IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-6, Issue-2 E-ISSN: 2347-2693

Identification of Commonly used Medicinal Leaves using Machine Learning Techniques with SIFT Corner Detector as Features

Jharna Majumdar[1]*, Anand Mahato[2]

[1*] Dept. of CSE, Nitte Meenakshi Institute of Technology Yelahanka, Bangalore-560 064, India
[2]Dept. of CSE, Nitte Meenakshi Institute of Technology Yelahanka, Bangalore-560 064, India

**Corresponding Author: jharna.majumdar@gmail.com*

Available online at: www.ijcseonline.org

Received: 21/Jan/2018, Revised: 29/Jan/2018, Accepted: 12/Feb/2018, Published: 28/Feb/2018

Abstract— Medicinal leaves carry a huge value and importance in the medical field which can be directly used or medicines are made for medicinal purposes to cure patients. With the variety of leaves present, the proper identification of the leaves is very difficult without prior knowledge and experience. Computer Vision can bring the accurate identification of such leaves using the various feature extraction techniques using leaf images. The aim is to build a methodology using various feature extraction techniques to extract features, clustering algorithm to cluster the features and decision trees as a classifier. Feature extraction techniques like SIFT key descriptors which are robust and provide matching in spite of the change in intensity, size or rotation of the object in the images. Effective corner points are chosen from the image from which magnitude and orientation of surrounding are used to build descriptor that is the vector of feature for each corner points. For clustering the data, various partitional, hierarchical, density based methods are used to cluster the data which cluster the data with respect to inter-connectivity, similarity, closeness, etc. The clusters data is used to build the decision tree like C4.5 and CART which uses entropy and Gini index as the splitting criteria. All these methodologies put together to form an effective method to efficiently recognize the unknown leaf image using trained model.

Keywords— SIFT Corner points, Chameleon Clustering, Decision Tree Classifier.

I. INTRODUCTION

Various types of plants and trees having different types of leaves with a different shape, sizes, patterns, textures, etc. plays an various different role in human life. The various plants, trees or leaves can be identified effectively using their respective leaf. Due to a millions variety of leaves and plants available in the universe, it is not possible for everyone to know each and every one. Since a lot of them are very useful and many are useless, it is very useful to correctly identify the plants using their leaves. Hence this paper provides a mechanism for correctly training and identifying commonly used leaves.

Object Detection is the integral part of computer vision where various objects in the images or videos are identified using the specific features extracted from images. There are different methods and algorithms to accomplish object detection. Initially, the geometrical feature of object or colour measures and features were used to detect the object in an image which can be highly affected by the change in size, illuminance, rotation, etc. But the development of feature extraction techniques like SIFT has brought big changes in the area of object detection where objects can be detected in images irrespective of change in illuminance, noise, scaling, and rotation.

Clustering Algorithms like CURE and ROCK are based on the static modelling of clusters which only evaluates inter-connectivity, closeness or similarity between the clusters. The number of clusters in these algorithms is predefined which might not be suitable for a diversity of clusters. Chameleon clustering is an algorithm that uses dynamic modelling in hierarchical clustering. It does not depend on user-supplied information but it automatically adapts to the internal characteristics of the clusters being merged. With the emergence of new feature extraction techniques, new clustering methods also are considered.

Various classification techniques have been developed in the field of machine learning. One of the most popular ones is the decision trees which give the set of rules like structure using attributes to classify the input with respect to training dataset.

II. LITERATURE REVIEW

a. SIFT Corner Detector

In this section, a survey of a feature detector based on corner detectors used for this paper is discussed. SIFT(Scale Invariant Feature Transform) is a corner feature extraction technique proposed by D. G. Lowe in 2004 which is robust to the factors like rotation, scaling, noise, illuminance, etc. SIFT [2] algorithm is composed of four stages of computation:

b. Scale-space extrema detection

The first stage of computation searches over all scales and image locations. It is implemented efficiently by forming a Gaussian pyramid and finding local peaks in Difference-of-Gaussian (DOG) images that are invariant to scale and orientation.

c. Accurate key point localization

In the second stage, candidate key points are selected based on stability measures and eliminated if found to be unstable. This allows point to be rejected when having low contrast (and therefore be sensitive to noise) or poorly localized along an edge.

d. Orientation assignment

In the third stage, the dominant orientation for each key point based on its local image patch is identified. To determine the key point orientation, a gradient orientation histogram is from the gradient orientations of sample points within a region around the key point. The orientation is weighted by the gradient magnitude and a Gaussian weighted window with a σ that is 1.5 times the scale of the key point. Peaks in the histogram correspond to dominant orientations.

