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Speech Recognition Finding Number of Hidden Layers – Neural Networks

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ABSTRACT: This work deals about speech recognition. The main objective of the experiment is to choose suitable number of nodes in hidden layer and learning parameters through trial and error method. The network used in the process is feed forward multilayer perception trained with back propagation scheme. Speech data for the study are analyzed using linear predictive coding and log area ratio to represent speech signal for every 20ms through a fixed overlapped windows. The neural network operation is greatly influenced by the parameters i.e., number of hidden nodes chosen. Taking upon a sample experimental data and working on it to find the efficiency of the system. The system is trained and it is made to learn the slang and variations of the speech by the sample experimental data. Thus, the result shows that choosing suitable parameters leads to high efficiency in recognizing the speech components, slang and variations and the Learning Parameters.

1. INTRODUCTION

Speech recognition is an important field of study. Mastering the technology gives huge impact towards humans' ways of life. Today, human interaction with machines use devices like mouse and keyboards which depend much on hand movements, the speech technology can change the norms by allowing interaction via speech which is more rapidly, easy and ease.

Works on speech technology has been started since 1950's [3]. However, a speech recognition system that able to recognize speech like human's ability is yet to be achieved.

Nevertheless, the technology has reached a level which it can be applied to specific industrial purpose applications like flight information query, car making industries, and post package delivery request [4] and some software for

simple application like word dictation are also available commercially.

According to slice open, speech recognition by device is a difficult task because it requires machine to have depth knowledge about human's everyday speaking and conversation experience and linguistic knowledge [1].

A popular approach in speech technology is Artificial Intelligent (AI). The approach combines study of pattern recognition with machine ability to see, analyzed, learn and make decision imitating human's ability. This paper reports works in finding suitable learning parameters and number of hidden nodes for the recognition system.

2. SPEECH RECOGNITION MODEL

Human speech perception starts with receiving speech waveform through the ears. The speech will enter membrane basilar situated in the inner middle ear at which the signal waveform will be analyzed and produced spectrum signal. The spectrum signal will enter neural transducer which converts the signal to neural activities at the ear's nerve. The neural signal activities are translated into language code and the message will be sent to the brain for perception.

Figure 1 shows the graphic diagram of the process.

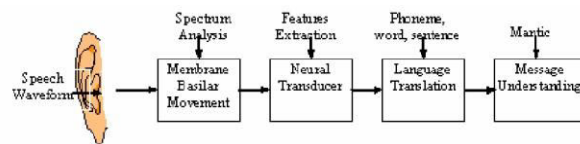


Figure 1. Human perception model.

The speech recognition system model built in this paper imitates the human perception model. Three levels of processes are required for recognition by machine that are the acoustic processing, features extraction and recognition. The analogue speech will be sampled, digitized and filtered. These processes convert the signal into discrete form. The signal is then decided for the start and end points so that only the

signal with information will be analyzed. The next process is to extract features from the signal within the start and end points. This experiment used Linear Predictive Coding (LPC) for spectral analysis and speech features representation. The number of frames from the resulted features differs from one utterance to other. Therefore, frame normalization need to be applied to become equal to the number of input nodes in neural network used in this experiment. The data for testing and training will go through the same processes. The training data will be fed into neural network to optimize learning process which lies in updating iteratively the weights between networks layers. Upon having optimized weight, it will be used to test the training patterns.

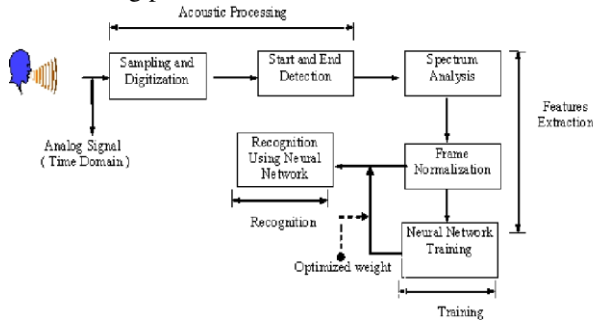


Figure 2. Speech recognition model using neural network.

