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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

"EDUABLE: AN ACCESSIBLE LEARNING APP FOR VISUALLY AND HEARING IMPAIRED"

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ABSTRACT

PROBLEM STATEMENT

Despite advancements in educational technology, students with visual and hearing impairments still face significant challenges in accessing and interacting with learning materials. Traditional educational tools often lack accessibility features like voice assistance, sign language interpretation, or Braille output, making it difficult for these students to learn effectively and independently. There is a pressing need for an integrated, AI-driven solution that accommodates the unique needs of differently-abled learners and provides personalized, multimodal educational support.

ABSTRACT

EduAble is an AI-powered assistive learning mobile application designed to enhance educational accessibility for visually and hearing-impaired students. The application integrates speech recognition, text-to-speech, sign language interpretation, and Braille conversion features to enable a more inclusive learning environment. Built using Java and XML, the system leverages voice assistance and computer vision to provide interactive and user-friendly learning support. By bridging communication gaps and enabling independence in accessing educational content, *EduAble* empowers differently-abled students to learn at their own pace and comfort.

INTRODUCTION

Students with visual and hearing impairments face numerous barriers in traditional learning environments, limiting their academic growth and participation.

With the advancement of AI and assistive technologies, it is now possible to design intelligent systems that cater to the specific needs of differently-abled learners.

EduAble is a mobile-based assistive learning application developed using Java and XML, incorporating AI features like speech recognition, text-to-speech, sign language interpretation, and Braille conversion.

The app offers voice assistance for visually impaired users, real-time sign language interpretation for hearing-impaired users, and OCR for reading printed text, ensuring accessible learning content delivery.

Goal of the Project:
The main objective is to create a user-friendly, intelligent, and affordable educational tool that enhances independent learning for visually and hearing-impaired students.

EXISTING SYSTEM

- **Be My Eyes**: Connects visually impaired users with volunteers for real-time video assistance, but lacks educational content or AI-based features.

- **Seeing AI:** Provides scene and object descriptions via voice, yet does not support sign language interpretation or Braille conversion.

- **Google Lookout:** Offers OCR and object recognition but is not tailored for educational environments or learning assistance.

- **Envision AI:** Focuses on general-purpose visual assistance; lacks integration of sign language or voice-based tutoring features.

- Most apps assist with daily navigation or object detection, not learning or classroom interactions.
- Educational needs like reading textbooks, converting content to Braille, or real-time tutor communication are not addressed.
- Apps rarely combine multiple accessibility features (voice, sign, Braille) in one unified platform.
- Lacks personalized learning modules or AI-driven support for hearing and visually impaired students.

PROPOSED SYSTEM

EduAble: An AI-powered accessible learning app designed specifically for visually and hearing-impaired students, integrating multi-modal support.

Voice Assistant Module: Enables hands-free navigation and interaction through speech, aiding visually impaired students in accessing content.

Sign Language Interpretation: Converts text to sign language sign language assisting hearing-impaired users in communication.

OCR to Braille Converter: Reads printed/handwritten educational content and converts it to Braille output for tactile reading.

Camera-Based Book Reader: When the camera is accessed, the app uses OCR to recognize printed book content and reads it aloud using text-to-speech, enabling visually impaired users to "read" physical books.

Tutor Connection Feature: Allows users to connect with real-time tutors through accessible interfaces for guided learning support.

Combines multiple accessibility technologies (voice, sign, OCR, Braille) into a single education-focused app.

LITERATURE SURVEY

Paper Name	Objective	Methodology	Algorithm	Merits	Demerits
M. P. Paulraj and R. Jegadeesan, “Portable Braille Tutor with Speech Output,” ICACCI, 2014	Develop a portable Braille tutor system that provides speech output.	Utilizes Braille input with speech synthesis to aid in learning.	Braille input + Speech synthesis (e.g., text-to-speech).	Portable and cost-effective; helps visually impaired individuals learn Braille.	Requires high-quality Braille input and clear speech output.
F. Chollet, “Xception: Deep Learning with Depthwise Separable Convolutions,” CVPR, 2017	Introduce a deep learning model using depthwise separable convolutions for improved model performance.	Depthwise separable convolutions for more efficient neural networks.	Xception model (Depthwise Separable Convolution).	Reduces computational cost; improves performance in image recognition tasks.	Limited applicability to other types of tasks; requires careful tuning for different datasets.
S. Amiriparian et al., “Deep Learning for Voice-Based Emotion Recognition,” Interspeech, 2017	Develop a deep learning system for recognizing emotions from voice inputs.	Deep learning techniques for extracting emotional features from speech.	CNN and RNN for emotion classification.	High accuracy in emotion detection; works with various emotional tones.	Sensitive to noise in audio; requires high-quality voice inputs for accurate results.
W. Zhao and Y. He, “Real-Time Speech-to-Text with Transformer Encoders,” ICASSP, 2021	Improve real-time speech-to-text conversion using transformer-based models.	Transformer encoder models for real-time speech recognition.	Transformer-based encoders for speech-to-text.	High accuracy for real-time transcription; robust to noise.	Requires large datasets; struggles with diverse accents and noisy environments.
Y. Zhang and Y. LeCun, “Text Recognition Using Deep Learning,” LNCS, 2011	Investigate deep learning approaches for accurate text recognition from images.	Deep learning models (CNNs) for text recognition in images.	Convolutional Neural Networks (CNN).	High accuracy in recognizing text from images; robust to various fonts.	Requires a lot of labeled data; struggles with cursive and handwritten text.

