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Nonlinear Adaptive Controller for Speed Control in Induction Motor Drives

M. Jasmin, S. Philomina and G. Angelo Virgin

Abstract--- *Induction motor is widely used in small scale aswell as the large scale industries. In industrial sector, there prevails a major drawback in speed controlling of three phase induction motor drives when subjected to heavy loads. These are called as disturbances in a motor. A motor can have both the internal disturbance as well as the external disturbance. To eliminate this types of disturbance many controller where implemented with fast computing algorithm. To reduce the computation time and also to get a minimum overshoot with respect to the changes in the state transient variables, a three first order Auto Disturbance Rejection Controller (ADRC) is used for evaluating the squirrel cage induction motor drive co-ordinates (d-q) as well as to regulate the speed of the motor under disturbances. It is clear that the control scheme of ADRC is much feasible and effective when compared to conventional controllers.*

Keywords--- *Squirrel Cage Induction Motor, Auto Disturbance Rejection Controller (ADRC), Field Oriented Control (FOC).*

I. INTRODUCTION

An induction motor is a nonlinear time varying system, whose state transient measuring is much difficult resulting towards difficultly in controlling. Here, the electrical energy is converted into mechanical energy that has a high performance drives system modifying the machine performance, dynamic model and parameter variations. An AC induction motor has a fixed outer portion, called the stator and a rotor that spins inside with a carefully engineered air gap between the two. Virtually all electrical motors use magnetic field rotation to spin their rotors.

A three-phase AC induction motor is the only type where the rotating magnetic field is created naturally in the stator because of the nature of the supply [2]. DC motors depend either on mechanical or electronic commutation to create rotating magnetic fields. A single-phase AC induction motor depends on extra electrical components to produce this rotating magnetic field. Depending upon the type of control mechanisms like scalar control [2,3], indirect torque control[4,5] direct torque control[1,5], field acceleration method, universal field orientation, direct self control [1] the current regulation in the loops are studied.

Numerous methods are available for the control of induction motor drives exhibiting nonlinear character. When it is related to the speed control, the following facts are to be studied since it is an extreme drawback due to the low starting torque and its associated proportional increase in load.

Many controllers were employed before the evolution of the adaptive controller. Since the induction motor drives are imposed with nonlinear characteristics, the developers made an Auto Disturbance Rejection Controller (ADRC) to overcome these problems. The ADRC was proposed by Han in 1998. The ADRC is a nonlinear

M. Jasmin, Assistant Professor, Department of Electronics and Communication Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai. E-Mail: Jasmin.ece@gmail.com

S. Philomina, Assistant Professor, Department of Electronics and Communication Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

G. Angelo Virgin, Assistant Professor, Department of Electronics and Communication Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

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controller for an uncertain system, it estimates and compensates the external disturbances and parameter variations, and as a consequence, the accurate model of the plant is not required. It means that the design of ADRC is inherently independent of the controlled system model and its parameters.

The induction motor is classically known for their availability in the ranges of fractional horse power (FHP) to multi megawatt capacity. Low power FHP can be applied for single phase machine. The stator and the rotor core made up of laminated ferromagnetic steel sheets.

A sinusoidal disturbance is created in the air gap of the induction motor due to the magnetic field rotations. The dynamic d-q modelling is done by considering the unit vectors of the field oriented control, where the direct axis and the quadrature axis are differentiated by the sine and cosine terms.

These state variables of the steady state response and the transient response are controlled by using three individual first order auto disturbance rejection adaptive mechanisms. The ADRCs have three function blocks 1) Nonlinear Differentiator (ND) 2) Extended State Observer (ESO) and 3) Nonlinear State Error Feedback (NLSEF). These controlling are stabilized using high power semiconductor diodes like Insulated Gate Bipolar Transistor (IGBT) which is a hybrid model of MOSFET and BJT.

