Indic TIMIT and Indic English lexicon: A speech database of Indian speakers using TIMIT stimuli and a lexicon from their mispronunciations

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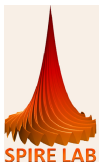


Overview

Key components

- **Indian English speech** corpus and Indian English lexicon.
- ∼**240 hours** of speech recording from 80 subjects.
- Each subject spoken a set of 2342 rich stimuli.
- A set of 2342 utterances were **annotated manually** and obtained phoneme transcriptions to reflect learners' pronunciation.
- Indic English lexicon containing **5,42,917** entries out of which **1,80,166** entries reflect Indian learners' mispronunciations.

Why Indian English speech corpus?

- L2 learners' spoken English **influenced** by their native language, which introduces mispronunciations and strong non-native accent.
- However, there is a **lot of demand** to build ASR system for non-native spoken English.
- ASR built with native English speech data **are not suitable** for the test conditions having non-native spoken English.
- Particularly, in CALL, mispronunciation detection and diagnosis is an **important** component.
- Moreover in India, **English language learning** has lot of demand, since it is a major language of communication in administration, law and education.

Why Indic TIMIT is unique?

Non-native Indian Context

- English speech corpus by Chinese speakers: ESCCL, SHEFCE, SELL, and SWECCL [a].
- German and Italian speakers: ISLE[b].
- Japanese speakers: NICT JLE[c].

[a] Chen, Hu, and Zhang, "Sell-corpus: an Open Source Multiple Accented Chinese-English Speech Corpus for L2 English Learning Assessment", 2019

[b] Menzel et al., "The ISLE corpus of non-native spoken English", 2000

[c] Izumi, Uchimoto, and Isahara, "The NICT JLE Corpus: Exploiting the language learners speech database for research and education", 2004

Indian Context

- Most of Indian corpora were collected primarily for ASR in Indian languages.
- Few Indian English corpora exist and those do not meet the requirements of ASR.

Why Indic TIMIT is unique?

Corpora	# speakers	Duration (HH:MM:SS)	Comments
DA-IICT[1]	137	00:10:00	20% data have sentence transcriptions
KIIT[2]	100	–	Only one speaker data is processed
IITKGP-MLILSC[3]	25	01:22:00	
L2-ARCTIC[4]	2	–	300 sentences have phoneme transcriptions

- A few are limited in the number of utterances with manual annotations.
- Data collected from Indian Government organizations such LDC-IL and TDIL are limited in dialects and data size.

[1] Patil, Sitaram, and Sharma, "DA-IICT cross-lingual and multilingual corpora for speaker recognition", 2009

[2] Agrawal et al., "Development of Text and Speech database for Hindi and Indian English specific to Mobile Communication environment.", 2012

[3] Maity et al., "IITKGP-MLILSC speech database for language identification", 2012

[4] Zhao et al., "L2-ARCTIC: A Non-Native English Speech Corpus", 2018

Recording of Indic TIMIT

Challenges in Indian context

- India is known for its language diversity, it has more than **1652** dialects/languages, out of which **22** are scheduled languages.
- It is **impractical** to record voice from the subjects belonging to all 1652 dialects/languages separately.

Strategy

- We consider languages which are scheduled languages and spoken by majority of the population.

Subject selection

- For selecting subjects, the following are considered:
- **Demographically** close languages share similar properties:
  - 1) North East, 2) East, 3) North, 4) Central, 5) West and 6) South.
- Indian languages are influenced by following **language families**:
  - 1) Indo-Aryan, 2) Dravidian, 3) Austro-Asiatic and 4) Tibeto-Burman.

