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Power Generation by Vertical Axis Wind Turbine and Solar Energy

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Abstract: ***Wind and solar energies are the types of non-conventional forms of energy and those are available in affluence. Electricity can be generated with the help of vertical axis wind turbine and solar panel. The main objective is to utilize these wind energy and solar energy in most efficient manner to get maximum electrical output. These are useful in producing electricity in Indian highways roads. Where we can take advantage of moving vehicles on the road and solar energy from sun. The turbine is fabricated as per specifications the blades are semi -circular shape and are connected to the disc which is connected to the shaft. The shaft is connected to the discs with the help of bearing and then the gears will be fixed to the shaft. The dc motor will mesh to the gear. When wind strikes the blades the dc motor generates the power. The power is developed so that is stored in battery. on the other side the solar energy is generated with the help of sun to the panel, and it converts into electrical energy. Hybrid energy system using wind turbine and solar energy gives continuous power without any interruption. That electricity is stored in battery which it can be used to domestic purposes, streetlamps and highways. So, the power is generated using VAWT and solar energy.***

Keywords: VAWT, Solar energy, Hybrid system, dc motor, battery

I. INTRODUCTION

Since there are now 7 billion people on the planet, every one of them needs energy for home use. Relying only on fossil fuels would put humans in danger as the demand for electrical energy develops exponentially and the availability of fossil fuels is getting more and more scarce.

At this rate, non-renewable energy will run out very quickly one day, and fossil fuels also contribute significantly to pollution and other environmental issues including greenhouse gas emissions and global warming. We need to find alternative energy sources that can give us a consistent supply of electricity without emitting any pollution considering all these issues. Pressure differences in the atmosphere are what generate wind.

Air particles travel from the high-pressure end to the low-pressure end because of the difference in atmospheric pressure. Air molecules are affected by the Coriolis effect while travelling, with the exception of the equator. The strength and direction of winds are frequently used to describe them. Gusts are brief, extremely fast wind bursts. Strong winds with a moderate duration are known as squalls. There are many terms used to describe strong winds, including breeze, gale, storm, and hurricane. Wind power or wind energy is the technique of utilising the wind to generate mechanical or electrical energy. Wind turbines convert the kinetic energy of the wind into mechanical power. Using this mechanical energy for tasks like pumping water or grinding grain is one option. Another is for a generator to convert it into electricity. The generator generates energy, which is then transferred from the tower to a readily available transformer before switching the output voltage, which is normally around 700 V, to the national grid (33000 V) or for personal use (about 240 V).

II. LITERATURE REVIEW

Mahmoud Mustafa Yaseen et.al., [1] A hybrid wind and solar energy generation was designed and developed. The hybrid system implemented was able to generate maximum power, voltage and current of 48.13W, 17.9V and 4.21A. These results were mainly achieved when the sunlight intensity was ideal for solar power harvesting and optimum wind speed for power harvesting using the VAWT (PMSG). The maximum output power obtained during testing was 48.13W whereas the minimum power generated is 18.18W.

Saklen Shamshu Sayyed et. al., [2] In this they have used a 12v-34v DC generator with a maximum speed of 2400 RPM. The generator converts mechanical energy into electrical energy produced by the wind power. As wind strikes on the blades therotor rotates and simultaneously the generator also rotates.

Then the output of generator is given to charge controller A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries to protect against electrical overload, overcharging, and may protect against overvoltage.

Ogunoh Chika C et. al., [3] By using this clean source of renewable source of energy, not only will it reduce the money spent on electricity bills but also help our planet recover from the effects of pollution and therefore reduce emission of greenhouse gases to the ozone layer.

MahasidhaBirajdaret. al., [4]Our work and the results obtained are very encouraged that vertical axis wind energy conversion are plausible and potentially very contribute to the production of the clean renewable electricity from the wind even under low ideal sitting conditions. With the idea on highway, it will power up streetlights. In most cities, highways are a faster route for daily commute and in need of constant light makes this a very efficient way to produce natural energy.

