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NeuroNote: Adaptive AI Support for Neurodivergent Learning Using an Attention-Aware Mobile Application

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Abstract: ***Online learning platforms often rely on passive video lectures, which can be challenging for learners who experience attention difficulties, particularly neurodivergent learners. Many students struggle to maintain focus during long lectures and may miss important explanations without realizing it.***
This paper presents NeuroNote, a mobile learning application designed to assist learners by monitoring attention during lecture playback and providing interactive learning support. The system detects user distraction using camera-based gaze monitoring and pauses the lecture when attention loss is detected. A flashcard summarizing the missed lecture segment is then displayed to reinforce understanding.
In addition, the application provides automatic lecture transcription and summary generation to help learners review key concepts efficiently. The system is implemented using Flutter for mobile development, SQLite for local data storage, and Supabase for optional cloud synchronization. The proposed system demonstrates how attention-aware learning tools can support neurodivergent learners and improve engagement in digital learning environments.
Keywords: Neurodivergent Learning, Attention Monitoring, Mobile Learning, Flashcards, Gaze Detection.

I. INTRODUCTION

Digital learning platforms have significantly increased access to educational resources, particularly through recorded video lectures. However, many learners struggle to maintain attention during long lectures, which can result in missing important explanations and reduced knowledge retention.

This challenge is particularly common among neurodivergent learners, such as students who experience attention-related difficulties. Traditional e-learning systems rarely provide mechanisms to detect distraction or help learners recover missed information during a lecture session.

To address this problem, this project proposes NeuroNote, a mobile learning support system that integrates attention monitoring and automated learning assistance. The application monitors user attention during lecture playback and pauses the lecture when distraction is detected. The system then presents a flashcard containing key content from the missed lecture segment, allowing the learner to quickly recall the concept before continuing the lecture.

In addition to distraction detection, NeuroNote also generates lecture notes by transcribing the lecture audio and extracting important content. These features enable learners to review key concepts efficiently and improve learning retention.

II. PROBLEM STATEMENT

Online learning platforms primarily rely on passive video-based lecture delivery, which does not actively support learners who experience attention difficulties. Many students, particularly neurodivergent learners, struggle to maintain focus during long lecture sessions, leading to missed information, reduced comprehension, and poor retention of key concepts.

Existing e-learning systems do not provide mechanisms to detect when a learner is distracted or to assist them in recovering missed content in real time. As a result, learners often need to rewatch entire lectures, which is time-consuming and inefficient. Additionally, traditional platforms lack automated tools for generating structured notes and summaries that can help learners quickly revise important topics. Therefore, there is a need for an intelligent and adaptive learning system that can monitor user attention during lecture playback, detect distraction in real time, and provide immediate support through features such as flashcards, transcription, and summarized notes. Such a system can enhance engagement, improve learning efficiency, and support neurodivergent learners in digital learning environments.

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III. LITERATURE SURVEY

Several studies have explored the use of technology to improve engagement and attention in digital learning environments. Attention monitoring techniques such as gaze tracking have been used to identify learner engagement levels during educational activities.

Research on automated note generation and lecture transcription has also demonstrated that converting lecture audio into text can significantly improve learning accessibility and review efficiency. These approaches reduce cognitive load and help learners quickly revisit important information. Inspired by these approaches, the NeuroNote system integrates attention monitoring and automated lecture transcription within a mobile application to provide interactive learning support for students.

Several research works have explored the use of gaze tracking systems for monitoring user attention in digital environments. Gupta et al. [1] proposed a smartphone-based eye tracking system that uses edge intelligence to improve efficiency and reduce computational cost. This approach highlights the potential of real-time attention monitoring in mobile applications.

Similarly, Nair and Verma [2] discussed the use of Generative AI in enhancing learning experiences for neurodivergent students. Their work emphasizes adaptive learning systems that personalize content delivery based on individual learning patterns.

Yamamoto et al. [3] explored deep learning-based gesture recognition systems, which demonstrate how computer vision techniques can be used to interpret user behavior and improve accessibility. Roberts and Bhattacharya [4] introduced an AI-based dyslexia detection framework that supports early intervention, showcasing the importance of AI in inclusive education systems.

