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## Table of Contents

Title	Page.No
Parallel Hierarchical Subspace Clustering for Segmenting Large Text Corpuses <i>S. Karthick, S. Mercy Shalinie, S. Umabharathi, S. Kavya Saroja</i>	1
Survey on: Home Automation Systems <i>Pratik Waghmare, Mayur Chandgude, Prafull Chaur, Abhay Chaudhari</i>	7
Attacks and mitigation techniques on mobile ad hoc network- A survey <i>Sagarika Kar Chowdhury, Mainak Sen</i>	11
Performance of CSS Cognitive Radio Networks under Primary User Emulation Attack <i>Rajesh D. Kadu, Dr. Pravin P. Karde, Dr. V. M. Thakare</i>	19
Computational Modelling of Bio signal-based Occupancy Sensing System using Doppler Radar <i>Preethi K Mane, Dr. K Narasimha Rao</i>	25
Flexible capacitive based printed sensor using different dielectrics for real time applications <i>Vithyasaahar Sethumadhavan, Snehal Saraf, Ajit Chaudhari, Ravindra Gaikwad</i>	32
Cost Estimation and Analysis of Computing Models in Education <i>Ms Zaibunnisa Malik, Ms Zainab Delawala, Ms Aarfah Ahmad</i>	37
Ontology Based information extraction from Resume <i>Mhapasekar Darshan Prakash</i>	43
An Improved Digital Watermarking Technique Based on 5-DWT,FFT & SVD <i>Ninny Mittal, Anand Singh Bisen, Rohit Gupta</i>	48
Design of Error Normalized LMS Adaptive filter for EEG signal with Eye Blink & PLI Artefacts <i>N.Sruthi Sudha, Rama Kotireddy Dodda</i>	54
FPGA Reconfiguration using UART and SPI Flash <i>Pranav S Mutha , Yogita M Vaidya</i>	59
Advanced Standard Encryption (AES) implementation on FPGA with hardware in loop <i>Sheetal U. Jonwal, Pratibha P. Shingare</i>	64

Optimized Driver Safety through Driver Fatigue Detection Methods <i>Omar Wathiq , Bhavna D. Ambudkar</i>	68
Single Band Planar Monopole Antenna with A-shaped EBG <i>Shridhar Desai , Nilesh B. Nagrale , Mahesh Kadam</i>	74
Easy Village <i>Aswini C, Jithin K C, Hasna A, Arun S, Dharanya K M, Nitha T M</i>	78
Modelling and Simulation of Photovoltaic Module for Micro inverter Application <i>Manthan Patel, Hinal Surati, Jay Patel</i>	82
Electrical energy audit in a Uka Tarsadia University – A case study <i>Urmil Desai , jaynesh patel, jay patel, ankur rana, darshan patel</i>	86
Efficient Algorithm and Study of QoS-Aware Mobile Ad Hoc Network Methods <i>Aparna Junnarkar, A.B. Bagwan</i>	90
Microstrip Patch Antennas for Wireless Communication: A Review <i>Mandar P. Joshi, Vitthal J. Gond</i>	96
Load Balancing in Cloud Computing: Methodological Survey on different types of algorithm <i>Jaimeel Shah, Dr Sharnil Pandya, Dr Narayan Joshi, Dr Ketan Kotecha, Dr D.B.Choksi</i>	100
Cognitive Examination for the Early Diagnosis of Alzheimer’s Disease <i>Sandeep C S, Sukesh Kumar A, Susanth M J</i>	108
Enhancement of Security by using Greedy Approach and Encryption in Mobile Ad Hoc Network <i>Abhishek Agrawal, Abhilash Sonker</i>	113
Design and Implementation of SRAM Macro Unit <i>Surya Narayan Panda, Somanath Padhi, Vedula Phanindra, Umakanta Nanda Sushant Kumar Pattnaik, Debasish Nayak</i>	119
A Comparative Analysis of Feature Selection Stability Measures <i>Mohana Chelvan P, Perumal K</i>	124
Comparative Analysis of Different Approaches to Solve The Job Assignment Problem <i>Mohit Manoj Vinchoo, Rugved Vivek Deolekar</i>	129
Wireless Power Transfer System for Biomedical Application: A Review <i>D.B.Ahire, Dr. Vitthal J.Gond</i>	135

Design of auto-performance optimization tool for Diesel engine <i>Abhishek Kumar, Anjay Prasad, Vishal Halale, Bipin Hingu, Kowsalya M</i>	141
Detecting Movements and Predicting the Future Path of a Moving Object in Wireless Sensor Network <i>sonal M Gupta, Sachin Deshpande</i>	146
Intelligent Knowledge Sharing for Agricultural Information <i>Chetana J. Kolte, Avinash Shrivias</i>	153
Multiple Image watermarking using LWT, DCT and Arnold transformation <i>Chandan Preet, Rajesh Kumar Aggarwal</i>	158
Eye-Writer Using Real Time Operating System <i>Abhijeet P. Desai, Sanjna S. Repal</i>	163
Trust based Mobile Ad-hoc Networks <i>Sonam Choubey, Krishna Kumar Joshi</i>	166
Improved Routing Security using Intrusion Detection System in Mobile Ad Hoc Network <i>Hemlata Kaurav, Krishna Kumar Joshi</i>	172
Standards Elimination Parser using Natural Language Processing <i>Chaitanya Lele, Himanshu Telkikar, Sumod Shinde, Rugved Vivek Deolekar</i>	177
Analysis of Diseases in Fruits using Image Processing Techniques <i>Kawaljit kaur, Chetan Marwaha</i>	183
Wireless Sensor Network for Real Time Monitoring and Controlling of Railway Accidents <i>Apurva Potdar, Sagar Shinde, Pooja Nikam, Monika Kurumkar</i>	190
Recognition Of Cursive English Handwritten Characters <i>Pritam Dhande,</i> <i>Reena Kharat</i>	199
A new neural network based algorithm for identifying handwritten mathematical equations <i>Sagar shinde, R. B. Waghulade, D. S. Bormane</i>	204
Efficiency Analysis of Quadratic Buck Converter for LED Lamp Driver Applications <i>Ravindranath Tagore Yadlapalli, Anuradha Kotapati</i>	210
Mathematical modeling of bevel gear for gate valve application <i>Avishkar Ramchandra Bhoskar, Sanjay D. Yadav</i>	

