International Journal of Computer Sciences and Engineering
Vol.**13**, Issue.**8**, pp.**49-57**, August **2025**
ISSN: 2347-2693 (Online)
Available online at: www.ijcseonline.org

ISSN: 2347-2693 (E)

Research Article

Languages Mapping Techniques Using Leaflet for Visualization of Dictionary Headwords

Manikanta V[1]

[1]SRP, Technical, CIIL, Mysore, India

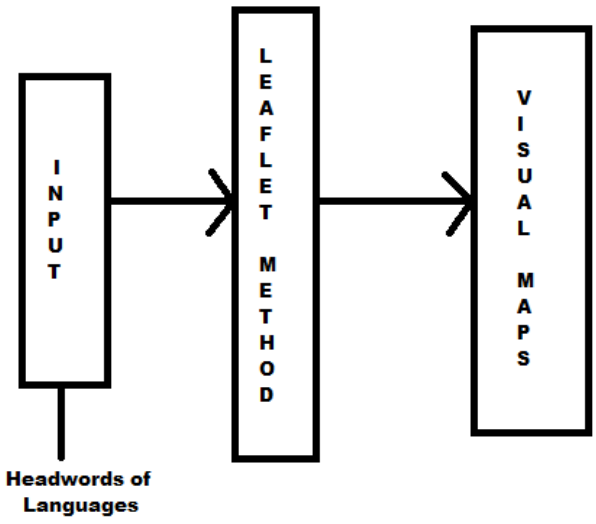
Corresponding Author: ✉

Received: 28/Jun/2025; **Accepted**: 30/Jul/2025; **Published**: 31/Aug/2025. **DOI**: https://doi.org/10.26438/ijcse/v13i8.4957

Abstract: Dictionaries are generally the listing of lexemes from the lexicon of one or more languages with arranging of alphabets grammatically. The dictionary provides information about definitions, pronunciations, usage, translation, etymologies, etc. The Indian Languages are classified into 121 languages from the included constituent eighth schedule 22 languages and non-eighth schedule 99 languages. From the 121 languages are classified into family groups of Indo-European, Dravidian, Austro-Asiatic, Tibeto-Burmese and Semito-Hamitic. Learning through multiple Indian languages in a single platform with visually is one of the big tasks in any of the field. Visualization of multiple languages easily represented the states, language and their meanings easily explored in the form of maps.

Keywords: Dictionary, Leaflet, Indo-European, Multilingual, Visualization

Graphical Abstract- The image is a digital map of India showcasing language distribution for dictionary headwords visualization using Leaflet and Advanced way of representations.



Input (Headwords of Languages)
- Represented by a box with small dictionary/book icon + label "Headwords of Languages."

Leaflet Method (Processing/Mapping Layer)
- Shown as a middle block with a map-marker or GIS icon, labeled "Leaflet Mapping Method."
- Add arrows showing flow from input → processing → output.

Output (Visual Maps)
- Illustrated by a colorful India map (with different states shaded) labeled "Visual Maps of Languages."

Styling Improvements
- Use colors (e.g., blue for input, green for Leaflet method, multicolor for maps).
- Replace plain arrows with smooth, bold arrows.
- Add a caption at the bottom:

This interactive Leaflet-based visualization allows you to attach audio clips and images to map points (or features such as polygons).

Input: Each marker (or feature) represents a headword of a language or a location associated with that language.

Method:
- When the user clicks on a marker, a popup window appears.
- The popup contains:
  - The headword text and its language name,
  - An embedded audio player so the user can listen to the pronunciation of the headword,
  - A linked image (thumbnail preview in the popup) that can be clicked to open the full-sized image in a new tab.

Output: This creates a visual + auditory mapping tool (a "visual map"), where users can explore different languages through both textual headwords and multimedia references.

Key Features
Interactive Popups – Display headwords with multimedia (audio + image).

Audio Integration – Users can listen to pronunciation directly in the map popup.

Image Linking – Small image shown inside popup; opens larger image if clicked.

Customization – Works for multiple languages, each marker can have its own audio/image files.

Scalability – Can be extended to cover many languages, locations, or datasets via GeoJSON.

This Leaflet method turns a simple language headword dataset into a multimedia-rich visual map, where clicking on a location shows both the spoken word (audio) and its visual representation (image).

1. Introduction

Multilingual education supports students in their academic studies, their ability to listen, read, speak and write. Studies with multiple educations bolster cognitive development, better academic achievement, and improved memory, resistance to dementia, cross-cultural appreciation and better career opportunities [17]. Dictionaries are main support of learning multi languages and information of multiple language sentences is required. To study of any language, good dictionary of the words are essential and it is highly advisable tool to support native language. Communications are easily expressed through any messages from multilingual environment.

Objective of the Study
The visualization of individual languages and their respective headwords allows all the languages to be viewed in a single attempt. One of the major objectives is to effectively visualize the data in a simplified way, using minimized audio or by including images.