II. AC MACHINE DRIVES

Induction motor are categorized on the basis of the windings and their rotating winding which has non ideal winding distribution for neglecting the effects of slots and apace harmonics. The classified elements are, 1) cage or wound rotor (dually fed) and 2) rotating or linear. The single phase and three phase motor are prominently employed throughout the industrial sectors. Among them the three phase winding plays a vital role in controlling the motion of the associated systems.

Many drives are developed for the industrial application, among them power semiconductor drives are efficient due to the silicon material. Some of the power semiconductor drives used is diode, thyristor, triac, GTO (gate turn-off thyristor), BJT (bipolar junction transistor), SIT (static induction thyristor), IGBT (insulated gate bipolar transistor) and power MOSFET.

The performance of the drive is measured by its torque-speed characteristics. The dynamic performance of an AC machine is complex because three phase rotor winding move along with the three phase stator winding. The control methods employed in AC machines are 1) scalar control (V/F), 2) vector control or field oriented control (FOC) and 3) direct torque control (DTC). The proposed scheme is experimented with the vector control mechanism.

A. Field Oriented Control

Vector control deals with the variation of the control variables due to the changes in their magnitude and phase orientation. Unlike the scalar control method, whose variations in the control variables are only due to the changes in the magnitude values of the set point. The proposed method is well known as decoupling, orthogonal or transvector control.

The limiting factor in the scalar control like inherent coupling effect giving sluggish response and the system instability to the higher order effect are sustained in this proposed scheme. There are two general methods of vector control, studied and schematized as 1) direct or feedback method (by Blanschke) and 2) indirect or feed forward method (by Hasse). Both the scheme generates a unit vector namely, cosine and sine angles for the control stator and rotor flux that provides natural decoupling air gap and coupling effect which has to be compensated by the decoupling compensation current.

At the low frequency response, the voltage signals are very low because of which the ideal integration is difficult since its estimated signal accuracy is reduced. In indirect vector control the torque producing components are controlled only after the transformation is undergone and not by its main reference input. The flux measurement is carried out using flux sensing coil or hall devices.

Another type of vector scheme without using speed sensor requires low speed range, including zero speed start up operation. Advanced scalar control techniques known as direct torque and flux control or direct self control is introduced for the voltage fed PWM inverter drives.

III. SPEED CONTROL CLOSED LOOP FOR MOTOR DRIVES USING THREE FIRST ORDER ADRCS

Disturbance Rejection controller is an adaptive based controller highly employed for uncertain systems that deals with the Nonlinearities. The Auto Disturbance Rejection Controller (ADRC), used for the speed control of induction motor drives is a first order system involving linear action while the disturbance induced into the motor make it behaves as a nonlinear system.

Auto Disturbance Rejection Controller (ADRC) is a robust control scheme highly employ in adaptive controlling of the system. Due to the fictitious variables the system modelling is not needed for the controlling, therefore the analytical description is eliminated. The interesting scenarios in the proposed scheme are its robustness and their adaptive ability.

A. Control blocks

The first order Auto Disturbance Rejection Control has three blocks that perform various functions like performing state trajectory, obtaining dynamic feedback linearization through control law. The order of the system increases the complexity of the system as well as the computation time. The ADRC-based speed control scheme for the induction motor drives has the advantage of good robustness to parameter uncertainty and external disturbance.

There are three control loops in the ADRC block classifying the functionality. They are 1) Extended State Observer (ESO), 2) Nonlinear Differentiator (ND) and 3) Nonlinear State Error Feedback (NLSEF). It is completely based on the control law as well as the linear feedback loop employing stability constrains that are inherent properties of a nonlinear system. Here, the steady state operation deals with the sinusoidal voltage-currents.

The extended state observer in the feedback state eliminates the error produced by the induction motor and the reference point. It makes the controller to follow the output system response with minimum peak overshoot and absence of the offset error in both steady state and transient state analysis.

