Design optimization of Solar Power Inverter using the GRA Method

*Ramya Sharma, M. Ramachandran, Vimala Saravanan, Chinnasami Sivaji

REST Labs, Kaveripattinam, Krishnagiri, Tamil Nadu, India.

*Corresponding Author Email: ramyasarma242@gmail.com

Abstract: *Among the most crucial components of a solar-powered system is an inverter. It is an apparatus that transforms the direct current (DC) produced by solar panels into the alternating current (AC) required by the electric system. Flashing hybrid solar inverter is the best solar inverter for home which offers the following features: - Its operating voltage is between 100-290V. - It has 700 VA of power. 5kW solar inverter price budget starts at $2,000 for excellent single-phase devices and $1,000 for existing datasets (like Sungrow) (eg Fronius or SMA). The most popular size, 5kW, can accommodate arrays up to 6.6kW in power. A solar charge controller can only function effectively during the day, because when the ultraviolet irradiance is strong and, the system's Voltage rating must reach the inverter at a moderate DC voltage level in order for it to function. Your photovoltaic systems and inverter operate at night power will be off. The inverter doesn't run overnight because it doesn't want to draw electricity. Instead, it rises again in the morning when the sun shines. Your home and solar system are connected to the utility grid. By switching to solar PV-based power generation from the airport's current conventional energy source, the carbon footprint of the facility can be decreased. Power distribution solar PV power facilities may be built in regions that are required to be broad and free of obstructions around runways. Based on first year operating data, the current study seeks to evaluate the operational efficiency of a 12 MWp solar-powered airport at Cochin Airport Limited (CIAL), India. With the aid of the most well-liked PV simulation programmes, such as Deterioration in quality and Solar Gis, the plant effectiveness is precisely rendered. The software's performance metrics were discovered to perfectly resemble the observed values. Economic and ecological studies of Kochi airports powered by solar energy attest to its efficiency in lowering carbon footprint, resulting in an airport with almost no emissions that is clean, green, and sustainable.Gray correlation analysis is widely used to measure the degree of relationship between sequences through the gray correlation coefficient. Gray relational analysis has been used by many researchers to optimize control parameters with multiple responses through gray relational grading. The fundamental tenet of the GRA approach is that the chosen option must have the "greatest degree of Green relation" to the positive-ideal solution and the "minimum of grey relation" to the negative-best answer. A technique for determining whether or not variables are connected and how much they are correlated is called grey correlation coefficient analysis. The primary method of determining these curves' geometric similarity is by the construction of characteristic series curves. Type of Solar Module, No of modules per string, No of string, No of inverters and No of transformers Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension. Stress Management in Healthcare Institutions in Work overload is got the first rank whereas is the Overtime is having the lowest rank.*

Keywords: *MCDM, Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension.*

1. INTRODUCTION

Several harmonics are introduced by a multilevel inverter driven by solar energy. For harmonic removal, a switching mechanism based on the Adaptive Neuro Fuzzy Induction System (ANFIS) is employed in this research. The switching mechanism for harmonic elimination in the case of a level cascade multilevel inverter is revealed by

understanding fundamental elimination for multilevel inverters [1].other parts, including solar panels, inverters (which change the Output current of solar panels into AC electricity), wiring, and support structures for the modules. The early grid-connected systems were made up of several hundred kilowatts of PV modules placed in a sizable central array that supplied power to the neighborhood's high-voltage electricity network similarly to a sizable thermal generator [2].An inverter is needed to change dc power into alternating current so that solar energy can be used to generate electricity. Because it is an electronic component that modifies the waveform of AC power as necessary, an inverter is to blame for issues impacting the reliability of the power. The electricity receiving electronics may be impacted by harmonics and waveform distortion as a result.After that, it can result in an issue with the electronic device. The properties of harmonics in the grid, PV system, and load are examined in this work. The PV system affects the majority of the grid's harmonics; however, because when inverter is supplied almost to its rated power, the percentages of vibrations are lowered, and the high frequencies of both the load depending on the type of load [1].A modern seven-phase inverter and a DC/DC transformer make up the solar power producing system. A DC/DC proposed converter combines an inverter and a DC-DC buck converter to transform a solar cell array's output voltage into two separate voltage sources with a variety of relationships. A full capacity converter and a capacitor choosing circuit are combined to create the new seven-level inverter. The full bridge converter transforms the three-phase DC voltage produced by the capacitor choosing circuit into a six different AC voltage from the two factors of the DCDC converter's output voltage. The suggested solar power production system does this by producing a sinusoidal waveform current that is supplied into the utility in phase with both the utility voltage [2].Using data from environmental sensors, estimate solar energy. In this study, a univariate second - order polynomial model was used to estimate solar power. The real solar power data obtained from the inverter is compared with the expected solar power data. The outcomes reveal details regarding the inverter's power generating effectiveness. Using a single PV system, the linear estimating model created for this study was validated. Although the type of data gathered and error rates may differ based on the inverter manufacturers, the coefficients reported in this study can be used with other PV systems. The proposed model must be modified in accordance with the electricity generation capacity in order to be applied to PV systems with various power generation capacities [3].systems for generating solar power. Both systems are coupled to an energy storage system and connected somewhere at output sides of independent converters. Storage batteries are typically situated close to wind and sun power generation systems, as each dc-dc converter in such a configuration is able to track the voltage and charge current of the energy storage system and appropriately optimizes the battery going to charge to give power to the load [5]. solar panel and a clamped diode inverter. By choosing an appropriate duty ratio, you can also raise the voltage level. As a DC-AC inverter, a transistor clamped multi-level inverter operates. A diode clamped non - linear and no inverter converts the output regulated Direct current from either the boost converter to AC voltage to supply AC loads [6].2,000 kWh.m-2 or more of solar radiation. Owing to the energy source's well-known benefits, isolated solar plants scattered throughout outlying locations are increasingly popular. To better serve the residents of these locations, this topic should be specified. A method for designing discontinuous photovoltaic systems is put out by numerous websites and software programmers [7].The average daily power supply in California is shown by solar power. Sunlight is accessible 50% of the time as during peak load period. Strategically, it makes sense to utilize more energy from the sun during the daytime and to stop using other energy sources, such as fossil fuels, at night and during certain rainy days in order to gradually diminish the usage of fossil fuels [8].A photovoltaic power-generation system uses a power inverter, so that as a result, it is evident that a stable energy qualities is collected with a relatively simple impedance network and that the electricity generated by the solar array is smooth as possible repurposed at a high power application notwithstanding the of its power supply. Moreover, the ripple characteristic of the solar arrays output current has been clarified [9].using modified capacitors and solar energy. This configuration extends the extra stages and generates two voltages, E and 2E, using shared capacitor components. By reducing the quantity of gate drivers and switch transistors, the topology can distinguish between all seven terminal voltage ranges. The six different inverter waveform that is solar-driven has a THD of 24.06 percent and an unfiltered output voltage of 0.53 percent, respectively. The simulation results showed that the seven-stage inverter powered by solar energy is feasible [10].Solar energy is converted into electrical energy by a PV system without producing any pollutants. A residential Power supply with a battery system provides the homeowner with more efficiency and financial advantages. To satisfy rising electrical demand during peak hours, this potential glycogen can be used. Residential power usage is lower at night, which puts less strain on the batteries [12].Utility solar power plants are significant in this situation. Although three-phase inverters remain the industry standard for big photoelectric (PV) power plant systems, single-phase inverters are now more frequently used in personal power plants and meter interconnection due to micro grid regulations. The development of single-phase generator solar inverter circuit topologies as well as control strategies is reviewed in detail in this work. Despite the present literature's abundance of reviews, this study offers a fresh perspective by concentrating