3. EXPERIMENTAL DATA

This experiment uses digit utterances from four speakers consist of two males and two females in their 20's. Each speaker uttered digit "0" up to "9" for 20 times. The utterances were recorded at different time to get utterance variation from speakers that is speakers may utter a same word differently at different time. They were told to speak clearly without any dialect or slang. The utterances were recorded using high quality microphone and sound editor software called GoldWave at a silence lab environment. Human speech puts much of its sound energy in the 200 Hz to 3.2 kHz frequency band [3]. Therefore, sampling size chosen for recording is 8 KHz which is twice the frequency of the original signal and follows the Nyquist rule of sampling.

Human speaks continuous speech. However, the speech is considered static during short period of within 10-50ms [7, 14]. Therefore, in this experiment every 20 ms, the speech will be analyzed using spectrum analysis algorithm to extract the information representing the speech. As mentioned earlier, the work used LPC for spectral analysis as the speech parameters extracted using fix window of

size 20ms and overlapped windows of size 10ms with number of order equal to 12. The LPC process can be described as in Figure 3. Each analyzed frame will produce 12 LPC coefficient representing features of the frame or known as features vectors.

Speech is highly varies in term of its duration, acoustic information and resulted pattern even for a similar word utterance by same speaker at different time. Therefore, the number of frames per speech pattern will be most likely different from each other. Since number of input to the neural network is fixed, the number of speech pattern frame need to be normalized prior to feed into the network for training or testing. There are three possibilities of the number of frames after features extraction which are:

- Number of frame is equal to the number of input node.
- Number of frame is less than the number of input node.
- Number of frame is greater than the number of input node.

Based on the possibilities the normalized algorithm is developed as in pseudo-code at Figure 4.

Basically, the normalization scheme works by squeezing and expanding the features linearly.

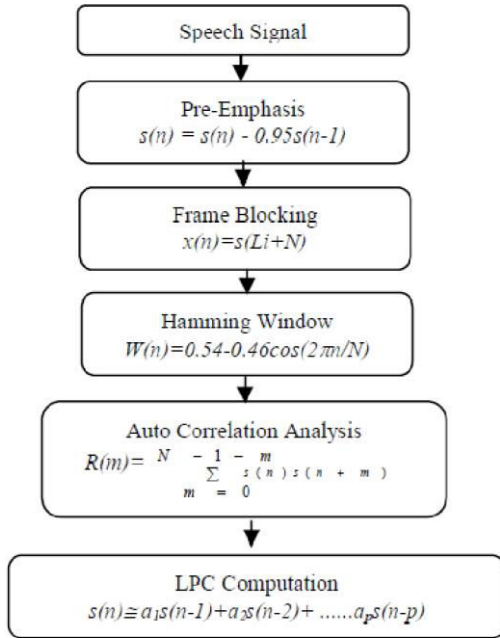


Figure 3. Flow diagram for LPC processing.

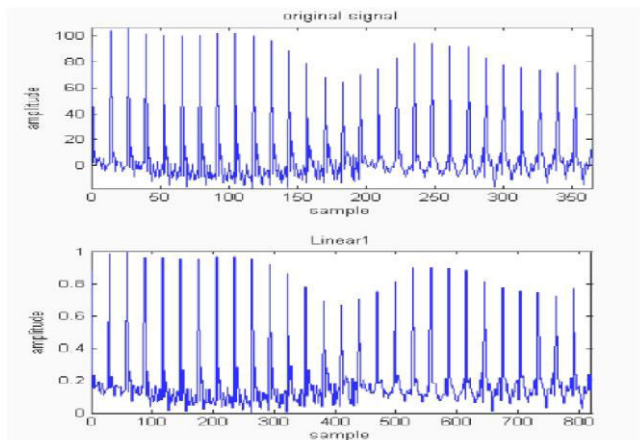
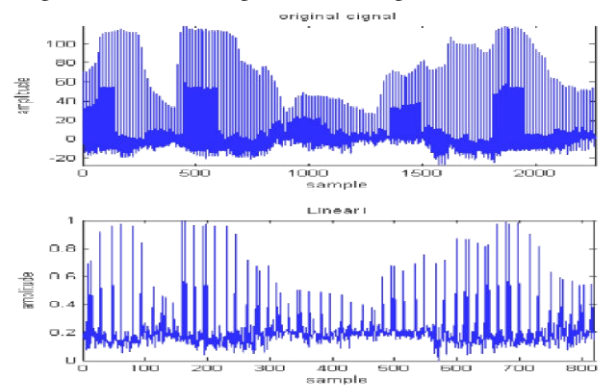
If the frame number is equal to the number of FIXFRAME that is the number of input node, then it will just copy as the features pattern for neural network training or testing. The second case is if the number of pattern frames is greater than FIXFRAME, then the pattern will be squeezed based on the ratio of the different. Similarly, if the number of pattern frames less than FIXFRAME, the pattern will be expanded based on the ratio of the FIXFRAME and the pattern frames. This normalization is known as linear normalization.

