

A Breadth-First Catalog of Text Processing, Speech Processing and Multimodal Research in South Asian Languages

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Abstract

We review the recent literature (January 2022–October 2024) in South Asian languages on text-based language processing, multimodal models, and speech processing, and provide a spotlight analysis focused on 21 low-resource South Asian languages, namely Saraiki, Assamese, Balochi, Bhojpuri, Bodo, Burmese, Chhattisgarhi, Dhivehi, Gujarati, Kannada, Kashmiri, Konkani, Khasi, Malayalam, Meitei, Nepali, Odia, Pashto, Rajasthani, Sindhi, and Telugu. We identify trends, challenges, and future research directions, using a step-wise approach that incorporates relevance classification and clustering based on large language models (LLMs). Our goal is to provide a breadth-first overview of the recent developments in South Asian language technologies to NLP researchers interested in working with South Asian languages.

1 Introduction

South Asian languages, with their diverse script systems, phonological structures, sociolinguistic contexts, and around 2 billion speakers, present unique challenges for both natural language processing (NLP) and speech processing tasks (Subbarao, 2008; Bhatt et al., 2021; Joshi et al., 2020). The region is home to hundreds of languages, many of which are low-resource, complicating the development of robust models for diverse tasks such as machine translation, speech recognition, and large language models (LLMs). In recent years, with the advent of large language models and similar breakthroughs in vision and speech, there has been hope that the benefits reaped by high-resource language communities will manifest to the same extent in low- and medium-resource languages in South Asia. The Asia Pacific artificial intelligence market, which includes several South Asian countries and valued at \$50.41 million in 2023, is projected to grow at 45.7% from 2024 to 2030 (GrandViewResearch, 2024).

Several commercial organizations have already allocated significant resources in this direction. The main ones are Google, Microsoft, and Meta, who each have dedicated projects aimed at improving the linguistic diversities of their models and training data, such as Project Vaani (IISc, 2024), Microsoft Cognitive Services (Microsoft, 2024), and No Language Left Behind (Meta, 2024). Other major South Asian companies have also started building highly capable language models that are built with a “local-first” approach, resulting in highly focused models for South Asian applications (Tata-NVIDIA, 2024; Tech-Mahindra, 2024; Ola, 2024; Reliance-NVIDIA, 2024; Zoho, 2024). Many South Asian startups are also focused on creating and applying large language models to South Asia-specific applications (Lanka Law, 2024; Inc., 2024; Traversaal.ai, 2024; CoRover.ai, 2024). Government organizations are also leading efforts in this direction, such as the Ministry of Culture and Information Technology in Nepal (of Communications & Information Technology, MoCIT), the Ministry of Electronics and Information Technology in India (MeitY, 2023), the National Technology Fund in Pakistan (UrduPoint News, 2024), the Computer Council in Bangladesh (EDGE Project, 2024), the Information and Communication Technology Agency in Sri Lanka (Information and Communication Technology Agency of Sri Lanka, 2024), and the National Center for Information Technology in Maldives (Kim, 2024), in addition to non-profit AI initiatives from organizations in south Asia and elsewhere, for example, Gupta and Banerjee (2024) and Ardila et al. (2020).

Given the pace of innovation in language technologies in South Asia and other demographics, survey and review articles that summarize the latest developments can help foster collaboration, inform perspectives, and educate new researchers in the field. This paper aims to provide a systematic review of the existing literature, identify

trends, and propose future research directions in text-based models, multimodal models, and speech-based models.

The closest article we found that is similar to our review is [Sankalp et al. \(2024\)](#), which focuses on 84 relevant publications, prioritizing depth over breadth. In this paper, we choose to prioritize breadth over depth, relying on machine learning-based literature survey techniques such as classification, clustering and topic modeling. We also cover multiple themes within the same article, namely language models, multimodal approaches, audio models. Other articles in this field focus on specific topics such as performance ([Hasan et al., 2024b](#)), data ([Parida et al., 2024](#)), and bias ([Gupta et al., 2024](#)).

