Symbolic Hand Gesture Recognition of Indian Classical Dance Form Kathak

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***Abstract*—Gestures are a huge part of human interaction and are used for non-verbal communication. Hand gesture recognition is an important application of human computer interaction and is considered to be one of the most complex problem in the field of computer vision. It has evolved rapidly in the recent years and thus, we can find its application in various fields such as entertainment, photography and even medicine.**

India is rich in art and culture and has a variety of dance forms that use hand gestures to convey a story, Kathak being one among them. Our project focuses on recognition of symbolic hand gestures of Indian classical dance form Kathak in real-time, by using artificial neural network. A training data set consisting of 52 different hand gestures called mudras which are of two different types: single hand and double hand, was generated with each category containing more than 500 images to train the system. The trained model was then used for real-time recognition of these symbolic hand gestures called mudras.

***Index Terms*—Mudras, Kathak, Region of Interest(ROI), Convolutional Neural Network, Human Computer Interaction (HCI).**

I. Introduction

IN this age of computers, human computer interaction (HCI) is an important factor in artificial intelligence. Gesture recognition is one such aspect of this problem and it is hard to solve due to the large number of different gestures. This project focuses on the application of hand gesture recognition in Kathak, that originated from the northern regions of India and is one among the eight Indian classical dance forms. Those who perform Kathak dance form are called Kathakars or storytellers as they communicate stories through rhythmic foot movements, hand gestures, facial expressions and eye work.

In Kathak, there are twenty-eight hand gestures using single hand which are shown in Fig. 1, known as Asamyukta mudras and twenty-four gestures using two hands which are shown in Fig. 2, known as Samyukta mudras which are used in Kathak.

These dance forms use different hand gestures to tell a story through dance and are used to depict symbolism, imagery and to express emotions.

The main purpose of this project is to help understand and recognize the hand gestures in Kathak. This project is aimed to help those who enjoy Indian classical dance but do not understand the meaning of each mudra by helping them to understand the story that the artist is conveying through their hand movements.

Fig. 1: Single Hand Symbolic Gestures (Asamyukta)

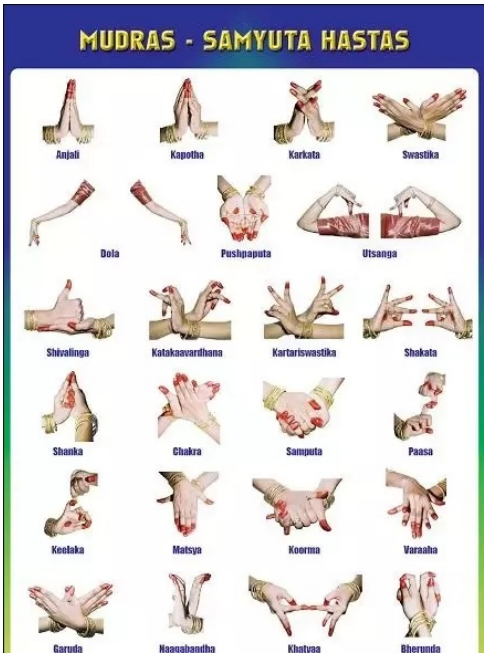

Fig. 2: Two Hand Symbolic Gestures (Samyukta)

II. Related Works

The idea of the project is primarily inspired by the paper by Vishwali Mhasawade and Joshi Akanksha [1] designs an intelligent system for hand gesture recognition in Bharatnatyam. It details recognition using contour detection and compares the contour values to recognize the gesture.
Some other papers that motivated the idea behind hand gesture recognition and neural networks were:
The paper by Phadtare, L. K., Kushalnagar, R. S., & Cahill, N. D [2] discusses a methodto estimate the palm orientation and the hand shape of a signer to recognize hand symbols. The methodology uses Microsoft Kinect to capture color and the depth images of a signer and analyzes the depth of the data corresponding to the hand point region and fits the plane to this data and defines the normal to this plane as the orientation of the palm.
The paper by Ghotkar, A. S., Khatal, R., Khupase, S., Asati, S., & Hadap, M. [3] proposes a system that has 4 modules which are real time hand tracking, hand segmentation, feature extraction and gesture recognition. These modules are then used to generate a recognition system to recognize the alphabets of Indian Sign Language.
The paper by Lee, H. C., Shih, C. Y., & Lin, T. M. [4] discusses a methodology to apply Artificial Neural Network for recognizing the sign language and transmitted the out-come to hand-held device. The paper uses background subtraction method to show a targeted gesture of motion images.
The paper by [5] proposes a technique which commands computer using six static and eight dynamic hand gestures. A vision-based hand gesture recognition method using transfer learning is used to aid the process.

III. METHODOLOGY

The project is created with the purpose of building a model for recognition of symbolic hand gestures (mudras) of Kathak dance form.

