Grammar Correction Assistant For Audio And Text Inputs Using NLP

Gururaja H S
Dept. of Information Science
B.M.S. College of Engineering
Bangalore, India
gururajhs.ise@bmsce.ac.in

Dhanush Jogi K
Dept. of Information Science
B.M.S. College of Engineering
Bangalore, India
dhanushjogi.is20@bmsce.ac.in

Adarsha Dalavai S M
Dept. of Information Science
B.M.S. College of Engineering
Bangalore, India
adarshadalavai.is20@bmsce.ac.in

Ajithkumar Ravindra Shetty
Dept. of Information Science
B.M.S. College of Engineering
Bangalore, India
ajithkumar.is20@bmsce.ac.in

***Abstract*—** This project endeavors to create an adaptable conversational assistant proficient in processing both audio and text inputs, seamlessly offering grammatical enhancements and returning results in the corresponding input format. Advanced natural language processing (NLP) techniques are harnessed for text analysis, while audio inputs are transcribed through cutting-edge speech-to-text technology.The system integrates a resilient grammatical correction model trained on diverse textual datasets, ensuring precise and contextually appropriate corrections. Automatic speech recognition (ASR) technology is employed for audio inputs, converting spoken words into text, upon which grammatical corrections are applied to generate the corrected text or audio output.The project relies on a fusion of deep learning models, including pre-trained language models for text analysis and neural networks for audio processing. The architectural design facilitates seamless modality transitions, prioritizing user experience.The Multimodal Correction Assistant caters to a range of applications, such as language acquisition, professional communication, and accessibility for users with diverse communication preferences. By incorporating cutting-edge technologies in both text and speech processing, this project contributes to the evolution of multimodal AI systems, ultimately elevating the quality of human-computer interactions.

***Index Terms*—** Grammar Correction, NLP, ASR, Audio and Text

I. Introduction

Within the domain of language processing and AI-driven communication tools, a discernible void exists in the realm of a comprehensive solution adept at seamlessly managing grammatical correction for both text and audio inputs. Clear and grammatically correct communication is essential in various facets of life, including education, professional settings, and everyday interactions. Despite the widespread use of digital communication tools, many individuals still struggle with grammatical errors in their written and spoken expressions.

While conventional chatbots have excelled in textual engagements, the integration of sophisticated grammar correction mechanisms into spoken inputs remains an unaddressed challenge. This presents a significant constraint for users who lean towards or necessitate verbal communication or are immersed in language learning scenarios where correction in both written and spoken forms is imperative. With the increasing prevalence of audio communication in virtual meetings, podcasts, and other platforms, there is a clear need for a comprehensive Grammar Correction Assistant that can cater to both written and spoken language.

In the domain of text-based grammatical correction, numerous NLP models, such as transformer-based architectures like BERT and GPT, have showcased impressive capabilities in comprehending and generating human-like text. These models, trained on extensive textual datasets, excel in capturing syntactic and semantic nuances, enabling precise grammatical corrections.

II. Related Work

[1] Grigori Sidorov "Syntactic Dependency Based N-grams in Rule-Based Automatic English as Second Language Grammar Correction". This paper tackles automatic English grammar correction for non-native speakers with a surprisingly simple approach: hand-crafted rules and "sn-grams," which are essentially paths through dependency trees capturing syntactic relationships. Despite utilizing minimal additional resources and requiring only two months to develop, the system delivered respectable performance in the CoNLL-2013 shared task. Although its simplicity limits it from challenging more sophisticated systems employing extensive data and machine learning, it stands as a valuable baseline. The paper emphasizes the utility of analyzing the system's errors, providing insights for further refinement. This work paves the way for future research in grammar correction, demonstrating the potential of basic rule-based approaches, even with limited resources, while highlighting the importance of error analysis for continual improvement.