Designing and Analysis of an Efficient and Accurate Approach for Image Segmentation	220
<i>Arpit Kushwah, Manish Dixit</i>	
Achievements and Perspectives of GaN based Light Emitting Diodes: A Critical Review	224
<i>Shameem Ahmad, Mohd Adil Raushan, M.J. Siddiqui</i>	
GaAs based charge plasma transistor for parameters performance enhancement	230
<i>Pooja Rani, Shweta Meena</i>	
Estimation of Crowd Density by Counting Objects	235
<i>Charul Singh, Mandar Sohani</i>	
Analysis of multilayered SAW based gas sensor	239
<i>Akriti Gupta, Pradeep Kumar, Sujata Pandey</i>	
Rectifier performance affected by time delays improves with fuzzy preview control	243
<i>Gundavarapu V Nagesh Kumar, Kavirayani Srikanth</i>	
Forecasting Air Quality Index using Regression Models: A Case Study on Delhi and Houston	248
<i>Sankar Ganesh S, Sri Harsha Modali, Soumith Reddy Palreddy, Arulmozhivarman P</i>	
Novel symmetric and asymmetric topology of multilevel inverter with reduced number of switches	255
<i>Kelam Bala Muralidhar Reddy, Swapnajit Pattnaik</i>	
An approach for Analysis and Identification of Raga of Flute Music using Spectrogram	261
<i>Anoop M N, Deepak T S, Shreekanth T</i>	
Energy Efficient Hierarchical Routing Protocols and Simulation Environment for Wireless Sensor Networks	267
<i>Praveen Singh Rawat, Vishal Kumar</i>	
An Energy Optimized Path Selection and Dynamic cluster head selection for Wireless Mesh Network	272
<i>Bhawna Gangwar, J.D. Bhosale, Neha Gangwar</i>	
A survey on Location Management in LTE network	278
<i>Abantika Choudhury, Abhijit Sharma, Uma Bhattacharya</i>	

Design and Study of Waveguide using HFSS–High Frequency Structural Simulator	284
<i>Naga Sai Sharath Saindla, Arun Kumar Yellola, Samya Sabavath, Neelan Kumar Uppari, Mudasar Basha</i>	
Initial analysis of brain EEG signal for mental state detection of human being	287
<i>Nisha Vishnupant Kimmatkar, B. Vijaya Babu</i>	
Efficient Implementation of GLCM based Texture Feature Computation using CUDA Platform	296
<i>Asad Parvez, Anuradha C. Phadke</i>	
Mimicking Voice Recognition Using MFCC–GMM Framework	301
<i>Unnikrishnan V M, Rajeev Rajan</i>	
Identifying Design Patterns for Risk Management System using Big Data Analytics	305
<i>D Kannan , B. Dojohnn Loyd</i>	
Implementation of a Real Time Communication System for Deaf People Using Internet Of Things	313
<i>Piyush Patil, Jayesh Prajapat</i>	
Environment Sniffing Smart Portable Assistive Device For Visually Impaired Individuals	317
<i>Piyush Patil, Akshay Sonawane</i>	
Smart IoT Based System For Vehicle Noise And Pollution Monitoring	322
<i>Piyush Patil</i>	
Providing Smart Agricultural Solutions/Techniques By Using Iot Based Toolkit	327
<i>Piyush Patil, Vivek Sachapara</i>	
Enhanced System For Selfish Node Revival Based On Watchdog Mechanism	332
<i>Afsal Meeran, Praveen A.N, Ratheesh T.K</i>	
Forecasting Air Quality Index based on Mamdani fuzzy inference system	338
<i>Sankar Ganesh S, N Bhargav Reddy, Arulmozhivarman P</i>	
An Optimal Color Image Edge Detection Approach	342
<i>Dibya Jyoti Bora</i>	
High Spatial Resolution Hyperspectral Image using Fusion Technique	348
<i>Suchitha K, Premananda B.S., Arvind Kumar Singh</i>	

Bliss Bot for Pharmaceutical Inspection	354
<i>G. Rohith Reddy, D. Rushali, T. Sai Jahnavi, B. Anil Kumar</i>	
A Novel Secure Authentication Approach for Wireless Communication using Chaotic Maps	360
<i>B. Madhuravani, DSR Murthy</i>	
Impact of ERB and Bark scales on Perceptual Distortion based Near-end Speech Enhancement	364
<i>Nikhil G.V, Keerthi A.M, Premananda B.S</i>	
Design of Multiband antenna with U shaped strip and L shaped strips for WLAN / Bluetooth / WiMAX/HYPERLAN Applications.	371
<i>P.N.Tajane &amp; P.L.Zade</i>	
Healthcare Monitoring System using IoT	374
<i>Swaleha Shaikh, Vidya Chitre</i>	
Full duplex Millimeter-Wave Radio-Over- Fiber System using Optical Heterodyning and Self-Homodyning	378
<i>Joseph Zacharias, Anju Krishnan R, Josy Joy, Saritha Elizabeth, Vijayakumar Narayanan</i>	
Data Security Using SVD Based Digital Watermarking Technique	382
<i>Alifa D'Silva, Nayana Shenvi</i>	
Authenticating Messages in Wireless Sensor Networks	387
<i>Jeba Sangeetha Nadar, Jayashri Mittal</i>	
Advanced Material Synthesis and its Characterization Towards Applications of Organic Electronics	393
<i>Sreemoyee Chatterjee, Suprovab Mandal</i>	
Synthesis of a Perylene-Diimide Derivative: Small Organic Molecule and Its Characterization towards Organic Electronics Application	400
<i>Sreemoyee Chatterjee, Suprovab Mandal</i>	
FPGA Implementation of Mouse Interface	407
<i>V.Pravalika, P.Bhavya Reddy, G.John, B.Anil Kumar, K.Madhava Rao</i>	
Design of Semi-orthogonal Wavelet for Human Ear Recognition	413
<i>Sakshi, Manish Kr. Saini, J.S. Saini</i>	
Low Leakage Write-Enhanced Robust 1T1SRAM Cell with Fully Half-Select-Free Operation	419
<i>Sayed Ahmad, Naushad Alam, Mohd. Hasan</i>	



A Novel Stream Cipher using Pseudo Random Binary Sequence Generator for Medical Image Encryption	425
<i>P.Vidhya Saraswathi,M.Venkatesulu</i>	
A review on Energy Efficient Data Centric Routing Protocol for WSN	
<i>Agrawal Ashish, Ankita Desai,</i>	430
<i>Achyut Sakadasariya</i>	
Automatic Dialect Recognition Using Feature Fusion	435
<i>Sreeraj V V, Rajeev Rajan</i>	
Multi-Modal Biometric Security with Multi-Algorithm	440
<i>Fathima N, Smitha Satheesh</i>	
Preventing Shoulder Surfing Attack Using Touch Screen Based PIN Authentication Method in Invisible Form	444
<i>Siddhesh Vaidya, Sayali Kadam, Varsha Bhosale</i>	
Development Of a Modular and Optimum Multisensor Integration Platform for Navigation	450
<i>S.Sajithra Varun, R.Nagaraj</i>	
Comparison of L, LC & LCL filter for grid connected converter	455
<i>Utsav P. Yagnik, Mehul D. Solanki</i>	
Classical Review of Frequency Response Analysis of Transformer	459
<i>Yagnik V. Ajudiya</i>	
A Novel Seven Segment Digital Clock Implementation On FPGA	
<i>Nikhil Kumar Vuthuri, Vijaya Mahewar, Gowtham yeddluri,</i>	465
<i>Eshwar sai Movva, Vandana.ch</i>	
FPGA based Traffic Light Controller	
<i>S. Venkata Kishore, Vasavi Sreeja, Vibhuti Gupta, V.Videesha, I. B. K. Raju, K. Madhava Rao</i>	469
Automated Secern Robot	476
<i>P. Santosh Reddy, Ch. Praveena Kumari, Ch. Sai Supraja, K. Prabhakara Rao</i>	
Energy Conservation through Energy Audit	481
<i>Vivek Jadhav, Rushikesh Jadhav, Pramod Magar, Sandip Kharat, S. U. Bagwan</i>	
An Efficient & Effective Feature Subset Selection for High Dimensional Data	486
<i>Swapnil Ramesh Kumbhar, Siddheshwar Vilas Patil</i>	
Pearson Correlation Coefficient Analysis (PCCA) on Adenoma Carcinoma Cancer	492
<i>Mujahid Adnan KR, Chandrasegar Thirumalai</i>	