Multiple key points are formed for the direction corresponding to the histogram maximum and any other direction within 80% range of the maximum value. Only 15% key points are assigned for multiple orientations while are stable and invariant to rotation.

e. Key point descriptor

The local image gradient magnitudes are measured around sampled scale in the region around each key point. The feature descriptor is computed as a set of orientation histograms on 16 × 16 pixel neighbourhoods around the key point. Each histogram contains 8 bins, and each descriptor contains a 4 × 4 array of histograms around the key point. Therefore, the feature vector for each key point is 4 × 4 × 8 = 128 dimension.

f. Chameleon Clustering Method

Chameleon is a clustering algorithm which uses a graph partitioning techniques along with the dynamic modeling in hierarchical clustering to obtain dynamic clusters. CHAMELEON uses a graph partitioning algorithm to cluster the sparse graph data objects into a large number of relatively small sub clusters. It then uses an agglomerative hierarchical clustering algorithm to find the merged clusters by repeatedly combining these clusters using the internal connectivity and closeness measures.

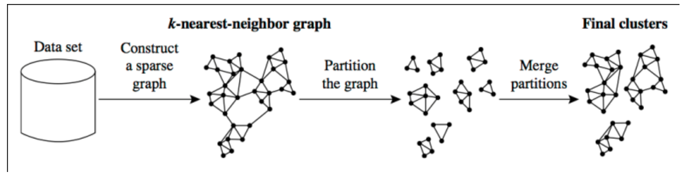


Figure. 1 Overall framework of CHAMELEON Algorithm [3]

Many of the existing clustering algorithms ignore the interconnectivity of clusters, Chameleon emphasis on interconnectivity and closeness during merging the clusters. As described in paper [3] [5] algorithm is divided into two parts: i) Finding Initial Sub-clusters ii) Merging Sub-Clusters using a Dynamic Framework

In the first phase, Initially K- nearest neighbour graph is formed from the data in which each vertex corresponds to a particular row and the properties of data is denoted by attribute values of the data. Here, the Euclidian distance metric is used to find the neighbourhood for each vertex which corresponds to the individual row of the dataset. In this work, the value of K is fixed to the square root value of a total number of data in the dataset. The nearest k value for an individual vertex is used to form edges between vertices with least distance.

CHAMELEON uses a multilevel graph partitioning algorithm[4] [6] to find the initial sub-clusters to partition the k nearest neighbor graph of the dataset into a large number of partitions or clusters such that the edge-cut is minimized.

Here, given Multi-level graph partitioning partitions the graphs into small partitions using three steps.

In the first step, the graph is coarsened into a small graph using a maximal matching algorithm which uses Heavy Edge Matching (HEM). In the second step, the coarsened graph is partitioned into two parts using Spectral bi-partitioning graph algorithm which is again further improved using Kernighan-lin refinement algorithm [17].

The second step is repeated until all the sub partitions become small which is less than 5% of the original graph. Then, third step all the small graph partitions are uncoarsened in the same way they were coarsened. In second phase of the algorithm, the partitions formed in phase 1 are combined together on the basis of Relative Closeness (RC) and Relative Interconnectivity (RI).,Then select two clusters Ci and Cj with maximum RI(Ci,Cj) * RC(Ci,Cj) value greater than the specific threshold, then clusters are merged. Repeat the same process until no cluster pair is left with RI(Ci,Cj)*RC(Ci,Cj) greater than the threshold. Finally, few clusters are left which fulfill the given criteria of threshold or number of clusters and final clusters produced by the algorithm.

A. C4.5 Decision Tree

Decision trees [12] are the data classification method first introduced by J.R. QUINLAN in 1985. There are various methods being developed to develop a decision that can successfully fit the existing data. Quinlan'sID3 algorithm was one of the effective and popular methods to develop a decision tree using Entropy and Information Gain values calculated from the dataset. But due to the restriction of the algorithm of only able to handle discrete attribute values the use of the algorithm was limited. Later, C4.5 an extension of Quinlan's earlier ID3 algorithm [18] was developed which can handle continuous values with additional missing value support and pruning techniques.