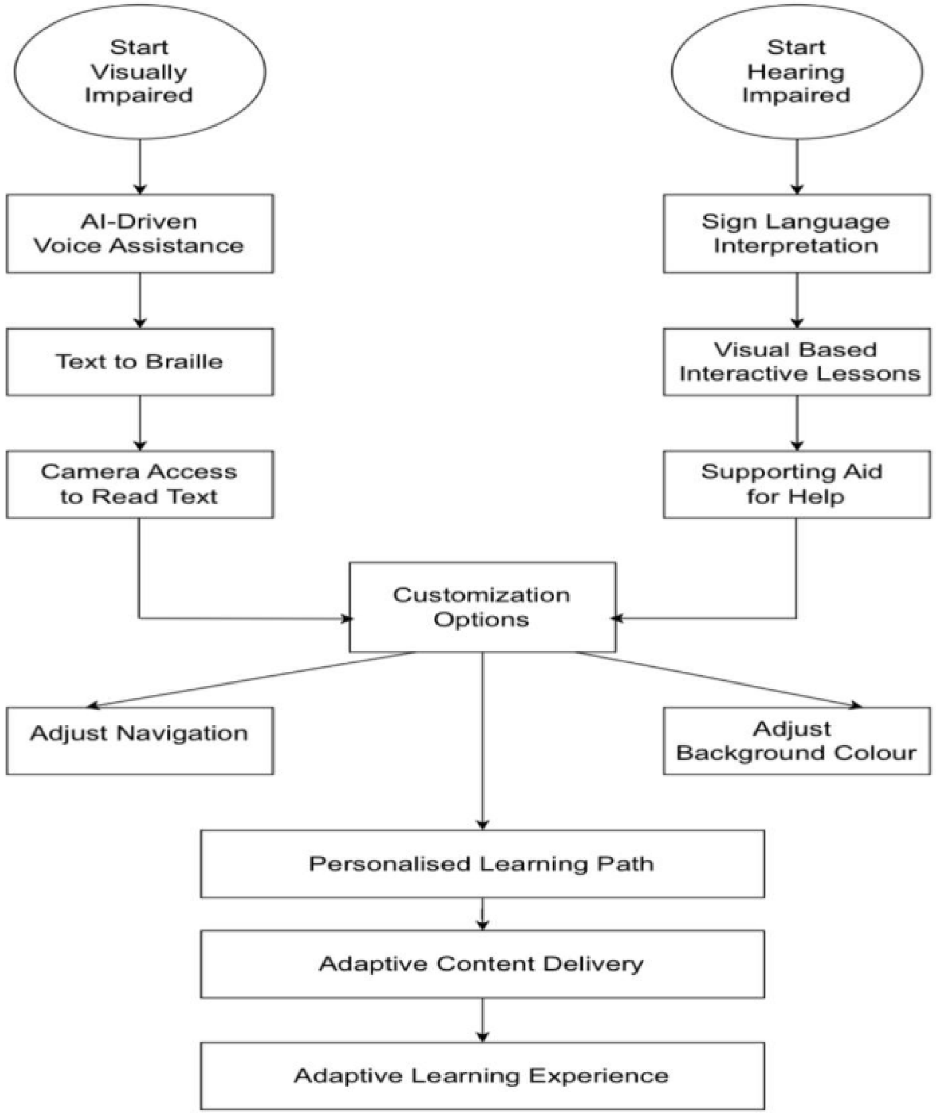
LITERATURE SURVEY

Paper Name	Objective	Methodology	Algorithm	Merits	Demerits
S. Sundaram and S. Narayanan, "Audio-Visual Speech Recognition Using Deep Learning," ACM Multimedia, 2014	Combine audio and visual features for improved speech recognition.	Deep learning models that integrate both audio and visual cues for speech recognition.	CNN for visual features + LSTM for audio features.	Improved recognition accuracy in noisy environments.	Complex system requiring substantial computational resources.
K. Wang, M. Bansal, and C. L. Zitnick, "Deep Structured Output Learning for Unconstrained Text Recognition," CVPR, 2012	Apply deep structured learning to text recognition in unconstrained environments.	Deep learning models for recognizing text in unconstrained scenarios, such as street signs.	Structured output learning models.	Effective for recognizing text in real-world images, such as street signs and natural scenes.	Performance degrades with low-quality images and complex backgrounds.
S. Ruder, "An Overview of Multi-Task Learning in Deep Neural Networks," arXiv preprint, 2017	Provide a comprehensive overview of multi-task learning and its applications in deep neural networks.	Review of various multi-task learning techniques in neural networks.	Multi-task learning algorithms (shared and task-specific layers).	Allows models to learn from multiple tasks simultaneously, improving generalization.	Requires carefully designed tasks and datasets; can lead to underperformance on specific tasks.
S. Sarkar and R. Sen, "Accessible AI Systems for the Differently Abled: A Survey," ACM Computing Surveys, 2022	Survey AI technologies designed to help differently-abled individuals.	Comprehensive survey of AI-based systems aiding accessibility for the differently-abled.	AI models for accessibility (speech, gesture, vision, etc.).	Broad survey of various AI systems aimed at accessibility; informative for researchers.	High-level overview; lacks in-depth technical analysis of specific systems.

LITERATURE SURVEY

Paper Name	Objective	Methodology	Algorithm	Merits	Demerits
E. Kazakos, A. Nagrani, A. Zisserman, and D. Damen, “Sign Language Recognition Using Temporal Convolutional Networks,” CVPR, 2019	Develop a sign language recognition system using temporal convolutional networks (TCN).	Temporal Convolutional Networks (TCNs) for modeling temporal dependencies in sign language videos.	Temporal Convolutional Network (TCN).	Effective at recognizing sequential gestures; works well for real-time applications.	Struggles with highly diverse datasets; limited performance with continuous signs.
