Advanced Artificial Intelligence Technologies and Developments inScientific Translation

تقنيات الذّكاء الاصطناعي المتقدمة ودورها في تطور الترجمة العلمية

أ.مريم محمد مصباح المودي ـ محاضر بالمعهد العالي للعلوم والتقنية

الزاوية / ليبيا

الملخّـــــص:

يستكشف هذا البحث تداخل تقنيات الذكاء الاصطناعـي المتقدمة وتأثيرها على مجال الترجمة العلمية، ومع تزايد الطّلب على ترجمة دقيقة وفعالة للمواد العلمية نتيجةً للعولمة، أصبحت الأدوات المعتمدة على الذّكاء الاصطناعي لا غنى عنها، وتُقيّم الدراسة التطورات الحالية في تقنيات ترجمة الذّكاء الاصطناعي، وتدرس قدراتها وحدودها، وتناقش آثارها على التواصل العلمي. من خلال تحليل الأدبيات ودراسات الحالة ورؤى الخبراء، تهدف هذه الورقة إلى تقديم فهم شامل للمشهد المتطور واقتراح توجهات للبحوث المستقبلية.

الكلمات المفتاحيـة: الترجمة الآلية العصبية – الترجمة العلمية – الذكاء الاصطناعي ـ الترجمة الآليـــــة

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Maryam Mohamed M. Almudi

A lecturer at the Higher Institute of Science and Technology

Zawia / Libya

Abstract:

This research paper explores the intersection of advanced artificial intelligence (AI) technologies and their impact on the field of scientific translation. As globalization intensifies the demand for accurate and efficient translation of scientific materials, AI-driven tools have become indispensable. The study evaluates current developments in AI translation technologies, examines their capabilities and limitations, and discusses their implications for scientific communication. Through literature analysis, case studies, and expert insights, this paper aims to offer a comprehensive

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understanding of the evolving landscape and propose directions for future research.

Keywords:

Artificial Intelligence (AI) - Scientific Translation - Neural Machine Translation (NMT) - Machine Translation (MT).

Introduction:

Scientific translation plays a crucial role in disseminating knowledge across linguistic and cultural boundaries. With the exponential growth of scientific publications worldwide, the need for timely and precise translation has never been more urgent—traditional translation methods, although effective, often fall short in speed and scalability. The integration of advanced AI technologies, particularly neural machine translation (NMT), has revolutionized the translation process, making it faster and more accessible. This paper investigates how these technologies are transforming scientific translation and evaluates their performance and potential.

School is a critical time for youngsters to grow and learn. In order to provide a strong basis for their future social lives and careers, teachers should focus more on helping students improve their English speaking and translating abilities. Students should also be able to utilize English freely. When AI is used effectively in university English instruction, students can become highly motivated, develop their creative thinking skills, and be inspired to actively participate in English language learning as translators. Teachers are not conducive to pupils' translation skills being effectively improved [1].

Effective use of AI in university English instruction can substantially inspire students to actively participate in learning English as translators, encourage them to think creatively, and motivate them. As a result, academics are becoming increasingly aware of it. Nonetheless, certain issues persist. Students' ability to translate is hampered by the absence of specialized translation courses and instructional resources for college English instruction. The way that translation tutors educate has some irregularities that make it difficult for students to effectively improve their translation abilities [2]. Secondly, the development of university English textbooks emphasizes students' foundational knowledge while providing limited

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opportunities for critical thinking, which is primarily evident in the lack of certain relevance of translation content formulas and the inability to develop targeted translation teaching contents according to students' majors. Although some translation contents are introduced in the arrangement of current university English textbooks, they focus on basic knowledge and lack practical training content for translation skills. In general, the development of students' English translation skills is still missing and needs further research [3].