1. Read Signal X (0 ... N)
2. If N == FIXSIZE, % case 1: equal size Xnew(n) = X(n); % copy
3. If N > FIXSIZE % case 2: bigger than Ratio = N/FIXSIZE; % calculate ratio
 $X_{new}(0...FIXSIZE) = X(n * Ratio);$
4. If N < FIXSIZE % case 3: smaller than Ratio = FIXSIZE/N % calculate ratio;
 $X_{new}((0..FIXSIZE) = X(n * Ratio);$
 FillEmpty (Xnew (i) = X(i+1));

5. Amplitude Normalization of signal X to 0 and 1

Figure 4. Normalization pseudo code.

The resulted pattern after normalization is as shown in Figure 5(a) and 5(b) for both cases of pattern size is greater and less than the fix features size respectively. Each pattern will pass through the processes described before fed into neural network for training and testing. All together, there are 800 patterns used in the experiment from which halves are for training and the remaining are for testing.



a) Original size greater than fix features (2360:820)

b) Original size less than fix features (360:820)

Figure 5. Original size



4. THE NEURAL NETWORK

The neural network model used in the experiment is Feed Forward Multi Layer Perceptron (FFMLP). Reviews show that three layers MLP with one hidden layer can be a universal classifier [3]. An experimental result showed that the use of two hidden layers does not give better result compare to one hidden layer [1]. Therefore, this experiment use three layer MLP that have one input layer, one hidden layer and one output layer. The features vectors representing speech pattern after the normalization is fed into neural network at input layer. These values are passed to the hidden layers and output layers through the connected weight between each layer. The output from each relation connection is calculated by summing the weight and the values between the connected layer and feed into non linear function like sigmoid and hyperbolic tangent functions. The calculation can be shown as follows:

$$Out_i = f(net\ i) = f(\sum W_{ij} Out_j + \phi_i) \quad (1)$$

Out_i is the i^{th} output value from the layer we want to calculate. Out_j is the node i^{th} output value from the preceding layer. W_{ij} is the weight value connected between the calculated outputs layers ie. Out_i and Out_j . ϕ_i is bias value at the calculated layer. The bias plays role in enhancing the learning process [1].

4.1. Training and Learning of the Network

The neural network in this work is MLP supervised learning. The scheme for training is back propagation with sum square error. The sum square error calculated as follow:

$$E = 1/2 \sum (e_j)^2 \quad (2)$$

Where $e_j = (t_j - o_j)$ and N is the number of input, t is the desire target output and o is the output gotten from the network based on the square error. For example the desired output of the pattern representing a word “sembilan” is $t[4] = \{0.1, 0.0, 0.0, 0.1\}$ while the output from the network is $o[4] = \{0.09, 0.05, 0.05, 0.09\}$. The sum square error for the first input pattern, $j = 1$ can be calculated as below. The desire target output and o is the output gotten from the network based on the square error. For example the desired output of the pattern representing a word “sembilan” is $t[4] = \{0.1, 0.0, 0.0, 0.1\}$ while the output from the network is $o[4] = \{0.09, 0.05, 0.05, 0.09\}$. The sum square error for the first input pattern, $j = 1$ can be calculated as below

$$\begin{aligned} e_1 &= [(t[0] - o[0])^2 + (t[1] - o[1])^2 + (t[2] - o[2])^2 + (t[3] - o[3])^2] \\ &= 0.0001 + 0.0025 + 0.0025 + 0.0001 \\ &= 0.0052 \end{aligned}$$

Each error of e_j like the above example influences the total sum error from network the learning process. Therefore, if the error is big then the sum error is big implying the bad learning. The learning process in back propagation is done through minimizing the sum error through updating the weights using methods known as steepest descend which can be simplify as in the equation below.

$$\Delta W_{ji} = \eta \delta_j O_{pi} \quad (3)$$

Where η is the learning rate, δ_j is the signal error at nod j from L layer and O_{pi} is the output for node i from $L-1$ layer. The value of δ_j is calculated as:

$$\delta_j = (t_{pj} - O_{pj}) O_{pj} (1 - O_{pj}) \quad (4)$$

If it is the output node and

$$\delta_j = \sum_{pk} O_{pj} (1 - O_{pj}) W_{kj} \delta_k \quad (5)$$

If it's the hidden node.

