ENERGY SAVING ROUTING SCHEME FOR IMPROVEMNT OF ENERGY EFFICIENCY WITHIN ELECTRIC GENERATORS USING SCHMITT TRIGGER

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Abstract

Electric generator produces electricity based on the fuel that is supplied. The generator efficiency could be impacted if longest route is selected for energy distribution by the electrons in the medium of transmission. In addition, per clock cycle, generator produce the electric signal but this signal density is decayed with every transmission. To resolve the issue, proposed system uses grid-based mechanism for the signal transmission through shortest route and to stabilise the power supply, Schmitt trigger is used. The grid-based mechanism clusters the similar electrons together and rest of the electrons are grouped into separate clusters. The signals are not transmitted by every electron but electron having highest form of energy is selected as cluster head that is used to transmit the signal towards another cluster head. This process continues until signal finally reaches its destination. The result of the proposed system is expressed in the form of packet drop ratio, lifetime of generator, throughput and average energy consumed.

Keywords: Grid based generator, Schmitt trigger, lifetime, throughput, average energy consumed.

Introduction

Electric generator produces electricity on the basis of excited electrons[1]. These excited electrons get the energy in the form of electric signals. As the electrons transfer the signals their energy decays and finally node in the form of electrons dies[2]. To revive the electrons within the transmission, again energy is required[3]. The total time required for the entire network of electrons to decay is known as lifetime[4]. The energy conservation is thus need of the hour[5]-[7]. The improvement in the following segments is desirable to improve the throughput and lifetime of the system.

- Forming grid for nearest node selection for signal transmission
- Stabilizing energy transmission

The energy conservation is achieved in the proposed mechanism by the use of nearest neighbour selection for signal transmission discussed solar system for energy efficiency in generator [8]-[10]. This means that least energy is consumed when signal is transmitted from source node towards destination node[11][12]. The stability is provided by the use of Schmitt trigger that managers the fluctuating values of the voltage and currents. The block diagram associated with the electric generator is gives in figure 1.

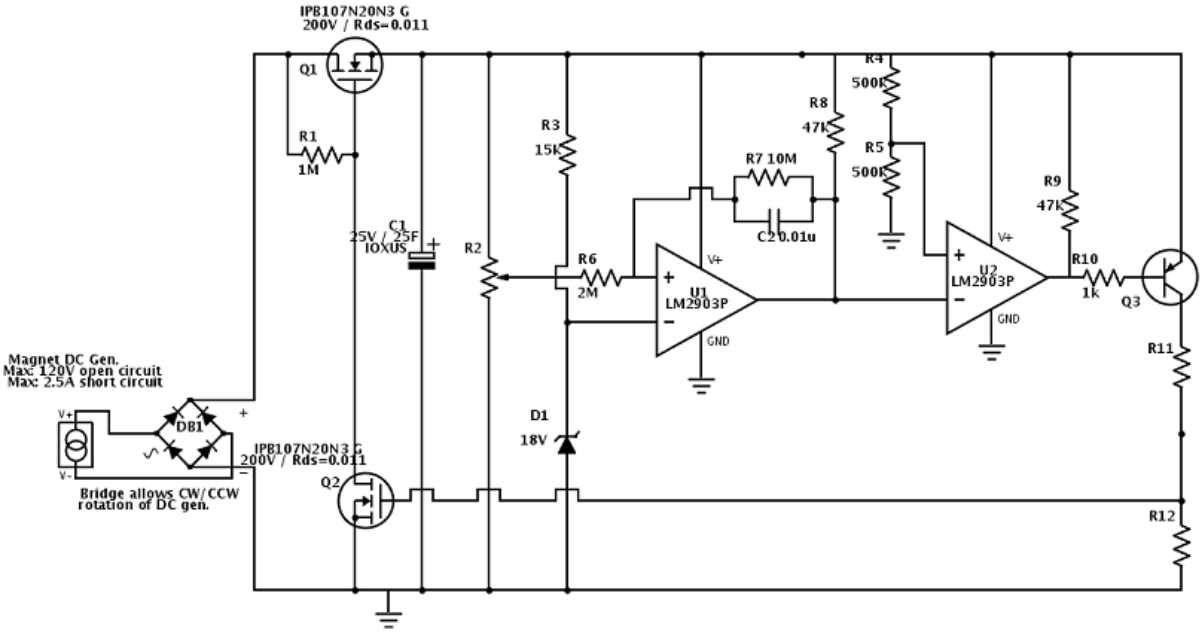

Figure 1: Block diagram of electric generator

Diodes will discharge energy in the coming new cycles to every electron within the transmission medium. On grabbing the energy electrons goes to excited state [13][14]. They come to ground state and emit energy which is observed by other neighbouring electrons. This process continues until signal is finally transmitted to the destination.