Historically, human translation has served as the primary method of translation since ancient times. However, with the development of computer technology and the rapid growth of the Internet, machine translation technology is gradually moving into history. As far as the definition is concerned, machine translation (MT) is a technology that can efficiently use computer computing power to convert and transfer information between two languages. The development of machine translation technology has moved from the research stage to the practical application stage. Machine translation is also the main driver of the dynamic development of translation services in the world. Deep learning also does well in NLP tasks including sentiment analysis, semantic extraction, word stem extraction, and text summarization. The machine Computational Intelligence and Neuroscience Machine translation is considered a major research task in the field of natural language processing in both academic and industrial applications due to its wide range of applications but also its complexity. With the start of the AI revolution, machine translation technology is definitely getting a boost from deep learning. Translation agencies and professionals frequently use neural machine translation (NMT) systems, such as Google Translate, DeepL Translator, and Microsoft Translator, to name a few. The goal of NMT is to develop algorithms capable of translating text between languages.NMT models are based on neural networks, which are computer systems that are modeled after the human brain[4]. By identifying patterns in the vast amounts of text in multiple languages they are trained on, these models can offer translations[5]. However, more recently, ChatGPT has become one of the most common AI tools used by professional translators,

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as it has an easy-to-use interface and is suited to both individual and wide-scale use [6].

Objectives of the Study

1. To analyze the current state of AI technologies in scientific translation.

2. To evaluate the effectiveness and limitations of these technologies in handling scientific texts.

3. To identify the implications of AI-driven translation for researchers, publishers, and global
    knowledge dissemination.

Questions of the Study

1. What are the most advanced AI technologies currently used in scientific translation?

2. How do these technologies compare with traditional translation methods in terms of accuracy,
    efficiency, and scalability?

3. What challenges do AI tools face when translating scientific material?

4. How can the scientific community leverage AI while ensuring quality and ethical standards?

Methodology of the Study

This study employs a qualitative research methodology. Data is collected through a comprehensive review of scholarly articles, white papers, and case studies published in the last decade. In addition, expert interviews and surveys with professional translators and computational linguists provide practical insights. Comparative analyses are conducted between AI-generated translations and human translations to assess performance. The study also incorporates scenario-based evaluations to explore real-world applications and limitations.

Literature Review

The field of machine translation (MT) has evolved from rule-based systems in the mid-20th century to statistical methods and now to deep learning approaches. Recent breakthroughs in NMT, notably through models such as Google's Transformer and OpenAI's GPT architectures, have significantly improved translation quality. Studies by Vaswani et al. and Brown et al. demonstrate how transformer-based models outperform previous methods in

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fluency and accuracy [7]. Furthermore, domain-specific adaptations and fine-tuning techniques have enhanced the applicability of these models in scientific contexts [8].

Despite these advances, challenges remain. Scientific texts often contain specialized terminology, and complex sentence structures, and require high semantic precision. Researchers like Specia et al. have highlighted the limitations of general-purpose AI models in maintaining domain fidelity. Moreover, ethical concerns, data privacy, and the need for human oversight are recurrent themes in the literature.

Artificial Intelligence

Artificial intelligence has revolutionized the language translation sector. However, even the most advanced artificial intelligence translation services aren't going to force human translators out of a job anytime soon. In fact, AI has redefined the sector, bringing exciting new job prospects and career opportunities for translation professionals.

Technology has undoubtedly become a necessary component of our everyday life. Technology and its highly developed artificial intelligence (AI) systems dominate life and have surpassed people in practical and administrative tasks. However, people can still succeed in other tasks that need intelligence and thought. However, there is a sharp rise in the amount of scientific translation. The quick development of science and technology in a number of domains is to blame for this. The enormous volume of materials will make it impossible for translators to handle, so technology is a necessary and urgent answer to boost translation productivity. "A new translation concept like artificial intelligence translation has emerged with the development of automated translation tools," Yang said [9].

Although the number of translation apps that are comparable to human translators has been increasing for some time, detractors contend that there is still a performance gap between the two (Li et al., 2020; Hassan et al., 2018). The following list will include the most significant categories of AI applications:

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1. ChatGPT

Chat GPT is a popular and practical app these days. Diaz (2023) provided additional information about Open-AI's creation of Chat GPT, a chatbot that was made available in November 2022. It makes use of the GPT-3 series and has been enhanced through reinforcement and supervised learning.

