Translation of the Light Verb Constructions in Japanese-Chinese Machine Translation

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Abstract. We study the light verb constructions in Japanese, the constructions of expressions with light verb "suru". Such factors as numerous semantic variants and the syntactic complexity of corresponding Chinese expressions of LVCs put great difficulties in the Japanese-Chinese translation, so current commercially available Japanese-Chinese translation softwares give bad results for LVCs translation. We systematically analyze and describe the phenomena and propose translation rules for the conversion of Japanese LVCs into Chinese. we conducted manual experiments using 200 sentences to evaluate these rules and achieved a translation accuracy of over 80%. We also introduce jaw, a pattern-based translation engine, which can be applied to any target language. We implemented our translation rules for LVCs in the Chinese version, jaw/Chinese and verified their applicability in real MT system by experiments using 100 sentences. Evaluations both by hand and by the machine indicate that it provides high performance and utility.

1 Introduction

In order to examine light verb constructions we must first consider the nature of light verbs. The term "light verb" first occurs in Jespersen [1] and Cattell [2].A light verb is a verb (usually a frequent verb with a very general meaning) which, when combined with certain complements, loses some of its normal semantics: such usages are said to be *semantically bleached*[3].Light verb constructions (hereafter LVCs) is a multiword expression that combines a light verb with a complement of noun, adjective, preposition or verb etc. [4].Light verbs are a cross-linguistic phenomenon, and are found in languages such as Persian, Japanese, and Chinese [5][6].In English the most usual light verbs are "make" "do" "take" "have" and "give" as in such LVCs as "have a look" "take a rest" "do a play" "give a hug" and "make a telephone call". In Grimshaw and Mester[7], the Japanese verb *suru* 'do' is analyzed as a light verb. Like the English light verbs, *suru* is assumed to be thematically "light" or incomplete for the contribution to the meaning of verb phrases. We found many studies about the Japanese LVCs (e.g., [8][9][10][11]). These studies discuss Japanese LVCs from various viewpoints and also define different scopes for Japanese LVCs. In this paper we use the terminology "LVC" in the broadest sense: A construction is a LVC if the light verb *suru* is involved in. It maybe questionable whether some sort of constructions we consider here can still be called light verb constructions, but we also investigate such sort of constructions for the sake of completeness.

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The linguistic importance and cross linguistic frequency of LVCs is well attested (e.g., [6]). LVCs have a high frequency of occurrence across many diverse languages and have particular properties so that draw special attention within linguistic and computational analysis researchers to explore them in great details (e.g., [3][8][12]). However the study of the LVCs in machine translation field has been, in comparison, largely overlooked. Few researchers have discussed LVCs from the viewpoint of machine translation ,and as yet there have been no studies on machine translation of Japanese LVCs into Chinese.

Although Japanese and Chinese both use Chinese characters, they belong to different language families. Chinese is an isolating language without inflexion and is typologically classified as SVO language, while Japanese is an agglutinative language with a basic SOV sentence order. In the study of Japanese-Chinese machine translation, one of the most difficult problems we have encountered so far is the translation of Japanese LVCs. Because of the high occurrence frequency of LVCs (nearly 30% sentences including LVCs in the investigating materials), the quality of its translation has a great impact on the overall Japanese-Chinese MT system. It is very necessary and important to make full analysis of it. Given the diversity and the complexity of Japanese LVCs, in Japanese-Chinese translation, they can be rendered as various parts of speech and different sentence patterns. However, current commercially available translation soft wares do not have a sufficiently deep analysis of these translation ambiguities and many mistranslations occur in areas such as word selection and word order determination.

In this paper, we study the usage of Japanese LVCs, analyze complicated correspondences with Chinese and discuss the application of this analysis to the MT system. We proposed translation rules for them, made manual experiments to evaluate the validity of the rules and conducted tests by the machine to certify the applicability of the rules in real MT system.

2 The Translation of Japanese LVCs into Chinese

In this section, we investigate the semantic usage of Japanese LVCs. We analyze and describe systematically the phenomena and propose a method for disambiguating the meaning of LVCs in Japanese-Chinese machine translation.

