Productivity Promotion Strategies for Collaborative Translation on Huge-Volume Technical Documents

Guiping Zhang zgp@ge-soft.com
Na Ye yena_1@126.com
Human Computer Intelligence Research Center, Shenyang Aerospace University, Shenyang, 110136, China
Fang Cai fangcai@berkeley.edu
Department of Statistics, UC Berkeley, Berkeley, 94704, U.S.
Chuang Wu wuchuang@ge-soft.com
Human Computer Intelligence Research Center, Shenyang Aerospace University, Shenyang, 110136, China
Xiangkui Sun sunxk@ge-soft.com
Jinfu Yuan yuanjf@ge-soft.com
Shenyang Global Envoy Software Co., Ltd., Shenyang, 110136, China
Dongfeng Cai caidf@vip.163.com
Human Computer Intelligence Research Center, Shenyang Aerospace University, Shenyang, 110136, China

Abstract

Automatic machine translation systems are seen unable to produce publishable quality translation, so various computer-assisted translation systems that emphasize human-machine cooperation have been proposed. However, translator collaboration technologies are underdeveloped, an area of great importance for large volume translation tasks. Ideally, all human translation knowledge is shared among translators in order to maximize productivity. In a knowledge engineering manner, our collaborative translation platform collects translation knowledge and actively pushes in real time. The mutual learning between translators and machine simultaneously builds the knowledge base and improves translators' proficiency. This paper introduces the collaboration strategies used in our platform that not only promote productivity but also ensure the translation quality. Comparative experiments by 36 professional translators prove the effectiveness of our collaboration strategies. A sounding result is that 22 professional translators completed a 97,000 page Chinese-English technical manual translation task within 42 months.

1. Introduction

With the advent of big-data era, the amount of technical documents (patents, standards, specifications, manuals) that need translation to different languages explosively increases. Huge-volume technical document translation suddenly became a bottleneck for the globalization of technology. Human translation is inefficient, whereas machine translation (MT) outputs are far from being satisfactory. Recently, the computer-assisted translation (CAT) technology aiming at improving the human translation productivity achieved great progress. The most popular two CAT modes are post-editing (PE) and interactive machine translation (IMT). For huge-volume technical document translation, however, the core issues are still unresolved.

Besides all the problems in traditional translation tasks, there are three additional challenges particular for huge-volume technical document translation tasks. First, high-volume means that the task requires many professional translators collaborating, so progress management and knowledge sharing technologies play essential roles and can fundamentally affect the overall speed. Second, when there is more than one translator, it is hard to enforce consistent word choices and consistent sentence structure within or across documents. Technical manual normally requires translation of at least publication level, where details like consistent word choice and sentence structure are required. Finally, technical documents require highly specialized knowledge during translation, like technical term knowledge and relevant technical reference knowledge. Without special design, the cost on terminology looking-up by itself will fail our task.

Attempting to deal with all these challenges, our collaborative machine translation platform/pipeline incorporates a new thought of the integration of knowledge management and machine translation, which centralizes on a user model. Section 3 and 4 describe the thinking, design and realization of the platform.

In the rest of this paper, we select several strategies adapted in our platform tackling two issues: speed and quality. Before starting translation, the high frequency terms and sentences are pre-translated to ensure the accuracy and consistency of important technical concept translations and reduce translation difficulty. During the process of collaborative translation, the reliability of each fragment in the reference translation is color-encoded according to the source of its reference material, so as to help the translators make decisions rapidly. The translations by other translators on the same or similar sentences are pushed in real time, enabling the whole team to share the results. The translators' progress ranking is displayed, informing them of the team progress knowledge and encouraging them to speed up. Automatic proofreading tool is provided to help translators quickly verify their translation. Synchronous quality checking is adopted to control the translation quality in time.

Comparative experiments in section 5 show that these strategies can effectively improve the translation productivity while maintaining high quality. With these strategies, 22 professional translators accomplished a 97,000 page technical manual translation task within 42 months (each translator worked for 19.4 months on average). The quality requirement is higher than publishable level.

