iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VIII **Month of publication:** Aug 2023

DOI: https://doi.org/10.22214/ijraset.2023.55401

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VIII Aug 2023- Available at www.ijraset.com

Improvement in Power Quality of Grid Connected PV & Wind Power Generation Systems

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Abstract: ***The small turbine shows the connection of the source. This system, also used by remote and off-network systems, is known as a crossover power system. It uses wind energy from wind turbines to provide the mechanical ability to convert to electrical force. Regarding cost, efficiency, and dependability, combining at least two sustainable power sources is preferable to using just one. n terms of cost, efficiency, and dependability, a combination of at least two sustainable power sources is superior to one. The most important component for every country's contemporary and agricultural progress is energy.***
Keywords: Charging station, DC grid, Electric vehicle, MATLAB Simulation.

I. INTRODUCTION

Energy is the biggest source for humans to use for their prosperity purpose. This source gives more well-being life to humans. It gives a futuristic source of income or non-pollution to the environment. Renewable power sources are the most demanding sources which use year on year, they are non-polluting and environmentally beneficial. Renewable power sources are comes from the sunlight, wind, rain, waves, geothermal heat, and tides. Energy produced from natural sources contains no carbon and produces less pollution than energy produced from coal and other fossil fuels, protecting these resources for future generations.

Natural resources that produce renewable, sustainable energy include wind turbines and solar photovoltaic systems. Although its development is highly exciting, the technological difficulties in merging a wind and solar power system are apparent. The Wind and solar systems introduce more energy as per other sources. The photovoltaic array generates DC output voltage to convert light energy into electrical energy, whereas the wind turbine generates AC output voltage from wind energy. Renewable energy sources (RES) which means solar and wind energy systems are frequently used to produce electricity. To satisfy the need for electricity, wind, and PV systems are combined. Power conditioners are used to regulate the output power of solar and wind energy. Batteries are used to store it. The grid makes use of the extra electricity. Nowadays load demand is more, then the turbine generates electrical energy from wind energy to provide the grid. In order to convert electricity, solar energy, and wind energy is connected to some electronic devices.

The quality of the system is the most important part of the whole system. To improve the system's effectiveness and performance, power quality must be maintained throughout the production, and distribution sectors. As a result, it is mostly used in renewable energy systems like PV and wind systems. In the current situation, when power resources are being consumed at an alarmingly fast rate, power quality is maintained by current as well as the voltage of a power system. Given the grave state of global warming and rising emissions, a significant penetration of renewable energy sources in the current micro-grid is essential to meet the rising demand for stress. The endeavor debuts the utilization of hybrid methods of energy production. The main goal of hybrid power production is to increase the quality of power. The energy is stored in a battery and is converted into alternating current (AC)and then its provided to the load. Control is provided with a multilayer inverter to enhance power quality.

The schematic representation for an alternate power production system combining wind and solar energy. The combination of components is depicted in the image in broad strokes. The energy from the sun is caught and processed to generate electricity. Perturb and Observe (P & O) is the monitoring technique that is most of the time used in the system. To increase the solar DC output power to feed to the inverter, the used energy is passed by a boost converter. An inverter is a device that transforms DC electricity into AC power. In order to provide the grid with the energy needed, an inverter with three phases converts the power it receives to AC. Similarly, wind power is converted into a usable form.

II. HYBRID ENERGY SYSTEM

The most effective method are used in the growth of the energy demand is hybrid energy-producing technologies. This technology generates energy from a combination of wind and sunlight energy.

These sources mostly depend upon the climate. The outside temperature is very high for producing solar power from sunlight radiation is stronger, but the wind power is not sufficient to that time. And when the wind, there will be more clouds and a rainy season, and at that time sunlight is a little dim as compared to the wind. As a result, energy is not produced at constant power production. Although there is wind throughout the day, sunlight provides the energy. Even if the wind is stronger at midnight, here will constantly be an energy source nearby. Seasonal variations show that sunlight is more beneficial in the summer and wind power is more beneficial in wintertime because of the stronger winds. Thus, the use of sources of renewable energy across all stages of the power generation process results in output that is greater in effectiveness and dependability than that produced by each unit separately.

