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VOICE TO TEXT SUMMARIZATION USING NLP

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Abstract

Voice-to-text summarization revolutionizes information processing by converting spoken words into concise written summaries. This technology employs advanced natural language processing algorithms to transcribe spoken content accurately and efficiently. Through sophisticated techniques such as speech recognition and machine learning, it distills lengthy verbal communication into condensed written form, preserving key ideas and eliminating redundancies. This transformative tool enhances accessibility and productivity across various domains, including education, business, and healthcare. By enabling rapid conversion of spoken language into actionable insights, voice-to-text summarization facilitates quicker decision-making and information dissemination. Its applications span from real-time meeting transcriptions to personal note-taking, empowering users to capture and retain essential information effortlessly. It emphasizes how this technology facilitates information dissemination, decision-making, and knowledge management, ultimately enhancing productivity and accessibility for individuals with diverse communication needs.

Keywords

voice-to-text, NLP, Machine Learning, tokenization, pos tagging.

1. Introduction

A voice-to-text summarization project is to leverage cutting-edge technology to convert spoken audio content into concise and coherent textual summaries automatically. In today's fast-paced world, where vast amounts of information are constantly being generated, the ability to quickly and accurately summarize spoken content has become increasingly important. Whether it's in the context of meetings, lectures, interviews, or other forms of spoken communication, the ability to extract key information efficiently can significantly enhance productivity, accessibility, and comprehension[1-3]. At its core, the objective of such projects is to bridge the gap between spoken communication and written text, offering users the convenience of accessing and interacting with spoken content in a textual format. This objective aligns with the broader goals of accessibility and inclusivity, making spoken content more accessible to individuals with hearing impairments or those who prefer textual information.

Voice-to-text summarization projects typically employ a combination of advanced technologies, including speech recognition algorithms and natural language processing (NLP) techniques. Speech recognition algorithms analyze the acoustic features of spoken audio to convert it into text, while NLP techniques process this text to identify key information, summarize it, and ensure coherence and readability[4-5]. Scalability and adaptability are important considerations, particularly in applications where large volumes of spoken content need to be processed efficiently. Systems should be capable of handling diverse types of spoken content, including different languages, accents, and domains.

Challenges and Limitations

- ASR Limitations: ASR systems are still imperfect and can misinterpret words, especially in noisy environments or with accents.
- Context Understanding: Maintaining the context and nuances of the original speech during summarization remains a significant challenge.
- Computational Costs: Advanced models, particularly in deep learning, require substantial computational resources and data for training, which can be a barrier to implementation.
- User Dependency: Summarization quality may depend on user feedback mechanisms, which could vary widely among users.

2. Related Work

Table 1: Literature on Voice to Text Summarization

Sl. No	Author	Year	Title	Methodology	Limitations
1	Gupta, A. & Verma, R.[6]	2021	Voice-Based Document Summarization Using NLP	Combined ASR with extractive summarization techniques to generate concise summaries.	Dependency on ASR accuracy; challenges in multi-speaker environments.
2	Zhang, L. et al.[7]	2021	Speech to Text: An Efficient Approach for Text Summarization	Used a deep learning framework integrating ASR with a transformer-based summarization model (e.g., BERT).	High computational cost; requires extensive training data.
3	Lee, J. & Kim, S.[8]	2022	Enhancing Voice Summarization with Contextual NLP Techniques	Applied context-aware embedding methods with traditional extractive summarization algorithms.	Difficulty in capturing nuanced context; potential loss of critical details.
4	Patel, M. & Kumar, R.[9]	2022	A Hybrid Approach to Voice-to-Text Summarization	Developed a hybrid model integrating ASR, sentiment analysis, and abstractive summarization techniques.	Misinterpretation of sentiment; challenges with sarcasm or idiomatic expressions.
5	Singh, T. & Sharma, P.[10]	2023	Real-time Voice Summarization System Using	Leveraged transformer architectures (e.g., T5)	Real-time processing challenges; perfor-

			Transformer Models	for real-time summarization after ASR processing.	mance varies with diverse accents.
6	Chen, Y. et al.[11]	2023	Towards Multimodal Summarization: Voice and Text Integration	Proposed a multimodal approach combining audio and text data for enhanced summarization using fusion techniques.	Complexity in synchronizing audio and text; increased processing time for multimodal inputs.
7	Kumar, S. & Singh, V.[12]	2023	Enhancing Voice to Text Summarization with User Feedback	Implemented a feedback loop mechanism where user corrections refine the summarization process.	Dependence on user feedback quality; extensive user interaction needed.

