Developing an Approach toward Automatic Error Detection in Learners' English Writing Based on the Source Language

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Abstract— **Automatic error detection systems for English writing have been improving since they were first introduced and are being applied to foreign language learning. However, these systems mainly focus on local errors, such as grammatical aspects in the target language and ignore the meaning intended in the source language. As a result, it is quite difficult to detect global errors using existing error detection systems. In this paper, we propose a new automatic error detection system to solve this problem. In order to determine whether the structure of an English sentence is in error or not, criteria for error determination must first be defined. Our system is based on the idea that criteria for error determination are created by the correspondence relation between Japanese and English using sentence patterns. In order to evaluate our system, by way of illustration, seven sentence patterns based on two grammar categories and four POS (part of speech) categories were selected. Automatic error detection using these seven sentence patterns was carried out on 100 Japanese sentences with subjects and their corresponding English sentences. As a result, we concluded that, using the sentence patterns in the source language, automatic error detection is effective when based on our criteria for error determination.**

Keywords-Error Detection; Sentence Pattern; Global Error; Parser; Source Language; Criteria for Error Determination.

I. INTRODUCTION

In this research paper we develop an approach toward automatic error detection in learners' English writing based on our previous work [1].

For English learners, writing is the most difficult skill to improve compared to speaking, reading and listening. "Writing abilities are not naturally acquired; they must be culturally (rather than biologically) transmitted in every generation, whether in school or in other assisting environments" [2]. Despite this linguistic feature, writing is not taught enough in schools relative to the other skills [3]. Possible reasons for this are curriculum guidelines based on the Grammar-Translation Method, and the burden on teachers [4]. Thus, a writing support tool for self-access is needed in order to heighten the writing skill without any assisting environment, and this will also lead to the cultivation of the learner's autonomy.

Meanwhile, for English teachers, writing is burdensome to teach as they must detect and grasp learners' errors one by one which is very time consuming. Generally, it is accepted that English essays written by learners with low proficiency contain a lot of errors. Of these errors, global errors negatively affect the structure of the whole sentence, and this limits the readers' comprehension. Therefore, it is necessary for teachers not to overlook such errors when proofreading an essay. However, in order to detect global errors, teachers would have to devote an inordinate amount of attention discovering all the potential structural errors. Thus, teachers have a tendency to overlook some structural errors due to time constraints. To reduce this burden on teachers, a writing support tool for structural error detection is needed.

II. TERMS AND RELATED WORK

In Section I, we stated the necessity of a writing support tool for automatic structural error detection. In this section, we are going to survey error and state the purpose of this study.

A. Terms of Error

There are two types of writing style based on the learner's proficiency; Japanese-English translation writing for beginner level learners (mainly for junior high school students and high school students) and free essay writing for advanced level learners (mainly for high school students and college students) [4].

Generally, detectable errors are influenced by the writing style. Errors related to the learner's passive knowledge should be detected by the Japanese-English translation writing. On the other hand, errors related to the learner's active knowledge should be detected by the free essay writing. Because of this, a writing support tool must be decided for each type of writing instruction. Thus, a writing support tool which can cope with both types of writing instruction would be conducive for English education.

In order to clarify the characteristics of errors made by Japanese English learners, scholars' research has focused on two approaches; detecting errors automatically [5]-[7] and detecting errors manually [8]-[10]. In this section we look at an example and examine how the latter type of research has been done.

In this study [9], learners' errors are classified into four categories; semantic error, logical error, pragmatic error, and grammatical error. Each category is further classified into either an error which actually hinders the comprehension of a sentence (global error), or an error which does not affect the comprehension of a sentence (local error). The author found that more than 70% of logical errors and pragmatic errors hinder comprehension, on the other hand, more than 60% of semantic errors and grammatical errors do not affect comprehension. This result indicates that it is difficult to detect logical errors and pragmatic errors automatically and suggests the importance of additional resources. Moreover, the ratio of error which hinders comprehension (global error) to total error is approximately 23%. Although this ratio is small, it is still significant. This shows that current automatic error detection is not suitable for detecting global errors. Thus, a writing support tool which targets global error is needed.

Global error includes a variety of errors such as semantic error, logical error, pragmatic error, grammatical error and so on. Thus, it is difficult to identify the error if we only have reference to the target language without any additional information. However, it is possible to identify the error if the source language is included which makes the source language (Japanese) indispensable for detecting global error.

B. Previous Research

As mentioned in the previous section, both students learning English and teachers teaching English are in a difficult situation. In order to address these pedagogical shortcomings, a number of writing support tools, especially automatic error detection systems using natural language processing technology are being used. They are being applied in foreign language learning classes to support students to acquire better writing skills and reduce the burden on teachers.

