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Local Binary Patterns and Linear Programming using Facial Expression

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Abstract

In this paper we propose a new approach to recognize facial expressions from static images. First, the local binary patterns (LBP) are used to well represent the facial images and then the linear programming (LP) technique is adopted to categorize seven facial expressions—happiness, neutral, disgust, sadness, fear, surprise, and anger. Experimental results express an average recognition precision of 94.2% in the JAFFE database, which outperforms the rates of all other reported methods in the same database.

INTRODUCTION

Facial expression recognition from static images is a more challenging problem than from image sequences because less information for expression actions is available. However, information in a single image is sometimes enough for expression recognition, and in many applications it is also useful to recognize single image's facial expression.

In the recent years, numerous approaches to facial expression analysis from static images have been proposed [1, 2]. These methods differ generally in face representation and similarity measure. For instance, Zhang [3] used two types of features: the geometric position of 34 manually selected fiducial points and a set of Gabor wavelet coefficients at these points. These two types of features were used both independently and jointly with a multilayer perceptron for classification. Guo and Dyer [4] also adopted a similar face representation, combined with the linear programming (LP) technique to carry out simultaneous feature selection and classifier training, and they reported a better result. Lyons *et al.* used a similar face representation with a simple LDA-based classification scheme [5]. All the above methods required the manual selection of fiducial points. Buciu *et al.* used ICA and Gabor representation for facial expression recognition and reported a good result in the same database [6]. However, a suitable combination of feature extraction and classification is still an imperative question for expression recognition.

In this paper, we propose a novel method for facial expression recognition. In the feature extraction step, the local binary pattern (LBP) operator is used to describe facial expressions. In the classification step, seven expressions (anger, disgust, fear, happiness, sadness, surprise, and neutral) are decomposed into 21 expression pairs such as anger-fear, happiness-sadness, etc. Twenty-one classifiers are produced by the LP technique, each corresponding to one of the 21 expression pairs. A simple binary tree tournament scheme with pairwise comparisons is used for classifying unknown expressions.

FACE REPRESENTATION WITH LOCAL BINARY PATTERNS

Figure 1 shows the basic LBP operator [7], in which the original 3 × 3 neighborhood at the left is thresholded by the value of the center pixel and a binary pattern code is produced. The LBP code of the center pixel in the neighborhood is obtained by converting the binary code into a decimal one.

Based on the operator, each pixel of an image is labeled with an LBP code. The 256-bin histogram of the labels contains the density of each label and can be used as a texture descriptor of the considered region.

Feature extraction is implemented as follows: First, the face image is divided into several nonoverlapping blocks (10 × 8 in our method after experimenting with different block sizes). Then, LBP histograms are calculated.

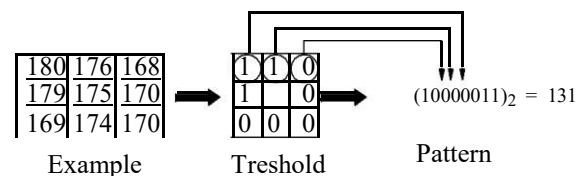


Fig. 1. The basic LBP operator.

lated for each block. Finally, the block LBP histograms are concatenated into a single vector. As a result, the facial expressions are represented by the LBP and the shape of the face is recovered by the concatenation of different local histograms.

To reduce the length of the feature vector, all the training samples' feature vectors are summed up and then averaged by the number of training samples. Then, for each region of an image, the patterns whose occurrence frequency is lower than a threshold are discarded.

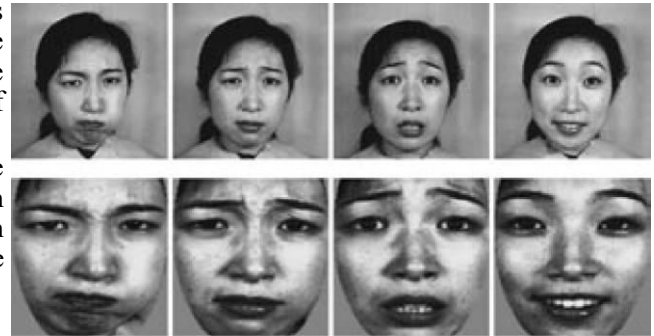


Fig. 2. Samples from original Japanese Female Facial Expression images before and after preprocessing.

