Artificial Neural Network Based Identification and Classification of Images of Bharatanatya Gestures

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Abstract

The main aim of recognising gestures is to build a system that can identify human gestures that are specific and then to use them to put forth desired information to the device. By using mathematical algorithms, human gestures can be interpreted. This is referred to as Gesture Recognition. Mudra is an expressive form of gesture that is mainly used in Indian classical dance form where the gesture is in visual form so as to connect with the audience. Different positions of body parts make an expressive and meaningful mudra which can be both static and dynamic. Here the project makes an attempt to identify the hand gesture/mudra using Image-processing and also Pattern Recognition methods. An attempt in computer aided recognition of Bharatnatya Mudras is made using Image classification and processing techniques using Artificial Neural Network. The entry that gives the least difference to the feature of a mudra is the match for the input image considered. Finally, the system also provides the health benefit of the identified mudra.

Key Words: Bharatnatya Mudras, Artificial Neural Network

1. Introduction

Daily life communication is performed via verbal communication and body language. A gesture is non-verbal action used to communicate with a part of the body. Fundamentally there are 2 techniques to accumulate the data identified with motion acknowledgment. Gadget based estimation which measures hand motions with information gloves which documents the precise places of hand signals as its positions will be specifically measured. Besides, vision based procedure which covers hand signer.

As a result of improvement in image processing techniques in recent years, image processing applications are now processed with computer aided system. Gesture recognition (Human) is an area that has seen better improvement in this field. It is very known that Indian classical dance form such as Bharatnatya, Kathak and nearly 16 types of Indian classical dance use 51 types of gestures called mudras.

These gestures are expressive as well as meaningful (static along with dynamic) postures of the hands. With suitable situations, the one who perceives the gesture should be capable to identify the gesture. Gesture recognition process is used here in the project so as to identify the Bharatnatya mudra.

Hybrid saliency technique is used here to identify the Bharatnatya mudra via computer aided method. Now this process will be performed with each mudra image and then it is stored in the database with also the features calculated and their respective meanings and health benefits. The different captured features are area, major axis length, minor axis length, centroid and eccentricity of each mudra. K Nearest Neighbour (K-nn) algorithm is used to classify each image in the database based on comparing the mudra feature's value to the one stored in the database. The stored image that gives least value as difference with respect to the feature will be considered as the match to the image. The details of the identified image is given by the system with its health benefits. Below are few sample mudras of single and double handed mudras.

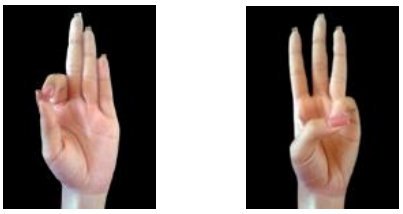

Figure 1.1: Single-handed mudras

Figure 1.2: Double-handed mudras

Work done so far has focussed only on 13 out of 51 gestures of Bharatanatya, hence in this project we have identified all the 51 of them using image processing techniques. No work has been done in the area of classification. Hence classifying these 51 has

been an additive motivation to our system of image processing.

Along with the identification and classification of these gestures, this project also identifies the health benefits of each mudra.

In this project, we design a system which identifies and classifies the captured gestures/mudras using image processing techniques.

Thus, our objectives are:

1. To collect the various forms of mudras.
2. To pre-process the images that is captured by applying image processing techniques.
3. To extract the features of the captured images.
4. To classify the images based on positioning of the fingers.

The process of artificial neural network involves two phases: Training and Testing which are explained in Section 3.

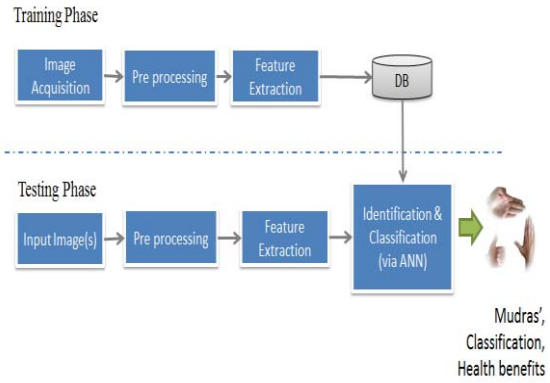

Figure 1.3: Architecture

The following list of activities define the process in which the static recognition of gestures is carried out:

• Image capture
• Pre-process
• Feature extraction
• Classifying

1.1 Image Capturing:

Here, this phase mainly deals with capturing images. These images are in turn processed in the subsequent phases. The images are usually captured using a camera in front view preferably. 2 or more cameras can also be used to collect images with different angles and orientations for better results as the information that can be obtained is more accurate.

This phase is very important compared to the phases that follow. This is because the entire image processing of an image depends on the quality of the image captured. Hence the images are captured at best available resolution with clean and clear background. Care has to be taken regarding the distribution of light in the background such that uniformity is maintained.

