Chapter 1
Introduction to Biometrics and Special Emphasis on Myanmar Sign Language Recognition

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1.1 Introduction and Background

Biometrics combines two important words, bio and metrics, and thus biometric deals with some biological measures or metrics employing biological features. Biometric concepts, theories, fundamentals, and applications become very relevant in present context since almost all technological advancements are using some type of biometric techniques for various reasons, such as authentication, security, etc. For example, in cell phone fingerprint biometrics is commonly used to authenticate right user/owner of phone to avoid any misuse of the functionalities of the phone. For example, when a person buys a new phone, that time the user is asked to register his/her fingerprint impressions which are recorded in the form of some suitable representation, and when authenticated user puts the fingertip while using (testing process in biometrics language), then the person is authenticated as the right person. Sinha et al. in their book on biometrics highlight the concepts and several emerging applications of the biometrics [1]. A typical block diagram of any suitable biometric method which depicts important flow of processes in biometrics can be seen in Fig. 1.1.

Actually, Fig. 1.1 shows a general purpose block diagram of biometrics; in fact it involves two important stages, namely, training and testing. Training has the following components:

- Image capturing or acquisition: Images such as faces, iris images, and fingerprints are captured in this process.

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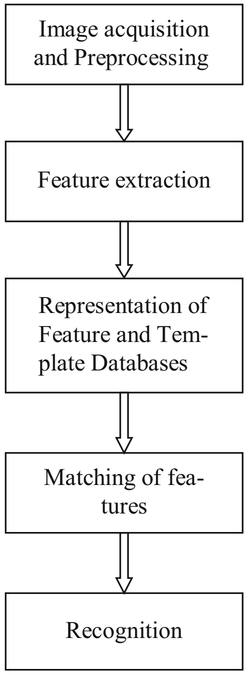


Fig. 1.1 Biometric process

- Preprocessing: This involves several steps for making the images suitable for further stages, such as resizing, reformatting, de-noising, etc. De-noising or image enhancement is also an important task that deals with any unwanted signal added in original images.
- Feature extraction: In this process, suitable set of features are extracted from the images that were captured and preprocessed.
- Representation of features: This process converts features of images into some suitable representations, generally referred to as templates, and the database of templates is created.

Testing stage involves all processes of training and few more, which are:

- Template matching: The face or any image which is being tested for recognition or authentication is subjected to all processes of training, and finally the template extracted from the test face or image is matched against all those which are saved in template database. If the image is matched properly, then it is authenticated.
- Recognition: After matching, the testing stage results in either authenticated or not. The classification or matching tasks are done by a number of algorithms and methods available. In fact, now it is very difficult to choose appropriate method for matching process since robustness is a big issue in the field of biometrics.

Actually, the recognition is also of two types, authentication and verification. In verification, the test face is verified as the authorized user, whereas as in authentication, the user is recognized exactly who the user is, and therefore verification is also known as 1 to N matching, and authentication is referred to as one to one matching. For example, in banking application, if an unauthorized user attempts to enter in the secured premises or attempts to make use of secured applications, then by using face or fingerprint biometrics, the intruder can be detected and caught.

Historical study of biometrics suggests that the concept of biometrics is very old and was used in the beginning of the nineteenth century for criminal investigation. There were traditional methods of using biometrics, either using some features of palm, fingers, or so, but now the technology has made the use and application of biometrics so sophisticated that the technology is available on microscale and nanoscale in numerous applications such as robotics, computer vision, DNA matching, protein synthesis, medical image analysis, remote sensing, and satellite imaging, and the list is huge. Sinha et al. study the role of biometrics in understanding the ability of human brain employing deep learning as a training method [2]; and one more such study is reported in [3] by Sinha et al. Sinha et al. implemented a signal language recognition using their own sign language databases as Indian sign language (ISL) database and implemented Devanagari text and numeral recognition using different methods, and this work proves to be extremely useful for speech- and vision-disabled people [4]. Patil et al. (2016) and Patil et al. (2011) implemented ISL and Devanagari character recognition using shift invariant feature transform (SIFT) and hidden Markov model (HMM) [5, 6]. Snehlata et al. in their work implemented multimodal biometrics using principal component analysis (PCA) method and achieved satisfactory performance in comparison with unimodal biometrics [7, 8]. Here, multimodal biometrics involved multiple modalities or traits such as face, iris, fingerprint, palm print, etc., whereas in unimodal the recognition is only on the basis of single modality, and the recognition accuracy is always limited due to challenges and problems with the modality chosen.

Handwritten recognition is researched extensively in [9–12] using SIFT- and HMM-based methods. One interesting application of biometrics is in license plate recognition (LPR) of vehicle number plates which is useful in automatic parking, surveillance, and toll systems. The research on LPR is found on number plates of a number of countries and implemented differently because the number plates and standards are different from country to country. Choubey et al. (2013) and Choubey et al. (2011) implemented bilateral portioning method and pixel count method for LPR that dealt very well with confusing number plates in case of presence of noise, such as I and T and O and Q [13, 14]. Lazrus et al. employed neural network for Indian number plate recognition [15], and the research studies were carried out for Myanmar number plate recognition (New Ni et al. 2018) in [16]. Indian license plate recognition was also implemented using some hybrid approaches, like neuro-fuzzy method in [17, 18] by Siddhartha et al.

1.2 Classification

The biometric methods are classified on the basis of several parameters such as types of traits, number of traits, and the authentication type. The methods are divided on the basis of types of modalities, as follows:

- Face recognition: Faces are biometric modalities or traits.
- Iris recognition: Iris of eyes is taken as trait.
- Fingerprint matching: Fingerprint impressions are modalities used in biometrics.
- Palm print matching: Palm prints are traits here.
- Hand geometry recognition: Based on using hand movements.
- Signature recognition: Considered as behavioral biometrics because signature is considered as one of the important behavioral traits in human being.
- Speech recognition: Uses speech as modality.
- Facial expression recognition: Faces with different mood conditions of a person such as sadness, happiness, laughter, etc. are taken into consideration for determination the type of nature or behavior of person.

Classifications on the basis of number of modalities are:

- Unimodal biometrics: Involves single biometric trait such as only face in simple face recognition.
- Multimodal biometrics: Involves more than one modality, such as AADHAAR car, which is very popular and widely used authentication card issued to every citizen in India which includes the face, iris, and all ten fingers of a person.

The way authentication is performed, biometrics is also classified:

- Authentication: one to one matching
- Verification: one to many matching

A different way of classifying the biometrics results:

- Soft biometrics: This utilizes some unique and non-transferable features of persons such as permanent scar mark, mole, etc.
- Hard biometrics: All other biometrics except soft are called as hard biometrics.

Initial work on biometrics suggests that most of biometrics are based on fingerprint matching. One such work is reported in [19] that highlights basic overview and types of biometrics giving stress on fingerprint recognition. This paper presents advantages of fingerprint and its working principle also, exploiting features of fingerprints and minutiae which are some representations of fingerprint ridges and valleys. The market-wise potential is also largest in fingerprint biometrics since it is used most commonly and popularly in enormous number of applications [1]. Fernando et al. in the most recent work discuss about selfie biometrics as a kind of face biometrics. Super-resolution methods are implemented and compared with iris recognition of large number of samples [20]. Nowadays, biometrics is being used in travel and other identity documents; in all travel modes especially in air travel, attempt is made to free the passengers from carrying boarding passes, and they can be allowed only on the basis of biometric system.

