A Multimedia Database Supports Intelligent English Distance Learning

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Abstract

This work presents a novel English distance learning system that was developed through multimedia database and Internet technologies called English multimedia corpus. The system includes English articles, dialogues, and videos. A student can study English writing and reading as well as view Web browser listings to connect the Corpus server. In the system, semantic query and “Link grammar” are applied to construct the English multimedia corpus system. Furthermore, it promotes the query level from keyword-base and content-based query to a semantic level. The main function of this system is to query the English sentence pattern through keywords from the English multimedia corpus. The other function is to detect grammatical errors in written English. Thus, the system not only teaches English grammar, but also, due to its database, allows teachers to understand the most frequent mistakes.

Keywords: Multimedia database, Link grammar, Distance learning, Linguistic corpus

1. Introduction

Traditional databases always store the character and numerical data. A primary function manages this basic data, for example, Students, School data, or Companies’ employee and financial data. Following computer-based technological advancements, multiple types of data, such as image, audio, video, and hypermedia documents, are applied to represent computer information. Thus, database technologies must support multimedia data, which is known as a multimedia database. It includes many facets, such as content-based retrieval [6,15], shape detection and object recognition [8,10]. Meanwhile, these technical aspects promote its numerous application domains. Many examples of distance learning, digital television, and distance medicine are implemented based on those techniques. This study presents an Internet-based English learning environment that applies multimedia database technologies.

Learning English is always a substantial difficulty for Chinese students. Some experts recommend that the best way to learn English is to establish a good study environment and practice it through several various approaches. This should make it a satisfying learning experience. Based on this viewpoint, teachers should provide students with a better environment to learn English. Distance learning based on Internet is one of the best solutions to create an English learning environment.

Currently, the highly distributed computing environment has been supported and applied popularly. Networking services should perform as tutoring tools. Numerous innovative approaches in this field have been investigated. Through implementing computer-mediated education, many advocates emphasize its positive aspects and English learning tutoring systems, which are computer-based, have been developed by numerous academic research groups [19-31].

Incidentally, students learning a foreign language through computing devices might encounter many difficulties. Some articles have discussed whether students’ frustrations inhibit their educational opportunity [20, 21, 23]. These frustrations were based on three interrelated sources: lack of prompt feedback, ambiguous Web instructions, and technical problems.

Hence, an easy-to-use English learning system was developed. The proposed system contains several preparations, which are relevant to English learning. While treating natural language processing, the system is constructed based on Link Grammar. However, in order to separate it from conventional approaches, modifications were included to improve its ability.

The proposed English-learning corpus stores mistakes that students make. That is, all errors that students will probably make on a particular question are determined in advance. Each type of mistake has correcting suggestions and error descriptions. Corpus can not only provide suggestions but it also records the mistakes that Chinese students might make in English. Another function of this Internet-based multimedia corpus is that a user can locate sample sentences patterns from movie scripts, live dialogues and textbook reading. Each sentence from live dialog and movie captions is parsed and analyzed by link grammar, which includes special tags. The end product is then stored within this proposed database system. Consequently, based on semantic retrieval, the system subscribes to query methodology.

In this paper, English sentence construction will be analyzed first. Notably, the sentence pattern is divided into nine classes. Secondly, each sentence pattern is parsed by link grammar, in which every pattern has a particular tag set. Consequently, the system constructs the query engine with these essential tag sets.

In general, similar learning systems store single sentences or vocabularies and facilitate query through keywords [19-22,24,25,27-31]. Semantic-based retrieval technologies are rarely used. This work discusses how to use the appended information, the special tag sets, which Link grammar generated to advance the query function from keyword-based to semantic-based.

Several web sites regarding learning corpus [19,20,21,22], and study several papers in addition to those that pertain to Link grammar [4,9,13,16] were surveyed. Furthermore, Schelenburg proposed realistic feedback processing [9], Brill developed machine learning and automatic linguistic analysis [12], and Chang presented automatic linguistic resolution: framework and applications [3]. Other similar systems are referenced [4,5,14,16,17].

In section 2, related works regarding Link grammar and XML are discussed. The system analysis for the proposed learning functions is introduced in section 3. Section 4 presents the architecture of the proposed system. Finally, section 5 contains the conclusion and discussions for future research.

2. Theoretical Backgrounds

Link grammar is an English grammar parser system that was proposed by The School of Computer Science of Carnegie Mellon University. The system is composed of Link Grammar compiler, Link Grammar tool, and Link Grammar distribution. The Link Grammar compiler is a graphical interface to create Link Grammar rules. It allows you to create rules that can be used to generate English sentences. The Link Grammar tool is a graphical interface to test Link Grammar rules. It allows you to test Link Grammar rules and see how they are used to generate English sentences. The Link Grammar distribution is a collection of Link Grammar rules that can be used to generate English sentences. The Link Grammar distribution contains rules for a variety of topics such as verbs, nouns, adjectives, adverbs, prepositions, and conjunctions.