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The Nonlinear Differentiator (ND) is used to define a desirable transition response for the step input. It smoothen the sudden changes in the input signal in order to decrease the overshoot of the output response. It provides good balance between the fast transient response and minimum overshoot. The phenomenal character of this nonlinear differentiator is its reduction of chattering phenomenon by employing continuous power function to the derivative estimator as well as linear correction terms for the improvement of dynamic performance.

The Nonlinear State Error Feedback (NLSEF) gives the control law to drive the state trajectory to track the desired reference. State error feedback, is a method employed in feedback control system theory to place the closed loop poles of a plant in pre-determined locations in the s-plane. Placing poles is desirable because the location of the poles corresponds directly to the Eigen values of the system, which control the characteristics of the response.

IV. SIMULATION EXPERIMENTAL RESULTS

The experimental setup has a pulse width modulation (PWM), based on feed forward or feedback methods. The space vector PWM is used for the variable frequency drives. If the load neutral is connected to the centre tap of the dc supply, all three half bridges operate independently. Inherent coupling effect giving sluggish response as well as instability over higher order system

V. V EXPERIMENTAL RESULTS

A. Load Disturbance Performance

Speed decreases with increase in load, since its starting torque is low. The loads are classified as internal and external disturbances. The internal disturbances are the coupled terms of input and output variables. Among them the three loops are given as, 1) load torque and coupling term between the speed loop and flux loop for the speed regulation of ADRCs that are compensated by ESO. 2) The q-axis stator current loop of ADRC is coupled by the rotor flux and rotor angular speed as well as the d-axis stator current and speed angular synchronization. 3) The product of the synchronous angular speed and q-axis stator current are the coupling terms considered for the ADRC d-axis stator current loop.

B. Parametric variation

Considering the step response fro the reference variation and the response of the disturbance as rapid in general case even though the rotor resistance is still chosen for obtaining the rapidity and the accuracy of the control algorithm. The steady state analysis and the transient response of the system analysis are much efficient while varying the set point under no load and load substitution condition. The varied parameters are the speed of the mechanical loop and electrical components (stator-rotor flux). The set point is a sinusoidal signal.

C. Model uncertainty

Uncertainty of the system results due to the impact of non ideal factors such as saturation, iron loss and core loss. Hysteresis band control generates flux torque ripple and switching frequency is not constant.

D. Analysis

The existing system involving the conventional PI controller provides low response since the inner loop characterization should be faster the outer loop. In ADRC, the disturbances occurring in the system and the internal

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disturbance are evaluated in the state observer block and are neglected, so that the output response follows the input response. The ADRC is an adaptive controller where self tuning is one of the beneficiary facts.

The prior scheme employs first order ADRC and concentrated only on the stator current and its associated flux. The increase in the order of the ADRC control loop makes the system as complicated and the evaluation of rotor flux due to the unit vectors.

The performance and application of the three phase induction motor delivers high performance more than 6 KHz of torque bandwidth, 200Hz small signal speed loop bandwidth, precise and smooth signal operations, trouble free four quadrant operation as well as fast torque and speed reversal.

The induction motor is the widely used in large scale industries due to its reliability, rugged construction, high efficiency, good power factor and it has a simple starting arrangement. Numerous methods are available for the control of induction motor drives exhibiting nonlinear character. When it is related to the speed control, the following facts are to be studied since it is an extreme drawback due to the low starting torque and its associated proportional increase in load.

