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Impact of Phonetics in Natural Language Processing: A Literature Survey

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ABSTRACT:- Phonetic analysis is a branch of natural language processing (NLP) which deals with how the sounds are produced when we talk and how words are related to sounds. Applying phonetic analysis to natural language is a challenging task as it involves making computer to understand how sounds are produced and analyze it. Phonetic analysis has its history starting centuries back however over the past few decades the researchers has addressed this problem in a broader perspective concentrating on different languages that are spoken across the world. The biggest provocation for the phonology is to recognize the language, process it for lexical, syntactic, semantic knowledge about the language and the challenges of speech recognition and speech synthesis. In this paper, we present the meaning of phonetics, phonology, its real implementation by investing the features of some of the techniques employed by various researchers.

Keywords – Homophones, Information Retrieval, Machine translation, Natural Language Processing (NLP), Phonetic analysis.

1. INTRODUCTION

The explosive growth of the World Wide Web has dramatically increased the amount of information on internet. Today we are drowned with abundant information but what is more important is the value of the information. People expect the information to be heard instead of only having the information in the form of text. However getting the computer to process sound is not an easy job. First we have to make the computer interpret Natural language, challenges of processing the natural language, how the sound is generated and how to produce the sound. With the help of NLP techniques, these are possible to achieve considerably.

1 .1 Phonetics: Phonetics is about studying the sounds we make when we talk. It concentrates on the way the sound is produced, how and why it sounds like and also compare with each other. [9]. They are,

- Acoustic phonetics: This deals with the waves of sound that are produced by human vocal organs for communication and how the sounds are transmitted. The sound is transmitted through air in the form of vibration from speakers' mouth to hearers' ear [9].
- Auditory Phonetics: This dispenses on how the brain and ear perceives the sounds. This branch deals with the physiological processes involved in the reception of speech [9].
- Articulatory Phonetics: Articulatory phonetics is interested in the movement of various parts of the vocal tract during speech. In simpler words, articulatory phonetics tells us how our mouth and vocal organs articulates and moves when we speak [9]. The examples of phonetic terms are shown in Table 1.

Table 1: **Examples of phonetic terms**

Term	Explanation	Example
Bilabial	Sound made using both lips.	/p/ as in **p**at /b/ as in **b**at
Labiodental	Sound made using the lower lip and upper teeth.	/f/ as in **f**at /v/ as in **v**ase
Alveolar	Sound made where	/d/ as in **d**ad

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	the tongue touches the alveolar ridge.	/s/ as in **s**at
Dental	Sound made using the teeth and tongue.	/ð/ as in **th**e/ θ/ as in **th**ing
Velar	Sound made using the back part of the tongue and the soft palate (velum).	/k/ as in **c**at/g/ as in **g**ate
Glottal	Sound made using the glottis.	Glottal stops:/ʔ/

There are two terms phonetics and phonology. Phonology is concerned with phonemes. Phonemes are the individual unit of speech which differs within each language. It also deals with the rules by which these sounds are constrained in order to make words (for example, in English, a word can never begin with the consonant cluster "ng").

Phonetics, however, is concerned with allophones, which are the actual physical manifestations of speech sounds. It is involved with how these sounds are actually produced in the vocal tract, transmitted by sounds waves and perceived by our auditory system. Phonetics is really just a description of the speech sounds, whereas phonology deals with meaning [9].

2. RELATED WORK

Phonetics was studied as early as 500 BC in the Indian subcontinent, with Panini's account of the place and manner of articulation of consonants in his 5th century BC treatise on Sanskrit. The major Indic alphabets today order their consonants according to Paṇini's classification. The Phoenicians are credited as the first to create a phonetic writing system, from which all major modern phonetic alphabets are now derived. Modern phonetics begins with attempts such as those of Joshua Steele (in Prosodia Rationalis, 1779) and Alexander Melville Bell (in Visible Speech, 1867) to introduce systems of precise notation for speech sounds. [10]

Stephen Hawking's Speech synthesiser: Stephen Hawking, an English theoretical physicist, cosmologist, author and Director of Research at the Centre for Theoretical Cosmology within the University of Cambridge uses speech synthesiser when he communicates. Using this he is able to convert the text into speech. A program called EZ keys has been written by world plus Inc. whatever he types on the keyboard the cursor will automatically scan each word row and column wise. Then the system produces the respective sounds. There is also word prediction option.

Mutalib et al, NSA has proposed a method of using the Soundex and Asoundex approach. In the paper titled *"Phonetic coding methods for Malay names retrieval, Semantic Technology and Information Retrieval (STAIR)"*, the author has carefully addressed the issues of homophones. Homophones are the words with the same pronunciation but provide different meanings. 'New' and 'Knew'; 'no' and 'know'; to, two, too; meat, meet: are some of the examples of homophones. The work is mainly concentrated on generating the "name code". Code generated by the program is then compared with the names in the test data. It has been shown for "Malay" language (Language spoken by Malaysian people) [7].

