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| RESEARCH ARTICLE

Study on the Effectiveness of ChatGPT in Translating Forestry Sci-tech Texts

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| ABSTRACT
ChatGPT, an advanced language model by OpenAI, enhances translation with its powerful language generation and understanding. In comparison to traditional human translation, ChatGPT is less costly, time-consuming, and knowledge-constraint, showcasing the substantial value of its application in translation practice. In the context of globalization, forestry translation plays an increasing role in facilitating global forestry development. To meet the growing need for efficient and high-quality translation in the forestry sector, this paper did research on the effectiveness of ChatGPT in the translation of forestry sci-tech texts. Combining quantitative analysis using BLEU and TER scores with qualitative evaluations by domain experts, this study compares the quality of translations produced by ChatGPT with that of the three mainstream machine translation tools in the market—Google Translate, Youdao Translation, and DeepL Translator regarding the translations' accuracy and readability. The findings reveal that while ChatGPT excels in domain-specific terminology and context-sensitive meanings, it faces challenges in dealing with texts with special sentence structures and making the translations adaptable. By identifying the strengths and limitations of ChatGPT in translating forestry sci-tech texts, this research illustrates that there is great potential for ChatGPT's application in forestry translation. Additionally, the study provides insights that can guide the development and refinement of machine translation systems to better meet the needs of specialized fields, ultimately facilitating more effective global communication and knowledge sharing.

| KEYWORDS

ChatGPT, forestry sci-tech texts, effectiveness, evaluation, quality of translation.

| ARTICLE INFORMATION

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1. Introduction

In the era of globalization, the exchange of scientific and technological knowledge across borders has become more crucial than ever. The forestry sector, which plays a pivotal role in environmental conservation, biodiversity preservation, and sustainable development, is no exception. Accurate and efficient translation of forestry sci-tech texts is essential for facilitating international collaboration and knowledge sharing globally. Although human translation can ensure the accuracy and readability of such specialized texts, this approach is often costly, time-consuming, and limited by the availability and expertise of professional translators. With the advancement of artificial intelligence (AI), machine translation has emerged as a promising alternative, offering potential solutions to the challenges faced by human translation. Among the latest developments in AI-driven translation tools is ChatGPT, an advanced language model developed by OpenAI. Compared to traditional human translation, ChatGPT offers significant advantages in terms of cost, speed, and scalability. This paper aims to explore the effectiveness of ChatGPT in translating forestry sci-tech texts. Given the growing need for high-quality and efficient translation in the forestry sector, it is crucial to assess whether AI-driven tools like ChatGPT can meet these demands. The study employs a mixed-methods approach, combining quantitative analysis using BLEU and TER scores with qualitative evaluations by domain experts. By comparing the performance of ChatGPT with three mainstream machine translation tools–Google Translate, Youdao Translation, and DeepL Translator, this research seeks to identify the strengths and limitations of ChatGPT in handling domain-specific texts. Ultimately, the findings of

this study will contribute to a better understanding of the potential and challenges of AI-driven translation tools, providing insights that can guide their development and refinement to better serve specialized fields like forestry.

2. Literature Review

The development of artificial intelligence has brought many revolutionary changes to various fields, including the field of translation. Nowadays, machine translation has become an indispensable tool in the process of translation, bringing much convenience to individuals, organizations, and governments. The advent of ChatGPT, a powerful language model, has opened up new possibilities for machine translation. Given this, there are growing studies at home and abroad conducted on the application of ChatGPT in translation tasks.

Some scholars conducted research on the effectiveness of ChatGPT in translating specific texts. For example, Wen and Tian(2024) explored the effectiveness of ChatGPT in translating China-specific discourse text. Wang and Ma(2023) delved into the application of artificial intelligence in biomedical text Translation through a comparative study. To explore the potential of ChatGPT's abilities in poetry translation, (Gao et al., 2024) conducted a comparative analysis of poetry translation quality, contrasting ChatGPT (with two different prompts) with Google Translate and DeepL Translator regarding fidelity, fluency, language style, and machine translation style. Mohammed(2024) conducted a rigorous evaluation of the effectiveness and precision of machine translation, represented by Google Translate (GT), in comparison to Large Language Models (LLMs), specifically ChatGPT 3.5 and 4, when translating academic abstracts bidirectionally between English and Arabic. Besides, some researchers studied ChatGPT from the aspect of machine translation post-editing. For instance, Geng and Hu(2023) analyzed the post-editing performance of ChatGPT in terms of error correction and the adjustments of syntactic structures, textual coherence, and register of both the English-to-Chinese and Chinese-to-English translated texts. Wang and Wang(2024) explored the effectiveness of the teaching model of "ChatGPT + MTPE" interactive post-editing competence.