2 Methodology

We adopt a multi-stage approach to curate and analyze articles, according to the schematic mentioned in Figure 1:

- **Google Scholar queries:** We used Google Scholar for our initial discovery of candidate papers, given its versatility and ability to efficiently index literature from multiple sources. We used *Publish or Perish* software ([Harzing, 2010](#)) to compile the metadata of the articles efficiently. In order to generate more diversity in our searches, we started with a base prompt, generated 5 queries from GPT-4o ([OpenAI, 2024](#)), and then manually reviewed those queries to make any necessary edits before using them to search for articles on Google Scholar.
- We sampled 20 paper titles out of our search results and labeled them as relevant or irrelevant.
- GPT-4o used these labels as in-context training data to predict relevance labels for all articles, using a batch size of 100 articles. Articles predicted to be irrelevant and/or published before 2022 were excluded from further analysis.
- We used OpenAI’s O1 model, given its advanced reasoning capabilities ([Zhong et al., 2024](#)), to group the papers predicted to be relevant into various topics. We also tried other approaches such as BERTopic ([Grootendorst, 2022](#)) for topic modeling, but the resulting

topics were not as coherent as the topics predicted by the O1 model.

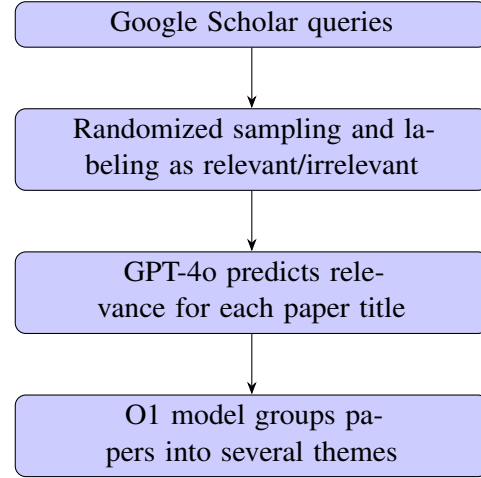


Figure 1: Flowchart for the Research Paper Classification and Theme Generation Process

Table 1 summarizes the results of our approach for each of the 3 fields we investigated.

Category	Initial Papers	Relevant Papers Detected (since 2022)
Language Models	1519	369
Multimodal Models	1709	84
Speech Processing	558	52

Table 1: Summary of relevant papers detected

3 Findings and Trends: Language Models

We found the following major themes in textual language processing:

3.1 Machine translation and cross-lingual transfer learning

In this topic we found papers on analyzing machine translation evaluations in low resource languages ([Singh et al., 2024c](#)), lexical enhancing of pre-trained language models for low-resource machine translation ([Lalrempuii and Soni, 2023b](#)), translating code-switched languages ([Huzaifah et al., 2024](#)), and Romanization-based LLM finetuning ([J et al., 2024](#)).

3.2 Hate speech, offensive content, sentiment analysis, and other applications

In this topic, we found several task-specific papers, such as sentiment analysis ([Tonmoy, 2023](#); [Rani et al., 2024](#); [Maqsood, 2023](#)), sarcasm detection ([Bhaumik, 2023](#); [Hassan et al., 2024](#)), hate speech

detection (Nath et al., 2023b), hate speech detection (Roy et al., 2022; Bansod, 2023), emotion detection (Vedula et al., 2023), fake news detection (Rauf et al., 2022; Balaji et al., 2023), depression detection (Hoque and Salma, 2023), cyberbullying classification (Hoque and Seddiqui, 2023), humor detection (Muttaraju et al., 2022), and misogyny detection (Singh et al., 2024a).

3.3 Bias and fairness

Bias and fairness studies have typically focused on Western cultural contexts and stereotypes, which do not take into account south Asia specific biases such as caste and religion. In this topic, the most comprehensive dataset we found was BheD Khan-delwal et al. (2024), where even GPT 3.5, a leading LLM, was found to have a much higher propensity to stereotype along the dimensions of caste and religion (79.52 % and 70.49 % respectively). Other studies have included aspects such as inclusivity (Khanuja et al., 2023), gender and religious bias (Sadhu et al., 2024), and gender bias that emerges while translating from English to South Asian languages with gender-neutral pronouns, for example, Bengali (Ghosh and Caliskan, 2023).

3.4 Adapting LLMs for South Asian Languages

In this topic we found papers on aspects such as prompt engineering (Hasan et al., 2024a), efficient foundation models (Niyogi and Bhattacharya, 2024), and translation-assisted chain-of-thought prompting (Upadhayay and Behzadan, 2024).