Analysis of Global Warming in India over Maximum Temperature using Pearson and Machine Learning	496
<i>Chandrasegar Thirumalai, Gajavelli Saikrishna, C Suprabath Raju, Senthilkumar M</i>	
Implementation of Image Fusion Based on Wavelet Domain using FPGA	500
<i>Manasa Pemmaraju, Sai Chand Mashetty, Srinivas Aruva, Mohanshankar Saduvelly, Bharat Babu Edara</i>	
Voice controlled Humanoid Robot with artificial vision	505
<i>U Bharath Sai, K Sivanagamani, B Satish, M Ranga Rao</i>	
Design and Implementation of Smart Solar LED Street Light	509
<i>Viraj Bhosale, Maheshkumar Bhairi, Manohar Edake, Bhaskar Madgundi Shubhangi Kangle</i>	
Performance of Branch Predictors of a CPU	513
<i>Atul Oak, R.D. Daruwala</i>	
An approach of Knowledge representation with dhAtu-roop using Paninian framework of Sanskrit Grammar	
<i>Bhavin Panchal, Vishvajit Bakrola, Dipak Dabhi</i>	
Detection of Leukemia and its Types using Image Processing and Machine Learning	522
<i>Preeti Jagadev, H.G. Virani</i>	
Species Recognition Using Audio Processing Algorithm	527
<i>Rahulkumar P. Tivarekar, Hassanali G. Virani</i>	
A Novel Study on Color Image Denoising and Comparison of Various State-of-the-art Methods	533
<i>Sidheswar Routray, Arun Kumar Ray, Chandrabhanu Mishra</i>	
Study of Back-Propagation and Self Organizing Maps for Robotic Motion Control: A Survey	537
<i>Sonali B. Wankhede</i>	
Study and Implementation of IOT based Smart Healthcare System	541
<i>Naina Gupta, Hera Saeed, Sanjana Jha, Manisha Chahande, Sujata Pandey</i>	
Implementation of Re-encryption Based Security Mechanism to Authenticate Shared Access in Cloud Computing	547
<i>Neha Mahakalkar, Vaishali Sahare</i>	

Traffic Information Verification Techniques in VANET: A Review <i>Bhumika Patel, Fenil Khatiwala, Vijay Reshamwala</i>	551
Mitigating Techniques of Black Hole Attack in MANET: A Review <i>Monika Mistry, Purvi Tandel, Vijay Reshamwala</i>	554
TURBO Coded OFDM Performance analysis For Digital Video Broadcasting <i>G.Rajeswara Rao, G.Sasibhushan Rao</i>	558
An Improved Digital Watermarking Technique Based on 5-DWT,FFT & SVD <i>Ninny Mittal, Anand Singh Bisen, Rohit Gupta</i>	561
An Improved Image Steganography based on 2-DWT-FFT-SVD on YCBCR Color Space <i>Sunil Kumar Yadav, Manish Dixit</i>	567
Search for Secure Data Transmission in MANET : A Review <i>Tosha Naik, Fenil Khatiwala, Achyut Sakadasariya</i>	573
AODV modification to address link breakage issue : A Review <i>Yashi Choksi, Purvi Tandel, Trushna Khatri</i>	576
Normalization Using Improvised K-Means Applied in Diagnosing Thyroid Disease with ANN <i>Kunal Mahurkar, D. P. Gaikwad</i>	579
An Efficient Channel Selection based on Task Classification <i>A.Karthika</i>	584
Design of Y shape gas carburetor for homogeneous mixture <i>Prashant Anil Rokade, Sanjay D. Yadav</i>	
Novel ABC Based Training Algorithm for Ovarian Cancer Detection Using Neural Network <i>Aditya Singh, Divya Kumar</i>	594
Smart Energy Meter Using Arduino and GSM <i>Sneha Chaudhari, Purvang Rathod, Ashfaq Shaikh, Darshan Vora, Jignesha Ahir</i>	598
Design of Split Ring Resonator Embedded Metamaterial Monopole Antenna for Short Range Communication <i>Dalfiah,J, Dabu Karuppasamy</i>	602
Design & development of IVN(In vehicle network) proto concept for vehicle parameter monitoring & control <i>Mayur A Bhosekar, V.V.Khatavkar</i>	607

Intrusion Detection System using Hybrid Fuzzy Genetic Algorithm <i>Sumalatha Potteti, Namita Parati</i>	613
A New Algorithm Combining Substitution and Transposition Cipher Techniques for Secure Communication <i>Umang Bhargava, Aparna Sharma, Raghav Chawla, Prateek Thakral</i>	619
Implementation of Unimodal to Multimodal Biometric Feature Level Fusion of Combining Face Iris and Ear in Multi-Modal Biometric System <i>Shradha D.Jamdar, Yogesh Golhar</i>	625
Color Image Dual Watermarking using DCT and DWT Combine Approach <i>Dimple Bansal, Manish Mathuria</i>	630
Analysis of GSM Air interface using DVB-T Receiver and GNU Radio <i>Kinjal Aggrawal, Mansi Kamani, Khyati Vachhani</i>	635
Arduino based Smart Electronic Voting Machine <i>V. Kiruthika Priya, V. Vimaladevi, B. Pandimeenal, T. Dhivya</i>	641
Hydroponics Farming <i>Rahul Nalwade, Tushar Mote</i>	645
Detection of Object in Motion Using Improvised Background Subtraction Algorithm <i>Prerna Dewan, Rakesh Kumar</i>	651
An Improved Linux Firewall Using a Hybrid Frame of Netfilter <i>Nivedita, Rakesh Kumar</i>	657
Performance Analysis of Energy Efficient Algorithm for MIMO Based CRN with Antenna Selection and Maximal Ratio Combining <i>Ashwani Singh, Hariharan S</i>	663
Process Design Kits for RF Analog & Mixed Signal Design Methodologies enabling Silicon Success <i>Mayank Chakraverty, Krishna Arla Prabhu, Harisankar PS</i>	669
Improving Replication Results through Directory Server Data Replication <i>Raksha Patil, Madhuri Zawar</i>	677
Survey on Design challenges and Analysis of service Architecture of DRM <i>T.S.Srinivas, V.B.Narasimha, M.E.Puroshothammam</i>	682
Analysis of Scheduler Settings on the Performance of Multi-core Processors <i>Sunita Dhotre, Suhas Patil, Pooja Patil, Rucha Jamale</i>	687