N. C. Camgoz, O. Koller, S. Hadfield, and R. Bowden, “Sign Language Transformers: Joint End-to-End Sign Language Recognition and Translation,” CVPR, 2020	Integrate sign language recognition and translation in a joint end-to-end model using transformers.	Transformer models for joint recognition and translation of sign language gestures.	Transformer.	Unified system for recognition and translation; achieves high accuracy for both tasks.	Computationally expensive; requires large datasets for training.
H. Gupta, K. Bali, M. Choudhury, and B. Srivastava, “OCR and NLP for Multilingual Indian Languages: Challenges and Techniques,” LREC, 2020	Address challenges in OCR and NLP for multilingual Indian languages.	Uses deep learning models and NLP techniques for multilingual OCR.	Deep Learning + NLP models.	Supports multiple languages; provides an effective solution for OCR in regional languages.	High computational cost; accuracy declines with complex scripts.

ARCHITECTURE



MODULES DESCRIPTION

- **1. Voice Assistant Module**

Allows visually impaired users to navigate the app and access content through voice commands. Provides hands-free interaction for easier control and accessibility.

- **2. Sign Language Recognition and Translation**

Recognizes sign language gestures and converts them into text or speech for seamless communication between hearing-impaired users and others. Enables real-time sign language translation.

- **3. OCR-Based Text Recognition**

Uses Optical Character Recognition (OCR) to scan and extract text from printed documents or books, converting it into a digital format for further processing, such as reading aloud.

- **4. Text-to-Braille Conversion**

Translates printed or digital text into Braille for tactile reading by visually impaired students, ensuring they have access to educational content in Braille format.

- **5. Camera-Based Book Reader**

Leverages the camera to scan physical books or documents and uses OCR to convert printed text to speech, allowing visually impaired users to read books independently.

- **6. AI-Powered Tutor Connection**

Connects users with real-time tutors for personalized learning, offering support through voice or sign language for an inclusive and accessible educational experience.

SUSTAINABLE DEVELOPMENT GOALS ADHERED AND JUSTIFICATION

1. **SDG 4: Quality Education:** Promotes inclusive education for visually and hearing-impaired students.

2. **SDG 10: Reduced Inequality:** Bridges the accessibility gap in education, reducing inequalities.

3. **SDG 8: Decent Work and Economic Growth:** Enhances employability and career prospects for differently-abled individuals.

4. **SDG 3: Good Health and Well-being:** Supports overall well-being and mental health through accessible education.

METHODOLOGY

- **1. Dataset Preparation:**

Trained model using sign language gesture-to-text pairs.

- **2. Gesture-to-Text/Voice Translation:**

Integrated Google Speech Recognizer and Text-to-Speech libraries for real-time translation.