Shubham Nandurkaret. al., [5] The main principle of vertical axis wind turbine is to convert kinetic energy of flowing wind into mechanical energy of rotation of blade or shaft. The flowing wind imparts force on turbine blades in the direction of wind flow. This force depends upon the wind speed, more the wind speed more is the force of impact. This force generates couple on the turbine. Once, this couple overcomes mechanical resistance of turbine, the turbine starts rotating.

P. Sai Chaitanya et. al., [6] Analysed the on design and development of vertical axis wind turbine blade. This paper explains that the windmill such as vertical and horizontal windmill is widely used for energy production. The horizontal windmill is highly used for large scale applications which require more space and huge investment. Whereas the vertical windmill is suitable for domestic application at low cost. The generation of electricity is affected by the geometry and orientation of the blade in the wind turbine. To optimize this by setting the proper parameter for the blade design.

Chetan Sonawaneet. al., [7] Considering the global energy crisis, use of the non-conventional energy resources has to be increased. By combining such a system, effectiveness is increase and also the seasonal dependency of the individual system can be overcome by use of hybrid energy system. Also, the various advantages of the vertical axis wind turbine make it suitable for to use in such a system. Vertical axis wind turbine can be made at very low cost by using various techniques and also by cheap material such as wood, aluminium, galvanized steel etc.

Samir J. Deshmukh et. al., [8] This paper gives ideas to learn about the design and fabrication of complex Aerofoil blades. Vertical axis wind turbine represents a very promising future for wind power generation. A vertical wind turbine can give output more than conventional HAWT. The rotor that is designed to harness enough air to rotate the shaft at low and high wind speeds. The efficiency of turbine is increased by proper designing of the aerofoil shape blade, The major components are placed at the ground level which ensures the safety of turbine.

J. Vignesh et. al., [9] Although predicting the future based on data is not always fully conclusive, we can deduce that: The VAWT technology is sliding into the use in small generating installations, especially in urban environments that currently have winds that are not exploited. There are studies about the omnidirectional-guide-vane which make power, speed and torque increase markedly in these sorts of environments. Employing Wind VAWT in / PV hybrid power generation system can be the solution at many locations since the cost of this system is lower than the use of both individual technologies.

E.A. Dinesh Kumara et. al., [10] This paper gives an overview of a vertical axis wind turbine. The behaviour of the Vertical Axis Wind Turbine (VAWT), present technological state, new finding through modelling work and future direction of VAWTs were reviewed. It was observed that VAWT plays a vital role in the present energy crisis. Ones can foresee that human being dwelling in a world with wind turbines and solar panels due to present energy crisis with the non-renewable energy. Wind energy has been identified as a promising renewable option.

Parth Rathod et. al., [11]It is evident that the power output of vertical axis wind turbine for two blade two stage is maximum. It is also observed that when H rotor is placed above S rotor then power output increases with respect velocity of wind and in H-Darrieus rotor NACA0021 has better self-starting performance and gives higher Cp than other airfoils.

Hafsa Murtaza et. al., [12] The design parameters were described in first along with their technical specification. The main idea was to design a small-scale vertical axis wind turbine integrated with solar power system. It is noticed from the evaluated results that the vehicles moving on highways can produce enough energy to provide electricity to the streetlights, the output gets enhanced when VAWT is integrated with solar power system and that electricity produced can supply nearby villages or off grid areas.

N. Venkata subbaiahet. al., [13] The use of wind energy for energy generation is one of the oldest methods for harnessing renewable energy. Use of renewable energy is an essential ingredient of socioeconomic development and economic growth. Renewable energy sources such as wind energy, tidal energy etc.