The rest of the paper is organised as under: section 2 gives the literature survey describing the mechanisms used to conserve energy through electric generator, section 3 gives the simulation setup and proposed methodology, section 4 gives the performance analysis and result, section 6 gives conclusion and future scope, section 7 gives the references.

Literature survey

The energy conservation is critical and researchers worked towards achieving that using distributed energy efficient mechanism. This mechanism ensures that energy distribution becomes symmetrical. Energy consumption reduces since nearest neighbour is selected for signal transmission.

V. Salas in 2006 proposed a convenience of the grid with distributed power supplies brings down the costs for connecting renewable energy resources to the grid. For connecting with the grid, the power supplied should qualitatively and quantitatively meet the needs of the power sector for interconnecting supplies. So we are monitoring the temperature and other physical parameters of the panel in order to produce electric power qualitatively and quantitatively in good manner by increasing the efficiency.

Nedumgatt *et al.*, 2011[8]utilized energy and exergy investigation to rate the impact of winding stream safeguard on a water based PV/T panel's productivity and found a greatest PV/T proficiency of 68% and a PV effectiveness of 13-13.8%. Moreover, the creators reasoned that the essential energy-sparing productivity had expanded from 79% to 91% when mass stream rate expanded from 0.011 kg/s to 0.041 kg/s [15][16].

A. Chouder in 2012 discussed wireless sensor network as it will enable the sensors which are placed over an object. So, these systems can be combined with electrical, mechanical and environmental monitoring sensors to be a part of remote, control system and lot more applications. The present electricity grid is way more complex due to its inability for expanding and continued growth in electricity demand. The present grid is non-uniform and has less intelligence due to the fact that the load side does not able to communicate with the supply side[17].

C.L Hou in 2015 proposed wireless sensors based mechanism as it plays a vital role in case of sensing of parameters that we want to sense and automate the process. Therefore, instead of using wired units, which also increases the complexity of the circuit we are moving on to wireless sensor units which uses some radio frequency propagation techniques to transmit and receive the signal and accordingly operate in order to fulfil the need of the end user.

A.l Shah in 2016 [10]discussed temperature rise as a major cause for reduction in efficiency and in order to overcome it we have to maintain the temperature of the panel at a prescribed level. Even though there are many cooling methods available we are going for arduino based cooling because it reduces the manpower needed to clean and cool the panel if necessary and another main purpose of using this arduino is its low cost and more efficiency and also it issues the user a complexity free integrated development environment(IDE). Generally system based on microcontrollers have been abundantly used for monitoring of the general physical parameters and to be specific, in solar energy application it serves a great purpose by significantly increasing the efficiency.

Al-Waeli *et al.*, 2016[9]analysed the impacts of bifacial air based Photovoltaic Thermal authority (PV/T) under the principal law of thermodynamics. The creators planned four bifacial modules comprising of two way types which are a solitary way and a twofold way parallel stream. The investigation found that the two parallel ways have the best proficiency around 45 to 64 %. The energy as consumed completely, nodes becomes dead and signal cannot be transmitted forward. This is a problem and causes packet drop ratio. Lifetime of the network is reduced and throughput is decreased[18].

B.K Bose in 2018 discussed many nonconventional sources available for production of electricity, one of the abundantly available source is the light i.e., Solar radiation through which we can able to produce electricity by means of photovoltaic cells in form of a panel. The panel will receive sunlight and it will convert photons falling over the panel in form of light into electricity and gives output as dc power. Despite of the availability of wind as a renewable source for production of electricity we are opting solar as a source because of the complexity involved in the construction and commissioning of wind farm. Since the solar panels are to be kept in an open space in order to produce electricity, they will get heated up due to the continuous operation and continuous exposure to sunlight which will affect the efficiency of the panel.

Wang, 2011[31] discussed the progressions that prompts the advancement of nano generators. It was discussed that as the size of electronic gadgets was shrining yet size of the battery continues as before, this could bring about mastery by battery when contrasted with gadget itself. Number of nano system utilized for sensors could be enormous. The force required if there should be an occurrence of enormous nano systems could likewise be more when contrasted with conventional sensors. To address the difficulties, self-controlled sensors were proposed by the author in 2005. The energy reaped from the climate was gathered by sensors and in this manner energy protection was accomplished. This writing additionally successfully discussed the development of an adaptable piezoelectrical nanogenerator. Two-dimensional piezoelectric zinc oxide nanosheets were added inside the nanogenerator to change over mechanical energy into electrical energy. The effect of surface morphologies and direction were considered in this writing. The coatings techniques and ecological impact on execution of nanogenerator was not discussed.