Temperature and Heart Beat Monitoring System Using IOT <i>G. Vijay Kumar, A.Bharadwaja, N.Nikhil Sai</i>	692
Parallelization of Graph Labeling Problem in Multicore using OpenMP <i>R.Muthuselvi, M.Muneeswari, K.Sudha, V.Vasantha</i>	696
Evolution and Prediction of Radical Multi-Dimensional E-Learning System with Cluster based Data Mining Techniques <i>N.V. Krishna Rao, N Mangathayaru, M. Sreenivasa Rao</i>	701
Experimental Studies on Realization of Underwater Optical Communication Link <i>Amardeep Kumar, Ramavath prasad Naik, U. Shripathi acharya</i>	708
Intelligent Security Lock <i>Varad Pandit, Prathamesh Majgaonkar, Pratik Meher, Shashank Sapaliga, Sachin Bojewar</i>	713
Implementation of Devanagri Character Recognition System Through Pattern Recognition Techniques <i>Snehal R. Pachpande, Anagha N. Chaudhari</i>	717
Backbone-Based Interflow Network Coding and Compression in VANETs <i>Glymalakshmy G, Latha R Nair</i>	723
Crime Identification using FP-Growth and Multi Objective Particle Swarm Optimization <i>Shivangee Agrawal, Vikas Sejwar</i>	727
Parallel Decision Tree with Map Reduce Model for Big Data Analytics <i>Arati Koli, Swati Shinde</i>	735
Modelling of a GaAs based Infrared LED with high efficiency and minimal computation time <i>Joyjit Chatterjee</i>	740
Automatic Plant Monitoring System <i>K. Krishna Kishore, M. H. Sai Kumar, M. B. S. Murthy</i>	744
Design and Analysis for Improving Reliability and Accuracy of Big-Data based Peripheral Control through IoT <i>M. Sandhya Rani, B Geeta Vani</i>	749
Facial Expression Controlled Robot <i>A. Sri Yasaswini, B.Akshitha, R Sai Suchitra, M Ranga Rao</i>	754

EEG Signal Artifact Removal Using ORICA Algorithm <i>Deepak Bansal, R.K. Sharma</i>	758
DWT based Epileptic Seizure Detection from EEG signal using k-NN classifier <i>Harender, R.K. Sharma</i>	762
Visual Quality Restoration & Enhancement of Underwater Images Using HSV Filter Analysis <i>Shailendra Kumar Dewangan</i>	766
Mapping of terms between Healthcare Providers and Patients <i>Judah Benhur Varma, K. Deeba</i>	773
Implementation Of Biometric Smart Card Using Multi Biometrics <i>R.Tamezheneal, S.Sumathi</i>	777
Classification and Detection of Ovarian Cysts in Ultrasound Images <i>G Vasavi, S.Jyothi</i>	783
Low-pass Filtering in CSD space and Sparsity based Denoising <i>Haritha G, Manju Manuel</i>	788
Design of Highly Nonlinear Photonic Crystal Fiber for Supercontinuum Generation <i>Neethu S Thankan, Joyce George</i>	793
Blur type inconsistency based image tampering detection <i>Amrutha S, Manju Manuel</i>	798
Reconfigurable Digital FIR Filter Bank for Hearing Aids Using Minimax Algorithm <i>Reshma A S, Manju Manuel</i>	803
On an Effort to Enhance Lifetime of A Regression based Clustered Network using Candidate Selection <i>K Lakshmi Joshitha, A Gangasri</i>	809
Design of a Low-voltage Low Power Dynamic Latch Comparator for A 1.2-V 0.4-mW CT Delta Sigma Modulator With 41-dBm SNDR <i>Tuhinansu Pradhan, Amit Bakshi</i>	815
FPGA Implementation of Min-Sum Algorithm for LDPC Decoder <i>Sreemohan P V, Nelsa Sebastian</i>	821
Strengthening Password Security through Honeyword and HoneyEncryption Technique <i>Vasundhara R.Pagar, Rohini G.Pise</i>	827

Comparative analysis of various Channel Estimations under different Modulation Schemes	832
<i>Indu Chandran, M.Raju, K.Ashoka Reddy</i>	
Design and Implementation of FIR Filter with modified Product Accumulation Block using Booth Multiplier	838
<i>Nisha Chaudhary, Shewta Meena</i>	
T- shape Microstrip Patch Antenna for WiMAX Applications	
<i>G.Krishna Reddy, Vikram S. Kamadal, D.Punniamoorthy, G. Venu Gopal, K. Poornachary</i>	842
Bankruptcy Prediction Model Using Random Forest	
<i>Rachana Ramesh, Shreya Joshi, Shagufta Tahsildar</i>	
Automatic ration material dispensing system using GSM and RFID technology	852
<i>Aishwarya M, Ananya K Nayaka, Chandana B S, Divyashree N, Padmashree S</i>	
Dielectric Pocket Ge-source Double Gate Junctionless MOSFET with improved OFF- Current and Subthreshold Characteristics	857
<i>Neelam Kumari, Shweta Meena</i>	
Detection of Heart Conditions using HRV Processor in MATLAB Simulink	861
<i>Anshul Malik, R.K. Sharma</i>	
Study of R Peaks using HRV Processor in MATLAB Simulink	865
<i>Himanshu Chhabra, R.K. Sharma</i>	
Cost Aware Test Suite Reduction Algorithm for Regression Testing	869
<i>C.P.Indumathi, S.Madhumathi</i>	
Dynamic Load Balancing Strategy in Software-Defined Networking	875
<i>Saket Bhelekar, Mrdrika Iyer, Gargee Mehta, Sheetal Chaudhari</i>	
Face Recognition and Detection using Neural Networks	879
<i>Vinita Bhandiwad, Bhanu Tekwani</i>	
Transformation of SQL system to NoSQL system and performing Data Analytics using SVM	883
<i>Sanket Ghule, Ramkrishna Vadali</i>	
Solar PV based resonant inverter for induction cooker	888
<i>Farheen Naaz Ansari, K Subramanian</i>	
FPGA Implementation of Encoder and Decoder for Golay Code	892
<i>Allan Jose, Sujithamol S</i>	