[2] Bibek Behera and Pushpak Bhattacharyya “Automated Grammar Correction Using Hierarchical Phrase-Based Statistical Machine Translation”. This paper proposes a novel use of Hierarchical Phrase-Based Statistical Machine Translation (SMT) for automated grammar correction. SMT, traditionally used for language translation, is shown to be effective in "translating" incorrect sentences to their grammatically correct counterparts. The system leverages parallel corpora of incorrect and correct sentences, extracting grammar rules and applying them to correct errors. Tested on the NUCLE corpus (50,000 sentences), the system achieved a BLEU score of 0.77, demonstrating its accuracy. Notably, increasing the training data size improved performance. Beyond its current achievement, the paper identifies exciting future directions, including tackling unknown words and further refining the system. This SMT-based approach holds significant promise for automated grammar correction, potentially benefiting both language learners and anyone striving for clear, error-free writing.

[3] Detmar Meurers “Natural Language Processing and Language Learning”. This paper explores the role of NLP in revolutionizing language learning by delving into both sides of the coin: how learners use language and how native materials present it. On one hand, NLP analyzes learner language in intelligent tutoring systems, providing personalized feedback, automating scoring, and uncovering patterns in vast learner corpora. This deep understanding fuels better teaching and tailored learning paths. On the other hand, NLP helps curate and adapt native materials, finding suitable reading matter and automatically generating engaging exercises from authentic sources. Imagine a writing tutor pinpointing your errors, suggesting alternatives, and adapting lessons based on your progress, all thanks to NLP. This personalized, data-driven approach promises a future where language learning is efficient, effective, and tailored to each student's unique needs.

[4] Grigori Sidorov, Anubhav Gupta, Martin Tozer, Dolors Catala, Angels Catena, and Sandrine Fuentes “Rule-based System for Automatic Grammar Correction Using Syntactic N-grams for English Language Learning (L2)”. The paper tackles English grammar correction for the CoNLL-2013 shared task using a simple, rule-based system. This system benefits from minimal resources like uncountable noun lists and dependency parsers, utilizing "syntactic n-grams" for rule creation. The paper advocates for a strategic combination of rule-based and machine learning approaches, where each shines. They see rules excelling in clear-cut cases like article choice and subject-verb agreement, while prepositions might benefit more from machine learning. Although performance is not stellar, the system serves as a valuable baseline due to its simplicity and quick development. The authors acknowledge more complex systems may outperform theirs, and their focus on readily identifiable errors leaves intricate corrections untouched. In essence, this paper offers a pragmatic rule-based grammar correction system, explores the usefulness of resources and syntactic n-grams, and sheds light on scenarios where rules can be surprisingly effective collaborators with machine learning.

[5] Mariano Felice, Zheng Yuan, Øistein E. Andersen, Helen Yannakoudakis and Ekaterina Kochmar “Grammatical error correction using hybrid systems and type filtering”. The paper discusses the use of two main methods for error correction: rule-based systems (RBS) and statistical machine translation (SMT). The RBS method relies on a set of predefined rules to correct errors, while the SMT method uses a large-scale language model to generate candidate corrections. The paper evaluates the performance of these methods using a development set and a test set. The results show that the RBS system achieves a precision of 0.67 and an F0.5 score of 0.42 on the development set. On the test set, the RBS system achieves a precision of 0.47 and an F0.5 score of 0.37. The SMT system, on the other hand, achieves a precision of 0.29 and an F0.5 score of 0.28 on the development set. On the test set, the SMT system achieves a precision of 0.47 and an F0.5 score of 0.44. The paper also explores different combinations of the RBS and SMT systems in a pipeline approach. The results show that a simple pipeline using the RBS system first and the SMT system second yields performance that is comparable to more sophisticated pipelines. However, performance is improved when considering the 10 best hypotheses from the SMT system.