on cutting-edge string and micro integrator circuit topologies as well as control strategies. Based on newly developed DC-DC converter as well as emerging inverter topologies, both single- and multiple-level solar inverters are examined, and unique control techniques for two levels are thoroughly investigated [13].Thus, the MPP will keep moving based on the ultraviolet and temperature levels. There are significant power losses if the input power is far from the MPP. In order to ensure that its PV panel generates the most power possible, the MPP must be monitored at all times in Contemporary Solar Energy [14].In order to forecast PV power one day in advance, a solar minute regional analogue ensemble method is proposed. This method has several benefits, including the following: (a) it only uses freely accessible public data; (b) it has a low computational cost, making it suitable for application scenarios; and (c) it has a high prediction accuracy, outshining the three baselines checked [15].Electricity supplied to that same utility system is becoming more and more visible as the world's need for electricity rises. Because to their very high cost, many PV systems haven't yet been integrated into the grid. In the past, the cost of the PV-module(s) has been a significant factor in the price of these systems. The cost of the module(s) is currently on the decline, and as a result, the price of something like the inverter(s) connecting to the based clustering is increasingly apparent in the overall cost [16].The fundamental circuit equations of photosynthetic (PV) cells, as well as solar power systems, solar radiation, and temperature variations, are used to create a simulation model. A two-diode model of a PV cell is suggested for improved accuracy at low radioactive material. The model was evaluated using such a directly connected Voltage level and an AC capacity using an IGBT-based inverter. The series as well as parallel resistances for this design must be calculated using an additional iteration approach. There is a straightforward PV array modelling with parallel resistance available [17].India has a solar power plant installed. This study performs a 10 MWp grid-connected solar photovoltaic energy plant with the following goals. to investigate seasonal fluctuations in PV plant production using data from a SCADA system under observation. Using yearly energy yield, sequenced yield, reference yield, and system losses to assess technical efficiency to contrast the real performance reports with the PVSYST as well as Solar GIS simulations' data [18].solar energy production. The generation of solar energy systems serves as an off-grid system because the fishpond is located far away from the power lines. Solar energy production provides power for all loads. For the nursery pond, aeration is required and the area is 50 m2. This water area is separated into 10 ponds that are each 2 x 1 x 0.5 metres in size. Carp seeds are also grown here; the seeds' ages range from two weeks to two months. Since the air's oxygen content is lowest in the evening, ventilation is necessary [19].By switching to solar PV-based power generation from the airport's current conventional energy source, the carbon footprint of the facility can be decreased. Utility-scale solar power generation facilities may be built in regions that are required to be broad and free of obstructions around runways. Drawing on first year operating data, the current study intends to evaluate the organizational efficiency of a 12 MWp solar-powered airport at Interlope Aviation Limited (CIAL), India [20].

2. MATERIAL AND METHOD

2.1. Type of Solar Module: With an efficiency rating of 20%, monocrystalline solar panels always had the highest rating of any kind of solar panel. They can so turn 20% of solar energy into useable energy. The usual range for polycrystalline panels is between 15% and 17%. Several PV cells are arranged in series and parallel in a PV module to raise voltage and increase current, respectively. The accepted term for massive power generation uses 36 cell modules. The majority of household photovoltaic arrays on the market these days have an hourly output rating of between 200 and 400 watts. The typical power range for household solar panel systems ranges is 1 kW to 4 kW.

2.2. No of modules per string: The minimal output voltage so each subsystem will produce for a certain installation site, or module Vmp min, must first be calculated in order to determine the minimum string size. To get the minimal number of modules, divide the estimated module minimum voltage by the inverter minimum voltage. The maximum integration of solar capacity has expanded between 100 kW to roughly 5 MW over the course of a decade. The maximum grid connected capacity has also risen for such commercial and institutional market, going over 10-15 kW to further than 100 kW.

2.3. No of strings: phrase When something is offered to you unconditionally or without restrictions, it is given even without additional requirements. There should be no conditions on providing aid to developing nations. count = 0; I in array (0, len (string)); sequence = "best of all worlds" If string[i] is not equal to "," all characters except spaces are counted: count equals count + 1; Returns the overall character count of a string, print("Total character count of a piece of rope: " + str (count); Using a for loop, you can determine the length of a document by measuring all the characters (up until the null characters) in it. A built-in string is an additional option. magnitude of () operator or the strlen () library function in .

2.4. No of inverters: The two primary types of inverters are voltage source inverters and frequency inverters. A voltage regulator (VSI) has a rigid Input dc voltage, which means that the impedance of the DC voltage at the transformer input signal is either infinite or zero. The inverter is marked with the following numbers: pulse signal, output horsepower, and peak kilowatt - hours (aka peak surge). • Input Voltage: The DC current needed to run the inverter is represented by this voltage. A 12 volt Washington (12V DC) electric motor powers the majority of automobiles. There are three basic categories of inverters: square wave, modified sine wave (really just modified square wave), and sinusoidal wave (occasionally alluded to as "true" or "pure" sine wave).

2.5. No of transformers: The number of turns there in secondary windings of the transformer divided by the quantity of turns in the main coil is known as the transformation ratio. Its definition is the difference between the transformer's input and output voltages. Transformer windings come in two primary varieties: core form and shell type. Step-down transformers include Berry type transformers. Transformers used in the power domain include step-up, isolation, iron core, ferrite core, toroidal core, and air core transformers. Step down transformers are utilised in both the electrical and electronic fields.

2.6. Short circuit current (ISC): When there is no voltage across the solar cell, it is said to be conducting short-circuit current (ISC) (ie, the solar cell is short-circuited). The short circuit current, which is frequently abbreviated as ISC, is depicted in the IV curve below. ISC is caused by the production and gathering of carriers produced by light. This is the maximum current that photovoltaic arrays can generate under typical test settings. In clear skies, during summer midday, and when the panel is angled towards the sun, the maximum current is substantially higher.

2.7. Open circuit voltage (VOC): The greatest voltage a solar panel can produce in an open circuit when there is no loading (ie measured by a millimeter across the open ends of the wires connected to the panel). It will consist a wok of panel 1 Plus wok of panel 2 if two or many displays are wired in series. The potential differences between the two leads of electrical equipment when it is detached are known as open-circuit voltage (also known as OCV or VOC). any round, please. There is no external load attached.

2.8. Operating Temperature: The thermal efficiency is the range of outside temperatures that the cogator can function in. The temperature range in which a refrigerator can be kept without being used is known as the storage temperature. Most electrical equipment should operate at a temperature of 40 °C (104 °F) or greater, and prolonged cooling wastes energy, raises expenses unnecessarily, adds to the burden of maintenance, and even poses operational risks.

2.9. Dimension: We have known for ages that we exist in three-dimensional space, which is a gigantic "cupboard" of height, width, and depth. It goes without saying that we can consider time to be an additional fourth dimension, as Einstein famously stated. According to the dimensions of a house (= height, length, and width) to measure something in a specific direction, especially its height, length, or width. a structure with large dimensions Examples: Dimensions include length, breadth, and height. One dimension is that of a line, two dimensions are those of a square, and three dimensions are those of a cube (3D).

