Implementation of Rule Based Algorithm for Sandhi-Vicheda Of Compound Hindi Words

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Abstract
Sandhi means to join two or more words to coin new word. Sandhi literally means 'putting together' or combining (of sounds), It denotes all combinatory sound-changes effected (spontaneously) for ease of pronunciation. Sandhi-vicheda describes [5] the process by which one letter (whether single or cojoined) is broken to form two words. Part of the broken letter remains as the last letter of the first word and part of the letter forms the first letter of the next letter. Sandhi-Vicheda is an easy and interesting way that can give entirely new dimension that add new way to traditional approach to Hindi Teaching. In this paper using the Rule based algorithm we have reported an accuracy of 60-80% depending upon the number of rules to be implemented.

Keywords: Rule Based Algorithm, Sandhi-Vicheda, Compound Hindi Words

I INTRODUCTION
Natural Language Processing (NLP) refers to descriptions that attempt to make the computers analyze, understand and generate natural languages, enabling one to address a computer in a manner as one is addressing a human being. Natural Language Processing is both a modern computational technology and a method of investigating and evaluating claims about human language itself. It is a subfield of artificial intelligence and computational linguistics. It studies the problems of automated generation and understanding of natural human languages.

A word can be defined as a sequence of characters delimited by spaces, punctuation marks, etc. in case of written text. A compound word (also known as co-joined word) can be broken up into two or more independent words. A Sandhi-Vicheda module breaks the compound word in a sentence into constituent words. Sandhis take place whenever there is a presence of a swara i.e.a vowel; the presence of a consonant with a halanta; the presence of a visarga. Sanskrit has a well defined set of rules for Sandhi-vicheda. But Hindi has its own rules of Sandhi-vicheda. They are, however, not so well-defined as, and much fewer in number than, the Sanskrit rules.

II RELATED WORK
Sandhi (in linguistics) [1] is a cover term for a wide variety of phonological processes that occur at morpheme or word boundaries, such as the fusion of sounds across word boundaries and the alteration of sounds due to neighboring sounds or due to the grammatical function of adjacent words. Internal sandhi features the alteration of sounds within words at morpheme boundaries, as in sympathy (syn- + pathy). External sandhi refers to changes found at word boundaries, such as in the pronunciation [tɛm bʊks] for ten books. This is not true of all dialects of English. The Linking R of some dialects of English is a kind of external sandhi, as is the process called liaison in the French language. While it may be extremely common in speech, sandhi (especially external) is typically ignored in spelling, as is the case in English, with the exception of the distinction between "a" and
"an" (sandhi is, however, reflected in the writing system of Sanskrit and Hindi). External sandhi effects can sometimes become morphologized. Most tonal languages have Tone sandhi, in which the tones of words alter according to pre-determined rules. For example: Mandarin has four tones: a high monotone, a rising tone, a falling-rising tone, and a falling tone. In the common greeting nǐ hǎo, both words in isolation would normally have the falling-rising tone. However, this is difficult to say, so the tone on nǐ is pronounced as nǐ (but still written nǐ in Hanyu Pinyin).

The Sanskrit Sandhi engine software is not currently available as a standalone application, since its local use demands the installation of an HTTP server on the user's host.

The Sandhi module[1] developed by RCILTS-Sanskrit, Japanese, Chinese at Jawaharlal Nehru University, New Delhi. RCILTS, JNU is a resource center for Sanskrit language of DIT, Government of India. At JNU work started in three languages viz., Sanskrit, Japanese, and Chinese. Using this module the user can get the information about Sandhi rules and processes. Sutra number in Astyadhyayi and its description is displayed. User can learn three types of Svarga Sandhi, Vyvyanjan Sandhi, Hal Sandhi through this Sandhi module Data is in Unicode. Sandhi exceptions and options are also incorporated. This module takes two words as input. First word cannot be null but second word can be. A user can input the two words and submit the form to get the result of the given input.