The large language processing model technology represented by ChatGPT is enthusiastically pursued in the field of natural language processing and has a great impact on artificial intelligence translation. While actively accepting and applying the technology, how to identify and alleviate the hidden worries brought by ChatGPT translation is a problem that needs careful consideration. Wang and Zhang(2024) took ChatGPT's instrumental value as the starting point, analyzed the translation characteristics of ChatGPT with concrete representations, explored its hidden worries from the metaphysical perspective of technical philosophy, and put forward the concept of "Digital Symbiosis," focusing on the translator's subject, language object, and translation ethics to provide a relief path ethics. Liu and Kong (2023) analyzed the core dimensions of translation technology ethics: first, the relationship between translation technology and humans, addressing issues like blurred data ownership, privacy invasion, and challenges to informed consent; second, the relationship between translation technology and the world, focusing on the devaluation of translation, fairness erosion, and security risks. Dorothy and Marion (2020) investigated how the use of neural machine translation influences the textual voice of a renowned translator from English into German, Hans-Christian Oeser. Weng(2024) discussed the ethics of machine translation in the era of artificial intelligence. The core of the discussion is the ethical issues raised by machine translation, including data privacy, copyright disputes, accountability, and cultural biases. In response to these challenges, solutions like improving data handling methods and enacting legal standards were proposed.

Despite the wealth of existing research on the application of ChatGPT in translation tasks, an exploration of the effectiveness of ChatGPT in translating forestry sci-tech texts remains conspicuously absent from both domestic and international scholarship. Therefore, this study aims to fill this gap, offering more possibilities for translation practice within this field later and ultimately better promoting global forestry development.

3. Methodology

This study intends to answer the following three questions: First, Does ChatGPT have an advantage over Google Translate, Youdao Translation, and DeepL Translator in translating forestry sci-tech texts? If so, in what aspects? Second, is it feasible for ChatGPT to replace human translators in translating forestry sci-tech texts? If not, what limitations does ChatGPT exhibit in the field of forestry translation? Third, in the era of artificial intelligence, what is the future of forestry translation?

In this section, an overview of the research methodology employed in this study will be provided. It will outline the research design, data collection methods, data analysis techniques, ethical considerations, and the limitations of the study. This section sets the stage for a detailed explanation of the methods used to investigate the effectiveness of ChatGPT in translating forestry sci-tech texts compared to other mainstream machine translation tools.

3.1 Research Design

This study adopts a comparative research design to evaluate the effectiveness of ChatGPT in translating forestry sci-tech texts. The research involves both quantitative and qualitative approaches:

Quantitative Analysis: The translation quality will be assessed using BLEU (Bilingual Evaluation Understudy) and TER (Translation Edit Rate) scores.

Qualitative Analysis: Domain experts will evaluate the translations to provide insights into accuracy, readability, and the handling of domain-specific terminology and context-sensitive meanings.

This comprehensive approach allows for a holistic assessment of translation quality, capturing both numerical performance metrics and expert insights into the translations' accuracy and readability.

3.2 Data Collection

Selection of texts. The texts used in the translation tasks were selected from *English for Forestry Science*, published by Foreign Language Teaching and Research Press. It contains rich knowledge of forestry science and technology. Through detailed analysis, it is found that the forestry sci-tech texts are characterized by specialized terminology and tight syntactic structure. According to the features above, this research selected 10 sentences in a targeted way. The selection criteria ensure a representative sample of the types of texts typically encountered in the field. The texts selected are displayed in Table 1.

