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Computer-assisted translation software: Current problems and development trends in the context of artificial intelligence

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Abstract

Computer-Assisted Translation (CAT) software is a product of the combination of computer software technology and translation. It is a professional translation software platform that integrates technologies such as translation memory, terminology management, machine translation, text alignment, segmentation technology and quality assurance. The use of CAT software enables rapid translation work and significantly ensures translation quality. Based on the working principles and basic operation processes of CAT software, the paper analyzes the current problems with CAT software and its prospects of CAT software in the context of artificial intelligence, with the aim of providing some reference for professional translators in the translation industry when choosing tools.

Keywords: Artificial intelligence, computer-assisted translation (CAT), machine translation, development trends

1. Introduction

Computer-Assisted Translation (CAT) technology is an important innovation in the field of modern translation. It significantly improves the efficiency and quality of translation work by combining computer software technology with translation technology. CAT software integrates a variety of advanced technologies, including translation memory, terminology management, machine translation, text alignment, segmentation technology, quality assurance and other technologies, to form a comprehensive professional translation platform. The synergistic effect of these technologies not only accelerates the translation speed, but also ensures the consistency and accuracy of the translation content.

From the perspective of CAT technology, this paper first elaborates the working principles and basic translation operation processes of current mainstream CAT software, including the specific implementation and application scenarios of various key technologies. Then, it analyzes some problems existing in CAT technology. In addition, it also looks forward to the future development trend of CAT technology, pointing out the main challenges and potential improvement directions faced by software in the current artificial intelligence context. Through this series of analyses, this paper aims to provide scientific basis and practical suggestions for professional translators in the translation industry when choosing and using CAT tools. It is also hoped that the research in this paper can promote the further development of CAT technology and promote the modernization process of the translation industry.

2. History and Development of CAT Technology

2.1 Early Stage (1970s to 1980s)

The origin of computer-assisted translation (CAT) technology can be traced back to the 1970s. At this stage, computer technology had just begun to be applied in the field of translation, mainly focusing on rule-based methods. Early CAT tools mainly relied on pre-set grammatical and lexical rules for translation. These tools were capable of handling some simple translation tasks but had limitations in dealing with complex sentences and maintaining contextual accuracy. For example, early systems like the predecessor of Trados were mainly rule-based translation memory banks, which achieved translation through manually coded rules and dictionaries.

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2.2 Development Stage (1990s)

In the 1990s, with the rapid development of computer technology and the Internet, CAT technology began to mature gradually. During this period, the emergence of statistical machine translation (SMT) technology greatly promoted the development of CAT tools. SMT uses a large amount of bilingual text data to train translation models, thus being able to translate texts more accurately. For example, well-known international CAT tools such as SDL Trados and Memo began to emerge and were gradually widely used in the translation industry. These tools not only improved translation efficiency but also facilitated terminology management and translation memory sharing, further improving translation quality and consistency.

2.3 Prosperous Phase (From the Early 21st Century to the Present)

Entering the 21st century, especially in recent years, with the popularization of the internet and the acceleration of the globalization process, the demand for translation has surged, and CAT technology has also entered a period of rapid development. During this period, Neural Machine Translation (NMT) technology has gradually become the mainstream. NMT utilizes deep neural networks to simulate the brain's translation process, enabling more natural and accurate text translation. In China, some local translation software companies, such as iFlytek and Baidu Translate, have also begun to adopt NMT technology. At the same time, local professional CAT software, such as XueRen CAT, Transmate, and YaXin CAT, have also emerged and have achieved significant results in the market.

