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Human-machine Collaborative Translation Based on Artificial Intelligence Technology

Rong Chen*, Bo Guo

Xi'an University of Posts & Telecommunications, Xi'an 710000, Shaanxi Province, China

Corresponding author: Rong Chen, chenrong@xupt.edu.com

Abstract: This paper is dedicated to an in-depth exploration of the human-machine collaborative translation, which specifically refers to the synergy between human translators and artificial intelligence tools. The paper systematically reports the merits and drawbacks emerging in the pre-translation, in-translation, and post-translation phases. To illustrate this, a real translation project is taken as an example to depict the detailed collaboration process. In the current translation field, the human-machine collaborative model has become a key research focus. Through this case study, several factors that influence the collaboration are identified. For instance, the accuracy and adaptability of artificial intelligence tools, as well as the human translator's ability to leverage and correct these tools. Moreover, strategies and methods to enhance collaboration and generate high-quality translations are discovered. These include proper utilization of AI features like automatic Translation Memories and Terminology Recognition, combined with human critical thinking and cultural understanding. By examining the cooperation mechanism and exploiting diverse translation tools, the aim is to strengthen the bond between humans and machines. This not only improves translation quality and accelerates the process but also lays a solid theoretical foundation for future research. The practical significance of this research topic is thus well-established, striving to optimize translation workflows and pioneer new paths for more proficient and accurate translations in the age of technological advancement.

Keywords: Human-machine collaborative translation; Artificial intelligence technology; Translation project

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1. Introduction

1.1. Related studies

In the rapidly evolving landscape of technology, artificial intelligence (AI) has made significant strides across various sectors, profoundly impacting the translation industry. Traditional translation methods, once predominantly reliant on human linguistic expertise, are increasingly supplemented by machine translation (MT) systems and computer-assisted translation (CAT) tools. While these AI-driven solutions demonstrate impressive

results in certain contexts, such as technical and scientific domains, limitations persist regarding cultural nuances, idiomatic expressions, and complex syntactic structures [1]. The reliance on machine translation can sometimes lead to errors that compromise the integrity and intended meaning of the source texts [2].

The concept of human-machine collaborative translation has emerged as a promising approach to mitigate these challenges. This model emphasizes the synergy between human cognitive abilities and machine efficiency, aiming to deliver translations that are not only accurate but also culturally and contextually relevant [3]. By integrating the strengths of both AI tools and human expertise, this partnership seeks to enhance both the quality and efficiency of the translation process.

Current literature underscores the benefits and challenges inherent in this collaborative model. Doherty and O'Brien found that while AI tools can quickly process large volumes of text, the intervention of human translators is essential in ensuring that translations are contextually rich and culturally appropriate [1]. Moreover, some researchers emphasize the importance of training human translators to effectively utilize AI tools, highlighting their role in correcting machine-generated outputs and applying their cultural knowledge to ensure high-quality translations [4]. Additionally, maintaining cultural fidelity is also important when leveraging AI in translation work, and the human touch is irreplaceable in many aspects of translation [5]. Furthermore, recent developments in translation management systems (TMS) have highlighted new models for collaboration between humans and machines, showing enhanced efficiency and quality in translation workflows [6].

Furthermore, recent developments in translation management systems (TMS) have highlighted new models for collaboration between humans and machines, showing enhanced efficiency and quality in translation workflows. These systems facilitate better communication and coordination among team members, allowing for a more streamlined process that leverages both human insight and machine capabilities.

1.2. AI technology in translation

AI tools have revolutionized the translation landscape by providing innovative solutions that enhance both the efficiency and accuracy of the translation process. These tools encompass a wide range of technologies, including machine translation (MT) systems, computer-assisted translation (CAT) software, translation management systems (TMS), and large language models (LLMs). Machine translation systems, such as Google Translate and DeepL, utilize advanced algorithms and neural networks to generate translations quickly, making them particularly effective for large volumes of text and straightforward language pairs.

Computer-assisted translation tools complement machine translation by offering features such as translation memories, glossaries, and real-time collaboration capabilities [7]. These tools enable translators to build a repository of previously translated segments, ensuring consistency and reducing the time spent on repetitive tasks. Moreover, they allow for the integration of AI-generated suggestions, which human translators can refine and adapt based on their expertise and understanding of the source material.

In recent years, large language models like OpenAI's GPT-4, Facebook's LLaMA, and Google's PaLM have gained prominence in the field of natural language processing [8]. These models, pre-trained on vast datasets, can produce human-like text and understand the context at a level that traditional translation tools often struggle with [9]. LLMs can help human translators recognize idiomatic expressions and generate contextually appropriate responses, making them valuable assets in the translation process. Their ability to fine-tune specific tasks, including translation, further enhances their utility, enabling more accurate and context-aware translations.

Translation management systems (TMS) further streamline the translation workflow by facilitating project

organization, team collaboration, and quality assurance processes. These systems often incorporate AI-driven analytics to assess translation quality, track progress, and manage deadlines, thereby improving overall project efficiency [10].