2. Related Work

Leaflet of several studies have demonstrated its use in geographic visualization. For example, Haklay and Weber (2008) highlighted the growth of volunteered geographic information (VGI) through platforms like OpenStreetMap, which integrates seamlessly with Leaflet for web-based mapping [18].

In the context of urban planning and smart cities, projects have utilized Leaflet to visualize real-time traffic, land-use data, and public infrastructure. For instance, Wu et al. (2017) employed Leaflet to build a smart transportation monitoring dashboard, enabling dynamic visualization of GPS-based vehicle data [19].

In environmental monitoring, Leaflet has been used to represent air quality, climate change impact zones, and water resource management. A study by Hofer et al. (2018) integrated Leaflet with sensor networks to display real-time environmental data layers, making it accessible to researchers and the public [20].

In epidemiology and public health, Leaflet has been used to track and visualize disease outbreaks. For example, Dong et al. (2020) in their COVID-19 dashboard (Johns Hopkins University) employed Leaflet for interactive case mapping, which became a global reference point [17].

In education and citizen science, Leaflet-based applications allow students and volunteers to engage with geospatial datasets. According to Bowman and Hodza (2019), Leaflet facilitated classroom GIS learning due to its low entry barrier compared to traditional GIS software [21].

Overall, Leaflet has emerged as a key tool for researchers and practitioners seeking open, user-friendly, and customizable solutions for geospatial visualization across domains such as urban analytics, environmental studies, health informatics, and education.

Various examples of leaflet projects
1. OpenStreetMap + Leaflet
Type: Base mapping & visualization
Description: Many OSM-based web maps (including humanitarian crisis maps) use Leaflet for rendering tiles, adding markers, and overlaying geospatial data. [22]
Use case: General-purpose, disaster response, community mapping.
2. COVID-19 Global Dashboard (Johns Hopkins University)
Type: Public health mapping
Description: Used Leaflet to plot confirmed, recovered, and death cases worldwide during the COVID-19 pandemic. [23]
Use case: Epidemiology, real-time health monitoring.
3. Mapbox + Leaflet Integration
Type: Advanced visualizations
Description: Developers combine Leaflet with Mapbox tiles for interactive city maps, traffic visualizations, and real-estate mapping.
Use case: Smart cities, navigation, real estate.
4. CartoDB (CARTO) Visualizations
Type: Spatial data analytics
Description: CARTO initially built many of its geospatial dashboards using Leaflet to visualize spatial queries interactively.
Use case: Urban analytics, mobility data, and demographics.
5. USGS Earthquake Hazards Program (Leaflet Earthquake Map)
Type: Natural hazard visualization
Description: USGS earthquake monitoring system uses Leaflet to display earthquake epicenters, magnitude data, and timelines.
Use case: Disaster risk management, seismology.
6. Humanitarian OpenStreetMap Team (HOT)
Type: Crisis mapping
Description: Leaflet maps are deployed to visualize disaster zones (e.g., Nepal Earthquake, Ebola outbreak) with crowdsourced mapping contributions.
Use case: Humanitarian aid, emergency response.

7. Leaflet Routing Machine
Type: Routing and navigation
Description: Open-source Leaflet plugin that provides driving, walking, or cycling directions on top of OSM data.
Use case: Transport apps, delivery systems.
8. Air Quality Monitoring Maps
Type: Environmental visualization
Description: Projects like OpenAQ and local city dashboards use Leaflet to visualize real-time air quality sensor data on maps.
Use case: Environmental monitoring, public awareness.
So, considering all these aspects, making it multilingual becomes an innovative way of conducting visualization studies.

Types of Dictionaries
Usage Dictionaries: The early stage of learning tells you what words mean and not a standard dictionary.[24]
Visual Dictionaries: The meanings are defined through pictorial representation to get the information.[25]
Bilingual Dictionaries: The words are collects between two languages with arranged manner.[26]
Synonym Dictionaries: It is a dictionary that finds groups of multiple words with the same meaning.[27]
Dictionaries of antonyms: It is a dictionary that finds groups of multiple opposite words.[28]
Normative dictionaries: The dictionary collects the words that language academies.[29]
Etymological dictionaries: The dictionary is the product of research in linguistic belongs to history.[30]
The encyclopedic dictionaries: An encyclopedic dictionary typically includes many short listings, arranged alphabetically, and discussing a wide range of topics.[31]
Technical Dictionaries: The dictionaries are consists of scientific or technical words.