3.5 Datasets and Benchmarks

In this topic, we found several datasets spanning various domains such as legal documents Kapoor et al. (2022), abstractive summarization of medical queries Khan et al. (2023), multilingual question-answering (Singh et al., 2024c), machine translation metric meta-evaluation (Sai B et al., 2023), named entity recognition (Haque et al., 2023; Murthy et al., 2022), classical literature-based monolingual corpora (Bhattacharyya et al., 2023), language-specific benchmark suites (Joshi, 2022), treebanks (Abirami et al., 2024), LLM generation (Singh et al., 2024d), and parallel corpora (Ramesh et al., 2022). We also found task-specific datasets such as fake review detection (Shahariar et al., 2024).

4 Findings and Trends: Multimodal Models

We found the following major themes in multimodal modeling:

4.1 Multimodal Machine Translation

Multimodal machine translation aims to improve translation quality by using multimodal input such as static images, such as the ViTA model (Gupta et al., 2021). Representative papers from this theme include Meetei et al. (2023) (Hindi-English), Laskar et al. (2023a) (English-Assamese), and Laskar et al. (2022a) (English-Bengali), and Sethi et al. (2022) (Sanskrit-Hindi).

4.2 Image Captioning

On this topic, we mostly found papers on image captioning in languages such as Hindi (Mishra et al., 2022, 2023b), Assamese (Choudhury et al., 2023; Das and Singh, 2022), Urdu (Afzal et al., 2023), Tamil (Vishnu Kumar and Lalithamani, 2022), Telugu (Reddy et al., 2023), and Bengali (Das et al., 2023c).

4.3 Multimodal Hate Speech and Offensive Content

On this topic, we found papers such as multimodal troll meme detection (Hasan et al., 2022), multimodal misogyny identification (Singh et al., 2024b), and multimodal hate speech detection (Singh et al., 2024b).

4.4 Multimodal Sentiment Analysis and Emotion Recognition

In this topic, we found papers on multimodal emotion recognition (Taheri et al., 2023), along with multimodal sentiment analysis of various types of content such as news (Das and Singh, 2023) and memes (Elahi et al., 2023).

4.5 Multimodal Datasets

Similar to the Visual Genome (Krishna et al., 2017), we found Visual Genome datasets in South Asian languages such as Bengali (Sen et al., 2022) and Mizo (Khenglawt et al., 2022). In addition to well-known multilingual multimodal evaluation datasets such as Thapliyal et al. (2022) and Nielsen and McConville (2022), we also found other interesting datasets such as multilingual audio/video facial expressions (Singh et al., 2023b) and multimodal face emotion recognition on code-mixed memes in Tamil (Kannan et al., 2023).

5 Findings and Trends: Speech Processing

We found the following major themes in speech processing:

5.1 Code Mixing

We found papers on several code mixing-related topics such as normalizing code-mixed text to generate speech (Manghat et al., 2022), automatic speech recognition (ASR) in noisy code-mixed speech (Verma et al., 2023), adapters for code-mixing (Kulkarni et al., 2023), collaging monolingual corpora for code-mixed speech synthesis (Hussein et al., 2024), and benchmarking code-mixed speech synthesis (Hamed et al., 2023).

5.2 Abusive speech, language identification, and speech-to-speech translation

In this section, we found papers on specific tasks such as abusive speech detection (Spiesberger et al., 2023), language identification (Kulkarni et al., 2022), and speech-to-speech translation for English → Kannada (Malage et al., 2023a), Punjabi → English (Kaur et al., 2024), and English → { Hindi, Telugu, Gujarati, Marathi, Punjabi } (Spiesberger et al., 2023).

5.3 Speech modeling and speech recognition

The most prominent of the recent models we found in this topic are the AI4Bharat wav2vec models for South Asian language speech recognition (Javed et al., 2022). We also found papers on aspects such as end-to-end speech recognition (Changrampadi et al., 2022), speech recognition focused on specific phonemes (Gupta et al., 2022), postprocessing for error correction (Kumar et al., 2022b), senone prediction and senone mapping (Madhavaraj and Ganesan, 2022), and joint speech-text representation learning (Chen et al., 2023b).

6 Speech processing with low resources

In this topic, we found papers on approaches relevant to low-resource speech recognition and synthesis, such as data augmentation (Majhi and Saha, 2024a), novel loss functions for low-resource speech recognition (Chen et al., 2023a), text-to-speech pseudolabels (Gupta et al., 2022), mining audio and text pairs from public data (Bhogale et al., 2023), deep prefix tuning for dialect adaptation (Alumäe et al., 2023), and merging Hidden Markov Models with HiFiGAN (Su et al., 2020)

to improve voice quality in text-to-speech systems (Srivastava et al., 2023).