1.3 Societal and Ethical Issues

Implementation of biometrics at large scale for benefit of masses requires user participation at all levels, right from biometric capturing process to user-end support. When the implementation is targeted as large masses, then it has some limitations related to social implications and ethical matters. For example, AADHAAR is a most common identity tool in India, and every citizen in India has been issued this card [1], but the implementation of the project in terms of data capturing of faces, iris, and fingerprints raised few important issues in society, and many of experts were of opinion that the biometrics is violation of personal secrecy and privacy. The parliaments have discussed a number of times on this matter, and a number of amendments are made to address the issues raised as concerns from various groups or the society.

In a technical report on biometrics [21], social implications were discussed in detailed with few case studies. The European Commission (2005) in this report highlighted various types of biometric technologies with implementation strategies, diffusion of methods, and focused on DNA, face, and iris biometrics. Among many social aspects [1], few important are reported here:

- Social exclusion and human factors: Ethnicity, age, gender, etc. are also needed in declaration process of biometric applications used for common mass beneficiary schemes. More amount of research on user-friendliness and usability of biometric data need to be carried out so that awareness can be created and people can support the implementations, since there are some inhibitions or apprehensions in providing the data, while training process is performed in biometric application.
- Feeling of trust breach: Sometimes, the user participation is also affected due to the lack of trust between users (citizens) and implementation authority.
- Privacy of personal information: Various private and public sectors take the personal data of citizen for deploying and providing biometric services that causes apprehension in common masses with a feeling of their personal data being stolen and might be misused also.

Jain et al. also presented overview of social acceptance and challenges in biometrics [22]. In financial transactions such as credit card usage, health insurance, and other similar areas of market and commercial potentials, apprehensions are obvious of misuse or breach of privacy related to biometric personal data.

1.3.1 Ethical Issues

In technical report [21], ethical issues related to biometrics were also elaborated with examples. Biometric data can be used by various law enforcement agencies for various legal procedures that again require personal data, though law enforcement systems are devising laws for protection of personal data, but still the matter becomes serious when it involves personal data in legal system and delivery [1]. Emilio et al. studied social and ethical implications in biometrics particularly and was suggested that the implications and issues may be different for different nationalities, but some issues are unavoidable [23]. A number of reports mentioned how the reports attempted to address few ethical issues, such as RAND report (2001) addressed sociocultural issues; the European Commission report (2005) attempted to address social and ethical issues. In the report, physical privacy, religious objections, and personal information were said to be at risk or misused by the service providers or application facilitators. A wide range of legal, medical, and social issues were introduced in several reports [23].

1.4 Soft Biometrics

Traditional biometrics involves common modalities such as faces, fingerprints, iris images, hand geometry, facial expression, etc., but there are few biometric or biological traits which are unique and non-transferable, for example, scar, tattoos, weight, mark on face or somewhere else, mole, etc. [1]. Reid et al. use soft biometrics in application for surveillance where tattoos, body geometry, and scars were taken into consideration for biometric identification [24]. In a video footage from CCTV capture, the soft biometric traits are detected and made the basis of identification using some metrics for matching like false accept (FA), false reject (FR), and equal error rate (EER); and the main basis of matching between test samples against the database is Euclidean distance. Other suggested semantic traits as soft biometric modalities include arm length, chest, hair color, arm shape, leg shape, leg length, etc. One of the advantages of soft biometrics was reported as continuous authentication is not affected with time change since other modalities may change with time but some of soft traits do not change over time [1, 24].

Antitza et al. presented a survey on soft biometrics and suggested that the soft traits which are referred to as ancillary traits such as gender, age, scar, hair, color, and weight are used in combination with primary modalities such as face and fingerprints in order to improve reliability and matching accuracy of biometric system. This can be easily done in multimodal system by fusing both types of biometric traits [25]. Main advantages of the soft biometrics are:

- Human can understand the attributes related to soft traits easily.
- Robustness is reported to be better in implementing the methods for matching.

- These modalities can be taken or captured without consent for certain application, and thus privacy issues are not much important.
- Easier way of getting taxonomy of modalities, such as demographic, medical, behavioral, and geometric.

A number of methods which are used for soft biometric recognition were summarized in terms of their major findings and database size [25]. Few of them include support vector machine (SVM), neural network, and principal component analysis (PCA). There are some datasets also reported in this survey like CASIA gait DB [25] and IRIP gait DB [25].

1.5 Biometric Standards, Protocols, and Databases

Deployment of biometrics and services are required to follow certain standards or policies and also need to work under a set of rules and procedures, referred to as standards and protocols [1]. Generally, the standards are developed for:

- Supporting biometric applications and interoperability
- Conforming various architectures where biometrics are deployed and used
- Suggesting common metrics and models for use
- Dealing with usability, quality, and interoperability for biometrics applications
- Testing and research and development facilitation

Frances discussed the standards, norms, and protocols [26] in details with regard to a popular biometric application in India where each citizen has been given a unique ID (identity) also referred as UID (unique identity) that includes three modalities [1]. This policy papers recommend several suggestions and policies for implementing similar biometric for other nations as UID which is also called as AADHAAR card in India. Actually, the implementations like UID can save huge amount of money where a large number of ghost workers are claimed in various projects; and it has been benefitting India to great extent, and now no one can weed out money in the name of ghost workers since each account is being associated with UID number and the money directly goes to their account as direct benefit transfer (DBT) to the beneficiaries. This report highlights difficulty in such issues in Cambodia, Tanzania, and Nigeria where a lot of money is weeded out just for the reason that the system like UID is not working. If the UID like implementation has to spread across many places, it has to follow certain rules and standards. The department that takes care of UID project, UIDAI, has initiated certification process for biometric equipment to be used for applications especially those dealing for a large number of masses. The certification is done through standardization testing and quality certification (STQC) which has set of procedures for testing, evaluation monitoring of various biometric equipment, and deployment.

UIDAI committee has framed certain biometric standards [27], biometric design standards for UID applications (2009), which include standards for faces, fingerprints with best practices, and members of different sub-committees. There are some important documents which were used in designing the standards:

- ISO/IEC 1544 for JPEG 2000 image coding
- IAFIS-IC-0110 (V3) for fingerprint image compression
- ISO/IEC 19785-1:2006, ISO/IEC 19794-2:2005, ISO/IEC 19794-4:2005., ISO/IEC 19794-5:2005, ISO/IEC 19794-6:2005, and ISO/IEC CD 19794-6.3, respectively, for data specification, minutiae data, fingerprint data, face data, and iris data as Part 1, Part 2, Part 4, Part 5, Part 6.

1.5.1 Standards

The main objective of designing standards is to make interoperability easier and compatible between biometric devices and supporting IT systems. There are few important agencies involved in design process, such as American National Standard Institute (ANSI), European Committee for Standardization (CEN), International Organization for Standard (ISO), International Committee for Information Technology Standards (INCITS), and open and advancing standards for information society (OASIS).

Standards for face images include photographic requirements, enrollment, source type, pose, image compression, format**,** and feature blocks. ISO/IEC 19794-5 covers all such requirements for capturing face images for biometric applications. To sum up about these set of procedures and norms [1, 27]:

- Image being captured should of very good quality, probably best quality.
- Full frontal images of 300 dpi and 24 bit RGB color space should be captured.
- Expression of face needs to be without smile, mouth closed, and open eyes.
- Roll, yaw, and pitch angles are required to be within 5° on positive as well as negative value.
- JPEG 2000 image compression to be used.