3. Leaflet map

3.1 GeoJSON

Leaflet is open source of mobile friendly interactive maps using JavaScript library and performance is very fast, simplicity to use across all platforms. Visualization of maps using leaflet is one of the main advantages to find respective regions of information easily. [32]

Ex: Create a map in the ‘map’, add the map to layer, a marker with popup text. The visualization of the map is easily providing the information in figure [Fig. 1].

```
var map = L.map('map').setView([51.505, -
                0.09], 13);
L.tileLayer('https://tile.openstreetmap.org
            /{z}/{x}/{y}.png', {
          attribution: ''}).addTo(map);

    L.marker([51.5, -0.09]).addTo(map)
.bindPopup('A pretty CSS popup.<br> Easily
              customizable.')
               .openPopup();
```

Fig.1: Create a map

3.2 Using GeoJSON with Leaflet

GeoJSON is lightweight, simple, straightforward using GIS technologies and services. [32]
Ex: GoeJSON interacts with map vectors using GeoJSON objects.
A GeoJSON objects are represented in Geometry, Feature, Feature collection, etc. It supports various geometrical features of Point, Polygon, Multipoint, LineString, MultiLineString, MultiPolygon, and GeometryCollection. The features are consisting of geometrical objects and other extra properties. Featurecollection is a collection of various features.[33]
Ex: GeoJSON Feature is mentioned the Feature, Properties, Geometry, etc. Using properties to make our convenient method of vectors and geometry features with coordinates are easily deployed to the map layer in figure [Fig 2].

```
vargeojsonFeature = {
"type": "Feature",
"properties": {
"name": "Coors Field",
"amenity": "Baseball Stadium",
"popupContent": "This is where the Rockies
play!"
    },
"geometry": {
"type": "Point",
"coordinates": [-104.99404, 39.75621]
    }};
```