2.1 Diverse usage of LVCs in Japanese,

There are a lot of sentences containing LVCs in Japanese. We conducted a statistical investigation over 154,958 Japanese sentences in Japanese-English parallel corpus [13], extracted the sentences containing LVCs and found 48,753 sentences containing LVC (nearly 31.5%). Among these 48,753 sentences, 38,977 sentences contain LVCs with some particle such *as* "*o*" "*ga*" "*ni*" "*to*" etc. directly before the light verb "*suru"* (type1)*,* while 11,103 sentences contain LVCs in which light verb *"suru"* (type2) is used directly in combination with a noun (so-called verbal noun) in order to convert it to a verb, or is used to verbify other parts of speech, such as adjectives, verbal adjectives and adverbs.

The corresponding Chinese expressions are also diversified: LVCs can be translated into parts of speech such as verbs, adverbs, and conjunctions, as well as causative sentences, passive sentences, and so on. The following sentences are examples of the diverse correspondence between Japanese and Chinese expressions.

[1] Although it is said that the light verb *suru* is of little semantic content in Japanese, it seems clear that light verbs can contribute different elements of their semantics to different LVCs. While translated into Chinese, it needs a variety of Chinese verbs in order to deliver the correct meanings for different LVCs. For instrances:

1. Japanese: Manngo wa don na iro wo site imasuka?
   Chinese: Mangguo shi shenme yanse de? (What color is the mango?)
2. Japanese: Samuke ga suru. Kaze wo hiita kamosirenai.
   Chinese: Ganjue faleng,yexu ganmao le. (I feel cold. I may have caught a cold.)
3. Japanese:Kono honn wa sen en suru.
   Chinese: Zhe ben shu zhi 1000 riyuan. (This book is worth 1000 yen.)

[2] LVCs in Japanese are also more productive and syntactically-flexible expressions, and correspond to not only predicate but also various parts of speech in Chinese.

4. Japanese:Dekakeyou to suru to, okyaku san ga kita.
   Chinese:Zhengyaochumen, kere laile. (adverb)
   (I was about to go out when a visitor arrived.)
5. Japanese:Ano toki hajimeteita to suru to imagoro wa mou owatteitadesyou.
   Chinese:Ruguo nage shihou kaishi, xianzai yijing jieshu le ba. (Conjunction)
   (If it began at that time, it should be finished now.)

[3] It can also correspond to different Chinese sentence patterns.

6. Japanese: Sinamono wo kane ni suru. (To change goods into money.)
   Chinese:Ba dongxi biancheng qian. ([ba] sentence)
7. Japanese:Noyama kun wo watasitati no daihyou ni suru.
   Chinese:Rang yeshanjun zuo women de daibiao. (causative sentence)
   (Let's make Noyama our representative.)

These examples of the diversified correspondence between Japanese and Chinese demonstrate the necessity of developing a method for translating LVCs in Japanese-Chinese machine translation.

2.2 Solutions and Translation Rules for LVCs

Given the diversity and the complexity of Japanese LVCs, we try to find method to propose translation rules of LVCs for Japanese-Chinese MT. We extracted 1000 sentences containing the LVCs as investigating materials from154, 958 Japanese sentences in a Japanese-English parallel corpus [13]. We extracted the LVCs from the investigating materials and manually translated them. Based on the examination of these example sentences, we found the Japanese LVCs are roughly employing the following six structures:

(1) (NP+LV) structure: the combination of nominal or noun phrase (NP) with LV
(2)(VP+LV) structure: the combination of verb phrase (VP) with LV
(3)(VN+LV) structure: the combination of verbal noun (VN) with LV
(4)(ADJ+LV) structure: the combination of adjective (ADJ) with LV

(5)(ADV+LV) structure: the combination of adverb (ADV) with LV
(6)(ONO+LV) structure: the combination of Onomatopoeia (ONO) with LV

Furthermore we make a summary for the semantic classification of LVCs according to their corresponding Chinese expressions. Table 1 shows part of semantic classification of for (NP+LV) structure and (VP+LV) structure.

