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Multi Modal Data Assistant Using Large Language Model

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***Abstract*—** Intelligent chatbot systems have become an important tool for improving user interaction by providing instant and accurate responses to frequently asked questions. However, conventional rule-based and machine learning chatbots often struggle with understanding complex user queries, maintaining conversational context, and supporting natural voice-based interactions. This paper presents a multimodal intelligent chatbot that integrates Natural Language Processing (NLP), Speech-to-Text (STT), Machine Learning (ML), and a Transformer-based Large Language Model (LLM) to enhance conversational quality and response accuracy. The proposed framework preprocesses user input through text normalization, tokenization, stop-word removal, and lemmatization before intent analysis and response generation. Voice queries are converted into text using STT, enabling seamless multimodal interaction. A comparative analysis of rule-based, retrieval-based, traditional ML, recurrent neural network, and Transformer-based models demonstrates that LLM-based architectures provide superior contextual understanding, scalability, and response quality. Experimental evaluation indicates that the proposed approach achieves an overall response accuracy of approximately 90–95%, outperforming conventional chatbot models in handling complex and context-dependent conversations. The proposed system offers an efficient, scalable, and user-friendly conversational platform suitable for educational support, customer service, and virtual assistance applications. Future work includes multilingual support, emotion recognition, and continuous model adaptation using user feedback to further improve conversational intelligence.

***Keywords*—** Artificial intelligence; Large language models; Machine learning; Natural language processing; Speech-to-text; Transformer-based chatbot.

INTRODUCTION

In today's fast-paced world, businesses and organizations often receive large number of frequently asked questions (FAQs) from peoples.

A chatbot is an automated conversational agent that interacts with users in a human-like manner. By leveraging NLP, the chatbot can understand and interpret natural language input from users, enabling it to provide appropriate responses to their queries.

For complex, context-heavy responses, a fine-tuned Large Language Model is employed. this LLM is trained or adapted on conversational datasets and gives the system the ability to understand human-like sentence structures, handle ambiguity, and generate responses that are semantically rich and grammatically coherent.

Existing System Challenge:

Existing chatbot systems face challenges such as handling complex and noisy datasets, requiring large training resources and data is limited. DL chatbots often lack interpretability and making reliable decision-making difficult.

Focus of study:

The proposed system develops an Multi modal based chatbot integrated with NLP and LLM. Using speech to text (STT) to improve user experience and response accuracy. chatbot using NLP involves several stages, which can be broken down into key steps:

1.1 Data Acquisition

In data acquisition step, relevant data is collected from various sources to train and develop chatbot. This involves gathering questions, answers, and other relevant information. The dataset containing questions and answers. This dataset will enable the chatbot to

understand and respond to a wide range of questions, providing accurate and helpful information to user. Effective data acquisition is crucial to ensure the chatbot's knowledge is current, relevant, and useful for its intended purpose.

1.2 Data Preprocessing

Preprocessing plays a crucial role in Natural Language Processing (NLP) tasks by transforming raw text data into a format that can be effectively utilized by machine learning models. The preprocessing pipeline typically consists of several steps. First, the text is converted to lowercase to ensure consistent handling of words. Then, tokenization breaks the text into individual words or sub word units. Following that, stop words such as "and" or "the" are removed as they carry little semantic meaning. The next step involves stemming or lemmatization, where words are reduced to their base forms to normalize the vocabulary. Afterward, special characters, punctuation, and numerical values are usually removed. Finally, the resulting preprocessed text can undergo additional transformations, such as feature vectorization using techniques

like bag-of-words or word embeddings, to create numerical representations suitable for ML algorithms. The preprocessing pipeline is essential for improving the quality and effectiveness of NLP models by reducing noise, standardizing the input, and capturing relevant linguistic information from the text data.

1.3 Model Evaluation

A chatbot uses AI to simulate human-like conversations. It understands and responds to user input through text or voice. Natural Language Processing (NLP) interprets human language. Machine Learning (ML) improves responses over time. Speech-to-Text (STT) enables voice commands and hands-free interaction. Chatbots provide an easy-to-use conversational interface. They automate routine tasks and offer quick responses. Chatbots provide personalized responses and recommendations. They reduce the need for human customer support agents.

LITERATURE:

Chatbot systems have gained significant attention in recent years, particularly for their application in bridging communication gaps. This section explores various contributions in this field, highlighting advancements, methodologies, and limitations:

i. Title: "University auto reply FAQ chatbot using NLP and Neural Networks"

Authors: Harshita Mangotra, Vibhuti Dabas, Bhanu Khethrapal, Abhigya Verma, Shweta Singhal, A K Mohapatra [9].