3. System Design

The proposed system contains the following components:

- **Link Grammar compiler**: A graphical interface to create Link Grammar rules. It allows you to create rules that can be used to generate English sentences.
- **Link Grammar tool**: A graphical interface to test Link Grammar rules. It allows you to test Link Grammar rules and see how they are used to generate English sentences.
- **Link Grammar distribution**: A collection of Link Grammar rules that can be used to generate English sentences. The Link Grammar distribution contains rules for a variety of topics such as verbs, nouns, adjectives, adverbs, prepositions, and conjunctions.
Mellon University (CMU). Link grammar is a context-free formula to describe natural language [32]. Link grammar consists of a set of words, which are the terminal symbols of the grammar, and each has a linking requirement. The linking requirements of each word are gathered in a dictionary. Figure 1 illustrates the linking requirements through a simple dictionary for the words, a/the, cat/mouse, John, ran, chased.

Fig. 1: words and connectors in a dictionary

Each of the intricately shaped boxes is labeled connector. A pair of compatible connectors will join, and only one of those attached to a given black dot must be satisfied. Figure 2 depicts how the linking requirements are satisfied in the sentence, "The cat chased a mouse."

Fig. 2: All linking requirements are satisfied to form a linkage

The linkage can be perceived as a graph and the words can be treated as vertices, which are connected by labeled arcs. Thus, the graph is connected and planar. The labeled arcs that connect words to others on either their left or right are links. A valid parse is called a linkage. Thus, the following is a simplified form of the diagram indicating that the cat chased a mouse is part of this language.

Fig. 3: the cat chased a mouse

The use of a formula to specify a link grammar dictionary is convenient for creating natural language grammars, however it is cumbersome for mathematical analysis thereof, and as well as in describing algorithms to parse link grammar. An alternate method of expressing link grammar is known as disjunctive form, in which each word has an associated set of disjuncts. A disjunct is denoted as:

\[(L_1, L_2, ..., L_m)(R_n, R_{n-1}, ..., R_1)\]

Where \(L_1, L_2, ..., L_m\) and \(R_n, R_{n-1}, ..., R_1\) are the connectors that must connect to the left and right, respectively. Thus, simply rewriting each disjunct and combining them all with the or operator to create an appropriate formula translates a link grammar in from a disjunctive to a standard form can be completed by as follows:

\[(L_1&L_2&...&L_m&R_n&R_{n-1}&...&R_1)\]

Enumerating all ways that the formula can be satisfied translates a formula into a set of disjuncts. For example, the formula

\[(A-\text{ or } ( )) & D- & B+ & ( () ) & (O- \text{ or } S+)\]

corresponds to the following eight disjuncts, may be used in some linkages:

\[
\begin{align*}
&((A,D) \text{ (S,B))} \\
&((A,D,O) \text{ (B))} \\
&((A,D) \text{ (S))} \\
&((A,D,O) \text{ ())} \\
&(D) \text{ (S))} \\
&(D,B) \text{ ())} \\
&(D) \text{ (B))} \\
&((D,O) \text{ ())}
\end{align*}
\]

Table 1 presents an abridged dictionary, which encodes linking requirements of the above example.

Table 1: the words and linking requirements in a dictionary

<table>
<thead>
<tr>
<th>words</th>
<th>formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>a/the</td>
<td>D+</td>
</tr>
<tr>
<td>cat/mouse</td>
<td>D- &amp; (O- or S+)</td>
</tr>
<tr>
<td>John</td>
<td>O- or S+</td>
</tr>
<tr>
<td>ran</td>
<td>S-</td>
</tr>
<tr>
<td>chased</td>
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The linking requirement for each word is expressed as a formula involving that includes the operators &, and or, parentheses, and connector names. The + or – suffix on a connector indicates the direction in which the matching connector must lie be placed. Thus, the farther left a connector is in the within an expression phrase, the nearer the word to which it connects must be.

A sequence of words is a sentence defined by grammar, if links can be established among the words so as to satisfy the formula of each word. It includes the following meta-rules:

- **Planarity:** Links are drawn above the sentence and do not cross.
- **Connectivity:** Links connect all the words in the sequence.

### Ordering
When the connectors of a formula are traversed from left to right, the words to which they connect proceed from near to far. Namely, consider a word, and consider two links connecting that word to the word on its left. The link connecting the closest word (the shorter link) must satisfy a connector that appears to the left (in the formula) of that connector in the other word. The same process occurs for a link to the right.