Table 1. Semantic classification of LVCs (partial)

Structure type	Class ID	Semantic classification	Examples
NP+LV	1	Have a feeling of Experience with the senses (sound, color…)	寒気がする. 自動車の音がする. I feel cold. The sound of the car is heard.
NP+LV	2	Have (a characteristic)	英子さんは長い足をしている。 Eiko has long legs.
NP+LV	3	Engage [be engaged] in Act [officiate, serve] as	彼は以前校長先生をしていた. He used to be a principal.
NP+LV	4	Change [turn into, convert]	母は端切れをベッドカバーにしてしまった My mother made pieces of cloth into a bedspread.
NP+LV	5	Decide to do Make it a rule	わたしは定食にします I decided to order the table d'hote.
NP+LV	6	The passing of time	あれから2か月して赤ん坊が生まれました。 2 months later, the baby was born.
NP+LV	7	Judging from	標準からするとまだまだ足りない Judging from the standard, it is still insufficient.
NP+LV	8	For	この二,三日は冬にしては暖かすぎる It is too warm on these several days for winter.
VP+LV	9	Try; attempt	歩けもしないうちから走ろうとするな Do not try to run while you cannot walk.
VP+LV	10	Be about to do; be on the point of doing	出かけようとすると,お客さんがきた I was about to go out and the guest came.
VP+LV	11	If, to be supposed to	あの時始めていたとするともう終わっていたでしょう If it began at that time, it should be finished now
VP+LV	12	Though	あるとしても,ごくわずかだ Although there are some, it is tiny
VP+LV	13	No sense, representing inflectional information	彼らは飲んだり食べたりして楽しく遊んだ。 They had a good time eating and drinking.

As we know that most of the meaning of a LVC comes from the complement of the construction, based on the semantic classification, we dug into each structure and proposed the translation rules suitable for different structures.

[1] The Translation of (NP+LV) Structure:

Since the basic characteristics of (NP+LV) constructions are to a large extent determined by those of the NP themselves, in order to characterize (NP+LV) structure properly, it is necessary to characterize NPs into proper types. We typed the NP by the following two conditions:

①Particles：in Japanese, syntactic functions of phrases are indicated with various particles[8]. The particles involved in the LVCs with (NP+LV) structure are *o*, *ga,ni(to)* and *wa* which we assume to specify noun phrases as accusative(object), nominative(subject), dative(target) and topic respectively.

② type of the nominal: the semantics attributes of nouns involved in the NP

Taking into account the limitations of the possible Chinese combinations, we develop translation rules (see Table 2, we here express the translation rules in this format just for easily understanding, the real translation rules stored in the system are in the form as shown in the two examples of table 9 in section 4.2) which can be processed by *jaw/Chinese* (Section 3). In the following tables, N1, N2, N3… represent nouns and X represents a word or part of a sentence.

Table 2. Translation rules for (NP+LV) structure (Partial)

ID	class	Particles	Japanese Pattern	Conditions and attributions			Translation rules
				Attribution of N1	Attribution of N2	Attribution of N3	
(1)	1	ga+ suru	N1 ga N2 ga suru	subject	feeling		N1 感觉 N2
(2)	1	ga+ suru	N1 ha N2 ga suru	Noun, pronoun	stimulus		N1 有 N2
(3)	2	wo+suru	N1ga N2 wo suru	subject	shape/color /status		N1 是 N2 的
(4)	3	wo+suru	N1 ga N2 wo suru	Human being	job		N1 当/是 N2
(5)	4	ni+suru	N1 ga N2 wo N3 ni suru	Noun, pronoun	Descendant, offspring	occupation	N1 要把 N2 培养成为 N3
(6)	5	ni+suru	N1 ga VP koto ni suru。	Human being			N1 决定 X

[2] The Translation of (VP+LV) Structure:

We studied the (VP+LV) structures and found that the light verb *suru* is usually responsible for representing inflectional information: tense, causative, passive, politeness on speech level and negation and acts as the auxiliary verb. The corresponding Chinese for LVCs in this structure are mainly functions as the conjunctions and adverb. We considered a Japanese VP roughly composed of two sections: propositional content and function words after predicate (FWAP). We proposed the translation rules by judging the FWAP of the VP and light verb *suru* without taking the attributes of verbs into consideration (see Table3).