Method: The GRA approach became at the start developed by means of Deng and efficaciously applied to multi-attribute selection-making issues as a part of gray gadget concept, GRA is suitable for fixing issues of complex relationships among Several factors in the current literature and variables. Various A kind of GRA technique is proposed on this have a look at, we introduce an easy and green GRA approach [21]. Gray Relational Analysis (GRA) is MCDM helps with problems is a tool and First proposed with the aid of Deng. It has been correctly utilized in fixing diverse MCTM problems. GRA stands for an outcome evaluation model may degree correlation among collection and Records analysis method or Belongs to the geometric approach category Usually, researchers target They set up the series reference Scope of the research problem Based on Cont. Therefore, the goal of grey correlation evaluation technique is to degree the correlation among the reference collection and the contrast series [22]. Derived from Gray system idea, GRA is a quantitative method for figuring out the connection among sequences the usage of a limited amount of information. The primary The idea of GRA is that of series of curves styles closeness of relationship is primarily determined by The Series quantity is additive and vice versa. GRA two Complexity between factors and variables Ideal for solving problems with contacts. In solving various MCTMs It has been effectively implemented troubles consisting of worker choice [23]. Gray Correlative Analysis (GRA) and techniques for regulation alternatives through simulating the proper solution Both the techniques yielded the same gold standard The parameter level i.E. 10µm particle size, 5% reinforcement, 8mm diameter device, 710rpm velocity, 20mm/min. To become aware of the significance of the outcomes of 139.48N in-feed pressure, sixty-three.92N cross-feed force, forty-two.6N thrust force, sixty-eight.96oC temperature and zero.198µm floor roughness, each procedure on response parameters The impact of the variable is done. All although the parameters are encouraging parameters, whereas Speed became a less significant factor [24]. GRA (Gray Correlation Analysis) version. First at the grid, the neighbor of each charge Countries and their one-dimensional resonance Statistics by comparing indicators Skills count. 1D-LBP after receiving the signals, in those indicators Statistical settlements is

calculated. These functions are GRA are classified using A perusal of the literature well-known shows that no such look at exists. The 1D-LBP technique changed into recently implemented Characteristic from vibration alerts First time to extract. Additionally, it is vibration signals in GRA Used for the first time in the category [25]. The Intuition mixed with vague synthesis The GRA method is a fuzzy set of decision makers Since considering information, many standards of achievement for decision-making problems carries significant risk. Therefore, in fate, this method can be applied to handle Job Evaluation, Dealer Selection, Factory Location manufacturing structures and so on inclusive multi-criteria decision-making Uncertainty in issues of areas of control choice issues [26]. GRA first interprets the overall All in comparative rankings Performance of alternatives. According to this called ash relative formation. According to these scenarios, a Super target sequence described. then, evaluate all Gary correlation coefficient in rows and A satisfactory target collection is calculated finally this gray contact based on the coefficients, the perfect target sequence and for each variant sequence of gray contact between The size is calculated [27]. GRA proposes an incorporated GRA for distribution network and AHP technique reconstruction to plan hydropower technology. Particle reinforced stem Electric discharge apparatus GRA to improve the method Provide a sample fabric. Proposes GRA to estimate the relative have an impact on of fuel fee, gross domestic product variety motors and vehicle kilometers travelled to electricity growth. Taiwan uses the Fuzzy-GRA technique to assess the economic overall performance of box lines. Proposes an incorporated GRA approach for provider evaluation of environmental know-how management abilities. Examine and rank the energy performance of office homes the usage of GRA [28]. Gray correlation analysis (GRA) is commonly used in Asia. It is an outcome evaluation version, which On an absolute basis Similarity between rows or measuring diploma of distinction degree of dating. The motive of GRA is to have a look at elements that affect structures [29]. Gray Relational Analysis (GRA) is proposed as a way that may for sequences of the type Measure the correlation between facts evaluation technique or geometric pattern. Reason of GRA technique, primarily based on degree of similarity with interelements Degree of relationship. GRA there are few studies that have used Oil pipelines in gas wells of environmental factors on corrosion Assess the impact, principle of application of GRA Factors identified. with many overall performance characteristics Electro Discharge machining method GRA united states of America for an expatriate task the usage of GRA using a mixed GRA and technique for included water resource protection assessment in Beijing. Decided the pleasant layout aggregate of a product from elements to suit a given product picture represented with the aid of a phrase pair the usage of GRA, introduced GRA and proposed a brand new struggle reconstruction method of trust functions. Electrocardiogram (ECG) Heart Rate Discriminator proposed a technique to degree frequency components in distinct ECG beats the usage of GRA. GRA changed into proposed for prediction-integrated circuit outputs [30]. (GRA) is A system's reference/inspirational state (desired) factors and others for compared (alternative) factors Used to show the relationship between When a systems approach examines the degree of association for two alternatives using the distance measure between. For the GRA model Concepts with computational process are briefly reviewed [31]. GRA is a choice-making technique based totally on the grey gadget principle first developed by way of Deng in gray principle, wherein black represents a gadget with incomplete statistics, while a white gadget represents whole facts. However, the grey relation is associated with incomplete facts and gap of elements may be measured one by one. Gray evaluation enables to make amends for the deficiency in statistical regression while experiments are ambiguous or the experimental technique can't be carried out exactly [32]. GRAph ALigner (C-GRAAL) between networks to increase the amount of aligned edges uses heuristics and primarily Based on network topology. So, social, shipping or electric Any kind involving networks It can also be used on a network. Eukaryotic and Prokaryotic PPI networks of species we use C-GRAAL to align and PPI networks between species, and the subsequent renovations are great Connected and functional topology Technically aligned areas We show that We reveal. We are efficiently validating more than one predictions and Across biological specializations Next to change Use alignments organisms. Furthermore, we display that PPI in humans to align networks C-GRAAL can be used pathogens host from network topology Pathogen with proteins It can sense patterns of interactions by myself [33]. Traditional GRA techniques fail to cope with incomplete weight information Intuition above with ambiguous MADM issues a thrilling and vital research topic is a way to derive characteristic weights from each given intuitive fuzzy records and incompletely recognized characteristic weight statistics based at the fundamental best of the traditional GRA technique. For this reason, intuition is ambiguous to fix MADM problems GRA to develop a technique The concept of expanded statistics, wherein facts approximately characteristic weights are incompletely regarded, and attribute values [34].

3. RESULT AND DISCUSSION

TABLE 1. Solar Power Inverter

	Short circuit current (ISC)	Open circuit voltage (VOC)	Operating Temperature	Dimension
Type of Solar Module	43.65	140.69	33.16	35.63
No of modules per string	23.63	142.97	38.65	45.63
No of strings	36.63	130.56	42.51	53.36
No of inverters	23.17	148.50	46.51	41.63
No of transformers	45.56	186.41	36.65	50.16