Based on equation 3, the value of learning rate, η determines the slope size of the equation that is how long the learning process takes. The right choice of η is needed for a faster convergence. However, large value of η may lead to unstable learning. To help enhancing learning process, momentum rate, α is added to the equation 3 to become the following equation.

$$w_{ji}(n) = \eta(\delta_{pj} - O_{pi}) + \alpha w_{ji}(n-1) \quad (6)$$

The value of the momentum rate, α take into consideration the changes of the previous weight. The network training process can be illustrated as in Figures 6 and 7 shows the flow diagram of back propagation scheme.

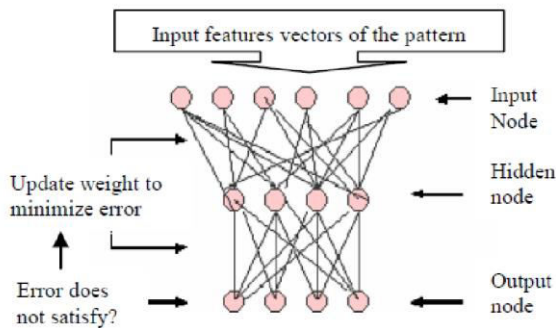


Figure 6. Training process

4.2. Output Node Pattern Representation

The network is a supervised network where target output is used to supervise learning process by error reduction. Therefore, the output nodes for the training pattern need to be well represented. The network model in this experiment use four nodes to represent speech pattern consist of digit “kosong” up to “sembilan”. These nodes will be classified as the speech by giving logic value “on” and “off” on each nodes in form of binary. Table 1 shows the target output representation for digit “0” to “9”. The value 0.0 indicates the node is “off” while 0.1 indicates the node is “on”. The values 0.0 and 0.1 are selected through trial and error.

After training process, the values of output nodes will change depend on the network learning progress. An example for the output nodes after training can be shown as in Table 1. It can be observed in Table 1 that the outputs do not have exact value of 0.0 and 0.1 as in the target. However, after the training process the output nodes value approaching 0.1 is consider “on” and the value near to 0.0 is consider “off”. The problem occurs is how do we determine the suitable threshold value as to which the

value need to be grouped as “on” or “off”.

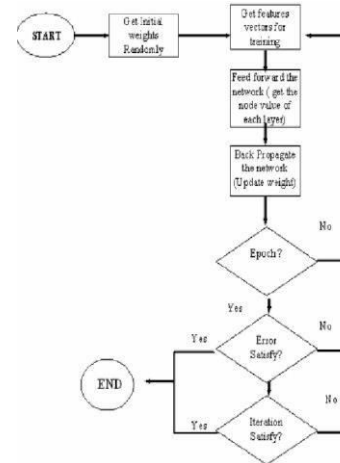


Figure 7. Back propagation training scheme.

Table 1. An example of output nodes after training.

Digit	Output Nodes			
	O[0]	O[1]	O[2]	O[3]
0	0.00012	0.00027	0.00006	0.00008
1	0.10219	0.00010	0.00020	0.00007
2	0.00023	0.04808	0.00091	0.00061
3	0.12182	0.06562	0.00022	0.00010
4	0.00012	0.00021	0.04763	0.00071
5	0.08226	0.00011	0.09762	0.00081
6	0.00010	0.09722	0.10021	0.00022
7	0.08221	0.05672	0.07562	0.00021
8	0.00003	0.00032	0.00031	0.10110
9	0.07862	0.00011	0.00043	0.67123

4.3. Speech Pattern Classification

The classification was done by having two phases threshold comparison to decide whether a node is grouped as “on” or “off”. The two threshold values are 0.04 for the first phase and 0.006 for the second phase.

The values are chosen by trial and error. The classification is done as in Figure 8.

Each node will be compared with first threshold value 0.04. If the value is bigger than the threshold value then it will be labeled as “on”. The nodes that fail the first threshold are compared with the second threshold as not to miss selected. If the node is greater than the threshold, then it will also be labeled as “on”. The next step is to map the answer through binary representation.

