

2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT 2018)

**Bengaluru, India
10-12 July 2018**

Pages 1-789



IEEE Catalog Number: CFP1852J-POD
ISBN: 978-1-5386-4431-7

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IEEE Catalog Number:	CFP1852J-POD
ISBN (Print-On-Demand):	978-1-5386-4431-7
ISBN (Online):	978-1-5386-4430-0

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TABLE OF CONTENTS

DESIGN OF 1.176GHZ MICRO-STRIP PATCH ANTENNA FOR IRNSS APPLICATIONS.....	1
<i>Bhargav Pansuria ; Sandeep Sharma ; Abhishek Rawat</i>	
ENHANCED GATEWAY DEPLOYMENT SCHEME FOR LOAD BALANCING IN HETEROGENEOUS NETWORKS	5
<i>R. Kushwah ; S. Tapaswi ; A. Kumar</i>	
INTERNET GATEWAY SECURE LOCATION INDEPENDENT MOBILE CONNECTIVITY FROM PUBLIC NETWORKS.....	12
<i>Raghu Anantharangachar ; Kapleeswaran Viswanathan ; Jitendra Kumar ; B N Shreedevi ; Sanket Naik ; Vani Narayan</i>	
A LIGHTWEIGHT BIOMETRIC-BASED AUTHENTICATION SCHEME FOR TELECARE MEDICINE INFORMATION SYSTEMS USING ECC.....	21
<i>Shreeya Swagatika Sahoo ; Sujata Mohanty</i>	
SYNTHEZISING AND IMITATING HANDWRITING USING DEEP RECURRENT NEURAL NETWORKS AND MIXTURE DENSITY NETWORKS	27
<i>K. Manoj Kumar ; Harish Kandala ; N. Sudhakar Reddy</i>	
IOT BASED AUTOMATIC ELECTRICITY MONITORING AND REMOTE LOAD CONTROL SYSTEM USING PIC18F4550	33
<i>Md. Jakaria Islam Mozumder ; Surojit Ghosh</i>	
GLOBAL LAND TEMPERATURE PREDICTION BY MACHINE LEARNING COMBO APPROACH	37
<i>Himika ; Shubhdeep Kaur ; Sukhchandan Randhawa</i>	
ENVIRONMENT FRIENDLY FREQUENCY SCALING BASED COUNTER DESIGN.....	45
<i>Tarun Agrawal ; Anjan Kumar ; Juhি Sharma</i>	
AN ENHANCED ALGORITHM FOR VARIABLE REORDERING IN BINARY DECISION DIAGRAMS.....	49
<i>Chaitanya Varma</i>	
LVCMOS BASED 4-BIT REGISTER.....	53
<i>Tarun Agrawal ; Anjan Kumar ; Priyanka ; Pooja Aggarwal ; Syed Saad Tirmizi</i>	
RGB MODEL BASED IMAGE ENHANCEMENT TECHNIQUE FOR STEGANOGRAPHY	56
<i>Advait Gopal Ranade ; Sweta Dargad ; Krupali Mistry</i>	
MORSE CODE DATASETS FOR MACHINE LEARNING	60
<i>Sourya Dey ; Keith M. Chugg ; Peter A. Beerel</i>	
PERFORMANCE EVALUATION OF DUAL HOP DECODE AND FORWARD RELAYING PROTOCOL UNDER GENERALIZED GAMMA FADING CHANNELS	67
<i>Ankush Thakur ; Ajay Singh</i>	
RCDSD: RSA BASED CROSS DOMAIN SECURE DEDUPLICATION ON CLOUD STORAGE.....	71
<i>Shivansh Mishra ; Surjit Singh ; Syed Taqi Ali</i>	
IMPACT OF PRIMARY USERS DUTY CYCLE ON OPTIMUM SECONDARY USERS IN COGNITIVE RADIO SYSTEMS	78
<i>Dipen Bepari ; Pradeep Kumar ; Santosh Kumar Choudhary</i>	
MINIMUM SPANNING TREE IN COGNITIVE RADIO NETWORKS: A DISTRIBUTED APPROACH TO MAINTAIN FOR NODE FAILURES	83
<i>Tsewang Stanzin ; Mahendra Kumar Murmu</i>	
GSWA: A SURVIVABLE DYNAMIC MULTICAST EFFICIENT RWA SCHEME IN WDM MESH NETWORKS.....	89
<i>Smita Paire ; Monish Chatterjee ; Sufia Khanam ; Uma Bhattacharya</i>	
STUDY OF AEROSOL DISTRIBUTION OVER THE POTENTIAL SINK REGION DURING CENTRAL PORTUGAL FOREST FIRE EVENT	95
<i>Arka Ghosh ; Manu Mehta ; Soubhik Biswas</i>	
BANDWIDTH ENHANCEMENT OF DUAL BAND IMPEDANCE TRANSFORMER WITH TRANSMISSION ZERO	102
<i>Kochar Inderkumar ; Pallav Rathore ; Kaustubh Prabhu</i>	
COMPARISON AND SIMULATION OF ANALOG AND DIGITAL PHASE LOCKED LOOP	106
<i>Abhishek Godave ; Pranali Choudhari ; Anita Jadhav</i>	
AUTONOMOUS FARMING AND SURVEILLANCE AGRIBOT IN ADJACENT BOUNDARY	110
<i>Dasari Naga Vinod ; Tripty Singh</i>	

COMBINING COMMON WORDS AND SEMANTIC FEATURES FOR SENTENCE SIMILARITY	117
<i>M. Krishnasiva Prasad ; Poonam Sharma</i>	
IMAGE PROCESSING BASED DETECTION OF COUNTERFEIT INDIAN BANK NOTES	121
<i>Mrutunjay Singh ; Preetam Ozarde ; Konidena Abhiram</i>	
POPULATION BASED STOCHASTIC TECHNIQUE FOR OPTIMUM DESIGN OF OPEN FIELD LAYOUT WITH INTEGRATED SCHEDULING	126
<i>K. Mallikarjuna ; K. Sateesh Babu</i>	
A DIRECT SEQUENCE SPREAD SPECTRUM TRANSCEIVER WITH ENHANCED SECURITY USING CHAOTIC AND GOLD SEQUENCE.....	133
<i>Rahul Gupta ; S. Anuradha</i>	
SERVICE DESIGN METRICS TO PREDICT IT-BASED DRIVERS OF SERVICE ORIENTED ARCHITECTURE ADOPTION	139
<i>Supriya Pulparambil ; Youcef Baghdadi ; Abdullah Al-Hamdani ; Mohammed Al-Badawi</i>	
SMART AND AUTOMATIC HEALTH MONITORING OF PATIENT USING WIRELESS SENSOR NETWORK	146
<i>Asha G Hagargund ; Aman Srivastav ; Chandan Kumar Nayak ; Mausam Kumar Singh</i>	
REAL TIME HEAT EXCHANGER CONTROL USING PREDICTIVE FUNCTIONAL CONTROL	153
<i>Amit Vijay Waghmare ; Surender Kannaiyan</i>	
ENERGY EFFICIENT REAL TIME ENVIRONMENTAL MONITORING SYSTEM USING BUFFER MANAGEMENT PROTOCOL.....	158
<i>R. Maheswar ; P. Jayarajan ; S. Vimalraj ; G. Sivagnanam ; V. Sivasankaran ; Iraj S Amiri</i>	
PERFORMANCE EVALUATION OF FAULT NODES USING QUEUE THRESHOLD BASED ON N-POLICY PRIORITY QUEUEING MODEL	163
<i>P. Jayarajan ; R. Maheswar ; G.R. Kanagachidambaresan ; V. Sivasankaran ; M. Balaji ; Jagannath Das</i>	
1KW HOME INVERTER USING CASCADED CURRENT FED PUSH PULL CONVERTER AND SPWM INVERTER.....	168
<i>Kaushik Kushalappa Naik ; N Venugopal</i>	
NEW HIDDEN POLICY CP-ABE FOR BIG DATA ACCESS CONTROL WITH PRIVACY-PRESERVING POLICY IN CLOUD COMPUTING	173
<i>Sucharita Khuntia ; P. Syam Kumar</i>	
ADMM BASED DISTRIBUTED VOLTERRA MODELING OF NONLINEAR DYNAMICAL SYSTEMS USING AD-HOC WSNS	180
<i>Sachin N. Kapgate ; Saurav Gupta ; Priyanka Priyadarshini Sahoo ; Ajit Kumar Sahoo</i>	
TOWARDS A SECURE SDN ARCHITECTURE	187
<i>Karthik Raghunath ; Prabhakar Krishnan</i>	
THE SIGNIFICANCE OF POWER ELECTRONICS COMPONENTS ON SUSTAINABLE ENERGY SOURCES	194
<i>Deepak Kumar Chy ; Md. Khaliluzzaman</i>	
ANALYSIS OF WEB AUTHENTICATION METHODS USING AMAZON WEB SERVICES.....	201
<i>K. Swedha ; Tanuja Dubey</i>	
A K-FACTOR CPU SCHEDULING ALGORITHM	207
<i>Sumedha Garg ; Deepak Kumar</i>	
DETECTION OF ANOMALOUS BEHAVIOUR IN CROWDS USING NEWTON PRATT'S CURVE FITTING TECHNIQUE	213
<i>K. Shreedarshan ; Praneet Singh ; Rahul Jayanth ; Eshwari Prabhakar ; N.M Mona</i>	
SOLAR FED HYBRID ENERGY STORAGE SYSTEM IN AN ELECTRIC VEHICLE	220
<i>R S Sreelekshmi ; R Anusree ; Visal Raveendran ; Manjula G. Nair</i>	
A NOVEL MPP TRACKER CONTROL FOR A SOLAR FED ENERGY STORAGE SYSTEM IN ELECTRIC VEHICLE	227
<i>Pradeep T Pillai ; R S Sreelekshmi ; Manjula G. Nair</i>	
IMPLEMENTATION OF PUBLIC KEY CRYPTO PROCESSOR WITH PROBABILISTIC ENCRYPTION ON FPGA FOR NODES IN WIRELESS SENSOR NETWORKS	233
<i>G Leelavathi ; K Shaila ; K R Venugopal</i>	
PERFORMANCE EVALUATION OF NONLINEAR SPATIAL FILTERS ON MR IMAGES	239
<i>V.R. Simi ; Damodar Reddy Edla</i>	
AN ANALYSIS OF PATH PLANNING MECHANISMS IN WIRELESS SENSOR NETWORKS	244
<i>Ketan Sabale ; S. Mini</i>	
MOTH FLAME BASED OPTIMIZED PLACEMENT OF RELAY NODES FOR FAULT TOLERANT WIRELESS SENSOR NETWORKS	251
<i>Saunhita Sapre ; S. Mini</i>	