IV. PROPOSED SYSTEM / METHODOLOGY

The NeuroNote system follows a structured workflow to monitor user attention and provide adaptive learning support. Initially, the user selects and plays a video lecture within the application. The system continuously monitors the user's gaze using the device camera to determine attention levels. If the system detects that the user is distracted, it automatically pauses the lecture. At this point, a flashcard is generated using the lecture transcript corresponding to the missed segment. This flashcard helps the user quickly recall the key concept before continuing. The system also processes lecture audio to generate textual notes and summaries. These notes are stored locally and can be reviewed later by the user for revision. This workflow ensures that users do not miss important information and can maintain engagement throughout the learning session. The system ensures minimal delay in detecting distraction and generating flashcards, thereby maintaining continuity in learning. The workflow is optimized for real-time performance, ensuring that users receive immediate feedback and support during the learning process.

V. IMPLEMENTATION

The NeuroNote system demonstrates how attention monitoring and automated note generation can improve learning engagement. During testing, the system successfully detected distraction events and displayed flashcards corresponding to the missed lecture segments. The generated transcripts and summarized notes also provided an effective method for reviewing lecture content without rewatching the entire lecture. These features support active recall and help learners recover missed information more efficiently.

The system was implemented as a Flutter mobile application. The application integrates video playback, gaze monitoring, automatic transcription, and flashcard generation modules to provide attention-aware learning support. The system was tested using sample lecture videos to evaluate its functionality.

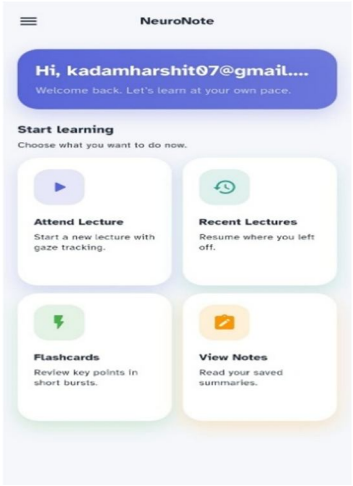


Fig. 1: Home Screen of NeuroNote mobile application showing learning modules.

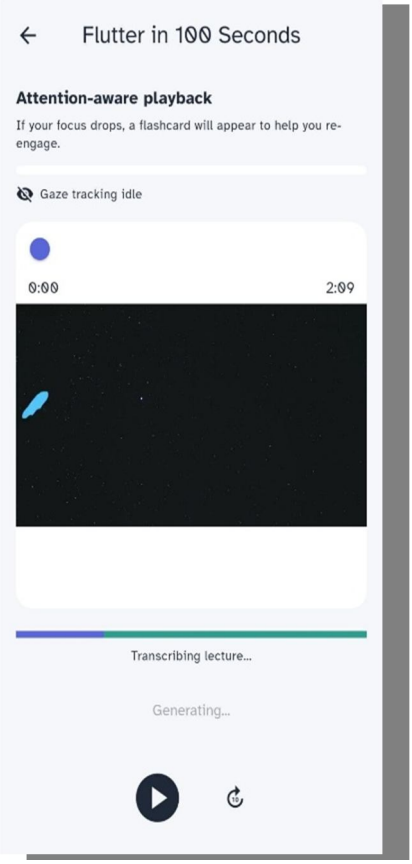


Fig. 2: Lecture playback screen with attention-aware monitoring

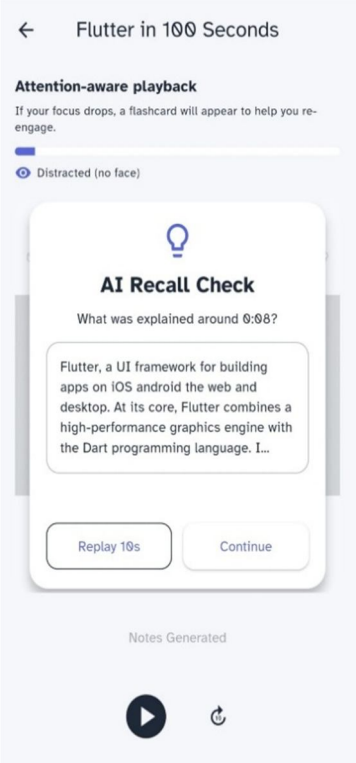


Fig. 3: Flashcard generated when user distraction is detected by the system.

