DOI: 10.21917/ijct.2022.0411

THE FUZZY LOGICAL CONTROLLER BASED ENERGY STORAGE AND CONSERVATION MODEL TO ACHIEVE MAXIMUM ENERGY EFFICIENCY IN MODERN 5G COMMUNICATION

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Abstract

Energy conservation and energy efficiency for smart antenna design is the reduction of energy consumption per unit of service or product in 5G Communication without reducing production quality and quantity. Efficient use of energy is important in many ways. First, fossil fuels such as oil and coal, which are important sources of energy, are depleting. Greenhouse gas emissions released into the atmosphere during energy production and consumption processes are major causes of climate change and global warming. In this paper, a smart energy storage and conservation model based on fuzzy logical controller was proposed to achieve maximum energy efficiency for smart antenna design in modern 5G Communication. For the initial level the proposed model regularly monitor the energy levels of different industrial components and then allot the energy as per the requirement of the components. If there any excess allocation required, then the proper requirement will request by the operator. Once the request is valid, the requirements will allocate to the components. The biggest factor that provides energy efficiency for smart antenna design is thermal insulation. Consuming less fuel means releasing less harmful gas into the atmosphere.

Keywords:

Energy, Conservation, Efficiency, Consumption, Fossil Fuels, Industry, Greenhouse, Fuzzy Logical Controller

1. INTRODUCTION

From an economic point of view, 70% of the energy consumed is supplied from abroad [1]. Efficient use of energy is essential to reduce dependence on foreign energy and leave a more livable world for future generations [2]. Preventing energy from escaping to the environment by using any insulating material is called insulation [3]. Insulation in buildings, hot and cold piping is an important energy saving method. In many countries, large amounts of energy are used for heating and cooling [4]. Insulation is important not only for energy savings, but also for safety and comfort at work. When plants are operating buildings and residences are efficiently and accurately insulated. The energy efficiency for smart antenna design was increases while also providing significant cost savings [5]. Also, insulation work is permanent and generally maintenance free. But more importantly, energy conservation prevents harmful waste gas emissions and prevents global warming [6]. Today, as fossil energy resources are dwindling around the world, renewable and alternative energy sources are increasingly targeted. However, studies in this direction have not yet reached a level that can meet the demand.

Century, human life has become more comfortable with the development of technology, but energy consumption has increased [7]. Today, technological products are widely used in all areas of life. Like other countries, with increasing population in our country, energy consumption is increasing significantly [8]. Energy efficiency for smart antenna design in our country has reached very important dimensions. Long-term sustainable economic growth depends on concrete steps to be taken in energy efficiency for smart antenna design [9]. Increasing energy expenditure in our economy means the current account deficit increases, and this energy is imported [10]. On the other hand, dependence on exports is increasing. There are two ways to break out of this cycle. On the one hand to increase the number of energy resources and the level of energy production, on the other hand to create awareness among the consumers, to use the available energy efficiently and to avoid unnecessary waste [11]. To meet the energy needs of such people from domestic sources and reduce dependence on foreign sources, increasing energy production and efficient use of energy is critical [12]. Sustainable energy means conservation of limited resources, efficient use of energy resources and energy conservation [13]. When the United Nations Industrial Development Organization was asked to prepare an energy management system standard, an International Organization for Standardization (ISO) began an immediate study [14].

Energy efficiency for smart antenna design refers to reducing energy consumption per unit of service or product volume without reducing production quality and quantity in industrial enterprises. The main objective of these papers is,

- Ensuring efficient use of energy used in industries. This means ensuring that all machines used in factories use as little or as much energy as they need.
- Avoiding unnecessary energy consumption by the industrial machines. This application calculates the maximum power demand of the devices and provides their usable power.
- Reduce the burden of energy costs on the economy and protect the natural environment

2. RELATED WORKS

Teo, T et al. [1] discussed an energy is the fuel and energy resources of a country, which includes the receipt, transfer, transformation and utilization of various forms of energy and energy resources. It is the intersection point of the dynamic, economic and social elements of social development and a regulating factor in ecological and economic space. Pan, C et al. [2] expressed the state of industry and individual enterprises, on the one hand, reflects the state of the environment, on the other - the state of economic development and the quality of human thought. Michalczuk, M et al. [3] discussed the Energy audit is a basic element of the system to improve the efficiency of the use of fuel and energy resources. Energy audit is an integral part of a set of measures to improve the company's performance. Sutharasan, M et al. [5] expressed an Energy analysis is the collection and analysis of information on the consumption of fuel and energy resources in order to obtain reliable data on the efficiency of their use, identify opportunities for improving energy efficiency for smart antenna design with the development of energy saving measures and reflect the results obtained. Sockeel, N et al. [6] discussed the Human society's needs for various forms of energy, mainly electricity, are increasing rapidly. Only coal, oil, natural gas and nuclear fuel are used to obtain it in increasing quantities. Recently, non-traditional energy generation such as wind power plants, hydropower plants (HPPs) on small rivers, solar energy, biogas plants are becoming more widespread.

