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Research on human–machine collaborative academic English translation paths driven by generative artificial intelligence

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Abstract. Generative Artificial Intelligence (GenAI), with its powerful corpus-processing and rapid text-generation capabilities, has been widely applied in the field of translation, bringing new momentum to academic English translation. Human–machine collaborative translation based on Large Language Models (LLMs) can substantially improve the efficiency of academic English translation and play an important role in supporting international academic publication, communication at international conferences, and the dissemination of academic discourse internationally. However, GenAI also has inherent limitations in handling complex academic logic and constructing discourse for cross-cultural communication. Therefore, exploring human–machine collaborative approaches to academic English translation driven by GenAI is of considerable significance for effectively improving the quality and efficiency of academic English translation. Accordingly, this study analyzes the characteristics of academic English translation, as well as the advantages and limitations of applying GenAI to academic English translation, and proposes pathways for human–machine collaborative academic English translation driven by GenAI, with the aim of providing practical guidance for academic English translation.

Keywords: human–machine collaboration, academic English translation, generative artificial intelligence, translation pathways

1. Introduction

The emergence of Generative Artificial Intelligence (GenAI) has brought about a transformation in translation production and given rise to an entirely new translation paradigm—Large Language Model (LLM)-driven Human–Machine Collaborative Translation (HMCT) [1]. With its powerful corpus-processing and rapid text-generation capabilities, LLMs have been widely applied in the field of translation, injecting new vitality into academic English translation. LLM-based human–machine collaborative translation can substantially improve the efficiency of academic English translation and play an important role in supporting international academic publication, communication at international conferences, and the dissemination of academic discourse internationally. However, GenAI also has inherent limitations in handling complex academic logic and constructing discourse for cross-cultural communication. Therefore, exploring pathways for LLM-driven

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human–machine collaborative academic English translation and effectively improving the quality of academic English translation are of considerable significance for enhancing the capacity to disseminate academic discourse internationally.

International research on human–machine collaborative translation has primarily focused on machine translation quality evaluation, comparative studies of human and machine translation, and collaborative feedback mechanisms. Representative studies have examined the advantages and limitations of human–machine collaborative translation; machine translation quality evaluation and optimization; the history and contemporary challenges of machine translation in the era of LLMs; comparative studies of human and machine translation [2]; evaluations of the applicability of machine translation; multimodal neural machine translation; deep learning strategies for machine translation; learner autonomy in students' use of machine translation and AI tools for English for Academic Purposes; and collaborative feedback mechanisms in human–machine translation [3].

Research in China has mainly focused on human–machine collaborative translation models, translator training, and the applications and challenges of GenAI in translation. Representative studies include AI-enabled translator training; LLM-enabled translation quality assessment; research on human–machine collaborative translation teaching models; machine translation literacy; the applications, challenges, and responses associated with GenAI in translation; and comparisons between translator-produced and machine-translated texts in terms of quality. Research specifically addressing academic English translation has mainly examined translation strategies in particular academic disciplines, such as agriculture and medicine, as well as the linguistic features and translation techniques of academic English, machine translation post-editing, and the translation of academic English terminology. However, relatively little research has been conducted on pathways for LLM-driven human–machine collaborative academic English translation.

2. Overview of academic translation activities

2.1. Academic translation and academic English translation

Translation is a comprehensive, interdisciplinary, cross-cultural, and cross-linguistic activity that involves a range of integrated language skills, including reading, comprehension, bilingual conversion, lexical selection, and writing. Academic translation, by contrast, refers to the practice of converting texts in a specific academic field from a source language into a target language. It is characterized by a clear purpose, professionalism, scientific rigor, and precision, with the primary aim of facilitating the cross-linguistic and cross-cultural transmission of academic knowledge. Yin Haihong [4] points out in *An Examination of the Concepts from "Academic" to "Academic Translation"* that academic translation is the linguistic transformation of the outcomes of systematic research and rational inquiry. In a broad sense, academic translation encompasses all scientific and knowledge-based research outputs in the humanities and social sciences and the natural sciences, including professional monographs, academic works, and journal articles. Therefore, in terms of the objects of translation, academic translation covers a wide range of fields, including the natural sciences, social sciences, and humanities. In terms of the contexts in which translation services are provided, academic translation primarily serves academic activities such as domestic and international academic publication, conference communication, and research collaboration.