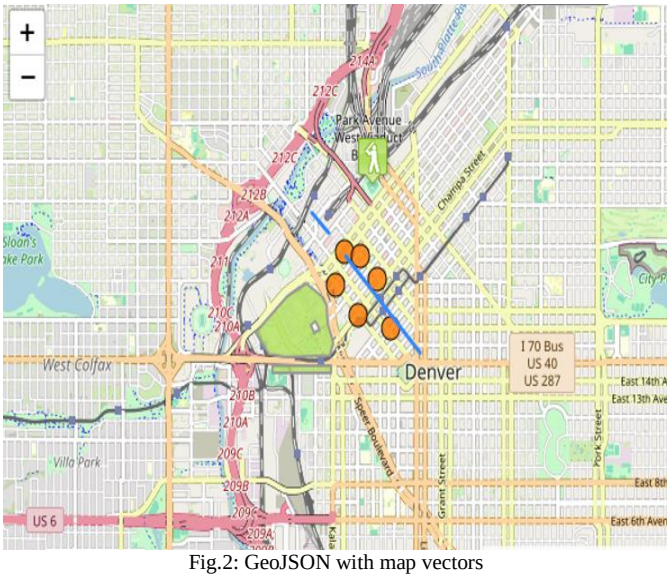


Fig.2: GeoJSON with map vectors

3.3 Simple example of leaflet

```
 <!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="utf-8" />
  <title>Leaflet: Onclick Audio + Image Link</title>
  <meta name="viewport" content="width=device-width,
initial-scale=1" />
  <link
    rel="stylesheet"
    href="https://unpkg.com/leaflet@1.9.4/dist/leaflet.css"
    integrity="sha256-
p4NxAoJBhIIN+hmNHrzRCf9tD/miZyoHS5obTRR9BMY=
"
    crossorigin=""
  />
  <style>
    html, body, #map { height: 100%; margin: 0; }
    .popup-media img { max-width: 240px; display: block;
margin-top: 6px; border-radius: 6px; }
    .popup-media audio { width: 240px; margin-top: 6px; }
    .legend {
      background:#fff; padding:8px 10px; border-radius:10px;
box-shadow:0 2px 8px rgba(0,0,0,.15);
      font: 13px/1.2 system-ui, Segoe UI, Roboto, Arial, sans-
serif;
    }
    .legend .dot{display:inline-
block;width:12px;height:12px;border-radius:50%;margin-
right:6px;vertical-align:middle}
  </style>
</head>
<body>
<div id="map"></div>

<script
  src="https://unpkg.com/leaflet@1.9.4/dist/leaflet.js"
  integrity="sha256-
20nQCchB9co0qIjJZRGuk2/Z9VM+kNiyxNV1lvTlZBo="
  crossorigin=""
></script>

<script>
// --- 1) Basic map ---
const map = L.map('map').setView([22.8, 79.6], 5);
L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.pn
g', {
  maxZoom: 18, attribution: '© OpenStreetMap'
}).addTo(map);

// --- 2) Example headword points (replace with your data) ---
/*
  Fields:
    - lang: Scheduled language
    - headword: dictionary headword
    - audio: URL to MP3/OGG (must be CORS-accessible)
    - image: URL to an image (thumbnail shown, full size
opens in new tab)
*/
const headwordPoints = [
  {
    coords: [28.61, 77.21], // Delhi
    lang: "Hindi",
    headword: "पुस्तक (pustak)",
    audio: "test /En-us-book.ogg",
    image: " 320px-Hindi.svg.png"
  },
  {
    coords: [22.57, 88.36], // Kolkata
    lang: "Bengali",
    headword: "বই (boi)",
    audio: "test/En-us-boy.ogg",
    image: "/320px-Bengali_alphabet.svg.png"
  },
  {
    coords: [17.38, 78.49], // Hyderabad
    lang: "Telugu",
    headword: "పుస్తకం (pustakam)",
    audio: "test/En-us-book.ogg",
    image: "/320px-Telugu_alphabet_chart.svg.png"
  },
  {
    coords: [13.08, 80.27], // Chennai
    lang: "Tamil",
    headword: "புத்தகம் (putthagam)",
    audio: "test/En-us-sound.ogg",
    image: " /320px-Tamil-alphabet-chart.svg.png"
  }
];

// --- 3) Marker + popup with audio and image ---
// Optional: per-language colors
const langColor = {

"Hindi":"#e41a1c","Bengali":"#377eb8","Telugu":"#4daf4a",
"Tamil":"#ff7f00"
};

function makeIcon(color="#2E7D32"){
  // Simple circle-like SVG icon
  const svg = encodeURIComponent(
    `<svg xmlns='http://www.w3.org/2000/svg' width='28'
height='28' viewBox='0 0 28 28'>
      <circle cx='14' cy='14' r='10' fill='${color}' stroke='white'
stroke-width='3'/>
    </svg>`
  );
  return L.icon({
    iconUrl: `data:image/svg+xml;charset=UTF-8,${svg}`,
    iconSize: [28, 28], iconAnchor: [14, 14], popupAnchor: [0,
-12]
  });
}

headwordPoints.forEach(p => {
  const color = langColor[p.lang] || "#6c757d";
  const marker = L.marker(p.coords, { icon: makeIcon(color)
}).addTo(map);
```



```
  // Popup HTML: title + audio + image (click to open full)
  const html = `
    <div class="popup-media">
      <div><b>${p.headword}</b></div>
      <div>Language: <b>${p.lang}</b></div>
      <audio controls preload="none">
        <source src="${p.audio}" type="audio/ogg">
        <source src="${p.audio}" type="audio/mpeg">
        Your browser does not support the audio element.
      </audio>
      <a href="${p.image}" target="_blank" rel="noopener">
        <img src="${p.image}" alt="Image for ${p.headword}"
/>
      </a>
      <small>Click image to open full size</small>
    </div>
  `;

  marker.bindPopup(html);

  // Optional: also play audio automatically when popup opens
(mobile may block)
  marker.on('popupopen', () => {
    const audioEl = document.querySelector('.leaflet-popup
audio');
    if (audioEl) { audioEl.pause(); /* do not autoplay to avoid
browser blocks */ }
  });
});

// --- 4) Legend control (example languages) ---
const legend = L.control({position:'bottomright'});
legend.onAdd = function() {
  const div = L.DomUtil.create('div','legend');
  div.innerHTML = '<div><b>Scheduled
Languages</b></div>';
  Object.entries(langColor).forEach(([name, color]) => {
    div.innerHTML += `<div><span class="dot"
style="background:${color}"></span>${name}</div>`;
  });
  return div;
};
legend.addTo(map);
</script>
</body>
</html>
```

How it works

- Click a marker → a popup opens with:
  - the headword + language,
  - an HTML5 <audio> player (user presses play),
  - an image preview that links to the full-size image in a new tab.
- Swap the sample URLs with your own audio (MP3/OGG) and image files.
- Use one marker per headword or per location; or load a GeoJSON and in onEachFeature bind the same popup HTML using feature.properties.