Ramesh, G et al. [8] expressed the most urgent strategic tasks in the world economy at the present time is to reduce its energy intensity. In this regard, based on an overview analysis, a theoretical review of existing definitions in this area is carried out; the conclusion is confirmed that there is no clear point of view chosen by the majority of scientists in scientific information sources. Rex, M et al. [9] discussed the Energy conservation is a way to implement a set of measures to reduce energy consumption, at least ensuring safety. The energy efficiency, in turn, the degree of conformity of the result (final result) takes into account the activity of specific types of energy resources used or consumed their energy storage at a certain time or for a certain period of time. Gopi, B et al. [11] expressed the criterion of energy efficiency for smart antenna design can be formulated as a certain result of an activity with a low expenditure of energy resources or a maximum result of an activity with a certain expenditure of energy resources without high expenditure.

3. PROPOSED MODEL

In a market economy, the goal setting, motivation for entrepreneurial activity is profit extraction, the desire to achieve its maximum value under specific conditions of production and sale. Obviously, before proceeding with the definition of directions and specific ways to solve this problem, it is important to understand what energy saving and energy efficiency for smart antenna design mean. Energy measurement is carried out as follows are shown in Fig.1:

- Obtaining objective data on the amount of energy resources used;
- Determination of energy efficiency for smart antenna designindicators;
- Determine potential for energy savings and increased energy efficiency;
- Develop a standard, publicly available list of measures for energy conservation and energy efficiency for smart antenna design improvement and their cost evaluation

Suppose there is a system of bodies consisting of both conductors and dielectrics. The bodies of the system can make small quasi-steady motions. The temperature of the system is maintained constant, that is, heat is supplied to the system or removed from it if necessary. The dielectrics included in the system are assumed to be isotropic, and their density is set constant. In this case, the ratio of the internal energy of the bodies not in contact with the electric field does not change.

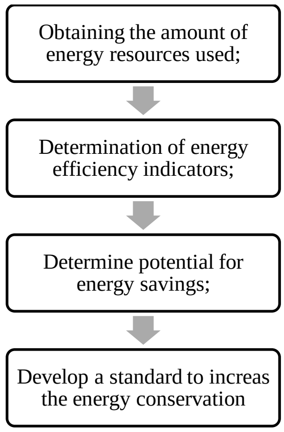


Fig.1. Energy measurement factors

- Power system: a collection of all types of energy resources, their methods of production (extraction), transformation, distribution and use, as well as technical means and institutional complexes that ensure the supply of all types of energy to consumers.
- Energy conservation: an organizational science, practice, information activity aimed at reducing consumption (losses) in the process of extracting, processing, transportation, storage, production, use and disposal of fuel and energy resources by government institutions, legal entities and individuals.

Let us consider variations of energy changes in such a system. In a large number of cases it is possible to calculate the mechanical forces acting on an electric field using the law of conservation of energy, and it is sometimes easier to do this than to consider the direct effect of the field on the individual. Body parts of the system. In this case, they work according to the following scheme. Suppose it is necessary to find the force acting on the body in the field. A body is assumed to be moving. If an electric field is created in a conducting medium (conductor), an ordered movement of electric charges arises in it - an electric. When electricity passes through a uniform conductor, heat called Joule heat is released.

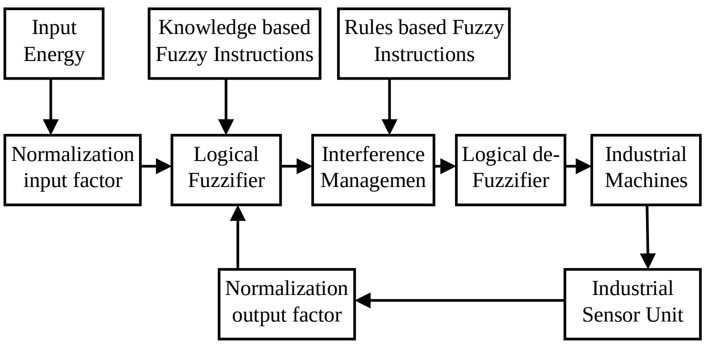


Fig.2. Proposed model

The amount of heat released is determined by the Joule-Lens law shown in Eq.(1):

$$P_a = I^2 R = I * A = \frac{A^2}{R} \quad (1)$$

where, P_a = Transmission power, I = Required current, R = Transmission resistance and A = Transmission Area.

