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# Traditional to Modern Tools: A Comparative Study of Visual Lip Feature Extraction with Dlib

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**Abstract**

Visual Lip refers to the visible movements and contour of the lips during speech. It shows how the mouth moves when pronouncing sounds without any audio. This study report describes the various visual lip feature extraction methods and tools with the steps involved in each tool. Overall Relationship between different lip extraction Models and tools also discussed in study report. The current study reports the status of research literature chronologically, explaining various tools for lip feature extraction mainly focusing set up dependency for Dlib tool. The current study also explains various lip feature extraction tools including dlib, Mediapipe and OpenCV with conducting a comparative study, with its description, speed, accuracy, advantages, disadvantages and output with each tool. Set up dependency with each package and version for Dlib tool as it has version compatibility errors also taken into consideration in this report. Paper reports 10 common Visual Features that extracted from Dlib with its calculation. Our findings show that lip extraction has a variety of uses in everyday life. Various Challenges for feature extraction while using Dlib tool are also discussed in the paper. Until now, research on visual lip extraction using each tool has been conducted independently. Based on our findings, we determined that the comparative and in-depth dependency and setup for Dlib tool. Therefore this work is unique and published for the first time.

## Introduction

Lip Feature Extraction is the process of finding and extracting significant visual features of the lips from an image of the face or video. Its applications include visual speech recognition, lip synchronization or lip reading, and facial analysis. The input is a discrete facial image or video. If it is video, a series of image frames are extracted from video. From each image lip extraction tool detects face and landmarks. Lip Feature Extraction refers to the process of extracting visual information only from the lips. To accurately find lips, we must first identify the face border using several facial cues called facial landmarks.

There are various tools including Dlib which detects 68-point facial landmark, Mediapipe Face Mesh detects 468 landmarks which in turn is more precise, and OpenCV which is used for basic face detection. From such type of tools we easily able to extract lip features or landmarks. This paper explores the background research on the various techniques for lip feature extraction with comparative study mainly focusing Dlib tool with challenges and applications.

### A. Lip feature Extraction

The key component is a lip from the face that has been extracted for visual speech. The position and angles of our face in the camera frame are essential for ensuring that the lips are clearly visible. To become familiar with the lip contour of each statement is important. The input is a video or image. If it is video, a series of image frames are extracted from it. Faces are identified from each image, whether they are single or many faces. According to prior research, lip-synchronization, lip reading, and other related studies need the extraction of lip features from face images, which can be accomplished in two main steps [1], [2], [10], and [20]: lip detection and localization and lip feature extraction.

***1. The Lip detection and localization.*** It is a type of image segmentation in which video is divided into subsequent frames. There are various lip detection technologies, including.
*1. A top-down, model-based approach.* The geometric shape of the lip, known as the lip counter, is used to extract features using this technique. The results are quite accurate because it employs vector-based images. There are two methods used in this approach: Active Shape Models (ASM) and Active Appearance Models. In ASM, primary and secondary landmark points are determined based on feature shape. AAM uses shape and gray-level appearance to find landmarks.
*2. A bottom-up approach.* Using nonlinear, scale-space analysis to turn images into domains. Scale, amplitude, and position information are isolated from the image. This multiscale spatial analysis (MSA) technique is a rapid and reliable method for visual features that are independent of the absolute amplitude or position of image levels.
*3. Image-based Lips Detection Methods.* This approach includes three methods, which are given as follows:

- RGB Approach: Red, green, and blue are the primary colors. A combination of these colors was utilized to differentiate between skin and lip pixels.
- HSV Approach: Hue, saturation, and V are brightness or intensity values used to differentiate lip and facial pixels.
- YCbCr Approach: Y is the luminous component, Cb and Cr are the blue and red chroma components. Separation of Lip is possible as lips are redder in colour than faces using some formulae and masking.

***2. Lip feature extraction***

It is the process of detecting the region of the lip using an algorithm. The lip is monitored for seven major geometric features: mouth width, mouth height, mouth area, aperture height, aperture width, aperture area, and nose-to-chin distance. Feature extraction can be performed using a 1D or 2D raster scan.
Lip reading is done using several tools that first extract lip features, such as LipNet, Google's Deep Mind, and Dlib.
The full process of lip-feature extraction, as described above, is shown in the following figure (see Fig.1).