A Robust Technique for Splicing Detection in Tampered Blurred Images <i>Ambili B, Nimmy George</i>	897
Fixed Latency Serial Transceiver with Single Bit Error Correction on FPGA <i>Aiswarya A.S, Anu George</i>	902
Automatic Recognition of Facial Expression Using Features of Salient Patches with SVM And ANN classifier <i>Varanya P V, Anu George</i>	908
Smart Luggage <i>P. Sai Vamsi, V. Madhava Sarma, S.V.Y.S. Samraj, S.R. Deepika, N. Neha, K. Prabhakara Rao</i>	914
Opportunistic Subcarrier Allocation scheme for FFR-aided LTE networks <i>K.Srinivasa Rao, N.Roopu Vathi</i>	919
Design and Implementation of different types of Full adders in ALU and leakage minimization <i>Sushant Kumar Pattnaik, Umakanta nanda, Debasish Nayak, Soumya R.Mohapatra, Aditya B. Nayak, Anwesha Mallick</i>	924
Feature Selection Based Intrusion Detection System Using the Combination of DBSCAN, K-Mean++ and SMO algorithms <i>Vandana Shakya , Rajni Ranjan Singh Makwana</i>	928
A Survey: On Data Deduplication for Efficiently Utilizing Cloud Storage for Big Data Backups <i>Anand Bhalerao, Ambika Pawar</i>	933
Implementation on an approach for Mining of Datasets using APRIORI Hybrid Algorithm <i>Kajal R. Thakre, RanjanaShende</i>	939
A Model for Forecasting Dengue Disease Using Genetic based Weighted FP-Growth <i>Vandana Rajput, Amit Manjhvar</i>	944
A Compact Four Element UWB MIMO Antenna <i>P Naveen Kumar Reddy, S Anuradha</i>	949
Random Dopant Induced Threshold Voltage Variation Analysis of Asymmetric Spacer FinFETs <i>Navdeep Gehlawat, Gaurav Saini</i>	953



An Assessment Framework of SIAM/ARAI Fuel Efficiency using Semi-Supervised and Similarity Methods	957
<i>Chandrasegar Thirumalai, Kolisetty Sidhardha, Kalyan Kumar D, Devireddy Vinod Kumar Reddy</i>	
Study of Self-Heating Effects on Fully Depleted SOI MOSFETs with BOX layer Engineering	962
<i>Sudhanshu kumar pandey , Gaurav saini</i>	
Simulation Study of Permanent Magnet Synchronous Generator (PMSG) connected to Variable speed Wind Energy Conversion System (WECS)	966
<i>Anjana Jain, Shashwat Trivedi, Paras Sharma, Shyam Gopal Reddy, R. Chaitanya, Dr. Shankar. S</i>	
IOT based wearable biomedical monitoring system	971
<i>Supriya Kale, Satendra Mane, Pravin Patil</i>	
Online User Behavior: A Decade's Perspective	977
<i>Dhanashree Deshpande, Shrinivas Deshpande</i>	
Impact of Modifiable and Non-Modifiable Risk Factors on the Prediction of Stroke Disease	985
<i>Priya Govindarajan, Ravichandran KS, Sundararajan S, Sreeja S</i>	
Performance Evaluation of Different Routing Protocols For 802.11b and 802.11n	990
<i>Prerana Dhanaraj Mahajan, Shraddha Panbude</i>	
Prediction of Diabetes Disease using Control Chart and Cost Optimization-Based Decision	996
<i>Chandrasegar Thirumalai, K Vamsi Krishna, G V SaiSharan, Kota Jayadev Senapathi</i>	
Calculating the User-item Similarity using Pearson's and Cosine Correlation	1000
<i>Dharaneeshwaran N, Srinivasan A, Nithya S, Senthilkumar M</i>	
Detection of Colorectal Carcinoma Cell using Cantilever based MEMS Bio-Sensor	1005
<i>Syed.shameem, P.S.srinivas babu</i>	
FPGA Implementation of Image Enhancement Technique for Automatic Vehicles Number Plate Detection	1010
<i>Rahul Shandilya, RK Sharma</i>	
Low Power Positive-Edge Triggered D-type flip-flop	1018
<i>Rahul Shandilya, RK Sharma</i>	

Dynamic Analysis of Luo Converter With All Parasitics <i>Deepa.K, MD.Fayaz Baig, P.Mohith, A.V. Abhinav</i>	1024
Real Time Detection and Reporting of Vehicle Collision <i>Parag Parmar, Ashok Sapkal</i>	1029
Sigma Delta Analog to Digital Converter: Design and Implementation with reduction in Power Consumption <i>Neha Gandhi, Sushma Shelke</i>	1035
Implementation of One Cycle Control for a Stand Alone System <i>V. Sailaja, K. Deepa, Aniket Sahare, E. Pranaynath Reddy, G. Krishna Sai Reddy</i>	1040
Examination of Sea-Surface Temperature, Salinity and Water Level Predicted by Coastal Ocean Models utilizing Box-Plot Method <i>Chandrasegar Thirumalai, L. Alice Auxilia, K. Sowmiya, E. Kavitha</i>	1044
Far Field Prediction of a PCB Using Simulation and Validation <i>Gokarna Patil,Pratibha Shingare, Rajesh H, Sunil Dandge, R S Mahajan</i>	1048
Data analysis using Box and Whisker plot for Functional Point <i>Divagar K, Deepchandar E, Kavin K, Kumaran U</i>	
Prediction of Benign and Malignant Tumor <i>Kriti Sharma, Apoorva Rani, Brahimini Muktha, Chandrasegar T</i>	1057
Design and Analysis of Meanderline PIFA Antenna with MIMO System for Mobile Handheld Device <i>Jayendra Rahul Toro, Yogesh Kumar Choukiker</i>	1061
An Experimental Investigations on Classifiers for Brain Computer Interface (BCI) based Authentication <i>E.Grace Mary Kanaga, Muthu Kumaran, M.Hema, R.Gowri Manohari, Tina Anu Thomas</i>	1066
Data analysis using Box and Whisker plot for Stationary shop analysis <i>Vignesh V, Dinakaran K, Pavithra D, Chandrasegar Thirumalai</i>	1072
Analyzing Complexity Nature Inspired optimization Algorithms using Halstead Metrics <i>Madhan M, Anbuarasan T, Dhivakar I, Chandrasegar Thirumalai</i>	1077
Data analysis using Box plot and Control Chart for Air Quality <i>Praveen V, Delhi Narendran T, Pavithran R, Chandrasegar Thirumalai</i>	1082
Analyzing User Knowledge by Pearson and Spearman Method <i>P Yuvaraj, R Anirudh, Sharmila J, Chandrasegar Thirumalai</i>	1086