It should be noted that during the passage of electricity, heat can not only be released, but also absorbed, which is observed when the current passes through the junction of dissimilar metals. This phenomenon is called the Peltier effect. The work of Coulomb forces ($x(a)$) on the motion of the charge (∅) is determined by the expression:

$$x(a) = P_a\,(\varnothing_1 - \varnothing_2) \tag{2}$$

This form of the law applies only to direct current, i.e., to such a current whose magnitude does not change with time. The amount of heat released in a conductor per unit time is called the thermal power of the current. Energy balance in electrical circuits is determined by the law of conservation and energy conversion. Let's write it in the following form:

$$A(t) = \Delta F + H \tag{3}$$

where,

$A(t)$ is the work done on the system by external forces,

ΔF is the change in energy of the system,

H is the amount of heat released.

We can calculate that if $A(t) > 0$, the external forces do positive work on the system and if $A(t) < 0$ then the external forces do negative work on the system. If $\Delta F>0$, then the energy of the system increases, and if $\Delta F < 0$, the energy of the system decreases. $H>0$, then heat is released in the system and $H<0$ means no heat is released in the system. In the general case the energy of the system consists of different types of energy - it is the energy of the electric field, and the kinetic energy of charged bodies and the potential energy in the gravitational field.

The strength of an electric field can be defined in terms of the charge and properties of the electric field. For a single conductor, that is, a conductor located far away from other conductors, the expression for the field strength is:

$$F = \frac{A*\varnothing_{11}^{2}}{2} = \frac{t^2}{2A} = \frac{t*\varnothing_{11}}{2} \tag{4}$$

Unlike a single conductor, the field of a capacitor is concentrated in the space between its plates. The energy stored in the capacitor can be determined by the formula: Accordingly, for the potential of a charged capacitor,

$$F = \frac{A*\varnothing_{21}^{2}}{2} = \frac{t^2}{2A} = \frac{t*\varnothing_{21}}{2} \tag{5}$$

The ratio of the field energy to the volume over which this field is concentrated is called the volume energy density of the electric field. By analyzing the above formulas, it can be seen that a change in the charge of a capacitor, its capacitance or voltage across the plates leads to a change in the energy of the electric field of the capacitor. To change the capacitance of a charged capacitor, for example by moving its plates, it is necessary to perform external mechanical work. This is because the plates are oppositely charged, and work is done against the Coulomb forces that attract opposite charges. If the capacitor is connected to an EMF source, in addition to mechanical work, external forces on the source also do work. However, if the process of discharging the condenser is carried out slowly, no heat is released:

$$P = I^2 * At = \left(\frac{\Delta w}{t}\right)^2 * At = \frac{(\Delta w)^2 * A}{2} \tag{6}$$

If 't' is large enough (tends to infinity), then the amount of heat released 'P' will be very small. Suppose there is a system of bodies consisting of both conductors and dielectrics. The bodies of the system can make small quasi-steady motions. The temperature of the system is maintained constant, that is, heat is supplied to the system or removed from it if necessary. The dielectrics included in the system are assumed to be isotropic, and their density is set constant. In this case, the ratio of the internal energy of the bodies not in contact with the electric field does not change. Let us consider variations of energy changes in such a system.

4. RESULTS AND DISCUSSION

The proposed energy storage and conservation model (ESCM) was compared with the existing Fuzzy logic control of energy storage system (FLCESS), hybrid energy storage system (HESS), Fuzzy logic-based power management strategy (FLPMS) and Virtual inertia emulator-based model (VIEBM).

4.1 MANAGEMENT OF SECONDARY ENERGY RESOURCES

Energy obtained during any technological process as a result of non-utilization of primary energy in the form of a by-product of the main product and not used in this technological process. For example, after heat exchangers, steam obtained in technological processes can be used to heat rooms. If the charge moves in an electric field along a closed path, then the work done by Coulomb forces is zero in this case.