Table 1 shows the Solar Power Inverter for Grey relational analysis. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension and Solar Power Inverter.Type of Solar Module, No of modules per string, No of strings, No of inverters, No of transformersin this Alternatives and Evaluation value.
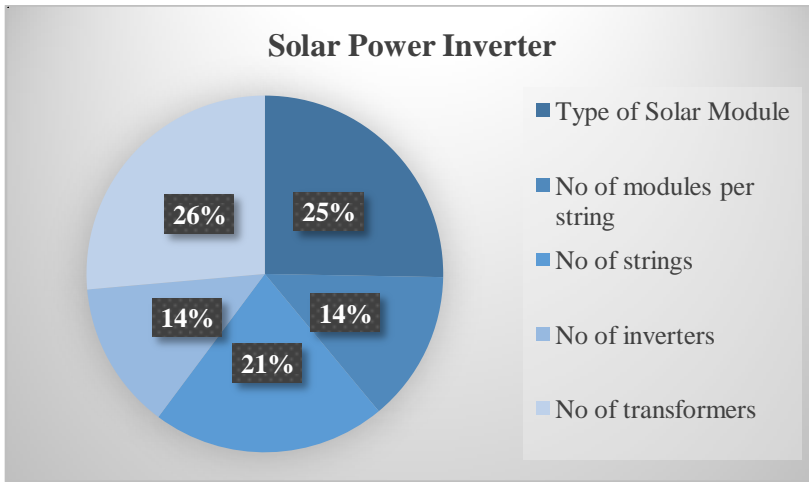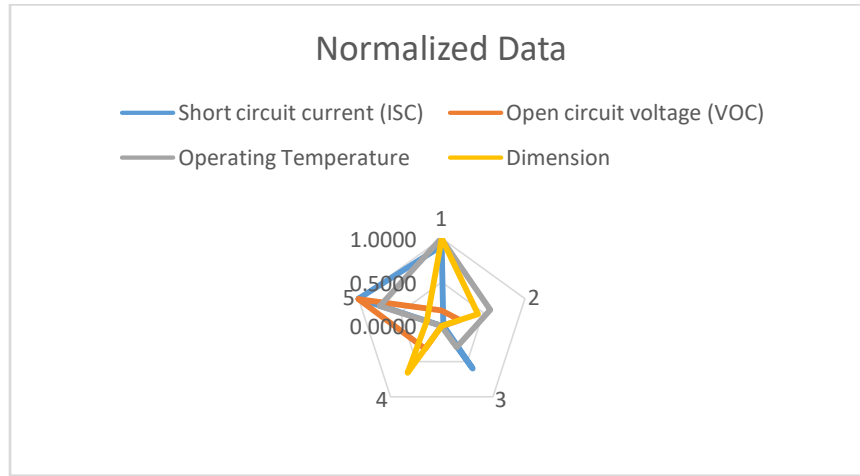

FIGURE 1.Solar Power Inverter

Figure 1. Shows the Solar Power Inverter Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension Solar Power Inverter. Type of Solar Module, No of modules per string, No of strings, No of inverters, No of transformers. From the figure 1 and table 1 it is seen that No of transformers is showing the Highest Value for Short circuit current (ISC) and No of inverters is showing the Lower value. No of transformers is showing the Highest Value for Open circuit voltage (VOC), Open circuit voltage (VOC) and No of strings is showing the lowest value. No of inverters is showing the Highest Value for Operating Temperature and Type of Solar Module is showing the lowest value. No of strings is showing the Highest Value for Dimension and Type of Solar Module is showing the lowest value.

TABLE 2. Normalized Data

Normalized Data			
Short circuit current (ISC)	Open circuit voltage (VOC)	Operating Temperature	Dimension
0.9147	0.1814	1.0000	1.0000
0.0205	0.2222	0.5888	0.4360
0.6012	0.0000	0.2996	0.0000
0.0000	0.3212	0.0000	0.6616
1.0000	1.0000	0.7386	0.1805

Table 2 shows the Normalized data for Solar Power Inverter. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension and Solar Power Inverter. Type of Solar Module, no of modules per string, No of strings, No of inverters, No of transformers it is also the Normalized value.

FIGURE 2. Normalized data

Figure 2 shows the Normalized data for Solar Power Inverter. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension and Solar Power Inverter. Type of Solar Module, no of modules per string, No of strings, No of inverters, No of transformers it is also the Normalized value.

TABLE 3. Deviation sequence

Deviation sequence			
Short circuit current (ISC)	**Open circuit voltage (VOC)**	**Operating Temperature**	**Dimension**
0.0853	0.8186	0.0000	0.0000
0.9795	0.7778	0.4112	0.5640
0.3988	1.0000	0.7004	1.0000
1.0000	0.6788	1.0000	0.3384
0.0000	0.0000	0.2614	0.8195

Table 3 shows the Deviation sequence for Solar Power Inverter. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension and Solar Power Inverter. Type of Solar Module, no of modules per string, No of strings, No of inverters, No of transformers it is also the Maximum or Deviation sequence value.

TABLE 4. Grey Relation Coefficient

Grey relation coefficient			
Short circuit current (ISC)	**Open circuit voltage (VOC)**	**Operating Temperature**	**Dimension**
0.8543	0.3792	1.0000	1.0000
0.3380	0.3913	0.5487	0.4699
0.5563	0.3333	0.4165	0.3333
0.3333	0.4242	0.3333	0.5964
1.0000	1.0000	0.6567	0.3789

Table 4 shows the Grey relation coefficient for Solar Power Inverter. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension and Solar Power Inverter. Type of Solar Module, no of modules per string, No of strings, No of inverters, No of transformers it is also Calculated the Maximum and minimum Value.
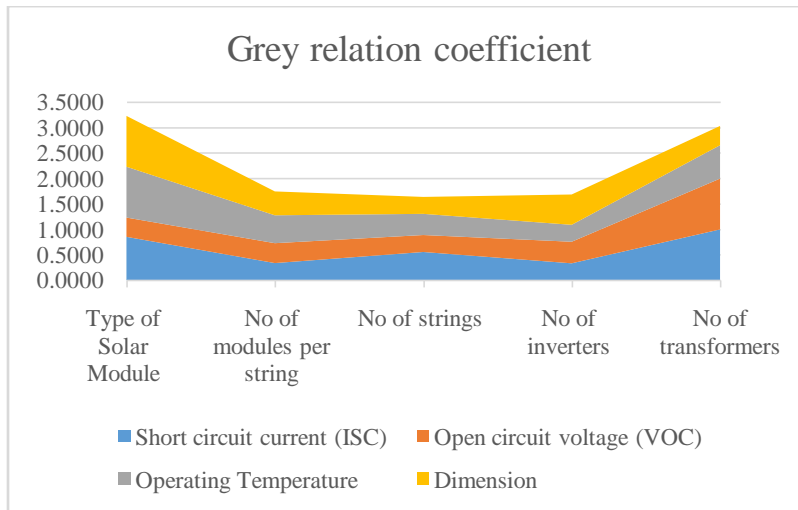
FIGURE 3. Grey relation coefficient

Figure 3 shows the Grey relation coefficient for Solar Power Inverter. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension, and Solar Power Inverter. Type of Solar Module, no of modules per string, No of strings, No of inverters, No of transformer it is also the Grey relation coefficient Value.

TABLE 5. Result of final GRG Rank

	GRG	**Rank**
Type of Solar Module	0.8084	1
No of modules per string	0.4370	3
No of strings	0.4099	5
No of inverters	0.4218	4
No of transformers	0.7589	2

Table 5 shows the Result of final GRG Rank of GRA for Solar Power Inverter. GRG RankType of Solar Module is showing the highest value for GRG Rank and No of strings is showing the lowest value.
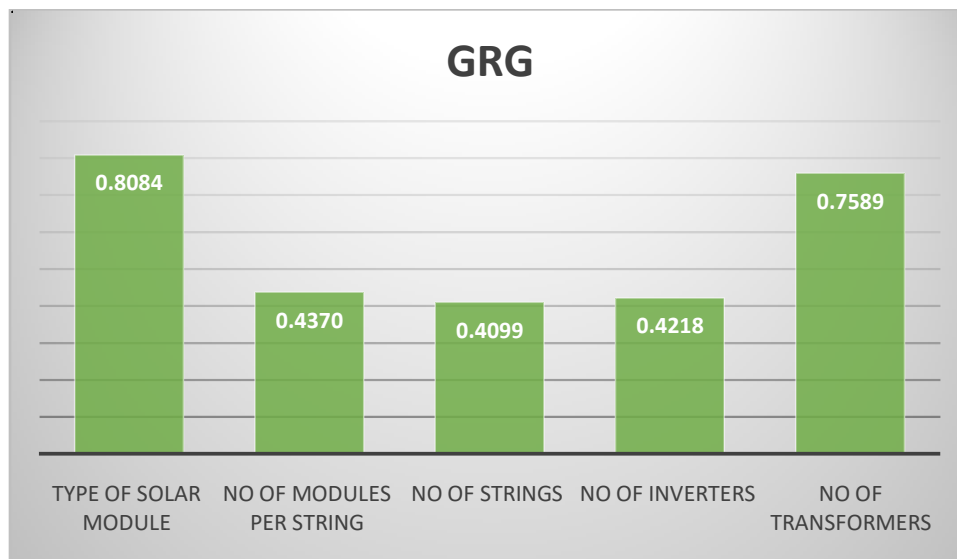
FIGURE 4.GRG