While AI tools, including LLMs, have made significant strides in enhancing translation capabilities, it is important to recognize their limitations. Issues such as the handling of cultural references and complex syntactic structures remain challenging for AI systems. Therefore, the role of human translators in reviewing and refining AI-generated translations is crucial to ensure the final output meets the desired quality standards and effectively conveys the intended meaning.

In summary, AI tools, including LLMs, play a critical role in modern translation practices, offering both efficiency and support to human translators. By understanding how to effectively integrate these tools into their workflows, translators can enhance their productivity while maintaining the quality and cultural relevance of their translations.

The case study in this paper provides a concrete example of human-machine collaborative translation mode in action. It demonstrates how human translators and AI tools can effectively interact to produce high-quality outputs in the three stages of the translation process—pre-translation, in-translation, and post-translation.

By exploring the collaborative mechanism and evaluating various factors influencing the partnership of human translators and AI tools, this paper aims to identify effective strategies for optimizing translation workflows. Ultimately, it not only contributes to the theoretical framework surrounding human-machine collaboration in translation but also offers practical insights for enhancing translation quality amid technological advancement.

2. Human-machine collaborative translation

2.1. Mechanism of human-machine collaboration in translation

In the human-machine collaborative translation model, the interaction between human translators, computer hardware, and software can be understood through a logical framework similar to the relationship between software and hardware in a computing system. This collaboration leverages the unique strengths of both human expertise and machine efficiency to enhance the translation process.

Human translators play an important role in this model, akin to the software layer in a computer system. With their deep knowledge of language, culture, and context, human translators are essential for refining and adapting machine-generated translations. While machines can generate quick and efficient translations, they often lack the nuanced understanding of linguistic subtleties, tone, and cultural context that a human translator brings. The human translator makes final decisions, ensuring that the translation is both accurate and contextually appropriate.

On the other hand, the computer hardware serves as the physical foundation for the entire process. This includes processors, memory, and storage devices that provide the computational power necessary for running the software tools that assist in translation. Just as a computer system would be unable to perform without hardware, the translation process depends on the reliable performance of this infrastructure to process vast amounts of data quickly and efficiently. The hardware supports the machine translation engines, language models, and translation management systems, ensuring that they operate at scale.

The software layer in this model includes the various tools that assist the translator in their work. These software applications include translation management systems (TMS) integrated with machine translation

engines, large language models (LLMs), and AI-driven search engines. These tools automate repetitive tasks, suggest translations, and provide access to relevant resources, databases, or glossaries. They act as an augmentation of the translator's capabilities, making the process faster and more efficient, while also allowing the human to focus on the more complex and nuanced aspects of the translation.

The relationship between human translators, hardware, and software in this model is one of interdependence. The machine provides the computational speed and efficiency needed to process large volumes of text, generate translation suggestions, and access databases of linguistic resources. At the same time, it is the human translator who directs and supervises the software's output, ensuring that the machine's suggestions are refined and contextualized. While the machine offers assistance, it is the human who makes the final decisions, evaluating and correcting the machine's output as needed.

In this collaborative setup, the hardware executes the instructions provided by the software, processing data and running the machine translation systems. Without hardware, the software would have no platform to function, and the translation process would not be possible at the speed or scale required. However, the human translator is the ultimate controller, guiding the software to ensure that the translation is of high quality, linguistically sound, and culturally sensitive.

Therefore, the human-machine collaborative translation model highlights the symbiotic relationship between human expertise and machine automation. Both components—human cognition and machine efficiency—are indispensable. The machine aids in speeding up the translation process, handling repetitive tasks, and providing useful suggestions, while the human translator ensures that the final product is accurate, meaningful, and contextually appropriate. By combining the strengths of both, this model significantly enhances translation efficiency, accuracy, and consistency, making it a powerful approach for modern translation workflows (**Figure 1**).

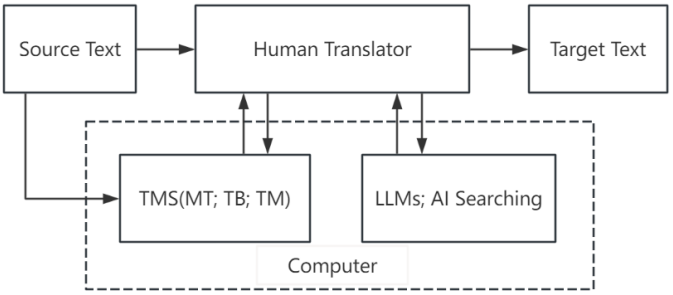

Figure 1. Human-machine collaborative translation model

2.2. Translation process

The translation process is commonly categorized into three primary stages: pre-translation, in-translation, and post-translation. In this model, human translators engage in a collaborative process with computational tools to accomplish translation tasks efficiently and accurately.

The pre-translation phase marks the initial stage of the process, during which human translators undertake a thorough analysis of the source text. This includes examining its context, tone, and cultural nuances to ensure a nuanced understanding of the material. Human translators also collaborate with artificial intelligence (AI) tools, such as large language models, for the extraction of domain-specific terminology. Additionally, translation management systems (TMS) are employed to streamline project organization, optimize workflows, and manage project timelines effectively.

