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AI-POWERED REAL-TIME LECTURE SUMMARIZER AND CONCEPT MAPPER

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ABSTRACT
With the increasing adoption of digital education, students often face difficulty in capturing important information during lectures while focusing on understanding the content. Manual note-taking can lead to incomplete or inaccurate documentation of lecture material. This research presents an AI-powered system that automatically converts lecture audio into structured learning resources. The proposed system integrates speech recognition, natural language processing, and keyword extraction techniques to generate lecture summaries and concept maps. Speech-to-text conversion is performed using automatic speech recognition models, while summarization algorithms extract key ideas from the transcript. Concept mapping visually represents relationships between the main topics discussed in the lecture. The system improves learning efficiency by helping students quickly review lecture content and identify key concepts.
KEYWORDS: *Speech Recognition, NLP, Lecture Summarization, Concept Mapping, Educational AI*

1. INTRODUCTION

In modern educational environments, lectures remain one of the primary methods of knowledge delivery. However, students often struggle to listen, understand, and take notes simultaneously during lectures. This can lead to incomplete notes and reduced comprehension.

Artificial Intelligence technologies such as speech recognition and natural language processing provide solutions to automate lecture documentation. Speech recognition systems convert spoken lectures into text, while NLP techniques summarize and analyze the generated transcripts.

This project proposes an AI-powered lecture summarization system capable of converting lecture audio into text, generating concise summaries, and visualizing key concepts through concept mapping.

2. LITERATURE REVIEW

Research on AI-assisted educational tools has increased significantly in recent years.
Automatic Speech Recognition (ASR) systems have improved through deep learning models, enabling accurate transcription of spoken lectures. NLP-based summarization techniques help extract the most relevant information from large textual data.

Keyword extraction algorithms are used to identify key concepts within a lecture transcript. Concept mapping techniques visually represent relationships between these concepts, making it easier for students to understand complex topics.

3. METHODOLOGY

The proposed system follows several stages to process lecture audio and generate structured learning outputs.

Speech-to-Text Conversion
Lecture audio is converted into text using a speech recognition model such as **OpenAI Whisper**.

Text Preprocessing
The transcript is cleaned using preprocessing techniques such as:

- Lowercase conversion
- Stop word removal
- Special character removal
- Text normalization

Text Summarization
NLP-based summarization algorithms extract key sentences to generate concise lecture summaries.

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Keyword Extraction
Important keywords are extracted using **KeyBERT**, which identifies the most relevant concepts within the transcript.

Concept Mapping
Extracted keywords are connected using **NetworkX and PyVis** to generate an interactive concept map.

4. SYSTEM IMPLEMENTATION

The system is implemented using **Python** and several AI libraries. The main technologies used include:

- **OpenAI Whisper** for speech-to-text conversion
- **Transformers-based models** for text summarization
- **KeyBERT** for keyword extraction
- **NetworkX and PyVis** for concept map generation
- **Flask framework** for building the web interface

The system allows users to upload lecture audio files and automatically generate transcripts, summaries, and concept maps.

5. SYSTEM ARCHITECTURE

The proposed system follows a modular architecture designed to process lecture audio and convert it into structured learning material. The architecture consists of several interconnected modules that work together to transform raw lecture audio into useful academic outputs. The process begins with the audio input module, where users provide lecture audio either by uploading recorded lecture files or capturing live lecture audio through a microphone. The input audio is then passed to the speech-to-text module, which converts the spoken lecture into textual format using speech recognition technology. This module generates a transcript representing the complete lecture content in written form. Once the transcript is generated, it is processed by the text preprocessing module, which cleans the text by removing unnecessary words, filler expressions, and formatting inconsistencies to improve readability and prepare the data for further analysis. After preprocessing, the cleaned transcript is sent to the summarization module, which analyzes the lecture content and extracts the most important sentences to generate a concise summary highlighting the key points of the lecture. The processed text is further analyzed by the concept extraction module, which identifies significant keywords and topics that represent the main ideas discussed during the lecture. These extracted concepts are then used by the concept mapping module to create a visual representation that illustrates the relationships between different lecture topics. Finally, all generated outputs, including the lecture transcript, summarized content, and extracted concepts, are displayed through a user-friendly interface, allowing students to easily access and review the lecture material in a structured and organized format. This modular architecture ensures efficient processing of lecture data and provides meaningful learning resources that support effective understanding and revision.

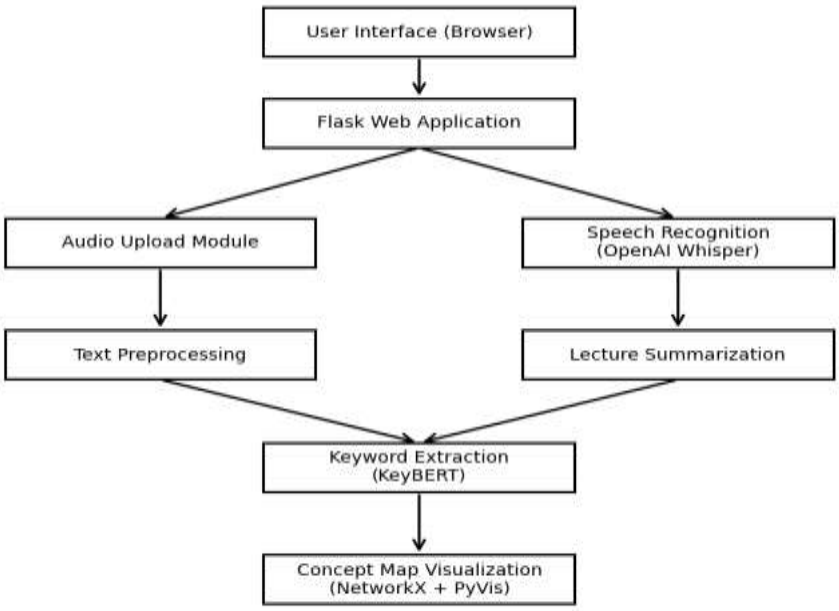


Figure1: System flow diagram

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6. RESULTS AND ANALYSIS

Algorithm	Accuracy (%)	Remarks
Traditional ASR	82%	Struggles with noise
Deep Learning ASR	90%	Better speech recognition
Whisper ASR	94%	High accuracy and noise handling

The results demonstrate that the proposed system produces accurate transcripts and meaningful summaries that assist students in reviewing lecture content efficiently.

7. CONCLUSION

The proposed AI-powered lecture summarization and concept mapping system provides an automated solution for lecture documentation. By integrating speech recognition, natural language processing, and visualization techniques, the system generates structured learning material directly from lecture audio.

This approach helps students reduce the burden of manual note-taking and improves knowledge retention through summarized content and concept visualization.

8. FUTURE WORK

Future improvements may include:

- Real-time lecture summarization
- Multi-language support
- Mobile application integration
- Improved summarization models
- Integration with learning management systems

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