3. Existing System

In existing meetings in any company, the process of data management is through storing live meeting information in the form of video recordings or audio recordings. Most of the time employees take notes from on-going meetings and use them for reference. In a voice-to-text summarization project involves several key components. It utilizes advanced speech recognition algorithms to accurately transcribe spoken language into text. This involves breaking down the audio input into phonetic segments and matching them to words in a given language model. Secondly, natural language processing (NLP) techniques are employed to extract important information from the transcribed text. These techniques may include part-of-speech tagging, named entity recognition, and sentiment analysis. Thirdly, the system employs summarization algorithms to condense the transcribed text into a shorter, more concise form while retaining the essential meaning and key points. These algorithms may utilize techniques such as extractive summarization, where important sentences or phrases are selected from the text, or abstractive summarization, where a new summary is generated based on the content of the text. Overall, the existing system in a voice-to-text summarization project combines speech recognition, natural language processing, and summarization techniques to accurately transcribe and summarize spoken content. Despite its advancements, the existing voice-to-text summarization system has notable limitations. Firstly, accuracy issues persist, especially in noisy environments or with diverse accents, leading to transcription errors. Secondly, complex linguistic nuances and context may be overlooked, resulting in inaccuracies in summarization.

Drawbacks of Existing System

- If any employee is not present in the meeting then he needs to collect information from other employees.
- There is no effective method of clear analysis for meetings with clear summary.

4. Proposed System

In the proposed system we are using voice to text conversion and converting every employeevoice into text and store it into a database and then combine each employee who is part of the meeting and combine into single text and then summarize using NLP with scipy package and then summarize entire meeting information in to small paragraph. The proposed system in a voice-to-text summarization project aims to address the limitations of the existing system while enhancing its capabilities. Firstly, it incorporates state-of-the-art speech recognition technologies to improve accuracy, especially in challenging environments with background noise or accents.

This may involve employing deep learning models trained on diverse datasets to better understand and transcribe various speech patterns. Secondly, the proposed system integrates advanced natural language processing techniques to capture nuanced linguistic features and context, enhancing the quality of the summarization process. This includes leveraging deep semantic analysis and entity recognition to extract key information more accurately. Thirdly, the system implements real-time processing optimizations to handle large volumes of audio data efficiently, ensuring timely transcription and summarization. Additionally, the proposed system may offer customizable summarization options, allowing users to adjust the level of detail or focus based on their preferences. Overall, the proposed system seeks to deliver more reliable, accurate, and customizable voice-to-text summarization capabilities, catering to a wider range of use cases and improving user experience.

5. SYSTEM DESIGN

The System Design describes the system requirements, operating environment, system andsubsystem architecture, files and database design, input formats, output layouts, human machine interfaces, detailed design, processing logic, and external interfaces. Here’s a step-by-step explanation of the methodology:

Step i: Voice Input Collection

- **Recording Voice:** The process begins by capturing audio input from users using microphones or audio recording devices.
- **Format Preparation:** The audio should be in a format suitable for processing (e.g., WAV, MP3).

Step ii: Automatic Speech Recognition (ASR)

- **Transcription:** The recorded voice input is transcribed into text using ASR technologies. This step involves:
    - **Feature Extraction:** Converting audio signals into features (like Mel-frequency cepstral coefficients) that can be processed.
    - **Model Prediction:** Using machine learning or deep learning models (e.g., Hidden Markov Models, Deep Neural Networks) to convert audio features into text.

Step iii: Preprocessing of Transcribed Text

- **Text Cleaning:** Remove noise, filler words (like "um," "uh"), and irrelevant parts from the transcribed text.
- **Normalization:** Standardize text formats (e.g., converting to lowercase, correcting grammar and punctuation).
- **Tokenization:** Split the cleaned text into sentences or words for further analysis.

Step iv: Text Summarization

- **Choosing a Summarization Technique:**
        - **Extractive Summarization:** Identify and extract the most important sentences or phrases from the transcribed text.
        - **Algorithms:** Techniques like TextRank, Latent Semantic Analysis (LSA), or graph-based methods can be used.
    - **Abstractive Summarization:** Generate new sentences that convey the core message of the original text.

- **Models:** Use neural networks, particularly transformer-based models (like BERT, T5, or GPT), to generate coherent summaries.