- **3. Feature Extraction:**

Used Android framework and machine learning techniques (CNNs) to process sign language gestures.

- **4. Backend & Database Integration:**

Developed backend in Java, communicating with Firebase database for real-time data management.

- **5. Frontend Implementation:**

Designed user interface using XML in Android Studio.

- **6. Model Evaluation:**

Evaluated using accuracy, BLEU score, and real-time latency metrics.

- **7. Visualization and Interpretation:**

Provided visual feedback for real-time gesture recognition and translation.

SCALABILITY

- **Modular Architecture**: Allows for easy feature additions and upgrades without system disruption.
- **Cloud-Based Database (Firebase):** Enables real-time data sync, remote access, and effortless scaling for a large user base.
- **Cross-Platform Support:** Facilitates extension to other platforms (iOS, web) with minimal changes.
- **Customizable for Diverse Needs**: Adaptable for different languages, educational levels, and disabilities.

FLEXIBILITY

- **Customizable Content:** Adaptable to different languages and educational levels.
- **Modular Architecture:** Allows for easy integration of new features and technologies.
- **Support for Multiple Disabilities:** Can be tailored to support various disabilities and needs.
- **Regional Adaptability:** Can be customized for regional sign languages and communication methods

FEASIBILITY

- **Technical Viability:** Built using established technologies (Android, Java, Firebase) ensuring technical feasibility.

- **Scalable Infrastructure:** Firebase enables real-time data sync and effortless scaling.

- **User-Centric Design:** Designed with user needs in mind, ensuring a practical and effective solution.

- **Cost-Effective Solution:** Leverages cloud-based services and open-source technologies to minimize costs.

SYSTEM REQUIREMENTS

Software Requirements

1. **Operating System:** Windows 10/11
2. **Development Platform:** Android Studio
3. **Programming Language:** Java
4. **UI Design Language:** XML
5. **Speech Libraries:** Google Speech Recognizer, Android Text-to-Speech (TTS)
6. **Database:** Firebase Realtime Database or Firestore

Hardware Requirements

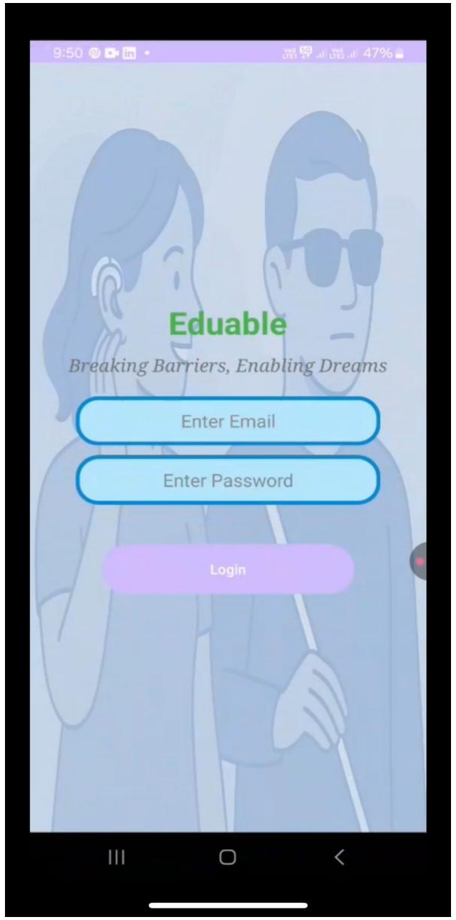
1. Processor: Intel Core i3 / AMD Ryzen 3 or higher