In order to produce the cheapest electrical feasible, hybrid generation facilities blend electrically linked renewable energy sources such as wind and solar with regulation techniques. The benefit of connecting a powered generation unit to the system is because, in the unlikely circumstance that renewable energy generation is ever disrupted, the grid may act as a further source of power or a substitute source. The extra electricity generated by renewable energies is stored on the grid and used to meet the load demand. Hybrid power generation is the best choice for the foreseeable future since changes in seasonal patterns on both sunlight and wind can be addressed on the foundation of combining the energy and output efficiency is increased. Combination power generation is the best choice for the years to come since changes in the weather for both wind and sunlight can be addressed on the basis of combining the energy and output efficiency is increased.

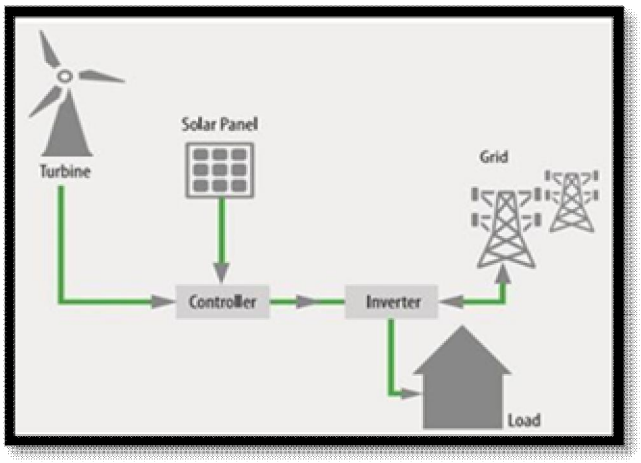

Fig. 1 Hybrid Energy System.

The combination power generating diagram employing wind and solar electricity is shown in Figure. Before energizing the electrical system or another device, the two energy supplies are blended using regulating procedures. In the MPPT technology, sunlight from the sky is supplied in order to create controlled DC results, and then it converts into AC. A generator converts the mechanical power and then the wind turbine converts energy into electricity, it is connected to the inverter. The output is connected to the grid. This system, which combines sunlight and wind power, is crucial to continual electricity production due to any seasons in wind and sunlight.

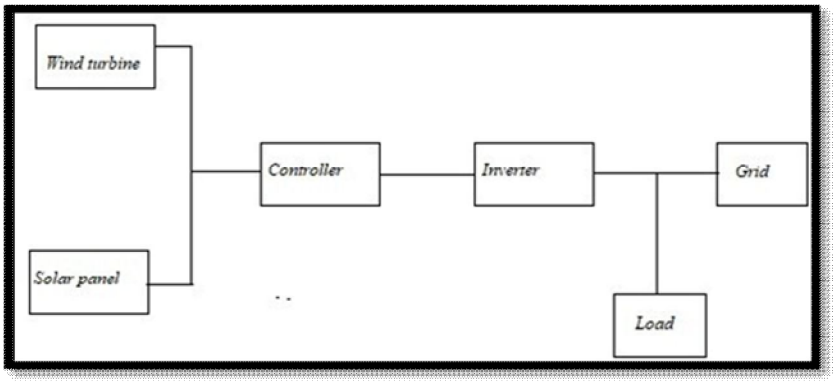

Fig. 2: Block Diagram of Hybrid Energy System.

A schematic representation of an AC power production system combining wind and solar energy is shown in Figure. A combination of components is depicted in the image in broad strokes. The energy received by the sun is caught and processed to generate electricity. Perturb and Observe (P & O) is the most used monitoring technique that is employed. To increase the sunlight DC power to the inverter, and then energy is sent by the boost converter. An inverter is a device that transforms DC electricity into AC power. In order to provide the grid with the energy needed, an inverter with three phases converts the power it receives to AC. Similarly, wind power is converted into a usable form.

Conventional fuel sources damage the environment. As a result, the use of renewable energy sources and so on, received more attention. The most rapidly evolving and encouraging sustainable energy source is wind energy. The development of breeze turbine technology and control techniques has been closely linked to the maximum penetration of wind turbines in the force framework during the past twenty years. In this situation, consideration for wind energy transformation systems is growing for doubtfully-taken care of acceptance machines. Two broad categories of wind turbines are as follows: vertical axle and an inclined pivot. The proper dimension of wind turbines, their depth, corrosion problems with the rotating devices, and efficiency of conversion from rotary to electricity are all factors that limit the amount of energy that can be extracted from the breeze. The rotating energy is converted to power in a more advanced form [7]. By using ways for providing power, turbines powered by wind converted the electrical energy available in a breeze into mechanical power. The breeze depends on the air thickness and the wind velocity since the power it contains is active energy.