6.1 Datasets and benchmarks

In this topic, we found papers on metrics (Shah et al., 2022b), south Asia-specific versions (Javed et al., 2023) of popular speech processing benchmarks such as Yang et al. (2021), and language-specific datasets such as Mirishkar et al. (2023a) (Telugu) and Alam et al. (2022) (Bengali).

7 Findings and Trends: Low-Resource Language Spotlight

For this section, we searched the literature on the following low-resource languages. The languages were chosen because they have an official status at least in the regions in which they are widely spoken. We used literal string-based matching rather than topic modeling and LLM-based relevance, because the precision and recall of the GPT-4o relevance classifier was significantly low (precision 0.33, recall 0.7) when compared to the relevance models for textual, multimodal and speech processing on the labeled dataset used for in-context learning in the GPT-4o prompt. We observed that Nepali, Assamese, and Telugu were the most popular languages, with more than 50 papers each since 2022.

7.1 Nepali (63 papers)

Spoken primarily in Nepal and parts of India, Nepali belongs to the Indo-Aryan language family and is spoken by over 28 million people. We found the most papers in this language, with several major themes being covered, such as text summarization (Awale et al., 2022; Pokhrel and Adhikari, 2023), keyword generation (Shrestha et al., 2024), sentiment analysis (Pahari and Shimada, 2023; Zimmer and Tripathee, 2024; Gurung, 2024; Pudasaini et al., 2024), and named entity recognition/parts of speech tagging (Subedi et al., 2024; Niraula and Chapagain, 2023; Pradhan and Yajnik, 2024). There are several papers on language modeling and evaluation in Nepali (Subedi et al., 2024; Majhi et al., 2024; Pudasaini et al., 2023; Luitel et al., 2024). There have also been papers on multimodal applications such as visual question answering (Gyanwali et al., 2024), (Parajuli and Joshi, 2023), video captioning (Hyoju and Joshi, 2023; Budhathoki and Timilsina, 2023), optical character recognition (Paudel et al., 2024), and the transla-

tion of American Sign Language to Nepali (Paneru et al., 2024). On the speech side, there has been significant work in speech recognition (Acharya, 2022; Joshi et al., 2023; Joshi and Shrestha, 2023; Joshi et al., 2022; Ghimire et al., 2024; Raj et al., 2023b,a) and text-to-speech synthesis (Rai et al., 2024; Khadka et al., 2023).

We also observe an emerging trend in terms of studies on AI ethics (Jha, 2024) and AI applied to various domains such as social good (Kumar et al., 2024; Kapri, 2022), studying social media trends (Dhakal et al., 2024), along with health care applications such as Alzheimer’s (Adhikari et al., 2022) and prenatal health (Poudel et al., 2023). This shows how NLP research in Nepali has extended to cutting-edge topics beyond traditional topics such as machine translation.

7.2 Assamese (58 papers)

Assamese, an Indo-Aryan language, is spoken predominantly in the Indian state of Assam and parts of neighboring Indian states. It has around 14 million speakers. Research themes have included chatbots (Sarma and Pathak, 2024), transliteration (Baruah et al., 2024b,a), named entity recognition (Pathak et al., 2022), parts of speech tagging (Pathak et al., 2023; Talukdar and Sarma, 2023b, 2024b,a; Phukan et al., 2024), machine translation (Laskar et al., 2022b, 2023b; Kashyap et al., 2024), sentiment analysis (Das and Singh, 2023), text summarization (Goutom et al., 2024; Baruah et al., 2022; Goutom and Baruah, 2023), data augmentation (Lalrempuii and Soni, 2023a), tokenizers (Tamang and Bora, 2024), and text classification (Talukdar and Sarma, 2023a; Medhi and Sarma, 2023).

Outside the text modality, we encountered research in image captioning (Nath et al., 2022), speech-based vocabulary identification (Dutta and Choudhury, 2022), Assamese sign language recognition (Bora et al., 2023), emotion recognition from speech in Assamese (Choudhury and Sharma, 2023), and speech-based gender detection (Dutta et al., 2022). We also came across speech signal and phonetic analysis studies, such as vowel speech signal identification (Sarmah et al., 2023), word stress and its effects on Assamese and Mizo languages (Gogoi and Nath, 2023), and Assamese-Bengali cognate detection (Nath et al., 2023a). There was some work on cultural and societal empowerment too, for example, linguistic preserva-

tion (Borah et al., 2023), and machine learning-based detection of Assamese cultural objects such as Assamese Dhol (musical instrument) and Mohor sing (musical instrument) (Lahkar and Gogoi, 2023).