Academic English translation primarily refers to translation practices involving Chinese and English as the source and target languages, specifically the translation of academic texts from Chinese into English or from English into Chinese.

2.2. Distinctive linguistic features of academic English translation

Translation activities are closely associated with text types. Whether a text belongs to scientific discourse or literary discourse directly determines differences in the ways it is understood and expressed. Since academic texts constitute the primary objects of academic translation, their language exhibits distinctive academic characteristics and differs fundamentally from that of literary translation.

Yin Haihong [4] argues that the distinctive features of academic translation lie in its systematicity, rigor, and standardization. These characteristics are reflected in established academic genres formed through rational reasoning, logical argumentation, critical examination, and empirical verification. Such inherent academic genres can serve as criteria for identifying academic translation. The distinctive features of academic English translation in contrast to literary translation are specifically manifested in the following aspects.

2.2.1. Lexical level: professionalism and precision of terminology

Academic English texts contain a large number of field-specific technical terms that serve as core carriers of academic concepts. These terms have clearly defined connotations and extensions and are highly specialized and often unambiguous. The accuracy with which they are translated directly determines the scientific validity of the target text. Literary language, by contrast, often pursues *defamiliarization*. The concept of "defamiliarization" was proposed by Russian Formalist theorist Viktor Shklovsky. It refers to the deliberate use of fresh or unusual language to break through the barriers of routinized everyday language, thereby creating a novel reading experience and enabling readers to perceive things anew—to make "stone stony". Accordingly, in terms of terminology, academic English tends to employ standardized vocabulary and makes extensive use of technical and semi-technical terms. Abbreviations, symbols, formulas, and charts are also frequently used, while words expressing subjective behavior and emotion are relatively uncommon. Rhetorical devices such as metaphor, hyperbole, and personification are rarely employed.

2.2.2. Syntactic and discourse levels: logical sentence structures and objective argumentation

As noted above, academic translation is the linguistic transformation of the outcomes of systematic research and rational inquiry. Systematicity and rationality are primarily manifested in the objectivity and logical coherence of research or intellectual inquiry. Consequently, academic discourse generally contains strong logical relationships between preceding and subsequent propositions as well as clearly developed chains of argumentation. At the syntactic level, academic English frequently employs long sentences, conventional sentence patterns, passive voice, and nominalization. At the discourse level, academic writing emphasizes clear and objective description, conceptual precision, strong logical coherence, concise expression, orderly organization, and rigorous structure. Literary translation, in contrast, places greater emphasis on conveying emotions, creating imagery, and achieving expressive resonance. Its sentence structures are therefore often more flexible, with greater emphasis on the readability, aesthetic appeal, and literary quality of the target text. Literary translators may employ syntactic transformation, rhetorical devices, and other strategies of free translation to convey the artistic conception of the original. Literary translation is less dependent on explicit logical relationships and, while maintaining fidelity to the original text ("faithfulness"), allows translators a greater degree of creative adaptation to achieve "expressiveness" and "elegance".

2.2.3. Academic conventions: standardization and consistency of formatting

Academic texts often contain a substantial number of figures, tables, annotations, and other elements and are subject to relatively strict formatting conventions. Different types of academic publications, such as journals, monographs, and research papers, also have their own specific formatting requirements. Standardized formatting constitutes a universal convention in academic communication and must therefore be strictly observed during the translation process to ensure that the target text conforms to the requirements of the

intended academic context. Literary translation, by comparison, is generally not subject to such strict or relatively uniform formatting conventions.