PERFORMANCE ANALYSIS OF MIXER DESIGNS IN GIGA HERTZ RANGE OF OPERATIONS.....	257
<i>T O Athira ; P Rajeswari</i>	
A NOVEL ENERGY EFFICIENT SCHEDULING FOR HIGH PERFORMANCE COMPUTING SYSTEMS	262
<i>Tarun Biswas ; Pratyay Kuila ; Anjan Kumar Ray</i>	
A ROBUST APPROACH FOR GENDER RECOGNITION USING DEEP LEARNING	268
<i>Shefali Arora ; M.P.S Bhatia</i>	
DESIGN OF MULTI-PLL BOARD USING ARM7 CONTROLLER.....	274
<i>Abhishek Godave ; K. Aurobindo ; Pranali Choudhari ; Anita Jadhav</i>	
ANALYSIS OF LOW POWER REDUCTION TECHNIQUES ON CACHE(SRAM) MEMORY	278
<i>Reeya Agrawal ; Vinay Kumar Tomar</i>	
OPTIMIZED LAPLACIAN GENERALIZED CLASSIFIER NEURAL NETWORK.....	285
<i>Shraddha M. Naik ; Ravi Prasad K. Jagannath ; Venkatareshbabu Kuppili</i>	
A NOVEL GRAPH BASED CLUSTERING APPROACH TO DOCUMENT TOPIC MODELING	290
<i>Prateek Chanda ; Asit Kumar Das</i>	
THE ANALYSIS OF DIGITAL MAMMOGRAMS USING HOG AND GLCM FEATURES.....	297
<i>Krishna Chaitanya Tatikonda ; Chandra Mohan Bhuma ; Srinivas Kumar Samayamantula</i>	
DECEIT IDENTIFICATION TEST ON EEG DATA USING DEEP BELIEF NETWORK.....	304
<i>Annushree Bablani ; Damodar Reddy Edla ; Venkatareshbabu Kuppili</i>	
A ROBUST IRIS RECOGNITION APPROACH USING FUZZY EDGE PROCESSING TECHNIQUE.....	310
<i>Onkar Kaudki ; Kishor Bhurchandi</i>	
NOVEL FITNESS FUNCTION FOR SCE ALGORITHM BASED ENERGY EFFICIENCY IN WSN	316
<i>Amruta Lipare ; Damodar Reddy Edla</i>	
HYBRID TECHNIQUE FOR DENOISING MULTI ENVIRONMENT NOISE IN SPEECH PROCESSING	323
<i>K. Kirankumar ; M. Suneel ; P. Surendrakumar</i>	
IMPLEMENTATION AND OPTIMIZATION OF THROUGHPUT IN HIGH SPEED MEMORY INTERFACE USING AXI PROTOCOL	330
<i>C Sarojini ; Jaisingh Thangaraj</i>	
CRICKET SHOT DETECTION FROM VIDEOS.....	335
<i>Archit Semwal ; Durgesh Mishra ; Vineet Raj ; Jayanta Sharma ; Ankush Mittal</i>	
DETECTING EFFICIENT PARKING SPACE USING SMART PARKING.....	341
<i>Ajay Zajam ; Surekha Dholay</i>	
A NOVEL TWO-ELEMENT LINEAR ARRAY FOR DSRC BAND	348
<i>K.S. Kola ; D.G. Patanvari ; S.B. Naik ; M.V. Reddy ; A. Chatterjee</i>	
FPGA AS A RECONFIGURABLE ACCESS POINT IN DENSE WIRELESS LANS USING FDMA-TDMA COMBINATION	353
<i>Anushree Jain</i>	
CO-SALIENCY DETECTION VIA WEAKLY SUPERVISED LEARNING	359
<i>Aditya Kompella ; Raghavendra V. Kulkarni</i>	
AN ADAPTIVE WARP CORRECTION ALGORITHM FOR HANDWRITTEN TEXT IMAGES WITH NON-LINEAR BASELINES	365
<i>Soumyakanti Roy ; Gourab Adhikari ; Tanmoy Dasgupta ; Tapan Pradhan</i>	
A COMPACT SUPER WIDEBAND ANTENNA FOR WIRELESS COMMUNICATIONS.....	372
<i>D. Srikanth ; S. Anuradha</i>	
AN ENERGY-EFFICIENT SCHEDULING FRAMEWORK FOR CLOUD USING LEARNING AUTOMATA	376
<i>Sampa Sahoo ; Bibhudatta Sahoo ; Ashok Kumar Turuk</i>	
A FAST AND ACCURATE MODULE FOR CALCULATING FRACTIONAL ORDER DERIVATIVES AND INTEGRALS IN PYTHON	381
<i>Tamojit Midya ; Debasish Garai ; Tanmoy Dasgupta</i>	
ARCHITECTURE OF PARALLEL CRC ENCODER USING STATE SPACE TRANSFORMATIONS	387
<i>Lekshmi S Prabha ; R S Geethu</i>	
A NOVEL TECHNIQUE FOR UNWARPING CURVED HANDWRITTEN TEXTS USING MATHEMATICAL MORPHOLOGY AND PIECEWISE AFFINE TRANSFORMATION	394
<i>Gourab Adhikari ; Soumyakanti Roy ; Tanmoy Dasgupta ; Tapan Pradhan</i>	
FUZZY BASED CONGESTION-AWARE SECURE (FUCAS) ROUTE SELECTION IN ICN.....	401
<i>P. Vimala Rani ; Nagarathna Ravi ; S. Mercy Shalinie ; P. Parivethan ; K. Rajkumar</i>	

ENSEMBLE CLASSIFIER TO ENHANCE COMPUTER AIDED DIAGNOSIS OF PARKINSON DISEASE.....	408
<i>Harkawalpreet Kaur ; Avleen Kaur Malhi</i>	
MINIMIZING LATENCY DUE TO FLOW TABLE OVERFLOW BY EARLY EVICTION OF FLOW ENTRIES IN SDN	414
<i>M. Khursheed Ali Khan ; Vibhav K. Sah ; Pradhumn Mudgal ; Saumya Hegde</i>	
P300 DETECTION USING ENSEMBLE OF SVM FOR BRAIN-COMPUTER INTERFACE APPLICATION	418
<i>Sourav Kundu ; Samit Ari</i>	
PERFORMANCE IMPROVEMENT FOR MULTI-BAN ROUTING PROTOCOL FOR SOCCER PLAYER MONITORING AND STUDY OF FACTORS CONTRIBUTING TOWARDS EFFICIENCY OF THE PROTOCOL	423
<i>Ankit Milind Waghmare ; Pradnya H Ghare</i>	
STUB-LOADED RESONATORS APPLICATION IN ULTRA COMPACT MULTI-BAND BANDPASS FILTER	429
<i>Vinay Naresh Rahangdale ; Joydeep Sengupta</i>	
HIGH PERFORMANCE CIRCUIT TECHNIQUES FOR NEURAL FRONT-END DESIGN IN 65NM CMOS	432
<i>R. Nagulapalli ; K. Hayatleh ; S. Barker ; S Zourob ; N. Yassine ; B Naresh Kumar Reddy</i>	
OPTIMIZATION OF ROUTING ALGORITHM FOR WBAN USING GENETIC APPROACH	436
<i>Ashwini Umare ; Pradnya Ghare</i>	
SIMPLIFIED SIFT HISTOGRAM OF ORIENTED GRADIENTS BIN LOCATOR ON FPGA	442
<i>E P Rejil Raj ; Bibin Sam Paul ; G Lakshmi Narayanan</i>	
DESIGN OF MAJORITY LOGIC BASED COMPARATOR	446
<i>Kartikeya Dubey ; R Marshal ; G Lakshminarayanan</i>	
IMPLEMENTING CLASSIFICATION ALGORITHMS IN MEDICAL REPORT ANALYSIS FOR HELPING PATIENT DURING UNAVAILABILITY OF MEDICAL EXPERTISE	452
<i>Chandraraj Singh ; Naveen Chegoju ; V R Satpute</i>	
SIFRS: SPOOF INVARIANT FACIAL RECOGNITION SYSTEM (A HELPING HAND FOR VISUAL IMPAIRED PEOPLE)	457
<i>Aditya Dixit ; Vr Satpute</i>	
AUTOMATED TOPIC MODELING AND SENTIMENT ANALYSIS OF TWEETS ON SPARKR	464
<i>Prema Monish ; Santoshi Kumari ; C Narendra Babu</i>	
A TECHNIQUE TO REDUCE THE CAPACITOR SIZE IN TWO STAGE MILLER COMPENSATED OPAMP.....	471
<i>R. Nagulapalli ; K. Hayatleh ; S. Barker ; S Zourob ; N. Yassine ; B. Naresh Kumar Reddy</i>	
ADAPTIVE BEAMFORMING USING ZELINSKI-TSNR MULTICHANNEL POSTFILTER FOR SPEECH ENHANCEMENT	475
<i>S. Siva Priyanka ; T. Kishore Kumar</i>	
MAMMOGRAMS CLASSIFICATION USING MULTIRESOLUTION TRANSFORMS AND CONVOLUTION NEURAL NETWORKS.....	481
<i>G. Prathibha ; B. Chandra Mohan</i>	
REAL-TIME INDIAN SIGN LANGUAGE (ISL) RECOGNITION	488
<i>Kartik Shenoy ; Tejas Dastane ; Varun Rao ; Devendra Vyavaharkar</i>	
VISIBILITY ENHANCEMENT OF FOG DEGRADED IMAGE SEQUENCES ON SAMEER TU DATASET USING DARK CHANNEL STRATEGY	497
<i>Tannistha Pal</i>	
REAL-TIME AQI MONITORING SYSTEM: AN ECONOMICAL APPROACH USING WIRELESS SENSOR NETWORK	503
<i>Mohit S. Rane ; Arjav R. Naik ; Khyati Vachhani</i>	
AN EFFICIENT FUZZY BASED EDGE ESTIMATION FOR IRIS LOCALIZATION AND PUPIL DETECTION IN HUMAN EYE FOR AUTOMATED CATARACT DETECTION SYSTEM.....	509
<i>Aditya Dixit ; Shashwat Pathak ; Rahul Raj ; Ch Naveen ; V.R Satpute</i>	
SUBSTRATE INTEGRATED WAVEGUIDE BASED RECTANGULAR CAVITY RESONATOR FILTER FOR WIFI APPLICATIONS.....	515
<i>C Devika ; K Karthika ; Nikhila Raj ; Ks Swetha ; P Rahul Lal</i>	
FAULT DETECTION IN GEARBOX USING MOTOR ELECTRICAL SIGNATURE ANALYSIS	519
<i>S. Vigneshkumar ; Vignesh K. Shankar ; Prakash N. Krishna ; P. Supriya</i>	
FUZZY LOGIC BASED SMART HOME ENERGY MANAGEMENT SYSTEM.....	525
<i>Prakash N. Krishna ; Suraj R Gupta ; P.V. Shankaranarayanan ; S Sidharth ; M Sirphi</i>	
ENHANCING REPLICA SYNCHRONIZATION IN HADOOP DISTRIBUTED FILE SYSTEM.....	530
<i>Jyoti Kumari ; Tarun Biswas ; Satyanarayana Vuppala</i>	