1.2 Pre-processing:

Pre-processing usually deals with optimizing the captured image so that it helps in extracting the features in the subsequent phases. It is just an intermediate step so that the noise and addition disturbance can be eliminated from the captured image. This phase can also be used in order to highlight or focus on the interested regions in an image.

1.3 Feature extraction:

This phase plays an important role in the recognition process. Feature extraction here refers to extracting features such as size, shape, colour or texture for each image captured. These features should be unique and distinguishable from each other so that the end result of the system is more reliable.

1.4 Classification:

The basic idea in classification phase is to pair the feature or a set of features with a predefined class so that it makes it easy to identify the gestures. There are many classification methods used over past few years which have proved to be working efficiently. As a rule, class will be characterized as an arrangement of elements referenced, which were obtained at the preparation period of the framework where set of prepared pictures are utilized. Consequently the arrangement comprises for the most part of finding the coordinating reference to highlight the elements separated in the past stage. This venture utilizes Artificial Neural Network as the classifier.

The organisation of paper consist of Introduction in Section 1, Literature Survey in Section 2, Proposed Methodology in Section 3, Results and discussions in Section 4 and Conclusion and future scope in section 5.

2. Literature Survey

The following is a gist of the papers we have referred for the above project. Research has been limited to small scale systems capable of recognizing a minimal subset of gestures.

Hasan [1] has connected scaled standardization for acknowledgment of motion in light of the element of brilliance coordinating. The info picture which is portioned, where edge method is utilized and the foundation is dark. Any portioned picture will be standardized (trimmed), where the middle mass of the picture is resolved, so that the directions are utilized to coordinate the centroid of the hand at the beginning.

Claudia Nolker and Helge Ritter [2] exhibited an acknowledgment model of hand signal

in view of acknowledgment of the fingertips. In their approach they discover full recognizable proof of all finger joint edges and in light of that a 3D model of hand is readied utilizing neural system.

Etsuko Ueda and Yoshio Matsumoto [3] introduced a novel system: a hand-posture estimation which can be utilized as vision-based human interface. In this strategy, the areas of hand are separated from numerous pictures acquired by a multiview point camera framework, and by the development of the "voxel demonstrate"," the hand stance is evaluated [4].

Chan Wah Ng, Surendar Ranganath [5] displayed an arrangement of hand acknowledgment. Picture furrier descriptor was utilized as their prime component and ordered with the RBF arrange. Their framework's general execution was 90.9%.

Eng-Jon Ong and Bowden [6] exhibited an unsupervised, novel way to deal with prepare the productive and hearty finder which is competent distinguishing the nearness of human turns in a picture furthermore groups the hand shape too. Their approach is utilized to identify the hand area utilizing a helped course that has classifiers in order to recognize shape alone in dim scale picture.

Hasan [1] additionally connected multivariate Gaussian dissemination to perceive hand motions where he utilized non-geometric elements. The information which is hand picture will be sectioned utilizing two distinct strategies [6]; skin shading based division utilizing HSV shading model and the grouping based thresholding procedures [6]. A few operations are performed to catch hand shape and to concentrate hand highlight; of the X and Y hub [6].

3. The Proposed Methodology

Training is a phase where the dataset is created represented in the above figure. All the Bharatnatya Mudras are captured one at a time.

- Initially, initial pre-processing of the sample image is done where simple filtering is done to eliminate the noise if in case.
- Features of sample images are extracted by applying the saliency detection technique. The major axis length, area, eccentricity, minor axis length are some of the features.
- The result of this phase highlights the object with respect to the background and obtains the salient features of both double and static single hand gestures.
- The same process is applied on every collected gesture and is stored in the database along with properties calculated, name and health benefit of the mudra.

Testing is a phase where the input is the captured image of the Mudra.

- Initially, initial pre-processing of the sample image is done where simple filtering is done to eliminate the noise if in case.
- Features of captured images are extracted by applying the saliency detection technique. These area, minor axis length, eccentricity, major axis length are few properties.
- The values are then compared to the entries of each gesture present in the database by using ANN classifier.
- There will at least be one image in the database for which the difference between the entry is minimum. That image is considered as the match.

The different implementation stages are: The initial phase is to capture the static single and double hand gestures images using a standard camera system. In second stage, the images will be cropped and resized to a standard size of 113x150. Also the background is changed to black and white. In the next stage, we perform feature extraction, in which the input data is transformed to get a set of features. The objective of extracting features is to understand what the images convey. The features aid in reliable recognition of the images. All the 28 shape features extracted are stored in a database in the upcoming phase. The same process is performed on every image in the database and the resulting features are appended to the database along with the meaning and properties calculated for each gesture. In the last stage, images are classified using ANN classifier.

Classification is the level where a feature vector or a set of features is used to identify the gesture by assigning it to a predefined class. To recognize the input gesture and to display the name and its health benefit is main task of the classification phase. Out of multiple techniques available to classify, we have implemented ANN technique in this project. . Simulated neural system is a computational model motivated by creature's focal sensory system (specifically the cerebrum), which are equipped for machine learning and additionally design acknowledgment.

