A Framework of Translator From English Speech To Sanskrit Text

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Abstract— Human computer interaction is defined as Users (Humans) interact with the computers. Speech recognition is an area of computer science that deals with the designing of systems that recognize spoken words. Speech recognition system allows ordinary people to speak to the system. Recognizing and understanding a spoken sentence is obviously a knowledge-intensive process, which must take into account all variable information about the speech communication process, from acoustics to semantics and pragmatics. This paper is the survey of how speech is converted in text and that text in translated into another language. In this paper, we outline a speech recognition system, learning based approach and target language generation mechanism with the help of language English-Sanskrit language pair using rule based machine translation technique [1]. Rule Based Machine Translation provides high quality translation and requires in depth knowledge of the language apart from real world knowledge and the differences in cultural background and conceptual divisions. Here the English speech is first converted into text and that will translated into Sanskrit language.

Keywords— Speech Recognition, Sanskrit, Context Free Grammar, Rule based machine translation, Database.

I. INTRODUCTION

The Speech is most prominent & primary mode of Communication among of human beings. The communication among human computer interaction is called human computer interface. Speech has potential of being important mode of interaction with computer [2]. Speech Recognition can be defined as the process of converting speech signal to a sequence of words by means Algorithm implemented as a computer program. The goal of speech recognition area is to developed technique and system to develop for speech input to machine based. In this paper we are converting the speech input into machine based language and then that language is converted into other language. So basically this project is taking speech input in English and then converts it into Sanskrit. English is a widely spoken language across the globe and most official communication and documentation is being done in this language. In India, there exist several regional languages including Hindi, where a lot of documentation exists in this language.

The Sanskrit is considered to be mother of all Indian languages and is one of the oldest synthetic language in which a lot of ancient literature exists. Its storehouse of knowledge is an unsurpassed and the most invaluable treasure of the world. This language is a true symbol of the great Indian tradition and thought, which has exhibited full freedom in the search of truth, has shown catholicity towards universal truth. This unique language contains not only good account of wisdom for the people of this country, but it is also an unparalleled and right way to acquire proper knowledge and is thus significant for the people of entire world. Sanskrit is most interesting and scientific language in the world. In addition to these, it would help us to invigorate various languages of India. As Mahatma Gandhi rightly said: “Sanskrit is like the river GaêgÁ for our Languages”.

In this modern age Sanskrit is being treated as one of the scientific languages of the world. Its script, i.e. DevanÁgarÍ is also easily accessible by the computer in its various programs. However, it is known that computers are now emerging as powerful instrument in ushering a new era of global revolution in the field of modern education for all type of progress of the people in the society. The advantages offered by these new tools of education combined with the power of technology are being absorbed and adopted for the purpose of Sanskrit studies in India and abroad too. Utilization of computer technology for facilitating Sanskrit studies in general classroom environment, individual and group learning of rudiments of Sanskrit in the form of conversational sentences, Teaching packages for astrology, architectural science (vAstu-vidya), Sanskrit grammar, astronomy, etc. based on the subject of interest through the medium of English and other languages. However, computer technology being utilized as right tool to preserve, popularize and propagate the traditional Sanskrit studies [3].

II. BACKGROUND OF SPEECH RECOGNITION

A. Types Of Speech Recognition

Speech Recognition system can be divided into various different classes by describing what of utterance they have the ability to recognize. These classes are classified as following [4]:

1. **Automatic Speech Recognition (ASR)**: This type of speech recognition involves the design and implementation of systems that can transcribe speech into text. The system is trained on large amounts of speech data to recognize a wide range of spoken words.

2. **Diarization**: This type of speech recognition focuses on identifying and separating different speakers in a recording. It is often used in meetings or discussions where multiple people are speaking simultaneously.

3. **Speaker Recognition**: This type of speech recognition system is designed to identify a speaker based on their unique speech patterns. It is often used in forensic applications or for secure access systems.

4. **Adaptive Speech Recognition**: This type of speech recognition is designed to adapt to the user's speech patterns over time. It is often used in applications where users may have different speech patterns or accents.

5. **Speech-to-Text**: This type of speech recognition is designed to convert spoken language into written text. It is often used in applications such as voice typing or voice dictation systems.

