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ExamVox: A Proposed AI-Powered Voice-Based Examination Writing Device for Blind and Hand-Disabled Students

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Abstract: ***Students who are blind or cannot use their hands often depend on human scribes during written examinations, which creates problems of scribe availability, privacy, consistency and independence. This paper presents ExamVox, a proposed dedicated, sealed and offline-capable voice-driven examination writing device. The system reads questions aloud, captures spoken answers, converts speech to editable text through automatic speech recognition (ASR), and lets the student review answers through read-back before submission. The proposed architecture combines a noise-adaptive audio front end, an exam-intent router that separates answers from commands, a text formatter, speech-to-LaTeX for mathematical expressions, voice-to-SVG for simple diagrams, encrypted auto-save and a signed PDF or printed answer sheet. The hardware concept is based on a Raspberry Pi 5 with a microphone, bone-conduction earpiece, display, battery backup and a sealed enclosure, with an estimated basic cost of INR 18,000–30,000. This is a design-stage contribution: no prototype results are claimed, and the paper sets out a plan for measuring recognition accuracy, command accuracy, latency and usability.***

Keywords: ***accessible examination, assistive technology, automatic speech recognition, text-to-speech, visually impaired students, offline computing, Raspberry Pi, noise reduction, data encryption.***

I. INTRODUCTION

Written examinations are the standard way of assessing students' knowledge. Students who are blind or who cannot use their hands for writing usually need assistive technology or a human scribe. Relying on another person raises practical problems: a suitable scribe must be arranged, the quality of assistance can vary, the student's privacy is reduced, and the spoken answer may not be recorded accurately [1].

ExamVox is a proposed voice-driven examination writing device that lets an eligible student interact with an examination through audio and voice commands. It is intended to read questions aloud, convert spoken answers into text, allow review and correction, and produce a verifiable answer document. A dedicated device is proposed, instead of a general-purpose computer, so that the examination workflow can be controlled and logged.

The contributions of this paper are: (i) a requirement analysis for a scribe-free examination device for blind and hand-disabled students; (ii) a proposed hardware and software architecture; (iii) a scope, risk and cost description; and (iv) an evaluation plan. The remainder of the paper is organised as follows: Section II reviews related work, Section III states the problem and objectives, Section IV describes the proposed system, Section V lists hardware resources, Section VI defines scope and stakeholders, Section VII gives the evaluation plan, Section VIII discusses advantages and limitations, and Section IX concludes.

II. RELATED WORK

A. Voice-Based Examination Systems

Dharmasena and Jayakody [2] describe an online examination system for visually impaired students that reads questions aloud and accepts answers and navigation commands through voice. Budak et al. [3] studied a voice-assisted online exam system built on Universal Design principles with fourteen visually impaired students; audio, keyboard and screen-reading support helped students complete assessments independently, using customizable pages and biometric-based authentication. Raju et al. [5] describe a cross-platform app that lets visually impaired students take exams through voice commands or typed responses without a human scribe, and grades answers using simple natural language techniques. Tubo et al. [6] present a computer-based test guide that uses text-to-speech and speech-to-text with NLP so that students can hear questions and answer by voice; on 20 student voice recordings they report average precision, recall and F1 scores of 96%, 79% and 86%.

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B. Policy Context

The Government of India's guidelines for written examinations for persons with benchmark disabilities describe the facilities and support, including scribes, that students are entitled to [1]. This supports the need for an accessible alternative that reduces dependence on a scribe.

C. Gap Addressed

The systems above are mainly software applications running on general-purpose computers or phones, and they mostly address visually impaired students. ExamVox instead proposes a dedicated, sealed and offline-capable device that also serves students who cannot use their hands, supports spoken mathematics and simple diagrams, and produces a signed and logged answer record. Voice input has also been used as a replacement for hand use in other assistive tools; for example, Ramos et al. [7] combine head-movement pointer control with voice commands and offline speech-to-text dictation for people with upper-limb disabilities, although their interface is not designed for examinations. Open-source ASR models such as Whisper [4] are candidates for the speech recognition stage. Dutta et al. [8] ran fine-tuned tiny Whisper models faster than real time on a Raspberry Pi 5 for children's speech, while a larger model suffered thermal throttling, which shows that the model size must be chosen carefully for offline operation on this hardware.