### Exclusion
No two links may connect the same pair of words.

The use of a formula to specify a link grammar dictionary is convenient for creating natural language grammars, however it is cumbersome for mathematical analysis thereof, and as well as in describing algorithms to parse link grammar. An alternate method of expressing link grammar is known as disjunctive form, in which each word has an associated set of disjuncts. A disjunct is denoted as:

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3. System analysis

The proposed system contains two varieties of learning functions, or two sub-systems. These sub-systems are English pattern query system and English sentence error-detect system. The detail will be discussed in the following.

3.1 English pattern query system

To develop this system, English sentence patterns were analyzed. Based on general analysis, there are five English sentence patterns, as follows:

- **Simple sentence pattern**
- **Negative sentence pattern**
- **Interrogative sentence pattern**
- **WH question sentence pattern (What, When, Where,...)**
- **Impressive sentence pattern**

They can then be divided by tense, as follows:

**Simple pattern**

- The simple present tense: He writes a letter everyday.
- The simple past tense: He wrote a letter yesterday.
- The simple future tense: He will write a letter tomorrow.

**Perfactive pattern**

- The present perfactive tense: He has written a letter.
- The past perfactive tense: He had written a letter when I arrived.

The future perfactive tense: He will have written a letter before...
I arrive.

**Continuous pattern**
The present continuous tense: He is writing a letter now.
The past continuous tense: He was writing a letter when I arrived.
The future continuous tense: He will be writing a letter when I arrive.

**Perfective proceed pattern**
The present perfective continuous tense: He is writing a letter now.
The past perfective continuous tense: He was writing a letter when I arrived.

Link grammar parses these sentences to determine the label correlation of their sentence patterns (Table 2-5).

<table>
<thead>
<tr>
<th>Table2: Simple sentence pattern and link grammar tags</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active voice</strong></td>
</tr>
<tr>
<td><strong>Simple pattern</strong></td>
</tr>
<tr>
<td>present</td>
</tr>
<tr>
<td>Ss or Sp</td>
</tr>
<tr>
<td><strong>Continuous pattern</strong></td>
</tr>
<tr>
<td>present</td>
</tr>
<tr>
<td>Ss or Sp + Pp</td>
</tr>
<tr>
<td><strong>Proced pattern</strong></td>
</tr>
<tr>
<td>present</td>
</tr>
<tr>
<td>Ss or Sp + Pp</td>
</tr>
<tr>
<td><strong>Perfective continuous pattern</strong></td>
</tr>
<tr>
<td>present</td>
</tr>
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</table>

Illustrate:
- Ss and Sp: connects subject nouns to finite verbs
- I: connects infinitive verb forms to certain words such as modal verbs and "to"
- PP: connects forms of "have" with past participles.
- PV: connects forms of the verb "be" to past participles.
- Pg: connects forms of the verb "be" to present participles.
- Pp: connects forms of the verb "be" to past participles.
- "been".

Subsequently, each pattern receives a label constituent type. This characteristic parses each sentence in the system, which stores the resulting label set. For example, (Ss, ppf, pg) is a label set that was achieved and stored following link grammar parsing. Then, a user can employ query language to arrive at the English sentence pattern they desire. Initially, to ensure that a pattern is accurate, analysis of only one type of pattern is performed. The system can then be upgraded to handle multi-patterns. The system can also process multiple queries in several types of patterns. However, this has some difficulties, which are discussed in section 3.2.

**3.2 English sentence error detect system**
In this section, the Enhanced Link Grammar, which is based on a dictionary with modified disjuncts, is illustrated. Herein, word linkage and the applications of Enhanced Link Grammar are discussed, respectively.

**Modified Dictionary**
In general, the formula of each word is complicated. Initially, the word that requires connector changes is analyzed. Various formulas impose distinct constraints on the proposed system. Thus, although changes may improve the system, many may not. To illustrate, simple words are tested prior to further explanation.

For example, some verbs must be followed by an *infinite* – to, a *gerund* or a *particle*. However, several verbs can accept several varying types. For example, "We enjoy walking in the rain." is accurate, but "We enjoy to walk in the rain." is not. However, the link of the word "enjoy" can be altered to accept the infinitive – to.

Figure 4 presents that the link grammar that has the original dictionary cannot accept an inaccurate sentence. That is, an error message "No complete linkage found." will appear.

**Fig.4: the original link grammar parser**

However, Fig. 5 presents the experimental result when the same two sentences are parsed by the link grammar that contains the modified dictionary.

**Fig. 5: the modified link grammar parser**
Thus, "enjoy" can link to either a gerund or an infinitive – to. Incidentally, there are ten types of catalogued error tags for error detection. In the next section, the error tag, including the links that can and cannot be modified, is discussed.

