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Braille to Text and Voice Using Convolutional Neural Network

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Abstract: Braille is an essential communication system for visually impaired individuals, but converting printed Braille into digital text and speech remains a major challenge. This paper presents an intelligent Braille Recognition System using Convolutional Neural Networks (CNN) for recognizing Braille characters from images and converting them into readable text and speech output. The proposed system uses MobileNetV2 architecture along with OpenCV-based image preprocessing techniques such as grayscale conversion, adaptive thresholding, segmentation, and noise reduction to improve recognition accuracy. The recognized Braille text is converted into speech using the pyttsx3 Text-to-Speech engine, enabling real-time audio output. The system provides a user-friendly web interface developed using Flask, HTML, CSS, and JavaScript for uploading images and viewing results. Experimental results demonstrate high recognition accuracy and efficient real-time performance. The proposed system improves accessibility, promotes inclusivity, and helps visually impaired individuals access printed Braille documents independently.
Keywords: Braille Recognition, CNN, MobileNetV2, Deep Learning, Text-to-Speech, OpenCV, Assistive Technology.

I. INTRODUCTION

Braille is a tactile writing system used by visually impaired individuals for reading and writing through raised dot patterns. Even though Braille plays an important role in education and communication, converting physical Braille documents into digital text remains difficult. Manual transcription is time-consuming and requires trained experts.

This project proposes an AI-based Braille Recognition System that converts Braille images into text and voice using deep learning and image processing techniques. The system uses OpenCV for preprocessing and MobileNetV2 CNN architecture for Braille character recognition. The recognized text is converted into speech using pyttsx3 Text-to-Speech technology.

The proposed system improves accessibility and helps visually impaired users access information independently through automated text and voice generation.

II. LITERATURE SURVEY

1) Braille-to-Text and Voice Conversion Using CNN: Bangar P., Deshmukh S., and Patil A. proposed a CNN-based Braille-to-text and speech conversion system with real-time performance and improved recognition efficiency.
2) Braille Translator using CNN and OCR: Ansari M., Shaikh F., and Khan R. developed a Braille translator using CNN and OCR techniques for converting Braille into English text.
3) Bidirectional Braille-Speech Communication: Pérez-Aguirre A. et al. introduced a bidirectional Braille-speech communication system for deafblind individuals using deep learning and speech technologies.
4) Image Preprocessing for Optical Braille Recognition: Shirsekar A., Patil D., and Mahajan S. focused on image preprocessing techniques such as noise removal and edge detection for Optical Braille Recognition systems.

III. PROBLEM STATEMENT

Printed Braille documents are difficult to digitize efficiently using manual methods. Existing solutions either require expensive hardware or fail to provide accurate recognition and speech output. Variations in image quality, lighting conditions, and Braille dot alignment create additional recognition challenges.The project aims to develop an automated system capable of converting English Braille images into digital text and speech using deep learning and image processing techniques.

IV. OBJECTIVES

1) To recognize English Braille characters from images using CNN.
2) To preprocess Braille images using OpenCV techniques.
3) To convert recognized Braille into readable text.

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4) To generate voice output using Text-to-Speech technology.
5) To develop a user-friendly web application for accessibility.

V. METHODOLOGY

The methodology consists of the following stages:

1) Image Acquisition
2) Image Preprocessing
3) Braille Segmentation
4) CNN-based Character Recognition
5) Text Generation
6) Translation (Optional)
7) Text-to-Speech Conversion