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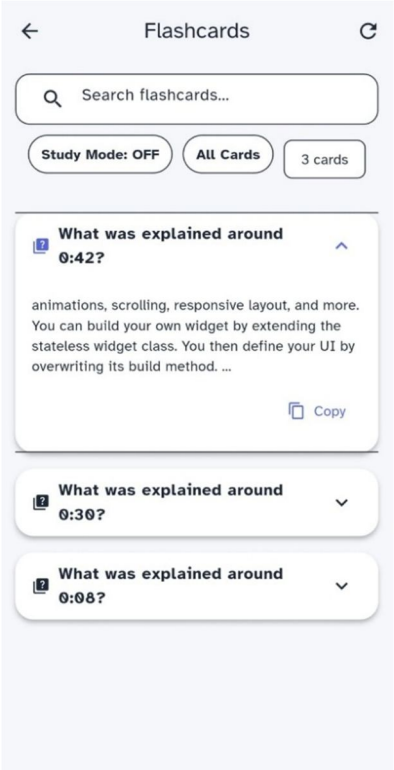


Fig. 4: Flashcard review interface

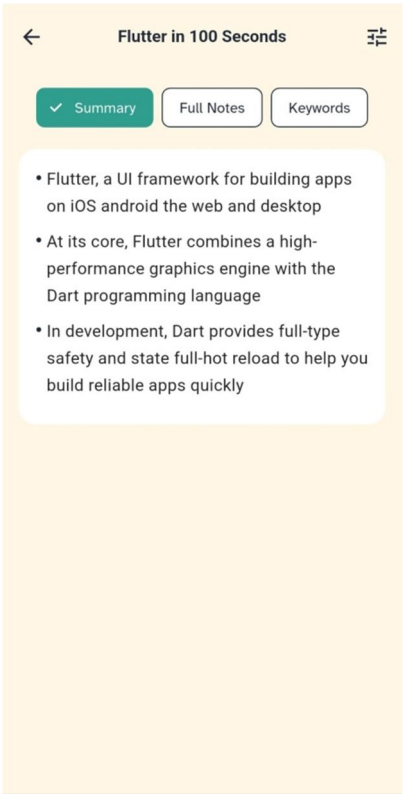


Fig. 5: Automatically generated lecture notes

The system was evaluated based on usability and responsiveness during real-time lecture playback scenarios.
The application interface is designed to be user-friendly and intuitive, allowing users to easily navigate between lectures, notes, and flashcards. The integration of multiple modules within a single application ensures a seamless learning experience. The system was tested under different conditions to ensure stability and responsiveness

VI. RESULTS AND DISCUSSION

The NeuroNote system was tested using recorded lecture videos to evaluate its functionality. During testing, the application successfully detected distraction events and paused the lecture when the user was not focused on the screen. The system then displayed flashcards containing the missed lecture content, allowing the learner to recall the information.
In addition, the automatic transcription module generated lecture summaries and keywords, which helped users review key concepts without rewatching the entire lecture. The results demonstrate that attention-aware learning tools can improve engagement and support learners with attention difficulties.
The system demonstrated stable performance across different test scenarios. The gaze detection module responded accurately to changes in user attention, and the generated flashcards effectively summarized key concepts. Users were able to recall missed information without rewatching the entire lecture, which improved learning efficiency. The results indicate that integrating attention monitoring with adaptive content delivery can significantly enhance user engagement.