Subject selection

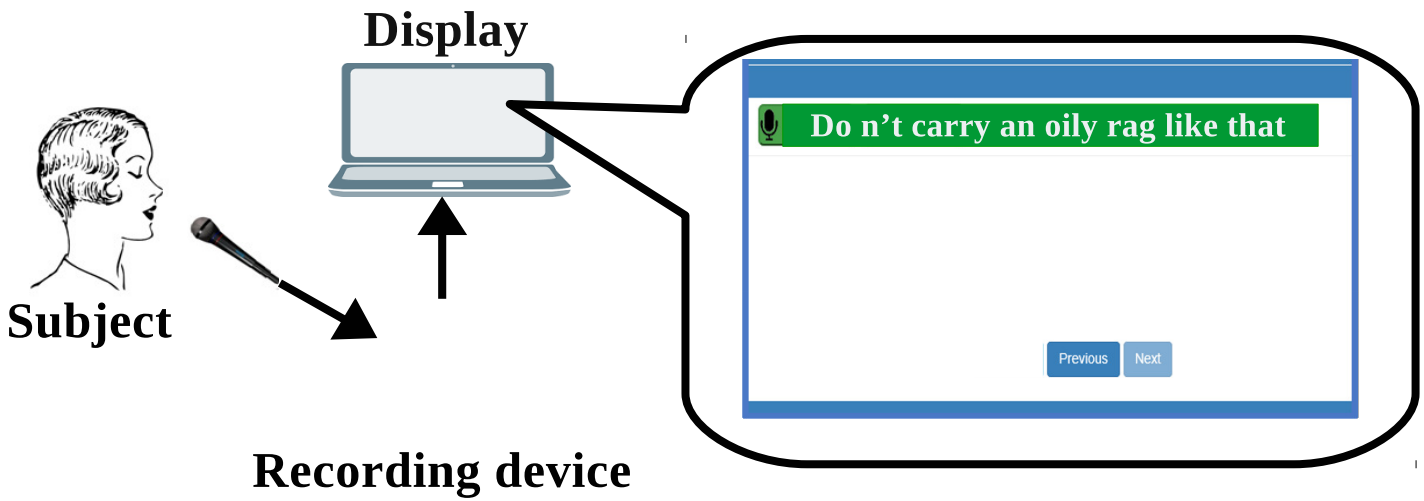
Region	Native language	Population percentage	Originated and/or influenced language family	Number of subjects (M/F) recorded	Grouping
North East	Assamese	1.28	Indo-Aryan Austro-Asiatic Tibeto-Burman	2 (0/)	Group-1
	Nepali	0.28	Indo-Aryan Tibeto-Burman	1 (0/1)	
	Manipuri	0.14	Tibeto-Burman	1 (1/0)	
East	Bengali	8.10	Indo-Aryan Austro-Asiatic	8 (4/4)	
	Maithili	1.18	Indo-Aryan	1 (1/0)	
	Oriya	3.21	Indo-Aryan	3 (2/1)	
North	Punjabi	2.83	Indo-Aryan	2 (0/2)	Group-2
Central	Hindi	41.03	Indo-Aryan	14 (8/6)	
West	Gujarati	4.48	Indo-Aryan	4 (3/1)	Group-3
	Konkani	0.24	Indo-Aryan	2 (0/2)	
	Marathi	6.99	Indo-Aryan	10 (5/5)	
South	Kannada	3.69	Dravidian Indo-Aryan	8 (3/5)	Group-4
	Telugu	7.19	Dravidian Indo-Aryan	8 (5/3)	
	Malayalam	3.21	Dravidian	8 (3/5)	Group-5
	Tamil	5.91	Dravidian	8 (5/3)	

- Consider L1 spoken by ∼90% population
- Group balance
- Gender balance in each group
- 16 subjects in each group
- In total 80 subjects

Subject selection

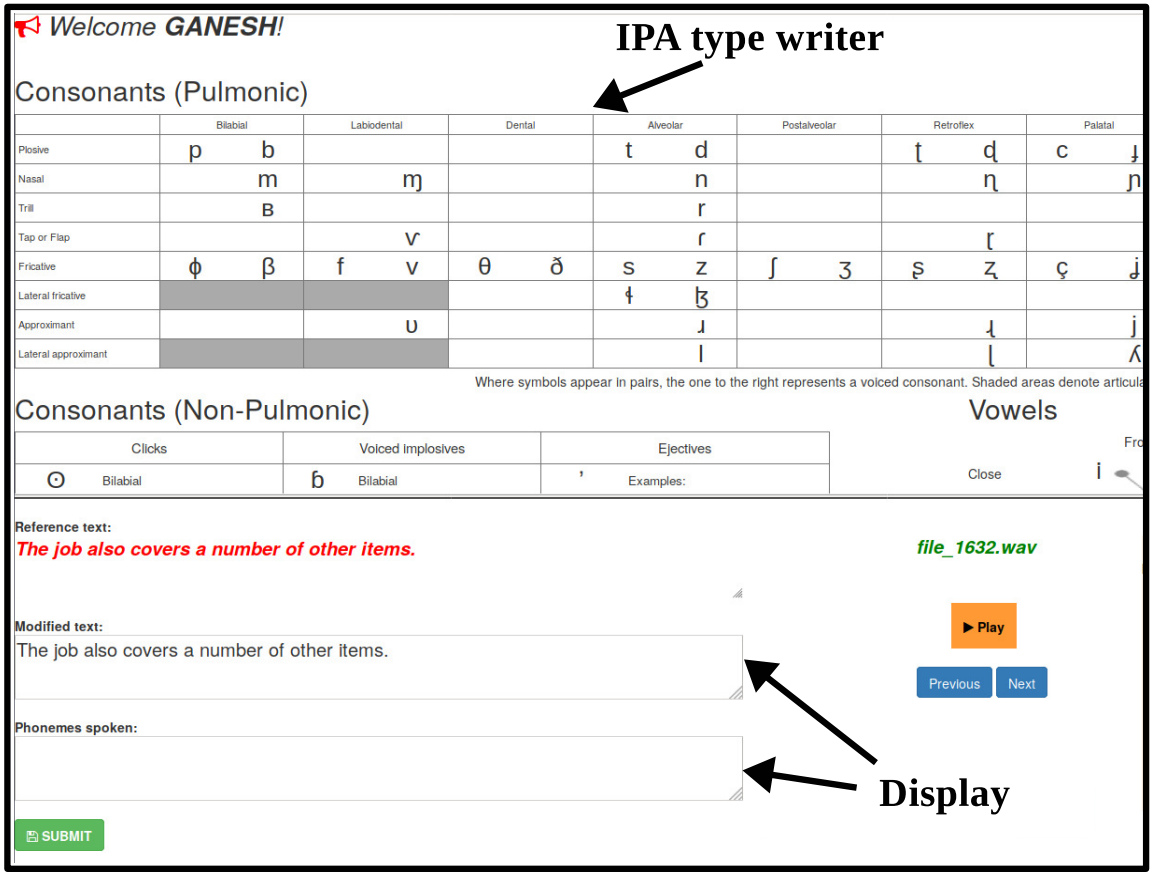
- The age of the subjects varies from 18 to 60 years with an average age of 25.42 years with standard deviation of 6.05 years.
- Subjects are UG, PG students and working staff from Indian Institute of Science, Bangalore, India.
- The subjects have variabilities in their pronunciation ability of reading English.