C4.5 for continuous data creates a binary decision tree which is branched using an attribute threshold selected whoever has maximum information gain among all attributes. C4.5 is one of the popular methods in machine learning to successfully classify data using decision trees.

III. Proposed Methodology

In the proposed work, a new methodology has been developed to efficiently and effectively classify the features extracted from images of medicinal leaves in order to correctly identify the unknown query leaf image. The proposed mechanism consists of various machine learning techniques like clustering and decision tree along with the newly developed feature extraction algorithms.

There are various new or existing methods and approaches being using in proposed methods are,(i) Application of medicinal leaves for machine learning (ii) SIFT algorithm for feature extraction (iii) Edge Threshold to reduce SIFT features from images (iv) Batchelor and Wilkins' Algorithm to determine the number of clusters (v)Chameleon clustering to cluster features (vi) Clustering and Decision tree combined for learning the given leaves.

The proposed method is subdivided into 2 phases based on functionality. Those are,

i. Learning Phase
ii. Identification Phase

A. Learning Phase

Learning Phase consist of Feature Extraction, Clustering and Classification. Fig 2 depicts the flow diagram of learning phase.

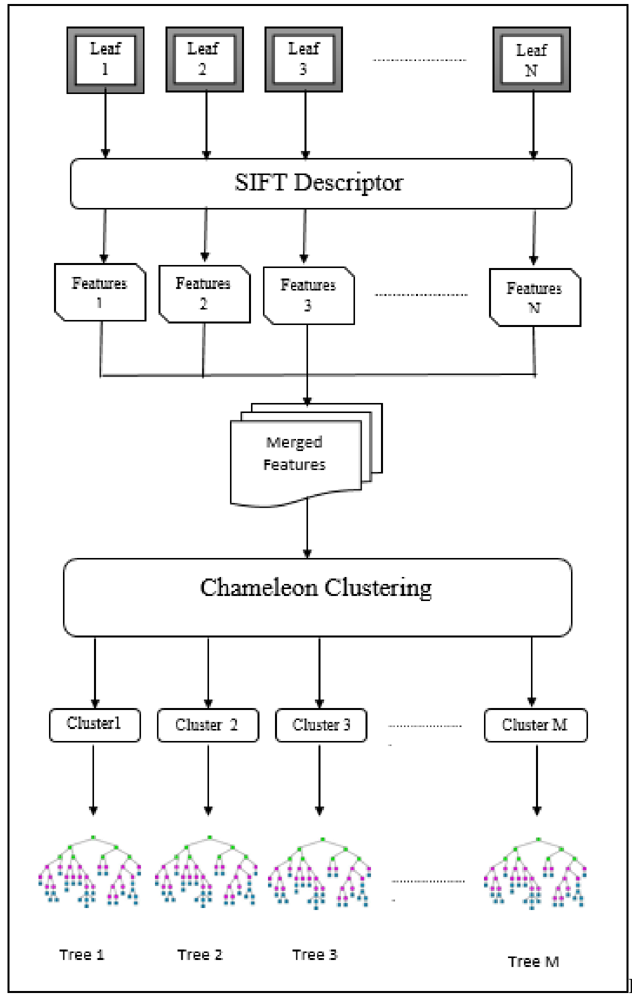


Figure. 2 Flow Diagram of Identification Phase

SIFT(Scale Invariant Feature Transform) by David Lowe [2] is used as a feature extraction mechanism to extract feature points from leaf images since it is robust to rotation, scaling, noise, illumination, etc. For the extraction of SIFT feature OpenCV library [11] has been used with all the default parameters Sigma1.6, edge threshold 10, contrast threshold 0.04, etc. Features are extracted from the all the training leaf images which are then merged to form a training dataset. Chameleon Algorithm is used as the clustering algorithm in proposed method since clusters are formed with respect to cluster similarity as well as inter connectivity. The feature dataset is used to form multiple numbers of dynamic clusters using chameleon with various sizes dependent on cluster density and type.

At Last, C4.5 decision trees is formed for each individual clusters so multiple decision trees are created representing each cluster with similar key points which are small in size, easy to build and faster.

The training phase is carried out prior to identification so, the time consumed for clustering and building trees has no impact on the performance for matching in the identification phase. Hence we refer training phase as an offline task.

B. Identification Phase

As shown in Fig. 3 for identification phase, the unknown query leaf image is used to query the trained system for identification of leaf type.