2. Related Work

More than thirty years ago, Kay (1980) proposed the idea of integrating machine translation and other assistant tools into human translation work (finally published in 1997). And it is predicted that the enhancement of such a system will finally lead people to achieve the goal of machine translation. With the continuous progress of the technologies such as machine translation, information retrieval and knowledge management, human-machine synergetic translation has replaced the traditional human translation mode and evolved several new modes.

Translation memory (TM) is the language processing technology which is earliest adopted in the translation process. Up till now, many professional translators still work by retrieving translations of similar fragments in the TM base. With the rapid development of statistical machine translation (SMT) technology, performing post-editing on SMT output becomes a new translation mode. It has been proved that both TM and PE can improve the translation productivity and quality (Mandreoli et al., 2006; Garcia, 2011; Arenas, 2014). Another pilot translation mode is the interactive-predictive machine trans-lation (Barrachina et al., 2009;

Sanchis-Trilles et al., 2014), in which the human gives the longest correct prefix of the translation and the system accordingly performs new decoding. The above research mainly focuses on how to improve the translation performance of an individual translator.

In recent years, how to achieve highly efficient and high quality collaborative translation among multiple translators became a new interest. Some researchers studied the methods of having Internet users to perform crowdsourced translation (Zaidan and Callison-Burch, 2011; Yan et al., 2014), having community members to perform community post-editing on the user generated content (Mitchell et al., 2014), or having monolingual users cooperate to translate (Hu et al., 2010). These studies focus on non-professional translators or even non-bilingual users, and aim at making the quality of translation achieve comprehensible level or specialized level. But publishable-level translation task is still difficult to accomplish.

In terms of large-scale collaborative translation among professional translators, the most relevant work is that of Karamanis (2011). The localization practice in two Language Service Providers is thoroughly investigated. The translator team's activities of manually establishing terminology glossary (Esselink, 2003; Wittner and Goldschmidt, 2007), searching the TM, sending emails and constant messages, and talking with other team members to communicate and share translation results are introduced. In this paper, we further developed these spontaneous and naïve collaboration activities. Automatic analysis tools are used to fully mine the important terms and fragments in the whole translation task, allowing the platform to actively share the translation results and team progress in real time. Besides, the translation quality is controlled more timely through automatic proofreading and synchronous quality checking. These strategies help the translators to better understand the translation task, the team decisions and progresses, so that they can accomplish precise and consistent translation more rapidly.

3. Collaborative Translation Practice

3.1. Project Background

In 2010, we started a 97,000 page publication-level Chinese-English technical manual translation project. A project team consisting of a translating group, a quality checking group, a R&D group, and a technology storming group was formed.

The members of the translating team are all full-time professional translators. The members of the quality checking team are all full-time professional and experienced translators. They are paid by the amount of translations that meet the quality requirement. At the beginning, the R&D team mines the requirement and configures a series of systems and tools that support the translation. Then they continuously receive feedback from translators during the collaborative translation process, rapidly develop new functions and perform small scale trials. If a new function is satisfactory, then it will be applied in the platform.

We made system developers and translators sit next to each other, so that translators can keep communicating with the technicians and the technicians can watch the real translating scenario to improve the platform in time.

3.2. The Collaborative Translation Process

High-volume technical document translation is a well-known difficult task. Our approach is to break down large pieces of work into smaller, simplified and more manageable parts. On the basis of the collaborative translation platform, we built a translation pipeline consisting of 3 main stages: pre-translation analysis stage, translation stage and post-translation management stage. Before translation, deep and fragmented analysis is performed. During translation, multi-dimension knowledge view, multi-aspect translation collaboration, multi-channel knowledge pushing and multi-layer quality controlling are provided. After translation, fine-grained management is performed. In this way, the pipeline decomposes the difficulties in the source texts and refines the translation step by step, thus achieving the effect of mutual knowledge increment between human and machine. The overall collaborative translation process is illustrated in Figure 1.