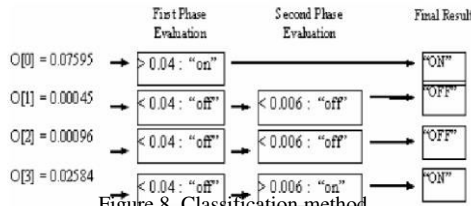


Figure 8. Classification method.

5. A QUEST FOR NEURAL NETWORK LEARNING

NUMBER OF HIDDEN NODES

There are factors that influence the network learning process. Some of them are the choice of learning parameters and network topology. As mentioned in section 4.1, the learning and momentum rate play important roles in enhancing network learning process.

While suitable number of hidden node gives better mapping of the network input to output connection [2]. There are several experiments done to find the suitable learning and momentum rate. The best value however is not the same for all cases. This experiment used pairs of learning and momentum rate that have been used for speech recognition study using neural network [2].

In this experiment, five pairs of learning and momentum rate are chosen for the experimentation from which four pairs have been used previously on speech recognition by neural network experimentation. The pair {0.9, 1.0} is chosen randomly. The experimental learning and momentum rate pairs are shown below.

Momentum	0.5	0.5	1.0	0.9	0.1
Learning Rate	0.25	0.75	0.9	1.0	0.9

In finding suitable number of hidden nodes, some suggestions are given by previous researchers. Among the suggestions are,

$$h = n, h = 2n, h = n, m [2] \text{ dan } h = 3n [4]$$

where n is the number of input nodes and m is the number of output nodes. Nevertheless, these suggestions are not suitable if the input node is large like in this experiment. Because it will lead to biggest number of hidden nodes and thus lead to complexities and time consuming. Therefore, based on trial and error approach, this experiment choose number of hidden nodes start at 30 up to 70 with increment of 5 that is as in the set {30, 35, 40, ..., 60, 65, 70}.

5.1. Testing

Testing is done on different set of 320 speech patterns where each digit is tested 32 times. The testing set is a new set never introduced to the neural network. The test patterns were fed into neural network randomly just to make sure the neural network do not memorize the pattern but able to make generalization in recognition.

The recognition rate is calculated by comparing number of true recognized pattern to the total number of tested patterns. Assuming X is the set of test pattern, n is the total number of test patterns and $R(x)$ is the recognition function where

$$R(X_i) = \begin{cases} 1 & \text{if true recognized} \\ 0 & \text{if false recognized} \end{cases}$$

Therefore, the recognition rate is calculated as

$$\text{recognition rate} = \frac{\sum_{i=1}^n R(X_i)}{n} \times 100$$

The learning can be shown in error graph versus iteration time for each training set.

6. EXPERIMENT RESULT

The experimental result in finding the suitable number of hidden nodes is shown at Table 2. Figure 9 illustrate the result in graph recognition versus number of hidden nodes from 30 to 70.

Table 2 shows that for all number of hidden nodes using the chosen learning parameters from the first experiment gives recognition rate of above 90%. At number of hidden nodes equal to 30, the recognition rate is 92% and increase to 93% at number of hidden nodes equal to 40. The maximum recognition rate of 95% was at number of hidden nodes equal to 45 and 50. The recognition starts to decrease to



93% again at number of hidden nodes equal to 55 up to 70. Thus choosing the parameters and hidden nodes has improved the efficiency

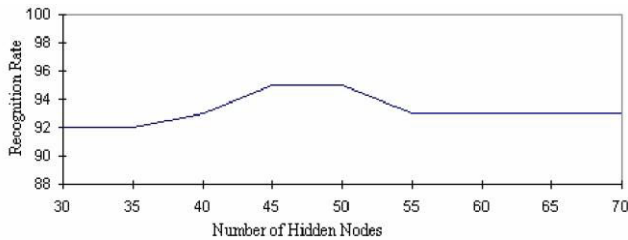


Figure 9. Graph of recognition rate versus number of hidden nodes

Table 2. Experimental result on number of hidden nodes.