Analysis of Age, Astigmatic and Tear Protection Rate in Contact Lenses Selection	1090
<i>Jagadish D, Vasanth Kumar J, Kumaran U, Chandrasegar Thirumalai</i>	
Remote sensing HSI Classification and estimation of mimetite mineral spectral signatures from ISRO,India	1095
<i>Shanti Swamy, S.M.Asutkar, G.M.Asutkar</i>	
Bare-Metal Agent Architecture for Target Communication Framework	1100
Shashanka Navada, Arun M, Srimukhee Balasubramanian	
SFCW Ground Penetrating Radar for soil profile measurement simulation mode user interface	1106
<i>Poonam Prabhakar Dive, Anil Kulkarni, Rama Rao, Ajay Khandare, Shraddha Panbude</i>	
Software Complexity Analysis Using Halstead Metrics	1109
<i>Hariprasad T, Seenu K, Vidhyagarani G, Chandrasegar Thirumalai</i>	
Heuristic Prediction of Rainfall Using Machine Learning Techniques	1114
<i>Chandrasegar Thirumalai, M Lakshmi Deepak, K Sri Harsha , K Chaitanya Krishna</i>	
Calculating the Heart Disease in Switzerland using Pearson's Correlation	1118
<i>Kalyanasundaram R, Tamizhselvan BR, Ajay Prasanth, Kumaran U</i>	
Evaluation of McCabe's Cyclomatic Complexity Metrics for Secured Medical Image	1122
<i>V Shanthi, G Krishna Chaithanya, Jeevana P, Chandrasegar Thirumalai</i>	
Analyzing the Linked List complexity using Correlation methods	1127
<i>K Sravani, D Pavithra, S Dhanya, Chandrasegar Thirumalai</i>	
Nature Inspired Algorithm	1131
<i>Ajay Adithyan T, Gururaj B, Vasudha Sharma, Chandrasegar Thirumalai</i>	
Relation Classification from Unstructured Medical Text using Feature Based Machine Learning Approach	1135
<i>Saumaya Gupta, Amit Kumar Manjhvar</i>	
Analysis on Diabetes Patients Using Pearson, Cost Optimization, Control Chart	1139
<i>Poovarasan R, Yuvashree K, Keerthi S, Chandrasegar Thirumalai, IEEE Member</i>	
Quantitative Performance Analysis of Face Recognition System	1143
<i>S.Srilatha, A.R.Pallavi, R.Uma, Srinivas Koppu</i>	

Analysis of LOC attributes using code analyzer and Correlation methods <i>Ganguri Srilatha, Pathi Sreshtha, R Madhumathi, Chandrasegar Thirumalai</i>	1147
Analyzing Correlation Coefficient using Software Metrics <i>Ujera, Sudha R, Ragavi V, Chandrasegar Thirumalai</i>	1151
Application of High Utility mining for Pattern Prediction <i>SHASHIKALA KAKARADDI (PATIL) , Sachin Bojewar</i>	1154
Digital Image Compression Hybrid Technique based on Block Truncation coding and Discrete Cosine Transform <i>Nehal Markandeya, Sonali Patil</i>	1159
Improved Rendezvous Nodes based LEACH using Multiplexing of Sensed Data <i>Isha Mahajan, Sanjeev Mahajan, R.C Gangwar</i>	1163
easy Connect(eC) <i>Anusha Chare, Krutika Dhakate, Neeraj Joshi, Arun M, Hariharasudhan V</i>	1169
A DETAILED STUDY ON MACHINE LEARNING TECHNIQUES FOR DATA MINING <i>Sivaramakrishnan R Guruvayur, Suchithra R</i>	1175

# ***Feature Selection Based Intrusion Detection System Using the Combination of DBSCAN, K-Mean++ and SMO algorithms***

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**Abstract**—IDS is the main concern of the security which is useful to prevent the attack at host and network level. In this propose work, classification of KDD intrusion dataset is proposed along with noise reduction, clustering and feature selection. DBSCAN algorithm has been applied to reduce noise present in KDD dataset. After noise removal genetic search approach is utilized to pick relevant feature. K-Means++ clustering method is utilized to cluster the dataset and resultant dataset is tested by SMO based classifier. A confirmation of concept prototype has been implemented to examine the performance of proposed approach using WEKA and MATLAB data mining tools. It is observed that proposed methods gives 96.922% accuracy. A comparative analysis performed between proposed methods and KMSVM (Simple K-mean with SVM classification) and it is observed that proposed method gives better results.

**Keywords**—IDS; KDD99cup; FS; DBSCAN; K Mean++; SMO.

## **I. INTRODUCTION**

The usage of web augmented altogether the fields. Because the usage of web is increasing in our way of life, the network (n/w) security is turning into necessary in sequence to get security, integrity and confidentiality of a resource. Together with the firewalls, IDS has become a main element of the protection system. The position of IDS is to lure the hacker's presence at the network. Because the large range of incidents is growing in our day by day existence IDS's used with improved techniques. IDS plays important role to secure the n/w and its main object is to look at the n/w activities mechanically to identify the malicious attacks. IDS are turning into serious component to secure the n/w in today's world. By exploiting data mining (DM) in IDS will higher the DR, managing the warning False Alarm (FA) rate and reduce FP rate. IDS deals and identifies with n/w resources and malicious n/w of computer. In sequence to detection information target IDS has been categorized as into 2 groups:

### **A. Host -based IDS(HIDS)**

HIDS's planned to observe, response and monitor to movement and attacks on that host.

### **B. Network-based IDS(NIDS)**

NIDS's capture n/w traffic for their IDS operation [1].

## **II. DATASET DESCRIPTION**

KDD'99 cup datasets is utilized for intrusion detection metrics. This data set represented by 41 features. It constitutes 4,940,000 data. Each TCP connection was labeled as "attack" or "normal" with a specific attack kind; the extent of all connection record is 100 bytes. Simulated attack kinds fall in a next four groups[2]:

**A. DOS:** In this form of attack, the memory useful resource or computing turns into too full or too busy to control denies valid, or valid requests customers get admission to to a device.

**B. U2R:** Attacker achive to a usual customer account on the computer system and is capable to utilize certain vulnerability to increase root access to the system.

**C. R2L:** It arises when an attacker who has the ability to transmit packets for machine above a n/w but who doesn't have an account on which machine exploits certain vulnerability to increase local access as a customer of which machine.

**D. PROBE Attack:** It's effort to collect info about a computers n/w for the apparent purpose of avoiding its security controls. Attacks could be classified depend on the mixture of these 41 features.

## **III. FEATURE SELECTION**

Real time intrusion detection isn't possible as a significance of abundantly of data continuing upon the web. Feature selection (FS) can aid to remove the specific computation besides replica complexity [3]. FS is really a method of selecting a

subset associated with of relevant features thru eliminating many needless and repetitive features from [4] the data for making effective Learning models. Procedure for Feature Selection: FS procedures require four basic stages in a simple FS approach illustrate in diagram 1.