ANALYSIS OF QUANTUM KEY DISTRIBUTION BASED SATELLITE COMMUNICATION	535
<i>Vishal Sharma ; Subhashish Banerjee</i>	
SECURITY AND PRIVACY DESIGNS BASED DATA ENCRYPTION IN CLOUD STORAGE AND CHALLENGES: A REVIEW	540
<i>Aruna Guruvaya Mogarala ; K. G. Mohan</i>	
EFFICIENT UTILIZATION OF WASTE HEAT TO ELECTRICAL ENERGY FOR REAL-TIME APPLICATIONS	547
<i>Pallavi Korde ; Vijaya Kamble</i>	
DATA DUPLICATE DETECTION	553
<i>Nikita Medidar ; Manik Chavan</i>	
SYMBOLIC REPRESENTATION MODEL FOR OFF-LINE SIGNATURE VERIFICATION	559
<i>Snehal K. Jadhav ; M. K. Chavan</i>	
DETECTING COMPROMISED HIGH-PROFILE ACCOUNTS ON SOCIAL NETWORKS	564
<i>Pooja V. Phad ; M. K. Chavan</i>	
SELECTION VIRTUAL MACHINE IN MOBILE CLOUD COMPUTING	568
<i>Rashid G. Alakbarov ; Oktay R. Alakbarov</i>	
A STANDALONE OPEN HARDWARE SYSTEM FOR ECG DETECTION AND CLASSIFICATION	572
<i>Unnikrishnan S. Nath ; C. R. Arunima ; R. Jaisha ; U. P. Amjad ; Joaquim Ignatious Monteiro</i>	
DESIGN AND IMPLEMENTATION OF SECURE AND ENCODED DATA TRANSMISSION USING TURBO CODES	577
<i>Shivleela Biradar ; Smitha Sasi</i>	
ROADMAP AMID CHAOS: CYBER SECURITY MANAGEMENT FOR ORGANISATIONS	584
<i>Ashutosh Bahuguna ; R. K. Bisht ; Jeetendra Pande</i>	
FEATURE SELECTION USING BINARY PSOGSA AND RADIAL BASIS NETWORK WITH A NOVEL FITNESS FUNCTION	590
<i>Raj B Prudhvi ; Kumar V Sai ; Y Abhishek ; K Venkataanareshbabu</i>	
PERFORMANCE ANALYSIS OF HYBRID COMPANDING PAPR REDUCTION METHOD IN OFDM SYSTEMS FOR 5G COMMUNICATIONS	596
<i>Sravanti Thota ; Yedukondalu Kamatham ; Chandra Sekhar Paidimarry</i>	
MULTICLASS OBJECT RECOGNITION AND CLASSIFICATION USING BOOSTING TECHNIQUE	601
<i>Harpreet Singh ; Dinesh Gupta ; Alok Kumar Singh Kushwaha</i>	
SLOTTED SUBSTRATE MINIATURIZED ULTRA WIDEBAND ANTENNA FOR WBAN APPLICATIONS	607
<i>Srinivas Doddipalli ; Atharva Kulkarni ; Prathamesh Kaole ; Ashwin Kothari</i>	
PERFORMANCE OF FD-CR NETWORK WITH IMPROVED ENERGY DETECTOR AND SI SUPPRESSION	611
<i>Nagesh Gandewar ; Prabhat K. Sharma</i>	
SEDA-SOA: A SCALABLE EVENT-DRIVEN CONTEXT-AWARE SERVICE ORIENTED ARCHITECTURE	615
<i>Majid Ayoubi ; Sadam Ravichandra</i>	
POWER EFFICIENT AND LIGHT WEIGHT APPROACH FOR SECURE MULTICAST TREE CONSTRUCTION IN MANETS	622
<i>Rubal Sagwal ; A. K. Singh</i>	
DESIGNING OF MULTIPLEXER AND DE-MULTIPLEXER USING DIFFERENT ADIABATIC LOGIC IN 90NM TECHNOLOGY	629
<i>Deepak Mittal ; Amit Nirjanan</i>	
A PERFORMANCE STUDY OF RANDOM INTERLEAVER BASED DATA LOSS RECOVERY TECHNIQUE FOR STRUCTURAL HEALTH MONITORING	636
<i>Shubham Kanhere ; Krishna S. Chouthankar ; Sibhali Haste ; V. S. G. Thadikemalla ; A. S. Gandhi</i>	
MAGNETIC INDUCTION COMMUNICATION BASED TRANSCEIVER COIL AND WAVEGUIDE STRUCTURE MODELING FOR NON-CONVENTIONAL WSNS	642
<i>Vivek Pathak ; Vinay Kumar ; Rabindra K. Barik</i>	
A CONTROLLABLE HOME ENVIRONMENT FOR THE PHYSICALLY DISABLED USING THE PRINCIPLES OF BCI	649
<i>K S Suhas ; Shuvankar Dhal ; P Veera Shankar ; Sachin H Hugar ; C Tejas</i>	
SIMULATING PRE-EVACUATION BEHAVIOR IN A VIRTUAL FIRE ENVIRONMENT	654
<i>El Mostafa Bourhim ; Abdelghani Cherkaoui</i>	
AN ADVANCE MOBILITY MANAGEMENT SCHEME IN WIRELESS NETWORK	661
<i>Abhishek Hazra ; Prakash Choudhary ; Oinam Vivek</i>	