EXPRESSION CLASSIFICATION BASED ON LINEAR PROGRAMMING TECHNIQUE

In [8], a single linear programming (LP) formulation is proposed which generates a plane that minimizes an average sum of misclassified points belonging to two disjoint points set. Consider the two point-sets A and B in the n -dimensional space R^n represented by the $m \times n$ matrix A and the $k \times n$ matrix B . The separating plane is as follows:

$$P := \{x \mid x \in R^n, x^T \omega = \gamma\}.$$

Here $\omega \in R^n$ is normal to the separating plane with a distance $|\omega|^{-1}$ to the origin.

The separating plane P determines two open half-spaces, $\{x \mid x \in R^n, x^T \omega > \gamma\}$ containing mostly points belonging to A , and $\{x \mid x \in R^n, x^T \omega < \gamma\}$ containing mostly points belonging to B . That is, we wish to satisfy

$$A\omega > e\gamma, \quad B\omega < e\gamma. \tag{2}$$

Here e is a vector of all 1's with the appropriate dimension. To the extent possible, or upon normalization,

$$A\omega \geq e\gamma + e, \quad B\omega \leq e\gamma - e. \tag{3}$$

Conditions (2) or (3) can be satisfied if and only if A and B do not intersect, which in general is not the case. We thus attempt to satisfy (3) by minimizing some norm of the average violations of (3),

$$\min_{\omega, \gamma} \frac{1}{m} \sum_{i=1}^m (-A\omega + e\gamma + e)_+ + \frac{1}{k} \sum_{j=1}^k (B\omega - e\gamma - e)_+. \tag{4}$$

Here $(x)_+$ denotes the vector in R^n satisfying $(x_+)_i := \max\{x_i, 0\}$, $i = 1, 2, \dots, n$. The norm $\|\cdot\|_p$ denotes the p norm, $1 \leq p \leq \infty$.

Formulation (4) is equivalent to the following robust linear programming formulation

$$\min_{\omega, \gamma, z} \frac{e^T y}{m} + \frac{e^T z}{k} \tag{5}$$

In our study, we use formulation (5) as a classifier to minimize wrong classifications.

Since formulation (5) is only used for separating two sets points, the seven-expression classification problem is decomposed into 21 two-class problems (anger-disgust, anger-fear, disgust-fear, etc.). In the training stage, 21 classifiers corresponding to 21 expression pairs are formed with 21 pairs of $\{\omega, \gamma\}$. In the testing stage, feature vector of a testing sample is fed to the different classifiers for recognition.

EXPERIMENTAL RESULTS

To assess the validity and efficiency of our approach, we experimented with the Japanese Female Facial Expression (JAFFE) database [9]. The database contains 213 images in which ten persons are expressing three or four times the seven basic expressions.

First, we preprocess the images using the subsystem of the CSU Face Identification Evaluation System [10]. The images are registered using eye coordinates and cropped with an elliptical mask to exclude nonface area from the image. As a result, the size of each preprocessed image is 150×128 . Sample images from the original and the preprocessed images are shown in Fig. 2.

We divide the database into ten roughly equally sized sets: nine sets are used for training and the remaining one for testing. The above process is repeated so that each of the ten roughly equally sized sets is used once as the test set. The average result over all ten cycles is considered as the recognition rate of one trial.

We repeat the above procedure 20 times and get 20 average results for these trials, of which the highest rate is 92.20%, the lowest rate is 82.00%, the mean is 89.20%

subject to

$$-A\omega + e\gamma + e \leq y$$

$$B\omega - e\gamma + e \leq z$$

$$y \geq 0, z \geq 0.$$

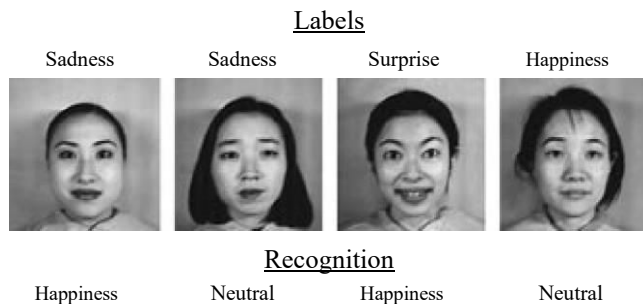


Fig. 3. Examples of disagreement.