A striking feature in Assamese NLP literature when compared to other low-resource South Asian languages was the relatively larger number of papers on hate speech. Hate speech is a growing concern in South Asian communities (Liebowitz et al., 2021; International, 2022), and existing literature has covered offensive language (Mim et al., 2023) and hate speech (Ghosh et al., 2023b,a; Baruah et al., 2023) detection in Assamese and other neighboring languages such as Bengali and Bodo.

7.3 Telugu (57 papers)

Telugu, a Dravidian language, is spoken primarily in the Indian states of Andhra Pradesh and Telangana. It has over 85 million speakers. In Telugu, we found work on morphological analysis (Dasari et al., 2023), sentiment analysis of news articles, social media and other textual data (Viswanadh, 2024; Naidu and Seshashayee, 2024; Rayala et al., 2023; Tallu and Battula, 2022), text summarization (Bhuvaneshwari and JyothiRani, 2023; Lakshmi and Latha, 2022; GL and Badugu, 2023), named entity recognition (Gorla et al., 2022; Duggenpudi et al., 2022), hate speech detection (Sai et al., 2024; Achamaleh et al., 2024), abusive comment detection (Priyadharshini and Chakravarthi, 2023), LLM evaluation (Kishore and Shaik, 2024), event extraction (Burramsetty and Gonugunta, 2022), domain adaptation (Hema, 2022), reinforcement learning from human feedback (Srinivas et al., 2023), language identification (Jaswanth et al., 2022), text classification (Marreddy, 2023; Santhoshi and Badugu, 2022), graph-based topic modeling (Namburu et al., 2024), word sense disambiguation (Koppula et al., 2022), machine translation (Vamsi and Bataineh, 2023), and question-answering (Kumar, 2024; Ravva, 2023).

Multimodal research included handwriting recognition (Babu et al., 2022; Revathi et al., 2024; MEENA et al., 2022; Reedy et al., 2024), whereas speech processing literature consisted of speech recognition (Yadavalli and Mirishkar, 2022; Mirishkar et al., 2023b), spoken digits modeling (Bhagath et al., 2022, 2023b), speech intelligibility (Venkateswarlu et al., 2022), and text-to-speech modeling (Kumar et al., 2023). Code mixing is

important in Telugu as it is in the majority of South Asian languages, and we observed that papers on other themes in Telugu NLP considered this aspect in their work. For a survey on Telugu-English code-mixed text, we refer the reader to [Maddu and Sanapala \(2024\)](#). Applications included tourist assistance ([Kolar and Kumar, 2023](#)), farmer assistance ([Srinivas et al., 2023](#); [Naidu and Seshashayee, 2024](#)), and IoT devices ([Bhagath et al., 2023a](#)).

7.4 Kannada (49 papers)

Kannada, another Dravidian language, is spoken primarily in the Indian state of Karnataka. It has over 44 million speakers. In Kannada, we found papers on hope speech detection ([Hande et al., 2022](#)), code-mixing ([Balouchzahi et al., 2022](#); [Vajrobol, 2022](#); [Shashirekha et al., 2022](#)), machine translation ([Sheshadri and Bharath, 2022](#); [Shetty et al., 2023](#); [Kashi and Vineeth, 2023](#); [Patil et al., 2024](#)), paraphrase generation ([Anagha et al., 2023](#)), part-of-speech tagging ([Mamatha, 2023](#); [Shetty et al., 2022](#)), preprocessing ([Lavanya and Swamy, 2024](#)), authorship attribution ([Chandrika and Kallimani, 2022](#)), and syntactical parsing ([Shree and Shambhavi, 2022](#)).

On the speech side, we found papers on code-mixed speech synthesis ([Suresh and Damotharan, 2024](#)), speech recognition in noisy environments ([Yadava et al., 2024](#); [Thimmaraja et al., 2023](#)), visual speech recognition ([Shashidhar et al., 2024](#); [Rudregowda et al., 2023](#)), and speech-to-speech translation ([Malage et al., 2023b](#)). Other themes included image caption generation ([Chethas et al., 2023](#)), subtitle generation ([Santosh and Livingston, 2023](#)), and handwritten character recognition ([Hebbi and Mamatha, 2023](#); [Tejas and Dutta, 2022](#)). We also found a paper analyzing Kannada social media trends ([Dey et al., 2023](#)). According to our survey, within the low-resource languages, Kannada seemed to be the most advanced when it came to speech-related research, especially in multimodal speech recognition, subtitle generation, and speech-to-speech translation, which also happen cutting-edge topics in high-resource languages.