III. PROBLEM STATEMENT AND OBJECTIVES

Blind students and students without the use of their hands may depend on a human scribe during written examinations. Finding a scribe, variation in the quality of assistance, and concerns about privacy, recording errors and misuse are recurring issues. General-purpose computer tools are also difficult to lock down for examination use. The objectives of the project are to: 1) design a dedicated, sealed and tamper-resistant examination device; 2) capture the spoken answer clearly; 3) convert speech into editable text; 4) support spoken punctuation, mathematical expressions and simple diagrams; 5) read questions and answers aloud when required; 6) provide a review mode and time alerts; 7) save answers securely and generate a verifiable document; and 8) evaluate recognition accuracy, command accuracy, latency and usability in future testing.

IV. PROPOSED SYSTEM

A. Enabling Technologies

1) *Automatic Speech Recognition*: ASR converts the student's spoken words into written text and is the core of the answer-capture function.
2) *Text-to-Speech*: TTS converts text into audio so that questions can be read aloud and recognized answers can be played back during review.
3) *Noise Reduction*: Noise reduction minimizes unwanted background sound in the audio input, which is intended to improve recognition in noisy examination halls.
4) *Offline Computing*: The device is designed to process speech and store data locally, provided the selected models can run adequately on the chosen hardware.
5) *Encryption and Access Control*: Encryption and access controls are proposed to protect the student's answers and preserve examination privacy.

B. Architecture and Workflow

The workflow of the proposed system is shown in Fig. 1. The question paper is presented to the student through audio. Speech captured by the microphone passes through a noise-adaptive front end and a multilingual ASR stage. An exam-intent router then decides whether the utterance is an answer or a command such as read, edit or flag. Answers are processed by a text formatter, a speech-to-LaTeX module for supported mathematical expressions, or a voice-to-SVG module for simple diagrams. The read-back verifier plays the text back so that the student can confirm or correct it. An integrity guard applies device controls and event logging, answers are auto-saved in encrypted form, and a signed PDF or printed answer sheet is produced at the end. The functions of the blocks are summarised in Table I.

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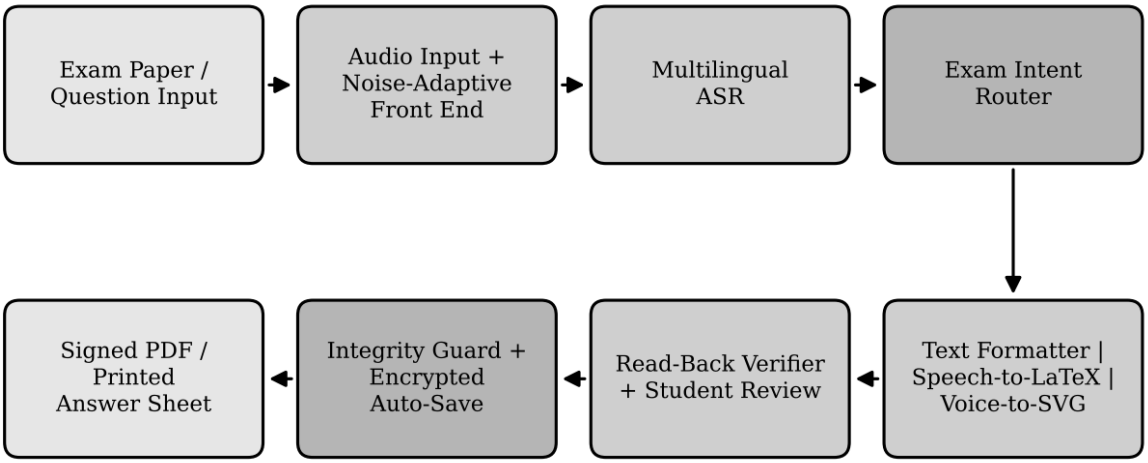


Fig. 1 Proposed ExamVox block diagram (conceptual, not a validated implementation)