6. **Automatic Speech Translation (AST)**: This type of speech recognition is designed to convert speech from one language to another. It is often used in applications where it is necessary to translate speech content in real-time, such as in meetings or conferences.

7. **Real-Time Speech Recognition**: This type of speech recognition is designed to recognize speech in real-time, which is crucial for applications such as voice-activated devices and virtual assistants.

8. **Multilingual Speech Recognition**: This type of speech recognition is designed to recognize speech in multiple languages. It is often used in applications where it is necessary to support users who speak different languages, such as in international meetings or translation services.

9. **Speech Recognition with Background Noise**: This type of speech recognition is designed to recognize speech in the presence of background noise. It is often used in applications where the background noise level is high, such as in cars or public places.
1) Isolated words: Isolated words usually require each utterance to have quiet (lack of an audio signal) on both side of sample window. It accepts single word and single utterance at a time. These systems listen to non listen states, where they require the speaker to wait between utterances (usually doing process during the pauses). Isolated utterance might be a better name for this class [5].

2) Connected words: Connected words system are similar to isolated words, but allow separate utterances to be 'run together' with a minimal pause between them.

3) Continuous speech: Continuous speech recognizers allow users to speak naturally, while the computer determines the content (basically its computer dictation). Recognizers with continuous speech capabilities are some of the most difficult to create because they utilize special method to determine utterance boundaries.

4) Spontaneous speech: At basic level it can be thought of as speech that is natural sounding and not rehearsed. An ASR system with spontaneous speech ability should be able to handle variety of natural features such as words being run together, “ums” and “ahs” and even slight stutters.

B. Speech Recognition Techniques

1) Template based approach matching [6]: Unknown speech is compared against a set of prerecorded words (templates) in order to find the best match. This has the advantage of using perfectly accurate word models. But it also has the advantage that prerecorded templates are fixed, so variation in speech can only be modeled by using many templates per words, which eventually becomes impractical. Dynamic Time Wrapping [7] is such a typical approach. In this approach template, usually consist of representative sequences of features vector for corresponding words. The basic idea here is to align the utterance to each of the template words and then select the word or word sequence that contains the best. For each utterance the distance between the template and observed feature vectors are computed using some distance measure and these distances are accumulated along each path. The lowest scoring path then identifies the optimal alignment for a word and the word template obtaining the lowest overall score depicts the recognized word or sequence of words.

2) Knowledge based approaches: An expert knowledge about variations in speech is hand coded into a system. This has the advantage of explicit modeling variations in speech; but unfortunately such expert knowledge is difficult to obtain and use successfully. Thus this approach was judged to be impractical and automatic learning procedure was sought instead.

3) Statistical based approach: In which variation of speech is modeled statistically, using automatic, statistical learning procedure, typically the HIDDEN MARKOV MODEL. The approach represents the current state of art. The main disadvantage of statistical models is they must take priori modeling assumptions which are liable to be inaccurate, handicapping the system performance. In recent years, a new approach to the challenging problem of conversational speech recognition has emerged, holding a promise to overcome some fundamental limitations of the conventional Hidden Markov Model (HMM) approach (Bridle et al., 1998 [8]; Ma and Deng, 2004 [9]). The new approach is the radical departure from the current HMM-based statistical modeling approaches. Rather than using a large number of unstructured Gaussian mixture components to account for the tremendous variation observable acoustic data of highly co-articulated spontaneous speech, the new speech model that have developed provides a rich structure for the partially observed dynamics in the domain of vocal tract resonances.

4) Learning based approaches: To overcome the disadvantage of the HMMs machine learning methods could be introduced such as neural networks and genetic algorithm/programming. In those machines learning models explicit rules or other domain expert knowledge do not need to be given they a can be learned automatically through emulations or evolutionary process.

5) The artificial intelligence approach attempts to mechanize the recognition procedure according to the way a person applies its intelligence in visualizing, analyzing, and finally making a decision on the measured acoustic features. Expert systems are used widely in this approach [11].
C. Matching Techniques

Speech-recognition engines match a detected word to a known word using one of the following techniques [12]:-

1) Whole-word matching: The engine compares the incoming digital-audio signal against a prerecorded template of the word. This technique takes much less processing than Sub-word matching, but it requires that the user (or someone) prerecord every word that will be recognized - sometimes several hundred thousand words. Whole-word templates also require large amounts of storage (between 50 and 512 bytes per word) and are practical only if the recognition vocabulary is known when the application is developed.