1. Production process in sequence to produce the upcoming applicant subset
2. Estimation function to it can estimate the subset
3. Ending criteria to make a decision when to end.
4. Acceptance process utilized for validates the subset [5].

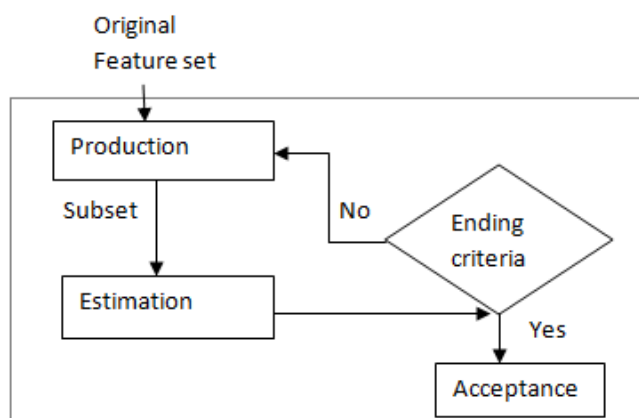


Fig.1 Basic FS algorithm

#### Input (I/P):

KS - Knowledge sample  $f$  with attribute  $F$ ,  $|F| = x$

M - Estimation to be highest

GO – successor production Output:

Result – (weighted) feature set

I: = initial position (F);

Result: = {consistent with M};

#### Repeat

I: = Search technique (I, GO (M), F);

$F' := \{ \text{consistent with M} \}$ ;

If  $M(F') = M$  (resolution) or  $(M(F') = M \text{ (resolution) and } |F'| < |\text{resolution}|)$  then

Solution:  $= F'$ ;

Until Stop (M, I).

The filter manner utilizes the selective principles for FS. The correlation statistical or coefficient test as f-test or t-test is exploited to filter in the filter FS approach [6].

#### IV. DENSITY-BASED SPATIAL CLUSTERING OF APPLICATION WITH NOISE (DBSCAN)

It locates region of maximum density from one another. This algorithm can be utilized to identify clusters of any shape in data containing noise and outliers. Identified clusters will be removed further.

Density = No of points in a particular radius.

Core point = If a point has greater than a particular no. of points within density. Core points are points inside of a cluster.

Border point = This point has less than core points in given density, but it is the nearest of a core point.

Noise point = Noise point is a point which is neither Core point nor Border point

Two or more core points are place within same cluster if they are adjacent within a distance of one another. Any border point that is adjacent enough to a core point is place within cluster as the core point. Noise points are rejected.

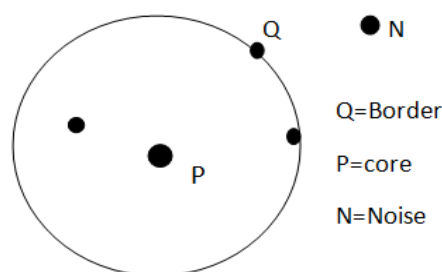


Fig.2 DBSCAN Concept

#### V. K- MEANS ++

K-Mean++ is associate algorithmic program for choosing the preliminary values for the K-Mean clustering. K-Mean problematic associate approach of evading the often unhealthy cluster found via the quality K-Mean algorithmic program. Although find a definite result to K-Mean problem for directional I/P unit NP-hard[8], the quality technique to find classified approximate result (often called Lloyd's algorithmic program for K-Mean) is used broadly speaking and regularly discover affordable results.

Following are the two theoretical drawback of K-Mean algorithm are:

- Primary, it's been conferred that the period of time of worst case of the algorithmic rule is super polynomial within the size of I/P.
- Second, the approximation initiate are often every which way unhealthy concerning the target operate equated to the best cluster.

The K-Mean++ algorithmic rule address ensuring obstacles via specifying a method to initialize the cluster center earlier continuing with the standard K-Mean optimization iteration. With the k-means++ data formatting,

the algorithmic rule is assured to observe outcome that's O (log k) competitive to the optimum k-means outcome [7].

## VI. SEQUENTIAL MINIMAL OPTIMIZATION (SMO)

The problem of Quadratic programming (QP) difficulty which arrives through SVM training is removed in SMO classification algorithm. SMO is a repeated algorithm for illuminating the optimization obscurity defined above. SMO halts this issue into an order of least feasible sub-issue that are then determination consistently. Owing to the linear fairness constraint comprising the Lagrange multipliers  $\alpha_1$ , the least feasible problematic includes 2 such multipliers  $\alpha_2$  and  $\alpha_1$  and. Then, for any 2 multipliers and the constraints are reducing to and this reduces issue is answered analytically: One necessity to discovery a least of a one-dimensional quadratic function.

$$0 \leq \alpha_1, \alpha_2 \leq C,$$

$$y_1 \alpha_1 + y_2 \alpha_2 = k$$

$K$  is the negative of the summation over the rest of time in the similarity constraint that is fixed in every repetition.

Following are the main steps of SMO algorithm:

- Locate a Lagrange multiplier that breach the Karush–Kuhn–Tucker  $\alpha_1$  (KKT) conditions for the optimization difficulty.
- Select a 2nd multiplier  $\alpha_2$  and optimize the pair off  $r(\alpha_1, \alpha_2)$ .
- Replicate steps (a) and (b) until meeting.

When everyone Lagrange multipliers convince the KKT situations, the difficulty has been resolved. Though this algorithmic rule is convinced to meet, heuristics are used to elect the couple of multipliers so as to increase the convergence rate. This is risky for huge data sets due to there are of  $n(n-1)$  feasible selections for  $\alpha_i$  and  $\alpha_j$ .

## VII. LITERATURE SURVEY

Saad Mohamed Ali Mohamed Gadal, Rania A. Mokhtar (2017) define a hybrid machine learning approach for NIDS arrangement of K-means clustering followed by SMO classifier. It proposes hybrid technique that capable to decrease the FP alarm rate, FN alarm rate, to better the DR and identify zero-day attackers. The classification has been done by SMO classifier. Next testing and training the define hybrid machine learning method, the outcome have illustrate which define method (K-mean followed by SMO) has attain the FA rate to (1.2%), positive DR of (94.48%) and attain accuracy of (97.3695%)[8].

Angela Denise Landress (2016) The define study will utilize a set of artificial intelligence machine learning approach to decline the measure of FP in ABID records. This technique collects clustering utilizing the K-means algorithm, FS which utilize the J48 Decision Tree algorithm, and self-establishing

maps to efficiently diminish FP used by KDD CUP 99 data set [9].