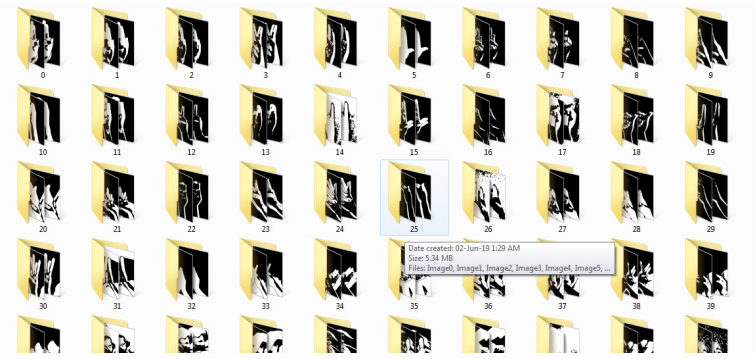

Fig. 3: Mudra Image Data Creation

1) Data Collection
In the initial phase of the project, a data set was created using a webcam. A total of 51 folders containing each mudra were created and each folder contained more than 500 images of each symbolic hand gesture. The mudra folders were assigned a number starting from 0, which were later associated to its mudra name while displaying the result. Fig.3 below shows how each hand gesture folder was stored.
The data-set was created by taking pictures from the web-cam such that the hand region is segmented, removing the background. The hand region is known as the region of interest (ROI) and the pixels in the ROI were assigned a value of 1 and the remaining regions in the image were assigned a value of 0 as shown in Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8 and Fig. 9.

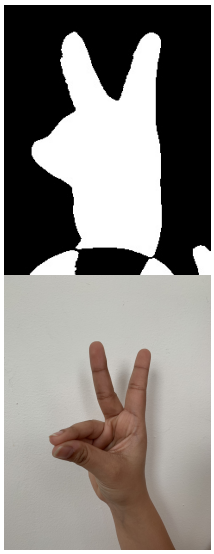

Fig. 4: Kartarimukha(Scissors Face)

Fig. 5: Pataka (Flag)

Fig. 6: Kapitha(Elephant Apple)

Fig. 7: Swastika (Auspicious Sign)

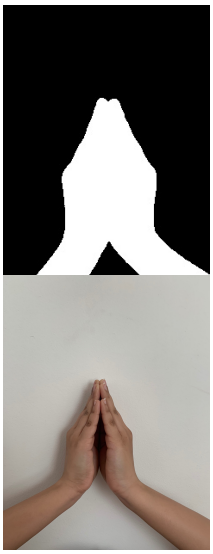

Fig. 8: Kapotam(Dove)

Fig. 9: Naagabandha (Entwined Snakes)

2) Model Generation
The data-set generated from the webcam is then used to generate a training model for the real-time recognition. Initially, the images from each folder are read as numpy array and the label of the folder is used to classify the image to its corresponding category. Each image is pre-processed by converting it to a gray-scale image and re-sizing it to a 120x120 image to ease the process of training.
These re-sized images are then converted into 4-dimensional data so that the network will be able to differentiate between the different number of images. The data-set is split into training and testing sets and the training set is used to create a model using convolutional neural networks where multiple number of filters of size 3x3 are applied in layers, along with max-pooling layers, each of size 2x2 to generate an appropriate model. This model is now tested against the test set and the accuracy of the model is verified against the label.

IV. Result

The trained model was then used for real-time hand gestures recognition [6] as shown in Fig.10 and Fig. 11. The model was found to be able to recognize each hand gesture with an approximate accuracy of about 89.6 %.

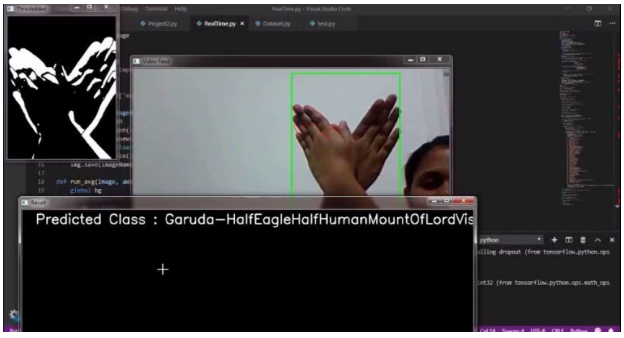

Fig. 10: Real-time Single Hand (Pataka: Flag)

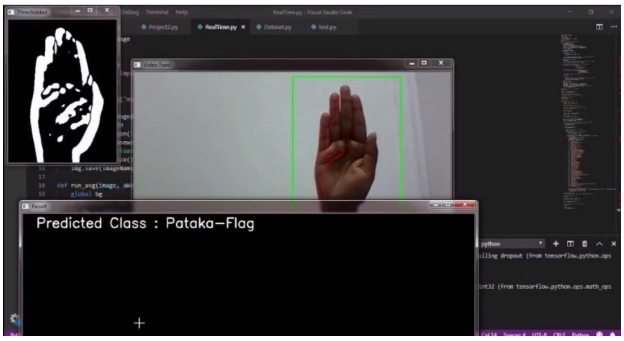

Fig. 11: Real-time Double Hand (Garuda: Half Eagle-Half Human Mount of Lord Vishnu)

The predictions given by the model gave faulty results when two gestures were very similar to each other and also when a gesture did not exactly match to the required gesture, down to even the exact angle as to how the hand is held by a trained Kathakar. The predictions were also unstable as they kept on changing too quickly if any minute movement was made.

V. Conclusion

In this world, there are different forms of art that is specific to each region and art helps to unite people. This project aims at generating a model for understanding the various mudras in Kathak dance form, so that one can understand the meaning of each of them and be able to appreciate it to the fullest and hence bring people closer through art.
In the future development of the project, the prediction process is to be stabilized and the project can also be further extended to work on a mobile application to make the prediction more dynamic.

References

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