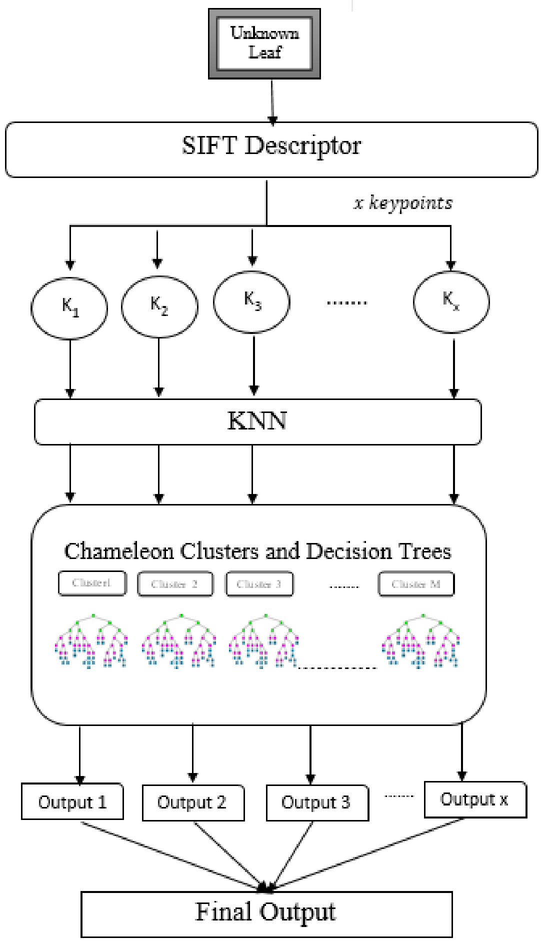


Figure.3 Flow Diagram of Identification Phase

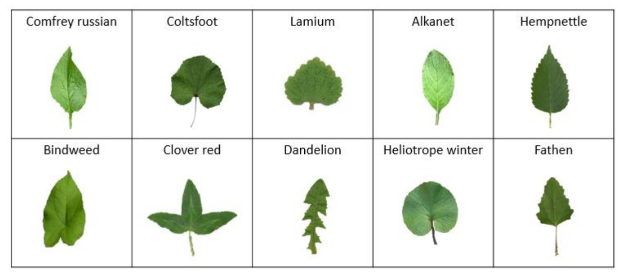
During Identification Phase, the SIFT feature of the query leaf is extracted which is compared with the centroids of the chameleon clusters calculated by taking mean of key points. KNN along with the Euclidian distance is used to identify the nearest match of each key point in the query image. Then the individual key point is subjected to decision tree of the cluster with the closest match which will give the label or name of the leaf where key point is matching. Similarly, the same procedure is carried out for all key points. Finally, a number of outputs from each key point is merged using voting to produce a single output which will be the name or label of the leaf which has maximum key point matches with the query image.

IV. Results and Discussion

In the current work, set of 10, 20, 30 and 40 medical Leafs with a different structure, shape, and sizes are taken as a training dataset for given model. The OpenCV [10] function is used to extract SIFT feature from training images which are then merged and again divided into a number of clusters determined by Batchelor and Wilkins' Algorithm using Chameleon clustering code developed in C++.For each clusterC4.5,decision tree code is invoked to build individual decision trees for each cluster which concludes the learning phase.

For identification, randomly testing set of 5, 8, 12, 15 leaves are selected respectively for 10, 20, 30 and 40 training images of medicinal leaves which are arbitrarily rotated and scaled. The SIFT feature is extracted again using same OpenCV call and then the features extracted is given as input to identification module which compares features to clusters and derives the output from respective decision trees which is merged to give single output. Fig. 4 shows 10 different classes of leaf dataset.

Figure. 4 Sample Leaf Dataset



From the given experiment, the matching accuracy is determined using a number of correctly matched query images of medicinal leaves along with the percentage of the key points matching for a correct match as shown in the Fig. 5. Identification accuracy of unknown leaf is varies with respect to training dataset of different size. Identification accuracy of the unknown leaf for 10,20,30,40 and 50 training dataset is 100, 98, 86, 80 and 75 respectively.