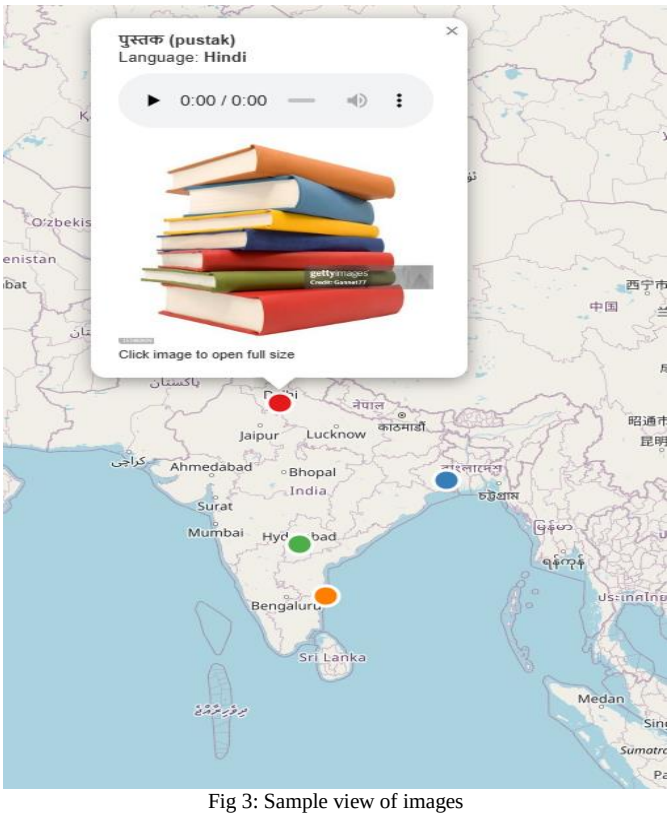


Fig 3: Sample view of images

4. Methodology

Algorithm to visualize the dictionary mapping

1) Find the Headword of the values of meaning and pictures.
2) All the information to integrate (Languages, Headword, Meaning, Picture) variable to respective information of the language.
3) Representation of features and properties

```
var geoJsonData = {
"type": "FeatureCollection",
"features": [
  {
          "type": "Feature",
          "properties": {
          "address": kashmir,
          "stroke-width": 2,
           "stroke-opacity": 1,
    },
           "geometry":
{
           "type": "Polygon",
]          "coordinates":
[
                    [
[74.70985914962547,34.50039583897685],
                    [
74.67223984109074,34.498866994032916],
                    ,
                    , //All Points of Kashmir Coordinates
],
// Adding all the States Coordinates
                ]
} }
```


4) Create a Tile Layer for URL template for the images of tiles
5) Create a map and add to tile layer
6) Create a marker cluster group and to the layer for displaying bind up properties
7) Finally adding to all properties to map.

5. Results and Discussion

The headword table is consists of many of the fields like English headword, Native Script Headword, Devanagari Script, IPA, language, audio filename, image of the headwords, etc. as shown in Table 1.

Table 1: Sample data

English	Native script	Devanagari	IPA	Lanaguage	A_fileName	ImageName
pigeon pea	अरहर	अरहर	ʌrhər	Hindi	pigeon_pea_Hindi.wav	pigeon_pea_Hindi.jpg
flaxseed	अलसी	अलसी	ʌlsi	Hindi	flaxseed_Hindi.wav	flaxseed_Hindi.jpg
black gram	उड़द	उड़द	ʊɽə d̪	Hindi	black_gram_Hindi.wav	black_gram_Hindi.jpg
wheat	गेहूँ	गेहूँ	gehũ	Hindi	wheat_Hindi.wav	wheat_Hindi.jpg
gram	चना	चना	cənɑ	Hindi	gram_Hindi.wav	gram_Hindi.jpg
hiccup	चावल	चावल	cɑvəl	Hindi	rice_Hindi.wav	rice_Hindi.jpg

From the table is consists of all scheduled languages over individual 500 headwords for their respective headwords of languages. So, from the map is easily view their respective regions of the languages easily and how maps are visually display are shown in below. The data is consists of languages related to dictionary words.

The table you mentioned lists several elements:

- English Word: The dictionary word in English (e.g., "pigeon pea").
- Native Script: The word in the language's native script (e.g., "अरहर" for Hindi).
- IPA: The International Phonetic Alphabet representation to show pronunciation.
- Language: The language in which the word is used (e.g., "Hindi").
- Audio File: A link to an audio file pronouncing the word.
- Image File: A link to an image file related to the word.

This table maps dictionary words to specific languages, and each language is tied to a geographical region. For example, the word "pigeon pea" in Hindi is tied to the Hindi-speaking region in India.

Purpose of the Leaflet Visualization

The Leaflet map is a tool to visually represent these languages on a geographical map of India. Here's what the map visualization does:

- Displays the Regions of the Languages: By using Leaflet, you can create markers or regions on the map that represent where specific languages are spoken. The map allows users to click on different regions or markers to learn about the language spoken there (including the dictionary word, pronunciation, and related media such as images or audio).
- Interactive Markers: You can add interactive markers or pop-ups on the map. When you click on a marker, the user can view details such as:
  - The language name (e.g., Hindi).
  - The corresponding dictionary word in the native script (e.g., "अरहर" for pigeon pea).
  - The IPA pronunciation of the word.
  - Audio to hear the word spoken in that language.
  - An image representing the object or concept (e.g., an image of pigeon peas).
- Visual Display of Data: The map serves as a visual representation of language distribution. Each region on the map corresponds to a particular language, and the markers provide more information about that language and the associated dictionary words. The visual component makes it easier to understand where languages are spoken and how they relate to the specific headwords (words in the dictionary).

How the Map Visually Displays the Data

The map can be displayed with different visual markers, showing the geographical regions where the languages are spoken. Here's how it works:

- Markers: On the map, you can add a marker at each geographical location where a language is predominant. When you hover over or click on these markers, a popup could appear displaying detailed information from the table, such as the dictionary word, its IPA transcription, and even links to audio and image files.
- Color Coding and Regions: Depending on the number of languages, you can color-code the regions to represent different linguistic zones (e.g., Hindi-speaking areas in blue, Tamil-speaking areas in green, etc.). This allows users to easily see the language boundaries or clusters on the map.
- Interactive Elements: Users can click, zoom, or hover over the map to view detailed information about languages. This interactivity allows for a deep dive into each language and its dictionary words, pronunciation, and visual representation.