Automatic error detection systems perform excellently with single grammatical errors, such as spelling, article usage, subject-verb agreement, prepositions and aspect errors [11]-[14]. Scholars focus on article and preposition errors in particular, because these errors appear in ESL (English as a second language) learners' essays and account for 20-50% of all grammar errors [15]. Given this situation, few error detection systems look at structural errors which lead to global errors [16]. In addition, although deep learning has had a strong influence on the field of Natural Language Processing over the last few years [17, 18], the building of a deep learning model is still at the stage of inception and no deep learning system for education practices has yet been proposed. Thus, current automatic error detection systems are limited in that they do not cover all types of learners' errors. From an English education perspective, a support tool for structural error detection is needed.

Moreover, most of the systems now in use are designed to analyze the target language (English) only. This unilateral approach may cause a discrepancy between the system's automatic correction feedback and the learner's intention [19]. English learners, especially those with low proficiency, when confronted with difficulties, tend to apply a communication strategy which avoids complicated structures and phrases in order not to make errors in an English essay [20]. That is, they write what they can, not what they want. Consequently, English teachers can not recognize learners' errors as deviations from the source language (Japanese) since the errors do not surface. In order to overcome this problem, the target language as well as the source language should be an object of analysis.

Therefore, a new automatic error detection system which can easily identify structural errors, cope with various types of global errors, and recognize learners' intentions is needed.

C. Purpose

The purpose of this study is to propose just such a new automatic error detection system, one which can easily determine whether a sentence structure is correct or not by comparing the basic sentence elements (subject and predicate) of Japanese and English using parsers based on sentence patterns. In our previous study, six sentence patterns were established, and four sentence patterns selected from them were examined by way of illustration in order to evaluate our approach [1]. In this study, we are going to extend sentence patterns from six to nine including two grammar categories in order to enhance the versatility.

This approach is based on the results of our previous studies, which showed that "detecting English errors using sentence patterns is more promising than detection that depends on full sentences" [1] [21].

D. The Structure of this Paper

In Section III, we propose an approach for a new automatic error detection system that can determine whether an English sentence structure is in error or not. In Section IV, we automatically detect structural errors according to criteria for error determination created by the corresponding relation between Japanese (source language) and English (target language). We then evaluate the accuracy of criteria for error determination based on the seven sentence patterns for illustration. In Section V, we refer to the efficacy of our new automatic error detection system using sentence patterns in the source language and the target language, and its wider potential.

III. APPROACH

In Section II, we surveyed error and stated the purpose of this study. In this section, we are going to suggest a method suitable for detecting errors automatically and its procedure.

A. Procedure

In order to facilitate the detection of structural errors, we focus on the subject and predicate, two of the basic sentence elements, and compare them in the source language (Japanese) and the corresponding target language (English). To conduct the comparison, we classify a number of sentence patterns and create criteria for error determination: rules based on the correspondence relation between Japanese and English using sentence patterns. We compare the basic sentence elements (a primary subject and predicate) of the source language and the corresponding target language using parsers based on sentence patterns and criteria for error determination. This approach follows the procedure below.

1. Select Japanese sentences and corresponding English sentences written by Japanese English learners as analytical data.
2. Set up a Japanese parser, CaboCha and an English parser, the Stanford Parser.
3. Automatically extract sets of sentence elements, primary subjects and predicates (verb) by a parser based on specific extraction rules.
4. Automatically sort the sets of primary subjects and predicates (verb) based on preselected Japanese sentence patterns.
5. Compare the extracted sentence patterns with the defined sentence patterns based on the criteria for determination.
6. Obtain the results of error determination as feedback (ERROR, POSSIBLE, UNKNOWN).

In the above feedback, ERROR stands for "an outright error." POSSIBLE stands for "not an error, but may not be a correct answer." UNKNOWN stands for "indeterminable."

B. Sentence Elements

Although each Japanese and English sentence contains various elements, such as subjects, predicates (verbs), objects, complements, etc., this study examines the set of a primary subject and predicate (verb) only. This is because all major sentence patterns contain a subject and a predicate verb in academic writing [22]-[24]. Additionally, it is efficient for teachers to determine whether the learners' English is grammatically correct by checking sets of a primary subject and a predicate verb only. This will support teachers in detecting errors since learners' errors are not always clear, and teachers have difficulty determining where the problems lie.

C. Parsers and Extraction Rules

To extract sets of primary subjects and predicates from Japanese sentences, the parser, Japanese Dependency Structure Analyzer, CaboCha [25] was utilized. To extract sets of primary subjects and predicate verbs from the corresponding English sentences, the Stanford Parser [26] was utilized. Table I indicates details of both parsers and extraction rules of subjects and predicates (verb).