Table 1 The Examples of Original Texts Selected

S1. Significant amounts of tapping are also done in Spain, Portugal, and Greece, with *P. pinaster*, *P. halepensis*, and *P. nigra*, and in Russia with *P. sylvestris*.
S2. Viruses cause minor galls, and the serious phloem necrosis in elms and locusts.
S3. The pigments responsible for photosynthesis absorb radiation most efficiently in the violet-blue and orange-red wavelengths which are parts of the visible lights.
S4. Denmark produces large quantities of foliage of A. procera and A. nordmanniana from strains with specially selected characteristics such as glauccousness and greenness.
S5. Modern uses of resins are in the manufacture of paint, varnish, and lacquers, as size in paper making to provide lustre and weight and to hinder the absorption of ink and moisture, and in making soap.
S6. Terminal feeders, insects that feed in the tips of the twigs, buds, and shoots, distorting growth and causing tree deformity, which affects timber value.
S7. Out of the spore grows a microscopically fine hollow filament called a hypha, which penetrates into wood or foliage and grows very rapidly, branching and rebranching to produce a gossamer, interwoven network known as a mycelium.
S8. Insects that can injure or, if not kept under control, destroy stands of trees exist in eight classes, as follows.
S9. Preliminary results from the study suggest that as of 2002, less than 500 hectares of genetically modified forest trees (poplar clones) were being grown commercially, in one country (China).
S10. The temple of Queen Hatshepsut, constructed in 1500 B.C. at Thebes, Egypt, has depictions of myrrh trees, introduced from Somalia, planted as sources of perfume, and Theophrastus reported trees of frankincense and myrrh planted on private estates in southern Arabia in the fourth century B.C.

Translation systems. The translation systems used in this study are listed in the following:

ChatGPT-3.5 (https://chat.openai. com/): Released in 2022 by OpenAI, this advanced conversational AI model is known for its vast linguistic data and strong contextual understanding.

Google Translate(https://translate.google.com/): A free web-based translation system provided by Google, this translation system provides instant translation between 133 languages, known for its extensive language support.

Youdao Translation(https://fanyi.youdao.com/): A popular Chinese translation tool provided by NetEase, this translation system supports 109 languages and is known for its ease of use.

DeepL Translator(https://www.deepl.com/zh/translator): Launched in 2017, this translation service supports 31 languages and is praised for its high-quality translations, serving over half a billion users.

Prompt. Besides, given the fact that the translations given by ChatGPT can vary by the prompt, we use the same prompt to ensure validity and reliability as much as possible. Besides, considering the features of the texts provided, the following prompt is used in this study to better explore ChatGPT's application in translating specific-domain texts.

Prompt: The following are English forestry sci-tech texts. Please pay attention to the features of this kind of text when translating it into Chinese, especially its terminology and sentence structure.

Evaluation Metrics. BLEU (Bilingual Evaluation Understudy) is a widely used machine translation evaluation metric (Papineni et al., 2002). This metric evaluates the quality of machine translations by comparing them with human translations. BLEU's scoring mechanism is primarily based on n-gram precision, checking the frequency of n-grams in the machine translation appearing in the reference translations. Scores typically range from 0 to 1, with higher values indicating better translation quality. The metric is simple and fast to compute. Despite its limitations, BLEU remains one of the most commonly used machine translation evaluation metrics in the industry.

TER (Translation Edit Rate) is another metric used to evaluate machine translation quality. Unlike BLEU, TER is based on edit distance. In short, TER quantifies the minimum number of edit operations required to make the machine translation identical to the reference translation. Scores typically range from 0 to 1, with higher values indicating lower quality, and it can more accurately capture subtle differences in translations (Snover et al., 2006). Overall, TER is a useful complementary metric. By combining these two different metrics, various aspects of machine translation can be evaluated, achieving a more comprehensive and accurate assessment of translation quality.

Meanwhile, this study used a questionnaire to send translations of 10 example sentences generated by four translation tools to senior translation teachers in the forestry field. The teachers, unaware of the translation sources, rated the quality of the translations. The overall scores of the 10 example sentences were calculated and analyzed, providing a multi-faceted and comprehensive evaluation of the model's translation quality.

3.3 Data Analysis

Data analysis combines quantitative and qualitative methods: 1) Quantitative analysis: BLEU and TER scores are calculated for each translated text to quantify the accuracy and fluency of the translations. These metrics provide an objective basis for comparing the performance of the different translation tools. 2) Qualitative analysis: Expert evaluations are analyzed to gain deeper insights into the translations' quality. The experts focus on accuracy, readability, handling of domain-specific terminology, and context-sensitive meanings. Their feedback highlights strengths and weaknesses in each translation tool's performance. The combined analysis provides a comprehensive assessment of ChatGPT's effectiveness in translating forestry sci-tech texts.

3.4 limitations

This study acknowledges several limitations: 1) Scope of Texts: The selected texts may not cover all possible types of forestry sci-tech texts, potentially limiting the generalizability of the findings. 2) Expert Evaluation: The qualitative evaluation relies on the subjective judgments of a limited number of experts, which may introduce variability. 3) Rapid Evolution of AI Tools: As AI-driven translation tools, including ChatGPT, are continually evolving, the findings may become outdated as new advancements are made.