Visualizing Language Distribution on a Map

For example, if you are looking at the word "pigeon pea" in Hindi:

- You would locate the Hindi-speaking region (likely the northern and central parts of India) on the map.
- By clicking on the marker for that region, a popup could show:
  - The word in Hindi native script: "अरहर".
  - The IPA pronunciation: "ʌrhər".
  - A link to audio: "pigeon_pea_Hindi.wav" for pronunciation.

- A corresponding image: "pigeon_pea_Hindi.jpg" showing what pigeon peas look like.

This process would be the same for other languages in the table like flaxseed, black gram, or wheat, each mapped to their respective regions on the map.

How the Data and Map Are Connected

- The data in the table ties directly to the regions displayed on the map:
- The headwords (like "pigeon pea," "flaxseed") are dictionary words that belong to certain languages (like Hindi, Kannada, etc.).
- Each language is spoken in a specific geographical region.

The map allows users to interactively explore where these languages are spoken by linking dictionary words with their visual and audio representations on the map.

Visualization of Dictionary mapping

The maps are displayed through leaflet using multiple GeoJSON coordinates are visually appeared in the figure [Fig 4].

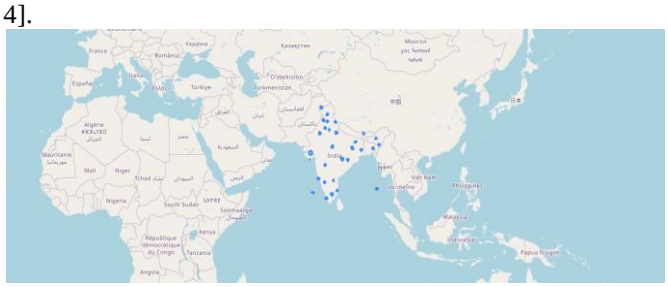


Fig. 4: Coordinates points of states

From dictionary mapping algorithm to visualize the dictionary words using maps are mentioned in the figure [Fig 5]. The concept is language express from other language to show in the map. Ex: While clicking the Kashmir, displayed the respective languages of Hindi and Kashmiri of the Headword word of **'अंकगणित'**. The images of the Headword along with the respective languages are easily visible using mapping algorithm. Users click any of the states with respect to the word and displayed the results of the meaning and images are visible.

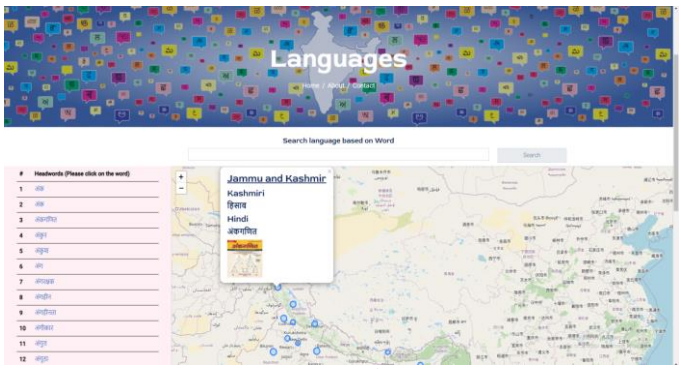


Fig.5: Results of image

Similarly, the Assamese headword 'আৱতি' can be easily explored visually by clicking on the respective point, with the results displayed in Kashmiri and Hindi, as shown in Fig. 6.

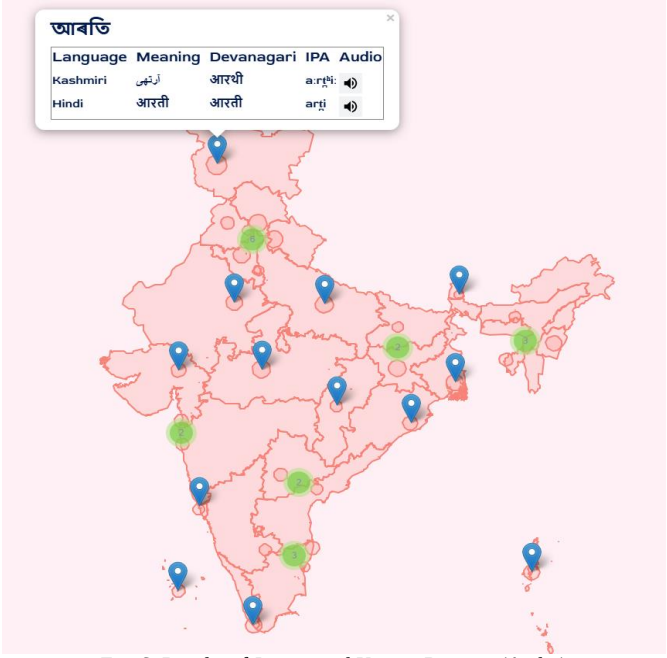


Fig. 6: Results of Jammu and Kasmir Regions (Audio)

Fig. 7: Results of Karnataka Region (Audio)

Likewise, the same word is represented at different points with their corresponding Kannada translations in Fig. 7. This demonstrates the ease of applying multilingual methods.