3. Principles and Basic Operation Process of CAT Software

3.1 Mainstream CAT Software and Its Working Principles

Currently, there is a wide variety of Professional computer-assisted translation (CAT) software, each with its own unique features. Overall, they exhibit a diverse range of functionalities and application scenarios. In terms of software deployment categories, they can generally be divided into desktop and web-based software. Although many mobile apps also have the capabilities of professional translation software, they are not based on computer platforms for translation purposes, and thus are not discussed here. Among the desktop software, the main ones include SDL Trados, Wordfast, MemoQ, XueRen CAT, Transmate, Déjà Vu, OmegaT, YaXin CAT, Across, Smart CAT, Mate CAT, and so on. Web-based software currently includes Google Translate, DeepL-Translator, Baidu Translate, Yahoo Translate, Microsoft Translator, Yandex Translate, Tencent Translate, Youdao Translate, Mate Translate, YI CAT, Sogou Translate, Bing Translate, ICIBA Translate, NiuTrans, etc. Although the interface layouts of various professional computer-assisted translation (CAT) software differ, and they each have their unique features, their key core functionalities generally include the following aspects: translation memory, terminology management, machine translation, text alignment, segmentation technology, and quality assurance. The working principles of these functionalities are as follows:

3.2 Translation Memory Technology (TM)

Principle: Translation memory technology stores

previously translated segments of source and target language text (Referred to as "translation units"). During new translation tasks, the system automatically searches for and provides similar or identical translation units. When encountering similar material, the system can automatically offer reference translations, thereby increasing work efficiency and translation quality^[1]. For the use of memory databases, translators must dynamically adjust the match rate to ensure the reasonable appearance of translation suggestions.

Basic Principle Process

- **Step 1:** Create a translation memory database: Initialize an empty translation memory database or import an existing translation memory file.
- **Step 2:** Segmentation: Divide the source text into independent translation units, typically sentences or paragraphs.
- **Step 3:** Matching: Search the translation memory database for entries that are similar or identical to the current translation unit.
- **Step 4:** Suggestions: If a match is found, the system displays existing translation suggestions.
- **Step 5:** Editing: Translators can edit and adjust the suggestions to fit the current context.
- **Step 6:** Save: Save the new translation unit into the translation memory database for future use.

Example: Suppose a translator is working on a contract document that contains the sentence "This contract shall take effect from the date of signature by both parties." If the translation memory database already has a similar translation unit, such as "This agreement shall take effect from the date of signature by both parties," the system will automatically provide this translation suggestion, and the translator only needs to make minor modifications.

3.3 Terminology Management Technology

Principle: Terminology management technology ensures the consistent use of professional terms throughout a translation project by creating and maintaining a terminology database. The terminology database includes definitions, translations, and usage instructions for terms.

Basic Principle Process

- **Step 1:** Create a terminology database: Initialize an empty terminology database or import an existing glossary.
- **Step 2:** Add terms: Add professional terms and their translations to the terminology database.
- **Step 3:** Tag terms: Identify and tag the terms in the source text that need to be translated.
- **Step 4:** Automatic replacement: The system automatically replaces terms in the source text based on the definitions in the terminology database.
- **Step 5:** Review: Translators review the results of the automatic replacement to ensure the correct use of terms.

Example: When translating a medical document, the terminology database may include the definition and translation of "心肌梗死" (Myocardial Infarction). When a translator encounters "心肌梗死" in the source text, the

system will automatically prompt and replace it with the English term "Myocardial Infarction."

3.4 Machine Translation Technology

Principle: Machine translation technology generates a preliminary draft of the translation of the source text through algorithms and models. Modern machine translation is primarily based on Neural Machine Translation (NMT) technology, which can produce more natural and accurate translation results.

Basic Principle Process

- **Step 1:** Input source text: Enter the text to be translated into the machine translation engine.
- **Step 2:** Generate translation draft: The machine translation engine generates a preliminary translation result based on the training model.
- **Step 3:** Edit and optimize: Translators edit and optimize the generated translation draft to improve accuracy and fluency.
- **Step 4:** Save: Save the final translation result into the translation memory for future use.

Example: Suppose a translator needs to translate an article about artificial intelligence. After using a machine translation engine to generate a preliminary translation, the translator can proofread and modify the draft to ensure the accuracy and professionalism of the translation.

3.5 Text Alignment Technology

Principle: Text alignment technology pairs the corresponding parts of the source language text and the target language text to facilitate the construction of translation memory and the assessment of translation quality.

