes correctly. In now a days many apps are coming into market which has both paid and free services in it. Besides this, We believe that "Money shouldn't be the barrier to gain knowledge", we strongly believe in our motto and will not compromising on the quality of the service and intend to offer this learning for free. This application helps you discover more about your hidden talent encourage in making it more better. We hope that our project will help users in improving their skills to learn music, expand their creativity and ability to create beautiful music. Through this app you can learn at your own pace and hence this is fun experiencing our app.

6.0.2 FUTURE WORK

We have developed this application using C major scale as it contains no sharps or flats. The key of C contains notes: C, D, E, F, G, A, B and we can mix up these notes to play melodies. For a beginner learner who is learning guitar or any other instrument, it is easy to start with C major as a lot of simple songs are written in this key. We are planning to extend our idea to develop it for G major scale and D major scale in the future. We also plan to provide a better feedback implementation that will help not only with pitches but with open chords and make the learning pages more user-friendly and interactive.

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