Wang, Lin and Wang, 2012[32]proposed an arc shaped triboelectric nanogenerator. Contact electrification between the polymer thin film and metal thin foil was utilised. Finite element simulation was conducted to study the working of proposed nano generator. The output voltage, current density and energy density after simulation appears to be 230 V, 15.5 uA/cm^2, 128 mW/cm^3. The energy efficiency achieved was also high and in the range of 10-39%. Environmental variables could increase the performance but not considered in this approach. In addition, metal coating could introduce stability and reliability which is missing in this nanogenerator.

Tang *et al.*, 2014[33]discussed power transformed and triboelectric nanogenerator that was intended to give regulated power output for running electronic circuits. The design was based upon mechanical agitation that drives TENG. It also lowers the output voltage by decreasing output charges. Enough power generated with this nanogenerator to send out an infrared signal. Energy conservation greater than 95% was achieved through PTM-TENG.

Yu *et al.*, 2015[34]proposed an organic film based triboelectric nanogenerator that could be used as self-powered and high sensitivity based acoustic sensor to detect the underwater target at low frequency as low as 100 Hz. The TENG arrangement for the detection uses three dimensional self-powered acoustic sensors operating at frequency of 110 Hz under acoustic pressure of 144.2 dB. The maximum open circuit voltage and short circuit current underwater was 65 V and 32 uA. This study extends the utilization of TENG from atmosphere to water, The problem with this approach however is effect of humidity and temperature was not discussed in the detection process.

Wang, Lin and Wang, 2015[35]discussed energy conservation within the sensors in the field of information technology. Technique of self-powered sensors that uses the ambient environmental energy to derive the operation becomes need of the hour. To achieve this twofold mechanism was discussed. First approach requires environmental energy harvesting device that could be used by the sensors. In the second approach, self-powered sensors could be created that could be triggered and get the energy from the ambient environment as energy goes below the threshold. The development in TENG(Triboelectric nano generator) for mechanical energy harvesting can be used as mechanical sensors because attributes associated with electrical signals are directly proportional to input mechanical behaviour. In addition, behaviour of the nanogenerator could be greatly influenced by environmental variables like temperature and humidity. As a UV sensor, thermal aspect was considered but humidity factor was not considered in this review. Metal fabrication was also not considered that could lead to voltage and current stabilization.

Lin *et al.*, 2017[36] proposed a self-powered wireless body sensor network (BSN) system for heart-rate monitoring by the integration of downy-structure-based triboelectric nanogenerator (D-TENG), a power management circuit, a heart-rate sensor, a signal processing unit, and Bluetooth module for wireless data transmission. The BSN system converts energy generated from human walk into electrical energy. Using this system maximum power of 2.28 mW with total conversion efficiency of 57.9% was delivered at low operation frequency. This energy is capable of driving a BSN system. The heart rate from the body was sent to heart rate monitoring circuit. A Bluetooth circuit was used to send and receive the information about heart rate. The information can also be displayed on the mobile phones in real time manner. By combining TENG based generator with TENG based sensors, a BSN system was created. This system however was not demonstrated at high temperature and variable humidity levels. This means stability and reliability could be at stake during heart rate monitoring.

Wang *et al.*, 2017[37] proposed an approach to generate energy from the vibrations. The vibrations as source of energy was considered over a wide frequency range. An elastic multiunit triboelectric nanogenerator (TENG) was configured to handle low frequency vibrational energy. This can result in maximum output power density of 102 W/m^{-3} at frequency as low as 7 Hz and maintain its stable current outputs from 5 to 25 Hz. A self-charging power unit was combined with TENG along with high capacity capacitors for achieving high power management efficiency of 45.6% at

20 Hz. The performance of the system was enhanced but impact of humidity and wired coating that increase stability and reliability was not discussed.

Rathore *et al.*, 2018[38] conducted review on triboelectric nanogenerator. Triboelectric generator works to achieve energy efficiency as well as source of energy. This works on the principal of triboelectric effect and electrostatic induction. TENG can be used to extract many forms of energy from environment. The utilization of TENG was effectively discussed as power source for many wearable devices. Along with the utilization working environment could be discussed which was missing and no coating and fabrication mechanism was discussed to enhance reliability.

Ali *et al.*, 2019[39]proposed a fabrication mechanism of stainless-steel controlled layer thickness and uniform particle distribution capability. The film was fabricated with starting electron beam power percentage of 3-10%. In case the deposition thickness was increased, surface thickness was reduced by 38%. It was also discovered that surface hydrophobic nature tends to be weakened in case temperature of fluid increases. This work comprehensively discussed the impact of temperature but fabrication with the steel could enhance reliability which was missing in this literature.