K.U. Ogbureke et al have proposed a paper which presents the phonetic segmentation and considerably deals with articulation phonetics. The work is concentrated on cross language phonetic segmentation using Hidden Markov Models (HMMs). It also provides extensive models that are applicable across languages. The efficiency was tested on Appen Spanish speech corpus and the efficiency of about 61.5% was achieved [5].

Patil H A et al have defined phonetic transcription for Indian languages like Gujarati and Marathi. In his paper [8], author has shown why the adhoc approaches does not work in order to establish the relationship between alphabetical symbols and phonetic symbols. The author has manifested some of the research issues like ambiguity between frication and aspirated plosive. The *anusvara* in both of these languages are produced based on the immediate following consonant. Furthermore, the effect of dialectal variations on phonetic transcription is also analyzed for Marathi. The writer also sighted some of the example sentences in the languages that were specified earlier.

The speech recognition system uses the knowledge obtained from phonotactics, phonology, and acoustic phonetics to apprehend admissible phonetic information. Hence the system can make

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broad classifications and also detailed phonetic distinctions. Espy-Wilson et al has proposed a paper [1] which discusses a framework for developing a phonetically based recognition system. The recognition task is the class of sounds known as the semivowels. Though the results obtained from the study were incomplete, it stimulated the bedrock for further studies.

Le, V.B et al. have shown how the IPA (International Phonetic Alphabet) system is limited to source/target phoneme mapping table construction and on the contrary the author has suggested an estimated model to compare the similarity between the two phonemes [2]. Based on the results of the above similarities, the polyphone and clustered polyphonic model similarities are investigated. According to the writer, the polyphone decision tree is built with the small amount of speech data. Then, clustered models in the target language are duplicated from the nearest clustered models in the source language and adapted with limited data to the target language. Results obtained from the experiments demonstrate the feasibility of these methods.

Khanagha, V et al have recommended a phonetic segmentation method based on speech analysis under Microcanonical Multiscale Formalism (MMF). The MMF depends on computation of local geometrical parameters, singularity exponents (SE). The SE conveys the phoneme boundaries. The author has proposed the 2-steps technique [6], which exploits the SE to upgrade the segmentation accuracy. The first step concentrates on detecting the boundaries of original signals and a low-pass filtered version and the union of all the detected boundaries are considered as the candidates. In the second step the hypothesis test was used over the original signal on the local SE distribution to determine the final boundaries. The authors have also done detailed evaluation and comparison test on TIMIT (acoustic-phonetic continuous speech corpus) which aids the other researchers to accomplish the collation task.

English language is homophonic in nature. The same words have multiple spelling orders. For example, ‘Soumya’ and ‘Sowmya’. Hence the author, Li Zhao et al, based on English phonetic spelling correction algorithms, has shown the mechanisms to solve common spelling errors such as missing letters, extra letters, disordered letters, as well as phonetic spelling errors in the perspective of from the same pronunciation, similar pronunciation. Algorithms such as phonetic spelling correction, phonetic spelling regulations, edit-distance and habit-distance is put forward carefully by the authors, thereby the overall exposition about spelling correction system is vigilantly proposed [4].

Authors Pitsikalis et al have shown an efficient new symbolic approach based on the HamNoSys symbols which converts the sign language annotations into structured sequences of labels established on the basis of Posture-Detention-Transition-Steady Shift phonetic model. Later these labels and their correspondence with visual features are exploited to build phonetics-based statistical sub-unit models. Next the sequences are aligned to the visual data to exact time boundary via the statistical sub-unit construction and decoding. Besides, the approach was experimented on the extended Lemmas Corpus of Greek Sign language. The method has shown satisfactory results not just on pure data-driven approaches but also in phonetic sub-unit models. This can also be expanded in interdisciplinary sign language analysis [3].

3. COMPARISON OF PHONETIC ALGORITHMS

The systematic way to equip the problem on phonetics in human language is to tackle the issues of homophones. Homophones are those words that have same sound but different spelling and meaning. There are lot of homophones in the English language. The study of homophones enriches one’s vocabulary by studying the meaning deeply and understanding carefully. Consider the following example: I) do not talk **aloud**. Aloud [noisily] II) they were **allowed** to go out. Allowed [permitted]. The first step towards phonetically identifying the language would be to build the dictionary of homophones. Further the dictionary should hold the corresponding meaning of each word and the related phoneme. Theoretically, it can shed light on a few questions on how the sound has to be processed and stored. To expand this, the sources on various approaches adopted by different researchers can be utilized.

Once the homophone dictionary is built along with the meaning of each homophone, this is succeeded by storing the sound of each of the word and its

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meaning. Sound storage is not an easy task. Issues of various phonetic complications and challenges need to be directed. Sound processing for computer is very difficult because of the language ambiguity. Computer cannot perceive and recognize sound like we human do. Diverse phonetic algorithm can be used for this purpose.