TABLE I
FUNCTIONS OF THE BLOCKS IN EXAMVOX

Block	Function
Audio input	Receives speech through a microphone or supported input switch
Noise-adaptive front end	Attempts to improve speech quality in a noisy room
Multilingual ASR	Converts spoken language into text for supported languages
Exam intent router	Separates an answer from a command such as read, edit or flag
Text formatter	Organises recognized speech into readable answers and applies spoken punctuation
Speech-to-LaTeX	Represents supported mathematical expressions in a structured format
Voice-to-SVG	Creates simple supported diagrams from spoken descriptions
Read-back verifier	Reads text back and supports confirmation or correction
Integrity guard and storage	Applies device controls, encryption and event logging
Signed PDF / print	Produces the final answer document for review and verification

V. HARDWARE RESOURCES

The hardware concept uses a Raspberry Pi 5 (8 GB) as the main processing unit, a microphone for speech capture, a bone-conduction earpiece for private audio output, a display for status and review, storage with battery and UPS backup, and a sealed enclosure with physical switches. Three hardware tiers (Basic, Standard and Pro) are proposed. The estimated costs in Table II are rough values and must be confirmed with vendor quotes.

TABLE II
ESTIMATED HARDWARE COST (BASIC TIER)

Component	**Cost (INR)**	**Purpose**
Raspberry Pi 5, 8 GB	8,000–10,000	Main processing unit
Storage, battery, UPS	3,300–5,500	Data storage, power backup
Microphone	1,500–3,000	Capture speech and commands
Bone-conduction earpiece	2,000–4,000	Private audio output
Display	1,500–3,000	Status and review interface
Enclosure, seals, switches	1,500–3,500	Physical controls
Estimated total	≈18,000–30,000	Rough estimate

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VI. SCOPE AND STAKEHOLDERS

The proposed scope covers support for blind students and students without hands, offline reading and answering where the selected models permit, review mode and time alerts, spoken mathematics and voice-to-diagram for supported cases, encrypted storage with a signed PDF or printing workflow, and the three hardware tiers. Version 1 does not cover freehand drawing, official examination-board certification, support for every Indian language, or online remote proctoring.

The stakeholders are students with visual or upper-limb disabilities, the project team, the project guide and institute, accessibility experts, examination authorities who decide whether the device may be approved for formal examinations, teachers and evaluators who review the output, and data contributors who provide consented speech samples.

VII. PLANNED EVALUATION METHODOLOGY

The proposed methodology is to define requirements, design the hardware and software architecture, build a prototype, test it with consented participants and examination-like audio, measure performance, and refine the system using accessibility feedback. Planned measures are word error rate (WER) of the ASR output, command accuracy of the intent router, response latency on the selected hardware, accuracy of spoken mathematics and diagrams, and student-reported usability. No prototype results are reported in this paper, and any claimed improvement will need to be supported by measured results.

VIII. ADVANTAGES AND LIMITATIONS

A. Advantages

ExamVox may reduce dependence on a human scribe and is designed for both blind students and students who cannot use their hands. Offline-capable operation may reduce dependence on internet connectivity. Read-back and review may help students find recognition mistakes, and encrypted saving with an audit trail is intended to improve privacy and verifiability. After evaluation, the design could be extended to other accessibility needs.

B. Limitations

Noise in examination halls may reduce recognition accuracy, and mathematical expressions and diagrams may be hard to dictate accurately. Language coverage and data for speech disabilities may be limited. Examination authorities may not approve the device for formal use without evaluation and certification. The hardware may cost more than a basic mobile application, raw audio and examination data create privacy and security responsibilities, and offline operation depends on whether the selected models run adequately on the chosen hardware.

C. Risk Reduction

TABLE III
RISKS AND POSSIBLE MITIGATION

Risk	Possible mitigation for future testing
Incorrect transcription	Confidence thresholds, read-back, correction commands and measured WER
Background noise	Microphone placement, noise testing and suitable audio processing
Unauthorised access or tampering	Sealed enclosure, restricted software, logs and security review
Data privacy	Data minimisation, encryption, access controls and retention rules
Accessibility barriers	Co-design with students and accessibility experts
Approval uncertainty	Early consultation with examination authorities and pilot evaluation

IX. CONCLUSION AND FUTURE WORK

This paper proposed ExamVox, a voice-driven examination writing device for blind students and students without hands. It combines question read-out, spoken answer capture, speech recognition, review, secure storage and verifiable output in one dedicated workflow. The concept responds to scribe availability, privacy and independence concerns, but its performance and suitability for real examinations have not yet been established. Future work is to build a working prototype, verify offline performance on the selected hardware, test recognition under examination-like noise, measure WER and command accuracy, evaluate usability with consented participants, and consult accessibility experts and examination authorities.