2) Sub-word matching: The engine looks for sub-words - usually phonemes - and then performs further pattern recognition on those. This technique takes more processing than whole-word matching, but it requires much less storage (between 5 and 20 bytes per word). In addition, the pronunciation of the word can be guessed from English text without requiring the user to speak the word beforehand.

D. Machine Translation Approaches [13]

1) Example-based machine translation (EBMT): EBMT is a method of machine translation often characterized by its use of a bilingual corpus with parallel texts as its main knowledge base, at run-time. It is essentially a translation by analogy and can be viewed as an implementation of case-based reasoning approach of machine learning.

At the foundation of example-based machine translation is the idea of translation by analogy. When applied to the process of human translation, the idea that translation takes place by analogy is a rejection of the idea that people translate sentences by doing deep linguistic analysis. Instead it is founded on the belief that people translate firstly by decomposing a sentence into certain phrases, then by translating these phrases, and finally by properly composing these fragments into one long sentence. Phraseal translations are translated by analogy to previous translations. The principle of translation by analogy is encoded to example-based machine translation through the example translations that are used to train such a system.

Example of bilingual corpa:

<table>
<thead>
<tr>
<th>English</th>
<th>Sanskrit</th>
</tr>
</thead>
<tbody>
<tr>
<td>He goes to school.</td>
<td>Sah zalam yati.</td>
</tr>
<tr>
<td>How are you?</td>
<td>Kathamasthi bhavan?</td>
</tr>
</tbody>
</table>

2) Statistical machine translation (SMT): SMT is a machine translation paradigm where translations are generated on the basis of statistical models whose parameters are derived from the analysis of bilingual text corpora. The statistical approach contrasts with the rule-based approaches to machine translation as well as with example-based machine translation.

Benefits:

- The most frequently cited benefits of statistical machine translation over rule-based approach are:

  Better use of resources

  There is a great deal of natural language in machine-readable format.

  Generally, SMT systems are not tailored to any specific pair of languages.

  Rule-based translation systems require the manual development of linguistic rules, which can be costly, and which often do not generalize to other languages.

More natural translations

Rule-based translation systems are likely to result in Literal translation. While it appears that SMT should avoid this problem and result in natural translations, this is negated by the fact that using statistical matching to translate rather than a dictionary/grammar rules approach can often result in text that include apparently nonsensical and obvious errors.

- Word-based Translation: In word-based translation, the fundamental unit of translation is a word in some natural language. Typically, the number of words in translated sentences is different, because of compound words, morphology and idioms. The ratio of the lengths of sequences of translated words is called fertility, which tells how many foreign words each native word produces. For example, the English word corner can be translated in Spanish by either rincón or esquina, depending on whether it is to mean its internal or external angle. Word-based translation systems can relatively simply be made to cope with high fertility, but they could map a single word to multiple words, but not the other way about.

- Phrase based translation: In phrase-based translation, the aim is to reduce the restrictions of word-based translation by translating whole sequences of words, where the lengths may differ.
• Syntax-based translation: Syntax-based translation is based on the idea of translating syntactic units, rather than single words or strings of words (as in phrase-based MT), i.e. (partial) parse trees of sentences/utterances.

Challenges with Statistical Machine Translation:
• Sentence alignment: In parallel corpora single sentences in one language can be found translated into several sentences in the other and vice versa. Sentence aligning can be performed through the Gale-Church alignment algorithm.
• Statistical anomalies: Real-world training sets may override translations of, say, proper nouns. An example would be that “I took the train to Berlin” gets mis-translated as “I took the train to Paris” due to an abundance of “train to Paris” in the training set.
• Data dilution: Data dilution is a statistical anomaly unique to a subset of natural language and has shown a negative impact on Machine Translation adoption for commercial use.
• Idioms: Depending on the corpora used, idioms may not translate “idiomatically”.
• Different word orders: Word order in languages differs. Some classification can be done by naming the typical order of subject (S), verb (V) and object (O) in a sentence and one can talk, for instance, of SVO or VSO languages.