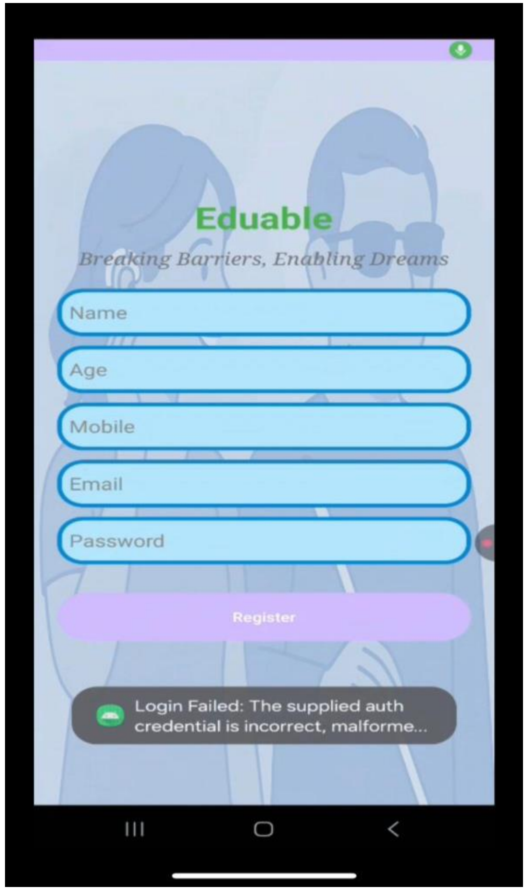
2. RAM: 8 GB

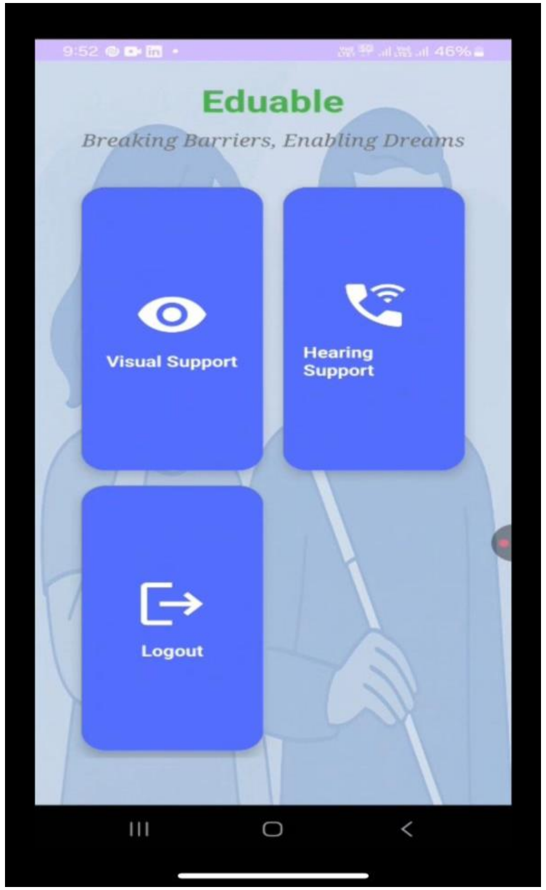
3. Storage: 256 GB SSD

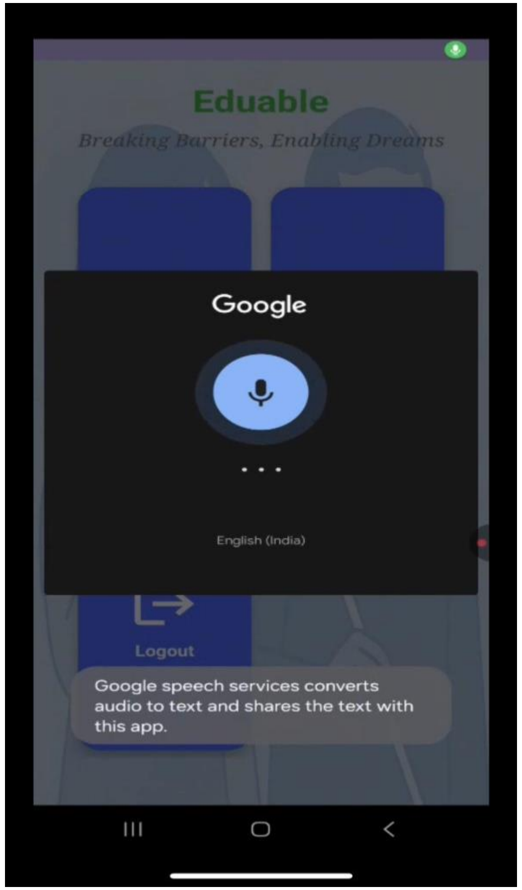
4. Graphics: Integrated GPU5. Device: Android device (API Level 24 or above for testing)