MINING NETWORK STREAM DATA FOR SELF LEARNING NETWORKS.....	666
<i>Sunil Angadi ; Radhakrishnan Gopalapillai</i>	
DESIRED TRANSMISSION RATE AND COVERAGE REGION ANALYSIS FOR FREQUENCY-SELECTIVE FADING AMPLIFY-AND-FORWARD MIMO RELAY CHANNEL.....	671
<i>Seyyed Reza Hoseini ; Ashkan Nazemi ; Armin Mehrabian</i>	
PHYSICAL LAYER SECURITY OF OUTDATED CSI BASED CRN	676
<i>Sukannya Chetry ; Ajay Singh</i>	
NEWS POPULARITY PREDICTION WITH ENSEMBLE METHODS OF CLASSIFICATION	681
<i>Aasim Khan ; Gautam Worah ; Mehul Kothari ; Yogesh H Jadhav ; Anant V Nimkar</i>	
TWEETNEWS: LOCATION AND TIME-BASED NEWS.....	687
<i>Rohan Sheth ; Mihir Varatha ; Rohit Nahata ; Sunil Ghane ; Anant V. Nimkar</i>	
ENABLING CONCURRENT CLOCK AND POWER GATING IN 32 BIT ROM.....	693
<i>Harekrishna Kumar ; Anjan Kumar ; Vinay Kumar Deolia</i>	
ENABLING TECHNOLOGIES FOR RANGE ENHANCEMENT OF MI BASED WIRELESS NON-CONVENTIONAL MEDIA COMMUNICATION	699
<i>Akshay Kulkarni ; Vinay Kumar ; Sanjay B. Dhok</i>	
IMPLEMENTING A NEURAL PROCESSOR FOR ACCELERATING DEEP LEARNING.....	706
<i>Sreejith R Warrier ; Senthil Murugan</i>	
HYBRID ARCHITECTURES FOR LARGE-SCALE BLENDED CLASSROOMS: A CASE STUDY	710
<i>R Ajith Kumar ; T Suchith Soman ; Sankaran Narayanan ; Kamal Bijlani</i>	
A PERCEPTUAL FIELD OF VISION, USING IMAGE PROCESSING.....	717
<i>S Pruthvi ; M.S Shama ; Hitesh. V. Harithas ; Sandesh. S. Chiploonkar</i>	
ANALYSIS OF STOCK MARKET BEHAVIOUR BY APPLYING CHAOS THEORY	724
<i>Rishab Sahni</i>	
CROSS-LAYER CLOSENESS CENTRALITY IN MULTIPLEX SOCIAL NETWORKS	728
<i>Ruchi Mittal ; M.P.S Bhatia</i>	
VIRTUAL PROTOTYPING FOR CLEAN INDUSTRIAL PROCESSES	733
<i>El Mostafa Bourhim ; Abdelghani Cherkaoui</i>	
MULTICLASS IFROWNN CLASSIFICATION ALGORITHM USING OVA AND OVO STRATEGY	740
<i>Shital Andhalkar ; B. F. Momin</i>	
ALG-DESIGN: FACILITATES TO LEARN ALGORITHMIC THINKING FOR BEGINNERS	747
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
BUILDING-BLOCKS: GENERATING 3D DESIGN BY SNAPPING BLOCKS.....	753
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
CT-BLOCKS: LEARNING COMPUTATIONAL THINKING BY SNAPPING BLOCKS	759
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
DB-LEARN: STUDYING RELATIONAL ALGEBRA CONCEPTS BY SNAPPING BLOCKS.....	766
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
TEXTURAL FEATURE BASED CLASSIFICATION OF MAMMOGRAM IMAGES USING ANN	772
<i>Ivarani Routray ; Nrusingha Prasad Rath</i>	
DIGITAL STORYTELLING USING SCRATCH: ENGAGING CHILDREN TOWARDS DIGITAL STORYTELLING	778
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
FRACTAL GEOMETRY: ENHANCING COMPUTATIONAL THINKING WITH MIT SCRATCH.....	784
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
CT-BLOCKS ANALYSER: ANALYSING CT-BLOCKS PROJECTS	790
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
MAP-BLOCKS: PLAYING WITH ONLINE DATA AND INFUSE TO THINK IN A COMPUTATIONAL WAY	795
<i>R Vinayakumar ; Kp Soman ; Pradeep Menon</i>	
ADVANCING RECOMMENDER SYSTEMS BY MITIGATING SHILLING ATTACKS.....	801
<i>Aditya Chichani ; Juzer Golwala ; Tejas Gundecha ; Kiran Gawande</i>	
IMAGE STEGANOGRAPHY USING IMPROVED ALGORITHMS TO ENHANCE SECURITY AND PAYLOAD OF TRADITIONAL LSB SUBSTITUTION	806
<i>Jayti Bhagat ; Pragya Gupta ; Neeraj Kohli</i>	
FOG COMPUTING AS A DEFENSIVE APPROACH AGAINST DISTRIBUTED DENIAL OF SERVICE (DDOS): A PROPOSED ARCHITECTURE.....	811
<i>Bhumika Paharia ; Kriti Bhushan</i>	
EFFECTIVE BUSINESS STRATEGY DECISION MAKING METHOD USING FUZZY LOGIC	818
<i>Himadri Shekhar Mondal ; M. Raihan ; Sunanda Roy ; Sabyasachi Mondal</i>	

DDOS DETECTION AND MITIGATION IN CLOUD VIA FOGFITER: A DEFENCE MECHANISM	822
<i>Bhumika Paharia ; Kriti Bhushan</i>	
DESIGN AND COMPARISON OF RECTANGULAR, SQUARE AND HEXAGONAL RF COILS FOR 1.5T MRI SYSTEM.....	829
<i>Niket Ugle ; Tapas K. Bhuiya ; Radhika Dapkar ; D. M. Shinde ; Soumendu Bagchi</i>	
PI V.I.S.I.O.N: PORTABLE INFINITESIMAL VIDEO INPUT SIGNAL PROCESSED INTELLIGENT OBJECT NAMING.....	833
<i>P Diganth ; Manasa K Ankolekar ; B S Neha ; Geetishree Mishra</i>	
COMPARATIVE STUDY OF ROGER AND FR-4 BASED CIRCULARLY POLARIZED MICROSTRIP PATCH ANTENNA WITH INJECTING A SINGLE SET OF SHORTING PINS.....	838
<i>Jayesh B. Patil ; Deepak C. Karia</i>	
GRAPHENE/MOS2BASED RF-NEMS SWITCHES FOR LOW ACTUATION VOLTAGE AND ENHANCED RF-PERFORMANCE.....	844
<i>Aakif Anjum ; Mukesh Madhewar ; Suhas S. Mohite ; Vishram B. Sawant</i>	
TAP BASED USER AUTHENTICATION ON SMARTPHONES FOR VISUALLY IMPAIRED PEOPLE.....	851
<i>Amit Banerjee ; Mahamudul Hasan</i>	
DETECTION AND RECTIFICATION OF DISTORTED FINGERPRINTS USING GEOMETRIC FEATURES AND FFNN.....	858
<i>Anand Vishnu Telore ; Deepa Parashar</i>	
HUMAN FALL DETECTION USING RFID TECHNOLOGY	865
<i>Bharati Kaudki ; Anil Surve</i>	
PREDICTION OF SGEMM GPU KERNEL PERFORMANCE USING SUPERVISED AND UNSUPERVISED MACHINE LEARNING TECHNIQUES	870
<i>Sanket Agrawal ; Akshay Bansal ; Sandeep Rathor</i>	
A WEARABLE POSTURE CORRECTOR DEVICE	877
<i>Krutika Bramhapurikar ; Arohi Prabhune ; Snehal Chavan ; Girish Chandra Ghivela ; Joydeep Sengupta</i>	
A LOW POWER DTMOS BASED MODIFIED CURRENT MIRROR FOR IMPROVED BANDWIDTH USING RESISTIVE COMPENSATION TECHNIQUE	882
<i>Ankit Chaudhary</i>	
SECURE LOG STORAGE USING BLOCKCHAIN AND CLOUD INFRASTRUCTURE	887
<i>Manish Kumar ; Ashish Kumar Singh ; T V Suresh Kumar</i>	
A NOVEL APPROACH FOR INTERNET OF THINGS BASED INTELLIGENT LIGHTING.....	891
<i>Rohan Purekar ; Meera Murali ; Radhika Joshi</i>	
DESIGN OF RPV FOR MEDICAL ASSISTANCE	897
<i>Vangara Vamsi Krishna ; Shivang Shastri ; Shubhra Kulshrestha</i>	
CONSTRUCTING KNOWLEDGE GRAPH BY EXTRACTING CORRELATIONS FROM WIKIPEDIA CORPUS FOR OPTIMIZING WEB INFORMATION RETRIEVAL	904
<i>Anjum Mirza ; Meghana Nagori ; Vivek Kshirsagar</i>	
PATTERN BASED SMART NOTIFICATION IN EDUCATION	911
<i>Arvind Gopal Ghodse ; Vivek Kshirsagar ; Meghana Nagori</i>	
ESTIMATION OF EARTHQUAKE SOURCE PARAMETERS USING MACHINE LEARNING TECHNIQUES.....	917
<i>Gaurav Rajguru ; Y. S. Bhaduria ; S. Mukhopadhyay</i>	
SCENARIO-BASED SIMULATION OF INTELLIGENT DRIVING FUNCTIONS USING NEURAL NETWORKS.....	924
<i>Parampreet Kaur ; Rajeev Sobti</i>	
GENERATING HOMOGRAPH MODELS IN TOPIC MODELING FOR EXPEDITING USER'S MODEL SELECTION.....	929
<i>Diksha Banswal ; Meghana Nagori ; Vivek Kshirsagar</i>	
MATHEMATICAL MODELLING AND SIMULATION OF PHOTOVOLTAIC MODULE USING MATLAB/SIMULINK.....	935
<i>Nupur Yadav ; D.K. Sambariya</i>	
FETCHING RELEVANT IMAGES AND VIDEOS IN KEYWORD BASED SEARCH MECHANISM WITH HYPERGRAPH LEARNING AND SIMILARITY MATCHING	941
<i>Sheetal D Patil ; Vivek Kshirsagar ; Meghana Nagori</i>	
ANALYSIS AND INTEGRATION OF NINE LEVEL CASCADED H-BRIDGE MULTILEVEL INVERTER CONFIGURATION IN A PHOTOVOLTAIC SYSTEM	947
<i>Nupur Yadav ; D.K. Sambariya</i>	