Basic Principle Process

- **Step 1:** Import bilingual text: Import the source language and target language texts into the system.
- **Step 2:** Automatic alignment: The system automatically aligns the source text and target text based on sentence structure and content.
- **Step 3:** Manual proofreading: Translators proofread and adjust the results of the automatic alignment to ensure accuracy.
- **Step 4:** Save alignment results: Save the aligned text into the translation memory for future use.

Example: When translating a technical manual, translators can use text alignment technology to align the Chinese and English versions of the manual, ensuring that each segment of text has a corresponding translation.

3.6 Segmentation Technology

Principle: Segmentation technology divides the source text into smaller translation units, such as sentences or paragraphs, to facilitate management and translation.

Basic Principle Process

- **Step 1:** Import source text: Import the text to be translated into the system.
- **Step 2:** Automatic segmentation: The system automatically divides the text into translation units

based on punctuation and sentence structure.

- **Step 3:** Manual adjustment: Translators adjust the results of automatic segmentation to ensure the rationality and completeness of each translation unit.
- **Step 4:** Translate: Translate each segmented text unit individually.

Example: When translating a news report, the system can automatically segment each sentence in the report, and translators can translate each sentence one by one, ensuring the accuracy and fluency of each sentence.

3.7 Quality Assurance Technology

Principle: Quality assurance technology improves the quality of the final translation product by automatically detecting and correcting common errors in translation, such as spelling mistakes, inconsistent terminology, and formatting errors.

Basic Principle Process

- **Step 1:** Import translation results: Import the completed translation text into the system.
- **Step 2:** Automatic detection: The system automatically detects common errors in the translation, such as spelling mistakes, inconsistent terminology, and numerical errors.
- **Step 3:** Reporting and correction: The system generates an error report, and translators make corrections based on the report.
- **Step 4:** Final review: Translators conduct a final review of the corrected text to ensure the accuracy and quality of the translation.

Example: When translating a financial report, quality assurance technology can automatically check whether the numbers in the report are consistent, ensuring the accuracy of financial data.

Professional CAT software integrates various technologies such as translation memory, terminology management, machine translation, text alignment, segmentation, and quality assurance, providing translators with an efficient and reliable translation platform. The synergistic effect of these technologies not only significantly improves the efficiency of translation work but also ensures the consistency and accuracy of the translated content. As illustrated by the detailed explanation of the principles and processes above, the application of CAT software in the actual translation process is very extensive, effectively solving various translation challenges and enhancing translation quality.

3.8 The Basic Process of Implementing Translation Work with CAT Software

The basic process of using professional CAT software for translation can be divided into several steps. These steps cover the entire process from project creation to the final export of the translation results. Below is a typical CAT translation software usage process, illustrated using SDL Trados Studio as an example, although other CAT tools such as memo and Word fast have similar operational steps.

3.8.1 Create a Translation Project

- **Step 1:** Launch the CAT tool: Open the CAT software, such as SDL Trados Studio.

- **Step 2:** Create a new project: Select the "New Project" option, enter the project name, project path, and other basic information.
- **Step 3:** Set language pair: Choose the source language and target language.
- **Step 4:** Link translation memory: Select or create a translation memory (TM) to store and reuse translated text segments.
- **Step 5:** Link terminology base: Select or create a terminology base (TB) to manage and ensure the consistency of terminology.
- **Step 6:** Import files: Import the files to be translated into the project, supporting various file formats such as DOCX, PDF, XML, etc.

3.8.2 Pre-translation

- **Step 1:** Execute pre-translation: Use the existing translations in the translation memory to pre-translate the imported files. Pre-translation can significantly reduce the workload of translators.
- **Step 2:** Review pre-translation results: Check the pre-translated text to ensure there are no omissions or errors.

3.8.3 Translation

- **Step 1:** Open the translation editor: Enter the translation editor interface to view the source text and translation area.
- **Step 2:** Translate sentence by sentence: Read the source text sentence by sentence and input the corresponding translation. The CAT tool will automatically display matching suggestions from the translation memory.
- **Step 3:** Terminology management: Use terms from the terminology base to ensure the consistency of professional terminology.
- **Step 4:** Use machine translation: If necessary, use the integrated machine translation engine to generate a preliminary translation draft, then manually proofread and modify it.
- **Step 5:** Save translation: Save the translation results after completing each unit.