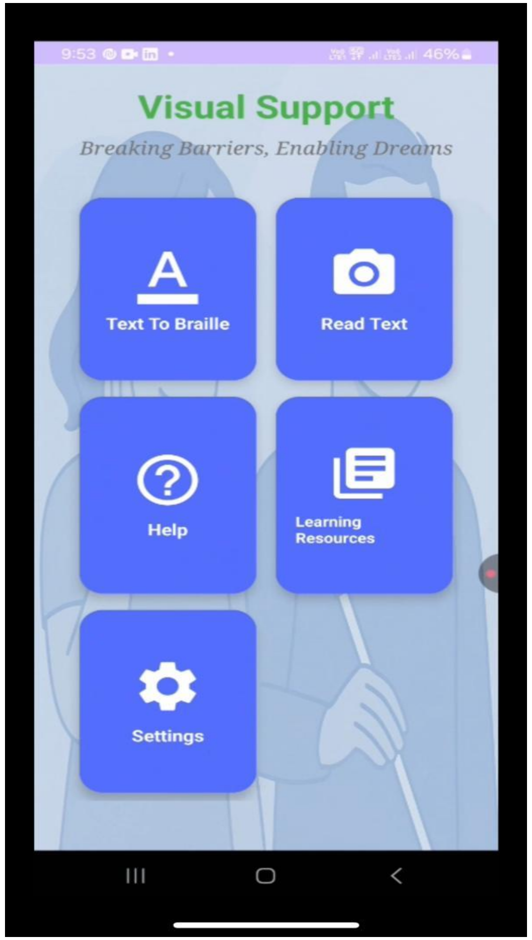
RESULT & DISCUSSION







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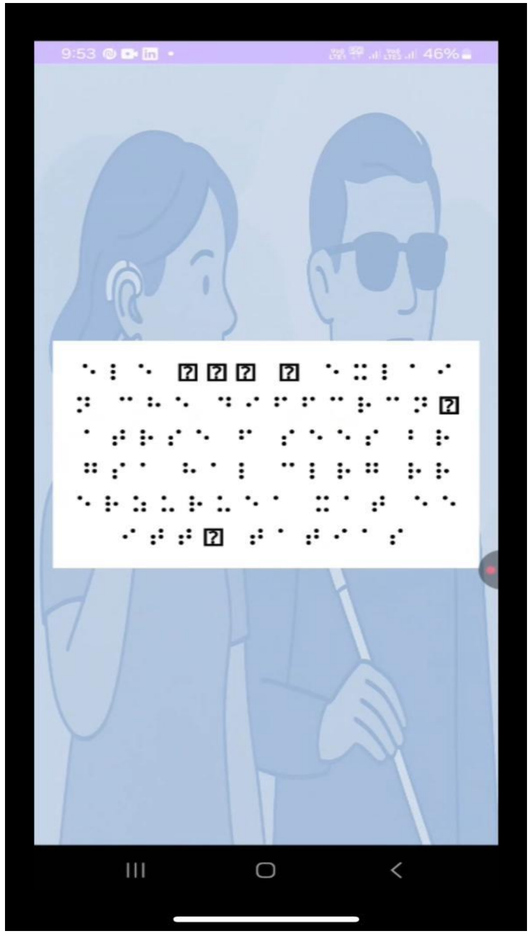
Visual Support
Breaking Barriers, Enabling Dreams
Text To Braille
Read Text
Help
Learning Resources
Settings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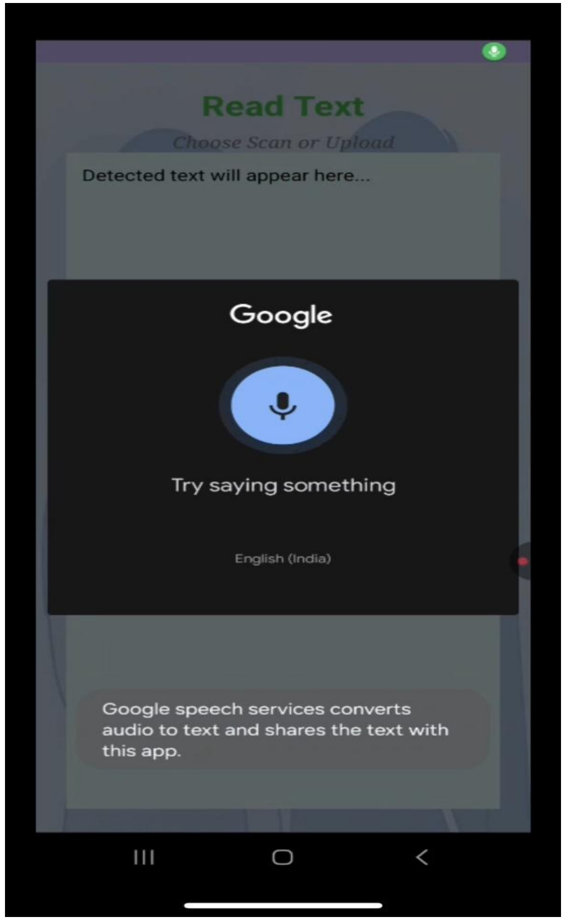
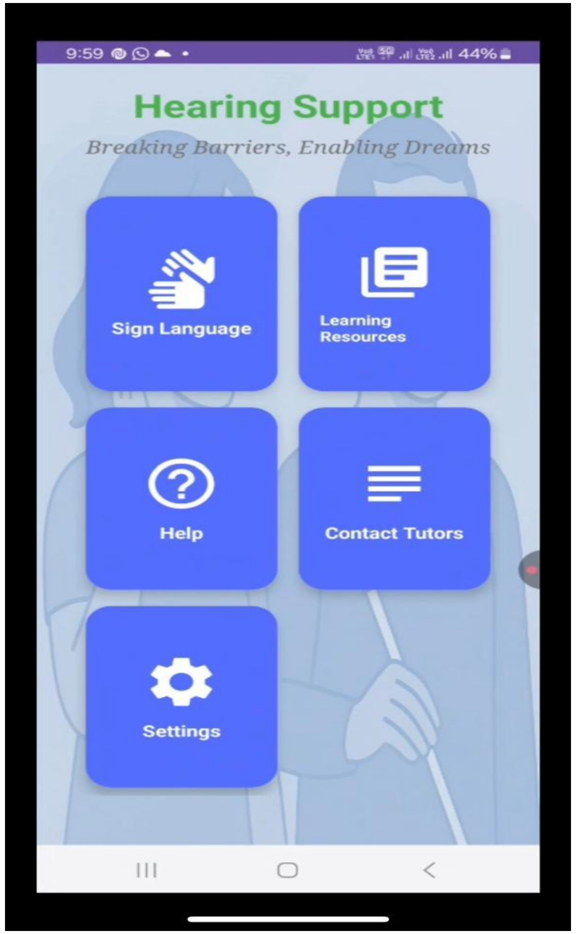