The results of the visualizations are

- **Interactive Icons**: Here use custom icons for the markers based on language or region.
- **Color-coded regions**: Here use color regions dynamically depending on the languages spoken in those areas.
- **Audio Integration**: To add audio for languages, here we use Leaflet's HTML content in popups to embed audio players.
- **Image Integration**: To add images for headwords, here we use Leaflet's HTML content in popups to add image.

The single way of method to view all the regions while we search any headword of with different languages of the word, meaning, IPA, Audio, images, etc. This is one of the most useful for multilingual environment platform to all the users, students, etc.

Discussions

The dictionaries are containing multiple types of science, sociology, linguistic, marketing, etc to provide the complete

information on multiple languages of the country and mutual understanding for development of languages. The visualization of maps to click map any regions or any languages to learn based on the regions of the language is one of the easiest ways of learning to all the people. Knowledge through multilingual in a single platform is useful to any of the fields are more useful for multiple users. The more advanced way of including audios, picture with multilingual is one of the crucial ways of learning mechanism. The data requirements include headwords collected from many linguistic experts, aiming to reach several lakhs.

6. Conclusion and Future Scope

Knowledge belongs not only to dictionaries but also enhances technology across various fields through the geographical representation of data. Grammar, common phrases, and linguistic features can also be included if authenticated data is collected from institutes and language experts across the country. The idea of a multilingual environment can be further enhanced by adding audio and video resources for the respective languages, which can also be integrated into Leaflet's geographical representation in the future.

Future Scope

- Multilingual Learning Platform
- The same framework can evolve into a language-learning tool where learners hear pronunciations, see images, and even watch videos.
- Helps in preserving endangered languages by making their headwords accessible interactively.
- Integration with AI / NLP
- Future integration with speech recognition or text-to-speech could allow automatic pronunciation playback for any new headword.
- AI-driven semantic search could let users explore related words or phrases across languages.
- Crowdsourced Contributions
- Users, teachers, and researchers can upload their own audio clips, images, or context sentences.
- This makes the system a living dictionary, always expanding and improving.
- Extended Media Support
- Beyond images and audio, Leaflet can support videos, animations, and interactive quizzes linked to headwords.
- This would make the map more engaging for education and research.
- Cultural & Geographic Insights
- Visualization can include regional dialect variations (e.g., markers colored by dialect).
- Headwords can be linked to cultural practices, folk stories, or songs, giving a geo-cultural dictionary.
- Mobile & Offline Accessibility
- A future mobile app with offline support could help students and communities in remote areas learn in their native languages without internet access.
- Research & Policy Making
- Linguists can use this tool to track language spread, evolution, and usage across India.
- Policymakers can visualize language resources for planning education and preservation strategies.

Author's statements

Acknowledgements: The authors are grateful for the reviewer's valuable comments that improved the manuscript.

Funding Source- none

Conflict of Interest- Authors declare that they do not have any conflict of interest.

Data Availability- none

References

[1] Tompkins, Gail E, "Language arts: Patterns of practice", Upper Saddle River, NJ : Pearson Merrill/Prentice Hall, **2005**.

[2] Tono Y, "Can a dictionary help one read better? On the relationship between EFL learners' dictionary reference skills and reading comprehension", In G. James (Ed.), Lexicographers and their works. Exeter: University of Exeter Press, **1989**.

[3] Scholfield, P, "Vocabulary reference works in foreign language learning", In N. Schmitt & M. McCarty (Eds.) Vocabulary: Description, acquisition, and pedagogy, Cambridge: Cambridge University Press, **1997.**

[4] Schatz E & Baldwin R, "Context clues are unreliable predictors of word meanings. Reading Research Quarterly", Vol.**21**, pp.**439-453, 1986.**

[5] Scherfer P, "Indirect L2 vocabulary learning. Linguistics", Vol.**31**, pp.**1141-1153, 1993**

[6] Scott J. A & Nagy W. E "Understanding the definitions of unfamiliar verbs. Reading Research Quarterly", pp.**184–200, 1997.**

[7] Shen. L, "Computer Technology and College Students' Reading Habits", Chia-nan annual bulletin, Vol.**32**, pp.**559-572, 2006.**

[8] Shen, Z. "The roles of depth and breadth of vocabulary knowledge in EFL reading performance". Asian Social Science, Vol.**4**, Issue.**12**, pp.**135-137, 2008.**