Similarly, fingerprint image standards ISO/IEC 19794-4 [27] covers the following:

- 500 dpi images for enrollment with 8-bit pixel depth and 200 gray levels of dynamic range.
- 500/300 dpi for authentication.
- JPEG2000 compression scheme should be used.

All other standards discussed have their own procedures and norms, for minutiae extraction and storing, image compression, etc. The standards for iris images in UIDAI, ISO/IEC 19794-6 include recommendations of some sub-committees, for example, ISO/IEC JTC 1/SC 37, introduced in 2010 [27]. Technical details, biometric accuracy, and best practices for each type of modalities are explained in detail [27]. International Telecommunication Union (ITU) suggests several organizations which are involved in designing and developing standards for various purposes related to biometric applications [28]. ISO and CEN are of those international organizations mainly responsible for development of such standards; one more such organization is International Electrotechnical Commission (IEC). NIST is an example of national-level organization for development of standards; few more are there, for example, Bureau of Indian Standards (BIS) and American National Standard Institute (ANSI). Industrial consortia are also there like IEEE that has separate consortium for this purpose as IEEE biometric consortium. There are numerous committees and their sub-committees for technical standards developments [28], such as:

- ISO/IEC JTC 1/SC 37 for biometric standards
- ISO/IEC JTC 1/SC 17 for standards related to personal identification
- ISO/IEC JTC 1/SC 27 for standards of security applications in IT systems

Electronic identity in Peru is DNIe (digital national identity) and Estonia has ID-Kaart as identity card [28], and all of them follow some standards governed by International Organization for Standardization, their committees, and sub-committees. Biometric standards and databases are discussed in [29] for visiting the USA.

1.5.2 Protocols

Protocols are used for an important task of dividing the databases into a number of datasets. For example, we have a huge face database that involve faces of different poses, different illuminations, and different face and head positions, and then the database can be portioned into number of datasets based on poses, head positions, illumination, etc. This process of partitioning is referred to as protocol which is actually some set of rules responsible for partition [1, 30–32]. Anongporn presents his doctoral thesis on authentication protocols used for biometric applications [33] and suggested ProVerif model and CPV02 model. Comparison of various types of models used as protocols was discussed in terms of different types of databases portioned into a number of datasets. Focus was made on security protocols used for authentication purpose.

1.5.3 Databases

Initially, in UID work, three databases were created as DB1, DB2, and DB3 [27]. DB1 covers 27 urban and 81 rural areas including 1351 images and single impression sensor technology. This employed FIPS 2001 APL standard and also image quality specifications of FBI. DB2 includes 20,000 persons and 200K total images all fingerprints segmented properly and prepared for database. DB3 has 5600 individuals that contain 56,000 images approximately [27]. This example of databases for biometrics is what was used in UID project, and all biometrics applications have their own databases separately for faces, fingerprints, and iris images like NIST has its own databases satisfying various biometric standards. Few other databases are described in [30] by Poh et al. in their report on biometric testing and evaluation, and such repositories are:

- US-based biometric consortium.
- CASIA is a database of center for biometrics and security research China.
- NIST databases.
- AR face databases of Spain.
- AT&T databases of faces.
- BANCA, a multimodal database.
- CASE-PEARL face database.
- FERET databases of NIST.
- JAFFE, Japanese female face database of facial expressions.
- KFDB, Korean face database.
- Yale Face database.
- MCYT-DB, fingerprint database.
- FVC 2000, FVC 2002, FVC 2004, and FVC 2006 all fingerprint databases.
- ICE databases for iris images by Iris Challenge Evaluation.
- CASIA-Iris-V3 for iris images.
- Many others as multimodal biometric databases for vein and hand geometry.

Melissa [34] and Aglika et al. also focused on databases study and survey [35]. Coding scheme was suggested in [35] for designing and implementing the protocols in multimodal biometric databases. Asma et al. studied extensively on multimodal biometric databases [36].

1.6 Myanmar Sign Language Recognition

As discussed in the beginning, biometrics is most commonly used in a number of security- and authentication-based applications. Based on modalities, the applications are classified. Speech recognition and face recognition are common biometrics among all biometric methods. Speech biometrics falls under behavioral biometrics, and face recognition is considered as physiological type of biometrics [1]. One more important application of biometrics is sign language recognition which uses hand geometry, palm geometry or movement which is very useful for people with hearing and vision disability. Sign language, as its name suggests, helps the disabled persons by communicating with the help of some gestures, symbols, and expressions. These movements and gestures may be captured from moving images (videos) as well as static images [1]. This section focuses on Myanmar sign language biometrics with implementation; sample results and discussion juts to showcase a case study of biometrics.

1.6.1 Sign Language Recognition

Sign language biometrics or recognition is researched in many countries as per their requirement, culture, and varying symbolic gestures [1, 37–55]. Thad et al. studied American Sign Language using video captured from wearable device [37]. Hidden Markova model (HMM) was used and tested in MIT research laboratory. Sana also implemented American Sign Language (ASL) using Otsu segmentation method [38]. Helen et al. discussed about sign language recognition using linguistic sub-units. The system used three types of sub-units for consideration which are learnt from appearance data and 2D and 3D tracking data. Then the sub-units are combined into a sign-level classifier with two options. HMM and sequential pattern boosting are used that provided 54% and 76% accuracy, respectively. The work was tested for big datasets having 984 signs, and it was observed that as the number of signs increases, then the accuracy is adversely affected [39]. Assaleh et al. presented sign language for Arabic language using HMM and resulted 94% of accuracy [40]. Razieh et al. implemented a multimodal biometrics for sign language recognition using Restricted Boltzmann Machine (RBM). The system achieved about 90% accuracy, but there is some difficulty on recognizing characters with low visual interclass variability such as high hand post similarity [41]. Irene implemented Iris sign language recognition [42]; Patil et al. on Indian Sign Language (ISL) in [43], Brandon et al. on ASL using neural network [44], Wijayanti et al. on alphabet sign language [45], Yanhua et al. [46] on Japanese Sign language Biometrics [46], Joyeeta et al. on ISL using video signal as input [47], Deepali et al. on ISL biometrics [48], Amit et al. on ASL [49], Paulo et al. on Portuguese Sign Language recognition [50], Cao et al. on ASL [51], Alina et al. on sign language biometrics [52], Dominique et al. on sign language recognition [53], and Fitri et al. on alphabet sign language recognition are few major research contributions in the field of sign language recognition [54]. Though there are several research works on sign language biometrics, most of them suffer from lack of robust method and robust databases.