3.8.4 Quality Check

- **Step 1:** Automatic quality check: Use the quality check function provided by the CAT tool to automatically detect common translation errors, such as spelling mistakes, inconsistent terminology, and formatting errors.
- **Step 2:** Review and correct errors: Repair the detected errors item by item according to the quality check report.
- **Step 3:** Manual proofreading: Conduct final manual proofreading to ensure the accuracy and fluency of the translation.

3.8.5 Export Translation Results

- **Step 1:** Export the translation: Export the completed translation file in the required format, such as DOCX, PDF, etc.
- **Step 2:** Export the comparison text: You can choose to export the source text and translation comparison file for subsequent proofreading and reference.
- **Step 3:** Update the translation memory: Save the new

translation units to the translation memory for future use.

3.8.6 Project Management and Collaboration

- **Step 1:** Project management: Use the project management features of the CAT tool to track project progress, manage task allocation, and file versions.
- **Step 2:** Multi-user collaboration: If the project involves multiple people, tasks can be assigned to different translators, supporting online collaboration and version control.
- **Step 3:** Proofreading and feedback: After translation, conduct proofreading, collect feedback, and make necessary modifications and improvements.

4: The problems and Opportunities of CAT Software

4.1 The problems with CAT Software

4.1.1 Translation Quality and Linguistic Flexibility

Computer-assisted translation software often shows deficiencies in translation quality when dealing with complex sentences and literary texts. This phenomenon is mainly due to the software's mechanized translation process, which fails to fully consider the differences in context and cultural background, resulting in translations that appear rigid and lack the natural charm of language. For example, when translating literary works, software finds it difficult to accurately convey the emotions and cultural connotations of the original text because literary texts often contain complex rhetoric and metaphors, which computer-assisted translation systems often cannot effectively handle. Additionally, current translation software has a low recall rate for fuzzy matching when dealing with polysemous words and complex sentence structures, further limiting its application in literary translation ^[2].

4.1.2 Fuzzy Matching and Terminology Base Limitations

Low recall rates for fuzzy matching are a key issue faced by CAT software. Particularly when dealing with complex or highly specialized texts, the effectiveness of fuzzy matching is poor, leading to the software's inability to provide sufficiently accurate reference translations. Additionally, the construction of a terminology base requires long-term accumulation, and its help to translators is limited in the initial stages of use, especially when facing entirely new fields. Translators may face the challenge of building a terminology base from scratch ^[3].

4.1.3 Adaptability and Scope of Application

CAT software demonstrates high efficiency in handling texts with high repetition, such as legal documents and instruction manuals, but falls short in fields like literary translation. This is because texts in these areas often contain complex sentence structures, rhetoric, and cultural backgrounds, which computer-assisted translation struggles to effectively address ^[4]. For example, rhetorical devices commonly found in literary works, such as metaphors and similes, are often inaccurately conveyed by computer-assisted translation in terms of their deeper meanings.

4.1.4 Technological Development and Automation Level

Current CAT software still has a relatively low level of automation, with many aspects relying on manual intervention and adjustment. This dependency mainly stems from the imperfections of translation memory and

terminology bases, requiring translators to frequently engage in post-editing and language polishing to enhance the quality and accuracy of the translation. Additionally, although computer-assisted translation technology has improved translation efficiency through terminology management systems and translation memory, human intervention is still necessary when dealing with ambiguous language structures to ensure the accuracy of the translation. In the future, with advancements in information technology, CAT software is expected to reduce manual operations and repetitive labor by improving terminology extraction functions and fuzzy matching search efficiency.

4.1.5 Human-Computer Interaction and the Role of the Translator

The core of computer-assisted translation lies in human-computer interaction, but currently, the software still lacks support for the translator's creativity, often requiring translators to spend a significant amount of time on post-editing and optimizing translations. This limitation is due to the software's mechanical division of text into smaller units for translation, ignoring the complexity of context and context, leading translators to adjust the structure and word order of the translation to ensure accuracy and fluency. Moreover, despite the vast terminology and memory bases of CAT software, these resources are difficult to utilize in the translation of literary texts due to a lack of sufficient terminology and repetitive sentences.