[6] Yash Thakare, Tejas Sridhar, Navanit Srisangkar, Pankaj Vanwari "Application for Grammar Checking and Correction". The paper delves into the fascinating world of grammatical error correction, exploring three key techniques namely Statistical, Rule-based and Hybrid. However, real-time correction presents hurdles: clunky tools, inconsistent data, and limited semantic analysis hamper progress. Additionally, handling non-standard formats like images remains a challenge. Despite these obstacles, the paper hints at the potential of machine learning, particularly neural networks, to streamline the process. By leveraging large datasets, these powerful tools could enhance existing techniques and push the boundaries of grammar correction. Overall, the paper offers a valuable roadmap for navigating the intricacies of grammatical error correction systems, highlighting both achievements and future horizons in this captivating domain.

[7] Shanchun Zhou and Wei Liu "English Grammar Error Correction Algorithm Based on Classification Model". This paper nvestigates the application of machine learning and data mining techniques for automatically detecting and correcting grammar errors in English text produced by nonnative language learners. It reviews the existing challenges in English grammar error correction algorithms and emphasizes the necessity for more accurate methods to aid nonnative learners in enhancing their writing skills. The authors outline the construction of a basic model for English grammar error correction using feature extraction and dynamic residual structure principles within the classification model framework. The paper delves into the model architecture, optimizer, and

presents results from a simulation experiment involving 1568 sentences with 32 types of grammar errors. Two English-speaking annotators independently mark errors and provide corrections.

[8] Chen Hongli "Design and Application of English Grammar Error Correction System Based on Deep Learning". The paper discuss the development of an English grammar error correction system. The article aims to propose a system that can detect and correct grammar errors in English sentences. It also focuses on the implementation of machine learning models to improve the accuracy of grammar error detectionThe article discusses the process of analyzing experimental results and presents a feedback filtering process to improve the quality of the error correction suggestions. Overall, the research article aims to contribute to the field of English grammar error detection and correction.

[9] Hubert Haider "Is Chat-GPT a grammatically competent informant?". The that-trace effect, observed in languages like English and French, is a constraint on wh-constructions with a gap in a specific structural position of a clause. This phenomenon is linked to obligatory subject positions in these languages but is absent in languages like Dutch and German. The effect, seen as a grammatical restriction or a by-product of sentence processing, varies across related languages. Chat-GPT determines grammatical correctness based on its training with vast text corpora, employing a foundational large language model. It assesses sentences against grammar rules without a deep understanding of specific subject matter.

III. Objectives

1. Investigate existing correction methodologies and technologies to identify gaps and opportunities for improvement.
2. Design a flexible and adaptive correction algorithm that can dynamically adjust its correction strategies based on varying input types and contexts.
3. Implement the grammer correction assistant system, incorporating the designed algorithm, and ensure compatibility with a wide range of input formats, such as text, audio, and other relevant data types.
4. Evaluate the performance of the grammer correction assistant in real-world scenarios, considering factors such as accuracy, speed, and adaptability across diverse input categories.

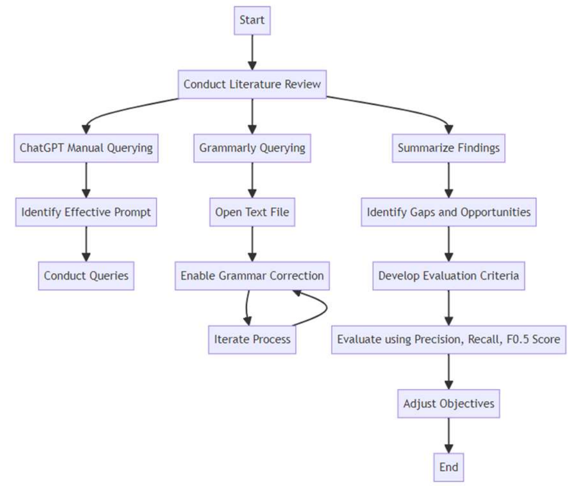

Fig. 1. Flow Chart for Objective-1

We opted for manual querying of ChatGPT instead of using an API due to ChatGPT's instability. When a query sentence resembles a question or demand, ChatGPT may deviate from the grammar error correction (GEC) process and respond to the perceived 'demand.' Through several trials, we identified an effective prompt for ChatGPT: 'Do grammatical error correction on all the following sentences I type in the conversation.' This prompt is used for querying ChatGPT with each test sample.