Figure 4shows the GRG of Result of final GRG Rank of GRA for Solar Power Inverter. GRG Rank Type of Solar Module is showing the highest value for GRG Rank and No of strings is showing the lowest value.
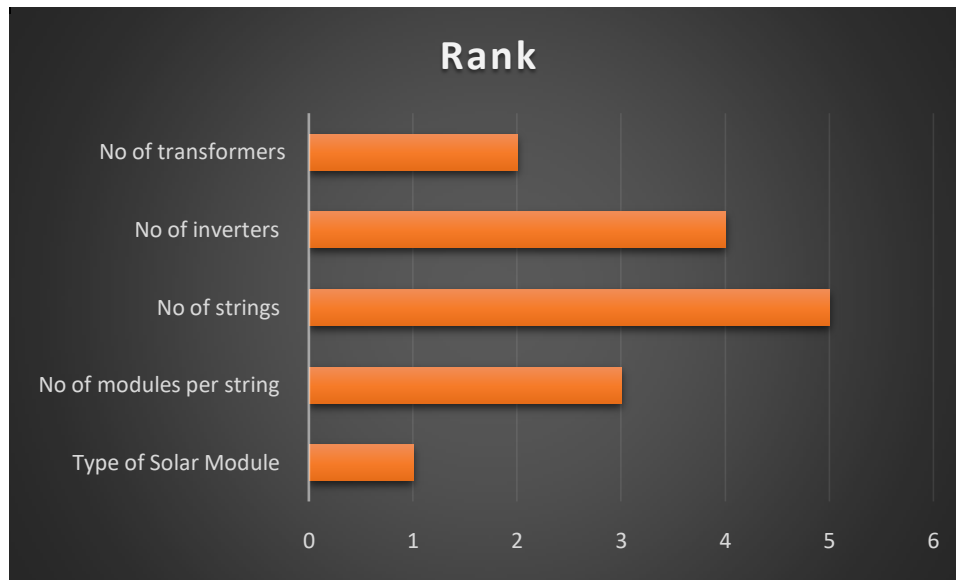

FIGURE 5. Shown the Rank

Figure 5shows the Rank of GRA for Solar Power Inverter. Type of Solar Module is got the first rank whereas is the No of stringsis having the Lowest rank.

4. CONCLUSION

Solar-powered system is an inverter. It is an apparatus that transforms the direct current (DC) produced by solar panels into the alternating current (AC) required by the electric system. Flashing hybrid solar inverter is the best solar inverter for home which offers the following features: - Its operating voltage is between 100-290V. - It has 700 VA of power. 5kW solar inverter price budget starts at $2,000 for excellent single-phase devices and $1,000 for existing datasets (like Sungrow) (eg Fronius or SMA). Gray correlation analysis is widely used to measure the degree of relationship between sequences through the gray correlation coefficient. By switching to solar PV-based power generation from the airport's current conventional energy source, the carbon footprint of the facility can be decreased. Power distribution solar PV power facilities may be built in regions that are required to be broad and free of obstructions around runways. By switching to solar PV-based power generation from the airport's current conventional energy source, the carbon footprint of the facility can be decreased. Power distribution solar PV power facilities may be built in regions that are required to be broad and free of obstructions around runways. The majority of household photovoltaic arrays on the market these days have an hourly output rating of between 200 and 400 watts. The typical power range for household solar panel systems ranges is 1 kW to 4 kW. The minimal output voltage so each subsystem will produce for a certain installation site, or module Vmp min, must first be calculated in order to determine the minimum string size. To get the minimal number of modules, divide the estimated module minimum voltage by the inverter minimum voltage. The thermal efficiency is the range of outside temperatures that the cogator can function in. The temperature range in which a refrigerator can be kept without being used is known as the storage temperature. Most electrical equipment should operate at a temperature of 40 °C (104 °F) or greater, and prolonged cooling wastes energy, raises expenses unnecessarily, adds to the burden of maintenance, and even poses operational risks. Gray relational analysis has been used by many researchers to optimize control parameters with multiple responses through gray relational grading. The fundamental tenet of the GRA approach is that the chosen option must have the "greatest degree of Green relation" to the positive-ideal solution and the "minimum of grey relation" to the negative-best answer. A technique for determining whether or not variables are connected and how much they are correlated is called grey correlation coefficient analysis. The primary method of determining these curves' geometric similarity is by the construction of characteristic series curves. Type of Solar Module, No of modules per string, No of string, No of inverters and No

of transformers. Short circuit current (ISC), Open circuit voltage (VOC), Operating Temperature and Dimension. Stress Management in Healthcare Institutions in Work overload is got the first rank whereas is the Overtime is having the lowest rank.

REFERENCES

[1]. Shimi, S. L., Thilak Thakur, Jagdish Kumar, S. Chatterji, and Dnyaneshwar Karanjkar. "MPPT based solar powered cascade multilevel inverter." In 2013 Annual International Conference on Emerging Research Areas and 2013 International Conference on Microelectronics, Communications and Renewable Energy, pp. 1-5. IEEE, 2013.

[2]. Dhanalakshmi, B., S. Dhamodaran, Ananda Ravuri, and Roshan Bonde. *Data Analytics with Python*. Booksclinic Publishing, 2023.

[3]. Rahim, N. A., and Saad Mekhilef. "Implementation of three-phase grid connected inverter for photovoltaic solar power generation system." In Proceedings. International Conference on Power System Technology, vol. 1, pp. 570-573. IEEE, 2002.

[4]. Ananthi, S., M. Sadish Sendil, and S. Karthik. "Privacy preserving keyword search over encrypted cloud data." In *Advances in Computing and Communications: First International Conference, ACC 2011, Kochi, India, July 22-24, 2011. Proceedings, Part I 1*, pp. 480-487. Springer Berlin Heidelberg, 2011.

[5]. Phannil, Natthanon, Chaiyan Jettanasen, and Atthapol Ngaopitakkul. "Power quality analysis of grid connected solar power inverter." In 2017 IEEE 3rd International Future Energy Electronics Conference and ECCE Asia (IFEEC 2017-ECCE Asia), pp. 1508-1513. IEEE, 2017.

[6]. Wu, Jinn-Chang, and Chia-Wei Chou. "A solar power generation system with a seven-level inverter." IEEE transactions on power electronics 29, no. 7 (2013): 3454-3462.

[7]. Seetha, J., Ananda Ravuri, Yamini Tondepu, and T. Kuntavai. "DETECTING THE SIDE CHANNEL ATTACK IN EMBEDDED PROCESSORS USING FEDERATED MODEL."

[8]. Park, Chul-Young, Seok-Hoon Hong, Su-Chang Lim, Beob-Seong Song, Sung-Wook Park, Jun-Ho Huh, and Jong-Chan Kim. "Inverter efficiency analysis model based on solar power estimation using solar radiation." Processes 8, no. 10 (2020): 1225.