It was reported in [3] that the expressers found it most difficult to pose fear expressions accurately and a human has more difficulty in recognizing fear. They achieved a recognition rate of 92.3% when all fear images were excluded. In our experiments, a highest rate of 95.6%, a lowest rate of 93.4% and an average rate of 94.6% are obtained when all fear images are excluded.

In [5], a recognition result of 92% using linear discriminant analysis (LDA) was reported, but they only included nine people's face images and, hence, only 193 of the 213 images were used.

The experimental results clearly show that our approach outperforms the other methods. In addition, it should be noted that only two positions of the eyes are needed in our approach while 34 fiducial points are manually selected in other methods [3–5].

It should also be noted that in the JAFFE database, some expressions had been expressed inaccurately or labeled incorrectly. This also influences the recognition results. Fig. 3 shows a few examples with the labeled expression and our recognition results.

CONCLUSIONS

How to get a proper combination for face representation and classification is crucial for facial expression recognition. The combination of the local binary pattern operator and the linear programming technique is one solution to this question. The Local Binary Pattern operator, which has demonstrated excellent performance in texture classification and face recognition, is

and the standard deviation is 1.35%.

In [3], a multilayer perceptron was used with 90.1% recognition accuracy. In [4], a technique called feature selection via linear programming was used and they achieved an accuracy of 91%. Therefore, better results are obtained with our approach. used in our method to describe a face efficiently for expression recognition. Then, 21 classifiers are produced based on linear programming technique and classification is implemented with a binary tree tournament scheme. Experimental results demonstrate that our method performs better than other methods on the JAFFE database. These preliminary results are promising and it is of interest to experiment with different facial expression databases.

REFERENCES

- [1] Kalaiprasath, R; Elankavi, R; Udayakumar, R; , Cloud security and compliance-a semantic approach in end to end security, International Journal on Smart Sensing and Intelligent Systems, V-10, I-5, PP:482-494, 2017.
- [2] Elankavi, R; Kalaiprasath, R; Udayakumar, R; , Wireless Zigbee Network Cluster-Capacity Calculation and Secure Data Conveyance Using Indegree, International Journal on Smart Sensing and Intelligent Systems, V-10, I-5, PP:174-185, 2017.
- [3] Kalaiprasath, R; Elankavi, R; Udayakumar, R; , A New Approach for Cloud Data Security: From Single to Cloud-of-Clouds, International Journal on Smart Sensing and Intelligent Systems, V-10, I-5, PP:604-613, 2017.
- [4] Elankavi, R; Kalaiprasath, R; Udayakumar, R; , Data Mining with Big Data Revolution Hybrid, International Journal on Smart Sensing and Intelligent Systems, V-10, I-5, PP:560-573, 2017.
- [5] Elankavi, R; Kalaiprasath, R; Udayakumar, Dr R; , A fast clustering algorithm for high-dimensional data, International Journal Of Civil Engineering And Technology (Ijciect), V-8, I-5, PP:1220-1227, 2017.
- [6] Gajmal, Yogesh M; Udayakumar, R; , Blockchain-based access control and data sharing mechanism in cloud decentralized storage system, Journal of web