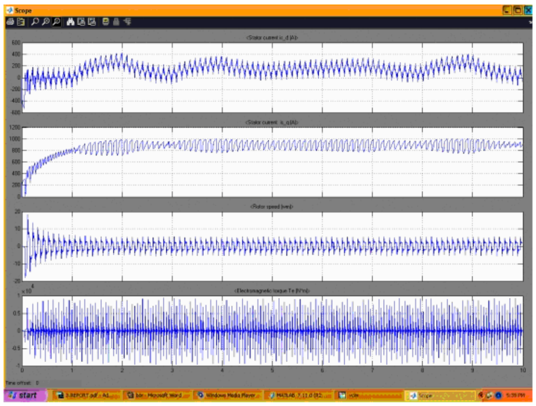

Fig.5.a Load Disturbance Performance

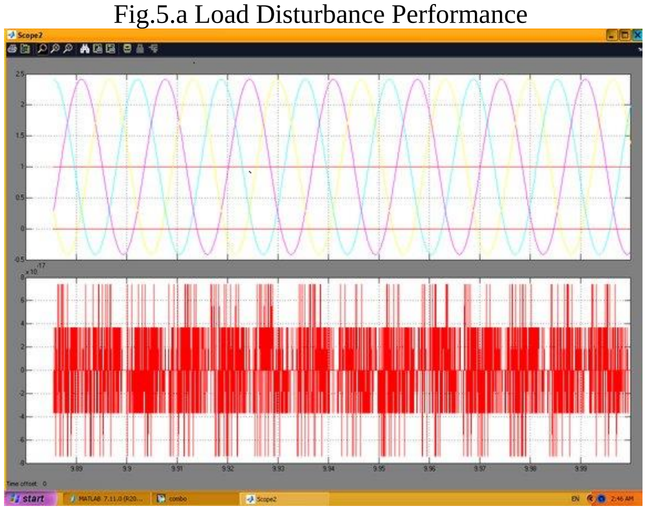

Fig.5.b Model Uncertainity

Fig.5 Simulation results of induction motor drive speed control at 1410r/min. (a) vector control of individual loops including electromagnetic torque. (b) ADRCs output at rated speed and induced disturbances

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VI. CONCLUSION

The internal disturbance and the external disturbance induced in the system are compensated by using the Extended State Observer (ESO) of the ADRC block. It is shown that the outcome of ADRC overshoot recovery is much prior to any other controller.

The implementation of the proposed scheme on a digital signal processor (DSP) is formulated, where the runtime of the ADRC algorithm is shorter. A TMS320F2812 DSP- based prototype is developed with the capability of compensating various disturbancdes occurring in the system and results as a feasible and effective controller. The digital signal controller comprises all the capabilities of the DSP processor into a small integrated chip likely dsPIC 33/30.

The performance of the proposed control scheme using MATLAB/simulink model has been established for a Squirrel cage induction motor driven by voltage source inverter (VSI). The robustness of the following scheme is investigated under the following three cases 1) Loaddisturbance; 2) the motor parameter variations; 3) The model uncertainty. The slip speed and the skews are two advantages of induction motor drive that helps it to run quietly by reducing the magnetic flux and reduces the locking tendency of the rotor at constant speed.

REFERENCES

[1] Sakthipriya N., An effective method for crop monitoring using wireless sensor network, Middle - East Journal of Scientific Research, V-20, I-9, PP:1127-1132, 2014.

[2] Vijayaragavan S.P., Karthik B., Kiran Kumar T.V.U., Effective routing technique based on decision logic for open faults in fpgas interconnects, Middle - East Journal of Scientific Research, V-20, I-7, PP:808-811, 2014.

[3] Kanniga E., Selvaramarathnam K., Sundararajan M., Kandigital bike operating system, Middle - East Journal of Scientific Research, V-20, I-6, PP:685-688, 2014.

[4] Sundararajan M., Optical instrument for correlative analysis of human ECG and breathing signal, International Journal of Biomedical Engineering and Technology, V-6, I-4, PP:350-362, 2011.

[5] Khanaa V., Thooyamani K.P., Saravanan T., Simulation of an all optical full adder using optical switch, Indian Journal of Science and Technology, V-6, I-SUPPL.6, PP:4733-4736, 2013.

[6] Slimani Y., Baykal A., Amir M., Tashkandi N., Güngüneş H., Guner S., El Sayed H.S., Aldakheel F., Saleh T.A., Manikandan A., Substitution effect of Cr 3+ on hyperfine interactions, magnetic and optical properties of Sr-hexaferrites, Ceramics International, V-44, I-13, PP:15995-16004, 2018.