3) Rule-based machine translation [14]

Rule-Based Machine Translation (RBMT; also known as “Knowledge-Based Machine Translation”; “Classical Approach” of MT) is a general term that denotes machine translation systems based on linguistic information about source and target languages basically retrieved from (bilingual) dictionaries and grammars covering the main semantic, morphological, and syntactic regularities of each language respectively. Having input sentences (in some source language), an RBMT system generates them to output sentences (in some target language) on the basis of morphological, syntactic, and semantic analysis of both the source and the target languages involved in a concrete translation task.

Direct Systems (Dictionary Based Machine Translation) map input to output with basic rules.
Transfer RBMT Systems (Transfer Based Machine Translation) employ morphological and syntactical analysis.
Interlingua RBMT Systems (Interlingua) use an abstract meaning.

RBMT systems can also be characterized as the systems opposite to Example-based Systems of Machine Translation (Example Based Machine Translation), whereas Hybrid Machine Translations Systems make use of many principles derived from RBMT.

Basic principles: The main approach of RBMT systems is based on linking the structure of the given input sentence with the structure of the demanded output sentence, necessarily preserving their unique meaning. The following example can illustrate the general frame of RBMT:

A girl eats an apple. Source Language = English; Demanded Target Language Sanskrit Minimally, to get a Sanskrit translation of this English sentence one needs:

A dictionary that will map each English word to an appropriate Sanskrit word.
Rules representing regular English sentence structure.
Rules representing regular Sanskrit sentence structure.

And finally, we need rules according to which one can relate these two structures together.

Accordingly we can state the following stages of translation:

1st: getting basic part-of-speech information of each source word:

a = indef., article; girl = noun; eats = verb; an = indef., article; apple = noun

2nd: getting syntactic information about the verb “to eat”: 

NP-eat-NP; here: eat = Present Simple, 3rd Person Singular, Active Voice

3rd: parsing the source sentence:
(NP sevphala) = the object of eat

Often only partial parsing is sufficient to get to the syntactic structure of the source sentence and to map it onto the structure of the target sentence.

4th: translate English words into Sanskrit

A (category = indef.article) => ein (category = indef.article)

Girl (category = noun) => bala (category = noun)

Eat (category = verb) => bhakshyati (category = verb)

An (category = indef. article) => ein (category = indef.article)
Apple (category = noun) => sevphala (category = noun)

5th: Mapping dictionary entries into appropriate inflected forms (final generation):

A girl eats an apple. => ekh bala sevphalam bhaksyati.

Reasons of Suppression: Insufficient amount of really good dictionaries.

Some linguistic information still needs to be set manually.

It is hard to deal with rule interactions in big systems, ambiguity, and idiomatic expressions.

Limited capacity of computers at that time.

III. LITERATURE SURVEY

There are various machine translation systems till date. The Desika system developed by Indian Heritage Group, C-DAC, and Bangalore is a NLU system for generation and analysis for plain and accented written Sanskrit texts based on grammar rules of Panini’s Astadhayi rules. The system is also able to analyze Vedic texts. Sanskrit Authoring System (VYASA) project is a multipurpose tool for Sanskrit – from being a multi-script editor to a language processing and interpretation tool. It also says that it provides tools for analyses at morphological, syntactic and semantic levels. The Anglabharti [15] employs a pseudo-interlingua approach which analyses English sentences once and creates an intermediate structure called PLIL (Pseudo Lingua for Indian Languages). This is the basic translation process which translates the English source language to. The PLIL structure is further converted to each Indian language through text-generation. Anglabharti-II uses a generalized example base (GEB) for hybridization besides a raw example base (REB). The major components of Anglabharti are:

1) Rule-base: This contains rules for mapping structures of sentences from English to Indian languages. This database of pattern-transformation from English to Indian languages is entrusted the job of making a surface-tree transformations, bypassing the task of getting a deep tree of the sentence to be translated. The approach used in Anglabharti has derived from the phrase structure grammar of Chomsky and the c-structure of lexical-functional grammar. The database of structural transformation rules from English to Indian languages forms the heart of the Anglabharti.

2) Sense disambiguator: This module is responsible for picking up the correct sense of each word in the source language. It should be of interest to note that sense disambiguation is done only for the source text. The approach used in Anglabharti may be termed rule-by-rule semantic interpretation. Here, the semantic interpreter is called each time a syntactic rule is applied.