A grid plant is connected to the electricity and its fulfill need according to the strategy used, and the construction of a combination of power production system combining sunlight and wind energy. The combination system combines the usage of sunlight and wind energy as resources while maximizing efficiency. This method enables power to be supplied to the stress of the system and then it is connected to the grid based on meteorological factors and the accessibility of solar and wind energy. The MPPT methodology, such as the Perturb and Monitor strategy, is used to track the solar energy that is currently accessible. Solar energy is created in accordance with the outside temperature and the accessible voltage of the photovoltaic cells. The sunlight is amplified without the aid of DC-DC boost conversions before being sent into an inverter that converts DC to AC circuit to power the load. For a wind power system, permanently magnetized synchronous equipment measures the wind turbine's rotor speeds. For the purpose of supplying a load, the power is supplied through inverters for DC to AC conversions.

The whole system works on the normal temperature and rays that come from the sun and the wind speed. This technique is used in converters, inverters, and transformers and creates energy. This combined system is converted in mode from Matlab/Simulink software.

III. MODELLING AND ANALYSIS

Sunlight and Wind power systems are modeled in the block from in Matlab/Simulink software. First, build a Simulink model using Matlab/Simulink software.

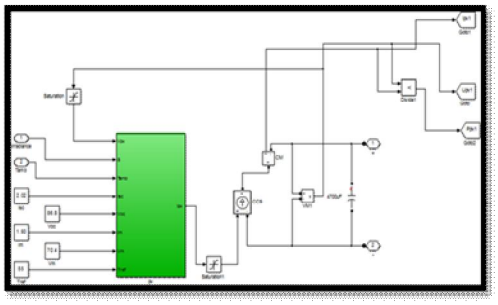

Fig. 3: PV Matlab Model.

Open Simulink, and then add the blocks from the library of Matlab. Then, connect the block to each other then gives the value of these each block, and build the model. This model gives the simulation and then the simulation results are shown in the waveform.

As seen in the illustration, the photovoltaic Matlab model. The fundamental equivalent circuit diagram for each solar unit creates a basic model. To maximize the result accuracy of the I-V features. The circuit is created by a diode and the diode is connected in parallel to each other. The model is represented by the mathematical form. The 2-diode model is higher accurate than the single-diode model. A single-diode is used for the operation of while using the system because if a 2-diode is used then it is more difficult for the system is more complicated. The equation is given below,

$$I = I_{pv} - I_{D1} - I_{D2}$$

$$I_{D1} = I_{01} * \left\{ exp\left(\frac{V}{A_1 * V_T}\right) - 1 \right\}$$

$$I_{D2} = I_{02} * \left\{ exp\left(\frac{V}{A_2 * V_T}\right) - 1 \right\}$$

Hence,

$$I = I_{pv} - I_{01} * \left\{ exp\left(\frac{V}{A_1 * V_T}\right) - 1 \right\} - I_{02} * \left\{ exp\left(\frac{V}{A_2 * V_T}\right) - 1 \right\} - \frac{V + R_s * I}{Rsh}$$

This equation shows that,
I01 - reverse saturation current by diffusion,
I02 - reverse saturation current due to recombination,
A1 - diode reality factor of diode 1,
A2 - diode reality factor of diode 2,
The temperature and solar irradiance of the current equation are given by.

$$I_{pv} = (I_{pv,n} + K_I * \Delta T) * \frac{G}{G_n}$$

$I_{pv,n}$ is the light on a solar plate under some test conditions (STC).
The current equation is given by,

$$I_0 = I_{0,n} * \left\{\frac{T_n}{T}\right\}^3 exp\left[\frac{qE_g}{AK}\left(\frac{1}{T_n} - \frac{1}{T}\right)\right]$$

The diode reverse saturation current equation is given by

$$I_{0,n} = \frac{I_{sc,n} + K_i * \Delta T}{exp\left\{\frac{V_{oc,n} + K_v * \Delta T}{A * V_{T,n}}\right\} - 1}$$

Under some tests,
Isc - short circuit current,
Voc - open circuit voltage,
Gn, and Tn - irradiance,
Ki and Kv - short circuit temperature coefficient.
The photovoltaic design is simulated in Matlab and it is based on some equations.
Sunlight radiation and temperature are inputs to the PV model; from these two variables, current, voltage, and power are created. The sun warmth and radiation have a significant impact on the output and vary as these inputs do. The converter circuit receives the voltage and the current of the system is produced. The solar panels' results are produced in DC form, which is converted into the subsequent form.