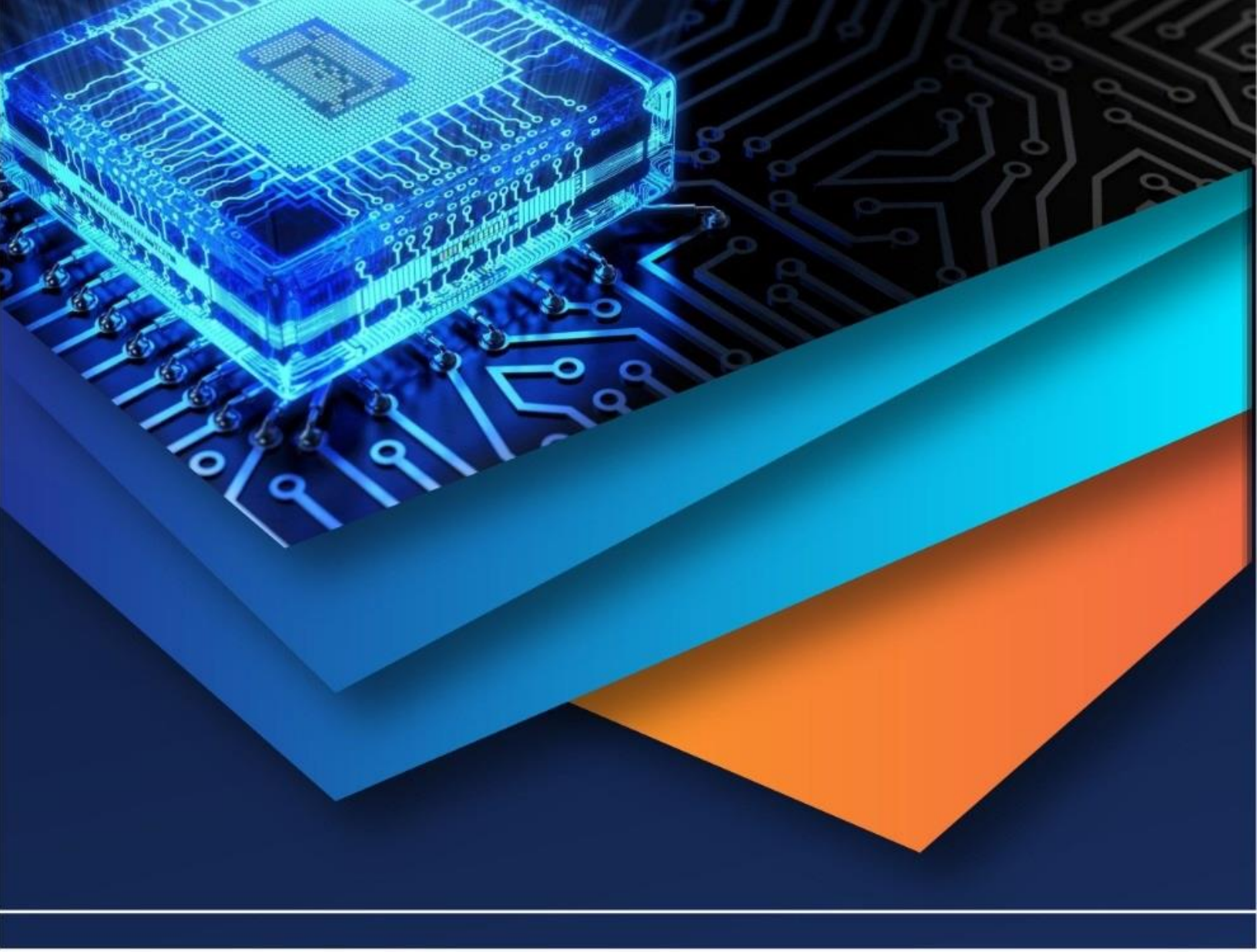
VII. CONCLUSION

This paper presented NeuroNote, an attention-aware mobile learning application designed to assist neurodivergent learners. The system integrates gaze monitoring, lecture transcription, flashcard generation, and note summarization to support learner engagement during video lectures. By detecting distraction and presenting recall flashcards, the system helps learners recover missed information efficiently. The results demonstrate the potential of attention-aware learning tools in improving digital learning experiences.

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