[9]. Tamilvizhi, T., R. Surendran, Carlos Andres Tavera Romero, and M. Sadish Sendil. "Privacy Preserving Reliable Data Transmission in Cluster Based Vehicular Adhoc Networks." *Intelligent Automation & Soft Computing* 34, no. 2 (2022).

[10]. Hirose, Toshiro, and Hirofumi Matsuo. "Standalone hybrid wind-solar power generation system applying dump power control without dump load." IEEE transactions on industrial electronics 59, no. 2 (2011): 988-997.

[11]. Raveendhra, Dogga, M. K. Pathak, and Aurobinda Panda. "Power conditioning system for solar power applications: Closed loop DC-DC convertor fed FPGA controlled diode clamped multilevel inverter." In 2012 IEEE Students' Conference on Electrical, Electronics and Computer Science, pp. 1-4. IEEE, 2012.

[12]. Ali, Mohammed Moanes E., and Sameer K. Salih. "A visual basic-based tool for design of stand-alone solar power systems." Energy Procedia 36 (2013): 1255-1264.

[13]. Chen, Yang, and Keyue Ma Smedley. "A cost-effective single-stage inverter with maximum power point tracking." IEEE transactions on power electronics 19, no. 5 (2004): 1289-1294.

[14]. Nagao, Michihiko, and Koosuke Harada. "Power flow of photovoltaic system using buck-boost PWM power inverter." In Proceedings of Second International Conference on Power Electronics and Drive Systems, vol. 1, pp. 144-149. IEEE, 1997.

[15]. Mishra, Nilamadhab, J. Seetha, Arra Ganga Dinesh Kumar, Supriya Menon, and Ananda Ravuri. "Design an Ant Lion-Based Yolo-V5 Model for Prediction and Classification of Paddy Leaf Disease." *International Journal of Intelligent Systems and Applications in Engineering* 11, no. 6s (2023): 599-612.

[16]. Tripathy, Ramamani, Rudra Kalyan Nayak, V. Saravanan, Debahuti Mishra, Gayatri Parasa, Kaberi Das, and Priti Das. "Spectral clustering based fuzzy C-means algorithm for prediction of membrane cholesterol from ATP-binding cassette transporters." In *Intelligent and Cloud Computing: Proceedings of ICICC 2019, Volume 2*, pp. 439-448. Springer Singapore, 2021.

[17]. Ali, A. Nazar, R. Jai Ganesh, D. Sivamani, and D. Shyam. "Solar powered highly efficient Seven-level inverter with switched capacitors." In IOP Conference Series: Materials Science and Engineering, vol. 906, no. 1, p. 012014. IOP Publishing, 2020.

[18]. Riya, K. S., R. Surendran, Carlos Andrés Tavera Romero, and M. Sadish Sendil. "Encryption with User Authentication Model for Internet of Medical Things Environment." *Intelligent Automation & Soft Computing* 35, no. 1 (2023).

[19]. Gurkaynak, Yusuf, Zhihao Li, and Alireza Khaligh. "A novel grid-tied, solar powered residential home with plug-in hybrid electric vehicle (PHEV) loads." In 2009 IEEE Vehicle Power and Propulsion Conference, pp. 813-816. IEEE, 2009.

[20]. Kabalcı, Ersan. "Review on novel single-phase grid-connected solar inverters: Circuits and control methods." Solar Energy 198 (2020): 247-274.

[21]. Kaliamoorthy, M., and V. Rajasekaran. "A novel MPPT scheme for solar powered boost inverter using evolutionary programming." In 2011 INTERNATIONAL CONFERENCE ON RECENT ADVANCEMENTS IN ELECTRICAL, ELECTRONICS AND CONTROL ENGINEERING, pp. 346-351. IEEE, 2011.

[22]. Zhang, Xinmin, Yuan Li, Siyuan Lu, Hendrik F. Hamann, Bri-Mathias Hodge, and Brad Lehman. "A solar time based analog ensemble method for regional solar power forecasting." IEEE Transactions on Sustainable Energy 10, no. 1 (2018): 268-279.

[23]. Siva Shankar, S., Bui Thanh Hung, Prasun Chakrabarti, Tulika Chakrabarti, and Gayatri Parasa. "A novel optimization based deep learning with artificial intelligence approach to detect intrusion attack in network system." *Education and Information Technologies* (2023): 1-25.

[24]. Kjaer, Soeren Baekhoej, John K. Pedersen, and Frede Blaabjerg. "Power inverter topologies for photovoltaic modules-a review." In Conference Record of the 2002 IEEE Industry Applications Conference. 37th IAS Annual Meeting (Cat. No. 02CH37344), vol. 2, pp. 782-788. IEEE, 2002.

[25]. Meshram, Sweeka, Ganga Agnihotri, and Sushma Gupta. "The Steady state analysis of Z-Source inverter based solar power generation system." In 2012 IEEE 5th India International Conference on Power Electronics (IICPE), pp. 1-6. IEEE, 2012.

[26]. Kumar, B. Shiva, and K. Sudhakar. "Performance evaluation of 10 MW grid connected solar photovoltaic power plant in India." Energy reports 1 (2015): 184-192.

[27]. Palanimuthu, Kogila, Birhanu Gutu, Leta Tesfaye, BuliYohannis Tasisa, Yoseph Shiferaw Belayneh, Melkamu Tamiru, and Desalegn Shiferaw. "Assessment of Awareness on COVID-19 among Adults by Using an Online Platform: 26 Countries View." *Medico-legal Update* 21, no. 1 (2021).

[28]. Prasetyaningsari, Igib, Agus Setiawan, and Ahmad Agus Setiawan. "Design optimization of solar powered aeration system for fish pond in Sleman Regency, Yogyakarta by HOMER software." Energy Procedia 32 (2013): 90-98.

[29]. Shankar, S. Siva, K. Maithili, K. Madhavi, and Yashwant Singh Bisht. "Evaluating Clustering Algorithms: An Analysis using the EDAS Method." In *E3S Web of Conferences*, vol. 430, p. 01161. EDP Sciences, 2023.

[30]. Rathor, Ketan, Keyur Patil, Mandiga Sahasra Sai Tarun, Shashwat Nikam, Devanshi Patel, and Sasanapuri Ranjit. "A Novel and Efficient Method to Detect the Face Coverings to Ensurethe Safety using Comparison Analysis." In *2022 International Conference on Edge Computing and Applications (ICECAA)*, pp. 1664-1667. IEEE, 2022.

[31]. Sukumaran, Sreenath, and K. Sudhakar. "Fully solar powered airport: A case study of Cochin International airport." Journal of Air Transport Management 62 (2017): 176-188

[32]. Tembhurne, S., C. M. Goswami, and S. V. Deshmukh. "An Improvement In Cloud Data Security That Uses Data Mining." *International Journal of Advanced Research in Computer Engineering & Technology* 4 (2015): 2044-2049.

[33]. Balamurugan, N. M., T. K. S. Rathish babu, K. Maithili, and M. Adimoolam. "Energy Optimized Techniques in Cloud and Fog Computing." *Hybrid Intelligent Approaches for Smart Energy: Practical Applications* (2022): 27-47.

[34]. Wang, Peng, Zhouquan Zhu, and Yonghu Wang. "A novel hybrid MCDM model combining the SAW, TOPSIS and GRA methods based on experimental design." *Information Sciences* 345 (2016): 27-45.

[35]. Zhang, Shi-fang, San-yang Liu, and Ren-he Zhai. "An extended GRA method for MCDM with interval-valued triangular fuzzy assessments and unknown weights." *Computers & Industrial Engineering* 61, no. 4 (2011): 1336-1341.