In order for electricity to flow for a long time in an electric circuit, it is necessary to have a part of the circuit in which, in addition to Coulomb forces, forces act on free charges, the nature of which is different. Coulomb is - external forces. Third-party forces work on special devices - at a charge on current resources. So, for example, in chemical current sources, external forces arise as a result of chemical reactions.

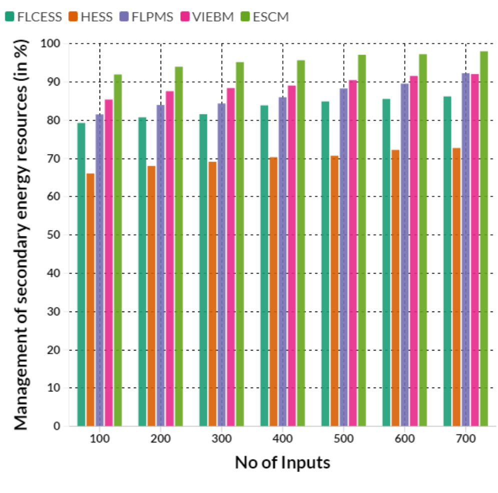


Fig.3. Management of secondary energy resources

The Fig.3 demonstrates the management of secondary energy resources. In a saturation tip, the proposed ESCM model obtained 95.64% of secondary energy management. In the same point the existing FLCESS reached 83.90%, HESS achieved 70.36%, FLPMS reached 85.98% and VIEBM obtained 89.07% of secondary energy resource management.

4.2 EFFICIENT USE OF FUEL AND ENERGY RESOURCES

Use of all forms of energy in economically reasonable, progressive ways in accordance with the current state of development of technology and technology and in accordance with the law. The numerically equivalent value of the work done by external forces to move a positive charge is called electromotive force (EMF).

Chemical current sources are capable of maintaining current in the circuit for a sufficiently long time until irreversible reactions occur. Chemical compounds are included in their composition. Therefore, if a chemical current source is closed with a conductor, the current value will decrease to zero over time as the energy of the chemical reactions in the source is consumed.

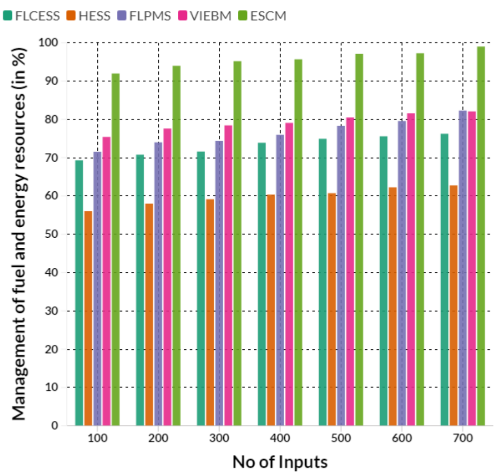


Fig.4. Management of fuel and energy resources

The Fig.4 demonstrates the management of fuel and energy resources. In a saturation tip, the proposed ESCM model obtained 95.64% of fuel and energy management. In the same point the existing FLCESS reached 73.90%, HESS achieved 60.36%, FLPMS reached 75.98% and VIEBM obtained 79.07% of secondary energy resource management.

4.3 PERFORMANCE INDICATOR

scientifically proven absolute or specific amount of consumption of fuel and energy resources (taking into account their constant losses) to produce one unit of products (work, services) for any purpose established by regulatory documents. The heat absorbed or released during the Peltier effect is greater than Joule heat and is determined by exposure.

Unlike Joule heat, which is proportional to the square of the current and is always released in the conductor, Peltier heat is proportional to the first power of the current and its sign depends on the direction of the current through the metal junction. Only in the case of solid metallic conductors is the work done by the current completely converted into heat. If the current does mechanical work (for example, in the case of an electric motor), then the current's work is only partially converted into heat.

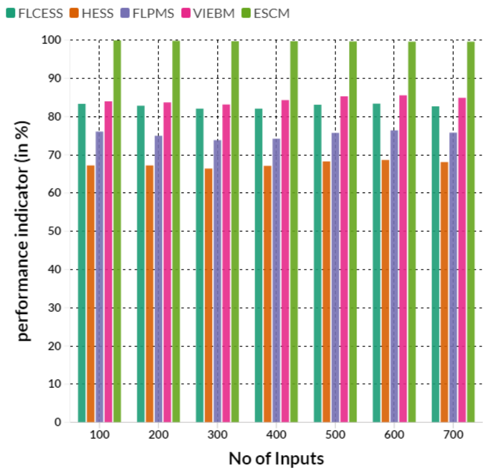


Fig.5. Management of performance indicator

The Fig.5 demonstrates the management of performance indicator. In a saturation tip, the proposed ESCM model obtained 99.68% of performance indication. In the same point the existing FLCESS reached 82.07%, HESS achieved 67.14%, FLPMS reached 74.20% and VIEBM obtained 84.29% of secondary energy resource management.