3. Advantages of applying generative artificial intelligence to academic English translation

Before the emergence of Large Language Models (LLMs), translators generally placed considerable emphasis on developing their technical competence. They sought to improve translation quality by using big data, search engines, specialized corpora from different academic disciplines, keyword-chain searches, and other resources. With the subsequent development of translation technologies, translators gradually began to use Computer-Assisted Translation (CAT) tools and Machine Translation (MT), such as online translation platforms and translation software, followed by corresponding post-editing. The emergence of Generative Artificial Intelligence (GenAI) can be regarded as a multiplier of translators' productivity. Trained on massive corpora, GenAI possesses powerful language-processing and rapid text-generation capabilities and offers significant advantages in translation, particularly in academic English translation.

3.1. Efficient processing of standardized texts to improve translation efficiency

Experimental methods, figure and table annotations, formulaic expressions, and other elements in academic translation exhibit a high degree of standardization. Their sentence structures, logical organization, and formatting conventions are relatively fixed. GenAI can rapidly identify the characteristics of such standardized texts and, drawing on pretrained academic corpora, quickly generate initial translation drafts. This can substantially shorten translation time and significantly reduce the workload of human translators.

3.2. Accurate terminology matching to provide a basis for translators' cognitive decision-making

Through training on large-scale academic corpora, GenAI has accumulated extensive repositories of disciplinary terminology and can rapidly identify and match basic terms in academic texts, providing commonly accepted translations that conform to fundamental disciplinary conventions. In the author's article, *Problems and Countermeasures in Chinese–English Surveying and Mapping Translation from the Perspective of Skopos Theory: A Case Study of the English Translation of Fundamentals of Geodesy*, the major problems encountered in specialized translation were identified as primarily involving the comprehension and re-expression of specialized knowledge, the standardization of specialized terminology in accordance with international conventions, and equivalence between source-language and target-language texts [5]. During the translation of this textbook, terminology databases and authoritative sources available online were first consulted to ensure terminological accuracy. The initial translations were then assessed in terms of their relevance and degree of correspondence with established usage. By entering the translated terms and their collocations into foreign-language search engines or specialized corpora, the translator could identify matching expressions and evaluate the quality of the English translations. GenAI, however, has a powerful corpus foundation and sophisticated syntactic and grammatical parsing capabilities, enabling it to perform high-quality language conversion rapidly and match terminology efficiently. It can even provide multiple translation options, together with explanations of their meanings and analyses of their respective contexts of use. This gives translators a broader and more reliable basis for cognitive decision-making. Translators need only consider factors such as context, semantics, connotations and denotations, and cross-cultural interpretation when making the final decision and selecting the most appropriate translation.

4. Challenges of applying generative artificial intelligence to academic English translation

Although Generative Artificial Intelligence (GenAI) offers significant advantages in academic English translation, it still has limitations in practical applications, which are mainly reflected in the following aspects.

4.1. Limited cross-cultural understanding and expression, with insufficient awareness of cultural differences

From the perspective of the core value of academic English translation, translation is not merely a conversion of linguistic symbols but also a means of disseminating academic ideas across cultures. High-quality academic English translation can break down language barriers, facilitate knowledge sharing and collaborative innovation among researchers from different countries, and promote international academic exchange. Conversely, deviations in terminology or translation during the translation process may lead to misinterpretation of information, thereby affecting the dissemination of research findings and the realization of their academic value.