- engineering, PP:1359–1388-1359–1388, 2021.
- [7] Gajmal, Yogesh M; Udayakumar, R; , A Bibliometric Analysis of Authentication based Access Control in Cloud using Blockchain, Library Philosophy and Practice, PP:0_1-16, 2021.
- [8] Shirke, S; Udayakumar, R; , Robust lane identification by using EW-CSA based DCNN, J. of Critical Reviews, V-6, PP:18-21, 2019.
- [9] Subhash, Ligade Sunil; Udayakumar, R; , A BIG SHARK ADAPTION ALGORITHM BASED RESOURCE ALLOTMENT APPROACH IN CLOUD COMPUTING ENVIRONMENT, PalArch's Journal of Archaeology of Egypt/Egyptology, V-17, I-7, PP:5374-5379, 2020.
- [10] Gajmal, Yogesh M; Udayakumar, R; , Privacy and utility-assisted data protection strategy for secure data sharing and retrieval in cloud system, Information Security Journal: A Global Perspective, V-31, I-4, PP:451-465, 2022.
- [11] Gajmal, Yogesh M; Udayakumar, R; , Analysis of Authentication based Data Access Control Systems in Cloud, PalArch's Journal of Archaeology of Egypt/Egyptology, V-17, I-7, PP:5319-5328, 2020.
- [12] Shirke, Suvarna; Udayakumar, R; , Evaluation of crow search algorithm (CSA) for optimization in discrete applications, 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), PP:584-589, 2019.
- [13] Shirke, Suvarna; Udayakumar, Ramanathan; , A novel region-based iterative seed method for the detection of multiple lanes, International Journal of Image and Data Fusion, V-11, I-1, PP:57-76, 2020.
- [14] Shirke, Suvarna; Udayakumar, R; , Fusion model based on entropy by using optimized DCNN and iterative seed for multilane detection, Evolutionary Intelligence, PP:44940, 2022.
- [15] Shirke, Suvarna; Udayakumar, R; , Hybrid optimisation dependent deep belief network for lane detection, Journal of Experimental & Theoretical Artificial Intelligence, V-34, I-2, PP:175-187, 2022.
- [16] Subhash, Ligade Sunil; Udayakumar, R; , Sunflower whale optimization algorithm for resource allocation strategy in cloud computing platform, Wireless Personal Communications, V-116, PP:3061-3080, 2021.
- [17] Subhash, Ligade Sunil; Udayakumar, R; , A Supremacy-Responsive Resource Distribution Technique for Controlled Workflow Implementation in Cloud Surroundings, Solid State Technology, V-63, I-5, PP:7662-7669, 2020.
- [18] Sindhu, Velagapudi Swapna; Lakshmi, Kavuri Jaya; Tangellamudi, Ameya Sanjanita; Lakshmi, C; , A Deep Learning Approach For Detecting Type 2 Diabetes Mellitus, 2022 International Conference on Computer Communication and Informatics (ICCCI), PP:44936, 2022.
- [19] Priyan, Siluvayan; Udayakumar, R; Mala, Pitchaikani; Prabha, Mariappan; Ghosh, Ananya; , A sustainable dual-channel inventory model with trapezoidal fuzzy demand and energy consumption, Cleaner Engineering and Technology, V-6, PP:100400, 2022.
- [20] Elankavi, R; Kalaiprasath, R; Udayakumar, R; , Potential Exploitation of Broadcasting System Using Multiple Smart Directional Antennas-Help of Sensor Network, International Journal of Mechanical Engineering and Technology (IJMET), V-8, I-6, PP:678-687, 2017.
- [21] Udayakumar, R; Kalam, Muhammad Abul; , Sentiment Analysis Using Machine Learning Algorithms, Mathematical Statistician and Engineering Applications, V-71, I-3s2, PP:1186–1200-1186–1200, 2022.