Recording setup



- During, an operator carefully listen to the subject's speech to spot any error (insertion, deletion of substitution of words).
- All 2342 unique sentences from TIMIT corpus considered for the recording.
- The recording is done in 16 sessions $\longrightarrow 15 \times 150 + 92$.

Manual annotation



- Two linguistics are annotated a set of 2342 stimuli.
- 512, 512, 295, 511 and 512 stimuli from the five groups.

Instructions

- Use '∼' to indicate the word boundaries in the phoneme transcriptions.
- In case of co-articulation between the words, merge those co-articulated words with '-' symbol in the modified text box (Don't split the words).
- Example: text transcription: "I didn't hurt you"; the uttered phonemes in the recording "i d ɪ d n t h ɝ tʃ u".
- Correct: in the "Modified text" and "Phoneme spoken" boxes, the entries should be "I didn't hurt-you", "i∼d ɪ d n t∼h ɝ tʃ u" but not "I didn't hur t-you", "i∼d ɪ d n t∼h ɝ∼tʃ u".

Analysis

Corrects	Insertions	Deletions	Substitutions
51.77	14.64	0.71	32.88

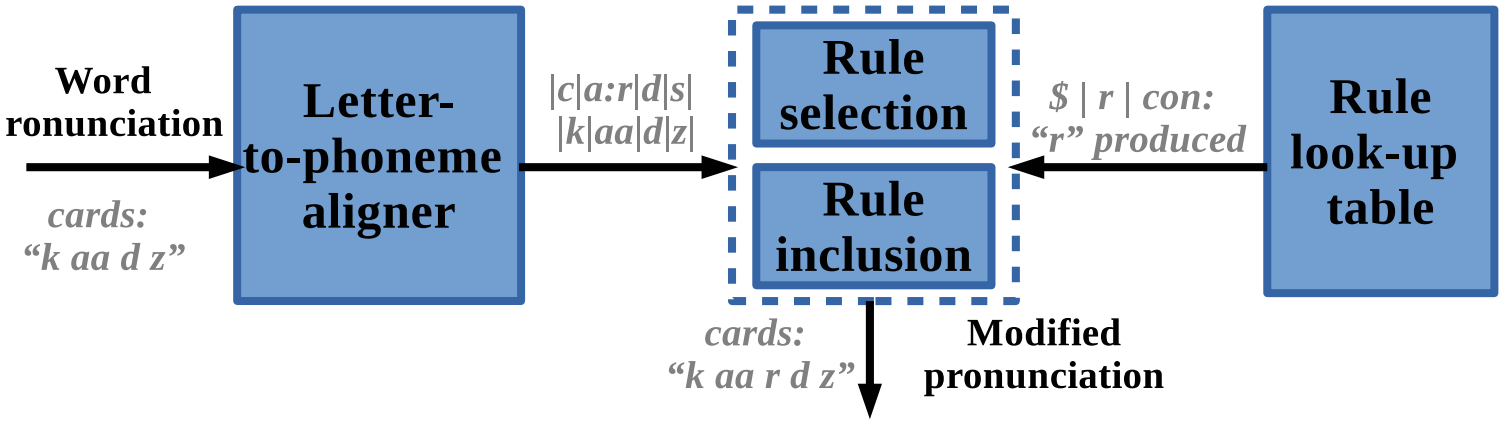
- String alignment is performed between the phoneme transcriptions in the TIMIT corpora and the manual annotated.
- The percentage of correct and erroneous phonemes are comparable.
- Thus, pronunciation of Indian speakers differs by a large extent from that of the native English speakers.