In summary, CAT software has significant advantages in improving translation efficiency, but it still faces many challenges in handling complex texts and ensuring translation quality. Future development needs to achieve breakthroughs in improving the efficiency of fuzzy matching, enhancing the adaptability of terminology bases, and elevating the level of software automation.

4.2 Opportunities Faced by CAT Software

4.2.1 Translation Memory and Terminology Management

One of the core functions of Computer-Assisted Translation (CAT) software is translation memory, which can save and manage terms and phrase pairs generated during the translation process, ensuring the coherence and consistency of the translation. The introduction of AI technology has further optimized this process by automating terminology extraction and terminology database management, improving the efficiency and accuracy of translation. Specifically, AI algorithms can automatically identify and extract terms from text and add them to the terminology database for reference and use by translators in subsequent translation work. This process not only reduces the workload of translators but also enhances translation quality by ensuring the consistency of terminology.

4.2.2 Intelligent Translation and Quality Control AI

Technology has significantly enhanced the translation capabilities of CAT tools through machine translation and natural language processing (NLP), especially when dealing with large volumes of text, where AI can provide faster and more accurate translation results. This combination not only improves translation efficiency but also increases translation accuracy. Moreover, AI plays a crucial role in quality control, offering intelligent proofreading and grammar checking to help translators identify and correct errors in a

timely manner, thereby enhancing the quality of the translation ^[5]. AI technology can analyze individual preferences and behavior patterns to provide personalized services, which also supports the personalized needs of translation.

4.2.3 Automation of Workflow and Project Management

The application of AI technology in CAT software is not limited to the translation process but also includes project management and automated workflows. Through intelligent project management and scheduling, AI can significantly improve the overall efficiency of translation projects. This process involves the integration of translation memory systems and terminology management systems to optimize requirement handling, pre-translation processing, resource matching, translator training, manuscript distribution, translation, proofreading, quality inspection, typesetting, delivery, and feedback modification. The integration of these functions allows translation companies to handle large-scale translation projects more efficiently, ensuring that projects are completed on time and improving translation quality.

4.2.4 Personalized Translation and User Adaptation

AI technology, by analyzing user preferences and translation history, enables CAT tools to provide personalized translation services. This adaptive capability not only increases user satisfaction but also enhances the relevance and accuracy of translation ^[6]. For example, AI can automatically adjust the translation style to meet the specific needs of individual users.

4.2.5 Multimodal Translation and Cross-Media Applications

By combining computer vision and speech recognition technology, AI has expanded the application scope of CAT software, supporting the translation of images and speech, suitable for processing multimodal content. This cross-media application enhances the adaptability of CAT software in multimedia environments ^[7].

4.2.6 Intelligent Assistance and Creative Enhancement

AI technology in CAT software significantly enhances the creativity and translation quality of translators by providing intelligent suggestions and creative support. Specifically, AI technology offers multiple translation options during the translation process, encouraging translators to make creative choices and optimizations. This approach not only increases the flexibility of translation but also allows translators to better adapt to the needs of different text styles and contexts. With the assistance of artificial intelligence, translators can make more creative expressions that are in line with the target language's expression habits while preserving the meaning of the original text ^[8]. For example, in literary translation, this creative enhancement is particularly important because literary works often contain rich cultural backgrounds and emotional expressions. AI technology can help translators better understand and convey these complex cultural elements, thereby achieving higher quality translations.

In summary, the combination of AI technology and CAT software brings higher efficiency, accuracy, and personalized services to the translation industry, promoting the intelligent development of translation tools. This

integration not only improves the translation process but also provides more creative support for translators.

5. Development Trends of CAT Software

5.1 Higher Translation Efficiency

The integration of artificial intelligence technology with computer-assisted translation has significantly improved translation efficiency. By leveraging computer systems and vast databases, AI can achieve rapid translation and deliver real-time output. This technology eliminates the need for human intervention, allowing for the completion of translation tasks at an extremely fast pace, far surpassing the efficiency of traditional human translation. Moreover, the automation of AI translation enables its application across multiple platforms, particularly on mobile devices, providing users with more convenient services.