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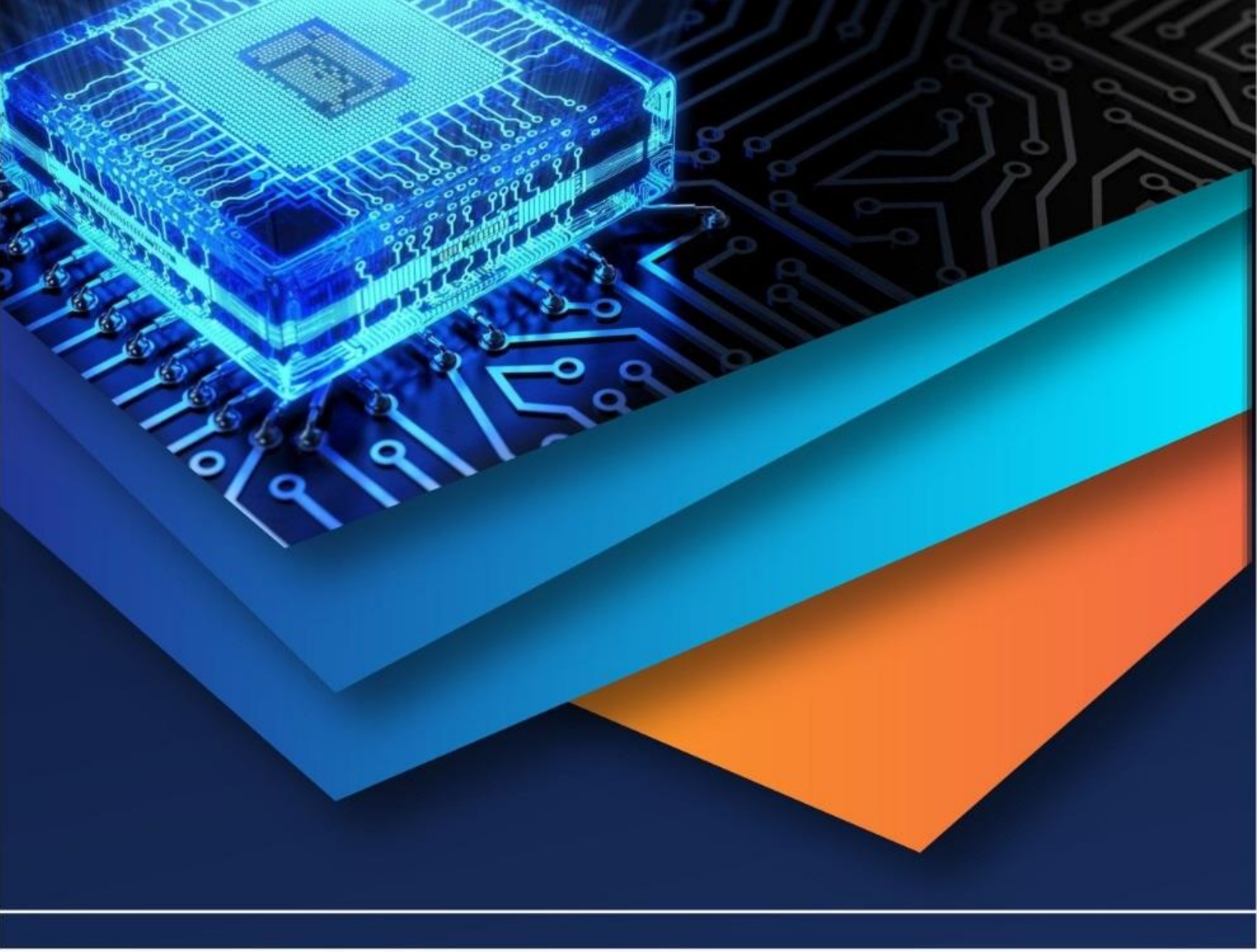
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