4.4 ALTERNATIVE AND RENEWABLE ENERGY SOURCES

Sources of electrical and thermal energy using the energy resources of rivers, reservoirs and industrial drainage, wind energy, solar energy, denatured natural gas, biomass (including wood waste), wastewater and solid domestic waste. In order for current to flow through the conductor for a sufficiently long time, steps must be taken to maintain the electric field in the conductor. An electrostatic field, i.e. a field of static electric charges, is not capable of maintaining a current for long periods of time.

As a result of the action of Coulomb forces on the conductor, such a redistribution of free charge carriers occurs that the field in it becomes equal to zero. Therefore, if a conductor is introduced into an electric field, the movement of charges arising in it will very quickly stop and the field potential at any point on the conductor will become the same.

The Fig.6 demonstrates the management of renewable energy resources. In a saturation tip, the proposed ESCM model obtained 99.68% of secondary energy management. In the same point the existing FLCESS reached 89.50%, HESS achieved 64.57%, FLPMS reached 87.31% and VIEBM obtained 93.73% of secondary energy resource management.

4.5 ENERGY SAVING INTENSITY

One of the main issues of economic development, and its essence lies in the use of a full range of effective measures aimed at increasing labor productivity, specific energy consumption for production. There are reversible chemical current sources - batteries. Such devices, when discharged, can be reset - charged -

that is, their performance can be restored by reversing chemical reactions using current from an external source.

Batteries store electrical energy while charging. The amount of energy a battery can store is determined by its capacity. Battery capacity is measured in ampere-hours. Circuits, i.e. circuits through which electricity can flow, current sources, conductors and capacitors can be part of a circuit.

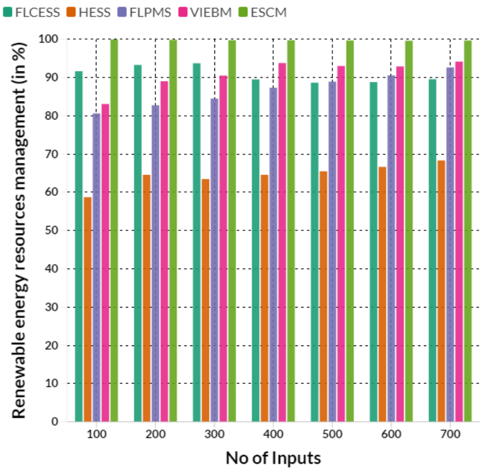
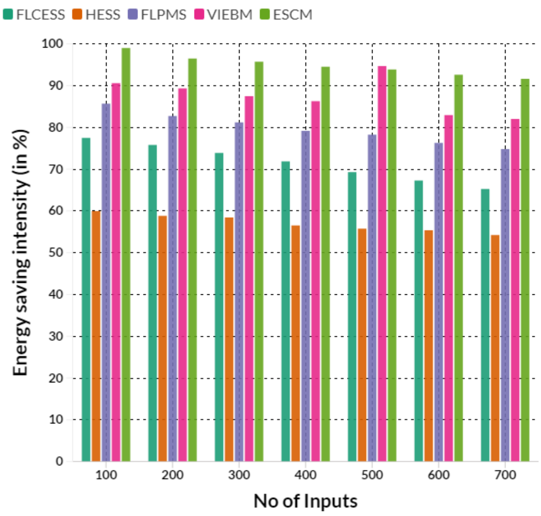


Fig.6. management of renewable energy resources



The Fig.3 demonstrates the management of secondary energy resources. In a saturation tip, the proposed ESCM model obtained 94.51% of secondary energy management. In the same point the existing FLCESS reached 71.87%, HESS achieved 56.51%, FLPMS reached 79.16% and VIEBM obtained 86.26% of secondary energy resource management.