TABLE I. EXTRACTION RULES OF CABOCHA AND THE STANFORD PARSER

Parser		**CaboCha 0.69**	**The Stanford Parser 3.6.0**
Target Language		**Japanese**	**English**
Extraction Rule	Subject	A clause including a case particle "が (GA)" or a binding particle "は (WA)" or "も (MO)" which has a dependency structure with the predicate	A nominal subject or a clausal subject
	Predicate (Verb)	The last clause	A verb (transitive or intransitive) or a "be" verb + copula which has a dependency structure with the subject

*が (GA), は (WA), も (MO) are particles in Japanese grammar that immediately follow a noun, a verb, an adjective, and indicate the subject of a sentence.

In this study, the process of extracting a set of a primary subject and a predicate (verb) utilized CaboCha and the Stanford Parser as described in our previous study [27].

Figures 1 and 2 indicate a sample result of parsing by CaboCha and the Stanford Parser. For CaboCha, Japanese sentence "今日は良い天気です。(Kyou Wa Yoi Tenki Desu.)" is used as an illustration. ("今日は良い天気です。" is the same meaning as "It is fine today.") For the Stanford Parser, the English sentence "It is fine today." is used as an illustration. Hereinafter, in this study Romanization is used when a Japanese sentence appears.

In Figure 1, "chunk" stands for a Japanese phrase. CaboCha divides a Japanese sentence into several phrases, and indicates the dependency relation between the phrases. "chunk id" is a phrase number. "chunk link" has the same number as chunk id if a dependency relationship exists. "tok" stands for a morpheme. "tok id" is a morpheme number. "tok feature" is morpheme information such as part of speech, conjugation and so on. Extracting a set of a subject and a predicate (verb) of a Japanese sentence utilizing CaboCha follows the procedure below.

1. Parse the Japanese sentence "今日は良い天気です。(Kyou Wa Yoi Tenki Desu.)" to obtain its dependency structure information (Fig.1).
2. Extract the last chunk which is tagged with the biggest "chunk id" as the "predicate." In this case,

the "predicate" is "天気 (Tenki)" and "です (Desu)" since the biggest "chunk id" is "2."

3. Extract all chunks whose "chunk link" is the same number as the "chunk id" of the "predicate" of the possible "subject."
4. Select the "subject" from the chunk whose "tok feature" has the case particle "は (WA)," or the binding particle "が (GA)" or "も (MO)."

Example Sentence	JPN:	今日は良い天気です。
	ROM:	(Kyou Wa Yoi Tenki Desu.)
	ENG:	(It is fine today.)

```
<sentence>
<chunk id="0" link="2" rel="D" score="-1.137013" head="0"
func="1">
<tok id="0" feature="名詞,副詞可能,*,*,*,*,今日,キョウ,キョー">今日
</tok>
<tok id="1" feature="助詞,係助詞,*,*,*,*,は,ハ,ワ">は</tok>
</chunk>
<chunk id="1" link="2" rel="D" score="-1.137013" head="2"
func="2">
<tok id="2" feature="形容詞,自立,*,*,形容詞・アウオ段,基本形,良い,
ヨイ,ヨイ">良い</tok>
</chunk>
<chunk id="2" link="-1" rel="D" score="0.000000" head="3"
func="4">
<tok id="3" feature="名詞,一般,*,*,*,*,天気,テンキ,テンキ">天気
</tok>
<tok id="4" feature="助動詞,*,*,*,特殊・デス,基本形,です,デス,デス
">です</tok>
</chunk>
</sentence>
```

*JPN is an abbreviation of Japanese. ROM is an abbreviation of Romanization. ENG is an abbreviation of English.

Figure 1. Sample of Parsing Result by CaboCha

Example Sentence	ENG:	It is fine today.
	JPN:	(今日は良い天気です。)
	ROM:	(Kyou Wa Yoi Tenki Desu.)

```
((u'fine', u'JJ'), u'nsubj', (u'It', u'PRP'))
((u'fine', u'JJ'), u'cop', (u'is', u'VBZ'))
((u'fine', u'JJ'), u'nmod:tmod', (u'today', u'NN'))
```

Figure 2. Sample of Parsing Results by the Stanford Parser

In Figure 2, "nsubj" stands for nominal subject. "cop" stands for copula. Copula is a linking verb that connects a subject to its complement. Extracting a set of a subject and a predicate (verb) of an English sentence utilizing the Stanford Parser follows the procedure below.

1. Parse the English sentence "It is fine today." to obtain its dependency structure information (Fig.2).
2. Extract a phrase which is tagged with "nsubj" as the "subject." In this case, the "subject" is "It."
3. Extract the part of the "predicate" which has a dependency relationship with the "subject." In this case, the part of the "predicate" is "fine."
4. Extract the part of the "predicate" (fine) and the "copula" (is) which have a dependency relationship with the "subject" (It).