[36]. Bekkanti, Ashok, Gayatri Parasa, Azmira Krishna, Syed Karimunnisa, and Cmak Zeelan Basha. "Computer based detection of alcohol consumed candidates using face expressions with SIFT and bag of words." In *2021 5th International Conference on Trends in Electronics and Informatics (ICOEI)*, pp. 1636-1640. IEEE, 2021.

[37]. Bali, Ozkan, Erkan Kose, and Serkan Gumus. "Green supplier selection based on IFS and GRA." *Grey Systems: Theory and Application* (2013).

[38]. Gopal, P. M., and K. Soorya Prakash. "Minimization of cutting force, temperature and surface roughness through GRA, TOPSIS and Taguchi techniques in end milling of Mg hybrid MMC." *Measurement* 116 (2018): 178-192.

[39]. Tasisa, Yirgalem Bekele, and Kogila Palanimuthu. "Psychosocial Impacts of Imprisonment among Youth Offenders in Correctional Administration Center, Kellem Wollega Zone, Ethiopia." *Medico-legal Update* 21, no. 2 (2021).

[40]. Deepa, S. N., and B. Aruna Devi. "A survey on artificial intelligence approaches for medical image classification." *Indian Journal of Science and Technology* 4, no. 11 (2011): 1583-1595.

[41]. Kuncan, Melih. "An intelligent approach for bearing fault diagnosis: combination of 1D-LBP and GRA." *Ieee Access* 8 (2020): 137517-137529.

[42]. Deeptha, R., K. Sujatha, D. Sasireka, R. Neelaveni, and R. Pavithra Guru. "Website Vulnerability Scanner." *Journal of Population Therapeutics and Clinical Pharmacology* 30, no. 15 (2023): 43-53.

[43]. Palanimuthu, Kogila, Eshetu Fikadu Hamba Yigazu, Gemechu Gelalcha, Yirgalem Bekele, Getachew Birhanu, and Birhanu Gutu. "Assessment of Stress, Fear, Anxiety and Depression on COVID-19 Outbreak among Adults in South-Western Ethiopia." *Prof.(Dr) RK Sharma* 21, no. 1 (2021): 440.

[44]. Zhang, Shi-fang, and San-yang Liu. "A GRA-based intuitionistic fuzzy multi-criteria group decision making method for personnel selection." *Expert Systems with Applications* 38, no. 9 (2011): 11401-11405.

[45]. Wei, Gui-Wu. "GRA method for multiple attribute decision making with incomplete weight information in intuitionistic fuzzy setting." *Knowledge-Based Systems* 23, no. 3 (2010): 243-247.

[46]. Rathor, Ketan, Keyur Patil, Mandiga Sahasra Sai Tarun, Shashwat Nikam, Devanshi Patel, and Sasanapuri Ranjit. "A Novel and Efficient Method to Detect the Face Coverings to Ensurethe Safety using Comparison Analysis." In *2022 International Conference on Edge Computing and Applications (ICECAA)*, pp. 1664-1667. IEEE, 2022.

[47]. Manivannan, P., and CS Kanimozhi Selvi. "Pairwise relative ranking technique for efficient opinion mining using sentiment analysis." *Cluster Computing* 22 (2019): 13487-13497.

[48]. Praveen Kumar, R., Jennifer S. Raj, and S. Smys. "Performance analysis of hybrid optimization algorithm for virtual head selection in wireless sensor networks." *Wireless Personal Communications* (2021): 1-16.

[49]. Maithili, K., G. Karthi, K. Thinakaran, M. Sureshkumar, and S. Sathya. "Efficient Network Resource Allocation Technique for Dynamic IoT Environment using Reinforcement Learning and CAT Optimization." *Design Engineering* (2021): 11799-11815.

[50]. Suryanarayana, S. Venkata, G. N. Balaji, and G. Venkateswara Rao. "Machine learning approaches for credit card fraud detection." *Int. J. Eng. Technol* 7, no. 2 (2018): 917-920.

[51]. SUJATHA, K., and V. CERONMANI SHARMILA. "EFFICIENT MUTUAL USER AUTHENTICATION PROTOCOL TO SHARE FILES USING ID IN CLOUD STORAGE." *Journal of Theoretical and Applied Information Technology* 98, no. 20 (2020).

[52]. Aravinda, T. V., K. R. Krishnareddy, Sony Varghese, P. V. Chandrika, T. Prabhakara Rao, and Victor Trofimov. "Implementation of Facial Recognition (AI) and Its Impact on the Service Sector." In *2022 International Conference on Applied Artificial Intelligence and Computing (ICAAIC)*, pp. 74-80. IEEE, 2022.

[53]. Seetha, J., D. Nagaraju, T. Kuntavai, and K. Gurnadha Gupta. "THE SMART DETECTION AND ANALYSIS ON SKIN TUMOR DISEASE USING BIO IMAGING DEEP LEARNING ALGORITHM." *ICTACT Journal on Image & Video Processing* 13, no. 4 (2023).

[54]. Goswami, Chandrashekhar, and Rahul Shahane. "Transport Control Protocol (TCP) enhancement over wireless environment: Issues and challenges." In *2017 International Conference on Inventive Computing and Informatics (ICICI)*, pp. 742-749. IEEE, 2017.

[55]. Gumus, Alev Taskin, A. Yesim Yayla, Erkan Çelik, and Aytac Yildiz. "A combined fuzzy-AHP and fuzzy-GRA methodology for hydrogen energy storage method selection in Turkey." *Energies* 6, no. 6 (2013): 3017-3032.

[56]. Chen, Yen-Ting, and Tsung-Yu Chou. "Applying GRA and QFD to improve library service quality." *The Journal of Academic Librarianship* 37, no. 3 (2011): 237-245.

[57]. Zhang, Li, Sudhakar Sengan, and P. Manivannan. "The capture and evaluation system of student actions in physical education classroom based on deep learning." *Journal of Interconnection Networks* 22, no. Supp02 (2022): 2143025.

[58]. Sathiyamoorthi, V., A. K. Ilavarasi, K. Murugeswari, Syed Thouheed Ahmed, B. Aruna Devi, and Murali Kalipindi. "A deep convolutional neural network based computer aided diagnosis system for the prediction of Alzheimer's disease in MRI images." *Measurement* 171 (2021): 108838.

[59]. Kirubakaran, B., and M. Ilangkumaran. "Selection of optimum maintenance strategy based on FAHP integrated with GRA–TOPSIS." *Annals of Operations Research* 245, no. 1 (2016): 285-313.

[60]. Kuo, Ming-Shin, and Gin-Shuh Liang. "Combining VIKOR with GRA techniques to evaluate service quality of airports under fuzzy environment." *Expert systems with applications* 38, no. 3 (2011): 1304-1312.

[61]. Pradhan, M. K. "Estimating the effect of process parameters on MRR, TWR and radial overcut of EDMed AISI D2 tool steel by RSM and GRA coupled with PCA." *The International Journal of Advanced Manufacturing Technology* 68, no. 1 (2013): 591-605.

[62]. Kuntavai, T., and A. Jeevanandham. "Adaptive wavelet ELM-fuzzy inference system-based soft computing model for power estimation in sustainable CMOS VLSI circuits." *Soft Computing* 24 (2020): 11755-11768.

[63]. Thanuja, R., and A. Umamakeswari. "Black hole detection using evolutionary algorithm for IDS/IPS in MANETs." *cluster computing* 22, no. Suppl 2 (2019): 3131-3143.