**4. The System Architecture and Examples**

**4.1 System architecture**
Corpus is a multimedia database that provides a dictionary as well as record errors, comments, and system feedback. Similar to English essays, dialog, sentences, words, terms, and attributes, the proposed English-learning corpus also has positive study data. It promotes language teaching and research. In addition to the original data, it also stores multimedia data, including instructional films, and audio clips, movies, music videos. Therefore, it provides a vivid, attractive learning environment. This system, presented in Fig. 9 and 10, is a multimedia corpus that provides four main functions of basic language learning; they are listen, speech, read, and write. That is a user can read an essay, listen to Standard English pronunciation, write compositions, practice dialog and recite text. The database is a vital tool for linguistic researchers. Philologists
can analysis mistakes that English as second language students typically make.

This system can be used over the Internet to access the data from the multimedia learning corpus. Figure 6 illustrates how a user can access this system from any location.

**Fig. 6 System architecture overview**

As stated, the proposed system contains two sub-systems, which are English pattern query system and English sentence error detect system. Notably, they share the same database.

Figure 7 depicts the architecture of the “English pattern query system”.

**Fig. 7 English pattern query system architecture**

Link grammar with the original dictionary parses the data, which produces link labels. The system then analyses and filters the link labels, which are stored into the database. When a user queries a sentence pattern, they use the interface of the system to obtain the desired pattern. Subsequently, the system will transform the query into readable data-type and, if possible, it will locate the relevant link label within the database. The system will retrieve the data and send it to the multimedia player on the web. The advantage of this is that a user can replay messages several times until they clearly understand the correct pronunciation of the sentence, as well as the context in which the sentence should be used.

Figure 8 depicts the architecture of the other second sub-system, “English sentence error detect system”.

**Fig. 8 English sentence error detect system architecture**

The user can input a sentence into the system. Following analysis, the link grammar with the modified dictionary will parse the sentence, and filter the link labels if error tags are detected. The system will locate the description and error examples within the learner corpus and then display that information on the web page. However, if the system fails to understand an error, it may not have been defined or is too complex. Those sentences will be stored in the database for philologist analysis and further subsequent system enhancement.

4.2 System examples

In this section, operation examples of the system, which is a web-based user interface, are presented. Figure 9 depicts the interface of the English pattern query system.

**Fig. 9 English pattern query system interface**

This provides users with an easy-to-use interface; that is they simply need to drop down the menu and select the pattern that they want to read. The system will then return the query result with the multimedia data on the web browser (Fig. 10).
This system also supports keyword-based queries. Figure 11 presents the interface of the English sentence error detect system.

You can also use this kind of word detect system.

After a sentence is input, link grammar with modified dictionary will determine errors. Figure 12 illustrates an example of a correctly input English sentence.

However, Fig. 13 presents the system’s response when an error is made.

the system searches the Learner Corpus and provides both correct and incorrect examples as well as a description thereof (Fig. 14).

5. Conclusions and Future Work
5.1 The Contribution and Remarks

After following analysis and experimentation, the system can easily use the label set, which is stored in the corpus and parsed with link grammar. Primarily, it assists junior or senior high school students to locate proper English sentence patterns.

Numerous linguistic experts recommend that the best way to improve English speaking ability is to establish a realistic learning environment and practice English through several distinct approaches. The proposed interactive multimedia system promotes this type of learning.

Sleator and Temperley developed Link Grammar, which is a word based parsing mechanism. Although the system was thought to be an accurate grammar checker, unlike the proposed system, it fails to focus on fault tolerance ability, which is particularly useful for non-native English speaking students. The proposed system can parse sentences that the original Link Grammar cannot.

Notably, our modified dictionary has progressed steadily. It appears that the idea proposed herein can be applied to other natural language processing and its corresponding applications.

The system not only queries English sentence patterns, but also parses input sentences on-line. It is important to philologists to analysis sentences generated by students, so they can easily locate common or special mistakes. Subsequently, they can alter the focus of their course for a complete learning environment.

This system provides a better and more interactive environment for both teachers and students. Furthermore, it combines the humanistic education with technology and
advances these two sciences for superior achievement.

5.2 Future Works

Generally, words are a basic unit of communication that are common to all natural language texts and speech-processing activities. When teaching English, teachers always want to know the types of mistakes that students may make. Thus, according to various functional necessities, the proposed system can be extended to cover encompass more scalable ranges. The notions presented herein can aid in the development of other similar applications.

XML has self-descriptive characteristics, which has resulted in increasing data interchange applications. These applications and research areas may become a popular subject in the future.

Reference:
[23] Interactive Javascript Quizzes for ESL Students: http://www.aitech.ac.jp/~iteslj/quizzes/isp