D. Sentence Patterns and Criteria for Determination

1. Grammar Points

There are six specific grammar points; 1. Tense (present / past), 2. Polarity (affirmative / negative), 3. Modal Auxiliary (ability), 4. be Verb (existence / state), 5. General Verb (thinking / cognitive), 6. Personal Pronoun (first person). These are selected on the basis of sentence patterns from two perspectives; technology and English education. Six grammar points were classified into two categories; A. Grammar Category (1, 2), B. Part of Speech (POS) Category (3, 4, 5, 6), and these two categories are independent of each other. Including a Grammar Category is a key feature of progress from our previous study [1]. As we explained in our previous study, the primacy of our research depends on the concept of using error detection to find grammar points based on unique characteristics of sentence structure. From the perspective of technology, we have found it possible to simplify and make error determination for all of these six grammar points.

From the perspective of English education, these six grammar points are indispensable and are part of a rudimentary knowledge of English. This is because all of these six grammar points are included in the official junior high school textbook (Table II). Thus, these grammar points are requisite knowledge for beginner level learners. Other than these grammar points, Polarity and Tense are especially important for beginner level learners to have a good command of English.

As for Grammar Category regarding Tense, Japanese is an agglutinative language, while English is an inflectional language. In Japanese, the tense is expressed by adding conjugation or an adverb. Thus, it is difficult for Japanese learners to have a good command of inflection. Regarding Polarity, there are three types of negative vocabulary (quasi-negation, partial negation, double negative) and various types of negative words (not, never, no, hardly, scarcely, rarely, seldom, few, little). Also, in terms of answering questions in English, the appropriate use of negative vocabulary depends on whether the person's question is positive or not. In Japanese the appropriate use of negative vocabulary does not depend on whether the person's question is positive or not.

Thus, it is difficult for Japanese learners to grasp the concept of English Polarity.

TABLE II. ENGLISH GRAMMAR LIST

7th Grade	8th Grade	9th Grade
Demonstrative Pronoun	**Past Tense (be verb)**	Passive Voice
be Verb (state)	Future Tense	Present Perfect
Negative	Modal Auxiliary	Sentence Pattern
General Verb	**be Verb (existence)**	Participle
Article	Gerund	Relative Pronoun
Plural Form	Infinitive	-
Personal Pronoun	Comparative degree	-
Third person Singular Present form "S"	-	-
Imperative Form	-	-
Interrogative	-	-
Progressive Form	-	-
Modal Auxiliary (ability)	-	-
Past Tense (general verb)	-	-

*This list is integrated from the six textbooks authorized by the Ministry of Education, Culture, Sports, Science and Technology.

TABLE III. FREQUENCY LIST BY BNC

	General Verb	Modal Auxiliary Verb	Pronoun
1	**know**	would	it
2	see	will	**I**
3	**think**	**can**	you
4	want	could	he
5	get	may	they

*BNC stands for "British National Corpus." Top 5 words in each POS.

As for the POS category, for native speakers of English, "think" and "know", "can" and "I" are very frequently used in each part of speech: general verb, modal auxiliary and pronoun (Table III). Thus, learners should be familiar with them because of their linguistical importance.

2. Sentence Pattern

We classified the following nine sentence patterns including six grammar points (Tables IV, V), because they are significant pedagogically and linguistically. The patterns were classified into two groups (predicate-based and subject-based).

TABLE IV. JAPANESE SENTENCE PATTERNS 1

Type			Predicate-Based Sentence Patterns
A	a	JPN	主語＋(ある / いる)
		ROM	Subject + (ARU / IRU)
	b	JPN	主語＋(ない / いない)
		ROM	Subject + (NAI / INAI)
	c	JPN	主語＋(あった / いた)
		ROM	Subject + (ATTA / ITA)
	d	JPN	主語＋(なかった / いなかった)
		ROM	Subject + (NAKATTA / INAKATTA)
B	a	JPN	主語＋名詞＋(です / である / だ)
		ROM	Subject + Noun + (DESU / DEARU / DA)
	b	JPN	主語＋名詞＋(でない / ではありません)
		ROM	Subject + Noun + (DENAI / DEWAARIMASEN)
	c	JPN	主語＋名詞＋(でした / であった / だった)
		ROM	Subject + Noun + (DESHITA / DEATTA / DATTA)
	d	JPN	主語＋名詞＋(でなかった / ではありませんでした)
		ROM	Subject + Noun + (DENAKATTA / DEWAARIMASENDESHITA)
C	a	JPN	主語＋形容詞＋(です /φ)
		ROM	Subject + Adjective + (DESU / φ)
	b	JPN	主語＋形容詞＋(ない / ではない)
		ROM	Subject + Adjective + (NAI / DEWANAI)
	c	JPN	主語＋形容詞＋た
		ROM	Subject + Adjective + TA
	d	JPN	主語＋形容詞＋(なかった / ではなかった)
		ROM	Subject + Adjective + (NAKATTA / DEWANAKATTA
D	a	JPN	主語＋(できる / できます)
		ROM	Subject + (DEKIRU / DEKIMASU)
	b	JPN	主語＋(できない / できません)
		ROM	Subject + (DEKINAI / DEKIMASEN)
	c	JPN	主語＋(できた / できました)
		ROM	Subject + (DEKITA / DEKIMASHITA)
	d	JPN	主語＋(できなかった/ できませんでした)
		ROM	Subject + (DEKINAKATTA / DEKIMASENDESHITA)
E	a	JPN	主語＋(思う / 考える)
		ROM	Subject + (OMOU / KANGAERU)
	b	JPN	主語＋(思わない / 考えない)
		ROM	Subject + (OMOWANAI / KANGAENAI)
	c	JPN	主語＋(思った / 考えた)
		ROM	Subject + (OMOTTA / KANGAETA)