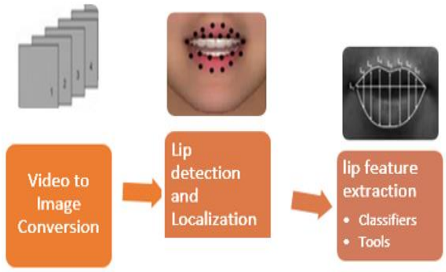


*Fig. 1: Overview of lip-feature extraction*

### Literature Survey

In this paper, we presented various tools and models for lip feature extraction, along with a comparison of their accuracy to recent digital methods. These software programs employ algorithms to automatically extract lip features.
Various feature extraction methods including methods based on lip geometrical features, lip appearance, lip texture and hybrid features of the lips are discussed in paper [5].
The Local Binary Patterns (LBP) operator was first suggested by Ojala et.al. The fundamental operation consists of a 9 pixel module that uses the center pixel as a threshold and processes 8 nearby pixels around it. If the pixel value above the threshold, the output is 1. If it is not then output is 0 [9].
The CLM model build can be used to determine the position of the nose, eyes, and mouth in a given facial image [10].
VGGNet extracts a set of features, which are then passed through numerous LSTM layers [11].
LipNet is the first end to end sentence-level lip-reading model. LipNet features an architecture of layers in which a sequence of mouth frames is fed into three levels of STCNN, followed by a spatial max-pooling layer. The extracted features are processed by two Bi-GRU units. [3], [12].
The majority of the publications employ dlibs ("dlib C++ Library," 2019) to detect faces and extract lip geometrical shapes utilizing landmarks for feature extraction [16].
Mediapipe is also used for lip extraction, and it includes a Face Mesh module with 468 landmarks. We can extract lip parts by training a CNN model

for classification based on lip height and width with PyTorch or TensorFlow. MediaPipe graph recognizes face landmarks using picture segmentation. It generates a perception pipeline graph for reusable calculators [22].
Newly introduced lip feature extraction methods Scale Invariant Feature Transform (SIFT) uses Difference of Gaussian (DoG) gives accuracy 93.9980% and Speeded up Robust Features (SURF) uses Hessian matrix gives accuracy 94.0972% [23].
In some methods it is challenging task for the researchers to extract lips as the amount of coloring agent to be used to highlight lips.
Following Table 1 shows various models for lip feature extraction, along with reported study and remarks.

**Table 1.** : Literature review on Different Models for Lip feature Extraction

| Ref | Author | Method/ Model | Reported Research | Remarks |
|---|---|---|---|---|
| [3], [12] | Fu, S. Yan,T.S. Huang. Assael,Y. M., Shillingford et.al. | LipNet with STCNN + Spatial Pooling | LipNet contains a hierarchy of layers in which a sequence of mouth frames is fed into three levels of STCNN, followed by a spatial max-pooling layer. The features extracted are processed by two Bi-GRUs. | LipNet does not require hand-engineered spatiotemporal visual features or a separately trained sequence model. |
| [9] | M. Xinjun, Y. Long , Z. Qianyuan | Local Binary Patterns (LBP) | The LBP operator has The fundamental operation consists of a 9 pixel module that uses the center pixel as a threshold and processes 8 nearby pixels around it. | LBP when combined with PCA can extract the local lip feature picture extremely well, therefore it has a certain ability to resist external light changes. Accuracy 86.7% [23] |
| **Ref** | **Author** | **Method/ Model** | **Reported Research** | **Remarks** |
| [10] | Aparna Brahme, Umesh Bhadade | CLM model | The CLM model is used to determine the position of the nose, eyes, and mouth in a given facial image. | CLM model consists of two models: shape model and patch model. The shape model is created using PCA and describes variance in the shape of feature points. |
| [11] | Amit Garg, Jonathan Noyola, Sameep Bagadia | VGGNet with CNN + LSTM layers | Using this extracted a set of characteristics, which were then fed through numerous LSTM layers to understand how lips move between frames. | VGGNet is utilized as a feature extractor, using convolutional layers to extract lip contours, mouth shape, and so on. |
| [23] | Anai, Tamara,Mersal,et.al. | SIFT and SURF | SIFT method extracts lip features using nearest neighbor (NN). SURF uses SVM or K-NN | For both methods The accuracy is greater than 90% |

Following Table 2 shows various Tools for lip feature extraction, along with reported study and remarks.