- [22] GAJMAL, YOGESH M; UDAYAKUMAR, R; , Data Access Controls in Cloud: A Survey., International Journal of Pharmaceutical Research (09752366), V-12, I-4, 2020.
- [23] Udayakumar, R; Khanaa, V; Kaliyamurthie, KP; , Optical ring architecture performance evaluation using ordinary receiver, Indian Journal of Science and Technology, V-6, I-6, PP:4742-4747, 2013.
- [24] Udayakumar, R; Khanaa, V; Kaliyamurthie, KP; , Performance analysis of resilient fth architecture with protection mechanism, Indian Journal of Science and Technology, V-6, I-6, PP:4737-4741, 2013.
- [25] Udayakumar, R; Khanaa, V; Saravanan, T; , Synthesis and structural characterization of thin films of SnO_2 prepared by spray pyrolysis technique, Indian Journal of Science and Technology, V-6, I-S6, PP:4754-7, 2013.
- [26] Udayakumar, R; Khanaa, V; , Health monitoring system for induction motors, Int. J. Eng. Comput. Sci, V-2, I-4, PP:1117-1122, 2013.
- [27] Udayakumar, R; Khanaa, V; , Quantum Computers-A Revolution InComputing, Quantum, V-8, I-4, PP:33-36, 2013.
- [28] Khanaa, V; Udayakumar, R; , Protecting privacy when disclosing information: k anonymity and its enforcement through suppression, database, V-1, I-2, 2012.
- [29] Khanaa, V; Udayakumar, R; , Hybrid Fuzzy Approches for Networks, International Journal of Innovative Research in science, Engineering and Technology, V-12, I-3, PP:24-31, 2012.
- [30] Udayakumar, R; Khanaa, V; Saravanan, T; Saritha, G; , Cross layer optimization for wireless network (WIMAX), Middle-East Journal of Scientific Research, V-16, I-12, PP:2013, 2012.
- [31] Udayakumar, R; Thooyamani, KP; Khanaa, V; , Coarse-Grained Parallel Genetical Gorithm to Solve the Shortest Path Routing Problem Using Genetic Operators, Middle-East Journal of Scientific Research, V-15, I-12, PP:1651-1654, 2013.
- [32] Khanaa, V; Udayakumar, R; , Efficient Pc Controlled By Hand Movement Using Mems Sensor Mouse, Indian Journal of science and Technology, V-12, I-6, PP:1438-1442, 2012.
- [33] Udayakumar, R; Khanaa, V; , Sixth Sense Technology, International Journal Of Engineering And Computer Science, V-2, I-4, 2013.
- [34] Udayakumar, R; Thooyamani, KP; Khanaa, V; , Secure Incentive Protocol for Multi-Hop Wireless Network with Limited Use of Public Key Cryptography, Middle-East Journal of Scientific Research, V-20, I-11, PP:1651-1656, 2014.
- [35] Udayakumar, R; Kaliyamurthie, KP; Khanaa, TK; , Data mining a boon: Predictive system for university topper women in academia, World Applied Sciences Journal, V-29, I-14, PP:86-90, 2014.
- [36] Udayakumar, R; Saravanan, T; , Tailored Image District Processing Precision Andwritten Appreciation, Middle-East Journal of Scientific Research, V-20, I-11, PP:1615-1625, 2014.
- [37] Udayakumar, R; Thooyamani, KP; , Khanaa, Deploying site-to-site VPN connectivity: MPLS Vs IPsec, World Applied Sciences Journal, V-29, I-14, 2014.
- [38] Udayakumar, R; Thooyamani, KP; , Random projection based data perturbation using geometric transformation, World Applied Sciences Journal, V-29, I-1, PP:24-31, 2014.
- [39] Thooyamani, KP; Khanaa, V; Udayakumar, R; , Wide area wireless networks-IETF, Middle-East Journal of Scientific Research, V-20, I-12, PP:2042-2046, 2014.