We also found papers describing AI applications such as virtual medical assistance ([Bai et al., 2023](#)), legal document summarization ([Megha et al., 2024](#)), and oral community knowledge management ([Aparna et al., 2023](#)).

7.5 Malayalam (28 papers)

Malayalam, a Dravidian language, is spoken primarily in the Indian state of Kerala. It has over 35 million speakers. In Malayalam, we found papers on text classification ([Krishnan and Anastasopoulos, 2022](#)), typographical error correction ([Ratnam et al., 2024](#)), named entity recognition ([Harikrishnan and Bindu, 2023](#)), summarization ([Nambiar et al., 2023](#); [Pankaj, 2023](#)), and question-answering ([K et al., 2023](#)). Interesting finds were papers on machine translation between Sanskrit and Malayalam ([Chingamtotattil and Gopikakumari, 2022](#); [Rahul et al., 2023](#)), along with a language-specific benchmark dataset, MbAbI, for Malayalam text understanding and reasoning ([Rahmath and Raj, 2023](#)), which consists of 20 natural language understanding/reasoning tasks, which are similar to the English language Babi benchmark ([Weston et al., 2015](#)).

In speech processing, we found papers on speech recognition ([Manohar and Rajan, 2023](#); [Manohar et al., 2023](#); [Manohar, 2023](#)), grapheme to phoneme conversion ([Priyamvada et al., 2022](#)), and representation learning ([Thandil and Basheer, 2023](#)). We also found papers on handwritten character recognition from contemporary contributors ([Sudarsan and Sankar, 2024](#)) and palm leaf manuscripts ([Baiju, 2023](#)).

7.6 Gujarati (21 papers)

Gujarati, an Indo-Aryan language, is spoken primarily in the Indian state of Gujarat. It has over 55 million speakers. In Gujarati, we found papers in topics such as hate speech and offensive content detection ([Ranasinghe et al., 2023](#); [Sathya et al., 2023](#)), sentiment analysis on Twitter ([Gokani and Mamidi, 2023](#)), reviews ([Shah and Swaminarayan, 2022](#)), and movies ([Shah et al., 2022a](#)), text summarization ([Kevat and Degadwala, 2023, 2024](#); [Mehta et al., 2022](#); [Desai, 2022](#)), machine translation ([Patel and Joshi, 2022, 2023](#); [Ganatra and Domadiya, 2024](#)), and typographical error correction ([Panchal and Shah, 2024](#)).

Similar to other languages, we also found papers on handwritten character recognition, for example, ([Kothadiya et al., 2023](#)), which uses vision transformers to recognize handwritten characters in Gujarati. Such studies are important, given the lack of access to efficient digital typing tools ([Hossain, 2024](#)) and the prevalence of handwritten documentation. In speech processing, we found papers on

spoken digits (Pandit and Bhatt, 2023), speech-to-text models to assist disabled people (Aasofwala et al., 2023). For a review of speech recognition in Gujarati, we refer the reader to Dua et al. (2024). We also found a paper on optical character recognition of various Gujarati language fonts (Joshi and Arolkar, 2022). In terms of applications, we found a paper that implements a model to recommend recipes to cardiac patients (Mehta and Thaker, 2023).

7.7 Odia (19 papers)

Odia, an Indo-Aryan language, is spoken primarily in the Indian state of Odisha. It has over 33 million speakers. We found papers on Hindi-Odia machine translation (Balabantaray et al., 2023), named entity recognition (Anandika and Chakravarty, 2023), parts of speech tagging (Dalai et al., 2023, 2024), hate speech detection (Som et al., 2024), language modeling (Dey and Maringanti, 2023; Kohli et al., 2023; Agarwal et al., 2023; Parida et al., 2023), and document summarization (Nayak and Das, 2022; Pattnaik and Nayak, 2022). We also found work on handwritten digit (Das and Mohanty, 2023) and character (Panda et al., 2022) recognition.

In speech processing, we found papers on voiced digit recognition (Mohanty et al., 2022a,b), automated speech recognition Voiced Odia digit recognition (Majhi and Saha, 2024b), and speech emotion recognition (Swain et al., 2022). Mishra et al. (2023a) gives a detailed review of automated speech recognition in Odia.