1.6.2 Myanmar Sign Language (MSL) Recognition and MIIT Database

Though there are numerous research on sign language biometrics, the research in this area is limited. In fact, the number of research on MSL is almost insignificant. However, there are significant amount of work in natural language processing on

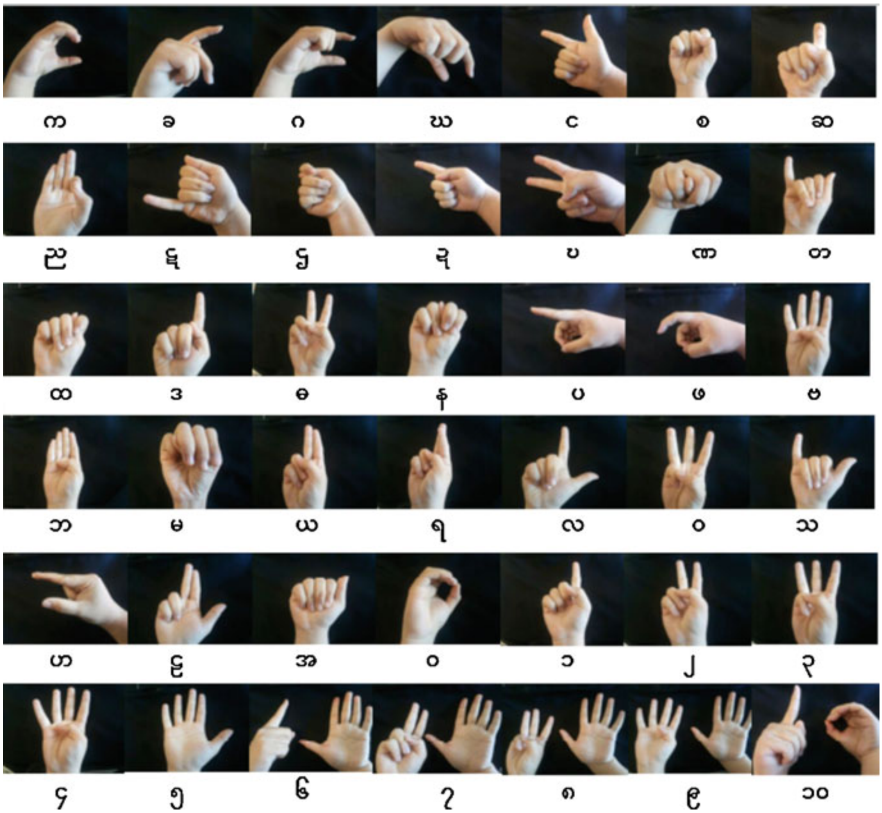


Fig. 1.2 Myanmar characters and numerals of MSL database

Myanmar language, grammar, and related analysis. One such work on MSL is reported in [55] by Thit et al. on Myanmar sign language text analysis using genetic algorithm which presents an overview of MSL biometrics.

We have attempted successfully to implement MSL using standard method and shift invariant feature transform (SIFT) that operates on databases of MSL created by our research group. Figure 1.2 shows the database developed by our research group working at MIIT Mandalay Myanmar toward their undergraduate project course.

The databases include arrays of alphabets and numbers [“Ka Gyi” “Ka Kway” “Ga Nge” “Ga Gyi” “Nga” “Sa Lone” “Sa Lane” “0” “0” “Nya” “Ta Talin Jade” “Hta Won Bell” “Dain Yin Gouk” “Dain Yin Hmote” “Na Gyi” “Ta Won Bu” “Hta Sin Htoo” “Da Dway” “Da Out Chike” “Na Nge” “Pa Sout” “Pha Oo Htote” “Ba Htet Chike” “Ba Gone” “Ma” “Ya Pa Lat” “Ya Gout” “La” “Wa” “Tha” “Ha” “La Gyi” “Ah” “0” “1” “2” “3” “4” “5” “6” “7” “8” “9” “10”]. The symbols are recorded as gestures of palm by the MIIT research team and recorded audio file also for each number and alphabet. The symbolic representations of the characters were verified with the help of a school in Mandalay running for deaf and dumb people. Deaf charity Mandalay Myanmar helps in collecting database and other gestures were recorded. All 33 alphabets (from “Ka” to “Ah”) and 11 numbers (“0” to “10”) are created and recorded as images. We also created sound or audio files for all these data with the help of Google Translate Text to Speak (TTS) assistant. Then, some preprocessing was applied to resize and reformat the images.

1.6.3 MSL Implementation and Results

The SIFT algorithm [1] is implemented for recognition of Myanmar Sign Language. SIFT extracts key points for matching, and while testing, key points are matched against those stored in database of key points. Key points may be considered here as template representation [1]. The steps of SIFT can be simply interpreted by the following:

- An input image of any gesture can be recognized with comparison of the image against databases of the images. The images are not stored as images but kept inside template database.
- Euclidean distance is used to match the images based on nearest value using feature vector stored inside the database. Feature vector is only the template here.
- SIFT has its meaning due to inclusion of scale, location, and orientation value which are extracted from the images and thus making the method appropriate and can take any orientation of input image.
- Clusters of feature vector are determined using Hough transform.
- Features are of two types, detector and descriptor. Frames are extracted by detector having some variations. Descriptor connects the regions and makes association to the images so that features become invariant of shift, scaling, rotation, orientation, and illumination variation.
- The images that were subjected to the method are gray scale images in order to reduce the computation time and save memory. Thus, all input images captured originally as color images are converted into gray scale before they are subjected to various stages of MSL recognition.

Figure 1.3 shows the steps in concise manner where preprocessing, initialization of databases, and creation of feature vector are important components of MSL biometrics.

The detailed flow diagram for implementation of MSL biometrics is shown in Fig. 1.4 where almost all stages and their functionalities are self-explanatory. If more than one result is produced, then threshold value or Euclidean distance is again checked and evaluated until we get a single and decisive output.

Now, results for an image are shown here to highlight the working of the method for MSL biometrics and Myanmar database. Figure 1.5 shows an original image from the MIIT database, and Fig. 1.6 is the grayscale image of Fig. 1.5.

SIFT frames and peak points can be seen in Figs. 1.7 and 1.8.