2. Chat on Bing

According to Moneus and Sahari (2024), Bing Chat is a recently introduced Microsoft tool that offers a "copilot for the web" experience through the use of AI technology. As users explore the web, communicate with friends, or use the Edge browser, Bing, and Skype apps, it enables them to receive tailored suggestions, responses, and insights. Now accessible on Skype and Bing Mobile, Bing Chat appears to be becoming more and more well-liked by customers who are looking for AI-powered solutions.

3. Perplexity

The conversational search engine Perplexity AI is marketed as an "answer engine" that uses natural language predictive text to deliver answers to queries. Launched in 2022, it uses web sources and incorporates links into the text response to generate replies.

4. Gemini

Gemini, formerly known as Bard, is a generative artificial intelligence chatbot developed by Google. Based on the large language model (LLM) of the same name and developed as a direct response to the meteoric rise of OpenAI's ChatGPT, it was launched in a limited capacity in March 2023 before expanding to other countries in May.

5. Poe

According to the Web Search Results, Poe is a chatbot platform developed by Quora that allows users to interact with AI chatbots powered by large language models like ChatGPT. It was announced in December 2022 and launched to the public on February 3, 2023, with desktop browser access made available on March 4, 2023. The name "Poe" is an acronym for "Platform for Open Exploration". Poe aims to provide an easy-to-use interface for people to interact with and explore different AI language

models through natural conversation and can answer any question and provide translation services.

6. Sider AI

Sider AI is an advanced AI assistant platform that offers a wide range of tools and functionalities, including chat, writing, reading, translation, and image testing with AI models like ChatGPT 3.5/4, Gemini, Claude, and more. It serves as an all-in-one AI assistant, providing features like group AI chat, AI reader, AI writer, ChatPDF, integrated image tools, and support for various AI models like GPT-3.5, GPT-4, Claude, and Gemini, allowing users to ask questions and receive immediate solutions from multiple AI bot.

How AI is redefining the translation industry

Even though AI won't be knocking human translators out of a job anytime soon, it is helping alter the translation services sector. It's making the entire process significantly more streamlined and has far-reaching applications. AI makes it simple for users to obtain fast and somewhat accurate translations on a daily basis. For travelers who are around the world, this can mean using a tool like Google Translate, which offers real-time translations for common conversations.

AI can facilitate communication between translators and non-native speakers. Artificial intelligence fills in vocabulary gaps by translating when necessary because even the most skilled translators cannot fully understand the second language they work in.

AI Changes How We Work as Translators:

Many professional translators view automation and artificial intelligence (AI) as dangers to their trade and are suspicious of the latest developments in AI. Professional translators will mostly be required to edit texts that have been machine-translated and teach AI to do so, according to the worry that artificial intelligence will transform the nature of the translation profession.

AI is indeed altering the way we do our work as translators, so in a way, this anxiety is warranted. The interface that manages the submissions, peer review, revisions, and editing and production procedures involved in publishing a journal article incorporates AI technology, which has been included in the editorial workflow in numerous scientific journals. However,

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human translators or other AI tools frequently review translations produced by machines. It has been demonstrated that this improves the editing process. Additionally, a lot of us already utilize tools like GPT-4 to double-check our translations and Grammarly and PaperPal to check our grammar[10]. It is feared that with all the new technological advancements, the creativity that translation and linguistic abilities require would be lost. Examining the AI tools, we use in our work and critically considering the hazards they may pose are essential in scholarly publishing, where neutrality is crucial.

