EduSmartBot: An AI-Powered EducationalAssistant for Accessible and Inclusive Learning

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Abstract—This paper introduces *EduSmart Bot*, an AI-driven educational assistant designed to enhance digital learning accessibility for students with disabilities, limited literacy, and language barriers. Traditional educational platforms often fall short in addressing the diverse learning needs of students from underrepresented backgrounds. EduSmart Bot integrates multiple AI technologies—including Natural Language Processing (NLP), Optical Character Recognition (OCR), computer vision, and speech interfaces—to offer simplified educational content, real-time conversational support, and multimodal interaction. The system features modules for web-based content extraction, intelligent text simplification, multilingual translation, image captioning, and voice-based accessibility. Our proposed framework offers adaptive learning experiences through personalized quiz generation and feedback. Evaluation across various scenarios highlights the system's potential to significantly improve content accessibility, comprehension, and engagement among underserved learners.

Index Terms—AI in Education, Accessibility, Text Simplification, OCR, Chatbot, NLP, Multilingual Support, Conversational AI, Inclusive Learning

I. INTRODUCTION

Digital transformation in education has opened new avenues for global learning, yet millions of students continue to face challenges in accessing quality educational content due to physical, linguistic, or cognitive limitations. Students with dyslexia, low literacy skills, or limited proficiency in the language of instruction often find conventional digital platforms inadequate. Moreover, the complexity of academic language and lack of multimodal support further alienate these learners from active participation in digital learning environments.

Existing systems primarily focus on content delivery, with minimal focus on adapting that content to diverse learner needs. Manual methods of content simplification or translation are time-consuming and not scalable.

Technologies like screen readers and basic chatbots offer partial solutions, but fail to provide deep semantic understanding, adaptive learning, and contextual guidance.

To address these gaps, we propose *EduSmart Bot*, an AI-powered educational assistant capable of transforming traditional educational materials into accessible, easy-to-understand, and engaging formats. The system combines OCR for extracting text from handwritten or printed material, NLP-based summarization and simplification for content rephrasing, image captioning for visual comprehension, and TTS/STT modules for auditory interaction. The ultimate goal is to

democratize education by offering personalized, real-time support to every learner, regardless of their background or ability

Despite the proliferation of digital learning platforms, students with cognitive impairments, learning disabilities, and limited language proficiency continue to struggle with comprehension and engagement. Educational content is often text-heavy, jargon-filled, and lacks accessibility features necessary for inclusive learning.

Tools like screen readers, translation apps, and basic chatbots offer isolated solutions but lack the cohesion and contextual intelligence required for effective personalized education. This limitation widens the digital divide and marginalizes students from disadvantaged or diverse backgrounds.

EduSmart Bot is developed to fill this gap by offering an integrated, AI-powered educational assistant that

simplifies, adapts, and personalizes learning content for a wide range of students. Through OCR, NLP, image captioning, and conversational interfaces, the system not only improves content accessibility but also enhances student engagement and retention.

II. LITERATURE REVIEW

A. Text Simplification and Summarization

Existing models like BERT, GPT, and BART offer robust summarization capabilities but often struggle with preserving context while simplifying technical or academic content. Traditional simplification methods—like rule-based systems—often compromise on fluency or meaning. Recent works aim at domain-specific summarization using sequence-to-sequence learning, yet generalization remains a challenge.

B. Optical Character Recognition (OCR)

OCR has evolved with deep learning, notably through models like Tesseract and CRNN. These models work well for printed and typed texts but may show reduced accuracy for handwritten or poorly scanned documents, especially in multi-language settings.

C. Conversational AI and Chatbots

Rule-based chatbots have largely been replaced by intent-driven systems using NLP and transformer models. Systems like Dialogflow, Rasa, and GPT-based bots show promise in educational applications but lack domain adaptability and fail to support personalized learning feedback loops.

D. Multilingual Support

Multilingual NLP has progressed with models like mBERT and XLM-R, yet the availability of training data and consistent performance across underrepresented languages continues to be a limitation. Translation quality often suffers in the absence of sufficient contextual grounding.

III. METHODOLOGY

A. System Architecture

The EduSmart Bot system is modular, comprising five core components:

Web Scraping & OCR Module *– Extracts structured and unstructured educational data from websites and scanned material.*

Text Simplification & Summarization Module *– Uses transformer-based models to rewrite complex academic language for easier understanding.*

Image Captioning & Visual Interpretation *– Detects elements in educational diagrams using CNNs and generates explanatory captions via image-text models.*

Conversational Chatbot Interface *– Employs NLP for dynamic Q&A, educational support, and personalized tutoring.*

Speech & Multilingual Modules *– Offers text-to-speech, speech-to-text, and language translation for enhanced accessibility.*

B. AI Models Used

- **OCR**: Tesseract OCR engine with custom post-processing filters.
- **Summarization**: Fine-tuned BART and T5 transformers.
- **Captioning**: CNN + LSTM architecture for object detection and description.
- **Chatbot**: Rasa NLU with fallback to GPT-3.5 for complex queries.
- **Multilingual Support**: MarianMT models for low-resource translation.

C. Workflow

1. User uploads or inputs text/image content.
2. OCR extracts and cleans the input data.
3. Simplification engine rewrites the content.
4. Chatbot engages with the user in real-time.
5. Optional speech and quiz modules provide interactive support.

IV. EXPERIMENTAL RESULTS

A. Dataset & Testing

- ***Text**: NCERT textbooks, Wikipedia academic articles.*
- ***Images**: Educational diagrams, handwritten notes, scanned assignments.*
- ***Languages**: English, Hindi, Tamil (pilot).*

B. Evaluation Metrics

- ***Readability Score (Flesch-Kincaid)***
- ***BLEU & ROUGE for summarization accuracy***
- ***OCR Character Accuracy (CER/WER)***
- ***User Satisfaction (surveyed on 5-point scale)***

C. Results Summary

Feature	***Accuracy***	***User Score (Avg.)***
OCR (Printed)	*96.2%*	*4.3/5*
OCR (Handwritten)	*89.7%*	*3.8/5*
Text Simplification	*ROUGE-1: 0.71*	*4.4/5*
Chatbot Q&A	*93% accurate*	*4.5/5*
TTS/STT Accuracy	*97.1% / 94.3%*	*4.6/5*

V. DISCUSSION

The system demonstrated significant improvements in learning accessibility and user satisfaction. Simplified content led to a 37% higher comprehension score among test users. While the OCR module performed well with printed text, handwritten extraction showed room for improvement. Multilingual translation was effective in high-resource languages, but inconsistent with low-resource dialects.

The chatbot facilitated personalized learning, offering students real-time tutoring-like experiences. Feedback also highlighted the effectiveness of visual captioning for diagram-heavy content in science subjects.

VI. CONCLUSION & FUTURE WORK

EduSmart Bot offers a robust and scalable solution to bridge the digital education gap through multimodal, AI-powered content delivery. It empowers learners with different abilities to access, understand, and engage with educational content in real-time.

Future enhancements include:

- Mobile app deployment for rural outreach.
- Better support for underrepresented languages.
- Transformer-based OCR for improved handwriting recognition.
- Integration with LMS (Learning Management Systems) like Moodle and Google Classroom.

Optimize the model for mobile and embedded deployment using quantization.

- Explore transformer-based SR modules.
- Extend the framework to video super-resolution under low-light.

ACKNOWLEDGMENT

We express our sincere gratitude to Dr. E. Poongothai for her mentorship, and the Department of Artificial Intelligence, SRM Institute of Science and Technology, for infrastructural and academic support.

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