Table3. Translation rules for (NP+LV) structure (Partial)

class	ID	Conditions			Translation rules
		Japanese Pattern	FWAP Of VP	FWAP of LV	
9	(1)	N1 ga VP rou to suru	rou to		N1 试图 VP
10	(2)	N1 ga VP you to suru	you to		N1 正要 VP
11	(3)	VP to sitara, X	to	tara	如果 VP, 那么 X
11	(4)	VP to sidemo, X	to	demo	即使 VP, 也 X
13	(5)	VP1tari VP 2tari suru	tari		一边 VP1, 一边 VP2

[3] The Translation of (VN+LV) Structure:
In our system, we consider the [VN*suru*] as whole content word (key word) and summarize the rules for each [VN*suru*] respectively. Here we discuss about the [VN-o suru] structure. The basic construction is [N1 ga VN-o suru]. We Check whether VN in Chinese is a pure noun or not. If VN is a pure noun, we need to choose the proper Chinese verb for LV according to the semantic attributes of VN in Japanese. Some rules we proposed are shown in table 4.

Table4. Translation rules for (VN-o LV) structure for pure noun (Partial)

ID	Conditions and attributions				VN in Chinese	Translation rules
	Japanese Pattern	Attribution of N1	Attribution of N2	Attribution Of VN		
(1)	N1 *ga* N2 *to VN-o suru*	subject	Human being	conversation	Pure noun	N1 和 N2 进行 VN
(2)	N1 *ga* N2 ni/ *to VN-o suru*	subject	Human being	correspondence	Pure noun	N1 给 N2 打 VN
(3)	N1 *ga* N2 *to VN-o suru*	subject	noun	action	Pure noun	N1 和 N2 做 VN
(4)	N1 *ga* N2 *to VN-o suru*	subject	noun	sports	Pure noun	N1 和 N2 玩 VN

If VN is also a verbal noun in Chinese, then VN can directly be adopted as a verb. However, we have to pay attention to the treatment of modifiers of VN. We classify the modifiers into the following three types and propose the translation rules (table5).

Table 5. Translation rules for (VN-o LV) structure for verbal noun (Partial)

modifier tpyes	Examples	Conditions		Translation rules
		Japanese Pattern	VN in Chinese	
1.telic	Tokyo e no ryokoo o suru	N1 *ga* N2 e/ni no *VN-osuru*	Verbal noun	N1 去 N2 VN
2.Bipredicational	Eigo no bennkyoo o suru	N1 *ga* N2 no *VN-osuru*	Verbal noun	N1VN N2
3.adjective	Tanosii ryokoo o sita	N1 *ga* ADJ *VN-osuru*	Verbal noun	N1VN 得 ADJ

[4] The Translation of (ADJ+LV), (ADV+LV) and (ONO+LV) Structure:
The Construction of (ADJ+LV) is usually used to express the result of the action, while the Construction of (ADV+LV) and (ONO+LV) can express the static property of something or the action of someone or something, as well as the result of action. When expressing the static property and actions of someone or something, according to the semantic features of Chinese, the meaning of LV is completely bleached. We summarize the translation rules in table 6.

To avoid the overgeneralization of the rules for LVCs, We also summarize numbers of literal patterns based on a fixed word in combination with LV to express

Table 6. Translation rules for (ADJ+LV), (ADV+LV) and (ONO+LV) structures (Partial)

ID	semantics	Japanese Pattern	Translation rules	examples
(1)	Result of an action	N1 ga N2 wo ADJ suru	N1 使 N2 变得 ADJ	女性を美しくする
(2)	Result of an action	N1 ga N2 wo ADV/ONO ni suru	N1 把 N2 弄 得 ADV/ONO	家をぴかぴかにする
(3)	Static property or an action	N1 ga ADV/ONO (ni/ to) suru	N1 ADV/ONO	彼はいつものんびりしている。

the Chinese idioms or phrase:

e.g. (1) Pattern: N1 ga X(adjective) ki ga suru.
Chinese: N1 you X de xinqing (N1 is in a X mood).

e.g. (2) Pattern: N1 ga N2 wo mimi ni suru
Chinese: N1 tingshuo N2 (N1 hears N2).