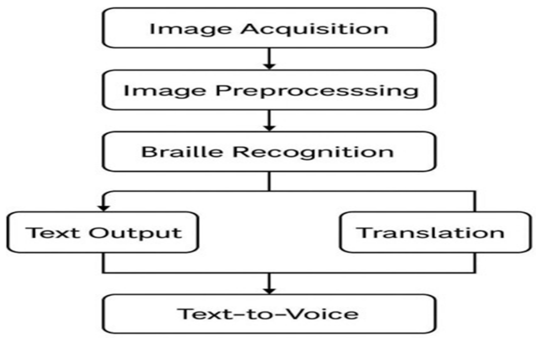

Fig 1. Data Flow Diagram

1) Image Acquisition: The system allows users to upload Braille images through a web interface. Images may be captured using a scanner, mobile camera, or digital camera.
2) Image Preprocessing: The uploaded image undergoes grayscale conversion, adaptive thresholding, Gaussian blur, and noise removal using OpenCV.
3) Braille Recognition: The segmented Braille cells are passed into the MobileNetV2 CNN model for character classification.
4) Text Generation: Recognized Braille characters are combined to form meaningful English words and sentences.
5) Text-to-Speech Conversion: The recognized text is converted into speech using the pyttsx3 engine.

VI. SYSTEM ARCHITECTURE

The system follows a client-server architecture where the frontend allows users to upload Braille images and the backend performs preprocessing, segmentation, deep learning inference, and speech generation. The MobileNetV2 CNN model classifies Braille cells into corresponding English characters. The generated text is optionally translated and converted into speech using pyttsx3.

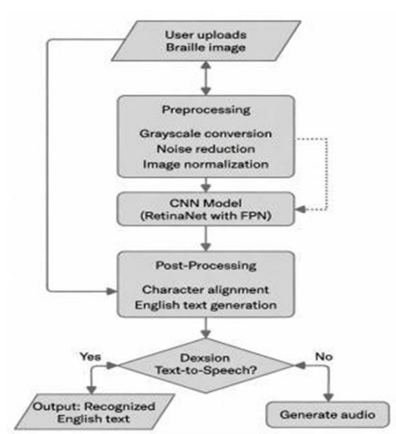

Fig 2. Functional Workflow

A. Modules Used

1) Input Module: Used for uploading Braille images.
2) Preprocessing Module: Performs image enhancement and segmentation.
3) CNN Recognition Module: Recognizes Braille characters using MobileNetV2.
4) Text Processing Module: Forms English sentences from predicted characters.
5) Text-to-Speech Module: Converts recognized text into voice output.

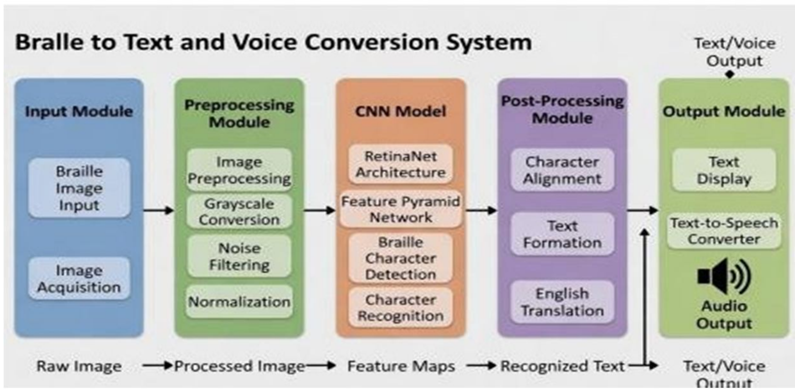

Fig 3. Block Diagram of Braille to Text and Voice Conversion System

VII. IMPLEMENTATION

The backend is implemented using Python and Flask. OpenCV is used for image preprocessing and segmentation. MobileNetV2 CNN architecture is used for Braille recognition. Frontend technologies include HTML, CSS, and JavaScript. The pyttsx3 library generates real-time speech output from recognized text.

Tools and Technologies

1) Python
2) Flask
3) OpenCV
4) TensorFlow
5) MobileNetV2
6) HTML
7) CSS
8) JavaScript
9) pyttsx3

VIII. RESULTS AND DISCUSSION

The system was tested using multiple Braille image samples under different lighting and resolution conditions. The CNN model achieved approximately 92–95% recognition accuracy under well-lit conditions .The system successfully converted Braille images into readable English text and generated clear speech output in real time.