3) Target text generator: Its function is to generate the translated output for the corresponding target languages. They take input of the intermediate form generated by the previous stages of Anglabharti.

4) Multi-lingual dictionary: This contains various details for each word in English, like their syntactic categories, possible senses, keys to disambiguate their senses, corresponding words in target languages.

5) Rule-base acquirer: This prepares the rule-base for the MT system.

Anubharti is a project at IIT Kanpur, dealing with template-based machine translation from Hindi to English, using a variation of example-based machine translation. Some of the features of Anubharti are based on the emerging trend of third generation of machine translation. The project uses hybrid example-based model for machine translation (HEBMT), combining the strategies used in the pattern/rule-based approach and the example-based approach. MaTra [16] is a project at C-DAC, Mumbai, and has been funded by TDIL. It aims at machine-assisted translation from English into Hindi, essentially based on a transfer approach using a frame-like structured representation. The focus is on the innovative use of man-machine synergy - the user can visually inspect the analysis of the system and provide disambiguation information using an intuitive GUI, allowing the system to produce a single correct translation. The system uses rule-bases and heuristics to resolve ambiguities to the extent possible. The Mantra [17] project has been developed by C-DAC, Bangalore. The project has been funded by TDIL and later by the Department of Official Languages. Mantra becomes part of Smithsonian Institution's National Museum of American History. The project is based on the TAG formalism from University of Pennsylvania, USA. A sub-language English-Hindi MT system has been developed for the domain of gazette notifications pertaining to government appointments. In addition to translating the content, the system can also preserve the formatting of input Word documents across the translation. The Mantra approach is general, but the lexicon/grammar has been limited to the sub-language of the domain.
Machine Translation systems are also available. Etrans [15] is English-Sanskrit Machine Translator System. By Etrans an English sentence is translated into string of Sanskrit. This system is highly dependent on the database for generating output and to extract the information programming logic have been developed. The software comprised of the following modules:

1) Parse Module
   - Input Module
   - Sentence Analyzer Module
   - Morphological Analysis Module
   - Parse Module
   - Parse Tree

2) Generator Module
   - Mapping
   - Output Module
   - Apart from these big achievements lot of small works all also going in this field of research, like Sanskrit voice engine etc.

IV. RESEARCH GAP

As we see earlier there is lot of work has been done in the area of English to Sanskrit machine translation system but there is no such system created yet that is capable of doing speech recognition of English and then converts that into Sanskrit language.

V. PROPOSED METHOD FOR CONVERSION OF ENGLISH SPEECH TO SANSKRIT TEXT

Our proposed system tries to fill this gap. So there is a requirement generated for a system that translates a string of English language into the string of Sanskrit language. The approach used for the translation is Rule-Based Machine Translation (RBMT, also known as the rational approach). Rule based translation includes:

- Process of analyzing input sentence of a source language syntactically and or semantically
- Process of generating output sentence of a target language based on internal structure each process is controlled by the dictionary and the rules.

The strength of the rule based method is that the information can be obtained through introspection and analysis.

The weakness of the rule based method is the accuracy of entire process is the product of the accuracies of each sub stage. Before getting into translation phase we have to compare two languages. The four major parameters that are needed to be considered for the translation are- Essence, Tense, Number and Translational equivalence, of this language pair. The English language has twelve tenses in all primarily Past, Present and Future. All three have a Perfect, Indefinite, Continuous and Perfect Continuous and it makes twelve forms of tenses. Sanskrit has primarily six tenses, Present, Past, Future, Order, Blessing and Inspiration. The English have two numbers i.e., Singular and Plural whereas; Sanskrit has three numbers Singular, Dual and Plural. The translation requires many sub-tasks:

- Determine whether a particular noun, is a subject, or an object.
- With knowing the preposition of a word determines the accurate vibhakti to be used.
- Translate the English root words corresponding to their Sanskrit equivalents.
- Generate the mapping for the nouns in the case of karaka and verbs in the case of lakara.
- Get the gender, number information for nouns and person; number and tense information for verbs.

To keep the information of vibhaktis in case of noun and lakaras in case of verbs we used MS Access. Thus for a sentence conversion we have to depend on the database.