When using these rules for translation, situations may arise in which more than one rule is matched. In this case, the optimal solution is selected according to the following conditions:

(1) The type and number of patterns used to compose the construction tree for the sentence.

According to the types of the pattern, Base type (section 4.2) takes priority than Addition types (section 4.2), and it gives priority to patterns that can compose the construction tree with less number.

(2) Types of limiting conditions.

There are there kinds of limiting conditions, the conditions of content word, the conditions of functional word and the fixed literal conditions. The strictness of each pattern is judged by these three conditions.

(3) The distance between semantic attributes in a thesaurus.

It gives priority to the one with short distance between the semantic attributes given in the pattern and the semantic attributes in the input sentence in a thesaurus.

2.3 The Comparison with Japanese -English Patterns

In this section, we made comparisons of the Japanese-Chinese translation patterns for LVCs mentioned in section 2 with the Japanese-English translation patterns listed in *Goi-Taikei--A Japanese Lexicon*[14](Table 7).

Table 7. The comparison of the number of translation patterns with Japanese-English

	The number of Japanese-English translation patterns	The number of Japanese-Chinese translation patterns
LVCs	319	92

The statistics shows that the number of Japanese-Chinese translation patterns is considerably less than the number of Japanese-English translation patterns. The difference can be analyzed as follows.

1. One Japanese-Chinese translation pattern corresponds to several Japanese-English translation patterns. We observed the following two points as the major reasons:

[1] The number of Japanese-English translation patterns with the structure [*N1 ga N2 wo N3 ni(to) suru*], in which N3 is the literal condition for the patterns, is more than half of the all. While in Chinese, there is a special sentence pattern called [ba] sentence which corresponds to most of the Japanese sentences with the structure [*N1 ga N2 wo N3 ni (to) suru*]. For example:

① Japanese: N1gaN2 wo hokori ni suru English: N1 be proud of N2

② Japanese: N1ga N2 wo urimono ni suru English: N1 feature N 2

③ Japanese: N1ga N2wo aite ni suru English: N1 make a companion of N 2

The Chinese translation for the above patterns is all [*N1 ba N2 dangzuo N3*].

[2] Compared with Chinese, preposition in English is more distinguishably used for different nouns. For example, due to the different prepositions, there are some Japanese-English patterns taking the structure of [*N1ga N2 woN3 no N4 ni(to) suru*] with N4 as the literal condition :

④Japanese: N1ga N2 woN3 no koujitu ni suru
English: N1 make N2 an excuse for N3

⑤Japanese: N1ga N2 wo N3 no mohann ni suru
English: N1makeN2 the example of N3

⑥Japanese: N1ga N2 wo N3 no mokuhyou to suru
English: N1aim at N2 as a target for N3

While for the translation to Chinese, the combination of the pattern ([N1*ga N2 woN3 ni (to) suru*]=>[*N1 ba N2 dangzuo N3*]) and pattern([*N1 no N2*] =>[*N1 de N2*]) can correspond to the above patterns([*N1 ba N2 dangzuo N3 de N4*]).

2. There is no corresponding Japanese-English translation pattern for certain Japanese-Chinese translation patterns. In this case it is because that Japanese-English translation patterns are not complete especially translation patterns for some sentence patterns or idioms. For instance,

⑦Japanese: N1 *kara suru to*X
English: From N1, X Chinese: *cong* N1*laikan* X

⑧Japanese: N1*ga* X(verb-equivalent words) *kao* (expression) wo suru
English: N1show the expression that X Chinese: N1 *louchu yifu* X *de biaoqing*

⑨Japanese: N1*ga ooki kao wo suru*
English: N1 be self-conceit Chinese : N1xiande liaobuqi/ N1baidajiazi

3 Outline of the *Jaw/Chinese* MT System

Jaw/Chinese is a machine translation system developed in our lab, which translates from Japanese to Chinese based on a pattern transfer paradigm. *Jaw* (from **J**apanese to **A**sian and **W**orld languages) is the translation engine, which is applicable to any target language.