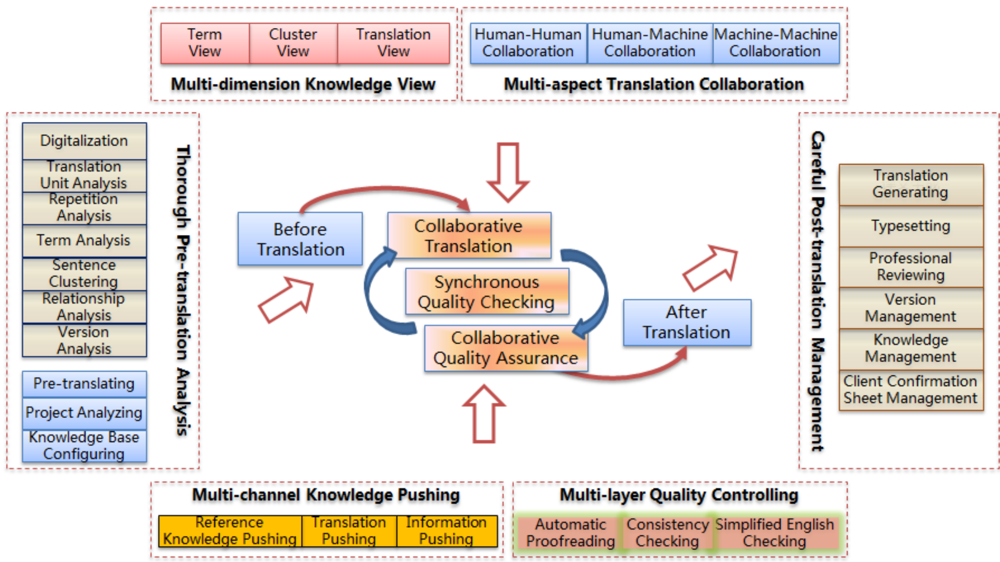

Figure 1. Overview of the collaborative translation process.

In the above figure, during the pre-translation stage, translation unit analysis is to split the source text in the manuals into basic translation units such as paragraphs and sentences. In this project, we take sentences as the basic units. Sentence clustering is to cluster sentences with similar contents. The clustering results are used for extracting translation templates and checking sentence-level consistency. In this project, sentences are clustered with a complete-linkage hierarchical clustering algorithm. Cosine distance is used to measure word-level similarity. Version analysis is designed to deal with the frequent changes in the document contents caused by the progress of technologies and the update of products. The differences among different versions are identified to avoid unnecessary repetitive work. Project analysis involves personnel recommendation, cost estimation and progress estimation.

During the translation stage, information pushing involves displaying the current translator's speed, his/her progress on the current document and all translators' progress ranking. Term view is for listing all the translation units that contain a certain term and their translations. It is designed for integrative viewing of the term translations. Clustering view is for listing all the similar translation units and their translations. It is designed for integrative viewing of the translations of similar units.

4. Platform Architecture

The work of this paper is based on a large collaborative translation platform. The platform includes six layers, namely knowledge layer, basic tool layer, interface layer, system layer, application layer and cloud service layer.

(1) The knowledge layer stores and manages the linguistic knowledge for translation such as terminology, bilingual sentences, rules and templates, process knowledge (e.g. translation history, quality checking errors and experience exchanges of translators) and domain knowledge (e.g. relevant technical references and term definitions).

(2) The basic tool layer provides the basic component set, including functional tools (such as data storage, network communication and data encryption), language analysis tools (such as lexical analysis, chunk analysis, parsing, text similarity computation and clustering), collaborative translation tools (such as machine translation, translation memory and translator activity recording) and knowledge management tools (such as knowledge collecting, accumulating, main-taining and sharing).

(3) The interface layer uniformly packages the tools of the previous layer. Popular network communication interfaces are provided and popular protocols such as HTTP, RESTful, SOAP and CMIS are supported to enable distributed management and concurrent access to the basic tools of the platform.

(4) The system layer provides all kinds of assistant systems for translators, including task management system, collaborative translation system, collaborative quality checking system, TM retrieval system, term management system and resource management system.

(5) The application layer configures the sys-tems according to the task requirement, and also realizes other applications such as translation data mining and pushing, enterprise-customized translation project management, translation skill teaching and crowdsourced translation.