The two major task of the system are parsing and mapping. Algorithm for the Lexical parsing [16] of the sentences includes-

- Tokenize the sentence into various tokens i.e. token list
- To find the relationship between tokens we are using dependency grammar. Token list acts as an input to semantic class to represent the semantic standard.
- Semantic class generates a tree.
- Sentence is splitted into words that are nouns, verbs etc.

The crucial task for the system is the semantic mapping. The steps should be followed by the semantic mapping are-

- The output from the first module i.e. lexical parser acts as input to the Semantic mapper.
- The tokens generated from the first module are stored in database.
- These tokens have grammatical relations which are represented with various symbols.
Look up in Sanskrit dictionary we are matching English semantic word with the dictionary Sanskrit word. This matching is not word by word but it will be semantic (meaningful) matching based on the relationship been established.

After matching the selected words from the Sanskrit dictionary are kept as another database collection.

Identify the relationships among the various Sanskrit words from these Data sets.

There are some basic writing rules for the users of the system to get accurate results. These are as follows-

- Keep the sentences short.
- Make sure sentences are grammatically correct.
- Avoid complicated grammatical constructions.
- Avoid words which have several meaning.

A. Technologies To Be Used

1) DOTNET: If the application is Windows platform specific then use .Net
- .Net is Language independent, so if the team has multiple skill expertise C#, VB.NET, C++, developers can still work on the same project with different skill set.
- Debugging is very effort-less therefore, can fix the bugs quicker.
- Deployment is very easy and simple
- Supports Cross Language Integrity.
- When you compile a dot net code it will create MSIL (Which is sort of machine lave language), which make it platform Independent.
- It’s fully Object orientated Language.
- Automatic Memory management.
- Automatic Garbage Collection.
- For speech recognition we will use using System.Speech.Recognition namespace. Through this we can easily convert speech into text. XML file will also be used here.

2) MS ACCESS: Microsoft Access, also known as Microsoft Office Access, is a database management system from Microsoft that combines the relational Microsoft Jet Database Engine with a graphical user interface and software-development tools.

It is a member of the Microsoft Office suite of applications, included in the Professional and higher editions. Microsoft Access stores data in its own format based on the Access Jet Database Engine. It can also import or link directly to data stored in other applications and databases. Microsoft Access offers several ways to secure the application while allowing users to remain productive. The most basic is a database password. Once entered, the user has full control of all the database objects. This is a relatively weak form of protection which can be easily cracked.

A higher level of protection is the use of workgroup security requiring a user name and password. This can be used to specify people with read-only or data entry rights but may be challenging to specify. A separate workgroup security file contains the settings which can be used to manage multiple databases. Databases can also be encrypted. The ACCDB format offers significantly advanced encryption from previous versions.

Additionally, if the database design needs to be secured to prevent changes, Access databases can be locked/protected (and the source code compiled) by converting the database to a .mde file.

B. FLOWCHART

1) Recognize the English sentences from speech input, which means there should be no need to type the sentences.

2) Convert the English speech into English text by looking in the xml file.

3) The English text will break into words by some functions.

4) Database will be referred for information of those English words. As in database, there will be many tables. One for subject, one for verb, one for object and many more.

5) On the basis of rules, Sanskrit words will be searched for corresponding English words.

6) Reorder the Sanskrit words in a meaningful sentence. Since Sanskrit sentence is in the form SUBJECT+OBJECT+VERB [17].

7) Finally Sanskrit text will be generated.
Fig. 1 Flow Chart [18]
VI. CONCLUSION

In this paper, the complete framework is to convert input speech language into target text language. The chosen language pair is English and Sanskrit, as a source and target language. English is a widely spoken language across the globe and most official communication and documentation is being done in this language. The Sanskrit is considered to be mother of all Indian languages and is one of the oldest synthetic language in which a lot of ancient literature exists. Not only in India but all over the world the value of Sanskrit has grown very rapidly. So this system will be useful for learner of Sanskrit language.

This system uses learning based speech recognition technique. And for translation it uses rule based machine translation. The system supports both English and Sanskrit grammar such as noun, verb adjective etc. We have considered sentences from all the three tenses i.e. present, past and future. It is our belief that this methodology can be adopted for translation of similar languages. The rule base can be extended to translate various types of literature in English to Sanskrit.

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