S.sivagamiet. al., [14] Reported the performance prediction and basic principles of small amplitude VAWT for sharp edge pitching during variable amplitude are discussed. Various structural problems were analyzed, and the final report was that the maximum energy generated by the turbine was due to the wide spectrum of wind speed and the amplitude of blade pitch varied with wind speed and blade tip speed ratio.

Dr. Jacquelynne Hernandez et. al., [15] "On wind speed pattern and energy potential in Nigeria." Reviewed wind speed distribution and wind energy availability; assessed potential for wind power generation in Nigeria. Annual mean wind speeds range are 2-9 m/s, with an annual power density of 3.4-520 kW/m2.

Mr. Mohammed Mustafa et. al., [16] For evaluating and designing the project, several resources' help has been taken. Precise information regarding various Solar and Wind phenomenon was procured from these resources. These sources provided immense help in understanding the total concept of Hybrid Power Generation and other topics closely related to it.

Ch. NVSS Lakshmi Narayana et. al., [17] In this project efficiency is calculated using Output energy of turbine and input energy of wind. Variation of efficiency with respect to blade angle was observed. Finally, it was concluded that when the angle between the blades is 30 degrees the efficiency is high when compared to remaining angles. It is observed that VAWT is good for lower wind speed. Turbine blades are designed with flat, curved and S-shape. The material used was aluminium.

N. Gopalakrishnan et. al., [18] The combination of wind and solar PV has the advantage that the two sources complement each other because the peak operating times for each system occur at different times of the day and year. The power generation of such a hybrid system is therefore more constant and fluctuates less than each of the two component subsystems. Other solar hybrids include solar-wind systems.

Vinit.V. Bidi et. al., [19] In this paper the fabrication of prototype model of Savonius type Vertical Axis Wind Turbine (VAWT) is made using easily available materials like, front wheels of bicycle with ball bearing, half cut PVC pipes, wooden base etc. The CADD model of the VAWT is prepared. This VAWT is placed in the medians of highway. The vehicles from both sides of medians accelerate the wind thus increasing its kinetic energy which forces the turbine blades to rotate in clockwise direction. This drives the rotor, which is connected to a DC generator, thus producing electricity. The effort is made to produce electricity at low cost.

M. Rambabu et. al., [20] This system is environmentally friendly. The working model of our project is combining energy source with solar system and vertical axis wind turbine system which is a good and effective solution for power generation, basically this system involves the combination of two energy system, suppose anyone source fails to generate another source will keep generating the electricity and will give the continuous power to the load. The renewable energy sources such as solar and wind energy are used to generate the electricity.

By considering all the above-mentioned journals, as per our knowledge we observed that the using of renewable energy sources we can produce electricity continuously without any interruptions unlike non-renewable energy source and also it reduces the global warming and pollution. So, we use wind and solar as energy sources by vertical axis wind turbine and solar energy to produce more power. This can be used for domestic purposes.

III. WORKING METHODOLOGY

A hybrid power generation system that combines a vertical axis wind turbine (VAWT) and a solar energy system can provide a reliable and efficient way to generate electricity. The working principle of such a hybrid system is as follows:

Wind Energy Generation: The VAWT captures wind energy and converts it into mechanical energy. The blades of the VAWT rotate, which turns the central shaft, which is connected to a generator. The generator converts the mechanical energy into electrical energy.

Solar Energy Generation: The solar panels capture sunlight and convert it into electrical energy through photovoltaic (PV) cells. The electrical energy generated by the PV cells is fed into an inverter, which converts it into alternating current (AC) that can be used to power homes, buildings, and other equipment.

Energy Storage: The electrical energy generated by the VAWT, and the solar panels is stored in a battery bank for use during periods of low wind or low solar radiation.

Energy Management: A controller or energy management system regulates the flow of electrical energy from the wind turbine and the solar panels to the battery bank and to the load (homes, buildings, etc.). The controller ensures that the energy generated by the VAWT, and the solar panels is used efficiently and optimizes the performance of the hybrid system.