During the in-translation phase, machine translation systems generate preliminary drafts based on the analysis of the source text. These drafts, however, are not considered final. Human translators engage in the process of post-editing, refining the machine-generated output by making necessary adjustments to improve accuracy, fluency, and appropriateness for the target audience. Translators may also leverage external AI-powered search engines to gather additional linguistic resources, ensuring that specialized terminology and context are appropriately addressed. Automated quality control and assessment tools are frequently employed at this stage to enhance the overall quality of the translation, ensuring that it meets the required standards.

In the post-translation phase, human translators utilize AI tools for a comprehensive final review of the translated text. This involves extensive proofreading to detect and correct any grammatical, spelling, or syntactical errors. In addition, translators ensure that the formatting and layout of the text conform to the required specifications, utilizing advanced editing software to present a polished and professional final output. The integration of human expertise and AI-driven tools throughout these phases ensures a high-quality translation product that combines linguistic precision with cultural relevance.

3. Case analysis

This case study pertains to a book translation project from English to Chinese, encompassing a multidisciplinary range of topics, including psychology, medicine, and sociology. The text further incorporates references to specific cultural literary works and historical events, which add layers of complexity to the translation process. The multifaceted nature of the subject matter, combined with the cultural and historical nuances embedded within the source text, presents significant challenges in terms of both linguistic accuracy and cultural fidelity.

The project spanned a duration of five months and involved a rigorous, collaborative approach between human translators and artificial intelligence (AI) tools. Throughout the translation process, the translators engaged closely with AI-driven resources to enhance efficiency and accuracy, ensuring that both technical concepts and cultural references were conveyed with precision. The integration of AI tools, such as machine translation systems, terminology databases, and quality control software, was essential in assisting human translators with managing the complexity of the subject matter and the intricate cultural nuances.

The primary objective of this project was to achieve an accurate and faithful representation of the original text, ensuring that specialized technical terms, as well as cultural and historical references, were effectively communicated to the target audience. The project sought not only to preserve the original intent and meaning of the work but also to facilitate a deeper understanding of the content among Chinese-speaking readers. By addressing both linguistic and cultural considerations, the project aimed to ensure that the translated text resonated meaningfully with the target audience while maintaining the integrity of the source material.

3.1. Pre-translation

In the pre-translation phase, a comprehensive set of measures was implemented to ensure the quality, accuracy, and professionalism of the translation process. A critical component of this phase was the integration of advanced artificial intelligence (AI) tools for terminology extraction, coupled with the establishment of a real-time translation memory system designed to enhance both efficiency and consistency throughout the project.

To extract specialized terminology from the source text, the study selected three prominent domestic large language models—DouBao, Tongyi Qianwen, and Zhipu Qingyan—all of which are recognized for their proficiency in processing complex technical content. The models were tasked with extracting terms from specific

excerpts of the source material, which covered a wide range of domains, including psychology, medicine, neuroscience, and sociology. To ensure a fair and consistent comparison across models, the study devised a set of standardized prompt statements, guaranteeing that all models were given identical instructions for terminology extraction. These prompts were carefully constructed to elicit accurate and relevant professional terms within the aforementioned fields.

The specific prompt provided to the models was as follows:

Prompt: “Please extract all the terminologies from the document, provide their Chinese definitions, and categorize them by fields such as psychology, medicine, neuroscience, sociology, etc.”

The results from all three models were analyzed, revealing a consistent extraction of terminology from the document. Each model provided not only the English and Chinese definitions of the terms but also detailed explanations where necessary. Furthermore, the extracted terms were organized according to the specified categories of the source fields. The results were then compiled and presented in **Figures 2**, **3**, and **4** below, which demonstrate the effectiveness of each model in accurately identifying and categorizing the relevant terminology.

This phase was instrumental in ensuring that the translation maintained both terminological precision and domain-specific consistency, thus setting the foundation for the subsequent stages of the translation process.

Figure 2. Results from DouBao

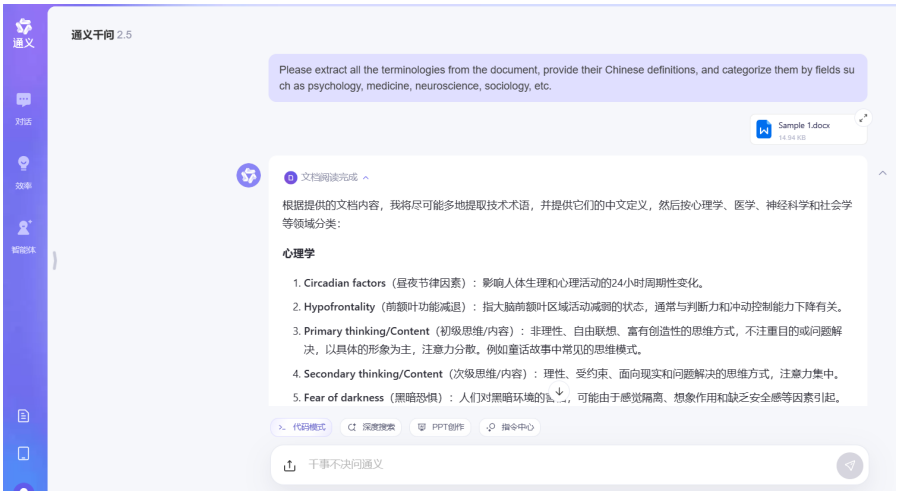

Figure 3. Results from Tongyi Qianwen

Figure 4. Results from Zhipu Qingyan

Upon completion of the terminology extraction process, the next step involved consulting with language experts to evaluate the accuracy and relevance of the extracted terms. The experts were tasked with determining whether each term was a specialized term within the specific domain or a more general, commonly used word. This expert review was essential in ensuring the reliability and precision of the terminology, particularly in distinguishing between terms that were contextually appropriate for the subject matter and those that were less relevant.