[9] Shi, Z.L, "A comparative study of three learning strategies in EFL students incidental vocabulary acquisition.", CELEA Journal, Vol.**31**, Issue.**6**, pp.**91-101, 2008.**

[10] Spencer, P. & Lederberg, A, "Different modes, different models: Communication and language of young Deaf children and their mothers", In L. Adamson and M. Romski (Eds.) Communication and Language: Discoveries from atypical development. Baltimore: Paul H. Brookes, pp.**203- 230, 1997.**

[11] Albu, Elena, "Description versus rejection in the analysis of negation: Evidence from Romanian and English", Lingua. 191–192. pp.**22–41, 2017**

[12] Anscombre, Jean-Claude & Ducrot, Oswald, "Deux mais en français?" Vol.**43**, Issue.**1**, pp.**23–40, 1977.**

[13] Blakemore, Diane, "Denial and Contrast: A Relevance Theoretic Analysis of "But"". Linguistics and Philosophy, Vol.**12**, Issue.**1**, pp.**15–37, 1989.**

[14] Blakemore, Diane. "Relevance and linguistic meaning: The semantics and pragmatics of discourse markers", Cambridge: Cambridge University Press. Vol.**99, 2002**

[15] Carston, Robyn, "The semantics/pragmatics distinction: A view from Relevance Theory", In Turner, Ken (ed.), The semantics-pragmatics interface from different points of view, pp.**85–125, 1999.**

[16] Chen, Baoqin, "Xianqinlianci er yufayuyikaocha [Analysis of the syntactic and semantic properties of the connective er in Qin Dynasty]", Guhanyuyanjiu [Studies on Classical Chinese]. Vol.**22**, Issue.**1**, pp.**89–96, 1994.**

[17] Dong, E., Du, H., & Gardner, L, "An interactive web-based dashboard to track COVID-19 in real time. The Lancet Infectious Diseases", Vol.**20**, Issue.**5**, pp.**533-534, 2020.**
[18] Haklay, M., & Weber, P, "OpenStreetMap: A new paradigm for spatial data?", International Journal of Spatial Data Infrastructures Research, 3, pp.**1-23, 2008.**
[19] Wu, H., Zhang, J., & He, H, "Development of a smart transportation monitoring dashboard using Leaflet and GPS data", International Journal of Smart Transportation, Vol.**2**, Issue.**1**, pp.**12-25, 2017.**
[20] Hofer, C., Müller, F., & Richter, T. "Integrating real-time environmental data with Leaflet for dynamic visualization in environmental monitoring.", Environmental Monitoring and Assessment, Vol.**190**, Issue.**5**, pp.**317-330, 2018.**
[21] Bowman, A., & Hodza, F. "Using Leaflet for classroom GIS learning: A low-entry barrier approach to geospatial education." Journal of Geography in Higher Education, Vol.**43**, Issue.**4**, pp.**549-561, 2019.**
[22] Haklay, M., Basiouka, S., Antoniou, V., & Ather, A., "How good is volunteered geographic information? A comparative study of OpenStreetMap and Ordnance Survey datasets.", Environment and Planning B: Planning and Design, Vol.**37**, Issue.**4**, pp.**682-703, 2010.**
[23] Dong, E., Du, H., & Gardner, L, "An interactive web-based dashboard to track COVID-19 in real time.", The Lancet Infectious Diseases, Vol.**20**, Issue.**5**, pp.**533-534, 2020.**
[24] Bryson, B, "The Mother Tongue: English and How It Got That Way", HarperCollins, **2014**.
[25] Biedermann, H, "The Visual Dictionary of the Universe.", DK Publishing, **2013**.
[26] Weiner, E. "Oxford English–Spanish Dictionary", Oxford University Press, **2018**.
[27] Roget, P. M., "Roget's Thesaurus of English Words and Phrases", Longman, **1852**.
[28] Hornby, A. S, "Oxford Advanced Learner's Dictionary of Current English", Oxford University Press, **2006**.
[29] Academia Española "Diccionario de la lengua española (22nd ed.)", Real Academia Española, **2001**.
[30] Calkins, S. W., "The Oxford Dictionary of English Etymology", Oxford University Press, **2012**.
[31] Klein, E. "The New Encyclopedic Dictionary.", McGraw-Hill, **2003**.
[32] Zevenbergen, L., & Holmes, B. "Leaflet: A JavaScript Library for Interactive Maps.", CartoDB, **2016**.
[33] Butler, M, "GeoJSON: A format for encoding a variety of geographic data structures", O'Reilly Media, **2011**.

AUTHORS PROFILE

Dr. Manikanta V holds an M.S. from the University of Mysore and a Ph.D. from Bharathiar University, Coimbatore, Tamil Nadu. He is currently working as a Senior Resource Person (Technical) at the Central Institute of Indian Languages, Mysore. He has 4.9 years of experience at the Central Food Technological Research Institute, Mysore, where he worked as a Project Assistant.