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In a hybrid power generation system, both the VAWT and the solar panels can operate together to provide a consistent and reliable source of electricity. The VAWT can generate electricity even in low wind conditions, while the solar panels can generate electricity even on cloudy days. The battery bank provides energy storage, ensuring that power is available even when the wind is calm, and the sky is cloudy.

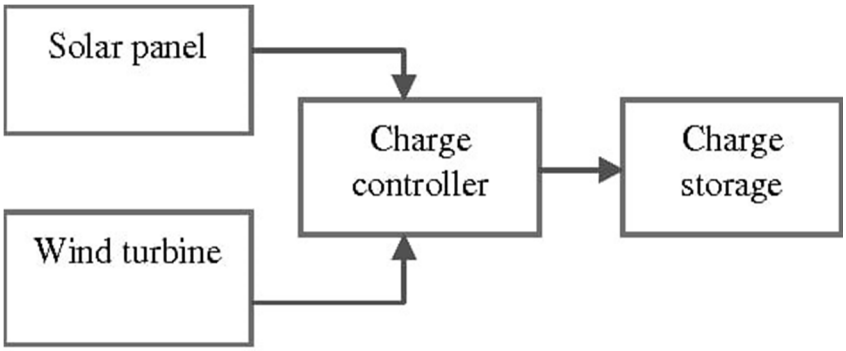

Fig. 1 Block diagram of the solar wind hybrid system

IV. FABRICATION

A. Dc motor

The capacity of dc motor is12v with maximum speed of 1000 RPM. The dc motor coverts the mechanical energy into electrical energy from the kinematic energy of the wind. When wind strikes the blade, the rotor rotates, and dc motor rotates.

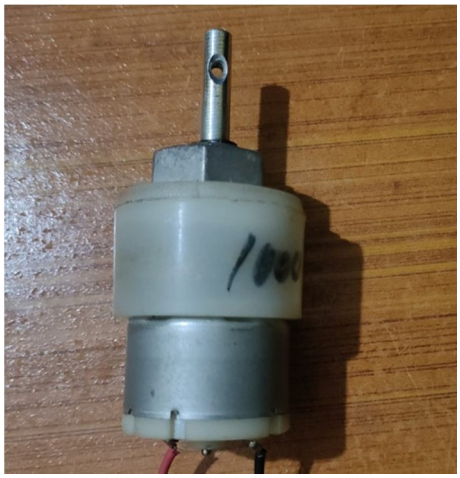

Fig. 2 DC motor

B. Spur gears

Spur gears are used to transfer the motion and power from shaft to another mechanical setup. So, it can alter the speed and multiply torque. The two spur gears are places at the bottom on the disc.

Fig. 3 Spur gears

C. Solar Panel

Solar panels are used to transform solar energy into electrical energy. The physical characteristics of a PV cell are quite similar to those of a conventional diode, which also has a semiconductor based PN junction. The energy of the photons that are taken in by the junction as it absorbs light is transmitted to the material's electron-proton system, producing charge carriers that are separated at the junction. The capacity of solar panel is 12v,20W which it is connected to charge controller.

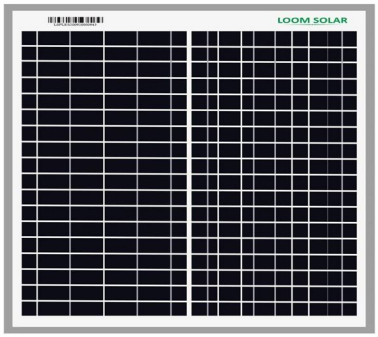

Fig. 4 Solar panel

D. Battery

The battery is used to store the power from the charge controller the capacity of the battery is used 12v 1.3AH DC

Fig. 5 Battery

E. Blades

The purpose of blades in a vertical axis wind turbine is to capture the energy from the wind and convert it into rotational motion, which can be used to generate electricity. The blades are designed to be aerodynamically efficient and are typically curved or twisted to optimize their performance. They are mounted on a vertical axis, which allows the turbine to capture wind from any direction, making it suitable for use in urban or confined spaces where the wind direction is variable

Fig. 6 Blades

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F. Ball bearings

The ball bearing used to rotate the shaft freely without any disturbance which reduces the friction and the bearing fixed to bottom of the disc.