- [40] Khanaa, V; Thooyamani, KP; Udayakumar, R; , Modelling Cloud Storage, World Applied Sciences Journal, V-29, 2014.
- [41] Khanaa, V; Thooyamani, KP; Udayakumar, R; , Elliptic curve cryptography using in multicast network, World Applied Sciences Journal, V-29, 2014.
- [42] Khanaa, V; Thooyamani, KP; Udayakumar, R; , Two factor authentication using mobile phones, World Applied Sciences Journal, V-29, I-14, PP:208-213, 2014.
- [43] Khanaa, V; Thooyamani, KP; Udayakumar, R; , Patient monitoring in gene ontology with words computing using SOM, World Applied Sciences Journal, V-29, 2014.
- [44] Kaliyamurthie, KP; Parameswari, D; Udayakumar, R; , Malicious packet loss during routing misbehavior-identification, Middle-East Journal of Scientific Research, V-20, I-11, PP:1413-1416, 2014.
- [45] Udayakumar, R; Saritha, G; Saravanan, T; , Modelling and Simulation of Electromechanical Systems Working with Nonlinear Frictional Loads and Controlled by Subordinated Control System of Coordinates, Middle-East Journal of Scientific Research, V-20, I-12, PP:1918-1923, 2014.
- [46] Saravanan, T; Saritha, G; Udayakumar, R; , Cassette Steganography for Entrenched Metaphors in Squashed Videos, Middle-East Journal of Scientific Research, V-20, I-12, PP:2475-2478, 2014.
- [47] Udayakumar, R; Khanaa, V; Saravanan, T; , Energy Demand Management Motor Control Using Multilevel Inverter, Middle-East Journal of Scientific Research, V-20, I-12, PP:2613-2619, 2014.
- [48] Thooyamani, KP; Khanaa, V; Udayakumar, R; , Wireless cellular communication using 100 nanometers spintronics device based VLSI, Middle-East Journal of Scientific Research, V-20, I-12, PP:2037-2041, 2014.
- [49] Saravanan, T; Srinivasan, V; Udayakumar, R; , Images segmentation via Gradient watershed hierarchies and Fast region merging, Middle-East Journal of Scientific Research, ISSN, V-9233, I-15, PP:12, 2012.
- [50] Saravanan, T; Srinivasan, V; Udayakumar, R; , Image Segmentation via Gradient Watershed Hierarchies and Fast Region Merging, Middle-East Journal of Scientific Research, V-15, I-12, PP:1680-1683, 2013.
- [51] Udayakumar, R; Khanaa, V; , Quantum Computers-A Revolution In Computing, Quantum, V-8, I-4, PP:33-36, 2013.
- [52] Khanaa, V; Udayakumar, R; , Hybrid Fuzzy Approches for Networks, International Journal of Innovative Research in science, Engineering and Technology, V-12, I-3, PP:24-31, 2012.
- [53] Khanaa, V; Udayakumar, R; , Efficient Pc Controlled By Hand Movement Using Mems Sensor Mouse, Indian Journal of science and Technology, V-12, I-6, PP:1438-1442, 2012.
- [54] Udayakumar, R; Thooyamani, KP; Khanaa, V; , Secure Incentive Protocol for Multi-Hop Wireless Network with Limited Use of Public Key Cryptography, Middle-East Journal of Scientific Research, V-20, I-11, PP:1651-1656, 2014.
- [55] Kalaiprasath, R; Elankavi, R; Udayakumar, R; , A New Approach for Cloud Data Security: From Single to Cloud-of-Clouds, International Journal on Smart Sensing and Intelligent Systems, V-10, I-5, PP:604-613, 2017.
- [56] Udayakumar, R; Saravanan, T; , Tailored Image District Processing Precision Andwritten Appreciation, Middle-East Journal of Scientific Research, V-20, I-11, PP:1615-1625, 2014.
- [57] R., Kalaiprasath; R., Elankavi; R., Udayakumar; , Cloud Information Accountability (CIA) framework ensuring accountability of data in cloud and security in end to end process in cloud terminology, International Journal of Civil Engineering and Technology, V-8, I-4, PP:376-385, 2017.