[7] Suguna S., Shankar S., Jaganathan S.K., Manikandan A., Novel Synthesis of Spinel Mn x Co 1−x Al 2 O 4 (x = 0.0 to 1.0) Nanocatalysts: Effect of Mn 2+ Doping on Structural, Morphological, and Opto-Magnetic Properties, Journal of Superconductivity and Novel Magnetism, V-30, I-3, PP:691-699, 2017.

[8] Mathubala G., Manikandan A., Arul Antony S., Ramar P., Enhanced photocatalytic activity of spinel CuxMn1-xFe2O4 nanocatalysts for the degradation of methylene blue dye and opto-magnetic properties, Nanoscience and Nanotechnology Letters, V-8, I-5, PP:375-381, 2016.

[9] Kumaravel A., Dutta P., Application of Pca for context selection for collaborative filtering, Middle - East Journal of Scientific Research, V-20, I-1, PP:88-93, 2014.

[10] Krishnamoorthy P., Jayalakshmi T., Preparation, characterization and synthesis of silver nanoparticles by using phyllanthusniruri for the antimicrobial activity and cytotoxic effects, Journal of Chemical and Pharmaceutical Research, V-4, I-11, PP:4783-4794, 2012.

[11] Amir M., Gungunes H., Slimani Y., Tashkandi N., El Sayed H.S., Aldakheel F., Sertkol M., Sozeri H., Manikandan A., Ercan I., Baykal A., Mössbauer Studies and Magnetic Properties of Cubic CuFe 2 O 4 Nanoparticles, Journal of Superconductivity and Novel Magnetism, V-32, I-3, PP:557-564, 2019.

[12] Raj M.S., Saravanan T., Srinivasan V., A modified direct torque control of induction motor using space vector modulation technique, Middle - East Journal of Scientific Research, V-20, I-11, PP:1572-1574, 2014.