Fig. 7 Ball bearings

G. Wooden discs

The wooden disc are used to hold the blades. Blades are clamped to the both bottom and top of the discs. Disc thickness is ¼ and height of the disc in 12inches.

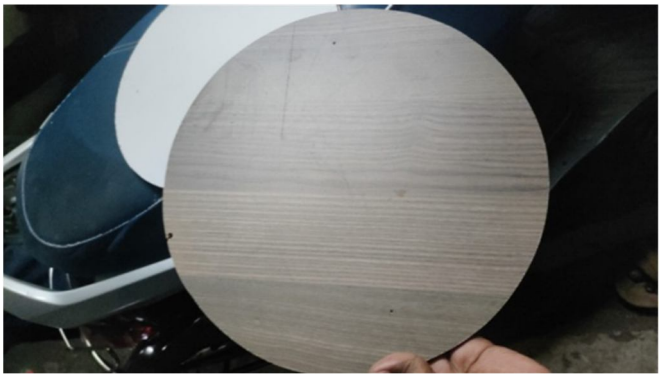

Fig. 8 Wooden discs

V. CALCULATIONS

Vertical axis wind turbine works on principle of converting kinetic energy of the wind into mechanical energy. The K.E of any particle is equal to the one half of its mass times the square of its velocity.

K.E. =½ mv^2. …….. (1)

K.E = kinetic energy

m = mass

v = velocity, M is equal to Volume multiplied by its density ρ of air,

Mass = ρ Av ……. (2)

Substituting eqn (2) in eqn (1) We had got,

K E = ½ ρ Av^2 watts

ρ = density of air (1.225 kg/m^3)

D = diameter of the blade

D = 0.5m

Available wind power Pa = (½ ρ π D^2 v^3)/4

P = 1/8 ρ π D^2 v^3

TRAIL 1

For velocity 3.5m/s

P = (½ ρ π D^2 V^3)/4

$P = (½*1.225*\pi*0.5^2*3.5^3)/4$
Power = 5.15Watts
TRAIL 2
For velocity 6m/sec
$P = (½\ \rho\ \pi\ D^2\ v^3)/4$,
$P = (½*1.225*\pi*0.5^2*6^3)/4$
Power = 25.57Watts
TRAIL 3
For velocity 4m/sec
$P = (½\ \rho\ \pi\ D^2\ V^3)/4$
$P = (½*1.225*\pi*0.5^2*4^3)/4$
Power = 7.69Watts

Solar Power Efficiency
Power = V*I
Power = 12*1.6
Power = 20Watts
Where:
P is the maximum power output. (in W)
V is voltage of the solar panel (in V)
I is current of the panel (in A)

VI. RESULTS AND DISCUSSIONS

By calculating the output electrical energy of the vertical axis wind turbine and solar energy through trial runs, we concluded that the power generated by the wind turbine and solar panel is sufficient to provide continuous electrical supply without voltage fluctuations and can be easily handled, and the range of 6 to 8 blades provides greater efficiency for generating power.

Fig. 9 Final image of the project

VII. CONCLUSION

In conclusion, both vertical axis wind turbines (VAWT) and solar energy are promising sources of renewable energy that can help to reduce our dependence on fossil fuels. VAWTs are well-suited for urban environments and can be installed on smaller scale projects. Solar energy is more widely used and can be easily integrated into existing energy systems. Both technologies have their own advantages and disadvantages, and the best solution will depend on specific needs, such as the location, climate, and available resources. However, it is important to note that both VAWTs and solar energy are part of a larger shift towards renewable energy sources and both technologies have a role to play in a more sustainable energy future.