(6) The cloud service layer makes use of the cloud computing and cloud security technologies to provide cloud-based translation service, online trading service and translator training service, finally achieving the goal of multiple translator collaboration under the cloud environment.

It is hard to describe every single technology used in our collaborative translation pipeline in one paper. In the next section, we will introduce several novel strategies for increasing translation productivity in the high-volume technical document translation context. As far as we believe, these strategies can be used in general large-scale translation situations. Of course, these strategies are far from being comprehensive. All the proposed strategies are implemented under the condition of ensuring quality. That is to say, if the translation cannot meet the quality requirement, then it will be returned to the translator for revision before it can be included in the productivity calculation.

5. Productivity Promotion Strategies

5.1. Pre-translating

Before starting translation, the technical terms in all the input documents are identified automatically. Since our practice is on a Chinese-English translation task, we trained a Conditional Random Fields (CRFs) model using 2000 manually labeled sentences for each domain to extract Chinese terms. The features are the context (word and part-of-speech) within a 3-word sized window. Experimental results on 568 documents show that the precision of Chinese term recognition is 75.06% and the recall is 79.30%. Then the frequencies of the terms in the whole translation task are counted and the terms are ranked according to the frequency. Table 1 gives some examples.

Term	Frequency
连接件(connector)	1559
制冷组件(cooling component)	1519
混合装置(mixing equipment)	1330
高压分离器(high pressure separator)	1220
…	…

Table 1: Examples of term analysis result.

The frequencies of the sentences in the whole task are also counted. The high frequency terms and sentences are considered to be important technical concepts and fragments. They are given to human experts to translate. And the corresponding fragments in the source texts are replaced with the decided translations. During the process of collaborative translation, any revision on these translations is prohibited.

To verify the influence of pre-translating on productivity, we divided 30 translators into two groups[1]. Each group has 3 teams, and each team has 5 members. A document of 10,000 characters is offered for translation. The teams in group A evenly split the document into 5 pieces and each member translates 2,000 characters. The high frequency terms/sentences are translated individually and review together after translation. The teams in group B perform pre-translating at first, and then evenly split the document for individual translation and review after translation. The average translation time and reviewing time are compared[2]. Table 2 shows the results (in minutes).

	Group A	Group B
Translation Time	241	282
Reviewing Time	182	70
Overall	423	352

Table 2: Comparative result of the pre-translating strategy.

It can be seen that the pre-translating of high frequency terms/sentences increased the translation time of group B, but greatly reduced the reviewing time. Therefore the overall time is less. For large scale translation tasks, pre-translating needs to be done only one time before starting translation, and will consequently save much more time. In terms of quality, pre-translating ensures that the translations of important concepts and fragments are highly consistent.

5.2. Translation Reliability Marking

In our human-machine interactive translation interface, a reference translation is provided for translators. Generally, a phrase translation model and a reordering model are both adopted in the phrase-based SMT systems. This brings about a mixture of phrase translation errors and reordering errors in the SMT output as illustrated in Figure 2.

[1] While dividing translators, we considered their translation capabilities and tried our best to divide evenly. Section 5.2-5.6 has the same consideration.

[2] When the translator needs to stop temporarily, he/she can click to stop the timing and click to continue when he/she starts again. Section 5.2-5.6 has the same setting.

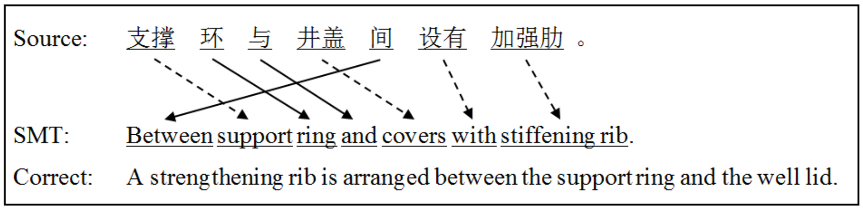

Figure 2. Mixed types of errors in the SMT output.