Subsequently, a comparative analysis of the performance of the three large language models was conducted based on three key evaluation metrics:

Quantity: The total number of terms extracted by each model, reflecting the overall output.

Accuracy: The ratio of accurate terms (those that were correctly identified and defined) to the total number of terms extracted, providing a measure of the precision of each model's extraction process.

Relevance: The proportion of specialized terms (those that are domain-specific and pertinent to the subject areas such as psychology, medicine, neuroscience, and sociology) relative to the total number of extracted terms, indicating the model's capacity to focus on terminology that is essential to the technical content.

Table 1 presents a summary of the comparative analysis of the three models based on these metrics. This detailed evaluation provides insight into the strengths and weaknesses of each model, facilitating a more informed decision on the most effective tool for terminology extraction in the context of specialized translation tasks.

Table 1. Comparison of terminology extraction results

Model	Quantity	Accuracy	Relevance
Dou Bao	16	88%	94%
Tongyi Qianwen	27	96%	96%
Zhipu Qingyan	18	89%	78%

From the table presented above, it is clear that Tongyi Qianwen outperformed the other models across all evaluation metrics, including quantity, accuracy, and relevance. This superior performance provided a substantial

reference for the subsequent stages of the translation process, offering high-quality extracted terminology that would contribute to the overall success of the project.

To ensure consistency and efficiency throughout the translation process, the study selected the YiCAT platform as the tool for establishing a translation memory (TM). This platform is designed to facilitate the automatic storage of translated content when using computer-assisted translation (CAT) tools, thus enabling translators to easily retrieve and reuse previously translated segments, thereby enhancing workflow efficiency and maintaining consistency across the translation.

At the outset of the translation process, the study began integrating the terms and related sentences extracted by Tongyi Qianwen into the YiCAT platform. This initial data input served as the foundation for creating a structured and systematic translation memory. As the translation progressed, each chapter's translated content and its corresponding translation results were systematically recorded in the memory, ensuring that the information was continuously updated and expanded. This iterative process enabled the translation memory to grow dynamically, incorporating new terms, phrases, and context-specific translations that contributed to improving the quality and consistency of subsequent translation work.

By implementing these steps, the pre-translation phase effectively leveraged multiple AI tools for terminology extraction and established a robust translation memory. This approach not only facilitated the smooth progress of the translation process but also ensured that the project was carried out efficiently, with a strong emphasis on consistency and accuracy. The establishment of a comprehensive translation memory in this phase laid a solid foundation for the continued success of the translation project, enabling a seamless transition to the subsequent stages.

3.2. In-translation

In this phase, the study fully utilized the diverse functionalities of the YiCAT platform to facilitate efficient human-machine collaboration and ensure the delivery of high-quality translations. Initially, the study employed the ChatGPT-integrated translation engine available on the YiCAT platform for the preliminary translation. This engine combines the advanced processing capabilities of artificial intelligence with deep learning models, enabling the rapid generation of accurate initial translations. The integration of AI in this stage significantly enhanced the translation efficiency, providing a substantial reduction in the time required for the initial translation process, thereby allowing the team to allocate resources to more complex tasks.

Following the completion of the initial translation, a rigorous post-editing process was conducted to refine and improve the automatically generated text. During this phase, the study systematically analyzed the initial translation in conjunction with the automatic quality assessment tools offered by YiCAT. These tools facilitated a comprehensive evaluation of key translation attributes, including accuracy, fluency, and adherence to professional standards. The system's assessment capabilities allowed the researchers to identify areas requiring revision and ensured that the translation met the highest quality standards.

YiCAT's artificial intelligence-based scoring system further assisted in the post-editing process by providing valuable insights into the quality of the translation. After the machine-generated translation was processed, the system estimated the edit time and editing distance for each sentence, offering an objective measure of the required revisions. The system then evaluated the overall translation quality and assessed the level of difficulty associated with the required edits. Based on these evaluations, sentences were assigned one of four quality scores: S (superior), A (excellent), B (good), or C (needs improvement).

The following presents three distinct examples of human-machine collaboration in various aspects of the translation process. These cases highlight how the combination of AI-generated translations and human expertise results in improved translation outcomes, ensuring both linguistic precision and contextual relevance.

ST1: Scientists think that, when we're excessively tired, the part of our brain that suppresses activity in the amygdala (the brain's emotional and fear headquarters) becomes impaired, leaving our emotions in free fall – and so we vent and rage.