Number of Hidden Nodes	Recognition Rate	Starting Error	Ending Error
30	92 %	0.96896	0.00021
35	92 %	0.77195	0.00026
40	93 %	0.84084	0.00093
45	95 %	0.84922	0.00010
50	95 %	0.81826	0.00029
55	93 %	0.84016	0.00053
60	93 %	1.27723	0.00547
65	93 %	0.75126	0.00475
70	93 %	1.07863	0.00086

7. CONCLUSION

It can be concluded from the experiment that the learning parameter and number of hidden nodes influence the ability of neural network classification. The effect of number of hidden nodes can be seen that the maximum recognition rate was only achieved at hidden nodes 45 and 50. Number of hidden nodes that is smaller than 45 would give lower recognition rate and if the number is greater than that 50 will also lead to lower recognition rate. In this experiment the best hidden nodes for this application is 45 due to its converge satisfy the error termination condition of 0.0001 even as the others do not.

REFERENCES

- [1] alaiprasath, 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] lankavi, 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] alaiprasath, 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] lankavi, 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] lankavi, R; Kalaiprasath, R; Udayakumar, Dr R; , A fast clustering algorithm for high-dimensional data, International Journal Of Civil Engineering And Technology (Ijciet), V-8, I-5, PP:1220-1227, 2017.
- [6] ajmal, 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] ajmal, 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] K hirke, S; Udayakumar, R; , Robust lane identification by using EW-CSA based DCNN, J. of Critical Reviews, V-6, PP:18-21, 2019.

- [9] ubhash, 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] ajmal, 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] ajmal, 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] hirke, 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] hirke, 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] hirke, Suvarna; Udayakumar, R; , Fusion model based on entropy by using optimized DCNN and iterative seed for multilane detection, Evolutionary Intelligence, PP:44940, 2022.
- [15] hirke, 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] ubhash, 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. G
- [17] ubhash, 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] indhu, 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] riyani, Siluvayan; Udayakumar, R; Mala, Pitchaikani; Prabha, Mariappan; Ghosh, Ananya; , A sustainable dual-channel inventory model with trapezoidal fuzzy demand S and energy consumption, Cleaner Engineering and Technology, V-6, PP:100400, 2022.
- [20] lankavi, 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] S dayakumar, 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] AJMAL, YOGESH M; UDAYAKUMAR, R; , Data Access Controls in Cloud: A Survey., International Journal of Pharmaceutical Research (09752366), V-12, I-4, 2020.
- [23] dayakumar, 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] dayakumar, 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] dayakumar, 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] dayakumar, R; Khanaa, V; , Health monitoring system for induction motors, Int. J. Eng. Comput. Sci, V-2, I-4, PP:1117-1122, 2013.
- [27] dayakumar, R; Khanaa, V; , Quantum Computers-A Revolution In Computing, Quantum, V-8, I-4, PP:33-36, 2013.
- [28] hanaa, V; Udayakumar, R; , Protecting privacy when disclosing information: k anonymity and its enforcement through suppression, database, V-1, I-2, 2012.
- [29] hanaa, 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] dayakunlar, 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] dayakunlar, 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] hanaa, 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] dayakumar, R; Khanaa, V; , Sixth Sense Technology, Internatiobhal Journal Of Engineering And Computer Science, V-2, I-4, 2013.
- [34] dayakumar, 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] K dayakumar, 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] dayakumar, 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] dayakumar, R; Thooyamani, KP; , Khanaa, Deploying site-to-site VPN connectivity: MPLS Vs IPsec, World Applied Sciences Journal, V-29, I-14, 2014.
- [38] dayakumar, R; Thooyamani, KP; , Random projection based data perturbation using geometric transformation, World Applied Sciences Journal, V-29, I-1, PP:24-31, 2014.
- [39] hooyamani, 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] hanaa, V; Thooyamani, KP; Udayakumar, R; , Modelling Cloud Storage, World Applied Sciences Journal, V-29, 2014.
- [41] hanaa, V; Thooyamani, KP; Udayakumar, R; , Elliptic curve cryptography using in multicast network, World Applied Sciences Journal, V-29, 2014.
- [42] hanaa, V; Thooyamani, KP; Udayakumar, R; , Two factor authentication using mobile phones, World Applied Sciences Journal, V-29, I-14, PP:208-213, 2014.
- [43] hanaa, V; Thooyamani, KP; Udayakumar, R; , Patient monitoring in gene ontology with words computing using SOM, World Applied Sciences Journal, V-29, 2014.
- [44] aliyamurthie, 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] dayakumar, 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] T aravanan, 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] K dayakumar, 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] K hooyamani, 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] K 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.



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