Due to cultural differences, countries also differ in their linguistic styles. China is a typical high-context culture, in which linguistic expression tends to be more spatially oriented and textual interpretation relies more heavily on contextual understanding. English-speaking countries, by contrast, are typically associated with low-context cultures, in which linguistic expression tends to be more linear and textual interpretation relies more heavily on logical relationships between sentences. In other words, Chinese sentence structures can generally be characterized as bamboo-like, emphasizing sequential connections and step-by-step progression, whereas English sentence structures tend to be tree-like, emphasizing subordination and hierarchical branching. Consequently, academic texts in English often adopt more direct and objective modes of expression. GenAI is unable to grasp such cross-cultural differences as deeply as human translators and therefore requires substantial human intervention to compensate for its limitations in cross-cultural communication. As stated in the Guidelines for the Application of Generative Artificial Intelligence in the Translation Industry [6], "translation professionals should pay attention to whether AI-generated content involves cultural conflicts, whether the emotional orientation of generated translations is compatible with the target language, and whether relevant expressions conform to the conventions of the target language".

4.2. Insufficient stability in translation quality and limited understanding of complex linguistic phenomena and logical relationships

The quality of GenAI-generated translations is significantly influenced by factors such as the clarity of the source text and the model's familiarity with the relevant academic discipline, resulting in considerable variability. For texts that are clearly expressed and belong to familiar academic fields, AI can often generate high-quality translations. However, when texts are ambiguous or concern less familiar academic fields, AI may produce inappropriate translations or omit important information. In addition, AI may generate so-called translation hallucinations, in which the target text appears fluent on the surface but does not accurately convey the meaning of the source text. Such problems are difficult to detect through simple grammatical checks and may therefore compromise translation quality to a certain extent.

Moreover, when analyzing complex logical relationships across multiple levels, particularly in the interpretation of long and syntactically complex sentences, GenAI may fail to identify semantic relationships and modification structures accurately. In cases involving polysemy, it may sometimes provide an inappropriate sense of a word and fail to accurately determine its extension, intension, or hierarchical semantic

relationships, thereby resulting in deviations in meaning or even mistranslation and compromising the rigor of academic discourse.

Furthermore, the terminology resources available to GenAI depend heavily on its training data. For innovative terms emerging in cutting-edge fields or through interdisciplinary integration, insufficient corpus support in the training data may make it difficult for GenAI to determine appropriate and standardized forms of expression. This may result in the creation of non-established terms or deviations in translation, thereby affecting the accurate transmission of academic information.

GenAI has distinctive advantages in academic English translation, particularly in efficiently processing standardized texts, improving translation efficiency, and accurately matching terminology to provide translators with a basis for cognitive decision-making. Nevertheless, it has limitations in cross-cultural understanding and expression and insufficient awareness of cultural differences. It may also fail to fully comprehend complex logical structures, polysemous expressions, and other linguistic phenomena, resulting in deviations in translation. Therefore, translators need to draw on their academic expertise and translation experience to accurately compensate for the limitations and shortcomings of GenAI in academic English translation. In this way, a new paradigm of academic English translation can be established in which human–machine collaboration is empowered by large language models.

5. Pathways for generative ai-driven human–machine collaborative academic English translation

Based on the strengths and limitations of generative Artificial Intelligence (GenAI) in academic English translation, and taking into account the core value and compensatory role of human translation, this study proposes a human–machine collaborative translation pathway consisting of "AI pre-processing → human optimization → AI secondary verification → human finalization → terminology database iteration". This pathway is designed to simultaneously improve the efficiency and quality of academic English translation. The specific steps are as follows.

5.1. AI pre-processing: establishing a foundation for translation

Based on the type of academic text, an appropriate specialized prompt template, such as a prompt specifically designed for translating experimental methods, can be selected. The text is then entered into generative AI tools such as DeepSeek, iFlyrec Translation, and Doubao to generate an initial translation draft. During this process, AI can simultaneously perform preliminary matching of basic terminology, segmentation of long and complex sentences, and preliminary formatting, thereby producing a draft translation that meets basic academic conventions.