MT1: 科学家认为，当我们过度疲劳时，抑制杏仁核（大脑的情绪和恐惧总部）活动的部分会受损，使我们的情绪失控，因此我们会发泄和暴怒。

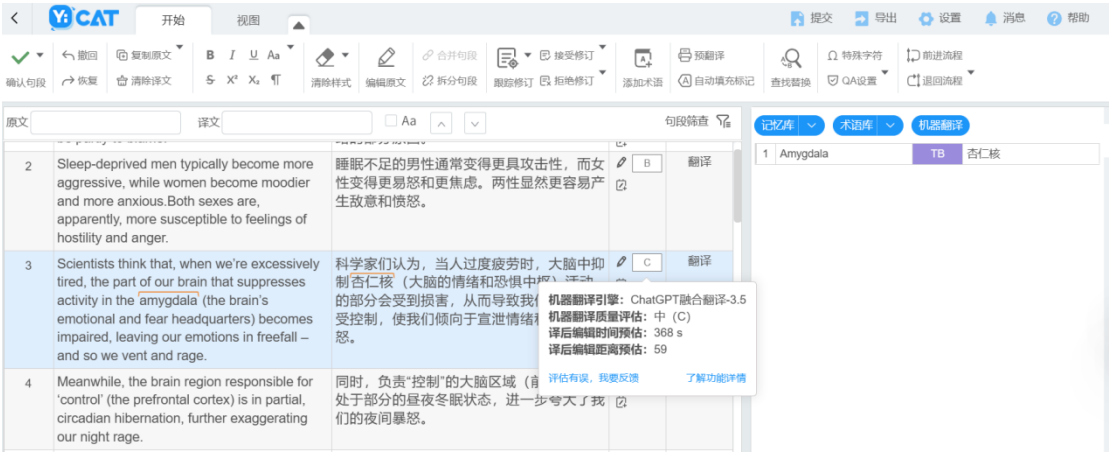

Figure 5. Case 1 machine translation on the YiCAT platform

As shown in **Figure 5**, the machine translation quality evaluation given by the system is C, the post-editing time is estimated to be 368s, and the post-translation editing distance is estimated to be 69. The machine translation quality is low, and the post-editing time and distance are long, so translators need to pay more attention to the sentence.

The researchers also extensively applied terminology databases and translation memories during the translation process to ensure consistency in terminology usage and style. The YiCAT platform allowed the researchers to access these resources at any time within the working interface, ensuring the accurate use of professional terms and avoiding ambiguities and confusion in the translations. The terminology base enabled in Yicat will automatically query the match result in translation. As shown in **Figure 5**, YiCAT automatically queried and marked the translation of the term "amygdala", which helped researchers to quickly check and improve the translation efficiency.

TT1: 科学家们认为，当人过度疲劳时，大脑中抑制杏仁核（大脑的情绪和恐惧中枢）活动的部分会受到损害，从而导致我们的情绪不受控制，使我们倾向于宣泄情绪和表达愤怒。

ST2: Everyone else was involved in vibrant "color field painting", but Krasner was "once more. . . going against the stream."

MT2: 其他人都参与了充满活力的"色彩场域绘画"，但克拉斯纳"再次……逆流而行."

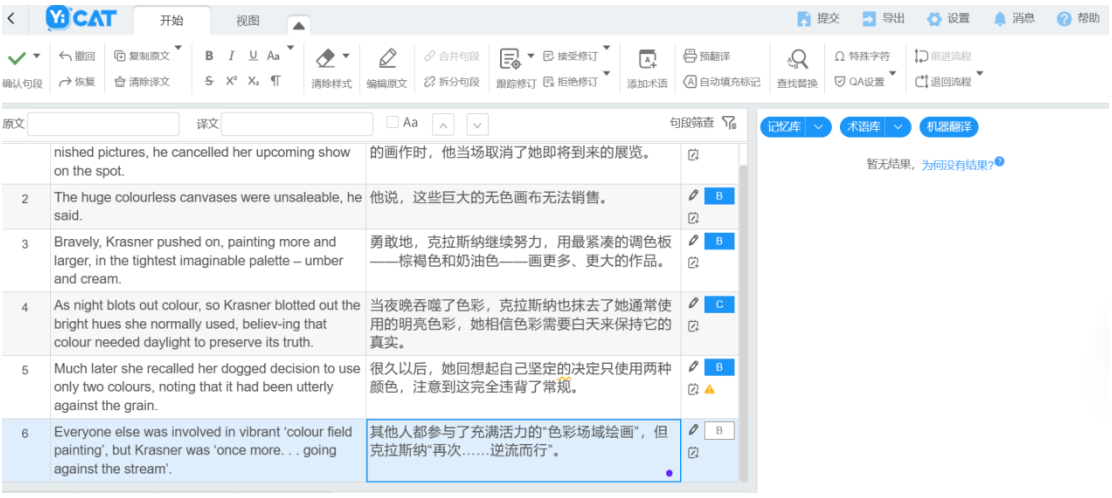

Figure 6. Case 2 machine translation on the YiCAT platform

Figure 7. Search Results from DouBao

As illustrated in **Figures 6** and **7**, the study employed external AI search tools, specifically utilizing DouBao's AI deep search functionality, to conduct in-depth research on the term "color field painting." The results generated by DouBao were accompanied by an extensive array of reference sources, each of which provided direct links to the original websites for verification of authenticity. This feature allowed researchers to cross-check and substantiate the information obtained, ensuring the reliability of the research.