7.8 Sindhi (16 papers)

Sindhi, an Indo-Aryan language, is spoken primarily in the Sindh province of Pakistan and parts of India. It has over 25 million speakers. In Sindhi, we found papers on corpus analysis (Talpur et al., 2023; Sodhar and Sulaiman, 2023a), chunking (Arora et al., 2024), coreference resolution (Farooqui et al., 2023), part of speech tagging (Memon et al., 2024; Nathani et al., 2023), grammar (Trumpf, 2023), sentiment analysis (Barakzai et al., 2022; Alvi et al., 2023; Sodhar et al., 2023), morphological analysis (Sodhar and Sulaiman, 2023b), fake news detection (Roshan et al., 2023). We found a paper on speech recognition (Bux et al., 2022) but no papers on other multimodal studies. For a survey of NLP resources in Sindhi, we refer the reader to Rajan and Salgaonkar (2022).

7.9 Bodo (15 papers)

Bodo, a Sino-Tibetan language, is spoken primarily in the Indian state of Assam. It has around 3 million speakers. In Bodo, we found papers on corpus creation (Narzary et al., 2022b), hate speech and offensive content detection (Mim et al., 2023; Ghosh et al., 2023b; Ranasinghe et al., 2023), named entity recognition (Narzary et al., 2024a), part-of-speech tagging (Pathak et al., 2024; Basumatary et al., 2023), machine translation (Kalita et al., 2023; Narzary et al., 2024b), word sense disambiguation (Basumatary and Barman, 2024; Basumatary et al., 2022), text summarization (Das et al., 2024), and autoregressive text generation (Das et al., 2023a,b). In speech processing, we found a paper on tonal identification in the Bodo language (Narzary et al., 2022a).

7.10 Pashto (8 papers)

Pashto, an Indo-Iranian language, is spoken mainly in Afghanistan and Pakistan. It has around 50 million speakers. In Pashto, we found papers on handwriting recognition (Hussain et al., 2022; Khaliq et al., 2023), sign language recognition (Shokoori et al., 2022), offensive language detection (Haq et al., 2023b), poetry generation (Ullah et al., 2024a), speech recognition (Ahmed et al., 2024), and alphabet analysis (Nasrat, 2023). Haq et al. (2023a) provides a toolkit for Pashto NLP.

7.11 Burmese (8 papers)

Burmese, a Sino-Tibetan language, is spoken primarily in Myanmar. It has over 32 million speakers. In Burmese, we found papers on machine translation between Burmese and other languages such as Wa and Rohingya (Yune and Soe, 2023; Myint Oo et al., 2022; Oo et al., 2023), multilingualism studies (Li et al., 2022), and medical automatic speech recognition (Htun et al., 2024). We also found a clinical microbiology dataset (Si Thu, 2024) in Burmese.

7.12 Konkani (5 papers)

Konkani, an Indo-Aryan language, is spoken primarily in the Indian states of Goa, Maharashtra, Karnataka and Kerala. It has around 3 million speakers. In Konkani, we found papers on text summarization (More and DSilva, 2023; DSilva and Sharma, 2022, 2023) and machine translation (Kamath et al., 2023). For a survey on NLP resources in Konkani, we refer the reader to Rajan

and Salgaonkar (2022).

7.13 Khasi (4 papers)

Khasi, a Sino-Tibetan language, is spoken primarily in the Indian state of Meghalaya. It has around 1.5 million speakers. In Khasi we found papers on machine translation (Hujon et al., 2024), speech recognition (Rynjah et al., 2022; Deepajothi et al., 2024), and word embeddings (Thabah et al., 2022).

7.14 Bhojpuri (4 papers)

Bhojpuri, an Indo-Aryan language, is spoken mainly in India and Nepal. It has around 55 million speakers. In Bhojpuri, we found papers on named entity recognition (Mundotiya et al., 2023), translating Hindi synsets to Bhojpuri (Ali and Gatla, 2023), speech corpora (Kumar et al., 2022a), and part of speech tagging and chunking (Mundotiya et al., 2022).

7.15 Kashmiri (3 papers)

Kashmiri, an Indo-Aryan language, is spoken primarily in the Indian state of Jammu and Kashmir and in Pakistani-administered Kashmir. It has around 7 million speakers. In Kashmiri, we were only able to find dataset-related papers (Qumar et al., 2024a; Lone et al., 2022; Qumar et al., 2024b).