Step v: Post-Processing of Summary

- **Refinement:** Clean the generated summary to ensure coherence and readability. This may involve:
  - Removing redundant phrases or sentences.
  - Ensuring grammatical correctness.

Step vi: Output Generation

- **Format Summary:** Present the final summary in a user-friendly format, which may include:
  - Text display for direct reading.
  - Voice synthesis for auditory feedback using Text-to-Speech (TTS) systems, converting the summarized text back into speech.

Step vii: User Feedback and Adaptation (Optional)

- **Feedback Mechanism:** Incorporate user feedback to improve summarization quality over time. This can include:
  - Users rating the quality of the summary.
  - Allowing users to correct inaccuracies, which can be used to retrain models and improve future performance.

5.1 SYSTEM ARCHITECTURE

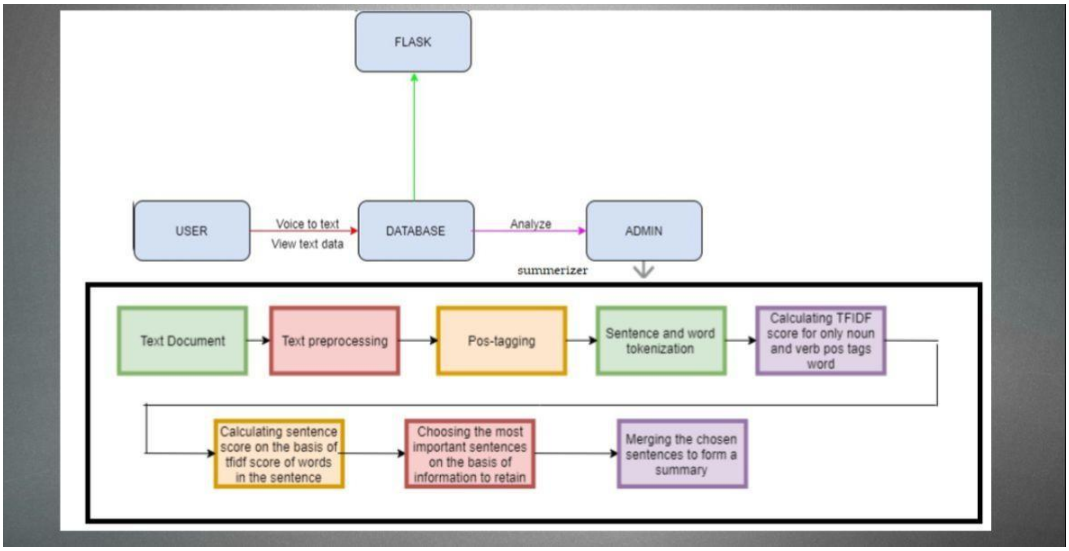

FLASK
USER
Voice to text
View text data
DATABASE
Analyze
ADMIN
summerizer
Text Document
Text preprocessing
Pos-tagging
Sentence and word tokenization
Calculating TFIDF score for only noun and verb pos tags word
Calculating sentence score on the basis of tfidf score of words in the sentence
Choosing the most important sentences on the basis of information to retain
Merging the chosen sentences to form a summary

Figure 1: System Architecture

The above diagram is the system architecture of our project where the data is processed step by step. The architecture consists of two modules i.e, user and admin. The user module in a voice-to-text summarization system serves as the interface through which users interact with the system. It encompasses features and functionalities designed to enhance the user experience and facilitate seamless interaction. This module typically includes components such as input interfaces for capturing audio, options for selecting summarization preferences or parameters, and output interfaces for presenting the generated summaries. The user module plays a crucial role in ensuring user satisfaction and engagement with the system by providing intuitive controls,clear feedback, and personalized experiences, ultimately enhancing the usability and effectiveness of voice-to-text summarization for end-users.The Admin Module in voice-to-text summarization systems serves as the control center for managing and overseeing various aspects of the system's operation and administration. This module typically includes functionalities related to user management, system configuration, and monitoring of system performance. Admin Module allows administrators to create and manage user accounts, assign roles and permissions, and control access to system functionalities. It also facilitates user authentication and authorization processes to ensure secure access to the system.

In the proposed work a combination of speech to text conversion and text summarisation is implemented. This hybrid method will aid applications that require a brief summary of lengthy speeches which is quite useful for documentation. The flow diagram of the proposed approach is mentioned in Figure 1, in which the speech recognition and text summarization is given as two different modules. The combination of these two modules aids any application in which summarization is required. The first and foremost step to work with NLP (Natural Language Processing) is to extract the features from the speech which has some values. If a word or a sentence is recognized as meaningless, then it becomes an obstacle to the summarization process. Even the punctuation plays a vital role in summarization as semantics is important while summarizing the text.