[64]. Makde, Shivani, Sonali Deshmukh, Bhuvaneshwari Gaddamwar, Khushbu Akare Poonam Thakur, Nikita Dongre, Shraddha Malwe, and Ansar Sheikh. "A Review on Detection of Covid Symptoms." *International Journal of Computational and Electronics Aspects in Engineering* 2, no. 3 (2021).

[65]. Memišević, Vesna, and Nataša Pržulj. "C-GRAAL: C ommon-neighbors-based global GRA ph AL ignment of biological networks." *Integrative Biology* 4, no. 7 (2012): 734-743.

[66]. Khan, Muhammad Sajjad Ali, and Saleem Abdullah. "Interval-valued Pythagorean fuzzy GRA method for multiple-attribute decision making with incomplete weight information." *International Journal of Intelligent Systems* 33, no. 8 (2018): 1689-1716.

[67]. Balaji, G. N., T. S. Subashini, and N. Chidambaram. "Detection and diagnosis of dilated cardiomyopathy and hypertrophic cardiomyopathy using image processing techniques." *Engineering Science and Technology, an International Journal* 19, no. 4 (2016): 1871-1880.

[68]. Kumar, Praveen. "Analysis of dynamic topology wireless sensor networks for the internet of things iot." (2017).

[69]. Rao, T. Prabhakara, B. Satyanarana Murthy, B. Rama Rao, L. Sumalatha, and PBV Raja Rao. "Extended Generalized Elgamal Cryptosystem for Secure M2M Communication." *Journal of Optoelectronics Laser* 41, no. 6 (2022): 427-437.

[70]. Kumar, AM Senthil, K. Parthiban, and S. Siva Shankar. "An efficient task scheduling in a cloud computing environment using hybrid Genetic Algorithm-Particle Swarm Optimization (GA-PSO) algorithm." In *2019 International Conference on Intelligent Sustainable Systems (ICISS)*, pp. 29-34. IEEE, 2019.

[71]. Prabha, B., P. Manivannan, and Puvvada Nagesh. "Human Abnormal Activity Detection in the ATM Surveillance Video." In *Evolution in Signal Processing and Telecommunication Networks: Proceedings of Sixth International Conference on Microelectronics, Electromagnetics and Telecommunications (ICMEET 2021), Volume 2*, pp. 39-48. Singapore: Springer Singapore, 2022.

[72]. Goswami, Chandrashekhar, and Parveen Sultanah. "A Study on Cross-Layer TCP Performance in Wireless Ad Hoc Network." In *International Conference on Intelligent Data Communication Technologies and Internet of Things (ICICI) 2018*, pp. 56-70. Springer International Publishing, 2019.

[73]. Rathor, Ketan, Sushant Lenka, Kartik A. Pandya, B. S. Gokulakrishna, Susheel Sriram Ananthan, and Zoheib Tufail Khan. "A Detailed View on industrial Safety and Health Analytics using Machine Learning Hybrid Ensemble Techniques." In *2022 International Conference on Edge Computing and Applications (ICECAA)*, pp. 1166-1169. IEEE, 2022.

[74]. Nirmala, A. P., Ansar Isak Sheikh, and R. Kesavamoorthy. "An Approach for Detecting Complications in Agriculture Using Deep Learning and Anomaly-Based Diagnosis." *Mathematical Statistician and Engineering Applications* 70, no. 2 (2021): 880-889.

[75]. Kuntavai, T., and A. Jeevanandham. "A Power Efficient Level Converter with Scalable Driving Capability Using Body Bias Techniques." *Journal of Computational and Theoretical Nanoscience* 15, no. 1 (2018): 237-244.

[76]. MAHADULE, TUSHAR B., ROMESHWARI D. CHETULE, VARSHA V. KAMBLE, ASAWARI CHARDE, and ANSAR I. SHEIKH. "Remote Android Access via SMS." (2020).

[77]. Kodati, Sarangam, and R. Vivekanandam. "Analysis of heart disease using in data mining tools Orange and Weka." *Glob. J. Comput. Sci. Technol. C Softw. Data Eng* 18, no. 1 (2018): 16-22.

[78]. Thanuja, R., and A. Umamakeswari. "Unethical network attack detection and prevention using fuzzy based decision system in mobile ad-hoc networks." *Journal of Electrical Engineering & Technology* 13, no. 5 (2018): 2086-2098.

[79]. Ayyadurai, M., K. Sujatha, R. Pavithra Guru, D. Sasirekha, A. Umamageswari, and S. Deepa. "An Ensemble Learning Approach for Fast Disaster Response using Social Media Analytics."

[80]. Balaji, G. N., T. S. Subashini, and N. Chidambaram. "Automatic classification of cardiac views in echocardiogram using histogram and statistical features." *Procedia Computer Science* 46 (2015): 1569-1576.

[81]. Shankar, S. Siva, and A. Rengarajan. "Data hiding in encrypted images using Arnold transform." *ICTACT Journal on Image And Video Processing* (2016): 1339-1344.

[82]. Kodati, Sarangam, R. Vivekanandam, and G. Ravi. "Comparative analysis of clustering algorithms with heart disease datasets using data mining Weka tool." In *Soft Computing and Signal Processing: Proceedings of ICSCSP 2018, Volume 1*, pp. 111-117. Springer Singapore, 2019.

[83]. Gutu, Birhanu, Genene Legese, Nigussie Fikadu, Birhanu Kumela, Firafan Shuma, Wakgari Mosisa, Zelalem Regassa et al. "Assessment of preventive behavior and associated factors towards COVID-19 in Qellam Wallaga Zone, Oromia, Ethiopia: A community-based cross-sectional study." *PloS one* 16, no. 4 (2021): e0251062.

[84]. Nachimuthu, Deepa Subramaniam, and Arunadevi Baladhandapani. "Multidimensional texture characterization: on analysis for brain tumor tissues using MRS and MRI." *Journal of digital imaging* 27 (2014): 496-506.

[85]. Sekaran, S. Chandra, V. Saravanan, R. RudraKalyanNayak, and S. Siva Shankar. "Human health and velocity aware network selection scheme for WLAN/WiMAX integrated networks with QoS." *International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN* (2019): 2278-3075.

[86]. Thanuja, R., E. Sri Ram, and A. Umamakeswari. "A linear time approach to detect wormhole tunnels in mobile adhoc networks using 3PAT and transmission radius (3PAT w)." In *2018 2nd International Conference on Inventive Systems and Control (ICISC)*, pp. 837-843. IEEE, 2018.

[87]. Kumar, R. Praveen, and S. Smys. "A novel report on architecture, protocols and applications in Internet of Things (IoT)." In *2018 2nd International Conference on Inventive Systems and control (ICISC)*, pp. 1156-1161. IEEE, 2018.

[88]. Bhandekar, Prarthana, Chanchal Tomar, Divyani Kasewar, and Ansar Sheikh. "A Survey on Smart Trolley System Based on Android Application." *Engineering and Technology* 4, no. 4 (2018): 55-56.

[89]. Kumar, K. Arun, and T. Prabhakara Rao. "JPEG Coding System Based on Mean Value Predictive Vector Quantization." *International Journal of Advanced Research in Computer Science* 2, no. 5 (2011).

[90]. Kodati, S., and S. Jeeva. "Smart agricultural using internet of things, cloud and big data." *Int. J. Innov. Technol. Explor. Eng* 8 (2019): 3718-3722.

[91]. Nirmala, A. P., Ansar Isak Sheikh, and R. Kesavamoorthy. "An Approach for Detecting Complications in Agriculture Using Deep Learning and Anomaly-Based Diagnosis." *Mathematical Statistician and Engineering Applications* 70, no. 2 (2021): 880-889.