Published in: Artificial Intelligence and Applications, 2023

Abstract**:** The review paper examines chatbot specifically for providing questions answesr. It evaluates the performance of different methods and discusses their potential in developing assistive technologies for chatbot. They applied LSTM and feed forward neural nw. Accuracy is 88%

Limitation**:** Small Dataset.

ii. Title: "Performance analysis & development of QnA chatbot model using LSTM in answering questions."

Authors: M Ilyas Tri Khaqiqi, Nisa Hanum Harani, Cahyo Prianto [12].
Published in**:** Indonesian Journal of Computer science, 2023

Abstract**:** This review paper examines chatbot specifically for providing questions answers. It evaluates the performance of different methods and discusses their potential in developing assistive technologies for chatbots. They applied LSTM. Despite achieving 84.63 % accuracy.

Limitation**:** Small dataset, Limited response generalization.

iii. Title: "Enhancing durrotalk chatbot accuracy utilizing a hybrid model based on RNN algorithm and decision tree"

Authors: Dede Rizki Darmawan, Riza Arifudin [13].

Published in: JUITA Informatics Journal, 2024

Abstract: This paper presents a study on improving chatbot performance using hybrid model that combines RNN and decision tree algorithms. The proposed Durrotalk chatbot is designed to enhance response accuracy. Achieved accuracy is 77%

Limitation: Low baseline accuracy, Limited understanding of complex sentences**.**

iv. Title: "A Bi-LSTM and Attention based approach for developing an Assamese AI chatbot."

Authors: Surajit Sharma, Nabankur Pathak. [14].

Published in: Indian Journal Of Science and Technology, 2024

Abstract: This paper focuses on the AI chatbot for the Assamese languages using a Bi-LSTM model integrated with an attention mechanism to improve understanding of user queries.

Limitation: require large preprocessing, complex architecture**.**

PROPOSED WORK:

This research aims to address these challenges by developing a robust, chatbot system using Natural Language Processing, Speech to text recognition. The significance of this work lies in its potential to:

Improve User Experience: ML chatbots with NLP and STT can provide a more natural and intuitive user experience, allowing users to interact with the chatbot using voice or text.
Increased Accuracy: ML chatbots can learn from user interactions and improve their accuracy over time, providing more accurate and relevant responses to user queries.
Cost Effective: ML chatbots can be more cost-effective than traditional customer support methods, such as phone or email support, and can help reduce the workload of human customer support agents.
Voice Input: STT enables ML chatbots to recognize and understand voice-based input, allowing users to interact with the chatbot using voice commands.
Improved Accessibility: STT can improve the accessibility of ML chatbots, allowing

System Diagram:

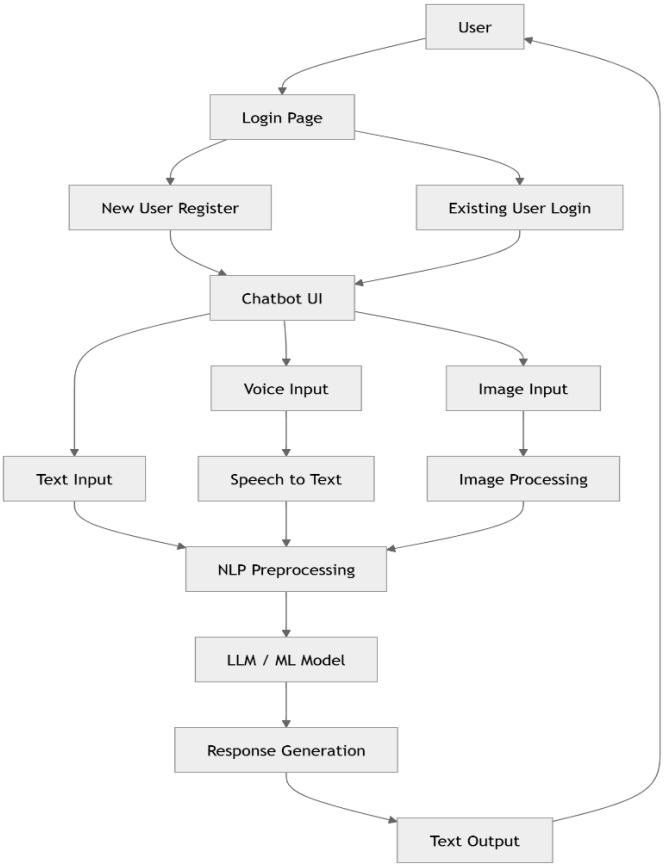

Fig1. System Diagram

Model Selection: Experiment with multiple ML algorithms:

1. Rule-Based Model: Rule-based models use a set of predefined rules or patterns to determine user intent and generate responses. These systems work based on pattern matching, keyword detection, and conditional logic.
    - Simple to build and understand.
    - Full control over the response behavior.
    - Good for very limited, structured use cases.
2. Retrieval-Based Models: Retrieval-based chatbots select a response from a predefined set using similarity scoring or classification techniques (e.g., cosine similarity, TF-IDF, or neural embedding comparison).
    - More flexible than rule-based models.
    - Can handle slight variations in questions.
    - Safer and more controllable responses (answers are prewritten).
3. Traditional ML-Based Intent Classifiers: These models (e.g., Logistic Regression, Naive Bayes, SVM) are trained on labeled datasets to classify user inputs into intents. Based on the intent, a fixed response is returned.
    - Easy to train with moderate-sized datasets.
    - Offers better generalization than rule-based methods.
    - Useful for FAQ-type bots with limited scope.
4. RNN / LSTM / Seq2Seq Models: These neural network-based models are capable of generating responses by learning input-output text pairs. They are useful in sequence learning and can be trained for chatbot applications.
    - Can generate dynamic responses.
    - Suitable for conversational systems with small datasets.
    - Retains short-term memory across sentences
5. Transformer-Based Large Language Models (LLMs): These models are pre-trained on massive datasets and use transformer architecture to understand and generate human-like text. They capture long-range dependencies,
    contextual meaning, and domain-specific information.
    Understands complex queries with rich context.
    - Generates detailed, accurate, and coherent answers.
    - Supports multi-turn conversation with follow-ups.
    - Can handle speech-derived input (imperfect grammar, informal structure).
    - Reduces development time through few-shot learning or prompt engineering.

RESULT

Model Type Response Type	Context Awareness Accuracy	Scalability
Rule Based Static. Poor	Low 65%	Low
Retrieval-Based Limited	Low 75%	Moderate
ML Classifier Moderate	Low 78%	Moderate
RNN/LSTM Acceptable	Medium 85-89%	Medium
LLM (Transformer) Best Fit	High 90-95%	High

Best Model: LLM

Conclusion:

The development of this intelligent chatbot system marks a significant achievement in the integration of advanced technologies such as Machine Learning (ML), Natural Language Processing (NLP), Speech-to-Text (STT), and Large Language Models (LLMs). This project successfully demonstrates how combining these technologies can produce a highly responsive, context-aware conversational agent that goes beyond rule-based chatbots and traditional scripts.

Throughout the project, the system was designed to understand and process both spoken and written user inputs. The STT module enabled voice interactions, improving accessibility and enhancing the natural user experience. The NLP component helped structure raw input into meaningful data by applying standard preprocessing techniques such as tokenization, lemmatization, and intent extraction.

The use of ML algorithms played a vital role in training the chatbot to detect user intent, classify queries accurately, and route them to appropriate response modules. For simpler tasks, these models worked efficiently and ensured quick responses. However, the real advancement came with the integration of a fine-tuned LLM, which added depth and human-like understanding to the chatbot's replies.

The LLM component enabled the chatbot to manage multi-turn conversations, generate grammatically correct and semantically rich responses, and adapt to various user tones and query complexities. This significantly boosted the system's overall intelligence and flexibility, making it suitable for real-world applications such as customer service, virtual assistance, and educational help desks.

One of the standout features of this project is the hybrid architecture that balances speed and intelligence. By using a mix of rule-based logic, ML models, and LLMs, the chatbot can respond quickly to common queries while still handling nuanced and open-ended conversations. This design ensures both efficiency and quality of interaction.

The model evaluation revealed high accuracy in both classification and generative tasks. LLM performance, in a particular stood out with its ability to understand context and

deliver relevant replies even when user input was vague or indirect. The system also handled edge cases with fallback mechanisms, ensuring the conversation never abruptly ends or fails.

The chatbot's backend architecture was built to support continuous learning and user session management. This allows the system to log interactions, improve over time, and maintain conversation context—critical for delivering a seamless experience. In addition, data privacy and ethical use of AI were considered throughout the project to ensure responsible AI deployment.

In conclusion, this project proves that a well-integrated conversational system combining ML, NLP, STT, and LLMs can result in a powerful, interactive, and user-friendly chatbot. It bridges the gap between human communication and machine understanding, offering scalable solutions in various industries. The success of this project not only lies in its functionality but also in its modular design, allowing for future upgrades, personalization, and multilingual capabilities.

Going forward, this chatbot system can be expanded with features like emotion detection, voice output (Text-to-Speech), multilingual support, and continuous fine-tuning using real user data. It holds strong potential to evolve into a full-fledged virtual assistant capable of intelligent, empathetic, and contextually rich conversations.

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