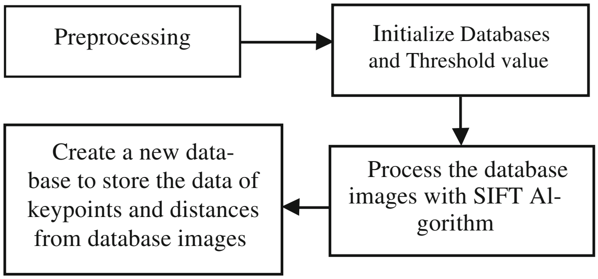


Fig. 1.3 Main stages in MSL recognition

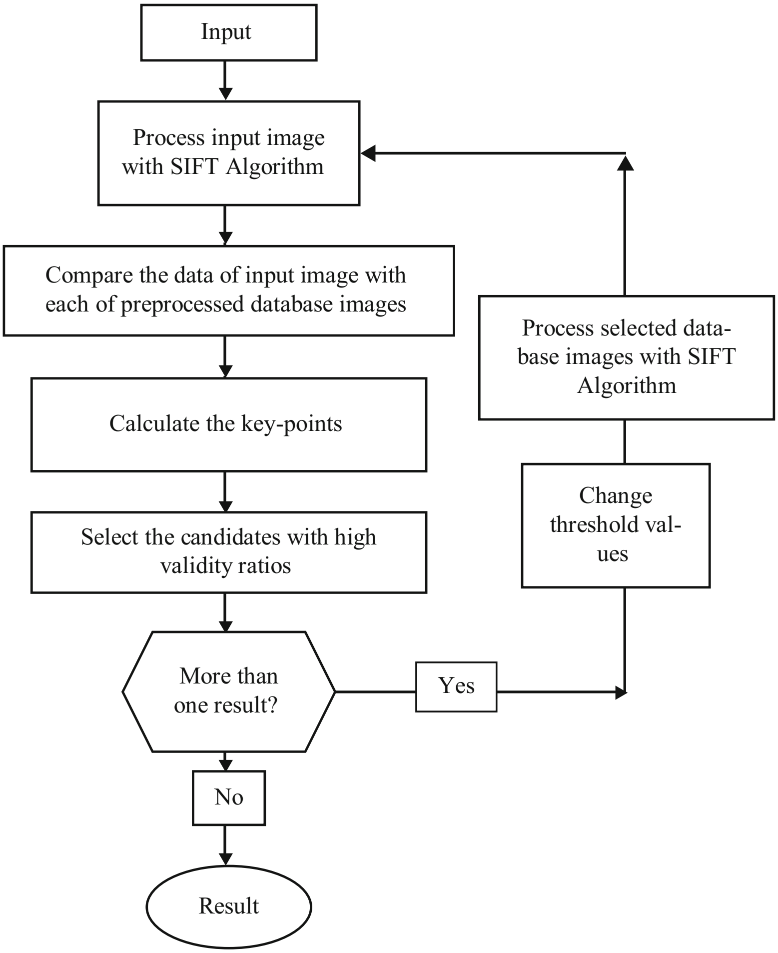


Fig. 1.4 Flow of steps for implementation of MSL recognition

Fig. 1.5 Original image as input

Fig. 1.6 Gray scale image of input

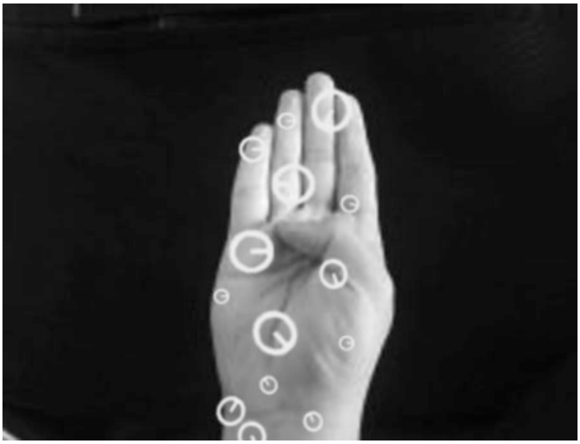
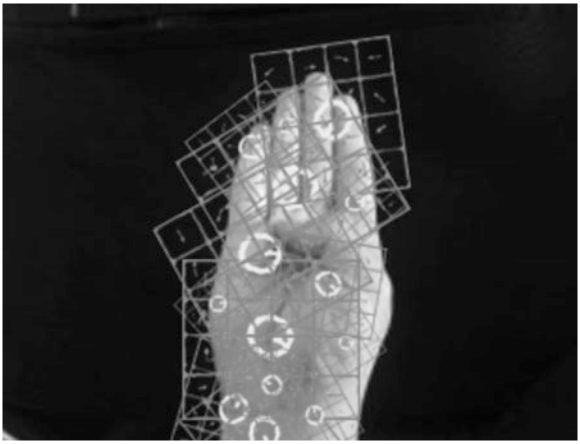


Fig. 1.7 SIFT frame

Fig. 1.8 Test SIFT peak threshold parameter



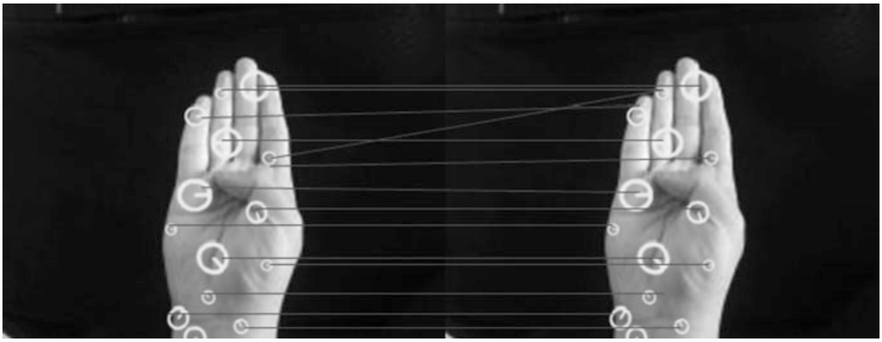


Fig. 1.9 Matching between features in two images

Fig. 1.10 Peak threshold 0

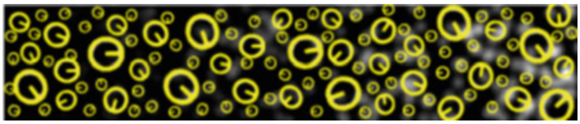
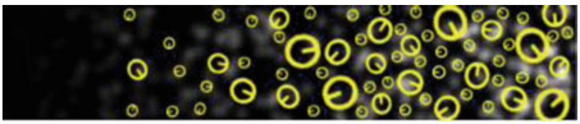


Fig. 1.11 Peak threshold 10



Descriptors help in finding similar regions in two images on the basis of matching key points in test image against image in database, as can be seen in Fig. 1.9.

Detector controls two values, peak threshold and edge threshold, as shown in Figs. 1.10, 1.11, 1.12, and 1.13. The number of frames that were detected for different threshold values are shown in figures.

Similarly, the results highlighting the number of frames for different values of edge threshold are shown in Figs. 1.14, 1.15, 1.16, and 1.17.

Fig. 1.12 Peak threshold 20

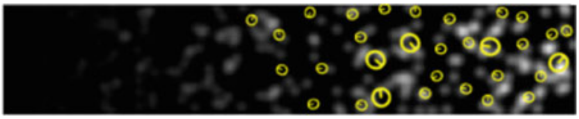


Fig. 1.13 Peak threshold 30

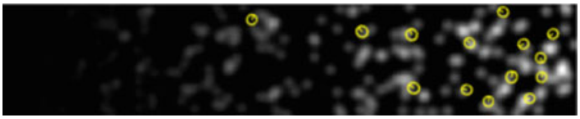


Fig. 1.14 Edge threshold 3.5

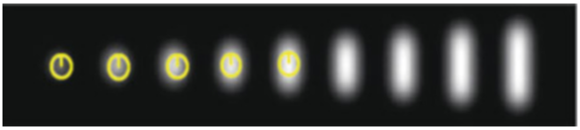


Fig. 1.15 Edge threshold 5

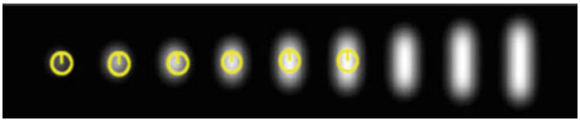


Fig. 1.16 Edge threshold 5.5

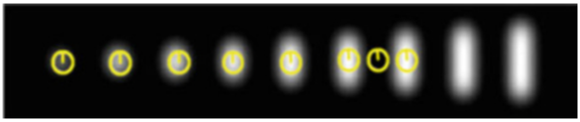
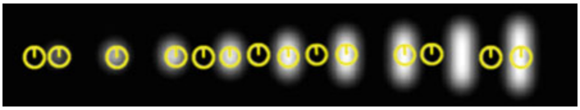


Fig. 1.17 Edge threshold 10



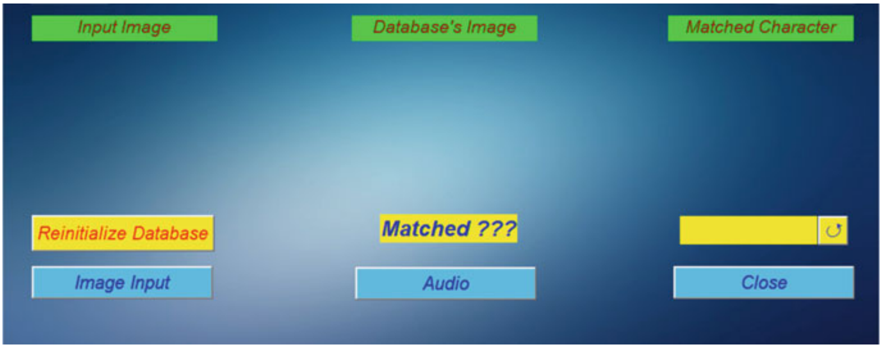


Fig. 1.18 A GUI for testing

Now implementation of MSL biometrics on MATLAB platform is briefly presented with the help of GUIs obtained while implementing and testing the work for Myanmar Sign Language recognition. Figure 1.18 shows a GUI for testing the work, and an input image is given in the system as can be seen in Fig. 1.19.