AI's Inherent Linguistic Bias:

English, Spanish, Chinese, and French are examples of high-resource languages that tend to perform better in NMTs and other large language models (LLMs), which have a notable imbalance in their coverage of languages. Due to the fact that ChatGPT and other advanced LLMs are primarily made to function better in English than any other language, they nevertheless have imbalances [11]. Because of this disparity, translations or writings written in languages other than English will not be as accurate or culturally appropriate as they ought to be. Furthermore, while AI systems like GPT-4 appear to be capable of translating a large number of languages into English, they encounter difficulties when attempting to translate English into any other language, particularly ones with non-Latin alphabets like Korean. There is a long history of colonization that has led to English being prioritized as the lingua franca in the scientific community. The bias in the AI tech industry makes sense, thus it's not surprising that the majority of NMTs and LLMs find it difficult to grasp the richness and context of non-English languages[12]. Numerous languages having a lesser online presence or spoken by smaller populations in under-represented locations are under-represented in the creation of NMTs and LLMs. According to critics, artificial intelligence (AI) could aid in the translation of widely used Western languages like English, Spanish, and French. However, for languages deemed "low-resource," such as Bengali, Swahili, isiXhosa, Tigrinya, Tamil, or Amharic, the same models and algorithms find it difficult to get the same results[13]. The prevalence of low-resource languages in developing nations with a history of colonization and oppression is not

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surprising. As a result, it is our duty as members of the scientific and academic publishing community to recognize these possible biases and take action to counter them. However, a paradigm shift in the field of professional translation has been sparked by the advancement of artificial intelligence. AI translation is being used by people, including professional translators. Research on whether AI software can translate different documents more accurately than human translators is lacking, though [14]. However, there is a need for translation in the field of scientific translation, and the complexity of these terms—particularly those that contain acronyms and abbreviations—may give rise to a subject of study. In order to identify potential answers to these issues and boost translation productivity and efficiency, this research looks into the difficulties and approaches associated with translating scientific texts using either human or artificial intelligence. Additionally, it attempts to assess the caliber of the translations generated and ascertain the degree of human-AI cooperation in translating scientific literature.

Studies Related to Scientific Translation

Scientific translation refers to the process of translating scientific texts, documents, and materials from one language to another. The texts may cover various scientific disciplines, such as medicine, biology, chemistry, physics, medicine, engineering, environmental sciences, and mathematics[15].

Al-Smadi conducted a study investigating the main problems encountered by translators in translating scientific texts from English into Arabic and revealed the main reasons behind these problems. A qualitative research design was applied, and the sample consisted of one scientific text translated by twenty BA students. The study revealed that translators faced problems such as word diction, preciseness, terminological consistency, word order agreement, tense and aspect, and passive structure. Moreover, the study showed that a lack of translators' experience in this domain, and the lack of awareness of the sensitivity of scientific texts are some of the most important reasons for these problems[16]. Along the same line, Nouri looked at and examined mistakes university-level Iraqi students make when translating a scientific text from English to Arabic[17]. 66 students from Al-Mustansiriyah University's Level 4 participated in the study. After the

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students completed translating a scientific text, the material was examined using a unique scoring system to highlight any issues with the translation. Because many of them relied on common dictionaries rather than specialized scientific dictionaries, the results demonstrated that students committed mistakes and had challenges when translating the text[18].

Challenges Associated with AI and Machine Translation[19]

*Quality vs. Cost Balancing Act:

Although the quality of Machine Translation (MT) has improved, there is still a trade-off between cost and quality. MT typically costs about $0.10 per word, while human translation costs $0.22. But when it comes to idiomatic idioms, cultural allusions, and complex language that needs human interpretation, machine translation quality still lags behind human translation.

*Potential for Bias:

The quality of the training data has a significant impact on how well AI and machine learning algorithms work. Biases may also be present in the translations produced if the data used is biased. When translating politically charged or sensitive material, this becomes a serious issue because poor translations might have dire consequences.

*Accessibility Challenges:

Machine translation can help remove language barriers, but if the translations are unclear or hard to understand, it may unintentionally create new ones. Machine translation can be particularly challenged by complex or technical language, which can result in translations that are difficult to follow or understand.

Machine translation will provide exciting employment prospects in the translation services industry.