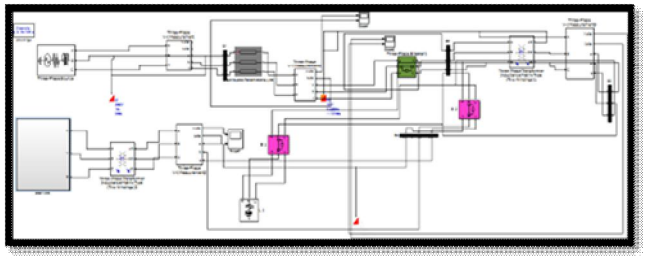

Fig. 4: Matlab or Simulink Model.

The combined PV-wind energy system in Figure was created using Simulink and Matlab. An electrically linked model of the combined sunlight and wind power is present. In the event of a power outage, the grid serves as an alternative by functioning as an alternate source of non-pollution sources of energy. When clean energy sources produce more energy than they need, the electrical system also serves as an inventory mechanism. The electrical system will inevitably satisfy all requests if it detects a lack of sunlight or wind power or if these resources are unable to handle the load demand.

IV. RESULTS

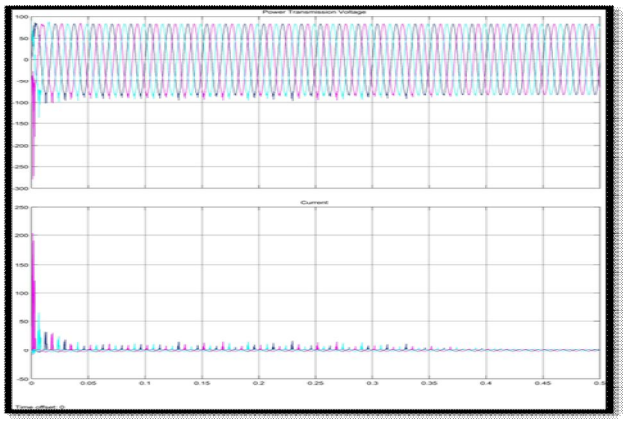

Fig. 5: Result of Hybrid power System.

The final result of the combined power system's oscillating voltage graph current is shown in a graph. This power is connected to the grid.

Using this powers the grid with wind as well as solar energy. The PV system and wind-generated power are linked in parallel and shared. These two systems are linked simultaneously to the arrangement, there is a variation in power output from both wind and solar resources since they operate on different environmental circumstances. As a result, are shown in the below fig.

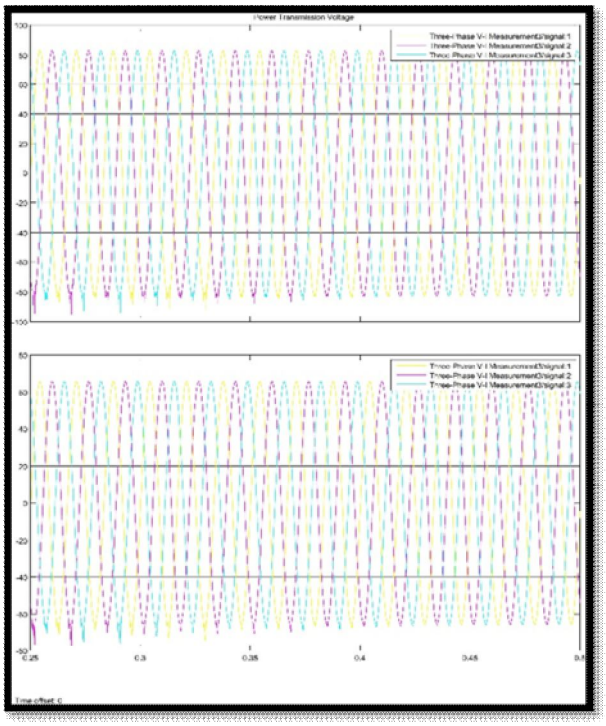

Fig. 6: Result of Voltage, Current of Load.

The wave represents the sinusoidal voltage, current output of stress.

V. CONCLUSIONS

The final result of the hybrid energy system oscillating voltage and current is shown in a graph. The combined system's supply is provided to the stress of the system and grid.

Using this system powers the grid to the wind and sunlight energy. The PV system and wind-generated power are linked in parallel and shared. These two systems are linked simultaneously to each other. there is a variation in power output from both wind and solar resources since they operate in different environmental circumstances. As a result, the measurement of power is not equal. The Matlab program was used to model the whole system and then produce the results or output. The result of that temperature and sunlight affect the production. As solar power rises, then output also power rises, and also current and temperature are raised and the value of voltage is fall, and the power declines. The primary result of the wind speed and direction, and the findings demonstrate is the variations of wind speed result in sinusoidal power. Combining sunlight and wind power sources results in the production of clean energy needed to fulfill the demand for power.