[13] Khanaa V., Thooyamani K.P., Using triangular shaped stepped impedance resonators design of compact microstrip quad-band, Middle - East Journal of Scientific Research, V-18, I-12, PP:1842-1844, 2013.
[14] Asiri S., Sertkol M., Güngüneş H., Amir M., Manikandan A., Ercan I., Baykal A., The Temperature Effect on Magnetic Properties of NiFe 2 O 4 Nanoparticles, Journal of Inorganic and Organometallic Polymers and Materials, V-28, I-4, PP:1587-1597, 2018.Thaya R., Malaikozhundan B., Vijayakumar S., Sivakamavalli J., Jeyasekar R., Shanthi S., Vaseeharan B., Ramasamy P., Sonawane A., Chitosan coated Ag/ZnO nanocomposite and their antibiofilm, antifungal and cytotoxic effects on murine macrophages, Microbial Pathogenesis, V-100, PP:124-132, 2016.
[15] Kolanthai E., Ganesan K., Epple M., Kalkura S.N., Synthesis of nanosized hydroxyapatite/agarose powders for bone filler and drug delivery application, Materials Today Communications, V-8, PP:31-40, 2016.
[16] Thilagavathi P., Manikandan A., Sujatha S., Jaganathan S.K., Antony S.A., Sol-gel synthesis and characterization studies of NiMoO 4 nanostructures for photocatalytic degradation of methylene blue dye, Nanoscience and Nanotechnology Letters, V-8, I-5, PP:438-443, 2016.
[17] Thamotharan C., Prabhakar S., Vanangamudi S., Anbazhagan R., Anti-lock braking system in two wheelers, Middle - East Journal of Scientific Research, V-20, I-12, PP:2274-2278, 2014.
[18] Thamotharan C., Prabhakar S., Vanangamudi S., Anbazhagan R., Coomarasamy C., Hydraulic rear drum brake system in two wheeler, Middle - East Journal of Scientific Research, V-20, I-12, PP:1826-1833, 2014.
[19] Vanangamudi S., Prabhakar S., Thamotharan C., Anbazhagan R., Collision control system in cars, Middle - East Journal of Scientific Research, V-20, I-12, PP:1799-1809, 2014.
[20] Vanangamudi S., Prabhakar S., Thamotharan C., Anbazhagan R., Drive shaft mechanism in motor cycle, Middle - East Journal of Scientific Research, V-20, I-12, PP:1810-1815, 2014.
[21] Anbazhagan R., Prabhakar S., Vanangamudi S., Thamotharan C., Electromagnetic engine, Middle - East Journal of Scientific Research, V-20, I-3, PP:385-387, 2014.
[22] Kalaiselvi V.S., Prabhu K., Ramesh M., Venkatesan V., The association of serum osteocalcin with the bone mineral density in post menopausal women, Journal of Clinical and Diagnostic Research, V-7, I-5, PP:814-816, 2013.
[23] Kalaiselvi V.S., Saikumar P., Prabhu K., Prashanth Krishna G., The anti Mullerian hormone-a novel marker for assessing the ovarian reserve in women with regular menstrual cycles, Journal of Clinical and Diagnostic Research, V-6, I-10, PP:1636-1639, 2012.
[24] Thanigai Arul K., Manikandan E., Ladchumananandasivam R., Maaza M., Novel polyvinyl alcohol polymer based nanostructure with ferrites co-doped with nickel and cobalt ions for magneto-sensor application, Polymer International, V-65, I-12, PP:1482-1485, 2016.
[25] Das M.P., Kumar S., An approach to low-density polyethylene biodegradation by Bacillus amyloliquefaciens, 3 Biotech, V-5, I-1, PP:81-86, 2015.
[26] Vanangamudi S., Prabhakar S., Thamotharan C., Anbazhagan R., Turbo charger in two wheeler engine, Middle - East Journal of Scientific Research, V-20, I-12, PP:1841-1847, 2014.
[27] Vanangamudi S., Prabhakar S., Thamotharan C., Anbazhagan R., Design and calculation with fabrication of an aero hydraulwicclutch, Middle - East Journal of Scientific Research, V-20, I-12, PP:1796-1798, 2014.
[28] Saravanan T., Raj M.S., Gopalakrishnan K., VLSI based 1-D ICT processor for image coding, Middle - East Journal of Scientific Research, V-20, I-11, PP:1511-1516, 2014.
[29] Ajona M., Kaviya B., An environmental friendly self-healing microbial concrete, International Journal of Applied Engineering Research, V-9, I-22, PP:5457-5462, 2014.
[30] Hemalatha R., Anbuselvi S., Physicohemical constituents of pineapple pulp and waste, Journal of Chemical and Pharmaceutical Research, V-5, I-2, PP:240-242, 2013.
[31] Langeswaran K., Revathy R., Kumar S.G., Vijayaprakash S., Balasubramanian M.P., Kaempferol ameliorates aflatoxin B1 (AFB 1) induced hepatocellular carcinoma through modifying metabolizing enzymes, membrane bound ATPases and mitochondrial TCA cycle enzymes, Asian Pacific Journal of Tropical Biomedicine, V-2, I-3 SUPPL., PP:S1653-S1659, 2012.
[32] Masthan K.M.K., Aravindha Babu N., Dash K.C., Elumalai M., Advanced diagnostic aids in oral cancer, Asian Pacific Journal of Cancer Prevention, V-13, I-8, PP:3573-3576, 2012.
[33] Asiri S., Güner S., Demir A., Yildiz A., Manikandan A., Baykal A., Synthesis and Magnetic Characterization of Cu Substituted Barium Hexaferrites, Journal of Inorganic and Organometallic Polymers and Materials, V-28, I-3, PP:1065-1071, 2018.
[34] Vellayappan M.V., Jaganathan S.K., Manikandan A., Nanomaterials as a game changer in the management and treatment of diabetic foot ulcers, RSC Advances, V-6, I-115, PP:114859-114878, 2016.