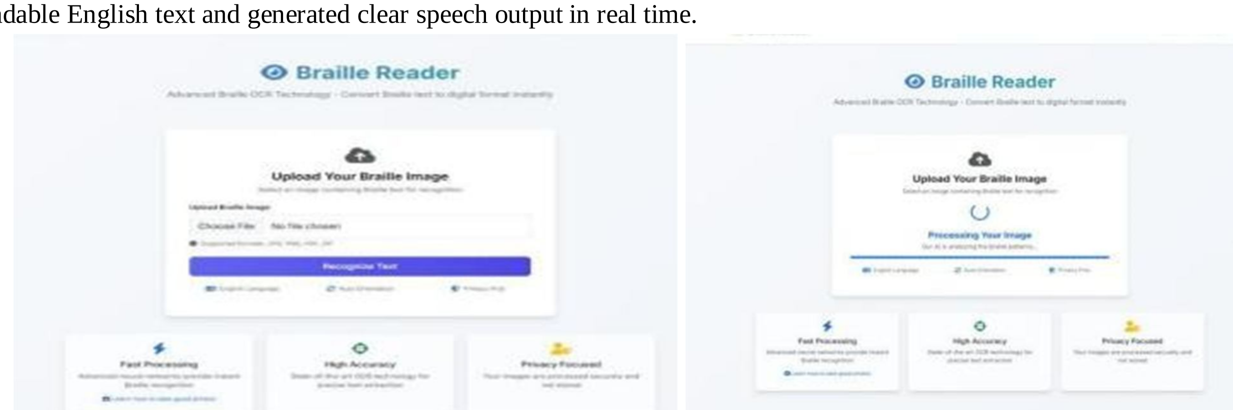

Fig 4. Result Page / Output Screenshot

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A. Experimental Results

Test Case   Output
HELLO   Correctly Recognized
BRAILLE IS A POWERFUL COMMUNICATION TOOL Correctly Recognized Voice Output   Generated Successfully
Translation Output   Generated Successfully

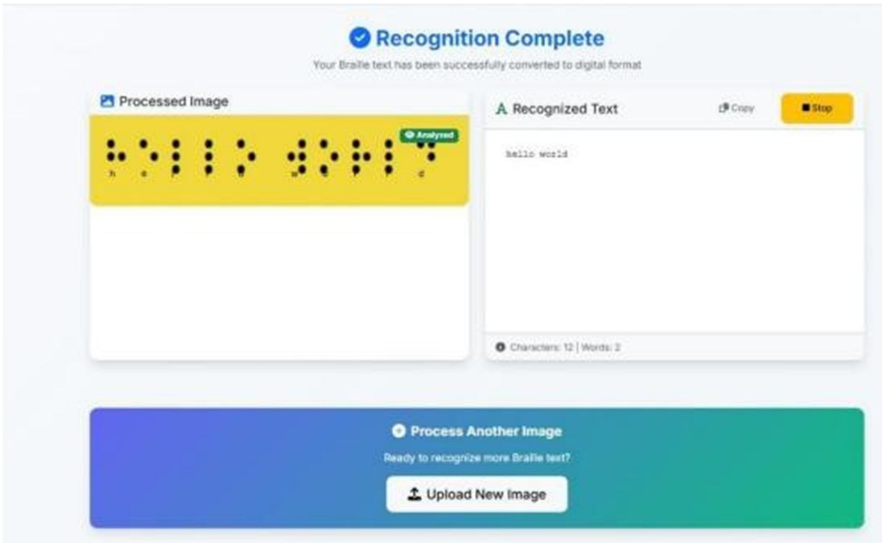

Fig 5. Output Screenshot

B. Advantages of the System

1) High recognition accuracy
2) Real-time speech generation
3) User-friendly interface
4) Lightweight deployment

IX. CONCLUSION

The Braille to Text and Voice Conversion System successfully demonstrates the integration of deep learning, image processing, and speech technologies for improving accessibility. The system accurately recognizes Braille characters from images and converts them into text and speech output. The project promotes inclusivity and provides an effective assistive technology solution for visually impaired individuals. Future enhancements may include multilingual Braille support, mobile application integration, and real-time camera-based recognition.

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