Chinese Tone Sandhi.[2] Cheng and Chin-Chuan from California University, Berkeley, Phonology Laboratory faced the problem that English stresses are interpreted by Chinese speakers when they speak Chinese with English words inserted. Chinese speakers in the United States usually speak Chinese with English words inserted. In Mandarin Chinese, a tone-sandhi rule changes a third tone preceding another third tone to a second tone. Using the tone-sandhi rule, they designed the experiment to find out how English stresses are interpreted in Chinese sentences. Stress does not exist in the underlying representations of English phonology. But in studying bilingual phenomena, the phonetic level is also important. Fry (1995) found that when a vowel was long and of high intensity, listeners agreed that the vowel was strongly stressed. The results of his experiments indicate that the duration ratio has a stronger influence on judgements of stress than has the intensity ratio, Lehiste and Peterson (1959) also reported experiments on stress.

English l-sandhi [3] involves an allophonic alternation in alveolar contact for word-final /l/ in connected speech [4]. EPG data for five Scottish Standard English and five Southern Standard British English speakers shows that there is individual and dialectal variation in contact patterns.

III PROBLEM DEFINITION

Developing programs that understand a natural language is a difficult task. Natural languages are large. They contain an infinity of different sentences. No matter how many sentences a person has heard or seen, new ones can always be produced. Also, there is much ambiguity in a natural language. Many words have several meanings and sentences can have different meanings in different contexts. Compound words are created by joining an arbitrary number of existing words together, and this can lead to a large increase of the vocabulary size, and thus also to sparse data problems. Therefore the problem of compound words poses challenges for many NLP applications. The problem domain, to which this paper is concerned, is breaking up of Hindi compound words into constituent words. In Hindi, words are a sequence of characters. These words are combined with ‘swar’, ‘vyanjan’, and matra’s. Hindi has its own rules of Sandhi-vicheda. They are, however, not so well-defined as, and much fewer in number than, the Sanskrit rules. So my problem is to break the compound word into constituent words with the help of rules of ‘Sandhi-vicheda’ in Hindi grammar. My problem is to design a Graphical User Interface, which accepts input as a Hindi language word (source text) from the keyboard or mouse and break it into constituent words (target text). The source text is converted into target text in Unicode Format.
IV IMPLEMENTATION

We have implemented the Rule-Based algorithm to first manually find the compound words and then develop the program that uses the database for displaying the correct meaning to the Sandhi-Vicheda word according to the Hindi grammar Sandhi-Vicheda rules.

4.1 Algorithm

hword = hindi word to be entered
cur = Variable that stores the length of string

Step 1: Repeat for every word of the input string.
Step 2: Count the Length of String.
Step 2.1: Store the Length of String in variable.
   For i = 1 To Len(hword)
   cur = Mid$(hword, i, 1)
Step 3: Find the position of Matra.
   hword.Substring(b - 1, 1)
Step 4: Apply the rules for sandhi –vicheda

Step 4.1: (Rule for “Sign-AA( ट्)” replaced with Swar “Letter-A( ट्)” in Sandhi vicheda)

| स्वाधी | र्व + अर्धी |
|--------|------------|
| भावाव | भाव + अर्ध |
| सत्याव | सत्य + अर्ध |
| यथाव | यथा + अर्ध |

Table 2: Rule I Implemented Word List

Step 4.2: (Rule for “Sign-AA( ा)” replaced with Swar “Letter-AA( ा)” in Sandhi vicheda)

| परिपकार | पर + उपकार |
|----------|-------------|
| महावधि | महा + उधि |
| आलोकसिंह | आल + उसिंह |
| सागरमें | सागर + उमे |

Table 5: Rule IV Implemented Word List

Step 4.3: (Rule for “Sign-E( ई)” replaced with Swar “Letter-E( ई)” in Sandhi vicheda)

| परिपकार | पर + उपकार |
|----------|-------------|
| महावधि | महा + उधि |
| आलोकसिंह | आल + उसिंह |
| सागरमें | सागर + उमे |