6. IMPLEMENTATION

Below is the detailed explanation of working principle and execution of the project:

Run the software: Before running the software first, we need to save all the files in a single folder and name it with the project title. This will help us in executing all the files simultaneously without any errors.

Steps for executing the project

i. Download and install the anaconda prompt and then open it with the local user. Import all the libraries like NumPy, pandas, TensorFlow etc., in the anaconda prompt and install them.

ii. After installing the libraries, open the anaconda prompt and type the command “conda activate tf” and click enter. This command will redirect us to the tensor flow console which is used to execute multiple python files in an array format.

iii. Now, copy the file path in which all files are saved. Then, go to the tensor flow console in the anaconda prompt and type “cd ” then paste the file path which is copied and click enter. Now, we will enter into the folder where all the files are saved.

iv. Now, type “python app.py” and click enter. A link will be displayed on the screen which will redirect us to the local host. Ctrl + Click on the link to open the software in your system local host. It starts with 127.0.0.1.

v. Now we have successfully started running our project in our local host. You can see buttons displaying 3 modules i.e, Home (which is default), Admin and User.

vi. Click on the admin module. Enter the details like username and password.The details will be stored in the database. Use the login credentials and login to the admin module and add the meeting name then logout from the admin module .

vii. Click on the user module, enter the details to sign up and sign in with the entered details.Enter into the particular meeting and give the data as text or in the voice format then submit, do it multiple times in the user module and logout.

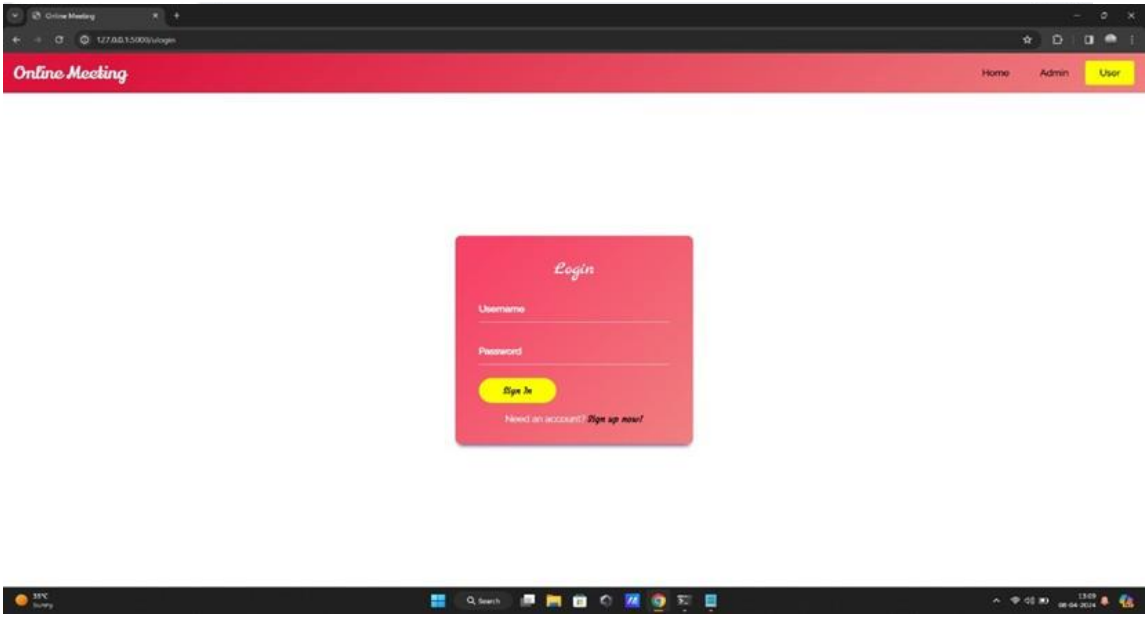
viii. Login again into the admin module, go into that meeting, open the voice chats of that meeting and click on combine

ix. To Know what has happened in the meeting where the user is not present can see all the data that has been spoken in the summarized chats.