AI and machine learning are making us reevaluate the function of human translators in the field. Even the greatest algorithms won't completely replace human translators, though. Instead, human translators are being called upon to fill new positions. Software is developing quickly, but it is still not yet able to produce entirely dependable results. Post-translation editors and proofreaders are therefore always needed. A business that wants to enhance its AI translations would require seasoned translators to go over

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a lot of translated material. Many industries, such as e-commerce, which depends on the production of large volumes of often updated information, have adopted machine translation[20].

There are other unexpected uses for AI translations, such as the legal industry, where machine learning and AI-assisted translations enable legal professionals to mine large datasets, making it easy to sort through thousands of case documents and supporting notes. While AI-assisted translations can expedite preliminary research, humans will always be a valuable resource in the translation and AI industries until artificial intelligence can produce flawless results.

Differences between human and machine translation[21]

To reach a global audience, translation is essential for any multinational business. Here's the problem, though: there are a lot of translation options. Either machine translation or human translation. These are the five ways that machine and human translation differ from one another.

1. Professional human translation works are translated from the source language to the target language by a professional translator, and machine translation translates content from one language to another with the help of a machine, with no human involvement.

2. Professional translators in human translation services are subject matter experts who have gained experience through years of translation work and have translation-related qualifications. Machine translations, on the other hand, make use of artificial intelligence (AI) and can be customized for specific industries[22].

3. Professional translators and linguists can translate about 2000 words per day, whereas machine translation, in the best-case scenario, can translate double the number of words and phrases. Speed is a crucial difference between human and machine translation[23].

Conclusion

Advanced AI technologies, particularly NMT models, have significantly enhanced the field of scientific translation. While they offer remarkable speed and scalability, challenges related to domain specificity, semantic accuracy, and ethical concerns persist. Human-AI collaboration remains essential to achieving high-quality translation outcomes. Continued research

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and development, focusing on domain adaptation, explainability, and hybrid approaches, will be vital in harnessing AI's full potential in scientific translation. The study emphasizes how artificial intelligence—in particular, neural machine translation—is leading this revolutionary trend. Improved comprehension of context, idioms, and subtleties has led to unprecedented levels of translation accuracy. According to the study, integrating human expertise significantly improves machine translation efficacy. Looking ahead, the development of multi-modal translation—which combines voice and visual recognition—offers encouraging prospects for more inclusive communication. The study acknowledges how crucial it is to address linguistic variety with contextually aware adaptive translation systems. The investigation of AI-driven translation, in summary, points to a future full of opportunities.

An infinite range of communication options is made possible by the combination of human ingenuity and AI accuracy, which helps to create a global society that can transcend linguistic barriers.

References:

1. F. Kong, "Application of artificial intelligence in modern art teaching," International Journal of Emerging Technologies in Learning (iJET), vol. 15, no. 13, p. 238, 2020.

2. X. Cao, Z. Li, and R. Zhang, "Analysis on academic benchmark design and teaching method improvement under artificial intelligence robot technology," International Journal of Emerging Technologies in Learning (iJET), vol. 16, no. 05, p. 58, 2021.

3. S. Nagi Alsubari, S. Deshmukh, A. Abdullah Alqarni, et al., "Data analytics for the identification of fake reviews using supervised learning," Computers, Materials & Continua, vol. 70, no. 2, pp. 3189–3204, 2022.

4. Vaswani, Ashish, et al. "Attention is All You Need." Advances in Neural Information Processing Systems 30 (2017): 5998-6008.

5. Kirov V, Malamin B. Are translators afraid of artificial intelligence? Societies. 2022;12:70. https://doi.org/10.3390/soc12020070 .

6. Specia, Lucia, et al. "Findings of the WMT 2020 Shared Tasks on Machine Translation." Proceedings of the Fifth Conference on Machine Translation (2020): 1-55.

7. Specia, Lucia, et al. "Findings of the WMT 2020 Shared Tasks on Machine Translation." Proceedings of the Fifth Conference on Machine Translation (2020): 1-55.