**Table 2.** : Literature review on Different Tools for Lip feature Extraction

| Ref | Author | Tool | Reported Research | Remarks |
|---|---|---|---|---|
| [16] | M.S.Patil, Satyadhyan Chickerur, et.al. | Dlib C++ Library | This tool detects faces and extracts the geometric shape of lips using landmarks. It uses 20 coordinates to identify the lip's edges. | Using one-height feature extraction accuracy of 77% is achieved. Using two-height feature extraction accuracy of 35% is achieved |
| [18] | Priyanka P. Kapkar and S.D.Bharkad | OpenCV | It Offers Haar Cascade and DNN-based face detectors. By default, it detects bounding boxes around | Computer vision system, built using Python and OpenCV, is |

| | | | | |
|---|---|---|---|---|
| | | | faces rather than specific landmarks. | capable of detecting and recognizing objects with high performance. |
| [22] | Gupta, Anurag, Yadav, Darshan, Raj, Akash, Pathak,Ayushman | Mediapipe | Lips are extracted using a Face Mesh module with 468 landmarks. We can extract lip parts by training a CNN model for classification based on lip height and width with PyTorch or TensorFlow. | Mediapipe rapidly executes a perception application across various platforms by leveraging reusable calculators and graphs. |

**Overall Relationship between Different Lip Extraction Models and Tools**

Following Fig 2 shows different lip extraction Models and tools from ancient to modern development .

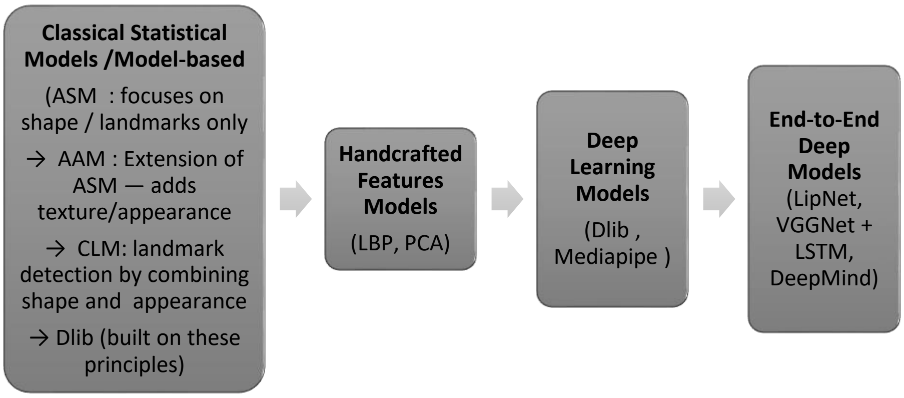


*Fig. 2: Relationship between different lip extraction Models and tools*

**Dlib**

This tool detects faces and extracts the geometric shape of lips using landmarks. Dlib detects 68-point facial landmarks.

**A. Setup and dependency**

There are many setups required when lip feature extraction achieved with Dlib. Several version compatibility issues located if any mismatch version. Some of the important libraries and its version dependency with Dlib shown in following Table 3.

**Table 3.** Dlib version dependencies with other python libraries

| **Package** | **Description** | **Version** |
|---|---|---|
| build | Python package build system | 1.2.1 |
| cmake | Build tool required for compiling C++ libraries like Dlib | 3.25.2 |
| dlib | Facial landmark detection library | 19.24.99 |
| matplotlib | Visualization and plotting library | 3.9.0 |
| **Package** | **Description** | **Version** |
| numpy | Core numerical computing library | 1.26.4 |
| opencv-python | Computer vision library for image processing | 4.10.0.84 |
| pandas | Data analysis and CSV handling | 2.2.2 |
| pip | Python package installer | 24.1.1 |
| scipy | Scientific and mathematical computation library | 1.14.0 |
| setuptools | Utilities for building and distributing Py packages | 70.1.1 |
| wheel | Format for built Python packages | 0.43.0 |

**B. Common Visual Features that extracted from Dlib**

Dlib uses 20 coordinates to identify the lip's edges. Following Table.4 shows some common lip features extracted using Dlib tool with its description and formula.