W. Tang, T. Zhou, et al, [40]in the year 2014, invented a power transformed and managed triboelectric nanogenerator (PTM-TENG) in which the main intension was to have an output power which is regulated and can be used for driving various electronic devices. Synchronized mechanical agitation was used in the designing of TENG that lowers the output voltage by switching the connections for capacitors and also increases the output charges. By this method an energy preservation efficiency of more than 95% was demonstrated. This device generates enough power so required for sending out an infra red signal and also proved to be helpful in the detection of external mechanical triggering actions.

The discussed mechanisms increase energy efficiency but throughput is significantly lowered. To enhance the energy efficiency stability is required that is accomplished with Schmitt trigger. The simulation setup is given in next section.

Simulation Setup and methodology of work

The simulation setup involves initial parameter that are used to enhance energy efficiency. The table 1 shows the parameters used in the proposed model.

Table 1: Simulation Parameters

Parameter	Description
Power(Watts)	Initial power used within the simulation
Voltage(V)	Initial voltage supply
Current(I)	Initial Current value that must be close to voltage supply
Throughput	Total Output
Average Energy Consumption	Amount of energy consumed by each node divided by total number of nodes

The methodology of work using Schmitt trigger and shortest path routing is given in figure 2. The result obtained from the simulation is presented in this section as well[19][20]. The initial value of voltage and current is presented as 100V and 100A. the initial power distributed to the generator is 0.5W. The initial screen describing the distribution of nodes randomly. In the proposed mechanism shortest distance is located. Once the distance is located, route is finalised and signal is transmitted. The mechanism ensures better energy efficiency, throughput and packet drop ratio.

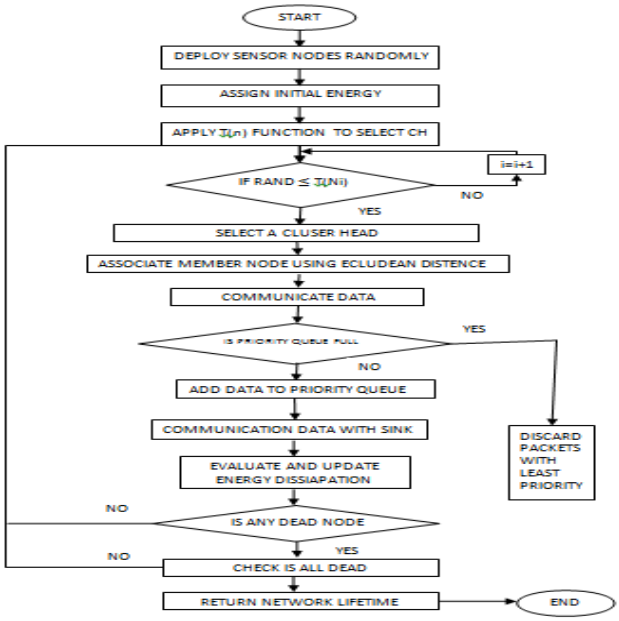

Figure 2: Proposed methodology

Figure 3 shows the initial screen from the simulation.

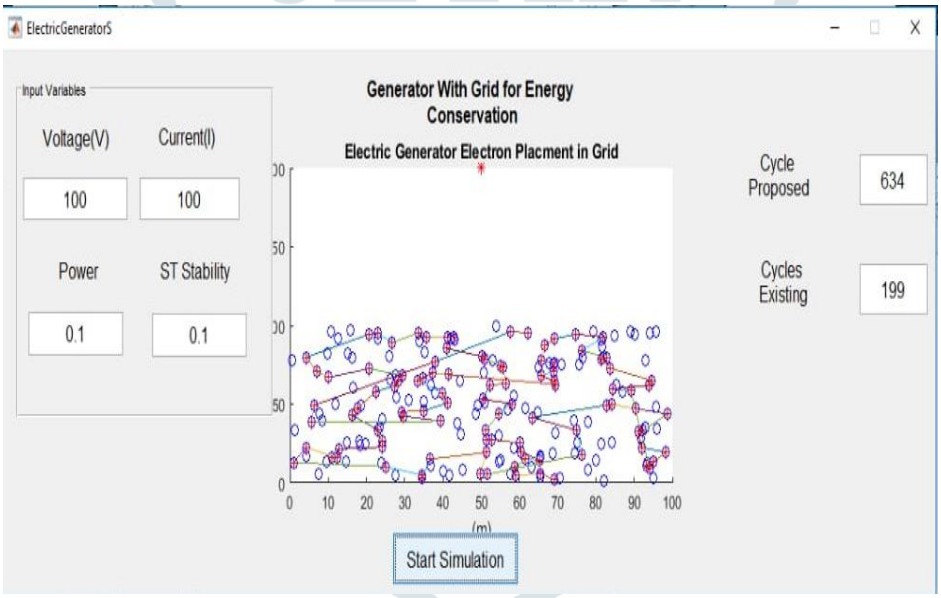

Figure 3: Screen for the proposed mechanism

Uniformly distributed nodes with voltage and current specifications are indicated with the figure 3. Mechanism ensures better energy efficiency and better lifetime in terms of cycles.