5.2. Human optimization: addressing core translation challenges

Translators should focus on the key issues identified in the AI-generated draft and carry out targeted optimization. First, they can compare translations generated by different AI tools, particularly in the translation of specialized terminology. For difficult or cutting-edge terms, comparing different versions can provide translators with a range of options and a basis for cognitive decision-making. Translators can then draw on their disciplinary knowledge, consult relevant academic literature, and seek advice from experts in the field to verify and revise terminology, thereby determining translations that are appropriate for interdisciplinary communication and avoiding deviations in meaning while ensuring terminological accuracy and consistency. Second, translators should review the argumentative logic of the target text and make appropriate adjustments

to sentence structures to ensure logical coherence. Third, they should refine the mode of expression, particularly in relation to cross-cultural academic communication. This requires translators to draw fully on their cultural literacy, cultural awareness, and intercultural competence while taking into account factors such as the conventions of academic discourse. On this basis, translators must determine appropriate translation strategies. For example, they must decide whether to accommodate the characteristics of the foreign culture and incorporate foreign-language modes of expression or adhere to the linguistic and cultural traditions of the target culture and adopt idiomatic target-language expressions—that is, whether to employ foreignization or domestication. They must also determine whether to preserve both the content and form of the source text or instead prioritize the communication of its overall meaning and emotional effect—that is, whether to employ literal translation or free translation. Such decisions should be made according to the purpose of translation. For specialized types of academic texts, such as texts involving sensitive subject areas, translators should also develop individualized translation strategies in accordance with the specific characteristics of the text.

5.3. AI secondary verification: supporting quality control

The human-optimized translation is re-entered into the generative AI tool for a second round of verification. This process includes several aspects. First, terminological consistency is checked to identify inconsistencies in terminology and flag potentially inaccurate expressions. Second, formatting conventions are verified to ensure that the translation complies with academic formatting requirements, including reference formatting and the conventions for labeling figures, tables, and their annotations. Third, grammar and fluency are reviewed to refine awkward sentence structures and improve the overall readability and fluency of the target text. Once the AI system flags potential issues, the results are fed back to the translator to facilitate targeted revisions.

5.4. Human finalization: ensuring the quality of the final translation

Based on the results of the AI secondary verification, the translator conducts a comprehensive final review of the target text. The translator thoroughly examines terminological consistency, syntactic appropriateness, logical coherence, and formatting accuracy, and corrects any terminological deviations identified during the verification process. The logical coherence and completeness of the argumentation are also reviewed to ensure that there are no gaps in reasoning or omissions of information. In addition, the translator checks the formatting of the translation to ensure compliance with the requirements of the intended academic context. Finally, the entire translation is carefully reviewed to refine its linguistic expression and ensure both fluency and academic appropriateness. Upon completion of the review, a final translation suitable for academic publication and scholarly communication is produced.

5.5. Terminology database iteration: improving the efficiency of human–machine collaboration

Terminological equivalents confirmed through human review are entered into a personalized terminology database, while the training corpus used by the generative AI system is updated accordingly. Through continuous accumulation of terminology and corpus updates, the accuracy of AI translation for specialized terms and texts from less commonly represented academic disciplines can be improved, while reducing the amount of subsequent human optimization required. When texts from the same field are translated in the future, the system can directly retrieve and apply the established equivalents, thereby improving both translation efficiency and quality. In this way, a sustainable human–machine collaborative mechanism based on use, optimization, and iterative improvement can be established.

6. Conclusion

With its powerful corpus-processing and rapid text-generation capabilities, Generative Artificial Intelligence (GenAI) has been widely applied in translation and has brought new vitality to academic English translation. By examining the distinctive characteristics of academic English translation—including the professionalism and precision of terminology at the lexical level, the logicality of sentence structures and objectivity of argumentation at the syntactic and discourse levels, and the standardization and consistency of formatting at the level of academic conventions—this study has identified the advantages and limitations of applying GenAI to academic English translation. On this basis, it proposes a human–machine collaborative academic English translation pathway consisting of AI pre-processing → human optimization → AI secondary verification → human finalization → terminology database iteration. The proposed pathway aims to provide concrete operational guidance for academic English translation practices.

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