4. Results and Discussion

This section presents and analyzes the findings of the study on the effectiveness of ChatGPT in translating forestry sci-tech texts. The results are structured around the quantitative metrics (BLEU and TER scores) and the qualitative evaluations provided by domain experts. The discussion interprets these results, comparing ChatGPT's performance with that of Google Translate, Youdao Translation, and DeepL Translator, highlighting strengths, weaknesses, and implications for future use and development of AI-driven translation tools in the forestry sector.

4.1 Quantitative Results: BLEU and TER Scores

The BLEU (Bilingual Evaluation Understudy) scores provide an objective measure of the fluency and accuracy of the translations. Table 2 presents the BLEU scores for translations produced by ChatGPT, Google Translate, Youdao Translation, and DeepL Translator.

Table 2 BLEU Scores (Unit:_%)											
Translation Tool	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**Average**
ChatGPT(Prompt 2)	38.8	4.6	8.6	48.4	15.4	38.5	8.3	2.1	40.1	13.1	21.79
Google Translate	20.2	3.5	7.3	11.4	13.0	10.7	3.2	4.9	46.8	15.3	13.63
Youdao Translation	22.0	8.1	7.3	7.1	19.2	12.4	21.8	5.1	30.6	13.5	14.71
DeepL Translator	11.0	5.0	7.3	8.2	12.0	15.4	12.0	5.2	47.4	17.5	14.1

The TER (Translation Edit Rate) scores measure the number of edits required to transform the machine translation output into a reference translation. Lower TER scores indicate higher translation quality. Table 3 shows the TER scores for each translation tool.

Table 3 TER Scores (Unit:_%)											
Translation Tool	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**Average**
ChatGPT	26	67	73	36	55	52	67	94	38	57	56.5
Google Translate	45	70	82	41	57	55	80	78	32	69	60.9
Youdao Translation	47	70	82	79	49	48	76	89	38	60	63.8
DeepL Translator	60	56	82	74	55	45	63	83	35	67	62

In order to present the results more directly, bar charts are also presented in the following, making it easier to compare the translation quality of different machine translation tools. Figure 1 presents average BLEU scores by different translation tools. Figure 2 shows the average TER scores by different translation tools.

Figure 1. Average BLEU Scores by Translation Tool

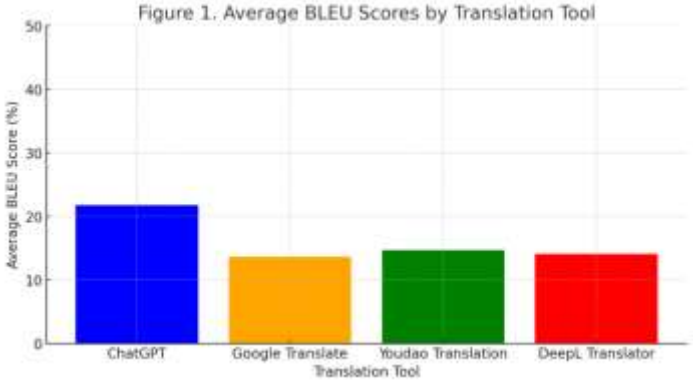
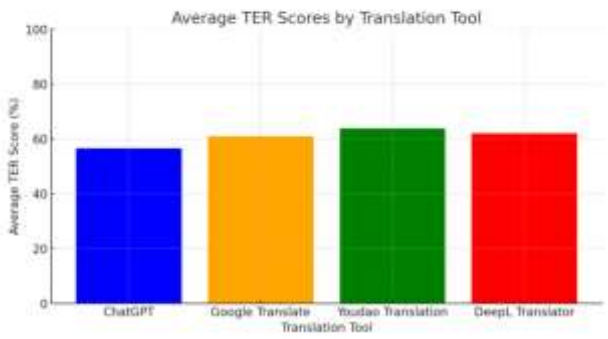


Figure 2. Average TER Scores by Translation Tool



Analysis of the results of BLEU scores. In total, as shown in Figure 1, ChatGPT achieved a comparatively competitive BLEU score, while the results of the other three machine translation tools showed little difference, indicating ChatGPT's ability to generate fluent and accurate translations. Besides, it can be found in Table 2 that ChatGPT outperformed other translation tools in translating S1, S4, and S6, showing ChatGPT can perform better in dealing with specialized terminology. However, according to Table 2, among the translations of 10 sentences, ChatGPT achieved the lowest mark in S8, suggesting that ChatGPT has difficulty in translating the cleft sentences. Zhou and Liu (2022) believe that if the BLEU score of a translation generated by the translation tool reaches 31.4%, it indicates that the translation is of good quality and meets the basic requirements of machine translation. From the statistics above, it can be known that machine translation tools still have weaknesses in dealing with the translation tasks of specialized-domain texts.