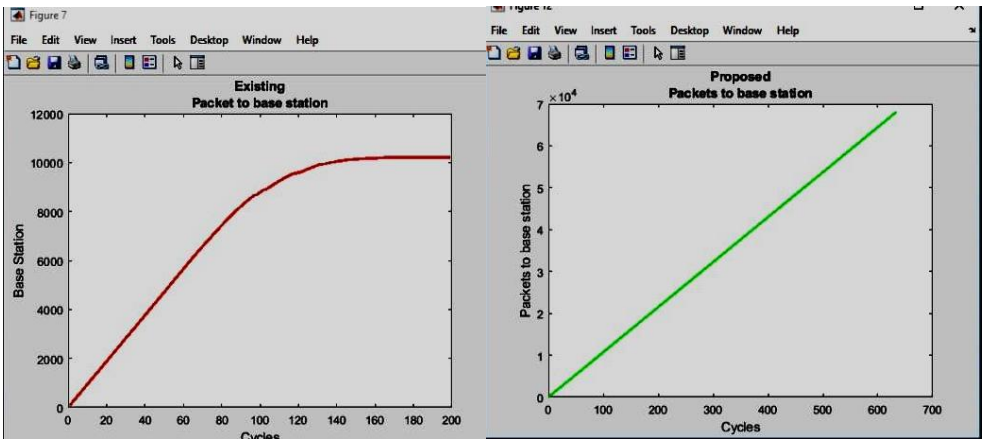

Figure 4: Packets to base station

Figure 4 indicates the packets to base station that is best for the proposed mechanism. The proposed mechanism uses Schmitt trigger that ensures optimality. The optimal mechanism results in better transmission of signals towards the destination nodes.

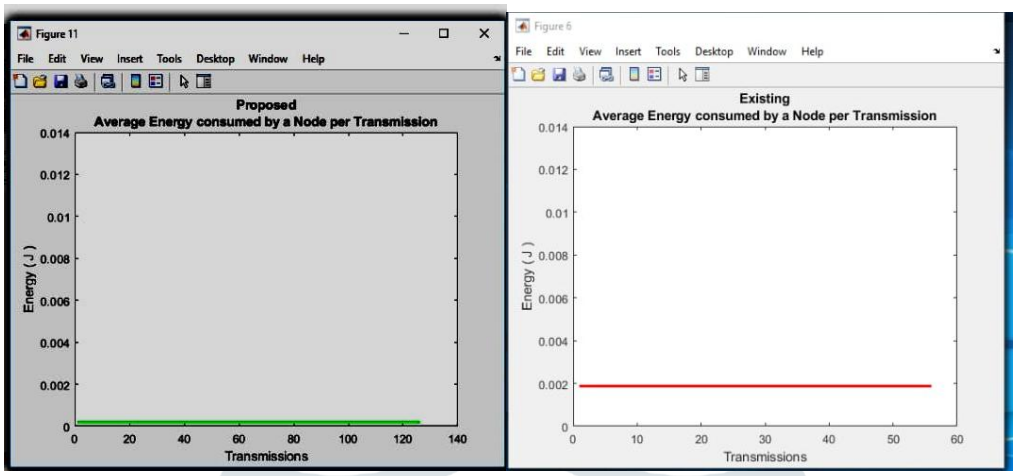

Figure 5: Average energy consumed of proposed and existing mechanism

Figure 5 shows that energy consumption in the proposed mechanism is much less as compared to existing mechanism. The primary reason for the same is grid formation and stability factor introduced due to Schmitt trigger.

The proposed methodology first of all distributes the electrons within transmission mechanism randomly[21]. After distributing the nodes, energy is allocated to the nodes. Signals are transmitted by determining the best possible node having highest energy. This node is denoted with CH. The nearest nodes are selected using the Euclidean distance. There is a buffer known as queue that will be used to aggregate the signals across CH[22]. Nearest nodes will be selected for signal transmission during a cycle. During the cycle, fluctuating voltage and current may leads to short circuit. This is tackled using the Schmitt trigger attached with the CH. Overall result will be improvement in throughput and energy efficiency.

Performance analysis and result

The result obtained from the simulation includes parameters such as throughput, packet drop ratio, average energy consumed and number of signals transmitted towards destination. The result is expressed in table 2.