	d	JPN ROM	主語＋(思わなかった / 考えなかった) Subject + (OMOWANAKATTA / KANGAENAKATTA)
F	a	JPN ROM	主語＋(知る / わかる) Subject + (SHIRU / WAKARU)
	b	JPN ROM	主語＋(知らない / わからない) Subject + (SHIRANAI / WAKARANAI)
	c	JPN ROM	主語＋(知った / わかった) Subject + (SHITTA / WAKATTA)
	d	JPN ROM	主語＋(知らなかった/ わからなかった) Subject + (SHIRANAKATTA / WAKARANAKATTA)
G	-	JPN ROM	主語＋述語動詞(存在動詞、思考動詞を除く) Subject + Predicate Verb (excluding Verbs which means existence and thinking)

*P-B is an acronym of "Predicate-Based." S-B is an acronym of "Subject-Based." "a" is present・affirmative. "b" is present・negative. "c" is past・affirmative, "d" is past・negative. Japanese sentence patterns

First, the predicate-based sentence pattern was sub-classified into seven sentence patterns: A) Subject + Verb (ARU / IRU), B) Subject + Noun + Auxiliary Verb (DESU / DEARU / DA), C) Subject + Adjective + Auxiliary Verb (DESU / φ), D) Subject + Auxiliary Verb (DEKIMASU / DEKIRU), E) Subject + Verb (OMOU / KANGAERU), F) Subject + Verb (SHIRU / WAKARU), G) Subject + Verb (excluding verbs which mean existence and thinking). In addition, each predicate-based sentence pattern has four sub-classifications which are combinations of Tense and Polarity; a) present・affirmative (pre_aff), b) present・negative (pre_neg), c) past・affirmative (past_aff), d) past・negative (past_ neg). Table IV indicates predicate-based sentence patterns. Not all Japanese sentence patterns are listed.

TABLE V. JAPANESE SENTENCE PATTERNS 2

Type		Subject-based Sentence Patterns
H	JPN ROM	～(する)こと＋(は / が / も)＋述語動詞 ~ (SURU) KOTO + (WA / GA / MO) + Predicate
I	JPN ROM	私＋(は / が / も)＋述語 WATASHI + (WA / GA / MO) + Predicate

Second, the subject-based sentence pattern was sub-classified into two sentence patterns: H) ~ (SURU) KOTO + (WA / GA / MO) + Predicate Verb (excluding an auxiliary verb), I) WATASHI + (WA / GA / MO) + Predicate Verb. Table V indicates these Japanese subject-based sentence patterns.

3. Criteria for Determination

The following is a supplementary explanation of each sentence pattern: A) ARU and IRU represent the "be" verb *existence*, B) DESU, DEARU and DA represent the "be" verb *state*, C) DESU also represents the "be" verb *state*, D) DEKIRU represents the modal auxiliary *ability*, E) OMOU and KANGAERU represent the general verb *thinking*, F) SHIRU and WAKARU represent the general verb *cognitive*, H) ~ (SURU) KOTO represents an inanimate subject, such as a formal subject, a gerund or an infinitive in English, I) WATASHI represents the personal pronoun "I". In Japanese verbs, the plain form is used.