**Table 4.** Visual Features that extracted from Dlib

| Sr. no. | Feature Type | Description | Calculation |
|---|---|---|---|
| 1 | Lip Aspect Ratio | Shape of mouth opening | height / width, width != 0 else 0 # Avoid division by zero |
| 2 | Lip Contour | Outer + inner lip boundaries | Uses 48–67 landmark points |
| 3 | Outer Lip Height | Vertical distance between top and bottom outer lip landmarks | height = y_max - y_min (outer lip landmarks) |
| 4 | Outer Lip Width | Horizontal distance between left and right outer lip landmarks | width = x_max - x_min (outer lip landmarks) |
| 5 | Inner Lip Height | Vertical distance between top and bottom inner lip landmarks | height = y_max - y_min (Inner lip landmarks) |
| 6 | Inner Lip Width | Horizontal distance between left and right inner lip landmarks | width = x_max - x_min (Inner lip landmarks) |
| 7 | Outer lip area/Mouth Area | Polygon area of outer lip contour | Area calculated with lip points 48–59 |
| 8 | Inner lip area | Area enclosed by inner lip contour | Area calculated with lip points 60–67 |
| 9 | Lip center : x | X-coordinate of lip center | Midpoint of left and right outer lip points: (x_max + x_min)/2 |
| 10 | Lip center : y | Y-coordinate of lip center | Midpoint of Top and Bottom outer lip points: (y_max + y_min)/2 |

**C. Comparative study for all tools**

Following Table.5 shows comparative study for three lip feature extraction tools with its description, dimensions, speed, accuracy, advantages, disadvantages and output .

**Table 5.** Comparison between Visual Features extraction tools

| Tool | Landmark Detection | 3D, Speed, Accuracy | Advantages | Disadvantages | OUTPUT |
|---|---|---|---|---|---|
| **Dlib** | 68-point Facial Landmark Detector. Lip-related landmarks are points 48–67 outer:48–59, inner: 60–67. | ✕ Speed: fast Accuracy: Moderate | High precision for lip region- Real-time performance. Can capture 3D lip movement, useful for lip reading and emotion recognition. | Only 2D (no depth info)- Less accurate for extreme head poses- Sensitive to lighting and occlusion |  |

| | | | | | |
|---|---|---|---|---|---|
| **Medi-apipe** | Face Mesh model with 468 land-marks (3D). Lip landmarks roughly, outer: 0–17 In-ner:61–19 | ✓ Speed: Very fast Accu-racy: High | Extremely precise and robust- | Requires GPU/modern CPU for best performance- Slightly more complex inte-gration than Dlib |  |
| **OpenC V** | Haar Cascade and DNN-based face de-tectors. De-tects bounding boxes around faces, no land-marks | ✗ Speed: Very fast Accu-racy: Moder-ate | Excellent for pre-processing (face detection before landmark extrac-tion)- Lightweight and easy to use | No detailed lip landmarks- Requires inte-gration with Dlib or Medi-apipe for lip analysis |  |

**The Challenges In Dlib**

There are some challenges in lip reading as given as follows:

1. Dlib can extract only 68 facial landmarks, with few points on lips so cannot capture micro-movements or subtle lip shapes. Also get reduced accuracy in the presence of facial occlusions, particularly beards and mustaches.
2. It Works efficiently in frontal view images only. Also lighting changes affects in performance.
3. It is Not End-to-End Deep Learning tool so Limited Real-Time Accuracy and less reliable than MediaPipe.