[35] Vellayappan M.V., Venugopal J.R., Ramakrishna S., Ray S., Ismail A.F., Mandal M., Manikandan A., Seal S., Jaganathan S.K., Electrospinning applications from diagnosis to treatment of diabetes, RSC Advances, V-6, I-87, PP:83638-83655, 2016.

[36] Bavitra K., Sinthuja S., Manoharan N., Rajesh S., The high efficiency renewable PV inverter topology, Indian Journal of Science and Technology, V-8, I-14, 2015.

[37] Vanangamudi S., Prabhakar S., Thamotharan C., Anbazhagan R., Design and fabrication of dual clutch, Middle - East Journal of Scientific Research, V-20, I-12, PP:1816-1818, 2014.

[38] Sandhiya K., Kaviya B., Safe bus stop location in Trichy city by using gis, International Journal of Applied Engineering Research, V-9, I-22, PP:5686-5691, 2014.

[39] Selva Kumar S., Ram Krishna Rao M., Deepak Kumar R., Panwar S., Prasad C.S., Biocontrol by plant growth promoting rhizobacteria against black scurf and stem canker disease of potato caused by Rhizoctonia solani, Archives of Phytopathology and Plant Protection, V-46, I-4, PP:487-502, 2013.

[40] Sharmila S., Jeyanthi Rebecca L., GC-MS Analysis of esters of fatty acid present in biodiesel produced from Cladophora vagabunda, Journal of Chemical and Pharmaceutical Research, V-4, I-11, PP:4883-4887, 2012.

[41] SenthiyaPrabha, P. (2014). Design of Energy Efficient Hierarchical Routing Protocol using ACO for WSN. *International Journal of System Design and Information Processing, 2*(2), 45-49.

[42] Kanimozhi, N., & Dr.Singaravel, G. (2018). Combining Image Security and Authentication Using Sift and Zernike Moments. *Bonfring International Journal of Networking Technologies and Applications, 5*(1), 17-20.

[43] Dubled, M., and Kim, Y.B. (2017). Numerical Analysis and Modelling of Solar Still with Granular Activated Carbon. *Bonfring International Journal of Power Systems and Integrated Circuits, 7*(2), 13-18.

[44] Anand, R., & Gupta, H. (2014). Unlocking the Wireless Smartphone Charging Potential. *International Scientific Journal on Science Engineering & Technology*, 17(10), 935-938.

[45] Kumar, M., & Purohit, R. (2014). A Compact UWB U-Shaped Slot MSA with B and Dispensation Characteristic for Communication. *International Scientific Journal on Science Engineering & Technology, 17*(10), 964-969.

[46] Wang, H., Chiang, W.H., Chou, C.W., & Chang, D.T.H. (2014). Dynamic Simulation of Electric Bus Vehicle. *The SIJ Transactions on Computer Science Engineering & its Applications, 2*(4), 57-64.

[47] Mizuno, J., & Takahashi, S. (2014). Electrical Chock Dangerous for Human in Flooding Situation. *The SIJ Transactions on Computer Science Engineering & its Applications, 2*(4), 82-85.

[48] Jayapratha, S., & Dr.Pabitha, P. (2018). Topic Categorization based on User behaviour in Random Social Networks Using Firefly Algorithm. *Bonfring International Journal of Software Engineering and Soft Computing, 8*(2), 11-15.

[49] Ramyadharshni, S.S., & Dr.Pabitha, P. (2018). Topic Categorization on Social Network Using Latent Dirichlet Allocation. *Bonfring International Journal of Software Engineering and Soft Computing, 8*(2), 16-20.

[50] Streit, A.G., & Rodriguez, C.K.D.S. (2015).Proposing a Bit Torrent-Like Protocol for Efficient Interactive Multimedia Streaming Applications. T*he SIJ Transactions on Computer Networks & Communication Engineering (CNCE), 3*(1), 13-22.