The research of a combination of sunlight-Wind energy generating the energy for the grid will be the primary emphasis of this project, which will use Matlab/Simulink software. The production of electricity from a single renewable energy source is unable to satisfy demand; thus, the combination of the sunlight-Wind model is developed and it impacts climatic. AC electricity is generated by a wind power system using a permanent magnet synchronous generator. In order to power the grid and supply the necessary energy, the two energy sources are integrated.

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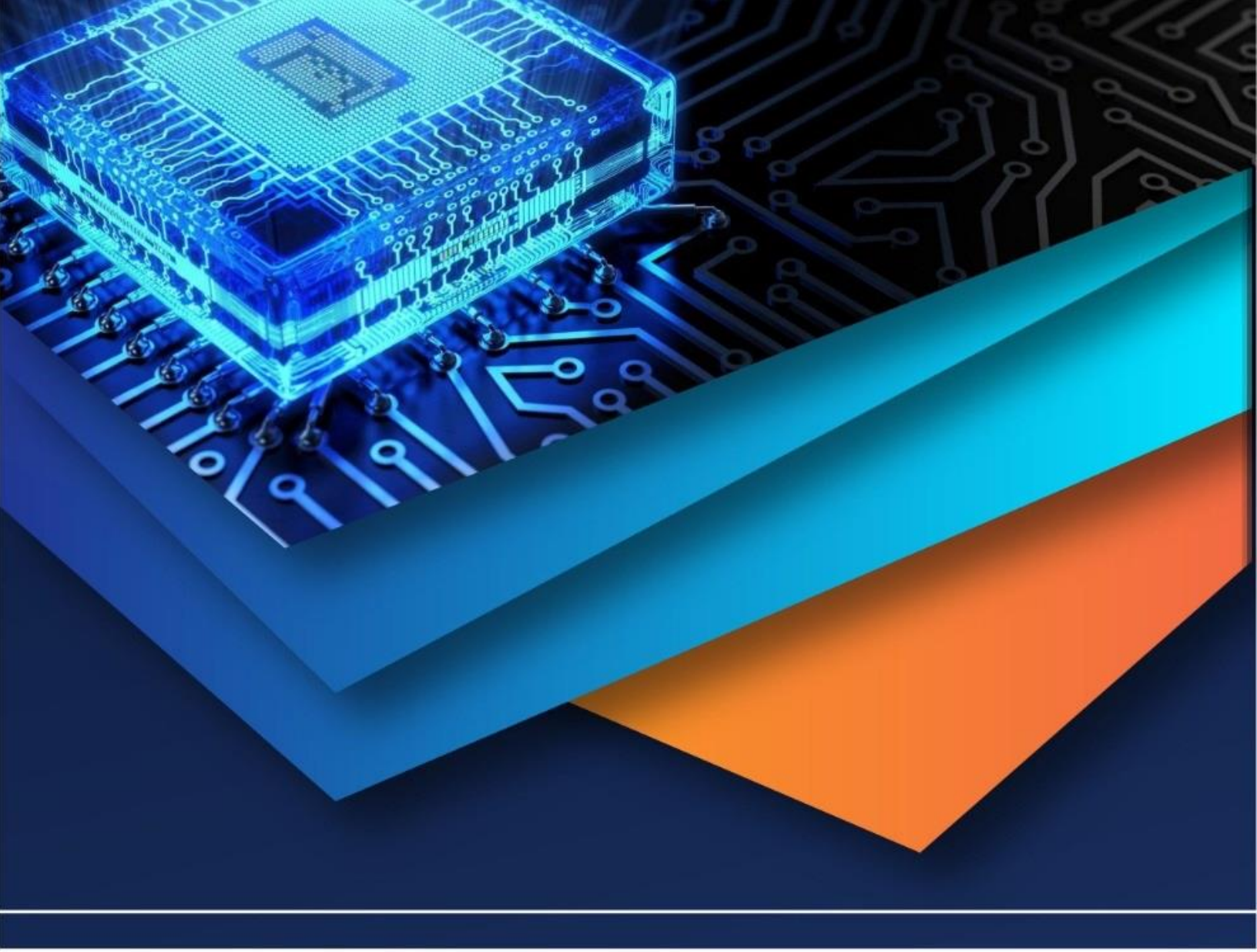

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