Analysis of the results of TER Scores. Overall, the bar chart in Figure 2 reveals that, in comparison to the other three machine translation tools, ChatGPT achieved a relatively low TER score, indicating that ChatGPT's translations require fewer edits to match the reference translations. And the results of the other three machine translation tools showed little difference. It can be seen in Table 3 that ChatGPT got the lowest mark in translating S1, which also suggests that compared to the other three machine translations, ChatGPT has better competence in translating sentences containing specialized terminology. However, according to Table 3, ChatGPT scored the highest mark, which means ChatGPT performed poorly in handling the translation of cleft sentences. Generally speaking, the lower the value of the TER, the higher the quality of machine translation. From the statistics above, it can

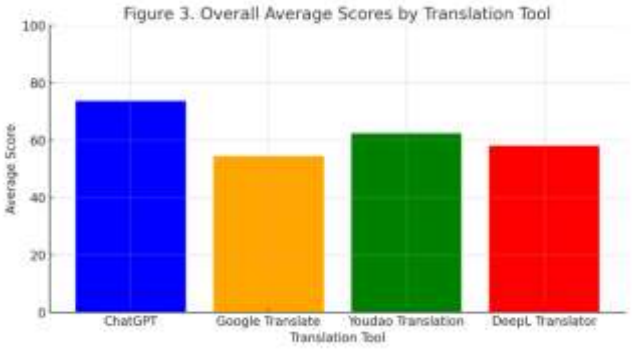
be known that there is still a low way to go for machine translation in dealing with the translation tasks of specialized-domain texts.

4.2 Qualitative Results: Expert Evaluations

Expert Evaluations Scores. Scores provided by two experts in the related domain according to the accuracy, readability, handling of domain-specific terminology, and context-sensitive meanings of the translations. Table 4 presents the scores given by two experts. Figure 3 shows the overall average scores by translation tool. Figure 4 displays individual expert average scores by translation tool.

Table 4 Scores given by Two Experts

	ChatGPT			Google Translate			Youdao Translation			DeepL Translator		
	A	B	Average	A	B	Average	A	B	Average	A	B	Average
S1	87	85	86	40	35	37.5	48	45	46.5	30	25	27.5
S2	73	75	74	35	30	32.5	60	50	55	55	55	55
S3	82	75	78.5	75	70	72.5	75	70	72.5	75	70	72.5
S4	88	85	86.5	33	30	31.5	55	50	52.5	63	55	59
S5	66	65	65.5	43	35	39	73	70	71.5	54	55	54.5
S6	78	75	76.5	42	45	43.5	47	50	48.5	57	55	56
S7	82	80	81	71	65	68	76	70	73	63	60	61.5
S8	37	45	41	77	80	78.5	68	75	71.5	65	65	65
S9	72	70	71	67	65	66	72	70	71	67	60	63.5
S10	78	75	76.5	80	70	75	63	60	61.5	68	65	66.5
Average	74.3	73	73.65	56.3	52.5	54.4	63.7	61	62.35	59.7	56.5	58.1