INTEGRATING SENTIMENT ANALYSIS AND USER DESCRIPTORS WITH RATINGS IN SIGHTSEER RECOMMENDER SYSTEM	954
<i>Vaidehi Anil Chaudhari ; Vivek Kshirsagar ; Meghana Nagori</i>	
PARALLEL COMPUTER SIMULATION OF RADIO WAVE PROPAGATION OVER LARGE URBAN AREAS AND IRREGULAR TERRAIN	961
<i>Andrey Chusov ; Alina Protopopova ; Alexey Lysenko</i>	
DESIGN AND EVALUATION OF WIRELESS TRANSCEIVER FOR VISIBLE LIGHT COMMUNICATION	968
<i>Perla Krishna Das ; Joydeep Sengupta</i>	
IMPROVING POWER & LATENCY METRICS FOR HARDWARE TROJAN DETECTION DURING HIGH LEVEL SYNTHESIS	972
<i>R Shathanaa ; N Ramasubramanian</i>	
AN APPROACH TO DEVELOP A SMART AND INTELLIGENT WHEELCHAIR	979
<i>Shridevi Soma ; Nandita Patil ; F Salva ; Vaishnavi Jadhav</i>	
ANALYSIS OF DISPERSION AND NONLINEAR PROPERTY IN DEFECTED CORE SQUARE PHOTONIC CRYSTAL FIBER	986
<i>Md. Rubayet Islam ; S. M. Rakibul Islam ; Mashfique Ahmed ; Fahim Ahmed ; Md. Mostafa Faruk ; Shovasis Kumar Biswas</i>	
CHARACTERIZATION OF A PROTOTYPE VISIBLE LIGHT COMMUNICATION SYSTEM	991
<i>Raghu Donga ; Saugata Sinha</i>	
BOTSCOOP: SCALABLE DETECTION OF DGA BASED BOTNETS USING DNS TRAFFIC	996
<i>Gulbadan Khehra ; Sanjeev Sofat</i>	
MODELLING AND ANALYSIS OF PHOTOVOLTAIC SYSTEM WITH IMPROVED INVERTER TECHNIQUE	1002
<i>Naveen Suman ; D. K. Yadav ; Tejendra Jangid</i>	
SURVEY OF CERVICAL CANCER PREDICTION USING MACHINE LEARNING: A COMPARATIVE APPROACH	1008
<i>Akshitha Shetty ; Vrushika Shah</i>	
MODELING AND ANALYSIS OF LOW VOLTAGE, HIGH ISOLATION CAPACITIVE TYPE RF-MEMS SWITCHES	1014
<i>Vishram B. Sawant ; Mukesh Madhewar ; Aakif Anjum ; Suhas S. Mohite</i>	
TOWARDS STREAM BASED INTRUSION DETECTION SYSTEM	1020
<i>Aakansha Soni ; S. Jaya Nirmala</i>	
ETAS - EFFICIENT TRAFFIC SIGNAL ASSISTANCE SYSTEM USING DEEP LEARNING	1026
<i>Anjana Niranjan ; Geetishree Mishra</i>	
HYBRID MULTIPLIER-BASED OPTIMIZED MAC UNIT	1031
<i>Kavindra Dwivedi ; R.K. Sharma Sharma ; Ajay Chunduri</i>	
LOW OVERHEAD WEIGHTED-GRAF-COLORING-BASED TWO-LAYER PRECODING FOR FDD MASSIVE MIMO SYSTEMS	1035
<i>Abdelrahman A.H. Anis ; Bassant Abdelhamid ; Salwa Elramly</i>	
ACCELERATIVE FACTOR BASED SPIDER MONKEY OPTIMIZATION	1042
<i>B. Bhagwanti ; Harish Sharma ; Nirmala Sharma</i>	
HORIZON, A WEB-BASED USER INTERFACE FOR MANAGING SERVICES IN OPENSTACK: AN INTROSPECTION	1048
<i>Ashish Lingayat ; Avinash Singh ; Vinay Naik ; Ranjana R. Badre ; Anil Kumar Gupta</i>	
A PROPOSED MODEL FOR LIFESTYLE DISEASE PREDICTION USING SUPPORT VECTOR MACHINE	1054
<i>Mrunmayi Patil ; Vivian Brian Lobo ; Pranav Puranik ; Aditi Pawaskar ; Adarsh Pai ; Rupesh Mishra</i>	
SDPM-RSA: AN EFFICIENT P-CYCLE BASED SURVIVABILITY SCHEME FOR MULTICAST SESSIONS IN ELASTIC OPTICAL NETWORKS	1060
<i>Susmita Das ; Joy Halder ; Uma Bhattacharya</i>	
LUNG NODULE CLASSIFICATION USING DEEP CONVNETS ON CT IMAGES	1066
<i>Haritha Sathyan ; J Vinitha Panicker</i>	
VLC BASED INDOOR BLIND NAVIGATION SYSTEM	1071
<i>M. Pravin ; T. V. P. Sundararajan</i>	
DOMAIN CLASSIFICATION OF TEXTUAL CONVERSATION USING MACHINE LEARNING APPROACH	1077
<i>Sandeep Rathor ; R. S. Jadon</i>	
AN OVERVIEW OF VARIOUS TRUST MODELS FOR VANET SECURITY ESTABLISHMENT	1084
<i>S. Sumithra ; R. Vadivel</i>	

IPPLACER: AN EFFICIENT 0-1 INTEGER PROGRAMMING BASED PLACEMENT FOR VLSI CIRCUITS.....	1091
<i>Prasun Datta ; Shyamapada Mukherjee</i>	
AN ALTERNATE ALGORITHMIC APPROACH TO FPGA PLACEMENT.....	1098
<i>S. Mukherjee ; A. Nainwal ; C. C. Das ; S. Purkayastha</i>	
A REAL-TIME SYSTEM FOR ENVIRONMENTAL STUDY BASED ON CLOUD COMPUTING	1104
<i>K Prathibha ; Pawan Hegde</i>	
OPTIMIZING THE PERFORMANCE OF DIGITAL VIDEO BROADCASTING (DVB-T) SYSTEMS USING 4G TECHNOLOGIES.....	1110
<i>Ravilla Dilli</i>	
PERFORMANCE ANALYSIS OF LOOK UP PROTOCOL FOR VANET INFORMATION RETRIEVAL SERVICES.....	1120
<i>Ravilla Dilli</i>	
HIGH SPEED MOST SIGNIFICANT BIT FIRST TRUNCATED MULTIPLIER.....	1130
<i>Charitha Chinta ; Raghvendra B. Deshmukh</i>	
CLOUD-BASED REAL TIME DATA ACQUISITION IN IOT ENVIRONMENT FOR POST DISASTER MANAGEMENT	1134
<i>Meghavi Choksi ; Mukesh A Zaveri ; J Sathish Kumar ; Saurabh K Pandey</i>	
AN OPTIMIZED DESIGN STRATEGY AND A PARADIGM FOR LOW POWER IOT DEVICES	1140
<i>Ammu Lakshmy Rajesh ; Rajendra Patrkar</i>	
AN OVERVIEW OF SMART CONTRACT AND USE CASES IN BLOCKCHAIN TECHNOLOGY	1147
<i>Bhabendu Kumar Mohanta ; Soumyashree S Panda ; Debasish Jena</i>	
SPECTRUM SENSING OF MULTI-PATH FADING CHANNELS FOR COGNITIVE RADIO APPLICATION	1151
<i>Bandi Akhil Kumar Reddy ; Ashwin Kothari</i>	
SMARTCRAWLER: A PERSONALIZED WEB SEARCH FOR RELEVANT WEB PAGES	1154
<i>Arati Anilrao Wardekar ; Poonam Gupta</i>	
SPEECH ENHANCEMENT FOR SPEAKER IDENTIFICATION.....	1158
<i>R Mahesh</i>	
SENSOR DATA ANALYSIS USING MOVING AVERAGE FILTER AND 256-POINT FFT FOR WIRELESS SENSOR NETWORKS	1162
<i>Mayur Chauhan ; Pratik Thorwe ; Monodeep J. Mukherjee ; Y. Srinivas Rao</i>	
ENHANCED SECURITY FOR MILITARY GRID REFERENCE SYSTEM USING VISUAL CRYPTOGRAPHY	1169
<i>Sandhya Anne Thomas ; Saylee Gharje</i>	
A FINE GRAIN ATTRIBUTE ENABLED ACCESS CONTROL.....	1176
<i>Sayali Sudhir Bhusare ; Alwyn Roshan Pais</i>	
ULTRAHIGH BIREFRINGENCE AND HIGHLY NONLINEAR SQUARE PHOTONIC CRYSTAL FIBER FOR S+C+L+U WAVEBANDS.....	1183
<i>Fahim Ahmed ; Probir Kumar ; Md. Abdul Hakim ; Md. Sabuj Miah ; Abdullah Al Noman ; Shovasis Kumar Biswas</i>	
A HYBRID DEEP LEARNING ARCHITECTURE FOR PARAPHRASE IDENTIFICATION	1187
<i>Divesh R. Kubal ; Anant V. Nimkar</i>	
HIGHLY NONLINEAR DISPERSION COMPENSATING SQUARE PHOTONIC CRYSTAL FIBER: DESIGN AND ANALYSIS.....	1193
<i>Fahim Ahmed ; Probir Kumar ; Eshrat Jahan Esha ; Asma Islam ; Md. Tawhid Islam Opu ; Shovasis Kumar Biswas</i>	
IMPLEMENTATION AND ANALYSIS OF SINGLE PRECISION FLOATING POINT MULTIPLICATION USING VEDIC AND CANONIC SIGNED DIGIT ALGORITHM	1197
<i>K V Gowreesrinivas ; P. Samundiswary</i>	
A NOBLE DEAD-END FREE THREE-DIMENSIONAL ROUTING AND SCHEDULING TECHNIQUES FOR MULTI-HOP WIRELESS NETWORKS	1201
<i>Afruza Begum ; Md Anwar Hussain ; S Md S Askari</i>	
EVALUATING SHALLOW AND DEEP NEURAL NETWORKS FOR NETWORK INTRUSION DETECTION SYSTEMS IN CYBER SECURITY	1207
<i>Vigneswaran K Rahul ; R Vinayakumar ; Kp Soman ; Prabaharan Poornachandran</i>	
AUTOMATED DETECTION OF BRAIN TUMOR CELLS USING SUPPORT VECTOR MACHINE	1213
<i>Geetanjali Birare ; V. A Chakkarwar</i>	
ADAPTIVE INTELLIGENCE FOR MASSIVE ONLINE OPEN COURSE	1217
<i>Karun Thankachan</i>	