Phonetic algorithm is an algorithm for defining index for various sounds by their pronunciation. These algorithms are based for English language and hence applying the rules of algorithms for other words in different language will not work as expected. The algorithms are very complex in their rules and exceptions because of the barrier in pronunciation and spelling in English language. For example: the word 'Antivirus' has different pronunciation in US and UK English. . Various techniques adopted by different researchers have been indicated in the comparative study table (Table 2) below

Table 2: **comparative study**

Author	Techniques	Description
Mutalib and et al	Soundex and Asoundex	Homophones and generating name codes in Malay language
K.U Ogbureke and et al	Hidden Markov models	Phonetic segmentation and the work is concentrated on articulation phonetics
Patil H.A and et al	Phonetic transcription	A relation has been established between alphabetical symbols and phonetic symbols
Espy-Wilson and et al	Match rating approach	A Framework has been developed in order to utilize the knowledge obtained from phonotactics, phonology, and acoustic phonetics
Le V.B and et al	Daitch-Makotoff soundex and match rating approach	Comparative study between two phonemes. Upon the obtained results, the similarities between polyphone and clustered polyphonic model are investigated
Khanagha and et al	Micro canonical Multi scale formulation (MMF), and phonetic segmentation	• Boundaries of the original signals and low-pass filtered and the union of both is evaluated in the first step • Hypothesis test is conducted on the original signal in the second step
Li Zhao and et al	Phonetic correction algorithm, edit distance and habit distance	Mechanisms to solve the extra letters, spelling errors, missing letters and disordered letters have been proposed
Pitsikalis and et al	Posture-detention transition steady shift phonetic model	Sign language is converted into structured sequences of labels

4. CONCLUSION

The major focus of this paper has been on the role of phonetic analysis in any human languages. It is observed from all the discussions on the above mentioned papers, a lot of appreciable and considerably foolproof approaches have been proposed. It is obvious that an efficient and effective method to solve the ambiguity in the phonology field is to build a dictionary of homophones. This paper also describes an approach that has been proposed for extracting relations among diverse papers that were reviewed and the concepts to construct a coherent and well ordered phonetic dictionary which concentrates on homophones. It is aimed to improve the accuracy by the use of various phonetic algorithms like

soundex, Daitch–Mokotoff Soundex, Match Rating Approach. In future, it is aspired to express the defined methodologies on the other regional languages such as Kannada by the use of knowledge extracted by integrating multiple papers.

REFERENCES

1. *A phonetically based semivowel recognition system*, Espy-Wilson, Carol Y, Acoustics, Speech, and Signal Processing, IEEE International Conference on ICASSP '86. (Volume: 11) Digital Object Identifier: 10.1109/ICASSP.1986.1168807
2. *Acoustic-Phonetic Unit Similarities For Context Dependent Acoustic Model Portability*. Le,V.B, Acoustics, Speech and Signal Processing, 2006. ICASSP 2006 Proceedings. 2006 IEEE International Conference on (Volume:1) ISSN :1520-6149 Print ISBN: 1-4244-0469-X
3. *Advances in phonetics-based sub-unit modeling for transcription alignment and sign language recognition*, Pitsikalis, Computer Vision and Pattern Recognition Workshops (CVPRW), 2011 IEEE Computer Society Conference on 20-25 June 2011 Page(s):1 – 6 ISSN :2160-7508 Print ISBN:978-1-4577-0529-8
4. *Based on the Phonetic Spelling Correction System Research and Implementation*, Li Zhao, Computational Intelligence and Software Engineering, 2009. CiSE 2009. IEEE International Conference on 11-13 Dec. 2009 Page(s):1 – 4 E-ISBN : 978-1-4244-4507-3 Print ISBN: 978-1-4244-4507-3
5. *Framework for cross-language automatic phonetic segmentation, Acoustics Speech and Signal Processing (ICASSP)*,2010, K.U. Ogbureke, IEEE International Conference on 14-19 March 2010 Page(s): 5266 - 5269 ISSN :1520-6149 E-ISBN : 978-1-4244-4296-6 Print ISBN: 978-1-4244-4295-9
6. *Improving text-independent phonetic segmentation based on the Microcanonical Multiscale Formalism.* Khanagha, V, Acoustics, Speech and Signal Processing (ICASSP), 2011 IEEE International Conference on 22-27 May 2011 Page(s): 4484 – 4487 ISSN:1520-6149 E-ISBN:978-1-4577-0537-3 Print ISBN:978-1-4577-0538-0
7. *Phonetic coding methods for Malay names retrieval, Semantic Technology and Information Retrieval (STAIR)*,2011,Mutalib, IEEE International Conference on 28-29 June 2011 Page(s):125 - 129 E-ISBN :978-1-61284-353-7 Print ISBN:978-1-61284-354-4 INSPEC Accession Number:12192197
8. *Phonetic Transcription of Fricatives and Plosives for Gujarati and Marathi Languages*, 2012, Patil, H.A. Asian Language Processing (IALP), 2012 IEEE International Conference on 13-15 Nov. 2012 Page(s):177 – 180 E-ISBN :978-0-7695-4886-9 Print ISBN:978-1-4673-6113-2
9. https://sites.google.com/a/sheffield.ac.uk/all-about-linguistics/branches/phonetics
10. http://en.wikipedia.org/wiki/Phonetics