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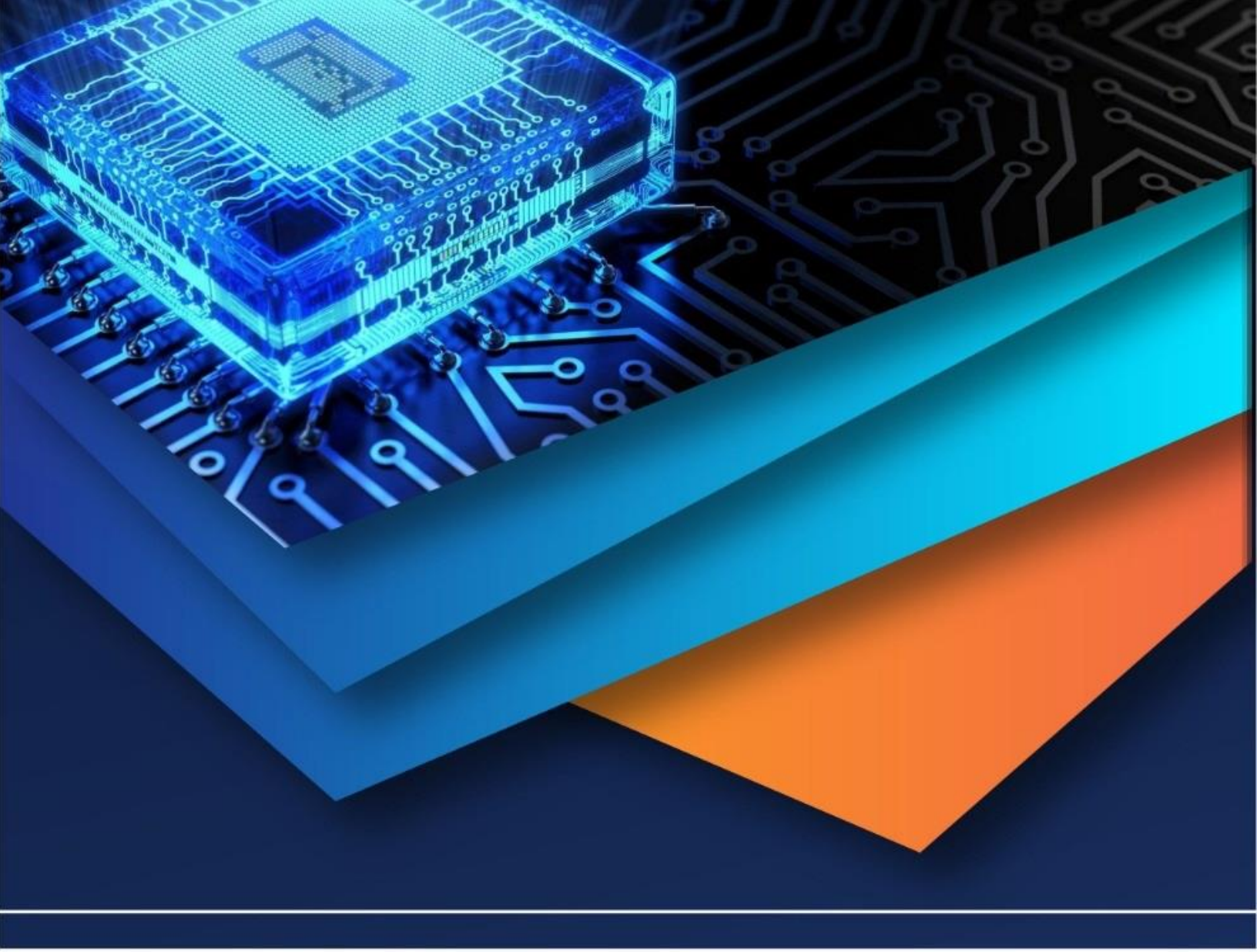

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