When conducting queries with Grammarly, our approach involves opening a text file and organizing the test samples into separate paragraphs. We activate all grammar correction settings and specifically instruct Grammarly to rectify sentences with correctness problems (indicated by a red underline). Simultaneously, we refrain from altering suggestions related to clarity (blue underline), engagement (green underline), and delivery (purple underline). This process is iterated multiple times until no errors are identified by Grammarly.

System	Precision	Recall	$F_{0.5}$
ChatGPT	51.2	62.8	53.1
Grammarly	67.3	51.1	63.3

Table. 1. Performance of ChatGPT and Grammarly

Specifically, the three metrics are expressed as:

$$\text{Precision} = \frac{TP}{TP + FP},$$

$$\text{Recall} = \frac{TP}{TP + FN},$$

$$\mathrm{F}_{0.5} = \frac{1.25 \times \text{Precision} \times \text{Recall}}{0.25 \times \text{Precision} + \text{Recall}},$$

Consider the below example,

Input: A greenhouse is a glass building used to grow plants. A greenhouse has transparent glass that allows the sunlight to pass through, but does not allow the heat inside to escape. The same affect occurs on the earth. The suns radiation passes through the atmosphere to heat the earth's surface. When heated, the earth's surface produces infrared radiation, which has a longer wavelength than that of sunlight.

Expected Output: A greenhouse is a glass building used to grow plants. A greenhouse has transparent glass that allows the sunlight to pass through, but does not allow the heat inside to escape. The same effect occurs on the earth. The sun's radiation passes through the atmosphere to heat the earth's surface. When heated, the earth's surface produces infrared radiation, which has a longer wavelength than that of sunlight.

Chatgpt Output: A greenhouse is a glass building used to grow plants. It has transparent glass that allows sunlight to pass through but does not let the extra heat escape. The same effect occurs on Earth. The sun's radiation passes through the atmosphere, heating the Earth's surface. When heated, the Earth's surface produces infrared radiation, which has a longer wavelength than sunlight.

Grammarly Output: A greenhouse is a glass building used to grow plants. A greenhouse has transparent glass that allows the sunlight to pass through but does not allow the heat inside to escape. The same effect occurs on the Earth. The sun's radiation passes through the atmosphere to heat the earth's surface. When heated, the earth's surface produces infrared radiation, which has a longer wavelength than that of sunlight.

We inspect the output of the two systems, especially those for long sentences, and find that ChatGPT is not limited to correcting the errors in the one-by-one fashion. Instead, it is more willing to change the superficial expression of some phrases or the sentence structure. While, Grammarly make minor changes to the source sentence.

System	#Under	#Mis	#Over
ChatGPT	3	3	30
Grammarly	14	0	1

Table. 2. Number of under-correction (Under), miscorrection (mis) and over-correction (Over) produced by ChatGPT and Grammarly.

As of now, we have achieved objective-1.