Table 2: Throughput using the Schmitt trigger and without Schmitt trigger

Cycles	Throughput(Without Schmitt Trigger)	Throughput(With Schmitt Trigger)
100	600	1000
200	689	1569
300	785	1600
400	856	1789
500	956	1825

The cycles for the proposed and existing system are observed. Total output indicating the signals transmitted towards the base or destination nodes. Higher the throughput better it is. The plot for the table 2 is given as under:

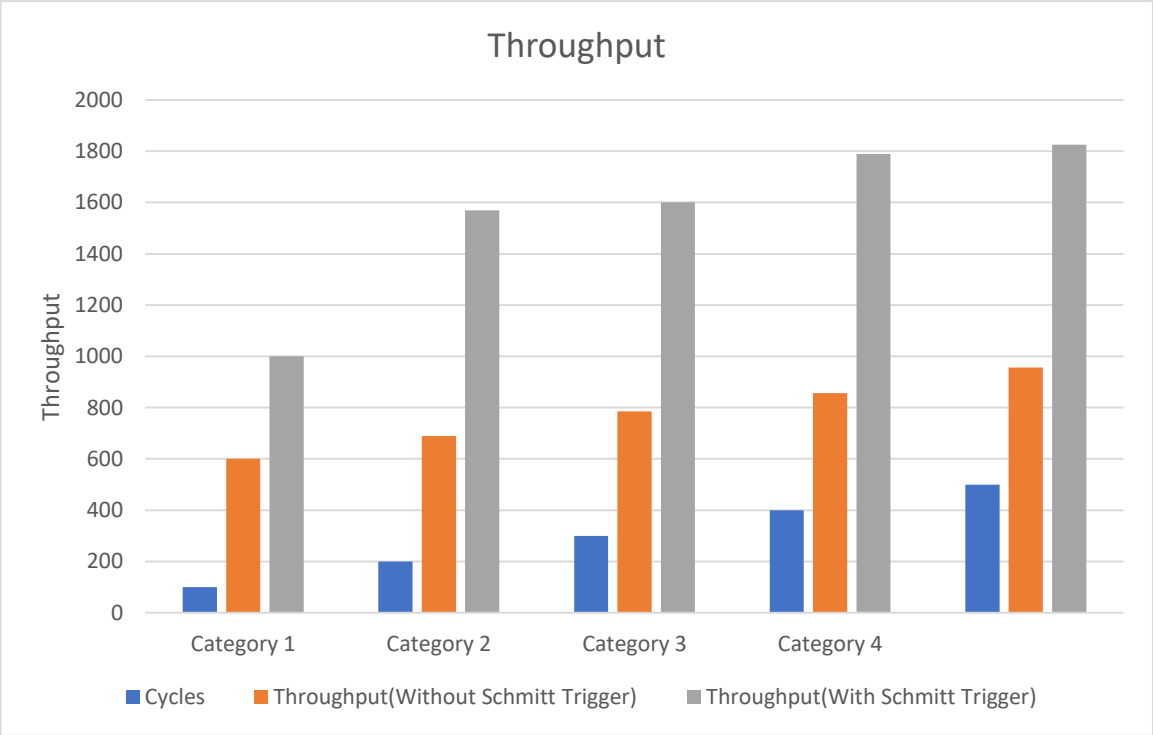

Figure 6: Throughput for the existing and proposed system

The throughput is improved by the margin of 30 to 40%[23]-[26]. The next parameter for evaluation is packet drop ratio. This parameter gives the optimised result and is estimated as total signals transmitted to total signals received. Table 3 gives the result for the same

Table 3: Packet drop ratio

Cycles	**Packet drop ratio(Without Schmitt Trigger) in %**	**Packet drop ratio(With Schmitt Trigger) in %**
100	6	1
200	7.89	1.5
300	8.5	1.6
400	8.56	1.7
500	9.26	1.85

The drop ratio is expressed in %. The packet drop ratio indicates the signals which are transmitted but not received at the destination nodes. The plot expressed the same.