Table 6: Rule V Implemented Word List

Step 4.4: (Rule for “Sign-E( ई)” replaced with Swar “Letter-E( ई)” in Sandhi vicheda)

| सदिय | सदा + एव |
|-------|-----------|
| महेव | महा + एव |
| यदिय | यथा + एव |
| एकेक | एक + एक |

Table 7: Rule VI Implemented Word List

Step 4.5: (Rule for “Sign-U( ऊ)” replaced with “Letter-U( ऊ)” in Sandhi Vicheda)

| सदिय | सदा + एव |
|-------|-----------|
| महेव | महा + एव |
| यदिय | यथा + एव |
| एकेक | एक + एक |

Table 8: Rule VII Implemented Word List

Step 4.6: (Rule for “Sign-EE( ऐ)” replaced with Vowel “Letter-EE ( , , , , )” in Sandhi Vicheda)

| सदिय | सदा + एव |
|-------|-----------|
| महेव | महा + एव |
| यदिय | यथा + एव |
| एकेक | एक + एक |

Table 9: Rule VII Implemented Word List

Step 4.7: (Rule for “Sign-EE ( ऐ)” replaced with “Letter-EE ( , , , , )” in Sandhi Vicheda)
**Table 8: Rule VII Implemented Word List**

|  |  |
|---|---|
| महावचन | महा + ऐघवचन |
| वेदावचन | वेद + ऐघवचन |
| परमेवचन | परम + ऐघवचन |
| यथाविहासिक | यथाव + ऐघविहासिक |

**Step 4.8:** (Rule for eliminating the half letter in Sandhi- Vicheda) If find the (Half CH) \( \bullet \) Letter then eliminates the Letter and decompose the word.

|  |  |
|---|---|
| साधनचर्ग | साधन + छर्ग |
| वस्कड | वि + छड |
| परेवसकड | परे + छड |
| लक्षणार्य | लक्ष + अर्य |

**Table 9: Rule VIII Implemented Word List**

|  |  |
|---|---|
| ग्रन्थि | ग्रि + चि |
| रोग्यांत्र | रो + अंत्र |
| दुर्गास्न | दु + साहस |
| निस्तार | नि + तार |

**Step 4.9:** (Rule of Visarga in Sandhi Vicheda) If find the (Half Letter) then replace with Sign ( : ) visarga.

**Step 5:** Repeat Steps 4.1 to 4.9 to check the next word for checking the Vyanjan that combined with Matra. Then replace the Matra with Swar.

**Step 6:** Find the Unicode value for each of the Hindi characters and additional characters and use those values to implement above rules.

**Step 7:** Display the results.

Our module was developed in Visual Basic.NET (2005) and the encoding used for text was in Unicode, most suitable for other applications as well. Unicode uses a 16 bit encoding that provision for 65536 characters. Unicode standard [18] assigns each character a unique numeric value and name. Presently it provides codes for 49194 characters:

In Hindi Language:  
- Total Swar=13  
- Total Vyanjan=33  
- Total Matra=13

**V RESULTS AND DISCUSSION**

We have tested our software on more than 200 words. Using the Rule based algorithm we have reported an accuracy of 60-80% depending upon the number of rules to be implemented. SANDHI-VICHEDA is an easy and interesting way that can give entirely new dimension that add new way to traditional approach to Hindi Teaching.

**VI CONCLUSION AND FUTURE WORK**

In this paper, we presented the technique for the Sandhi-Vicheda of compound hindi words. Using the Rule based algorithm we have reported an accuracy of 60-80% depending upon the number of rules to be implemented. As future work, database can be extended to include more entries to improve the accuracy. This software can be used as a teaching aid to all the students from Class-V to the highest level of education. With this software one can learn about the very important aspect of Hindi Grammar i.e. ‘SANDHI-VICHEDA’. By adding new more features, we can upgrade it to learn all the aspects of Hindi Grammar. It can also be used to solve and test the problems related to Hindi Grammar.

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