BREAST CANCER PREDICTION USING GENETIC ALGORITHM BASED ENSEMBLE APPROACH	1224
<i>Pragya Chauhan ; Amit Swami</i>	
HYINT: SIGNATURE-ANOMALY INTRUSION DETECTION SYSTEM.....	1232
<i>Roshan Kumar ; Deepak Sharma</i>	
OUTAGE ANALYSIS OF SELECTION COMBINING BASED HYBRID WIRELESS PLC SYSTEM.....	1239
<i>Neelima Agrawal ; Prabhat Kumar Sharma</i>	
A HYBRID APPROACH OF DEEP LEARNING WITH COGNITIVE PARTICLE SWARM OPTIMIZATION FOR THE BIG DATA ANALYTICS.....	1244
<i>Sandeepkumar Hegde ; Monica R Mundada</i>	
ANALYSIS OF CACHE(SRAM) MEMORY FOR CORE I™ 7 PROCESSOR.....	1249
<i>Reeya Agrawal ; V. K. Tomar</i>	
A COMPARATIVE STUDY AND ANALYSIS OF CONTRAST ENHANCEMENT ALGORITHMS FOR MRI BRAIN IMAGE SEQUENCES	1257
<i>Kavitha Srinivasan ; Nanditha Muthu</i>	
A MACHINE LEARNING PIPELINE TO OPTIMALLY UTILIZE LIMITED SAMPLES IN PREDICTIVE MODELING.....	1264
<i>Manar D. Samad ; Megan A. Witherow</i>	
BLOG RESPONSE VOLUME PREDICTION USING ADAPTIVE NEURO FUZZY INFERENCE SYSTEM.....	1269
<i>Harsurinder Kaur ; Husanbir Singh Pannu</i>	
THE RELEVANCE OF CONTAINER MONITORING TOWARDS CONTAINER INTELLIGENCE	1275
<i>R. Madhumathi</i>	
LOWER BODY PASSIVE EXOSKELETON USING CONTROL ENABLED TWO WAY RATCHET	1280
<i>Prabhakar Naik ; Jayant Unde ; Bhushan Darekar ; S. S. Ohol</i>	
AN IMPROVED THREE-LAYER CLUSTERING HIERARCHY FOR WIRELESS SENSOR NETWORKS: A PROPOSED FRAMEWORK.....	1286
<i>Sai Krishna Meghana Yendamuri ; Aditi Singh ; Pemeena Priyadarsini M Jasmine</i>	
PRIMORDIAL FINGERPRINTING TECHNIQUES FROM THE PERSPECTIVE OF DIGITAL FORENSIC REQUIREMENTS	1292
<i>Patil Rachana Yogesh ; Satish R. Devane</i>	
DESIGN AND IMPLEMENTATION OF POWER OPTIMIZED DUAL CORE AND SINGLE CORE DLX PROCESSOR ON FPGA	1298
<i>Sujoy Pandit ; Prateek Sikka</i>	
COMPARATIVE STUDY OF THE DETECTION OF MALICIOUS URLs USING SHALLOW AND DEEP NETWORKS	1303
<i>Anu Vazhayil ; R Vinayakumar ; Kp Soman</i>	
DESIGN OF SIGNAL ANALYSIS TECHNIQUES FOR DETERMINING THE PARAMETERS RESPONSIBLE FOR PLASMA DISRUPTIONS IN ADITYA TOKAMAK	1309
<i>B. Sheela Rani Pi ; N.M. Nandhitha Ci ; G. Yogalakshmi ; Rakesh L. Tanna Pc ; Joydeep Ghosh Pc</i>	
PERFORMANCE EVALUATION AND FEATURE VECTOR EXTRACTION OF REVIEW DATA SETS USING EVOLUTIONARY BASED SVM TECHNIQUES.....	1316
<i>Rajalaxmi Hegde ; S Seema</i>	
AN PERFORMANCE ANALYSIS OF RSA SCHEME USING ARTIFICIAL NEURAL NETWORK.....	1320
<i>Monmita Chakraborty ; Bappaditya Jana ; Tamoghna Mandal ; Malay Kule</i>	
EMBEDDED ASSISTIVE STICK FOR VISUALLY IMPAIRED PERSONS.....	1325
<i>Himanshu Sharma ; Meenakshi Tripathi ; Amit Kumar ; Manoj Singh Gaur</i>	
PREDICTION OF POTATO LATE BLIGHT DISEASE BASED UPON WEATHER PARAMETERS USING ARTIFICIAL NEURAL NETWORK APPROACH.....	1331
<i>Priyanka Sharma ; B.K. Singh ; R.P. Singh</i>	
AUDIT CLOUD: ENSURING DATA INTEGRITY FOR MOBILE DEVICES IN CLOUD STORAGE.....	1344
<i>L Krithikashree ; S. Manisha ; M Sujithra</i>	
A META-ANALYSIS OF CONTRAST MEASURES USED FOR THE PERFORMANCE EVALUATION OF HISTOGRAM EQUALIZATION BASED IMAGE ENHANCEMENT TECHNIQUES.....	1349
<i>B N Anoop ; P E Ameenudeen ; Justine Joseph</i>	
ASPECT BASED EMOTION ANALYSIS ON ONLINE USER-GENERATED REVIEWS.....	1355
<i>Swapnil Bhagaji Padme ; Pallavi V. Kulkarni</i>	

AN ENERGY EFFICIENT VIRTUAL-MIMO COMMUNICATION FOR CLUSTER BASED COOPERATIVE WIRELESS SENSOR NETWORK.....	1360
<i>Akash Sachan ; Shivangi Nigam ; Abhishek Bajpai</i>	
PAPR REDUCTION IN LTE UPLINK COMMUNICATIONS BY AIRY COMPANDING TRANSFORM	1366
<i>K. Shri Ramtej ; S. Anuradha</i>	
A NOVEL CONTROL SCHEME FOR A STANDALONE SOLAR PV SYSTEM EMPLOYING A MULTIPORT DC-DC CONVERTER.....	1371
<i>Dibyajay Krishna Behera ; I Anand ; B. Malakonda Reddy ; S. Senthilkumar</i>	
MULTI-LINGUAL INFORMATION RETRIEVAL USING DEEP LEARNING.....	1377
<i>Sonam Sanjogkumar Dodal ; Pallavi V. Kulkarni</i>	
SYNTHETIC TO REAL WORLD IMAGE TRANSLATION USING GENERATIVE ADVERSARIAL NETWORKS.....	1383
<i>Sreedhar Radhakrishnan ; C.-C Jay Kuo</i>	
RESOLVING THREATS IN IOT: ID SPOOFING TO DDOS.....	1389
<i>Abhishek Mishra ; Abhishek Dixit</i>	
A NOVEL OPTIMIZATION APPROACH FOR TRANSMITTER SEMI-ANGLE AND MULTIPLE TRANSMITTER CONFIGURATIONS IN INDOOR VISIBLE LIGHT COMMUNICATION LINKS.....	1396
<i>Karan Saxena ; Rishu Raj ; Abhishek Dixit</i>	
MPOWS: MERGED PROOF OF OWNERSHIP AND STORAGE FOR BLOCK LEVEL DEDUPLICATION IN CLOUD STORAGE	1403
<i>Shivansh Mishra ; Surjit Singh ; Syed Taqi Ali</i>	
HYBRID APPROACH FOR SHORT TERM WIND POWER FORECASTING.....	1410
<i>Vasanth Reddy ; Samidha Mridul Verma ; Kusum Verma ; Rajesh Kumar</i>	
COMMON DATA MODEL FOR HEALTHCARE DATA	1415
<i>Umair M. Khan ; Huzaifa Kothari ; Aditya Kuchekar ; Reeta Koshy</i>	
HIGH-LAYER DESIGN OF MULTIPLE CRITERIA RELAY SELECTION SCHEME IN WIRELESS RELAY-BASED NETWORKS.....	1420
<i>Seyyed Reza Hoseini ; Ashkan Nazemi ; Armin Mehrabian ; Fatemeh Alizadeh</i>	
BER ANALYSIS OF MASSIVE MIMO SYSTEMS UNDER CORRELATED RAYLEIGH FADING CHANNEL.....	1426
<i>Supraja Eduru ; Nakkeeran Rangaswamy</i>	
POPULATION ESTIMATION USING VEHICLE COUNT	1431
<i>Ayush Nagal ; Bhanu Parasher ; Ankush Mittal</i>	
IMAGE FUSION USING CONVOLUTIONAL NEURAL NETWORK WITH BILATERAL FILTERING.....	1436
<i>P. Mathiyalagan ; N Suvitha</i>	
A SYSTEMATIC APPROACH TO CUSTOMER SEGMENTATION AND BUYER TARGETING FOR PROFIT MAXIMIZATION.....	1446
<i>Kalyani Bhade ; Vedanti Gulalkari ; Nidhi Harwani ; Sudhir N. Dhage</i>	
MODELING TECHNIQUES FOR DRIVER'S LANE CHANGING BEHAVIOUR.....	1452
<i>Disha Bhatt ; Shilpa Gite</i>	
ANDROID BASED AMERICAN SIGN LANGUAGE RECOGNITION SYSTEM WITH SKIN SEGMENTATION AND SVM.....	1459
<i>Sakshi Lahoti ; Shaily Kayal ; Sakshi Kumbhare ; Ishani Suradkar ; Vikul Pawar</i>	
NETWORK INTRUSION DETECTION USING CLUSTERING AND GRADIENT BOOSTING	1465
<i>Parag Verma ; Shayan Anwar ; Shadab Khan ; Sunil B Mane</i>	
TARGET CLASSIFICATION AND TRACKING USING SYMBOLIC DYNAMIC FILTERING	1472
<i>N Sindhu ; Soumya Empran ; M Uttarakumari ; Sujatha D Badiger</i>	
A MASK REGIONAL CONVOLUTIONAL NEURAL NETWORK MODEL FOR SEGMENTING REAL TIME TRAFFIC IMAGES.....	1478
<i>Vishakha Lall ; Chitransh Gaurav ; Rishabh Khanna ; Waheed Nangigadda ; Satyasai Jagannath Nanda</i>	
JOTR: JOIN-OPTIMISTIC TRIPLE REORDERING APPROACH FOR SPARQL QUERY OPTIMIZATION ON BIG RDF DATA	1484
<i>Tanvi Chawla ; Girdhari Singh ; Emmanuel S. Pilli</i>	
A WIDEBAND TRIPLE U-SLOT MICROSTRIP ANTENNA FOR INDOOR WIRELESS APPLICATIONS	1491
<i>Jyotibhusan Padhi ; Madhulita Mohapatra ; Muktikanta Dash</i>	
A NOVEL DATA-DRIVEN DSSE METHOD TO ACHIEVE WATER SUSTAINABILITY FOR FARMERS IN MADURAI DISTRICT, INDIA.....	1496
<i>Rajesh Harinarayan Rajasekaran ; Mercy Shalinie Selvaraj ; Jay Ramanathan</i>	