Figure 1 shows a rough outline of *jaw*/*Chinese*, which contains three sub-processes: parsing a Japanese sentence, transferring it to a Chinese expression structure, and then generating a Chinese sentence.

First, a Japanese input sentence is morphologically and syntactically analyzed using *Ibuki*, a Japanese syntactical structure analysis system developed in our laboratory, and a dependency tree is constructed. Each node of the tree corresponds to one characteristic Japanese linguistic unit (*bunsetsu*), which is a phrase including one content word and any number of function words (or none). For example: *kowasarete simatta kamo siremasen ga* (however, (it) may have been destroyed) is one *bunsetsu*, composed of one content word (*kowasu*: destroy) and several function words (*reru*: be done to), (*tesimau*: have done), (*ta*: past), (*kamosiremasenn*: may be) and (*ga*: however). In this step, an Input Tree (IT) is created.

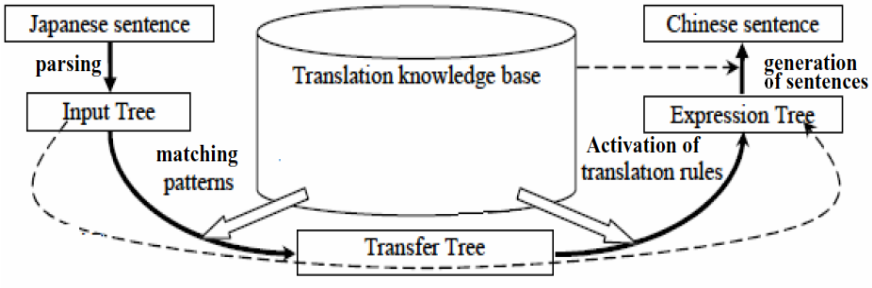

Fig. 1. outline of jaw/Chinese

Secondly, the input sentence (IT) is matched with the most similar expression pattern among those pre-stored in the transfer dictionary. Three types of transfer rule are employed for Japanese expression patterns: a base-type rule and two addition-type rules (see Section 4.2). This step creates a Transfer Tree (TT) with corresponding transfer rules. The rules for translating Japanese expression patterns to Chinese help to disambiguate correspondences in the translation. The conditions of Japanese patterns provide a way for disambiguation.

The translation rules are represented by C++ program stored as a dll file. The execution of this program creates a network of C++ objects, which represents the corresponding Chinese expression structure (Expression Tree, ET). The ET is an assembly of linguistic parts as members of C++ object used to express an input Japanese sentence in Chinese. Finally, execution of a linearization function on the ET places the members of the ET in a single line to give a Chinese output sentence with the correct sentence order. A linearization function is defined for each object as a C++ class method. We designed classes such as CProposition, CNoun, CQuantity, CpConnection, CAdverb, CModeC, and CModeJ for the Chinese ET.

4 Experiments and Evaluation

In order to verify and evaluate the translation rules for LVCs described in Section 2, a manual translation experiment was carried out; in addition, to verify that the translation rules are applicable in the real MT system, translation experiments were conducted using the *jaw/Chinese*.

4.1 Manual Experiments

We extracted 200(excluding the 1000 investigating sentences) Japanese sentences containing LVCs from a Japanese-English parallel corpus. Because the dictionary and the database of our machine translation system *jaw/Chinese* is still rather small, these sentences were first translated manually using our rules (translation A), and concurrently using commercially available MT software (translation B). We evaluated the translation results manually, focusing on the LVCs and judging for each individual sentence whether a suitable word for *LV* was used in the translation and whether the word was placed in the correct order. Each translated sentence was graded as follows:

○ = In terms of grammar, as accurate as natural Chinese translation.
△ = A little unnatural grammatically, but the overall meaning of the sentence is correct.
× = Incorrect both grammatically and in terms of overall meaning.

Evaluation of the results was carried out using two alternative criteria: (1) ○ is counted as a correct translation, and △ and × are incorrect translations and (2) ○ and △ are counted as correct translations, and × is incorrect. The results are shown in Table 8.