5. CONCLUSION

In a large number of cases, it is possible to calculate the mechanical forces acting on an electric field using the law of conservation of energy, and it is sometimes easier to do this than to consider the direct effect of the field on the individual. Body parts of the system. In this case, they work according to the following scheme. Molecules, and both atoms and particles, their components - electrons, protons, neutrons, etc. have kinetic and potential energy. In a saturated tip, the proposed ESCM model obtained 95.64% of secondary energy management, 95.64% of fuel and energy management, 99.68% of performance indication, 99.68% of secondary energy management and 94.51% of secondary energy management. Hence the proposed model obtained the better results while compared with other existing models. Depending on the nature of motion and the nature of the forces acting between these particles, energy transfer occurs in systems of such particles in the form of mechanical work, in the flow of electric current, in heat transfer, a change in the internal state of bodies manifests itself in the propagation of electromagnetic oscillations. These relationships are very important in the analysis of nuclear transitions. In most macroscopic processes, the change in mass can be neglected.

REFERENCES

[1] T.T. Teo, T. Logenthiran and K. Abidi, “Fuzzy Logic Control of Energy Storage System in Microgrid Operation”, *Proceedings of International Conference on IEEE Innovative Smart Grid Technologies*, pp. 65-70, 2016.

[2] C. Pan and X. Xu, “The Analysis of Series Hybrid Energy Storage System for Regenerative Braking based on Energy Constraint Control aimed at Deceleration”, *CSEE Journal of Power and Energy Systems*, Vol. 2022, pp. 1-14, 2022.

[3] M. Michalczuk and L.M. Grzesiak, “Fuzzy Logic based Power Management Strategy using Topographic Data for an Electric Vehicle with a Battery-Ultracapacitor Energy Storage”, *The International Journal for Computation and Mathematics in Electrical and Electronic Engineering*, Vol. 56, No. 2, pp. 1-14, 2015.

[4] S.A. Syed, K. Sheela Sobana Rani and V.P. Sundramurthy, “Design of Resources Allocation in 6G Cybertwin Technology using the Fuzzy Neuro Model in Healthcare Systems”, *Journal of Healthcare Engineering*, Vol. 2022, pp. 1-8,2022.

[5] A.S. Nandhini and P. Vivekanandan, “A Survey on Energy Efficient Routing Protocols for MANET”, *International Journal of Advances in Engineering and Technology*, Vol. 6, No. 1, pp. 370-387, 2013.

[6] N. Sockeel, B. Papari and M. Mazzola, “Virtual Inertia Emulator-Based Model Predictive Control for Grid Frequency Regulation considering High Penetration of Inverter-Based Energy Storage System”, *IEEE Transactions on Sustainable Energy*, Vol. 11, No. 4, pp. 2932-2939, 2020.

[7] J. Gowrishankar, P.S. Kumar and T. Narmadha, “A Trust Based Protocol for Manets in IoT Environment”, *International Journal of Advanced Science and Technology*, Vol. 29, No. 7, pp. 2770-2775, 2020.

[8] G. Ramesh, V. Aravindarajan and Feny Thachil, “Eliminate the Interference in 5G Ultra-Wide Band Communication Antennas in Cloud Computing Networks”, *ICTACT Journal on Microelectronics*, Vol. 8, No. 2, pp. 1338-1344, 2022.

[9] M.J. Rex, T. Kiruthiga and V.A. Rajan, “FPSMM: Fuzzy Probabilistic Based Semi Morkov Model among the Sensor Nodes for Realtime Applications”, *Proceedings of International Conference on Intelligent Sustainable Systems*, pp. 442-446,2017.

[10] S. Kannan and G. Dhiman, “Task Scheduling in Cloud using ACO”, *Recent Advances in Computer Science and Communications*, Vol. 15, No. 3, pp. 348-353, 2022.

[11] B. Gopi, J. Gowri and T. Kiruthiga, "The Moment Probability and Impacts Monitoring for Electron Cloud Behavior of Electronic Computers by using Quantum Deep Learning Model", *NeuroQuantology*, Vol. 20, No. 8, pp. 6088-6100, 2022.

[12] T. Karthikeyan and K. Praghash, "Improved Authentication in Secured Multicast Wireless Sensor Network (MWSN) using Opposition Frog Leaping Algorithm to Resist Man-in-Middle Attack", *Wireless Personal Communications*, Vol. 123, No. 2, pp. 1715-1731, 2022.

[13] T. Karthikeyan, "Improved Privacy Preservation Framework for Cloud-Based Internet of Things", CRC Press, 2020.

[14] S.B. Sangeetha, R. Sabitha and B. Dhiyanesh, "Resource Management Framework using Deep Neural Networks in Multi-Cloud Environment", Springer, 2022.