Enabling the disabled using learning aid

Project Guide: Dr. D. Thenmozhi **Team Members:** Lakshmi Priya B Nivedhitha D Sakthi Sairaj

Department of CSE, Sri Sivasubramaniya Nadar college of Engineering
Final Year Project, June 2022

Introduction

- According to Government of India, nearly **40 million people in India are blind** or have moderate to severe vision impairment due to uncorrected refractive error [1].
- **Braille literacy is an alarming 1%** [2].
- Therefore, the need of the hour is a comprehensive, end-to-end Learning System for the visually impaired.

Research Gaps:

- Simple image processing proves insufficient for handling perspective distortions, paper curvature, lighting glares and camera angle image tilts.
- Approaches using geometric regularity fail in the absence of rigid rectangular geometric layouts of braille cells.
- Most neural network approaches only classify a limited set and not all 64 braille symbols.
- Most approaches are language-specific letter mappings which also disregard punctuation and numbers.

Highlights of Project

To build a holistic **Learning Tool for the visually disabled** that

- **Converts captured Braille book images** to **English** or **Tamil** language text appropriately.
- Transforms generated text to **audio output**.
- **Summarizes content** optionally for efficient learning.

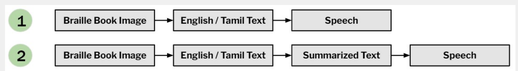

Figure 1. Project Flow

Distinguishing features of project:

- Encoded braille cell representation of all 64 braille symbols.
- Flexibility of expansion to other languages with addition of just a simple mapping function.
- No captured image restrictions like resolution, lighting, cropping, etc.
- App usable by visually imparied.

Dataset Description

Dataset Acquisition

- The AI4Good Lab [3] Braille Character dataset from McGill University was used as the base dataset.

Dataset	Total Images	Total Symbols
Base Dataset	26,724	37
Expanded Dataset	48,000	64

Table 1. Composition of Dataset

Dataset Expansion

- The dataset is expanded to all 64 generic braille encoding representations using image augmentation techniques.

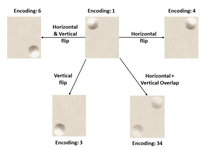

Figure 2. Generated braille cell images using augmentation

Dataset Balancing

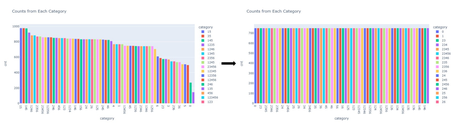

Figure 3. Balancing all classes in dataset

- From the new augmented dataset 80% of total is taken for training and 20% for validation.

Pipeline

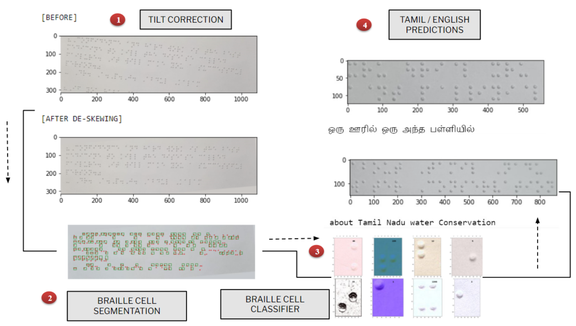

Figure 4. Balancing all classes in dataset

Functional Modules

- Image Tilt Correction
- Braille Cell Segmentation
- Braille Cell Classification
- Braille Recognition
- Text Correction
- Text Summarization
- Text to Speech

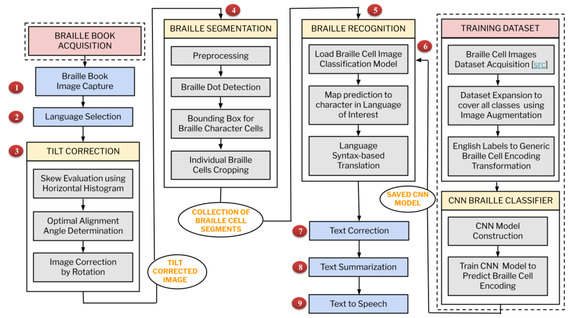

Figure 6. System Architecture

Application Design & User Interface

Figure 7. Application Design

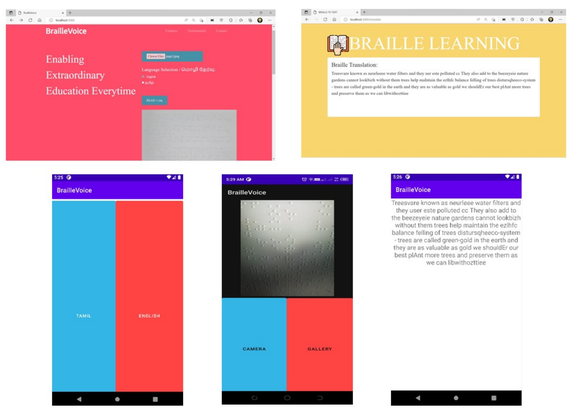

Figure 8. User Interface

Performance Analysis

Method	Jaro Winkler	Jaro Similarity	Levenstein Distance
ABC Braille [4]	96.69	85.99	96.47
Angelina [5, 6]	83.85	79.55	90.69
OUR MODEL	59.41	57.27	30.38
Edge Detection [7]	40.8	34.22	-17.65

Table 2. Performance scores obtained for English test dataset comprising of 11 full length braille image pages (5 chapters)

Language	Jaro Winkler	Jaro Similarity	Levenstein Distance
English	59.41	57.27	30.38
Tamil	66.80	58.50	40.00

Table 3. Performance scores obtained for English and Tamil

Inferences

- A novel OBR with multi-stage processing approach for translating whole single-sided printed braille documents has been built.
- The main objective of easy expandability to other languages is achieved.
- The tool is available in different forms like web app, mobile app, API for ease of use and accessibility.

References

1. *Tribune India Article: India Blind Population.* https://www.tribuneindia.com/news/archive/nation/india-home-to-20-per-cent-of-world-s-visually-impaired-738048
2. *Borgen Magazine - Braille Literacy.* https://www.borgenmagazine.com/braille-education/
3. *AI4GoodLab McGill University, Braille Cell Dataset.* https://ai4goodlabstg3.wpengine.com/
4. *ABC Braille.* https://abcbraille.com/
5. *Angelina Braille Reader.* https://angelina-reader.ru/?language=EN
6. Ilya G Ovodov. "Optical Braille recognition using object detection CNN". In: *arXiv preprint arXiv:2012.12412* (2020)
7. *Edge Detection.* https://github.com/MarynaLongnickel/Braille