Table 8. Evaluation of manual experiments

	Evaluated	Correct (○)		Correct rate (○)		Correct (○ and △)		Correct rate (○ and △)	
		A	B	A	B	A	B	A	B
LVCs	200	166	82	83%	41%	168	102	84%	51%

(A: translation using our rules; B: translation by commercially available MT software)

From the results, we can conclude that our method is valid and could achieve a rather high accuracy, compared with commercially available MT software.

4.2 Experiments Using *Jaw/Chinese*

We also conducted experiments using *jaw/Chinese* to verify the correctness and the applicability of the translation rules mentioned in Section 2. To analyze Japanese sentence patterns, we designed a base-type rule and two addition-type rules, denoted as Base Type, AdditionCW Type, and AdditionFW Type, respectively. The base-type rule is a case-frame-based rule, and deals with the translation of basic propositional content. Addition-type rules deal with adverbial and conjunctional expressions; these may be optionally added to base-type expressions. Table 9 shows two examples of them (one example is for NP+LV structure and the other is for VP+LV structures)

Table 9 also shows the corresponding translation rules for Chinese. Classes, member classes, member names, values, and case markers are the stuffs to build a C++ program for the translation rules; The C++ program is automatically constructed with these stuffs. We developed a *Jaw*-editor to write the Japanese patterns and transfer rules. We implemented the translation rules proposed in section 2 into Jaw/Chinese by Jaw-editor. However, some rules which could not be described using

the *jaw*-editor were written in tables of function words after predicate (FWAP), which contain information about modality, tense, aspect, speech acts, adverbs and so on.

Table 9. Japanese expression patterns and translation rules for Chinese

(1-1) Example 1of Japanese pattern for base type

Bunsetsu number	Dependency Bunsetsu Number	Semantic conditions of Dependent Bunsetsu	Function word (particle)	Key-word	Semantic conditions of Key-word
1	4	Noun, pronoun	ga		
2	4	Descendant,offspring	wo		
3	4	occupation	ni		
4	0			suru	action

（1-2）The corresponding translation rules for Chinese of Example 1

PatternID	Rule type	Class	Member Name	Member Class	Value	role Name	case Marker
1114979	Base Type	CProposition	m_centerW	CString	要	target	把
			m_subject	CNoun	1		
			m_directobject	CNoun	2		
			m_clauseObject	CProposition			
			m_centerW	CString	培养成		
			m_directobject	CNoun	3		

(2-1) Example2 of Japanese pattern for AdditionFW type

Bunsetsu number	Dependency Bunsetsu Number	Conditions of Dependent Bunsetsu	Function word	Conditions of content word	Key word	conditions of dependency Bunsetsu
1	2	VP	to			
2	3			suru	to	
3	0					VP

（2-2）The corresponding translation rules for Chinese of Example2

PatternID	Rule type	Class	Member Name	Member Class	Value
5001006	Addition FW Type	CProposition	m_pConnection	CpConnection	
			m_pSubordinate	CProposition	1
			m_connectWord1	CString	如果
			m_connectPos1	CString	head
			m_connectWord2	CString	那么
			m_connectPos2	CString	Head

In this way, we implemented the translation rules in *jaw/Chinese*; next, we carried out closed and open tests using the system. Closed tests were conducted on 30 sentences containing LVCs; all of the translations results were correct. Open tests were carried out using 100 sentences, and the results are shown in Table10. Both of the test shows that the rules is applicable in real MT system and the method gave translation results with a high accuracy, compared with commercially available MT software.

Table10. Evaluation of *jaw/Chinese* open-test experiments

	Evaluated	Correct (○)		Correct rate (○)		Correct (○ and △)		Correct rate (○ and △)	
		A	B	A	B	A	B	A	B
LVCs	100	82	41	82%	41%	84	48	84%	48%

5 Conclusions

We discussed Japanese LVCs, analyzed their diversified correspondence with Chinese, proposed a translation method for these constructions, and implemented translation rules based on this method in our *jaw/Chinese* MT system. We conduct manual experiments using 200 sentences to verify the effectiveness of the rules and made experiments by machine *(jaw/Chinese)* using 100 sentences to verify the applicability of the rules in real MT system. Both of the experiments gave a high translation accuracy of over 80% and verified the high performance and effectiveness of our method.

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