TABLE VI. SENTENCE PATTERN AND ITS CRITERIA FOR ERROR DETERMINATION

S.P.	Type	Criteria for Error Determination
A	a	If predicate verb is not **{am, is, are, be, have, has, exist, exists}**, it should be ERROR.
	b	If predicate verb is not **{am not, is not, are not, be not, do not have, dose not have, do not exist, does not exist}**, it should be ERROR.
	c	If predicate verb is not **{was, were, had, existed}**, it should be ERROR.
	d	If predicate verb is not **{was not, were not, did not have, did not exist}**, it should be ERROR.
B	a	If predicate verb is not **{am, is, are, be}**, it should be ERROR.
	b	If predicate verb is not **{am not, is not, are not, be not}**, it should be ERROR.
	c	If predicate verb is not **{was, were}**, it should be ERROR.
	d	If predicate verb is not **{was not, were not}**, it should be ERROR.
C	a	If predicate verb is not **{am, is, are, be}**, it should be ERROR.
	b	If predicate verb is not **{am not, is not, are not, be not}**, it should be ERROR.
	c	If predicate verb is not **{was, were}**, it should be ERROR.
	d	If predicate verb is not **{was not, were not}**, it should be ERROR.
D	a	If predicate verb is not **{can V, be able to V, am able to V, is able to V, are able to V}**, it should be ERROR.
	b	If predicate verb is not **{can not V, cannot V, not be able to V, am not able to V, is not able to V, are not able to V}**, it should be ERROR.
	c	If predicate verb is not **{could V, was able to V, were able to V}**, it should be ERROR.

	d	If predicate verb is not **{could not V, was not able to V, were not able to}**, it should be ERROR.
E	a	If predicate verb is not **{think, believe, consider, guess, suppose, assume}**, it should be ERROR.
	b	If predicate verb is not **{does not think, do not think, does not believe, do not believe, does not consider, do not consider, does not guess, do not guess, does not suppose, do not suppose, does not assume, do not assume}**, it should be ERROR.
	c	If predicate verb is not **{thought, believed, considered, guessed, supposed, assumed}**, it should be ERROR.
	d	If predicate verb is not **{did not think, did not believe, did not consider, did not guess, did not suppose, did not assume}**, it should be ERROR.
F	a	If predicate verb is not **{know, get to know, understand, find, notice, realize, recognize}**, it should be ERROR.
	b	If predicate verb is not **{does not know, do not know, does not get to know, do not get to know, does not understand, do not understand, does not find, do not find, does not notice, do not notice, does not realize, do not realize, does not recognize, do not recognize}**, it should be ERROR.
	c	If predicate verb is not **{knew, got to know, understood, found, noticed, realized, recognized}**, it should be ERROR.
	d	If predicate verb is not **{did not know, did not get to know, did not understand, did not find, did not notice, did not realize, did not recognize}**, it should be ERROR.
G	-	If predicate verb does not meet semantic agreements, it should be ERROR
H	-	If subject is not **{it, to verb, verb-ing}**, it should be ERROR.
I	-	If subject is not **{I}**, it should be ERROR.

*S.P. is an acronym of "sentence pattern." The above highlighted sentence patterns are dealt with in this study as an illustration.

The predicate-based sentence pattern A) "Subject + Verb (ARU / IRU)" always corresponds with a "be" verb, "have" or "exist" in English. If they are missing, the English sentence would be in error. "B) Subject + Noun + Auxiliary Verb (DESU / DEARU / DA)" and "C) Subject + Adjective + Auxiliary Verb (DESU / ϕ)" always correspond with a "be" verb in English, without the "be" verb, the English sentence would be in error. Sentence pattern D) "Subject + Auxiliary Verb (DEKIMASU / DEKIRU)" always corresponds with "can" or "be able to" in English, without them, the English sentence would be in error. Sentence pattern E) "Subject + Verb (OMOU / KANGAERU)" always corresponds with "think," "believe," "consider," "guess," "suppose," "assume" in English, without a "thinking" verb, the English sentence would be in error. Sentence pattern F) "Subject + Verb (SHIRU / WAKARU)" always corresponds with "know," "understand," find," "notice," "realize," "recognize" in English, without a "cognitive" verb, the English sentence would be in error. Sentence pattern G) "Subject + Verb" is the most common, if semantic agreement in terms of predicate (verb) is missing, an error would occur.

The subject-based sentence pattern H) "~ (SURU) KOTO + (WA / GA / MO) + Predicate Verb" always corresponds with an inanimate subject, such as a formal subject, a gerund or an infinitive in English, without the inanimate subject, the English sentence would be in error. Sentence pattern I) "WATASHI + (WA / GA / MO) + Predicate Verb" is the most basic form, without the subject "I" in the English sentence, it would be in error.

Table VI above shows nine sentence patterns and their original criteria for determination whether a sentence is correct or not.

IV. Results And Discussion

In Section III we suggested a method suitable for detecting errors automatically and its procedure. In this section, we are first going to examine our method and then draw a conclusion.

In order to evaluate our approach, by way of illustration, automatic error detection using seven sentence patterns (A, B, C, D, E, F and I) was carried out on Japanese sentences with subjects and their corresponding English sentences.