3.1 Selected Static Double Hand Gesture

All 51 types of static single hand (28) and double hand (23) mudras are considered in this system for recognition. The following images are the ones considered for training the system.

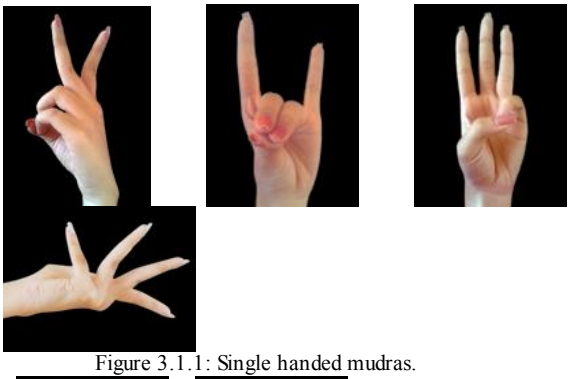

Figure 3.1.1: Single handed mudras.

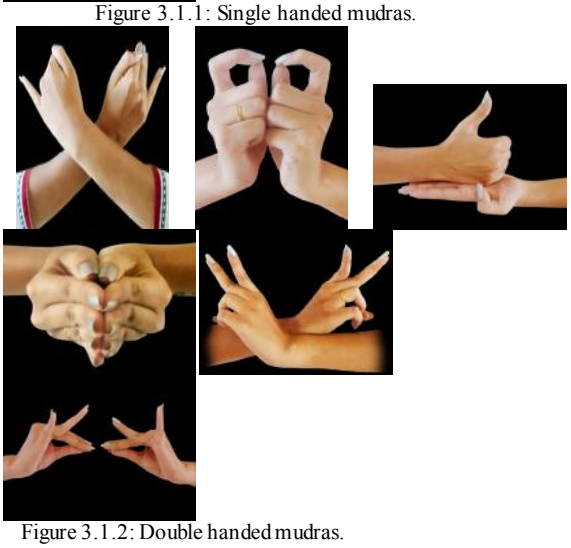

Figure 3.1.2: Double handed mudras.

4. Results and Discussions

The following figures show mudra before and after the pre-processing stage respectively.

Figure 4.1: Captured Ardhapataka

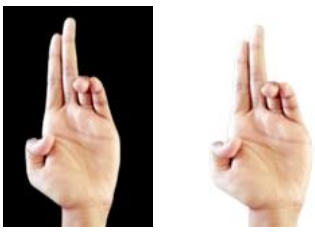

Figure 4.2: Pre-processed Ardhapataka with black and white backgrounds

Out of 230 gesture samples collected, the database consists of 5 images of each type with different orientations. Few images are used for training the system and the remaining images are used to test the system for accuracy. Using the precision formula, the accuracy of the system is calculated.

True positives, true negatives, false positives, and false negative are used for classification. The terms *positive* and *negative* refer to the prediction of the classifier. The terms true and false indicates if the prediction and external judgment match or no. The table shown below represents this.

	Actual class (observation)	
Predicted class (expectation)	**Tr.p** (true positive) Correctly Classified	**Fa.p** (false positive) Unexpected classification

Table 4.1: Expectation and Observation

Precision is then defined as:

$$\text{Precision} = \frac{\text{Tr.p}}{\text{Tr.p} + \text{Fa.p}}$$

97.82% is the accuracy obtained as the result of applying precision formula. The following table represents the entire result analysis which consists of the total image set, the samples that are correctly classified, the ones that are not and accuracy of the system.

Sample Size	**No. of Samples accurately classified (Tr.p)**	**No. of samples Misclassified (Fa.p)**	**Accuracy in %**
230	225	5	97.82%

Table 5.2 Result Analysis

This project has given amazing results in the identification and classification of mudras. We have classified our results into two categories: one for single-handed mudras and another for double-handed mudras, where for single-handed mudras, we have identified 26 and in double-handed mudras we have identified 20.

Figure 4.1 shows the Efficiency of Single-handed mudras and figure 4.2 shows the efficiency

of double-handed mudras. The result for identification of single-handed mudras is 98.46% and for double-handed mudras is 96%. On an average, the result for identification for the whole system is 97.82%.

Also, the system works efficiently for few mudras captured dynamically.

5. Conclusions and Future Scope

This project presents an ideal approach to represent the classification and recognition of different hand gestures of the Bharatnatya dance form. Image processing techniques is used to classify and recognise the gesture collected in the database. Then the ANN classifier is used to classify the images and display the name and health benefits of the hand gestures. The system is designed to work well with both single and double handed gestures. The system has an advantage of being used to teach and improve young dancers.

We can apply the system for the following:
1. As gestures are perceived through vision, it is a subject of great interest for the computer vision researchers by understanding images of the real-world so as to produce symbolic or numerical information, in the forms of decisions.

2. The well known Indian classical dance, Bharatnatya uses certain hand gestures to convey standard emotions. Such a system can be used as a tool to provide tutorials to teach and to correct the young dancers.

3. Many of these mudras are known to benefit the health too by their regular practice

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