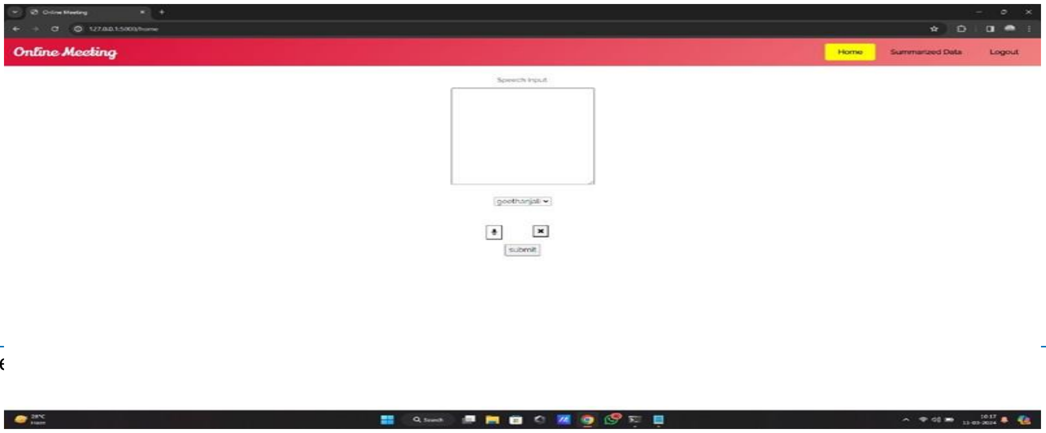
x. That's how data summarized data is displayed on the screen.

7. Results

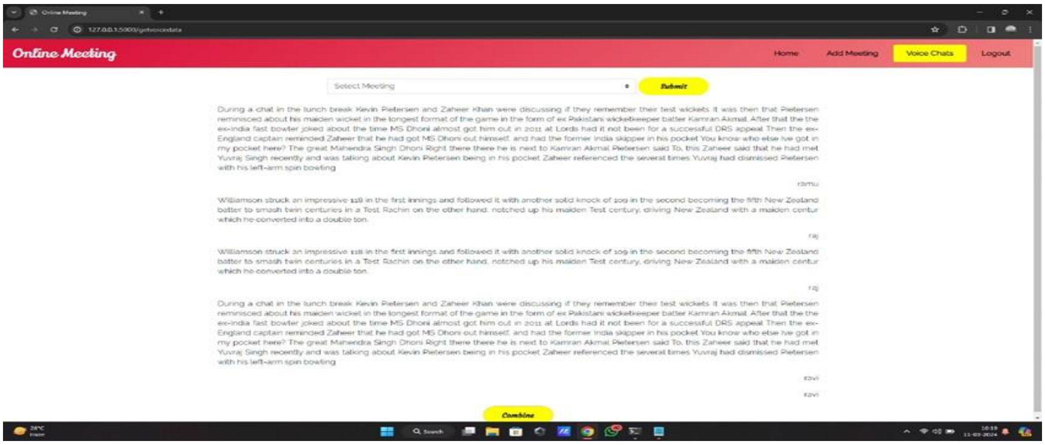
A. Home Page



B. Speech Input



C. Voice Chat



During a chat in the lunch break Kevin Pietersen and Zaheer Khan were discussing if they remember their test wickets It was then that Pietersen reminisced about his maiden wicket in the longest format of the game in the form of ex Pakistani wicketkeeper batter Kamran Akmal. After that the the ex-India fast bowler joked about the time MS Dhoni almost got him out in 2011 at Lords had it not been for a successful DRS appeal Then the ex-England captain reminded Zaheer that he had got MS Dhoni out himself. and had the former India skipper in his pocket You know who else Ive got in my pocket here? The great Mahendra Singh Dhoni Right there there he is next to Kamran Akmal Pietersen said To, this Zaheer said that he had met Yuvraj Singh recently and was talking about Kevin Pietersen being in his pocket Zaheer referenced the several times Yuvraj had dismissed Pietersen with his left-arm spin bowling

ramu

Williamson struck an impressive 118 in the first innings and followed it with another solid knock of 109 in the second becoming the fifth New Zealand batter to smash twin centuries in a Test Rachin on the other hand. notched up his maiden Test century, driving New Zealand with a maiden centur which he converted into a double ton.