The search results offered detailed explanations of the term "color field painting", including its cultural context and significance. Recognizing the term's deep-rooted cultural connotations, the study made a conscious

decision to include the translator's notes in the translations. These notes were carefully crafted to provide the target audience with additional background information, enabling them to fully appreciate the cultural relevance of the term. By integrating these explanatory notes, the researchers ensured that their translations were not only linguistically accurate but also culturally rich, thereby enhancing the reader's understanding of the material.

This approach was essential in maintaining the integrity of the original content while also ensuring that the translation resonated meaningfully with the target audience. The inclusion of cultural context within the translation process contributed significantly to improving the overall readability and comprehensibility of the text.

TT2: 当时其他人都在追求充满活力的 " 色域绘画 " (20 世纪 50 至 60 年代西方流行的绘画运动 , 采用大片可以令人沉思默想的色彩平面来表达最为深入的原始品性 .—— 译者注) , 而克拉斯纳却 " 再一次 …… 逆流而上 ."

As the translation process advanced, the automatic quality assurance (QA) feature played a critical role in continually refining the translations. This tool provided real-time monitoring of the text, identifying potential issues such as untranslated content, formatting inconsistencies, and repeated sentences. By leveraging the automatic QA feature, the researchers were able to detect and address these issues efficiently during the final review stage, ensuring the overall quality and consistency of the translation. Upon the initiation of the quality assurance phase, the system was set to flag any violations of the established translation rules. When the translation deviated from these rules, YiCAT would display three distinct icon reminders—denoting minor errors, general errors, and serious errors—on the right-hand side of the sentences that failed to meet the prescribed standards. This visual feedback allowed for quick identification and prioritization of issues, streamlining the post-editing process and facilitating prompt corrections. The integration of the automatic QA feature significantly enhanced the ability to maintain high-quality translations, ensuring that any discrepancies were addressed in a timely manner and that the final output adhered to the required linguistic and formatting standards.

ST3: Sleep researcher and co-author of "The Mind after Midnight", Michael Perlis, calls this "hypofrontality", a condition resulting from sluggish blood flow and poor glucose uptake in the brain regions responsible for judgment and impulse control.

MT3: 睡眠研究员 ,《午夜之后的心灵》的合著者迈克尔 · 佩尔利斯将此称为 " 前额叶功能减退 ", 这是由于大脑负责判断和冲动控制的区域血液流动缓慢和葡萄糖摄取不良所导致的一种状况 .

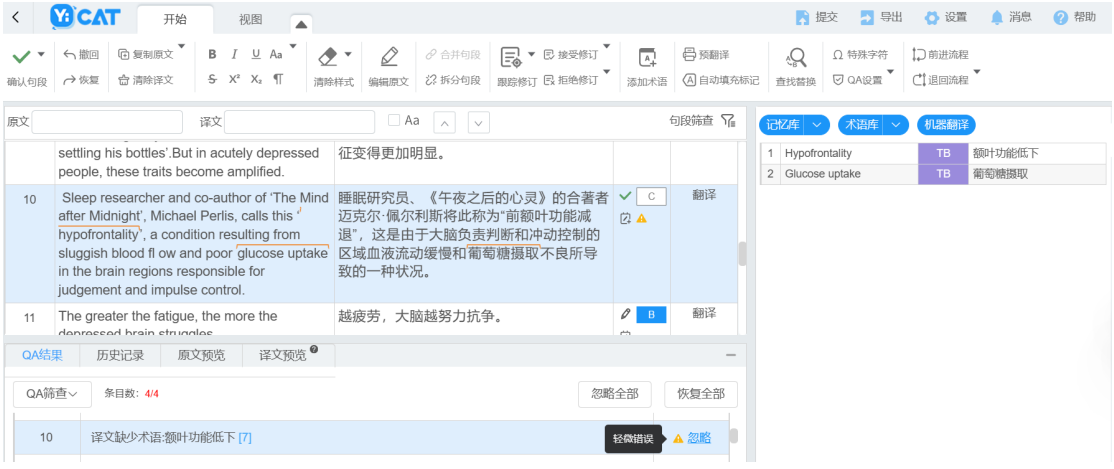

Figure 8. QA results on the YiCAT platform

As illustrated in **Figure 8**, a minor error icon was displayed next to the translation, accompanied by a specific error description at the bottom of the screen. The description indicated that the translation was missing the term "hypofrontality." This feature allowed researchers to promptly identify the missing term and cross-reference the translation with the relevant prompt. By modifying the translation to include the correct term, the researchers were able to address the issue efficiently. The automatic quality assurance (QA) function proved to be an invaluable tool in this process, as it facilitated the swift detection of errors such as missing terminology. By providing clear error notifications and enabling immediate corrections, this feature significantly reduced the time required for manual review and calibration, thereby enhancing the overall efficiency of the translation process.