APPLICATION OF COLORIMETRY TO DETERMINE SOIL FERTILITY THROUGH NAIVE BAYES CLASSIFICATION ALGORITHM	1503
<i>Surili Agarwal ; Neha Bhangale ; Kameya Dhanure ; Shreeya Gavhane ; V.A. Chakkarwar ; M.B. Nagori</i>	
PROTOCOL SPECIFIC MULTI-THREADED NETWORK INTRUSION DETECTION SYSTEM (PM-NIDS) FOR DOS/DDOS ATTACK DETECTION IN CLOUD	1509
<i>Rajendra Patil ; Harsha Dudeja ; Snehal Gawade ; Chirag Modi</i>	
A CPW-FED MONOPOLE ANTENNA WITH U-SLOTS FOR TRIPLE BAND APPLICATION	1516
<i>Srinath Singh ; G. Ujjwal ; Mohd. Hashmath ; Sulakshana Chilukuri</i>	
HANDWRITTEN BANGLA DIGIT RECOGNITION USING CHEMICAL REACTION OPTIMIZATION	1522
<i>Pritam Khan Boni ; Bappy Shahriar Abir ; H.M. Mehedi Hasan ; Md. Rafiqul Islam</i>	
A MULTIBAND SLOT ANTENNA FOR WIRELESS COMMUNICATION APPLICATIONS	1529
<i>Sai Sampreeth Indharapu ; M B Abhishikth ; Sulakshana Chilukuri</i>	
DETECTING AND ASSUAGING AGAINST INTEREST FLOODING ATTACK USING STATISTICAL HYPOTHESIS TESTING IN NEXT GENERATION ICN	1534
<i>P. Vimala Rani ; Nagarathna Ravi ; S. Mercy Shalinie ; P. Pariventhan ; K. Rajkumar</i>	
A PRIVACY PRESERVING IMPROVISED APPROACH FOR QOS AWARE WEB SERVICE RECOMMENDATION	1541
<i>Arif Ahmed Khan ; V. A. Chakkarwar</i>	
BANGLA SIGN LANGUAGE DETECTION USING SIFT AND CNN	1548
<i>Shirin Sultana Shanta ; Saif Taifur Anwar ; Md. Rayhanul Kabir</i>	
QUALITY ENHANCEMENT OF FOGGY IMAGES COMPRISING OF LARGE SKY REGION ON SAMEER TU DATASET	1554
<i>Tannistha Pal ; Mrinal Kanti Bhownik</i>	
NEW METHOD FOR ESTIMATING THE TREE-LIKENESS OF GRAPHS AND ITS APPLICATION FOR TRACING THE ROBUSTNESS OF COMPLEX NETWORKS	1561
<i>Artem Potebnia</i>	
APPLYING MACHINE LEARNING TECHNIQUES FOR SPEECH EMOTION RECOGNITION	1568
<i>K. Tarunika ; R.B Pradeeba ; P. Aruna</i>	
Author Index	

Domain Classification of Textual Conversation Using Machine Learning Approach

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Abstract- This paper presents an approach for classification of textual conversation into multiple domain categories using support vector classifier. The feature reduction is done through Principal Component Analysis (PCA) to extract the important features from the feature vector. These features are passed to different configurations of SVM and the best one is chosen for the final process of classification. The domain's categories are defined on real life situations and conversation to train the system like education & research, personal, patriotism, terrorism, medical, religious, sports, and business. The experiment results show that the proposed method works effectively with more than 75% accuracy.

Keywords- Machine Learning, Support Vector Classifier, Domain Classification, Textual Conversation, Machine Intelligence.

I. INTRODUCTION

The text is the basic means of communication. It not only communicates informative contents, but also produces some additional information like feelings, emotions, sentiments and domain. The Domain recognition is different to sentiment analysis and emotion recognition. The objective of sentiment analysis is to sense positive, neutral, or negative feelings from text, whereas emotion plays an elementary role in our daily lives. Its objective is to detect and recognize the feelings through the text, such as anger, fear,

disgust, happy, sad, and surprise[1]. Generally Ekman's six emotion class is used to detect the emotions. The Sentiment analysis can be classified into two categories; opinion mining and emotion mining. Opinion mining concern with the expression of opinions, for example neutral, positive or negative while emotion mining concerned with the pronunciation of emotions like sad, happy, excited etc.[2].

Domain recognition is one of the fields of affective computing. It refers to evaluating conversation towards different issues. If two persons are discussing their personal problem through text conversation then the category of domain is personal therefore; our system is capable enough to recognize its domain categories automatically for which the conversation has taken place while emotion recognition or sentiment analysis only reflect the mood or emotions. Classifying domain from the textual conversation can be applied to the various applications, based on human computer interaction. It is a relatively new classification and advancement in the field of affective computing and machine learning. It can also be useful to prevent miss happening or unwanted activities on the basis of text conversation. We can recognize different types of domains on the basis of communications or conversation. The categories of domain are defined on the basis of various real life situations and conversation. Every conversation or statement always may fall

into any one of the domain category, such as; education & research, personal, patriotism, terrorism, medical, religious, sports, and business. A large paragraph may provide the largest number of clues as features for domain analysis, however, least number of features reflect feature sparseness problem [3].

The aim of the proposed approach is to classify the domain of communication or conversation through textual contents with acceptable accuracy.

The proposed paper consists of five sections as follows: Section 2 related work proposed by various researchers section 3 contains the proposed work and Section 4 represents the result of the proposed scheme, finally, at last section 5 represents the conclusion and future scope of the proposed scheme.

II. RELATED WORK

It is a novel approach, therefore, no work is done in the same context, however, the similar approach is used by various researchers on sentiments and emotion recognition as:

[4] Proposed the application of spoken language understanding between human and machine through the deep belief network. Text classification algorithms used in this paper are SVM, boosting and maximum entropy. However, Result analysis in this paper shows that SVM effectively perform non-linear classification to high dimensional feature space and flexibility of changing the choice of the kernel. The working of linear kernel is much faster in comparison to other kernel. The approach used for text classification is very nice, however, overall process requires more computation time due to create deep network.

Mathematical description and model of different machine learning techniques like supervised, unsupervised, semi-supervised along with its impact is discussed [5]. The essential intention of learning is to find a decision function that is able to predict the output of future. In general, the prediction task is called classification when the output takes categorical values. In this paper, author also analyzed recent developments of deep learning and learning with sparse representations, focusing on their direct significance.

[6]Proposed an approach for emotion recognition from text. In this paper emotion generation rules are manually defined and semantic labels are used to represent an emotion state through the emotion association rules. A separable mixture model is used to estimate the similarity between an input sentence and emotion association rules of each emotional state. There are only three emotional states used in this paper for performance evaluation, i.e. happy, unhappy, and neutral, however, in real situation emotion state may vary from the defined states. Therefore, it has very limited emotion states.

[7] Proposed a multimodal approach for emotion recognition from speech and text using support vector machine. In this paper emotional keywords defined manually while emotion modification words assigned an integer value (positive or negative). A higher value represents more impact on emotion. For example, emotion modification value for the word, 'good', 'very good' and 'extremely good' are +1,+2,+3 respectively. Therefore extremely good have the highest value. If there is negative sentence, then these values are assigned as negative. They also discussed about neutral state of emotion, if emotion intensity value is lower than predefined threshold, however, other states of emotion is not defined in this paper. The training set used in

this paper is also limited. [2] Proposed an analysis of the current state of text sentiment, one step ahead on sentiment analysis. There are two concepts used in this paper; Opinion mining and Emotion mining. Opinion mining reflects attitude by using natural language processing. Emotion mining reflects emotions regarding topics by using machine learning technique. Parts Of Speech tagging is used to determine the sense of the text. This paper focused on the sentiment analysis on different way only. However, there is no way to find the domain of text paragraph discussed in this paper.

Detection and classification of acoustic scenes and event is proposed by [8] on the basis of audio signals. However, in an environment, events are overlapping or polyphonic whereas an audio signal is monophonic in nature. Therefore, to focus on a single event noise is spatially or spectrally suppressed in order to focus on one source of the event. On the basis of audio signal author proposed a method to recognize the environment like bus, office, street, park, restaurant, etc. and also discussed the classification of specific events presented by various researchers from the environmental audio like bird song, musical instruments and other harmonic sounds. Discussed events in this paper were very limited and due to the polyphonic environment the recognition of scenes and event is less accurate. Proposed detection and analysis of emotion from human speech is proposed in [9]. MFCC is used to classify the speech signal. From the speech signals we cannot find good accuracy because many of the human do not change their speech characteristics (like pitch, frequency, entropy etc.) at the time of the conversation. Therefore, the system is not able to find the emotion for this type of situation. The emotion used in this paper was also limited.

Works proposed by the researchers are focused on either emotion or sentiments While no one has discussed about domain classification and

recognition. The objective of the proposed method is to classify the domain of communication through textual contents with acceptable accuracy.