**Application Areas**

Lip extraction has various application areas that are listed as below:

1. Dlib is used for Face or lip motion tracking from videos.
2. MediaPipe Face Mesh is used for High-precision lip landmark extraction such as in Expression analysis.
3. OpenCV is used in Face detection as well as lip region cropping which can be used in security and surveillance area.

**Observation.**

- We have explained whole step by step process from lip detection and localization to lip feature extraction.
- We reviewed literature in chronological order with various visual lip feature extraction methods and tools with the steps involved in each tool.
- Our paper explained different lip feature extraction methods including Local Binary Patterns (LBP) , CLM model , VGGNet + LSTM ,LipNet with STCNN, SIFT + SURF . LipNet contains a hierarchy of layers having higher accuracy. SIFT and SURF both methods have accuracy is greater than 90%.
- The current study has reported explanation of various tools for lip feature extraction including dlib, Mediapipe and OpenCV with conducting a comparative study, with its description, dimensions, speed, accuracy advantages, disadvantages and output with each tool.
- Overall Relationship between different lip extraction Models and tools also discussed in study report.
- Paper has also discussed accuracy of method or tool wherever mentioned.
- We have given set up dependency with each package and version for Dlib tool as it has version compatibility errors. We have explained various common 10 Visual Features that extracted from Dlib with its calculation.
- Our findings also discussed that lip extraction has a variety of applications in real-world.
- Various Challenges for feature extraction while using Dlib tool are also discussed in the paper.

**Research Gap**

In existing methods for lip feature extraction several research gaps need to be addressed for further advancement. There are various factors affecting performance such as lighting conditions, multi speaker in one frame or face angle, facial occlusions etc.there is a Gap between Traditional and Deep Learning Approaches. Traditional handcrafted feature methods (LBP, SIFT, SURF) and modern deep learning models (LipNet, VGG-LSTM) are usually studied independently. Hybrid frameworks that combine geometric and deep features for improved performance are not explored extensively.

One more gap is Limited Comparative Evaluation across Tools. Although Dlib, MediaPipe, and OpenCV are widely used, systematic performance comparison with accuracy, speed, and output across tools for visual lip feature extraction is scarce. There is a need for standardized evaluation protocols.

## Conclusion

This study presents a comprehensive exploration of visual lip-feature extraction techniques. The work systematically describes the complete workflow beginning from lip detection, lip localization, region extraction, and finally visual feature extraction, enabling a clear understanding of the pipeline required for accurate visual speech processing.

A chronological literature survey was conducted to trace the advancement of lip-feature extraction frameworks from classical computer-vision approaches to state-of-the-art deep learning architectures. Traditional approaches such as Local Binary Patterns (LBP), Scale-Invariant Feature Transform (SIFT), and Speeded-Up Robust Features (SURF) were evaluated for their robustness against illumination variations, rotation, and noise conditions, where SIFT and SURF achieved accuracy levels above 90% in existing literature. Statistical and shape-based models including the Constrained Local Model (CLM) and ASM and AAM Models were reviewed.

Attention was given to deep learning-based architectures including VGGNet with LSTM networks, and LipNet utilizing Spatio-Temporal Convolutional Neural Networks (ST-CNN). These models demonstrate significant improvements in end-to-end visual speech recognition.

In addition we evaluated widely-used tools for lip-feature extraction such as Dlib, MediaPipe, and OpenCV comparative analysis in terms of operational workflow, dimensional parameters, computational speed, accuracy, advantages, limitations, and output characteristics.

The study also reported in previous studies was highlighted wherever available. For Dlib, specific installation and version-compatibility guidelines were documented, along with the computation of ten commonly used visual lip features extracted from the Dlib landmark framework. Challenges associated with Dlib particularly its sensitivity to head pose, lighting conditions, facial occlusion like beard or mustache, limited lip landmark precision, and restricted real-time accuracy were discussed in detail. These insights help researchers select appropriate frameworks based on application requirements, data availability, and computational constraints.

Overall, this study consolidates key concepts, techniques, tool evaluations, and accuracy reports surrounding lip-feature extraction, and serves as a structured reference guide for students, practitioners, and researchers working in visual speech processing and lip-reading based human-computer interaction systems.

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