7.16 Meitei (2 papers)

Meitei, a Sino-Tibetan language, is spoken primarily in the Indian state of Manipur. It has around 2.5 million speakers. In Meitei, we found 1 paper on handwriting recognition (Hijam, 2024) and 1 paper on speech recognition (Pangsatabam et al., 2023).

7.17 Chhattisgarhi, Dhivehi, Sairaki, Rajasthani, and Balochi (1 paper each)

Chhattisgarhi, an Indo-Aryan language, is spoken primarily in the Indian state of Chhattisgarh. It has around 16 million speakers. We found only 1 paper in Chhattisgarhi, which was a text-to-speech model trained on 20 hours of data from 2 speakers (Singh et al., 2023a).

Dhivehi, an Indo-Aryan language, is the official language of the Maldives. It has around 350,000 speakers. We found a paper that improved automatic speech recognition (Ahmed, 2023) in Dhivehi using sub-word modeling, language model decoding, and automatic spelling correction.

Saraiki, an Indo-Aryan language, is spoken primarily in Pakistan. It has around 30 million speak-

ers. We found a paper on a part-of-speech tag set in Saraiki (Malik et al., 2023).

Rajasthani, an Indo-Aryan language, is spoken primarily in the Indian state of Rajasthan. It has around 40 million speakers. We found a paper on the dialect recognition of the Bagri dialect of the Rajasthani language using an optimized feature swarm convolutional neural network (CNN) (Kukana et al., 2024).

Balochi, an Iranian language, is spoken primarily in Pakistan and Iran. It has around 10 million speakers. We found a paper on parts-of-speech tagging in Balochi using conditional random fields (Ullah et al., 2024b).

We were unable to find any papers for Dari, Rohingya, Kurukh, and Santali, although they were a part of our search. This might be because of the fact that Dari is very similar to Persian and the Rohingya language has a different name that did not show up in our search results. We tried searching again in Google Scholar by replacing “Rohingya” with “Rakhine,” but it did not yield any relevant search results. For Kurukh and Santali, a deeper search focused on these languages might yield some relevant results.

8 Conclusion

In this paper, we reviewed the recent research and development in South Asian language processing, prioritizing breadth of coverage over its depth. We emphasized key research trends at a field-specific level (text, speech, multimodal) in Sections 3, 4, and 5, and at a language-specific level in Section 7 with our low resource language spotlight survey, which covered 21 languages that are typically seen in the “long tail” of South Asian language processing and language processing in general. Such languages are masked by other higher-resource languages in papers and surveys on multilingual language processing. Finally, we hope that this survey inspires further investigations into the models, tasks, and benchmarks described here.

Limitations

Our survey shows that research and development in South Asian languages is thriving, and in many South Asian languages, researchers are trying to or have successfully replicated the successes of language, speech, and multimodal models currently enjoyed by high resource languages. However, in many areas, there is a clear gap among high-

resource and low-resource languages. In particular, we wish to present the following observations:

- We see that South Asian language publications are restricted to smaller venues, making it difficult for researchers to discover, share and collaborate on models, datasets, and tasks. We also see that in lower-resourced languages, there is a lack of awareness in the research community, given the lack of diversity in the number of distinct authors in publications related to language processing in those languages. We discovered many benchmarks that are typically not included in multilingual LLM evaluations, and it would be helpful for the community to combine these lesser-known benchmarks into an aggregated benchmark that can be hosted on popular platforms such as Huggingface.
- There has been some focus on sign languages and South Asian demographics with disabilities. However, such sign languages tend to be highly localized in South Asian communities and we need to perform more extensive surveys of the entire spectrum of sign languages in south Asia, as we build AI-based assistance tools for them.
- Most South Asian languages covered in our survey have some literature on code-mixing/switching, but we notice a lack of comparative studies on code-mixing in various South Asian languages.
- Meta-analysis using cutting-edge language models such as O1 and GPT-4o is promising and provides a strong baseline in the absence of sufficient labeled data, however, problems such as lack of cohesion within predicted topics and low precision/recall persist. Future efforts must focus on improving the precision and recall metrics of such meta-analyses, along with improving the coherence of LLM-generated topics.
- There is a need for a consistent ethics framework that is based in the unique cultural contexts of South Asian communities. For example, while depression detection and cyberbullying detection are important applications of language models, we must ensure that appropriate care is taken before these models are deployed in a real-world setting.

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