Hatim Mohamad Tahir et. al (2016) The intention of this research is to enhanced the existing ABID technique utilizing K-Means clustering process as to increase the DR and accuracy rate whereas decreasing FA. The trouble with outliers may interrupt the K-Means clustering procedure as it might be avoided in the clustering process from mixing with the normal data that make the NIDSs become less accurate. Thus this research aims to better the process of the ABID systems that balance the loss of information or ignored data in clustering. An integrated machine learning technique using K-Means Clustering with discretization method and Naive Bayes Classifier (KMC-D+NBC) is proposed against ISCX 2012 assessment of Intrusion Detection Dataset. The result depicts that the define approach method generates better DR i.e. 99.3% and accuracy i.e. 99.5% and decrease the FA to 1.2% with enhanced efficiency of 0.03 seconds time utilize to make this approach [10].

V. Jyothsna, V.V. Rama Prasad (2016) proposed canonical correlation analysis to optimize the features towards detecting the intrusions. The optimal election features simplifies the procedure of FAIS which is utilized in our earlier work article. The research was whole exploiting a data set of benchmark. The outcomes establish and promising to elect optimal attributes of the n/w transactions utilized for training. Moreover the define replica diminished the process complexity and completion time and retains the maximal prediction accuracy [11].

Nutan Farah Haq et. al (2015) In this paper an ensemble IDS system is define via a sequence of machine learning classifiers and a hybrid FS approach. This build a appropriate NSL-KDD train dataset, decrease features into 12 from 41 through the describe hybrid FS method; Building up classification models (Naive Bayes, Bayesian n/w and J48) using training data; Classification of test instances using majority vote and earlier built classification models as base classifier. The FP rate of the define replica is 0.021 with a TP rate of 98.0%. The outcome demonstrates that the proposed ensemble model is a consistent and exceed other classifiers performance [12].

## VIII. PROPOSED WORK

A novel approach has been proposed to increase the classification accuracy of KDD dataset. Proposed approach consists of following four phases shown in the figure 3.

- Noise Reduction
- Feature selection
- Clustering
- Classification

**Noise Reduction:** KDDCUP 99 intrusion detection dataset suffered by redundant data and noise, therefore it is important to remove noise before further processing. DBSCAN method is utilized for noise removal. Here first 1 lakh record of KDD

cup dataset has been supplied to DBSCAN methods for noise removal. 141 records are identified as noise by DBSCAN algorithm.

**Feature selection:** KDDCUP 99 dataset consists of 41 attribute. In which some are relevant and some are irrelevant therefore it is required to remove irrelevant attribute in order to improve classification accuracy. Genetic search technique has been utilized for feature selection work. Here out of 41 features only 13 relevant attributes are selected for further processing, shown in the table 1.

**Clustering:** In this phase K-Mean ++ algorithm has been applied on data set. K-mean++ generate five clusters as an outcome, shown in table 2.

**Classification:** In this phase SMO (Sequential minimal optimization) classification algorithm applied on clustered data which classifies whether intrusion present or not, shown in table 3.

9	Urgent
12	Logged in
14	lroot_shell
23	Count
30	diff_srv_rate
31	srv_diff_host_rate
32	dst_host_count
37	dst_host_srv_diff_host_rate

**Table 2: K-MEAN ++ outcomes**

S.NO	NAME	No of record
1	K1	79233
2	K2	830
4	K3	8
3	K4	230
5	k5	80301

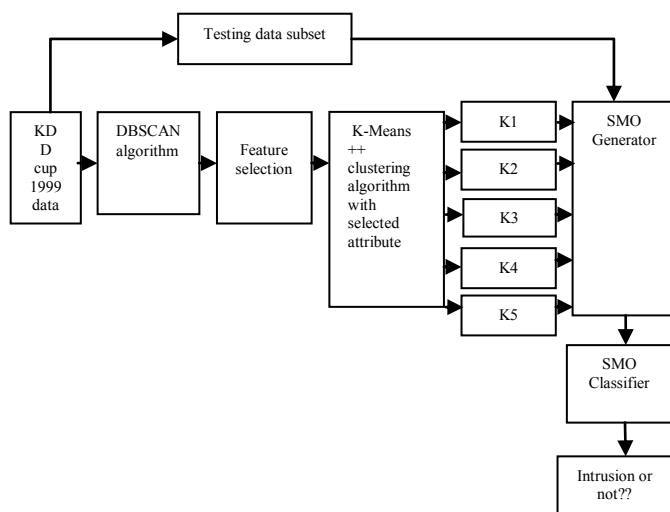


Fig. 3 Block Diagram of Proposed Architecture

## IX. EXPERIMENTAL RESULTS AND ANALYSIS

Experimentation has been carried out using WEKA 3.6.15 and MATLAB R2013b (8.2.0701) data mining tool.

Following table 1 shows the description of selected attribute from the whole attributes in dataset.

**Table 1: selected features**

Attribute No	Attribute Name
2	protocol_type
3	service
5	src_bytes
6	dst_bytes
7	Land

**Table 3: SMO outcomes on clustered data**

Data	Correct categorized instances	Incorrect categorized instances	Kappa statistic	Mean absolute error	Root mean squared error	Relative absolute error	Root relative squared error	Total Number of Instances
K1	99.918 %	0.082 %	0.99 84	0.22 24	0.2724	66.82 5%	66.80 12%	7923 2
K2	96.988 %	3.012 %	0.93 22	0.22 89	0.2842	75.87 6%	73.23 %	830
K3	100%	0%	1	0	0	0%	0%	8
K4	87.826 %	12.173 9%	0.79 53	0.20 75	0.3066	118.4 49%	104.2 58%	230
K5	99.882 %	0.1171 %	0.99 77	0.22 25	0.2726	66.77 7%	66.80 02%	8030 0
Average	96.922 %	3.0768 %	0.94	0.33 13	0.2271	65.57 42%	62.21 78%	3212 0

## X Comparative Analysis

A comparative analysis has been carried out between proposed approach and KMSVM. Here KMSVM is an approach in which features selection, clustering using k-means and SVM classified are utilized for classification. It is observed that (Hybrid approach of feature selection, DBSCAN, K-Mean++clustering and SMO classification) proposed methods generate better result than KMSVM.



**Table 4: Accuracy Outcomes for Reduced Attribute Set:**

S.No	Dataset	KMSVM	Proposed
1	K1	89.44%	99.918 %
2	K2	97.69%	96.988%
3	K3	100.00%	100.00%
4	K4	67.21%	87.826%
5	K5	65.91%	99.882%
Average		84.062%	96.922%



Fig. 4 Accuracy Graph

Fig. 4 is the comparison of Proposed with KMSVM algorithm in terms of accuracy.

## XI. CONCLUSION

Security is the most concerning issue in the modern time. In this report a novel approach is proposed which is a hybrid model of classification and clustering. KDD'99 Cup dataset suffered from noise which is removed by using DBSCAN algorithm than feature selection technique applied to select relevant attribute. Clustering algorithm applied to cluster data set into K1, K2, K3, K4, and K5. At last classification algorithm applied on clustered data to know intrusion happened or not. The overall approach improves the accuracy. It is observed that obtained accuracy is 96.922% which is better than KMSVM.

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