In the above example, it is relatively easy for the translators to judge and correct the phrase translation errors denoted with dashed lines. But the confusing reordering results of SMT may disturb the translators' train of thought. Discussions with 20 translators show that they need deeper analysis to identify reordering errors. And if the phrase alignment is labeled by arrows as in Figure 2, the reference translations will become too chaotic, especially for long sentences. Due to the above reasons, the reference translations are given in the monotone format as shown in Figure 3. The phrase translations are output in their original order as in the source sentence.

支撑	环	与	井盖	间	设有	加强肋	。
Support	ring	and	covers	between	with	stiffening rib	.

Figure 3. Example of monotone reference translation.

The phrase translations are marked with different colors to indicate their reliabilities. Figure 4 gives an example.

包括	机架	，	以及	固定在	机架	上的	传动装置	，
Involves	frame	,	as is also	is fixed to	frame	upper	gearing device	,

该	传动装置	带动	刀盘	座	转动	，
the	gearing device	is driven by	cutter head	seat	rotation	,

Figure 4. Example of translation reliability marking.

Purple font indicates that the translation comes from relevant reference X. Blue font indicates that the translation comes from relevant reference Y. Green font indicates that this is a translation used by other translators[3]. Orange font indicates this is a machine translation result.

Marking translation reliability can influence the translation productivity. We prepared a document of 1,000 characters and divided the translators into two groups, 18 in each group. Every translator is asked to translate the whole document. The reference translations in the interaction windows of group B are marked with reliability color.

Experimental results show that the average translation time of group A is 125 minutes, and that of group B is 111 minutes. The reliability color helps the translators to know the

[3] During post-editing, when a translator needs to revise the current translation of a phrase, he/she can right-click it, then a menu containing other options will pop up and he/she can left-click the correct one to accept it. These activities are recorded by the platform. And the option with the highest frequency of being left-clicked is displayed in the next time.

sources or reasons for the reference translations and make decisions easier, thereby increased the productivity.

5.3. Translation Pushing

After a translator completes a sentence, his/her translation is pushed to the same sentences waiting for translation in the whole task (directly replaced in the translation task window and labeled with its original translator) in real time to avoid translating the same content. Translation pushing includes two types. One is complete matched pushing (for exactly the same sentences), the other is fuzzy matched pushing (for the sentences with minor differences such as letters and digitals). In the latter type, the different parts are automatically revised. For example, when a translator completes the sentence "工作状态" (Operating Condition), all the sentences "CPU工作状态" in the remaining tasks will be automatically replaced with "CPU Operating Condition". After that, when the other translators face the pushed translation, he/she can accept it or revise it according to the context. If a translator finds that the pushed translation is wrong or problematic, then he/she can also tell its original translator or discuss with him/her to find out the best decision.

We prepared a document of 1,000 characters containing repetitive and similar sentences and divided the translators into two groups (18 in each). Every translator is asked to translate the whole document. Group B is provided with the translation pushing function.

Experimental results show that the average translation time of group A is 141 minutes, while that of group B is 111 minutes. The speed of group B is 1.27 times as fast as group A. For the technical documents with strongly related content, translation pushing can solve the translation of many sentences, improve the consistency and help the translators to make decisions. Meanwhile, because the results from other translators can be seen, this strategy also partly realizes collaborative quality checking among translators.

5.4. Progress Ranking

In this strategy, the real-time translation progress ranking of translators are displayed above the interaction window, including the translators who translate the most and the second most in the current month and the translators who translate the most and the second most in the current week.

We give the same set of documents to two translator groups. Each group has 18 translators. The members of group B can see the ranking in real time. The translators' performance in a week (5 workdays) is observed. Table 3 gives the average speed (character per day) of each day.

	Group A	Group B	Improvement
Day 1	560.2	560.7	0.09%
Day 2	550.8	555.9	0.93%
Day 3	576.6	586.4	1.70%
Day 4	556.9	571.1	2.55%
Day 5	547.8	555.4	1.39%
Average	558.5	565.9	1.32%

Table 3: Comparative result of the progress ranking strategy.

Experimental results show that the average speed of group B is 1.32% higher than that of group A. Displaying the fastest translators can inform the translators of the team progress and every one tends to try his/her best to catch up with the others' progress.