- [58] R., Kalaiprasath; R., Elankavi; R., Udayakumar; , Cloud computing security towards end to end terminology, International Journal of Pure and Applied Mathematics, V-115, I-8 Special Issue, PP:637-641, 2017.
- [59] R., Elankavi; R., Kalaiprasath; R., Udayakumar; , Potential exploitation of broadcasting system using multiple smart directional antennas -help of sensor network, International Journal of Mechanical Engineering and Technology, V-8, I-6, PP:678-687, 2017.
- [60] R., Elankavi; R., Kalaiprasath; R., Udayakumar; , A fast clustering algorithm for high-dimensional data, International Journal of Civil Engineering and Technology, V-8, I-5, PP:1220-1227, 2017.
- [61] Kalaiprasath, R; Elankavi, R; Udayakumar, R; , Integrating Multiple Smart Directional Antennas for Full Potential Exploitation of Broadcasting System, International Journal of Science and Research, V-5, I-1, PP:1398-1403, 2016.
- [62] Udayakumar, R; , Media Cloud: An Open Cloud Computing Middleware for Content Management, Journal of Chemical and Pharmaceutical Sciences, V-5, I-2, PP:382-395, 2012.
- [63] Udayakumar, R; , A modified collage steganography using modified fuzzy C-means algorithm on images, International Journal of Innovative Research in Computer and Communication Engineering, V-7, I-1, PP:83-89, 2012.
- [64] Udayakumar, R; , Computer Simulation of Polyamidoamine Dendrimers and Their Complexes with Cisplatin Molecules in Water Environment, Computer Simulation, V-2, I-4, 2014.
- [65] Thooyamani, KP; Udayakumar, R; , A Study on Fraud Detection Techniques: Credit Card, Journal of Computer Science and Applications, V-9, I-9, PP:1398-1403, 2007.
- [66] Rao, Kanamarlapudi Venkata Srinivasa; Udayakumar, Ramanathan; Khanaa, Velu; , An Efficient Authentication Method For Smart Card Verification In Online, Advances in Science, Technology and Engineering Systems Journal V, V-2, I-4, PP:133-138, 2017.
- [67] Udayakumar, R; Khanaa, V; Saravanan, T; , Energy Demand Management Motor Control Using Multilevel Inverter, Middle-East Journal of Scientific Research, V-20, I-12, PP:2613-2619, 2014.
- [68] Kaliyamurthie, KP; Udayakumar, R; , The Relationship between Semaphores and Telephony Using Saros, EUROSIA JOURNAL OF SCIENCE AND TECHNOLOGY, V-7, I-1, PP:77-89, 2020.
- [69] Subhash, Ligade Sunil; Udayakumar, R; , A BIG SHARK ADAPTION ALGORITHM BASED RESOURCE ALLOTMENT APPROACH IN CLOUD COMPUTING ENVIRONMENT, PalArch's Journal of Archaeology of Egypt/Egyptology, V-17, I-7, PP:5374-5379, 2020.
- [70] Subhash, Ligade Sunil; Udayakumar, R; , A Supremacy-Responsive Resource Distribution Technique for Controlled Workflow Implementation in Cloud Surroundings, Solid State Technology, V-63, I-5, PP:7662-7669, 2020.
- [71] Udayakumar, R; Khanaa, KP Kaliyamurthie; Geo, AV Allin; , Heterogenous Patterns in Database Using Mining, , 2014.
- [72] Udayakumar, R; , INFLUENCE OF WAR IN THE WORKS OF GEORGE ORWELL AND HAROLD PINTER, European Journal of Molecular & Clinical Medicine, V-7, I-3, PP:4902-4905, 2020.
- [73] Udayakumar, Rajangam; Prema, Durairaj; Kamaraj, Malaiyandi; , ANTIMICROBIAL ACTIVITY OF ETHANOLIC RHIZOME EXTRACT OF CURCUMA AMADA ROXB.(MANGO GINGER), , 2015.
- [74] Udayakumar, R; Kalam, Muhammad Abul; , Sentiment Analysis Using Machine Learning Algorithms, Mathematical Statistician and Engineering Applications, V-71, I-3s2, PP:1186-1200-1186-1200, 2022.
- [75] GAJMAL, YOGESH M; UDAYAKUMAR, R; , Data Access Controls in Cloud: A Survey., International Journal of Pharmaceutical Research (09752366), V-12, I-4, 2020.
- [76] Kothari, Kesar M; Udayakumar, R; Karthikeyan, Ram; Raj, Nikitha; , Modeling of the Manifold Configuration for Maximum Efficiency in a Hydraulic Machine, International Journal of Fluid Machinery and Systems, V-13, I-1, PP:136-149, 2020.



- [77] Udayakumar, R; Shah, Vivek J; Venkatesh, Sai Vijay; , Performance and Emission Characteristics of Biodiesel from Rapeseed and Soybean in CI Engine, Intelligent Manufacturing and Energy Sustainability: Proceedings of ICIMES 2019, PP:209-219, 2020.