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8. Johnson, Melvin, et al. "Google's Multilingual Neural Machine Translation System: Enabling Zero-Shot Translation." Transactions of the Association for Computational Linguistics 5 (2017): 339-351

9. Yang, C. (2022). The Application of Artificial Intelligence in Translation Teaching. In Proceedings of the 4th International Conference on Intelligent Science and Technology, 56-60. https://doi.org/10.1145/3568923.3568933 .

10. Dave P. ChatGPT is cutting non-English languages out of the AI revolution. [accessed February 5, 2024]. Wired, 2023. https://www.wired.com/story/chatgpt-non-english-languages-ai-revolution/ .

11. Expert insights on the use of MT for low-resource languages. [accessed February 5, 2023]. MachineTranslation.com, 2023. https://www.machinetranslation.com/blog/mt-for-low-resource-languages .

12. S. Marzouk and S. Hansen-Schirra, "Evaluation of the impact of controlled language on neural machine translation compared to other MT architectures," Mach. Transl., vol. 33, nos. 1–2, pp. 179–203, Jun. 2019, doi: 10.1007/s10590-019-09233-w.

13. Nicholas G, Bhatia A. Lost in translation large language models in non-English content analysis. The Center for Democracy & Technology, 2023. https://doi.org/10.48550/arXiv.2306.07377 .

14. Diaz, M. (2023). How to use ChatGPT: Everything you need to know. Retrieved 25 Oct 2023 from https://www.zdnet.com/article/how-to-use-chatgpt/ This preprint research paper has not been peer-reviewed. Electronic copy available at: https://ssrn.com/abstract=4441379 Preprint not peer

15. Krein-Kuhle, M. (2005). Equivalence in Scientific and Technical Translation: A text in context-based study. Unpublished PhD thesis. Salford: Salford University.

16. Al-Smadi, H. M. (2022). Challenges in translating scientific texts: Problems and reasons. Journal of language teaching and research, 13(3), 550-560.DOI: https://doi.org/10.17507/jltr.1303.11

17.J. Yu and X. Ma, "English translation model based on intelligent recognition and deep learning," Wireless Commun. Mobile Comput., vol. 2022, pp. 1–9, Mar. 2022, doi: 10.1155/2022/3079775.

18. Nouri, A. A. (2011). Difficulties Faced by Translation Students in Translating Scientific Texts from English - into - Arabic. Diyala Journal for Human Science, (50), 437-554

19. D. Munkova, P. Hajek, M. Munk, and J. Skalka, "Evaluation of machine translation quality through the metrics of error rate and accuracy," Proc. Comput. Sci., vol. 171, pp. 1327–1336, Jan. 2020, doi: 10.1016/j.procs.2020.04.142.

20. L. Kong, "Artificial intelligence-based translation technology in translation teaching," Comput. Intell. Neurosci., vol. 2022, pp. 1–9, Jun. 2022, doi: 10.1155/2022/6016752.

21.M. Hasyim, F. Saleh, R. Yusuf, and A. Abbas, "Artificial intelligence: Machine translation accuracy in translating French–Indonesian culinary texts," Int. J. Adv. Comput. Sci. Appl., vol. 12, no. 3, pp. 186–191, 2021, doi: 10.2139/ssrn.3816594.

22. M. Hasyim, F. Saleh, R. Yusuf, and A. Abbas, "Artificial intelligence: Machine translation accuracy in translating French–Indonesian culinary texts," Int. J. Adv. Comput. Sci. Appl., vol. 12, no. 3, pp. 186–191, 2021, doi: 10.2139/ssrn.3816594.

23.M. Hasyim, A. Y. Latjuba, A. M. Akhmar, Kaharuddin, and N. J. Saleh, "Human–robots and Google translate: A case study of translation accuracy in translating French–Indonesian culinary texts," Turkish J. Comput. Math. Educ., vol. 12, no. 4, pp. 1194–1202, Apr. 2021.