5.5. Synchronous Quality Checking

In the traditional translation process, the quality checkers usually start working until the translators finishes their tasks. In contrast, the process of synchronous quality checking is having the quality checkers and translators work at the same time. When the translators start working, the quality checkers can immediately see the results and perform checking.

We prepared a document of 1,000 characters containing repetitive and similar sentences and divided the translators into two groups. Each group has 9 teams, and each team has 2 members (one translator and one quality checker). Group A follows the traditional process of checking after translation, and group B adopts synchronous quality checking.

Experimental results show that the average translation time of group A is 175 minutes, and that of group B is 119 minutes. The speed of group B is 1.47 times as fast as group A. The reason for the obvious improvement is due to two aspects. First, in this way the traditional sequential working process is transformed into parallel working. Second, the translators can get to know their mistakes as early as possible and solve them, therefore the translation quality and speed afterwards are ensured.

5.6. Automatic Proofreading

When a translator completes the current translation unit, an automatic proofreading tool works to check the frequently appeared grammatical mistakes in the translation, including capitalizations, articles, punctuations, missed translation, spelling errors and some usages prohibited by the specification of the task. Whenever a mistake is detected, the tool labels the corresponding part to alert the translator. Mistake detection is implemented by a rule-matching strategy, in which rules are written manually in the form of regular expressions.

We give the same set of documents to two groups of A and B. Each group has 18 translators. The members of group B are provided with the proofreading tool. The translators' performance in a week (5 workdays) is observed. Table 4 gives the average speed (character per day) of each day.

	Group A	Group B	Improvement
Day 1	971.4	985.2	1.42%
Day 2	950.1	990.1	4.21%
Day 3	975.2	1032.4	5.87%
Day 4	956.3	1025.3	7.22%
Day 5	950.7	1022.7	7.57%
Average	960.7	1011.1	5.25%

Table 4: Comparative result of the automatic proofreading strategy.

Experimental results show that the average speed of group B is 5.25% higher than that of group A. With the increase of time, the difference in speed increases continuously. Through talking with the translators, we find that after adding the automatic proofreading function, once the system doesn't find mistakes, the translator will submit his/her translation confidently, thus improving the productivity.

5.7. Results and Analysis

Through 42 months collaborative work among 22 translators, this huge-volume technical document translation task was accomplished. Each translator worked for 19.4 months on average. During this time, more than 20 translation specifications are established, covering all aspects of the project from pre-translation analysis to post-translation management, from collaborative translation to collaborative quality assurance. Several million knowledge entries including bilingual sentence pairs, translation process logs, technical terms, proofreading knowledge, reference knowledge are accumulated.

The six strategies described in this paper played an important role in the accomplishment of the project. They realized the dynamic accumulation, real-time transformation and simultaneous increment of knowledge during the process of collaborative translation. Using this collaborative translation platform, the overall translation productivity increased by more than one time on this project.

In the stage of pre-analysis, the translation task is deeply understood as a whole. In the process of collaborative translation, the platform continuously accumulates the translation results of the whole team, and provides the translators with the newest translation knowledge, translation decisions, and the team progress knowledge in different ways with a fine-grained manner in real time, so that the translators can rapidly make the decisions. At the same time, the inner knowledge structure of the platform is also continuously optimized. The human and the machine make the most of their advantages and learn from each other to make common progress. With the increase of the collaborative translation time, the knowledge scale and the translation ability of both the translators and the platform are improved constantly.

6. Conclusion and Future Work

The translation of huge-volume technical documents is a task that requires multiple professional translators to collaborate. How to fully increase the productivity while maintaining high quality is a crucial problem. This paper proposed several strategies used in our translation pipeline to promote productivity, helping 22 professional translators to accomplish a 97,000 page Chinese-English publishable technical manual translation within 42 months. This paper also gave some clues to the translators' psychological activities and processes during collaborative translation, which help people to deepen the understanding of cognitive translation activity and psychology.

In the future, we will make use of the large amount of translation knowledge and quality checking knowledge to conduct collaborative translation on the same type of manuals. We will also study the assistant compilation technology of the same type of manuals, and the interactive interface customization technology for translators with different levels and different characteristics.

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