5.2 Lower Costs

AI translation reduces translation costs by decreasing reliance on human labor. Compared to traditional human translation, AI translation only requires inputting content into the corresponding translation platform and using translation machines to complete the task, thus saving a significant amount of money that would otherwise be spent on hiring professional translators. The application of this technology not only conserves budgets but also simplifies and accelerates the translation process, allowing for more precise estimation of translation time. Furthermore, the low-cost advantage of AI translation makes it more attractive in multilingual processing, especially in mobile applications, providing users with convenient services.

5.3 Higher Translation Quality

With the advancement of big data and machine learning technologies, the accuracy of AI translation is continuously improving. Google's AI translator has achieved cross-linguistic translation, with accuracy gradually approaching human levels. The introduction of Neural Machine Translation (NMT) technology has further enhanced the accuracy and efficiency of AI translation in recent years, significantly improving the accuracy and fluency of translations. NMT systems, through self-attention mechanisms, can better handle contextual relationships, thus performing well in translating complex sentences. This technology has shown significant results under large-scale parallel corpus conditions, although it still faces challenges in languages with scarce resources [9].

5.4 Stronger Multilingual Processing Capability

AI technology excels in multilingual processing, supporting mutual translation between multiple languages. This capability is rare in traditional translation because there are relatively few talents who can solidly master multiple languages. AI technology, through natural language processing techniques to train models, understands the connections between different languages, effectively solving this problem. Moreover, AI translation tools can not only meet the multilingual translation needs in daily communication but also provide more accurate translation services in complex language environments. For example, neural network translation systems, through deep learning technology, can better handle grammatical and semantic differences between different languages, although there are still shortcomings in handling professional terminology and

lengthy texts [10]. AI language models, by learning from a large amount of bilingual text, master the grammar, vocabulary, and expression habits of multiple languages, generating more accurate and fluent translations.

5.5 More Adequate Human-Machine Interaction

The combination of AI and CAT software has promoted human-machine interaction in the translation process. AI not only assists translators in improving translation efficiency and quality but also promotes the automation and intelligence of translation work through tools such as terminology databases and bilingual corpora [11].

In summary, the advantages of AI in computer-assisted translation software are mainly reflected in the enhancement of efficiency, cost, quality, and multilingual processing capabilities. With the continuous advancement of technology, the application prospects of AI in the field of translation will be even broader.

6. Conclusion

This paper has delved into the issues and development trends of Computer-Assisted Translation (CAT) software under the backdrop of artificial intelligence. By analyzing the working principles, basic processes, and practical application challenges of CAT software, we reach the following conclusions: Firstly, although CAT software integrates advanced technologies such as translation memory, terminology management, and machine translation, which have significantly improved translation efficiency and quality, there are still deficiencies in handling complex texts, maintaining linguistic flexibility, and adaptability. These problems limit the application of CAT software in certain fields, especially in literary translation and the translation of texts with strong professional characteristics.

Secondly, the development of AI technology has brought new opportunities to CAT software. AI products, such as ChatGPT, with their excellent machine learning, deep learning technologies, and large language processing models, can better understand the context of text, achieve more accurate expressions, and higher language fluency. They can also more accurately judge the emotions, culture, and other non-linguistic information in the text, realizing multimodal translation. Moreover, AI technology can help CAT tools optimize terminology management and translation memory, further improving translation efficiency and quality. Therefore, the integration of CAT tools with AI technology is an inevitable trend.

Lastly, from the perspective of development trends, CAT tools will continue to exist as auxiliary tools for translators, and the integration of AI technology will make them more intelligent and efficient. At the same time, translators still need to maintain ultimate control over the translation process to ensure that the translation quality meets professional standards. Thus, the integration of CAT tools with AI technology can not only improve translation efficiency but also ensure translation quality, which is key to the development of the translation industry. In the future, CAT software will become more intelligent and personalized, better meeting diverse translation needs. Meanwhile, technical challenges, ethical issues, and the protection of linguistic diversity will also be issues that cannot be ignored in the development of translation technology.

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