IV. SYSTEM DESIGN

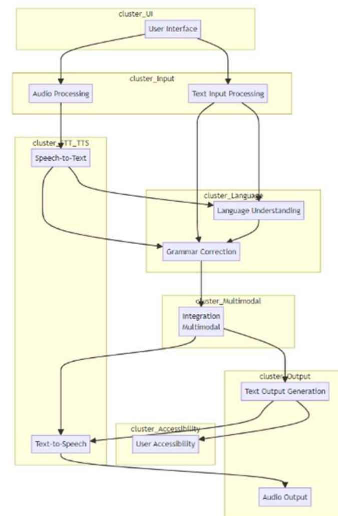

Fig. 2. System Design

- **User Interaction:** The user interacts with the system through the user interface (UI). This can be through typing text or providing spoken input.
- **Input Processing:** Depending on the user's input, the system processes it through two pathways: TextInput for text input and AudioInput for spoken input.
- **Speech-to-Text (STT):** If the input is spoken, the system uses Speech-to-Text (STT) to convert the spoken words into text that the system can understand.
- **Language Understanding (LU):** Both text and spoken inputs are then processed by the Language Understanding (LU) module. This module comprehends the meaning and intent behind the user's input.
- **Grammar Correction (GC):** The system checks for grammar errors in the user's input using the Grammar Correction (GC) module. It ensures that the language used is correct and coherent.
- **Integration Multimodal (MM):** The Multimodal Integration (MM) component combines the outputs from text and audio processing, providing a unified understanding of the user's intent.
- **Text Output Generation (TextOutput**): Based on the processed input, the system generates text-based responses using the Text Output Generation (TextOutput) module.
- **Text-to-Speech (TTS):** If the response is in text form and needs to be communicated audibly, the Text-to-Speech (TTS) module converts the text into spoken words.
- **User Accessibility (UA):** The system ensures accessibility for all users, considering diverse needs and abilities.

- **Audio Output:** The final response, either in text or spoken form, is presented to the user through the Audio Output module.

V. CONCLUSION

This paper evaluates ChatGPT on the task of Grammatical Error Correction (GEC). By testing on the CoNLL2014 benchmark dataset, we find that ChatGPT performs worse than a commercial product Grammarly in terms of automatic evaluation metrics. By examining the outputs, we find that ChatGPT displays a unique ability to go beyond one-by-one corrections by changing surface expressions and sentence structure while maintaining grammatical correctness. Human evaluation results confirm this finding and reveals that ChatGPT produces fewer under-correction or mis-correction issues but more over-corrections. These results demonstrate the need of a better Grammar Error Correction Model.

VI. REFERENCES

[1] GRIGORI SIDOROV "Syntactic Dependency Based N-grams in Rule Based Automatic English as Second Language Grammar Correction" International Journal of Computational Linguistics and Applications, vol. 4, no. 2, pp. 169-188, 2013.

[2] Bibek Behera, Pushpak Bhattacharyya "Automated Grammar Correction Using Hierarchical Phrase-Based Statistical Machine Translation" International Joint Conference on Natural Language Processing, pages 937–941, Nagoya, Japan, 14-18 October 2013.

[3] DETMAR MEURERS "Natural Language Processing and Language Learning" © 2020 John Wiley & Sons, Inc. Published 2020 by John Wiley & Sons, Inc.

[4] Grigori Sidorov, Anubhav Gupta, Martin Tozer, Dolors Catala, Angels Catena and Sandrine Fuentes "Rule-based System for Automatic Grammar Correction Using Syntactic Ngrams for English Language Learning (L2)" August 8-9 2013 Association for Computational Linguistics.

[5] Mariano Felice, Zheng Yuan, Øistein E. Andersen, Helen Yannakoudakis and Ekaterina Kochmar "Grammatical error correction using hybrid systems and type filtering" Maryland, 26-27 July 2014 Association for Computational Linguistics.

[6] Yash Thakare, Tejas Sridhar, Navanit Srisangkar, Pankaj Vanwari "Application for Grammar Checking and Correction" International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 06 | June 2020.

[7] Shanchun Zhou and Wei Liu "English Grammar Error Correction Algorithm Based on Classification Model" Hindawi Complexity Volume 2021.

[8] Chen Hongli "Design and Application of English Grammar Error Correction System Based on Deep Learning" Hindawi Security and Communication Networks Volume 2021.

[9] Hubert Haider "Is Chat-GPT a grammatically competent informant?" v. 1.3 – May 24th, 2023.