This study utilized 1,499 sentences for analysis from essay data written by 110 Japanese EFL (English as a foreign language) college students. The proficiency level of all the learners was equivalent to the A1 level of the Common European Framework of Reference (CEFR). All the participants were required to write an essay in Japanese with the following prompts: "It is important for college students to have a part time job" and "Smoking should be completely banned at all the restaurants in the country." They then had to translate their Japanese essay into English. The essay had to be 200 - 300 words, written in under one hour, with no use of a dictionary or internet enabled devices.

For parsing, 100 Japanese sentences with subjects and the corresponding English sentences were randomly selected from essay data including grammatically correct sentences and incorrect sentences. As a result of parsing, 31sentences were analyzed by predicate-based sentence patterns, and also 10 sentences were analyzed by subject-based sentence patterns. Each of the sentences are classified based on sentence patterns.

TABLE VII. SAMPLE RESULTS OF EXTRACTION AND ERROR DETERMINATION

	Results of Extraction				Results of Error Determination			
	JPN		ENG		Type of S.P.		S.S.	
	Sub.	Pre.	Sub.	Pre.	Sub-based	Pre-based	Sub-based	Pre-based
1	理由は	においだ	reason	smell	UNKNOWN	B_aff_pre	UNKNOWN	POSSIBLE
2	ことも	あります	Family	go	H	A_aff_pre	UNKNOWN	ERROR
3	可能性も	ある	we	have	UNKNOWN	A_aff_pre	UNKNOWN	POSSIBLE
•	•	•	•	•	•	•	•	•
31	私も	思います	I	think	I	E_aff_pre	POSSIBLE	POSSIBLE

*Sub. is an abbreviation of "subject." Pre. is an abbreviation of "predicate." S.P. is an acronym of "sentence pattern." S.S. is an acronym of "sentence structure."

In order to obtain feedback, comparisons between Japanese primary subjects and predicates and the corresponding English primary subjects and predicate verbs were conducted based on the extraction by parser and sorted based on sentence pattern.

Table VII shows sample results of extraction and determination. This table provides feedback to teachers. The results of extraction (left side) show sets of Japanese subjects and predicates and corresponding sets of English subjects and predicate verbs. The results of error determination (right side) show the type of sentence pattern and feedback (ERROR, POSSIBLE, UNKNOWN). An explanation of feedback can be found in Section III. "ERROR" represents global error where the structure of a sentence is wrong. "POSSIBLE" represents that the structure of the sentence is correct in agreement only for the subject and predicate. "UNKNOWN" stands for indeterminable because no relevant sentence pattern is seen. Teachers will be able to find learners' grammatical weak points through the ERROR feedback in Table VII and then focus their attention on the sentence patterns during the course of classroom English education. In this way our system can support teachers of English writing. Although there are many "UNKNOWN"s in Table VII, the number of "ERROR" and "POSSIBLE" will allow teachers to efficiently detect where the problems lie and thus reduce their burden.

To better evaluate the results shown in Table VII, the aggregate results were calculated manually in order of sentence pattern as shown in Table VIII. This also shows the evaluation results of the accuracy of criteria for error detection for both predicate-based sentence patterns (A, B, C, D, E, F) and the subject-based sentence pattern (I). Manual determination follows these steps; 1) Manually extract sets of sentence elements, a primary subject and a predicate (verb) based on specific extraction rules, 2) Manually sort the sets of subjects and predicates (verbs) based on preselected Japanese sentence patterns, 3) Manually compare the extracted sentence patterns with the defined sentence patterns based on the criteria for determination, 4) Obtain the results of error determination. The numbers in Results of Manual Determination are errors identified by criteria for determination (Table VI).

TABLE VIII. EVALUATION RESULTS OF THE PREDICATE BASED SENTENCE PATTERNS AND THE SUBJECT BASED SENTENCE PATTERNS

			Results of Determination by Error Detection System			Results of Manual Determination
Type	S.P.		ER.	PO.	UN.	ER.
Predicate Based	A-a	8	2	6	0	1
	A-b	1	1	0	0	1
	A-c	0	-	-	-	-
	A-d	0	-	-	-	-
	B-a	13	1	12	0	1
	B-b	0	-	-	-	-
	B-c	0	-	-	-	-
	B-d	0	-	-	-	-
	C-a	0	-	-	-	-
	C-b	1	1	0	0	0
	C-c	0	-	-	-	-
	C-d	0	-	-	-	-
	D-a	0	-	-	-	-
	D-b	0	-	-	-	-
	D-c	0	-	-	-	-
	D-d	0	-	-	-	-
	E-a	7	0	7	0	0
	E-b	0	-	-	-	-
	E-c	0	-	-	-	-
	E-d	0	-	-	-	-
	F-a	0	-	-	-	-
	F-b	0	-	-	-	-
	F-c	1	0	1	0	0
	F-d	0	-	-	-	-
	Total	31	5	26	0	3
Subject Based	I	10	0	6	4	2
	Total	10	0	6	4	2

In the above table, ER. stands for "ERROR." PO. stands for "POSSIBLE." UN. stands for "UNKNOWN." (-) stands for "unanalyzed" due to non-applicability.