raj

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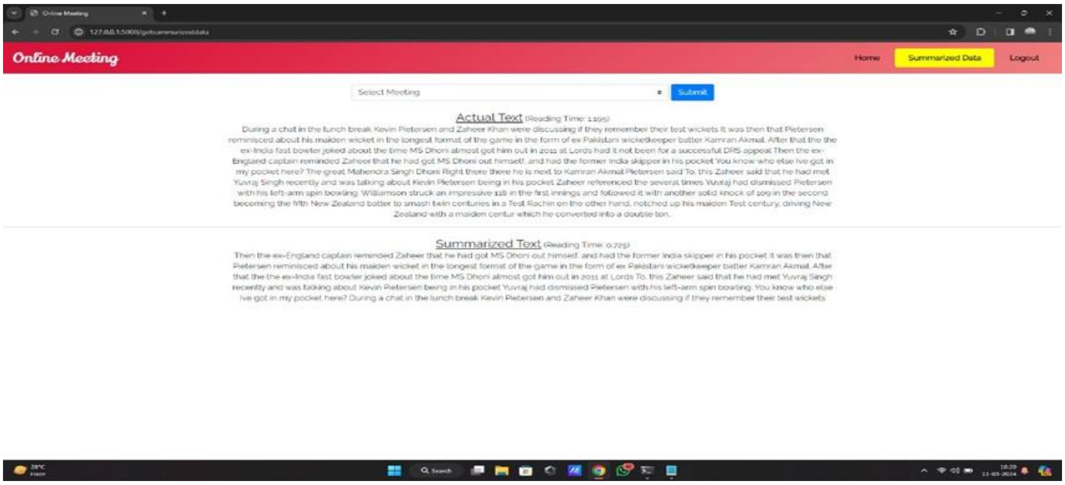
ravi

D. Summarized Chat



Actual Text (Reading Time: 1.19s)

During a chat in the lunch break Kevin Pietersen and Zaheer Khan were discussing if they remember their test wickets It was then that Pietersen reminisced about his maiden wicket in the longest format of the game in the form of ex Pakistani wicketkeeper batter Kamran Akmal. After that the the ex-India fast bowler joked about the time MS Dhoni almost got him out in 2011 at Lords had it not been for a successful DRS appeal Then the ex-England captain reminded Zaheer that he had got MS Dhoni out himself. and had the former India skipper in his pocket You know who else Ive got in my pocket here? The great Mahendra Singh Dhoni Right there there he is next to Kamran Akmal Pietersen said To, this Zaheer said that he had met Yuvraj Singh recently and was talking about Kevin Pietersen being in his pocket Zaheer referenced the several times Yuvraj had dismissed Pietersen with his left-arm spin bowling. Williamson struck an impressive 118 in the first innings and followed it with another solid knock of 109 in the second becoming the fifth New Zealand batter to smash twin centuries in a Test Rachin on the other hand. notched up his maiden Test century, driving New Zealand with a maiden centur which he converted into a double ton.

Summarized Text (Reading Time: 0.72s)

Then the ex-England captain reminded Zaheer that he had got MS Dhoni out himself. and had the former India skipper in his pocket It was then that Pietersen reminisced about his maiden wicket in the longest format of the game in the form of ex Pakistani wicketkeeper batter Kamran Akmal. After that the the ex-India fast bowler joked about the time MS Dhoni almost got him out in 2011 at Lords To, this Zaheer said that he had met Yuvraj Singh recently and was talking about Kevin Pietersen being in his pocket Yuvraj had dismissed Pietersen with his left-arm spin bowling. You know who else Ive got in my pocket here? During a chat in the lunch break Kevin Pietersen and Zaheer Khan were discussing if they remember their test wickets

8. Conclusion

It was confirmed that in unconstrained introduction discourse summarization at 70% and 50% summarization proportions, combining sentence extraction with sentence compaction is compelling; this strategy accomplishes way better summarization execution than our past one-stage method. The Voice-to-Text Summarization venture speaks to a noteworthy progression in characteristic language preparing and human-computer interaction. By tackling the control of machine learning and discourse acknowledgment advances, this extension offers various benefits and applications over different spaces. Firstly, the venture gives clients with the capacity to effortlessly change over-talked dialect into brief, composed rundowns, dispensing with the requirement for manual translation and sparing profitable time and assets. This usefulness is particularly important in scenarios where people are required to rapidly capture key data from gatherings, addresses, interviews, or discussions. Moreover, the Voice-to-Text Summarization venture upgrades availability for people with disabilities, permitting them to connect with advanced substances more successfully through discourse. This inclusivity viewpoint is crucial for guaranteeing riseto get to data and openings for all individuals of society. Moreover, the extension has suggestionsfor progressing data recovery and information management frameworks. By consequently producing outlines of sound substance, clients can quickly distinguish pertinent data and explore huge volumes of information more productively.

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