TT3: 睡眠研究员 ,《午夜后的大脑》一书的合著者迈克尔 · 佩里斯 (Michael Perlis) 将这个现象称为 " 额叶功能低下 ", 这是由于负责判断和冲动控制的大脑区域血流缓慢以及葡萄糖摄取不良引起的病症 .

Leveraging the robust capabilities of the YiCAT platform, the study established an efficient workflow throughout the translation phase, effectively demonstrating the strengths of human-machine collaboration. This integrated model not only expedited the overall translation process but also upheld the quality of the translation, ensuring that the final output accurately reflected the author's original intent. Furthermore, it was tailored to meet the specific linguistic and cultural needs of the target audience, thereby ensuring that the translation was both faithful to the source text and contextually appropriate. This approach exemplifies the potential of AI-assisted translation in enhancing both efficiency and quality, allowing for the delivery of a precise and meaningful translation.

3.3. Post-translation

In the post-translation phase, our primary focus was on refining the translated content to ensure its accuracy, quality, and coherence. Following the completion of the initial translations and subsequent edits, we implemented a comprehensive review process to enhance the overall integrity of the translated materials.

The first step in this process was a thorough proofreading of the translated texts, during which the study meticulously examined the content for typographical errors, grammatical inconsistencies, and any issues related to the consistency of terminology. This stage was crucial not only for ensuring that the translated documents adhered to professional linguistic standards but also for maintaining the fluency, clarity, and readability of the text. Following the proofreading, the study conducted a final round of quality assurance (QA) checks, with a particular emphasis on the accuracy of specialized terminology and the alignment of the translated text with the original source material. This involved verifying that the technical and cultural nuances were accurately preserved and that any discrepancies between the original and the translated text were identified and promptly addressed. This careful scrutiny further reinforced the integrity and precision of the translation. The final step involved the formatting of the translated documents to ensure compliance with the relevant publication standards. This included verifying the correct presentation of visual elements, ensuring the proper formatting of references and citations, and confirming that all other structural aspects of the document adhered to the required guidelines. By attending to these details, the researchers ensured that the translated content was not only linguistically accurate but also professionally presented, thus preparing it for final delivery to the client. This rigorous post-translation process ensured that the final output was both precise and polished, meeting the highest standards of translation quality and ready for professional use.

4. Discussion

4.1. Challenges in human-machine collaboration in translation

The process of translation, particularly for complex and specialized materials, requires a delicate balance between the capabilities of artificial intelligence (AI) tools and the expertise of human translators. This section explores the challenges and limitations inherent in this collaboration, with a focus on three key areas: the complexity of content, the limitations of AI tools, and the essential role of human translator skills. Each of these factors plays a crucial role in determining the overall quality of the translation output and highlights the need for a synergistic approach where human intuition and AI efficiency complement each other. By addressing these challenges, the study can ensure that translations not only retain technical accuracy but also preserve the cultural and contextual nuances that are vital to the intended meaning.

4.1.1. Complexity of content

The complexity of the source material, particularly in specialized domains such as psychology, medicine, and sociology, presents significant challenges for both AI tools and human translators. These fields often involve highly technical terminology and intricate concepts that require a profound understanding of the subject matter. Additionally, the presence of cultural references and historical contexts within the text further complicates the translation process. Such elements demand a nuanced interpretation that goes beyond mere linguistic equivalence and requires a deep awareness of both the cultural significance and contextual subtleties embedded in the original work. AI tools, despite their advanced capabilities, may not fully capture these layers of meaning. Consequently, a collaborative approach, wherein human expertise complements the computational power of AI, becomes essential. This collaboration ensures that the translation is not only linguistically accurate but also contextually appropriate and culturally relevant, allowing the target audience to fully comprehend the intended message.

4.1.2. Limitations of AI tools

Although AI tools such as machine translation engines and terminology extraction models play a critical role in enhancing translation efficiency, their performance is not without limitations. The effectiveness of these tools is often contingent upon the quality and scope of the data they have been trained on, as well as the specific context in which they are applied. For instance, the varying results produced by different AI models—such as DouBao, Tongyi Qianwen, and Zhipu Qingyan—underscore the fact that some models may be better suited for particular tasks, such as terminology extraction in certain fields or languages. This variance in performance highlights the necessity for a nuanced understanding of each tool's strengths and weaknesses. Human translators must, therefore, be prepared to critically evaluate and refine the outputs generated by AI, ensuring that any discrepancies, inaccuracies, or inconsistencies are promptly addressed. This ongoing process of review and adjustment is crucial for maintaining high translation quality, as AI tools alone are insufficient to guarantee perfect results in all contexts.

4.1.3. Human translators skills

Despite the growing significance of AI tools in the translation process, the expertise of human translators remains indispensable. Human translators possess a deep, contextual understanding of language, which enables them to interpret and convey not only the linguistic aspects of a text but also its cultural, emotional, and psychological nuances. This skill set is particularly important when translating materials that contain culturally specific references, humor, or emotional depth, elements that often defy straightforward translation by AI models. Human translators also

bring their judgment and intuition to the translation process, making informed decisions that account for the subtleties of tone, style, and the socio-cultural context of the target audience. While AI tools can facilitate and expedite many aspects of translation, it is the human translator's ability to navigate these complexities that ensure the translation remains accurate, culturally appropriate, and emotionally resonant. Thus, human expertise plays an essential role in complementing and refining the outputs of AI, particularly in complex and specialized domains.