Indian specific pronunciation errors

- New word pronunciations are obtained by incorporating the variations based on mispronunciation rules to the existing word pronunciations.

Phoneme specific context rules			
Previous phoneme	Target phoneme	Next phoneme	Indian specific variations
Vowel	Plosive	Vowel	Plosive is voiced
Nasal	Plosive	Any	Plosive is voiced
Any	Dipthong (except /aɪ/, /aʊ/)	Any	Substituted with long vowels
Any	/ʒ/	Any	Substituted with dʒ
Any/None	/θ/	Any	Substituted with /t̪ʰ/ or /t̪/
Any/None	/ð/	Any	Substituted with with /d̪/
None	Front vowel	Any	Phoneme /j/ is inserted before the vowel
None	Back vowel	Any	Phoneme /w/ is inserted before the vowel
None	/w/	Any	Phoneme /w/ is deleted
Any	/tʃ, dʒ, s, z, ʃ, ʒ/	Any	Substituted with /ɛs/ or /ɛz/ or /əz/
Any	/f/	Any	Substituted with /pʰ/
Any	/v,w/	Any	Substituted with /bʰ/
None	consonant	consonant	vowel is inserted before or within both the consonants
Letter specific context rules			
Previous letter	Target Letter	Next letter	Indian specific variations
Any	r	Any consonant	Phoneme /r/ is produced
Any	s	t	Phoneme /ʃ/ or /s/ is produced
Any	n	g	Both /ŋ/ and /g/ are produced
Any	r	None	Phoneme /r/ is produced
Both letter and phoneme dependent context rules			
Previous letter	Target letter	Next phoneme	Indian specific variations
Any	Double consonants	Short vowel	Geminate articulation

Lexicon construction



- Native English lexicon: augmenting all the word pronunciations from CMU, Beep and the lexicon available in the TIMIT corpus.
- A total of 3,62,751 are found in this lexicon.
- M2M aligner for letter-to-phoneme alignment[5].
- Results a total of 5,42,917 entries in Indic English lexicon.

[5] Jiampojamarn, Kondrak, and Sherif, “Applying many-to-many alignments and hidden Markov models to letter-to-phoneme conversion”, 2007

ASR performance with Indic TIMIT data

Experimental setup

- Kaldi ASR tool-kit.
- Lexicon: Native English lexicon.
- Train set: 1636 stimuli from randomly chosen 63 speakers maintaining region and gender balance.
- Test set: Remaining 706 stimuli from the remaining speakers.
- LM: The sentences in the training set.
- For the comparison: trained with TIMIT train set.

Result

- WER is 15.02 with Indic TIMIT and is 93.41 with TIMIT data.

Forced-alignment performance with Indic English lexicon

Experimental setup

- Lexicons: Native English lexicon, Indic English lexicon.
- Train set: 1636 stimuli from randomly chosen 63 speakers maintaining region and gender balance.
- Test set: Remaining 706 stimuli from the remaining speakers.
- Objective measure: Phoneme error rate (PER) between estimated phoneme transcriptions and manual annotated transcriptions.

Result

- PER is 28.79 with Indic English lexicon and is 32.49 with native English lexicon.
- Erroneous pronunciations from Indian learners in Indic English lexicon help in achieving lower PER.

Conclusion and Future work

- This work describes Indic TIMIT corpus, a phonetically rich Indian spoken English corpus, to cater to the demand for large corpora under non-native speech conditions.
- This also reports the construction of Indic English lexicon, which is obtained based on the pronunciation errors made by the Indian speakers while speaking English.
- The corpus contains $\sim$240 hours of speech recordings from 80 subjects and manually annotated phoneme transcriptions for a sub-set of 2342 recordings.
- Experiments are conducted to examine the effectiveness of Indic TIMIT and Indic English lexicon in comparison with the data from TIMIT and a native English lexicon.
- Further works are proposed to annotate five sets, where each set contains all 2342 stimuli from each region considering uniform number of stimuli per speaker and multiple annotators.

Acknowledgment

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THANK YOU