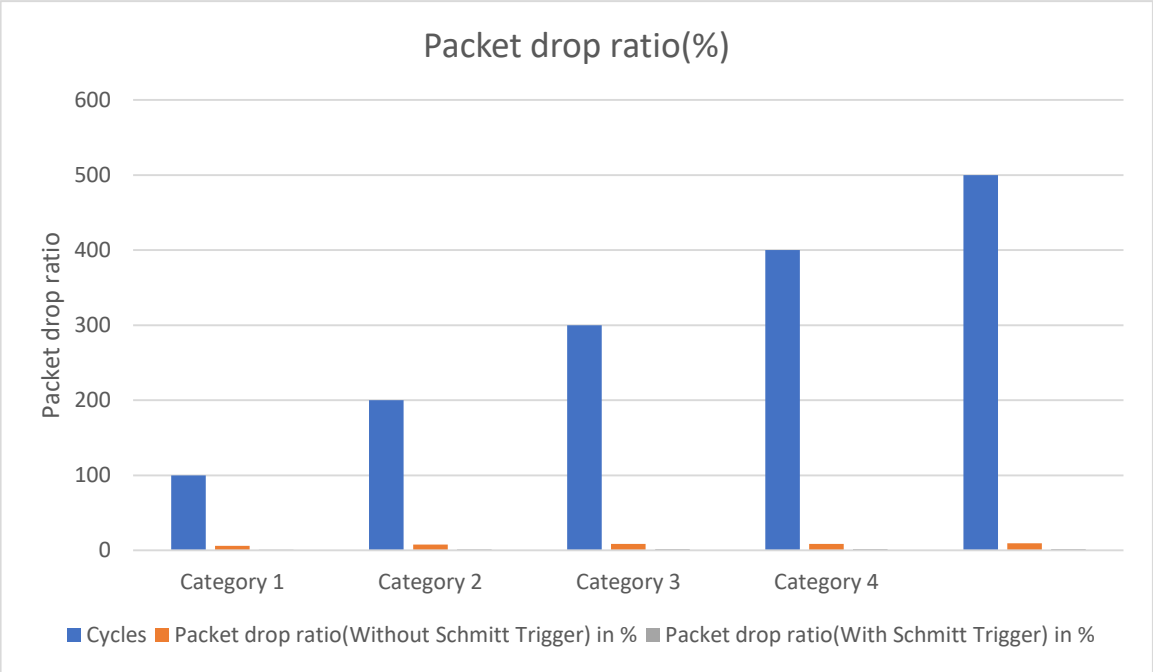

Figure 7: Packet drop ratio in percentage

The packet drop ratio is critical parameter that expressed the optimization of result using Schmitt trigger[27]-[30].The packet drop ratio is optimised by the factor of 15%. Next parameter that is observed is average energy consumed. The table 4 shows the average energy consumed by the nodes.

Table 4: Average energy consumed

Cycles	**Average energy consumed(Without Schmitt Trigger)**	**Average energy consumed(With Schmitt Trigger)**
100	0.05	0.01
200	0.07	0.015
300	0.08	0.016
400	0.1	0.017
500	0.25	0.025

The average energy consumed using the Schmitt trigger is reduced. The shortest distance nodes are selected for transmission of signals thus least possible energy is consumed. The plot expresses the result.