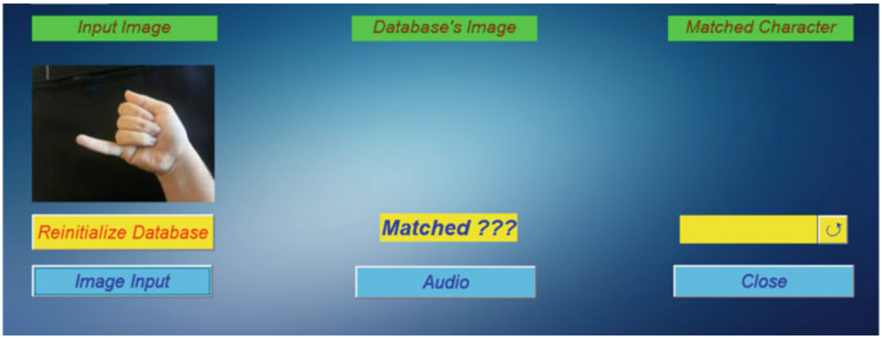


Fig. 1.19 An image given as input

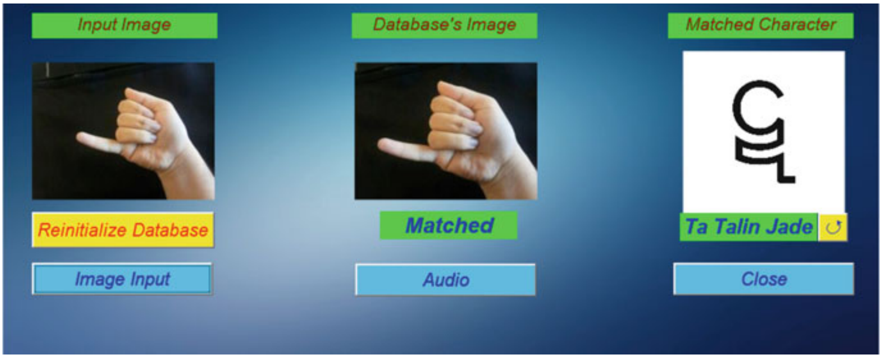


Fig. 1.20 Myanmar alphabet "Ta Talln Jade" recognized with suitable audio

We can see that the Myanmar alphabet "Ta Talln Jade" is recognized, and the images being tested and database image are the same. Most important feature of this work is that the audio is also associated with the sample being matched which can greatly help deaf and dumb people (Fig. 1.20).

Figure 1.21 shows the result for Myanmar alphabet "Ka Gyi," and alphabet "Nga" is shown in Fig. 1.22.

Figure 1.23 shows result of MSL biometrics for alphabet "Sa Lane." Result for number "1" is shown in Fig. 1.24, and "7" is shown in Fig. 1.25.