III. PROPOSED WORK

A proposed framework for domain classification includes five phases; Lexical Analysis, Features Extraction, Features Scaling, Features Reduction and Domain Classification & Recognition as shown in the figure 1. Useful words are extracted using lexical analysis from the input text paragraph or sentences. Then these words transform into a mathematical form for further processing through feature extraction and normalize these values because it is required to apply machine learning algorithm. After normalization, try to reduce the features through PCA. PCA is an unsupervised technique used for feature reduction in data analysis and machine learning. It transforms an $N \times M$ matrix of data set to $N \times K$ matrix were $M < K$. It actually maximizes the total variance of the independent variables. This is done by projecting the actual data set on a lower plane. Now, we need to classify the category of domain on the basis of classifiers.

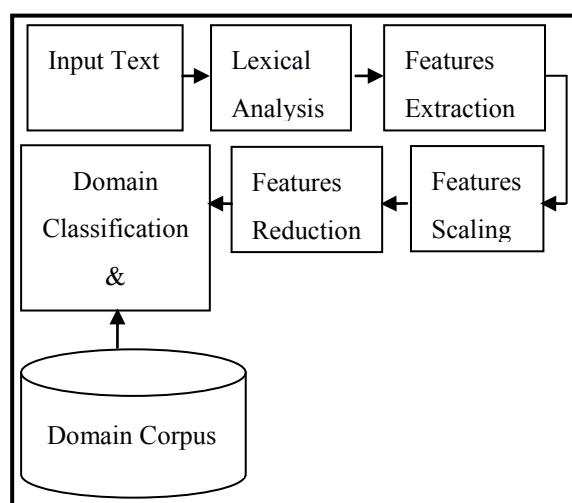


Figure 1. Proposed Framework for Domain Classification of Textual Conversation.

Every sentence or paragraph represents some clue about which conversation has taken place. In this context, the domain is classified into 8 categories, i.e., education & research, personal, patriotism, terrorism, medical, religious, sports, and business. The support vector machine has been extensively functioning in many research areas such as pattern matching, linear regression, data mining, data clustering etc. [7]. Therefore, to classify the text sentences into various domain categories, we used support vector machine with different configurations out of which select the best that produces the highest accuracy. The objective of SVM is to find a hyperplane that can completely distinguish different classes and it is decided by the maximal margin of classes. The samples that lie in the margin are called support vectors[10]. The equation of hyperplane is represented as an equation (1)

$$D(x) = w^T x + b \quad (1)$$

where w is weight matrix and b is the intercept.

SVM can efficiently perform non-linear classification to transform the data using a technique called the kernel trick. Based on these transformations, it finds an optimal boundary between the possible outputs. Much of the flexibility and classification power of SVM depends on the choice of kernel[4]. Generally, the kernel used in SVM are linear, polynomial, radial basis function (RBF) and sigmoidal. The selection of kernel depends on the nature of the data used for classification. Every kernel has its own pros and cons. A linear kernel is applied when the data is linearly separable and uses linear functions. Generally, linear kernel is suitable for text classification because the text is often linearly separable but in our case it does not provide the best results. Polynomial kernel may lead to overfitting therefore; it may cause the problem of generalization. The selection of polynomial kernel is suitable when we have discrete data with no natural notion of smoothness. The rbf kernel uses normal curves

around the data points, and sums these so that the decision boundary can be defined by a type of topology condition such as curves where the sum is above a value of 0.5[11]. RBF kernel is the most popular kernel because nonlinearly map samples into a higher dimensional space unlike to linear kernel and it also has less hyperparameters than the polynomial kernel. The sigmoidal kernel is suitable when the offset parameter is negative and close to 0 and problems where the number of dimensions is high or non linear separation in 2 dimensions.

IV. RESULT AND ANALYSIS

For the purpose of system evaluation, inorder to recognize the domain of text sentences, we collected 2713 sentences for training and 950 sentences for testing which includes 2520 different features. The domain of text sentences was tagged manually. The domain classification results are listed in the table 1. The table depicts various domains for classification and their respective number of sentences that are tagged. To evaluate the accuracy of the proposed system we used this tagged data as the target and passed the same sentences to the proposed system for prediction. The data set is comprised of sentences from various domains taken from standard sources of information like newspaper, social networking site, journal articles, etc.

Table 1. Tagged domain classification of textual sentences in the testing dataset.

Domain	No of Tagged Sentences
Religious	150
Research	90
Business	130
Sport	110
Medical	100
Terrorism	130

Patriotism	130
Personal	110

Experimental Results of PCA:

To train and test the performance of the proposed system we have collected total 3663 sentences. Out of which 2713 sentences are used for training and 950 sentences are used for testing which includes 2520 different features. After using PCA, 2520 features are reduced to 1495 only with threshold variance of 96%.

Variance represents a measurement of the variability in the data set. If we want a single principal component with the most variability, we need to search for maximum variance so that the principal component collects the most uniqueness from the data set. The graph represented in figure 2, shows the relationship between principal component and their respective variance where it is evident that the first principal component has the highest variance and remaining principal components exhibit decreasing variance.

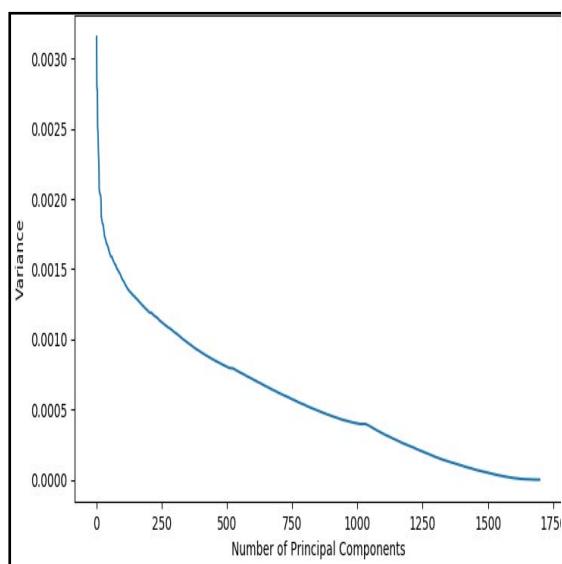


Figure 2. Relation between principal components and their variance.

Experimental Results of SVM:

In order to determine the correct SVM configuration we validate different SVM configurations on validation set. Validation set and training set used in proposed paper are divided in to ratio of 1:4.

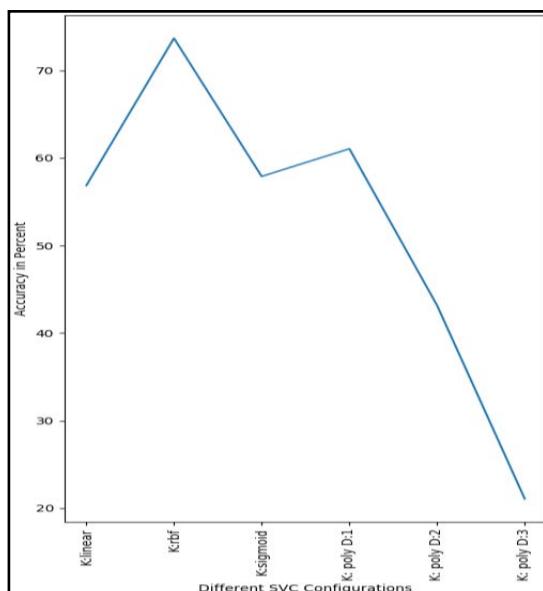


Figure 3. Cross Validation; Accuracy percentage of different SVM kernel configurations; kernel= linear, kernel=rbf , kernel=sigmoidal, kernel= polynomial with degree=1, 2 and 3.Relation between principal components and their variance.

Figure 3 shows the result of different SVM kernel configurations on validation set. Different configurations of kernel are taken as kernel= linear, rbf, sigmoidal and polynomial with the degree=1, 2 and 3. However, maximum accuracy is received when kernel selected as rbf as shown in figure 3. RBF kernel is one of the most popular kernel functions.

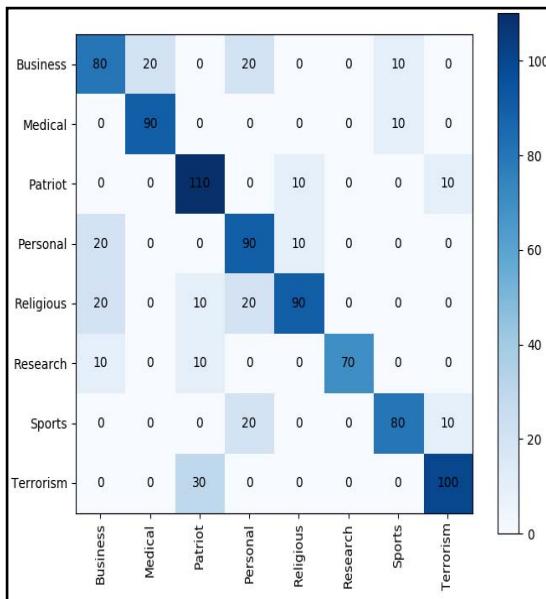


Figure 4. Confusion matrix of Domain Classification of Test Data.

Figure 4 is the confusion matrix that shows the correct and incorrect classification and recognition of text sentences based on a particular SVM configuration (kernel=rbf, C=1, $\gamma=1$) which is selected through a validation process as already shown in figure 3. The diagonal values represent the true positives or the correct classification of the domain, whereas the other values represent the mis classification of the domain. The figure 4 shows that the correct classification and recognition is more than 75%.

V. CONCLUSION AND FUTURE SCOPE

The paper explored the idea of domain classification for textual conversation. It was observed that domain recognition differs from emotion recognition and sentiment analysis because emotion recognition or sentiment analysis only reflects the mood or emotions while domain recognition recognizes its domain categories automatically for which the conversation has taken place. It is a relatively

new classification and advancement in the field of machine learning.

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