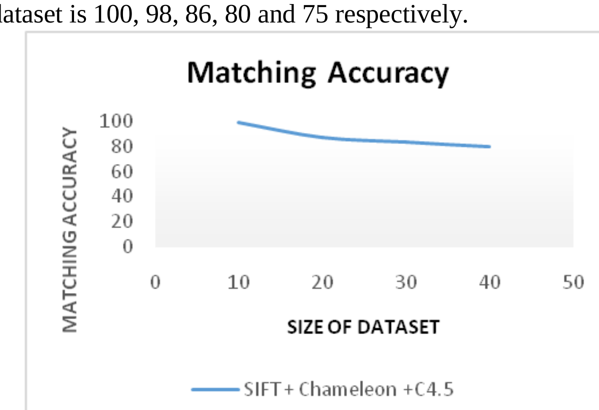


Figure 5. Matching Accuracy for proposed method

V. CONCLUSION AND FUTURE SCOPE

The outcome of this experiment shows promising results for applying the proposed method for identification of leaf using training examples. SIFT feature descriptor works very well to perform in identifying objects regardless of illuminance change, noise, rotation, and scaling of the image. Dynamic modeling chameleon is conceptually a sound method for any type of clustering. Chameleon works efficiently to build dynamic clusters minimizing inter-cluster similarity and maximizing the intra cluster similarity. Decision tree always has been the popular and efficient classifier for any type of dataset. Entropy and Information Gain for the attribute selection works very well to maximize data fitting. Combining these all techniques an efficient, effective, and robust framework has been formed for any type of object detection in images. Although the result of the current framework is acceptable it is not totally accurate since each methodology is not 100% robust. The future work includes the inclusion and testing of various other feature extraction techniques, new clustering methods, and other advanced decision trees in order to improve the overall performance of framework.

ACKNOWLEDGMENTS

Our sincere thanks goes to the Vision Group of Science and Technology (VGST), Karnataka to acknowledge our research and provide us the financial support to carry out the research at NMIT. The authors express their sincere gratitude to Ms. Shilpa Ankalaki for helping author during preparation of the manuscript of the paper.

Finally our sincere gratitude goes to Prof. N R Shetty, Director NMIT and Dr. H C Nagaraj, Principal NMIT for providing the infrastructure support and whole hearted encouragement to carry out the research at NMIT.

REFERENCE

[1] D. Lowe, “Object recognition from local scale-invariant features”, Proceedings of the International Conference on Computer Vision. pp. 1150-1157. 1999.

[2] D. G. Lowe, “Distinctive image features from scale-invariant key points”, International Journal of Computer Vision, November 2004, Vol 60, Issue 2, pp 91–110

[3] Karypis, George, Eui-Hong Han, and Vipin Kumar, "Chameleon: Hierarchical clustering using dynamic modeling." Computer, Vol: 32, Issue. 8, pp 68-75, Aug 1999

[4] Hendrickson, Bruce, and Robert W. Leland, "A Multi-Level Algorithm For Partitioning Graphs”, 95 Proceedings of the 1995 ACM/IEEE conference on Supercomputing, Article No. 28, San Diego, California, USA — December 04 - 08, 1995

[5] Karypis, George, Kirk Schloegel, and Vipin Kumar, "Parmetis: Parallel graph partitioning and sparse matrix ordering library", Version 1.0, Dept. of Computer Science, University of Minnesota (1997)

[6] Karypis, George, and Vipin Kumar, "A Coarse-Grain Parallel Formulation of Multilevel k-way Graph Partitioning Algorithm", Eighth SIAM Conference on Parallel Processing for Scientific Computing PPSC 1997

[7] Quinlan, J. Ross, "Bagging, boosting, and C4. 5", Proceedings of the Thirteenth National Conference on Artificial Intelligence and Eighth Innovative Applications of Artificial Intelligence Conference, AAAI 96, IAAI 96, Portland, Oregon, August 4-8, 1996, Volume 1.

[8] Quinlan, J. Ross, "Improved use of continuous attributes in C4. 5" Journal of Artificial Intelligence Research archive, Volume 4 Issue 1, January 1996, pp 77-90

[9] Peng, Wei, Juhua Chen, and Haiping Zhou, "An implementation of ID3-decision tree learning algorithm" From web. arch. usyd. edu. au/wpeng/DecisionTree2. pdf Retrieved date: May 13 (2009).

[10] Hssina, Badr, et al, "A comparative study of decision tree ID3 and C4. 5", International Journal of Advanced Computer Science and Applications 4.2 (2014): pp13-19.