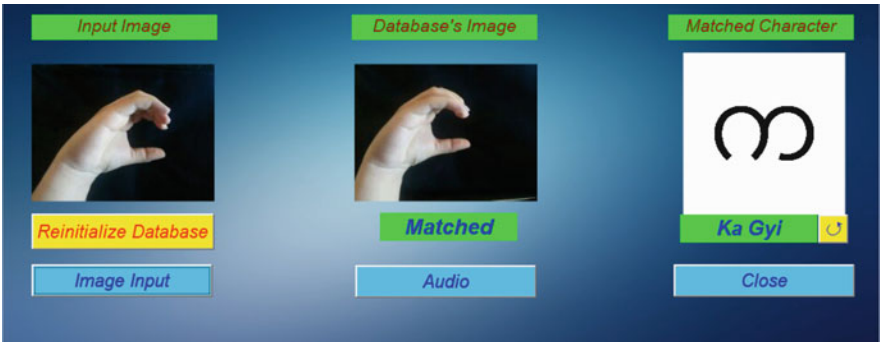


Fig. 1.21 Myanmar alphabet “Ka Gyi” recognized with suitable audio

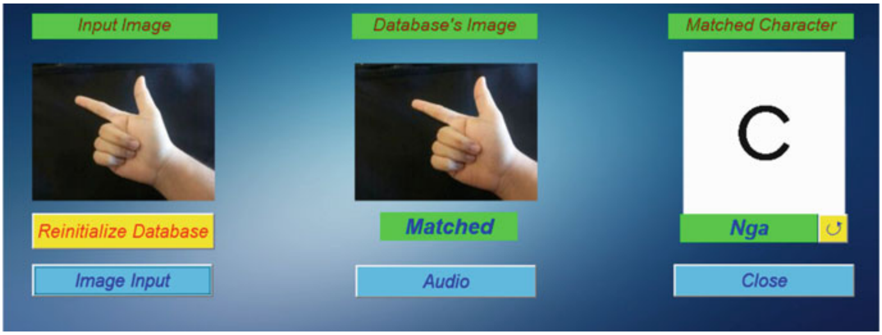


Fig. 1.22 Myanmar alphabet “Nga” recognized with suitable audio

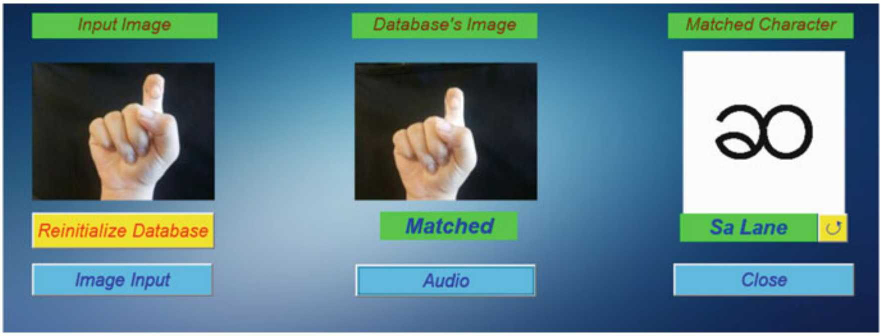


Fig. 1.23 Myanmar alphabet “Sa Lane” recognized with suitable audio

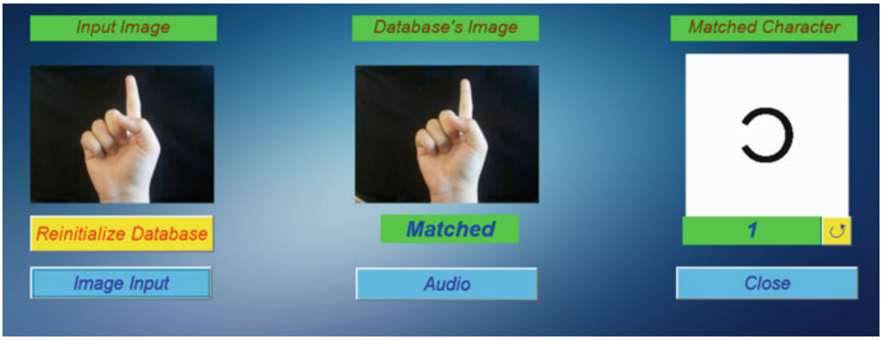


Fig. 1.24 Myanmar number for "1" recognized with suitable audio

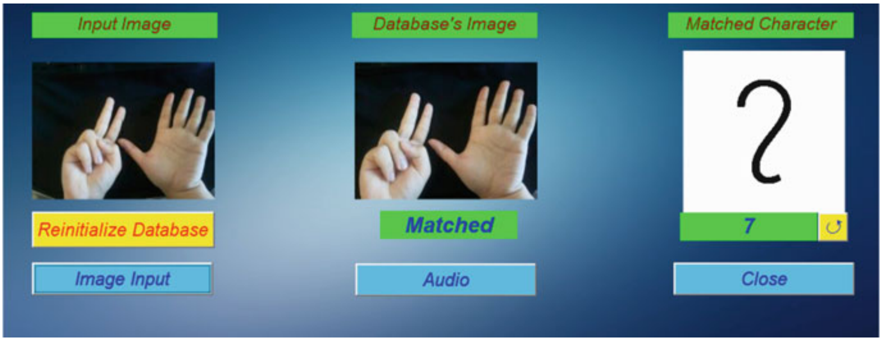


Fig. 1.25 Myanmar number for "7" recognized with suitable audio

1.7 Conclusions

The present chapter discussed overview, history, and background information of biometric techniques. Biometric databases, protocol, and standards were also presented with a number of real-time examples. An emphasis is given to Myanmar Sign Language recognition which has worked well with validation of results in terms of sound associated with each symbol or gesture.

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References

1. S. Patil, G.R. Sinha, *Biometrics: Concepts and Applications* (Wiley India Publications, a subsidiary of John Wiley, New Delhi, India, 2013)

2. G.R. Sinha, K.S. Raju, R. Patra, D.W. Aye, D.T. Khin, Research studies on human cognitive ability. Int. J. Intell. Defense Support Syst. **5**(4), 298–304 (2018)
3. G.R. Sinha, Study of assessment of cognitive ability of human brain using deep learning. Int. J. Inf. Technol. **1**(1), 1–6 (2017)
4. G.R. Sinha, Indian sign language (ISL) biometrics for hearing and speech impaired persons: Review and recommendation. Int. J. Inf. Technol. **9**(4), 425–430 (2017)
5. S.B. Patil, G.R. Sinha, Distinctive Feature Extraction for Indian Sign Language (ISL) Gesture using Scale Invariant Feature Transform (SIFT). J. Inst. Eng. India Ser. B **98**, 19–26 (2017). https://doi.org/10.1007/s40031-016-0250-8
6. B.P. Sandeep, G.R. Sinha, V.S. Patil, Isolated Handwritten Devnagri numeral recognition using HMM: A Holistic Approach. Second International Conference on Emerging Applications of Information Technology, pp. 185–189, 19–20 February, 2011, Kolkata, India
7. S. Barde, A.S. Zadgaonkar, G.R. Sinha, PCA based multimodal biometrics using ear and face modalities. Int. J. Inform. Technol. Comput. Sci. **5**, 43–49 (2014)
8. S. Barde, A.S. Zadgaonkar, G.R. Sinha, Multimodal biometrics using face, ear and iris modalities. Int. J. Comput. Appl. **2**, 9–15 (2014)
9. S.B. Patil, G.R. Sinha, Real time handwritten Marathi numerals recognition using neural network. Int. J. Inf. Technol. Comput. Sci. **2**(8), 76–81 (2012)
10. S.B. Patil, G.R. Sinha, K. Thakur, Isolated handwritten Devnagri character recognition using Fourier descriptor and HMM. Int. J. Pure Appl. Sci. Technol. **8**(1), 69–74 (2012)
11. S.B. Patil, G.R. Sinha, Feature extraction and matching using scale invariant Feature transform for Indian sign language. International Conference on Science and Technology for Sustainable development, pp. 5012–5019, 26 May 2016, Nashik
12. S.B. Patil, G.R. Sinha, Intensity based distinctive feature extraction and matching using scale invariant feature transform for Indian sign language, Mathematics and Computers in Science and Engineering Series. Proceedings of the 17th International Conference on Mathematical Methods, Computational Techniques and Intelligent Systems Mathematics and Computers in Science and Engineering Series, Mathematical Methods and Systems in Science and Engineering, Tenerife, Spain, ISBN: 978-1-61804-281-1, p. 245–255, 10–12 Jan 2015
13. S. Choubey, G.R. Sinha, A. Choubey, Bilateral Partitioning based character recognition for Vehicle License plate. International Conference on Advances in Information Technology and Mobile Communication – AIM 2011 April 21–22, 2011, Nagpur, Maharashtra, India, V.V. Das, G. Thomas, and F. Lumban Gaol (Eds.): AIM 2011, CCIS 147, pp. 422–426, 2011, © Springer-Verlag Berlin Heidelberg 2011
14. S. Choubey, G.R. Sinha, License Plate Localization using novel recursive algorithm and Pixel Count Method. i-manager's J. Embed. Syst. **2**(1), 06–16 (2013)
15. A. Lazrus, S. Choubey, G.R. Sinha, An efficient method of vehicle number plate detection and recognition. Int. J. Mach. Intell. **3**(3), 134–137 (2011)
16. N.N. Kyaw, G.R. Sinha, K.L. Mon, License plate recognition of Myanmar vehicle number plates A critical review. 2018 IEEE 7th Global Conference on Consumer Electronics (GCCE 2018), pp. 771–774, Japan
17. S. Choubey, G.R. Sinha, Pixel distribution density based character recognition for vehicle license plate. 2011 International Conference on Network and Computer Science (ICNCS 2011), 5, pp. 26–30, Kanyakumari India, 2011
18. S. Choubey, G.R. Sinha, B.C. Patel, A. Choubey, K. Thakur, Pixel clustering based partitioning technique for character recognition in vehicle license plate. 2011 3rd International Conference on Machine Learning and Computing (ICMLC 2011), 4, pp. 390–394, 26–28 Feb 2011, Singapore
19. H. Richard, An introduction to biometrics and large scale civilian identification. Int. Rev. Law. Comput. Tech. **13**(3), 337–363 (1999)
20. F. Alonso-Fernandez, R.A. Farrugia, J. Fierrez, J. Bigun, Super-resolution for selfie biometrics: Introduction and application to face and iris, in *Selfie Biometrics: Methods and Challenges*, (Springer, 2019), pp. 1–24. http://gigantes.ii.uam.es/fierrez/files/2019_HBookSelfie_SuperSelfieFaceIris_Alonso.pdf