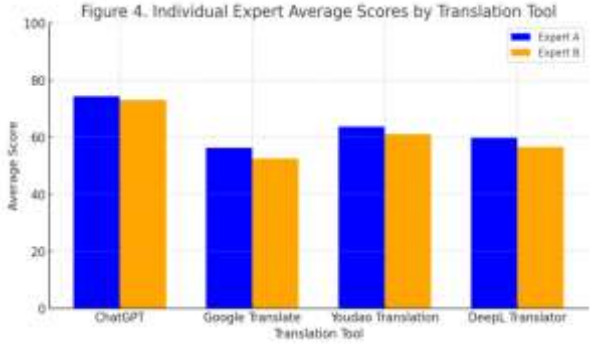


Figure 3 demonstrates a clear contrast between the performance of four translation tools. On the whole, it's clear from the bar chart that ChatGPT has the highest overall average scores from experts. Google Translate has the lowest average scores. Youdao Translation and DeepL Translator have intermediate scores, with Youdao generally scoring higher than DeepL. It can be said that, in the human reviewer's opinion, the translations generated by ChatGPT outperformed the other three machine translation tools. Meanwhile, it can be observed in Figure 4 that both two human reviewers, who are unknown translation sources, rated ChatGPT as the best at the translation task, followed by Youdao Translate and DeepL Translation, and Google Translate as the worst, which further enhances the reliability of the results. However, it can be seen in Table 4 that ChatGPT has particularly low scores in S8, showing that there are still challenges in its application in translating forestry sci-tech texts. Similarly, according to Table 4, many scores of the other three machine translation tools also fall below the passing mark, which suggests that in translating domain-specific texts, there is still room for machine translation to improve its performance.

4.3 Discussion

The comparative analysis highlights the strengths and weaknesses of ChatGPT relative to other translation tools. On the one hand, ChatGPT excels in handling specialized terminology and context-specific information. Taking the terminologies in sentence 1, ChatGPT can not only provide exact translations of them, such as P. pinaster, P. halepensis, and P. nigra, and P. sylvestris, but also add these Latin name behind the translation. By doing so, the translation can achieve its accuracy to the largest extent, for there is only one correct Latin name for any plant species. In comparison to ChatGPT, the other three machine translation tools just

retained these specialized terminologies in their translations instead of translating them. In translating context-specific information, ChatGPT also shows its advantage. For example, "size" in sentence 5 and "strain" in sentence 4. The two words are polysemous words whose meaning can vary by different contexts. Unlike the exact translation provided by ChatGPT, Google Translate offered a wrong translation of "size," and the deepl translator didn't translate this word at all. So is the same with the word "strain." On the other hand, ChatGPT still has weaknesses in translating forestry sci-tech texts. If the specialized terminology in the original texts is presented in the form of its English name instead of its Latine name, ChatGPT would only translate the terminology into the target language, not adding the Latin name behind the translation. In this way, the accuracy of translations can not be guaranteed, for common names for trees can change between countries and may even vary within the same country. For instance, taking the translation of "locusts" in sentence 2, the terminology "locust" can have many different meanings or names. Given the importance of the accuracy of forestry translation, the human translator inspector is indispensable in the process of translation. Besides, ChatGPT also has difficulty translating special sentence structures, especially cleft sentences. A good illustrative example of this point is the translation of sentence 8. When translating such a sentence, Chatgpt always didn't perform so well in terms of the adaptability of translations in the target language.

4.4 Limitations and Future Research

This study acknowledges several limitations, including the scope of texts, the limitations of the machine translation evaluation metrics, and the subjective nature of expert evaluations. Future research should explore a broader range of forestry texts, as well as more comprehensive evaluation metrics and more extensive expert evaluations. Additionally, comparing machine translation tools with professional human translators would provide deeper insights into the relative strengths and areas for improvement in machine translation technology.

5. Conclusion

This study provides a comprehensive evaluation of ChatGPT's effectiveness in translating forestry sci-tech texts, comparing it with three mainstream machine translation tools: Google Translate, Youdao Translation, and DeepL Translator. From the quantitative analysis using BLEU and TER scores, ChatGPT has an advantage over the other three mainstream translation tools. The qualitative assessments by domain experts show that ChatGPT also performs better than the mainstream translation tools on the market in most cases. Through quantitative and qualitative analysis, it can be concluded that ChatGPT is competitive with the existing machine translation tools. However, although there is great potential for applying ChatGPT to the forestry translation practice, the model still has obvious limitations in dealing with texts involving special sentence structure or terminology with non-fixed common names as well as making the translations more adaptable in the target language, which is far from the standard of "good" translation. In a nutshell, it is still infeasible for ChatGPT to replace traditional human translation or current machine translation tools. Human translators still play a key role in translation, especially in translating specific-domain texts, like forestry. ChatGPT may have a more excellent performance in the field of machine translation with its continuous optimization, but the inspection of human translators is always an indispensable part of the translation practice.

This research explored the potentials and limitations of ChatGPT's application in translating specialized forestry sci-tech texts, offering some insights for the improvements of machine translation so as to make it a more effective tool in translation practice, especially specific-domain translation. Ultimately, advancements in this field will facilitate more effective global communication and knowledge sharing, fostering greater international collaboration in forestry and other specialized sectors.

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