Read Text
Choose Scan or Upload
Detected text will appear here...
Google
Try saying something
English (India)
Google speech services converts audio to text and shares the text with this app.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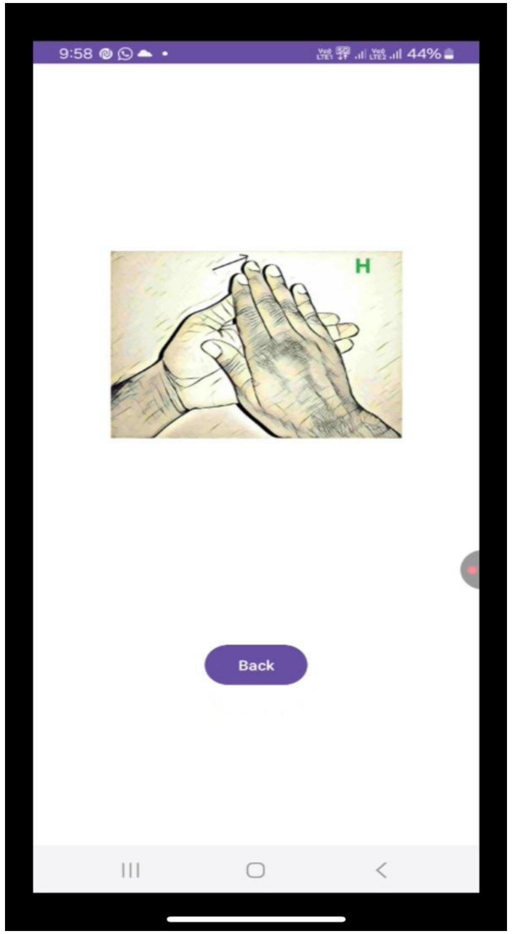
Hearing Support
Breaking Barriers, Enabling Dreams
Sign Language
Learning Resources
Help
Contact Tutors
Settings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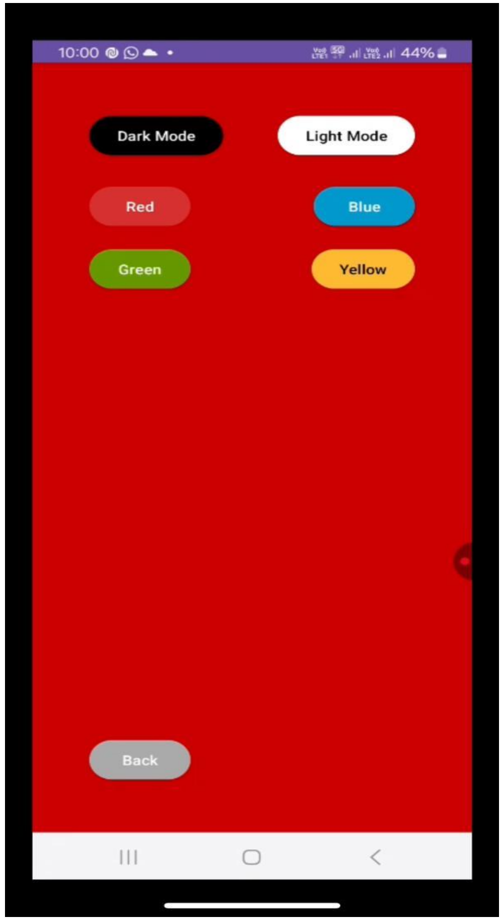
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Dark Mode
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Red
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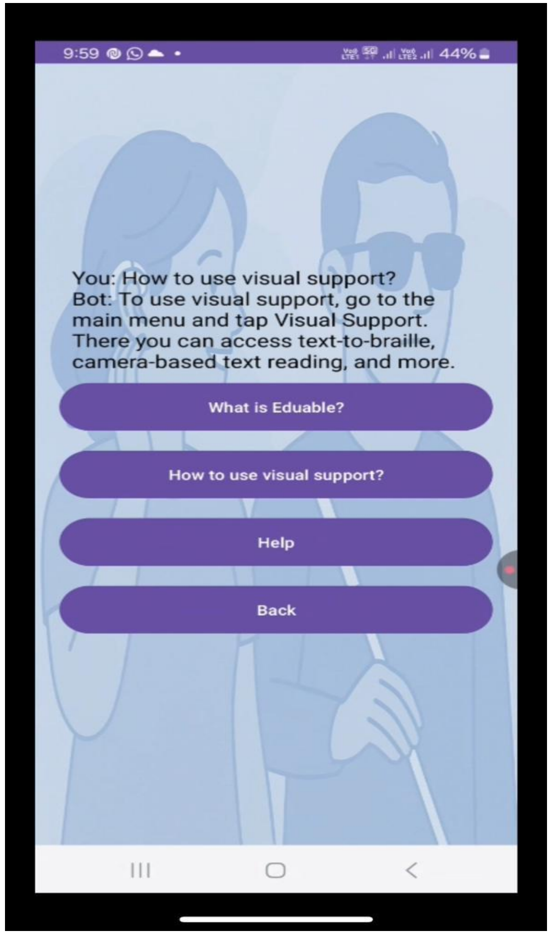
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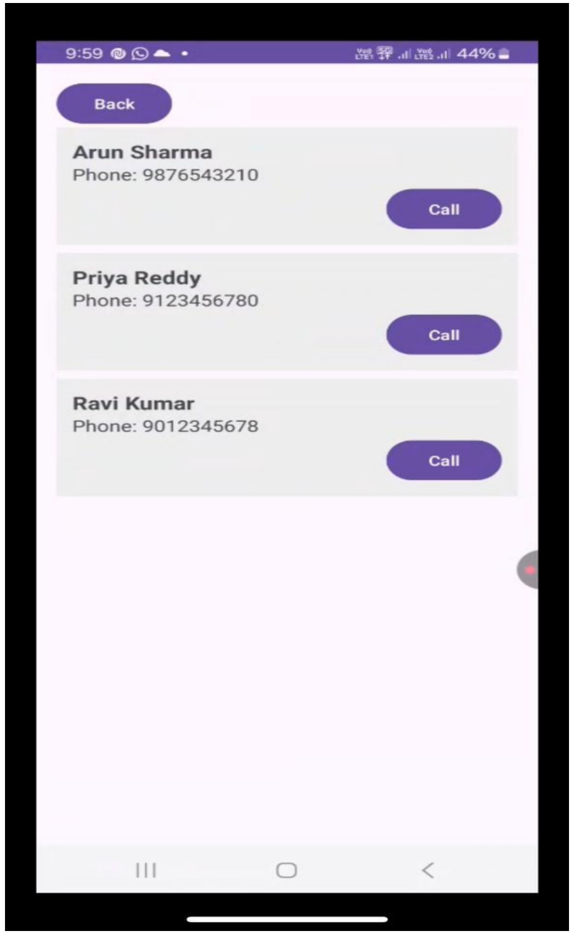
You: How to use visual support?
Bot: To use visual support, go to the main menu and tap Visual Support. There you can access text-to-braille, camera-based text reading, and more.
What is Eduable?
How to use visual support?
Help
Back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Arun Sharma
Phone: 9876543210
Call
Priya Reddy
Phone: 9123456780
Call
Ravi Kumar
Phone: 9012345678
Call

CONCLUSION

The EduAble project is a pioneering step toward creating an inclusive educational environment for visually and hearing-impaired students by integrating technologies like AI-driven voice assistants, sign language recognition, OCR-based text-to-speech, and Braille support. By addressing key Sustainable Development Goals such as quality education, reduced inequality, and good health and well-being, the app ensures accessible learning opportunities for all students, regardless of disability. With features like camera-based book reading, real-time tutor connections, and adaptive learning systems, EduAble empowers students to overcome barriers in education and achieve academic success. This project not only embraces technological innovation but also prioritizes inclusivity, paving the way for a more equitable and accessible future in education.

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Query?

THANK YOU !