Comparing the results of determination by error detection system with the results of manual determination in Table VIII, we obtained the following:

Sentence Pattern A

Our system classified 9 sentences into sentence pattern A. All of them were subclassified into appropriate sentence patterns. Of these 9 sentences, 3 sentences were classified into ERROR, and 6 sentences were classified into POSSIBLE. Agreement between manual determination and automatic determination was found to be 8 out of 9. This indicates our system is highly reliable for the "be" verb *existence*. However, our system could not determine one sentence appropriately which had a negative phrase as a subject. On getting this result, we realized the importance of idiomatic expressions.

Sentence Pattern B

Our system classified 13 sentences into sentence pattern B. All of them were subclassified into appropriate sentence patterns. Of these 13 sentences, 1 sentence was classified into ERROR, and 12 sentences were classified into POSSIBLE. Agreement between manual determination and automatic determination was 100%. This indicates our system is highly reliable for the "be" verb *state*.

Sentence Pattern C

Our system classified 1 sentence into sentence pattern C. This sentence was subclassified into an inappropriate sentence pattern. Agreement between manual determination and automatic determination was 0 out of 1, because of a problem dealing with homonyms. It is possible to solve this by customizing homonym information into our system.

Sentence Pattern D

No sentence was found in this category.

Sentence Pattern E

Our system classified 7sentences into sentence pattern E. All of them were subclassified into an appropriate sentence pattern. All 7 sentences were classified into POSSIBLE. Agreement between manual determination and automatic determination was 100%. This indicates our system is highly reliable for the "thinking" verb.

Sentence Pattern F

Our system classified 1 sentence into sentence pattern F. This sentence was subclassified into an appropriate sentence pattern. This sentence was classified into POSSIBLE. Agreement between manual determination and automatic determination was 100%. This indicates our system should be reliable for the "cognitive" verb.

Sentence Pattern I

Our system classified 10 sentences into sentence pattern I. All 10 sentences were subclassified into an appropriate sentence pattern. Of these sentences, 6 sentences were classified into POSSIBLE, and 4 sentences were classified into UNKNOWN. Agreement between manual determination and automatic determination was 6 out of 10.

We still need to address a couple of issues; 1) deficiencies in sentence patterns, 2) deficiencies in the parser.

Concerning deficiencies in sentence patterns, for example, when the subject is a negative phrase, the system still has difficulty dealing with it, as in the sentence "Nothing is as good as part time job for learning society." With respect to Deficiencies in the parser, our system is tied to the results of the parser CaboCha. Since it is not 100% accurate, any deficiencies are reflected in our system.

Given the nature of these results, it will be possible to improve the deficiencies in the ability of the system to handle additional types of sentence patterns. However, it is not possible for us to improve on the deficiencies in the parser.

V. CONCLUSION

In this study, we proposed an approach toward an automatic error detection system. Our approach is based on the idea that criteria for error determination are constructed by the correspondence relation of the core sentence elements, a subject and a predicate verb, between the source language and the target language utilizing sentence patterns.

As a result of examining the accuracy of our criteria for error determination based on the seven sentence patterns chosen, we concluded that if we use sentence patterns in the source language, automatic error detection was effective when based on our criteria for error determination.

In addition, we assume our approach will be applied to other languages if it is possible to extract the set of a subject and predicate verb from the source language and the target language, as we do here. Arabic, Chinese, French, German and Spanish are suitable for our approach because the Stanford Parser supports these languages. However, Chinese, like Japanese, is not written with a space between words and therefore needs morphological analysis as a pretreatment before parsing.

We are working to handle sentences that have no subject, as well as sentences that have multiple subjects, and expand the number of sentence patterns in order to respond to as wide a range of English essays as possible. From the characteristics of our pattern-driven approach to structural error detection, the accuracy of error determination is influenced by the extraction rate of a subject and a predicate verb. Topic-prominent languages which allow subject optional sentences, such as Japanese, Chinese and Indonesian, will have a negative impact on the accuracy of error detection because it is impossible to extract a subject based on the ability of present parsers. Therefore, it will be necessary to create rules which can compensate for the omitted subjects.

Moreover, the ability of developing sentence patterns, unlike other language error detection systems, will enable the system to deal with various learners' global errors which is a key point of our approach.

ACKNOWLEDGEMENT

This work was partially supported by JSPS KAKENHI Grant Number JP17K01081.

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