4.2. Optimizing human-AI collaboration in translation

The integration of artificial intelligence (AI) tools into the translation process has revolutionized the field, enhancing efficiency and enabling human translators to focus on more complex and nuanced tasks. However, to truly maximize the potential of AI in translation, it is crucial to adopt strategies that facilitate effective collaboration between human expertise and machine capabilities. This section explores several key aspects of this collaboration, emphasizing the importance of effectively utilizing AI tools, maintaining robust post-editing and quality assurance practices, and fostering a culture of continuous learning.

In particular, the study examines the role of AI tools such as the YiCAT platform's translation memory and automatic quality assurance features, which can significantly streamline the translation process by handling repetitive tasks and ensuring consistent quality. Furthermore, the study highlights the critical role of post-editing, where human insight and AI-generated content converge to refine the output, ensuring that it meets the highest standards. Finally, the section addresses the importance of continuous learning, encouraging translators to adapt to evolving technologies and further enhance their skills. By implementing these strategies, the collaboration between human translators and AI tools can be optimized, leading to translations that are not only efficient but also accurate, contextually relevant, and culturally sensitive.

4.2.1. Optimizing the integration of AI tools in translation workflow

To fully harness the potential of AI tools in the translation process, it is imperative to incorporate them strategically into the workflow. For example, leveraging the YiCAT platform's translation memory and automated quality assurance features can significantly streamline the translation process. By delegating repetitive and time-consuming tasks to AI tools, human translators can redirect their focus toward more complex and nuanced aspects of translation, such as the subtleties of cultural context and stylistic decisions. Furthermore, the systematic evaluation of AI tool performance, coupled with feedback mechanisms, fosters continuous refinement, ensuring that these tools remain effective and reliable in supporting the translation process.

4.2.2. Post-editing and quality assurance

A rigorous post-editing protocol is essential to elevate the quality of machine-generated translations. As exemplified by the case analysis, the integration of automatic quality assessment tools within the YiCAT platform enables translators to systematically evaluate the accuracy, fluency, and appropriateness of translations. By prioritizing sentences that are flagged for errors or necessitate substantial revisions, translators can allocate their efforts more effectively. This collaborative model, in which human insight is applied to refine AI-generated content, guarantees that the final translation output adheres to high standards of quality, blending machine efficiency with human expertise.

4.2.3. Fostering continuous learning and adaptation

Cultivating a culture of continuous learning among translators is crucial to improving translation quality in the context of evolving AI technologies. This can include structured training programs focused on the optimal use of AI tools, as well as domain-specific workshops designed to deepen translators' expertise. By promoting an environment in which translators share insights, strategies, and best practices, organizations can ensure that human expertise evolves in tandem with technological advancements. Such an approach not only strengthens the collaboration between human translators and AI but also enhances the overall quality of translations.

The dynamic interaction between human translators and AI tools is shaped by several factors, such as content complexity, the limitations inherent in AI systems, and the necessity for consistent terminology usage. Through the implementation of strategies that optimize AI tool integration, establish robust post-editing procedures, leverage comprehensive terminology databases, and encourage ongoing professional development, the quality of translations can be substantially improved. This collaborative model maximizes the respective strengths of human and machine capabilities, ensuring translations are not only accurate and contextually appropriate but also culturally sensitive.

5. Conclusion

The increasing integration of AI tools into the translation process marks a significant advancement within the field, though it also presents several inherent challenges. This study examines the complex interplay between human translators and AI technologies, emphasizing that, while AI can greatly enhance efficiency and assist in managing complex translation tasks, it cannot fully replicate the nuanced understanding that human translators provide. The complexity of source materials drawn from diverse disciplines—such as psychology, medicine, and sociology—demands not only technical translation skills but also a deep awareness of cultural and contextual subtleties, aspects that AI tools often fail to capture effectively.

Acknowledging the limitations of AI tools, particularly their variable performance depending on context and the quality of the training data, underscores the essential role of human involvement in the translation process. Human translators possess the intuition and judgment necessary to interpret nuanced meanings, make informed translation decisions, and address cultural references that require insight beyond the capabilities of AI.

To ensure the highest quality of translations, it is crucial to implement effective strategies. These include optimizing the use of AI tools, establishing structured post-editing and quality assurance processes, and fostering a culture of continuous learning among translators. Through the integration of these strategies, translation teams can strengthen the collaborative relationship between AI technologies and human expertise, resulting in greater accuracy, fluency, and cultural relevance in translations.

Finally, the human-machine collaborative model explored in this study not only accelerates the translation process but also enhances the final product. This synergy ensures that translations not only faithfully convey the original author's intent but also resonate with the target audience. As both AI technologies and human expertise continue to evolve, the potential for producing high-quality translations will expand, fostering more effective communication across linguistic and cultural boundaries.

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