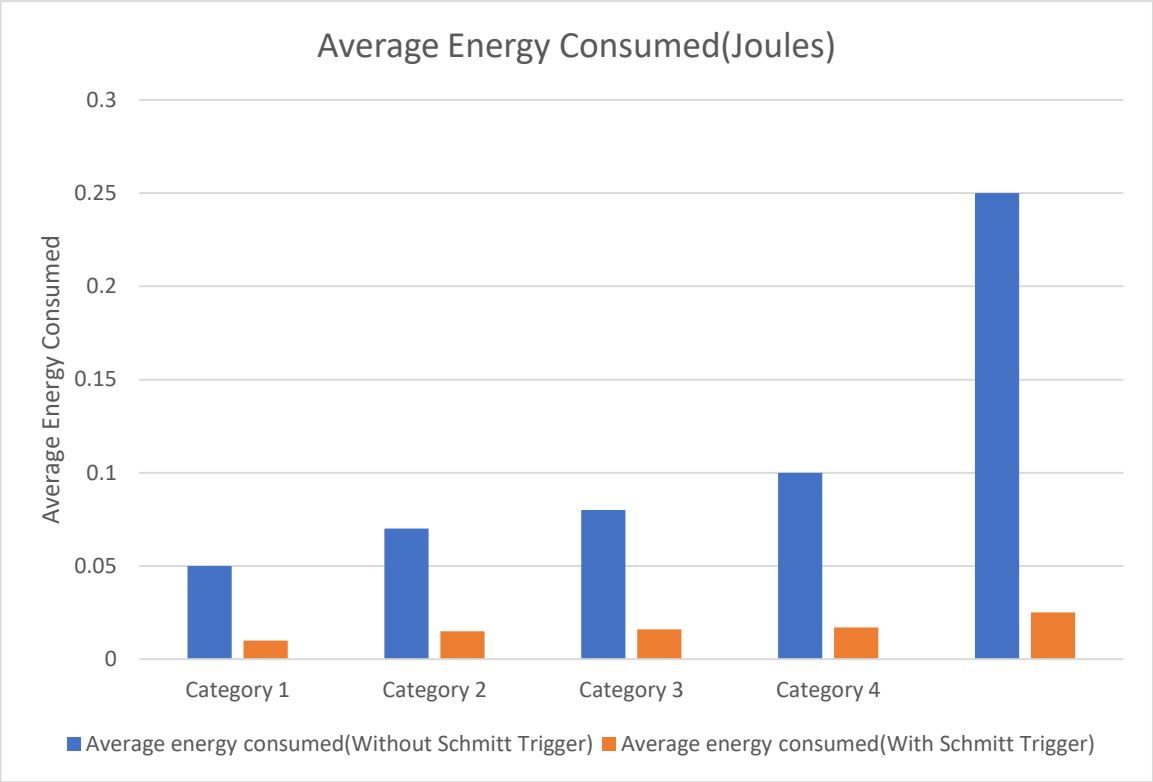

Figure 8: Average Energy Consumed

Signals that are transmitted towards the destination node are the next parameter that is used for evaluation. This parameter should be increased for optimality. This parameter shows improvement and hence proves worth of study.

Table 5: Signal to destination

Cycles	**Signal to destination (Without Schmitt Trigger)**	**Signal to destination (With Schmitt Trigger)**
100	5000	6500
200	5593	10920
300	6020	11290
400	7688	12098
500	8799	13020

The signals to destination are high in case of proposed mechanism. The primary reason for improvement is Schmitt trigger that stabilised the voltage supply. The mechanism shows improvement by 10%. This is expressed in the next plot.

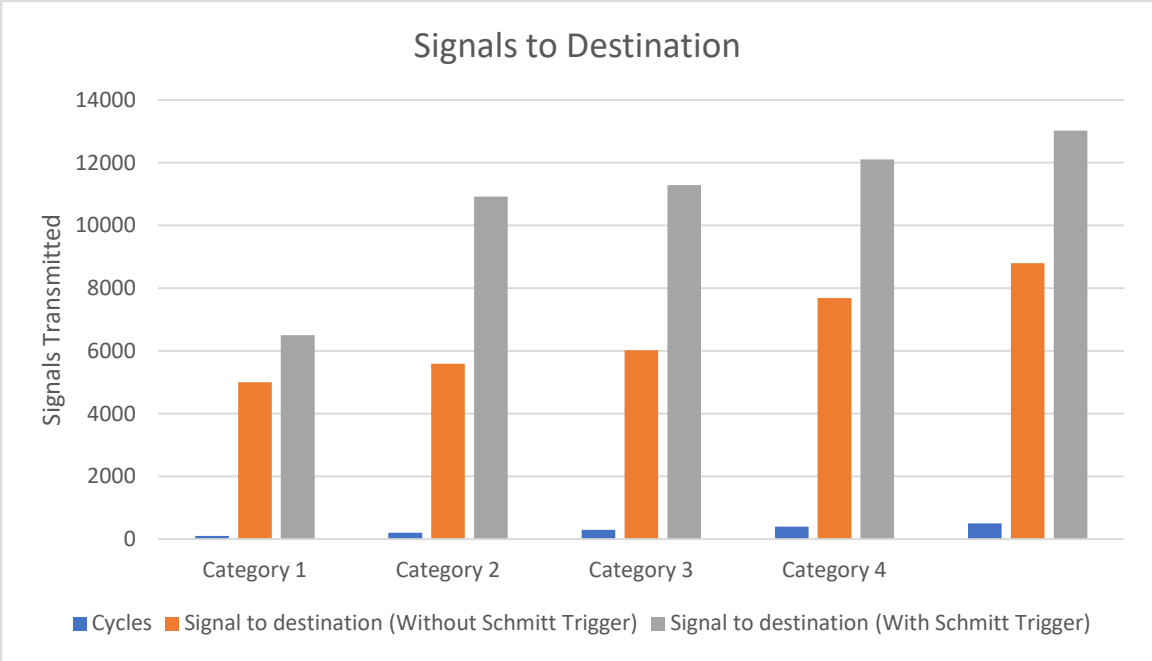

Figure 9: Signals transmitted per unit cycles

The signals to destination are highest for proposed system. The result obtained with every parameter is better and hence placing Schmitt trigger with shortest route optimise the electric generator and conserve energy.

Conclusions

Energy conservation is the prime objective of the proposed system. At the first phase, shortest route is selected by checking the energy and Euclidean distance. The node having highest energy and shortest distance from the destination node is selected for transmission. The stabilization is the next issue that is tackled using Schmitt trigger. The Schmitt trigger works in two phases. It retains the result for both half of the cycles. The result of packet drop is maintained within this trigger. This two way approach checks for the available node with highest energy and transmits the signal towards that node. Thus, packet drop ratio decreases significantly. Result in terms of energy consumed also shows improvement.

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