21. Technical Report Series on Biometrics at the Frontiers: Assessing the Impact on Society, For the European Parliament Committee on Citizens' Freedoms and Rights, Justice and Home Affairs (LIBE) European Commission Joint Research Centre (DG JRC), Institute for Prospective Technological Studies, 2005, https://www.statewatch.org/news/2005/mar/Report-IPTS-Biometrics-for-LIBE.pdf
22. A.K. Jain, A. Ross, S. Prabhakar, An introduction to biometric recognition. IEEE Trans. Circuits Syst. Video Technol. **14**(1), 4–20 (2004)
23. E. Mordini, C. Petrini, Ethical and social implications of biometric identification technology. Ann. Ist. Super. Sanita. **43**(1), 5–11 (2007)
24. D. Reid, S. Samangooei, C. Chen, M. Nixon, A. Ross, Soft biometrics for surveillance: an overview, in *Machine Learning*, (Theory and Applications. Elsevier, 2013), pp. 327–352. https://eprints.soton.ac.uk/342219/
25. A. Dantcheva, P. Elia, A. Ross, What else does your biometric data reveal? A survey on soft biometrics. IEEE Trans. Inf. Forensics Secur. **11**, 441–467 (2015)
26. F. Zelazny, The evolution of India's UID program: lessons learned and implications for other developing countries, CGD Policy Paper 008. Center for Global Development, Washington, D.C., 2012, http://www.cgdev.org/content/publications/detail/1426371
27. Biometrics Design Standards For UID Applications, Version 1.0, UIDAI Committee on Biometrics Unique Identification Authority of India, 2009, http://www.corporatelawreporter.com/wp-content/uploads/2013/05/Biometrics-Design-Standards-For-UID-Applications.pdf
28. Technical Standards for Digital Identity, Draft for discussion among World Bank Group, http://pubdocs.worldbank.org/en/579151515518705630/ID4D-Technical-Standards-for-Digital-Identity.pdf
29. Biometric Standards Requirements for US-VISIT, United States Visitor and Immigrant Status Indicator Technology (US-VISIT) Program, Version 1.0 March 15, 2010, https://www.dhs.gov/xlibrary/assets/usvisit/usvisit_biometric_standards.pdf
30. N. Poh, C.-H. Chan, J. Kittler, J. Gabbaly, J. Fierrez, A Anjos, S. Marcel, C. Karabat, Biometrics evaluation and testing, Funded under the 7th FP (Seventh Framework Programme, Theme SEC-2011.5.1-1, https://www.beat-eu.org/papers/d83.pdf
31. C. Braz, A security usability protocol for user authentication, Doctoral thesis project, University of Quebec at Montreal. Concordia University, 2007
32. Draft Biometric Open Protocol Standard, P2410/D11, February 2015, IEEE-SA Standards Board, Copyright © 2014 by The Institute of Electrical and Electronics Engineers, Inc. 20 Three Park Avenue, New York, USA, https://www.oasis-open.org/committees/download.php/56664/P2410d11.pdf
33. A. Salaiwarakul, Verification of secure biometric authentication protocols, Ph.D. thesis, School of Computer Science, The University of Birmingham, United Kingdom, June 2010
34. M. Chase, O. Dunkelman, Privacy preserving biometric database, http://www.cs.haifa.ac.il/~orrd/crypt/biometric.pdf
35. A. Gyaourova, A. Ross, A coding scheme for indexing multimodal biometric databases, Proceedings of IEEE Computer Society Workshop on Biometrics at the Computer Vision and Pattern Recognition (CVPR) conference, (Miami Beach, USA, 2009), https://www.cse.msu.edu/~rossarun/pubs/RossMultimodalIndexing_CVPRW2009.pdf
36. A. Kebbeb, M. Mostefai, F. Benmerzoug, C. Youssef, Efficient multimodal biometric database construction and protection schemes. int. Arab. J. Inf. Techn. **12**(4), 346–351 (2015)
37. T. Starner, J. Weaver, A. Pentland, Real-time American sign language recognition using desk and wearable computer based video. IEEE Trans. Pattern Anal. Mach. Intell. **20**(12), 1371–1375 (1998)
38. S.K. Jadwa, Otsu segmentation method for American sign language recognition. Int. J. Eng. Res. Gen. Sci. **3**(5), 916–923 (2015)
39. H. Cooper, N. Pugeault, R. Bowden, Sign language recognition using sub-units. J. Mach. Learn. Res. **13**, 2205–2213 (2012)
40. K. Assaleh, T. Shanableh, M. Fanaswala, F. Amin, H. Bajaj, Continuous Arabic sign language recognition in user dependent mode. J. Intell. Learn. Syst. Appl. **2**, 19–27 (2010)

41. R. Rastgoo, K. Kiani, S. Escalera, Multi-modal deep hand sign language recognition in still images using restricted Boltzmann machine. Entropy **20**(809), 1–15 (2018)
42. I. Hernandez, Automatic Irish sign language recognition, Thesis of Master of Science in Computer Science (Augmented and Virtual Reality), University of Dublin, Trinity College, 2018
43. S. Patil, G.R. Sinha, Offline mixed Devanagari numerals recognition using artificial neural network. Adv Comput Res **4**(1), 38–41 (2012)
44. B. Garcia, B. Garcia, Real-time American sign language recognition with convolutional neural networks, pp. 225–232, 2016, http://cs231n.stanford.edu/reports/2016/pdfs/214_Report.pdf
45. W.N. Khotimah, R.A. Saputra, N. Suciati, R.R. Hariadi, Alphabet sign language recognition using leap motion technology and rule based back propagation-genetic algorithm neural network. Jurnal Ilmiah Teknologi Informasi **15**(1), 23–37 (2017)
46. Y. Sun, N. Kuwahara, K. Morimoto, Analysis of recognition system of Japanese sign language Using 3D Image Sensor, 2013, http://design-cu.jp/iasdr2013/papers/1159-1b.pdf
47. J. Sinha, K. Das, Recognition of Indian sign language in live video. Int. J. Comput. Appl. **70**(19), 17–22 (2013)
48. D. Kaushik, A. Bhardwaj, Hand gesture recognition on Indian sign language using neural network. Int. J. Innov. Eng. Technol. **6**(4), 554–565 (2016)
49. A.K. Gautam, A. Kaushik, American sign language recognition system using image processing method. Int. J. Comput. Sci. Eng. **9**(7), 466–471 (2017)
50. P. Trigueiros, F. Ribeiro, L.P. Reis, Vision-based Portuguese sign language recognition system, 2014, https://www.researchgate.net/publication/262698351_Vision-Based_Portuguese_Sign_Language_Recognition_System
51. C. Dong, M.C. Leu, Z. Yin, American sign language alphabet recognition using Microsoft Kinect, 2015, https://ieeexplore.ieee.org/abstract/document/7301347
52. A. Kuznetsova, L. Leal-Taix´e, B. Rosenhahn, Real-time sign language recognition using a consumer depth camera, 2013, https://ieeexplore.ieee.org/document/6755883
53. D. Uebersax, J. Gall, M. Van den Bergh, L. Van Gool, Real-time sign language letter and word recognition from depth data, 2012, https://ieeexplore.ieee.org/document/6130267
54. F. Utaminingrum, K. Somawirata, G.D. Naviri, Alphabet sign language recognition using K-nearest neighbor optimization. J. Comput. **14**, 63–70 (2019)
55. T.T. Zaw, Myanmar text classifier using genetic algorithm, M. C. Sc. thesis, University of Computer Studies Yangon, Myanmar, 2018