[11] Bradski, Gary, and Adrian Kaehler, “ Learning OpenCV: Computer vision with the OpenCV library", O’Reilly Media, Inc.", 2008.

[12] Quinlan, J. Ross, "Induction of decision trees", Machine learning 1.1 (1986):pp 81-106.

[13] Dashora, Rajnish, Harsh Bajaj, and Akshat Dube, "Parallel Algorithm for the Chameleon Clustering Algorithm using Dynamic Modeling",International Journal of Computer Applications (0975 – 8887),Volume 79 – No8, October 2013

[14] Agrawal, Gaurav L., and Hitesh Gupta,"Optimization of C4. 5 decision tree algorithm for data mining application", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 3, March 2013, pp: 341-345.

[15] Singh, Sonia, and Priyanka Gupta, "Comparative study ID3, cart and C4. 5 decision tree algorithm: a survey", International Journal of Advanced Information Science and Technology (IJAIST),ISSN: 2319:2682 Vol.27, No.27, July 2014, pp: 97-103

[16] Wu, Xindong, et al, "Top 10 algorithms in data mining", Knowledge and information systems 14.1 (2008), pp:1-37.

[17] Kernighan, Brian W., and Shen Lin, "An efficient heuristic procedure for partitioning graphs", The Bell system technical journal 49.2 (1970), pp:291-307

[18] Quinlan, J. Ross, “C4. 5: programs for machine learning”, Morgan Kaufmann Publishers, Inc., 1993

Authors Profile

Dr. Jharna Majumdar is currently the Dean R & D, Prof. and Head Dept of M Tech Comp Science & Engineerinf and Head, Centre for Robotics Research at the Nitte Meenakshi Institute of Technology, Bangalore. Dr. Majumdar served Defence Research and Development Organization, Min. of Defence, Govt. of India from 1990 to 2007 as Scientist G and Head of Aerial Image Exploitation Division, Aeronautical Development Establishment, Bangalore, India. She has more than 40 years of research experience in India and abroad. She worked as a Research Scientist on ‘Robotics and Automation’ at the Institute of Real Time Computer Systems and Robotics, Karlsruhe, Germany from 1983 to 1989 and as a Research Scientist at the Stanford Research International California, USA in 2002. Dr. Majumdar has BTech (Hons) in ECE, a Post Graduate in Computer Technology from IIT Kharagpur and a PhD in Electrical Engg. from NIT Durgapur. Dr. Majumdar published more than 150 reviewed technical papers, has 4 Patents and received a large number of awards from DRDO and other organization. Some of her awards are: Award from President, Stanford Research International (SRI International), California, USA in 2002, Performance Excellence Award from the Prime Minister of India in 2004, Dr V M Ghatage award from Aeronautical Society of India in 2005, Dr. Suman Sharma Award from National Design and Research Forum (NDRF) in 2006, Dr. Kalpana Chawla Memorial Lecture Award in 2007, IEEE Award in 2011 and award received from the Vision Group on Science and Technology, Karnataka in 2016. She is a Fellow of the Aeronautical Society of India, Fellow of the Institution of Engineers and Life Member of the Computer Society of India. Her project with Indian Space Research Organization (ISRO) and the students from 7 Engineering Colleges to build the first Smallest Satellite in India of PICO Category has taken off to the orbit successfully on July 10 2010. Nitte Amateur Satellite Tracking Centre (NASTRAC) developed by a team of students from NMIT under her guidance is a patent and the First Tracking Station of Small Satellites in the country. The research team of Robotics under her guidance has received IEEE Award in 2011 and developed the First Robotic Exhibit at the Birla Science Centre Hyderabad on Jan 2012, which was inaugurated by Ex-President of India Dr. A P J Abdul Kalam. Research team of Robotics under her guidance is developing Humanoid Robots capable of Mimicking Human Facial Expression. Dr. Majumdar has brought large number of Funded Research Projects at NMIT from DRDO Laboratories and the Dept. of Science & Technology. She received CESEM Award from Vision Group on Science and Technology, Karnataka. Her current research areas include Real Time Image and Video Processing, Data and Video Analytics in Big Data. Robotics and Autonomous Systems, Machine Learning and Data Mining.

Mr. Anand Mahato pursed Master of Technology from Nitte Meenakshi Institute of Technology, in year 2017. He is currently working as Software of Engineer, in Kritikal Solution, Bangalor.