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Design and Fabrication of Paper Shredder Machine

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Abstract: ***In this paper, we will discuss about detailed study, design procedure and results of a paper shredder machine. A detailed study of various parts of shredder machine like stand (frame), transmission system and cutting system are made and designed separately. Study of paper shredder machine included the machine elements which convert manual existing system to automatic system. Paper shredder machine is a mechanical device which is used to cut the paper into chad, typically either strips or fine particles. We are making this project model for recycling of paper wastage(important documents, personal information like social security number, account number, credit card application and other personal information) in domestic area, industrial area etc. in this areas the paper waste is present in large quantity. But the available machines used to recycle this waste are costly. So our intension behind this project is to process the paper waste as cheap as possible by shredding. Benefits of this machine are the reduction of labor work which results in cost reduction and also reduction in time for shredding operation of paper. So we are going to design this for shred the paper waste, with the help of blades.***

Keywords: Paper Shredder Machine, Cutting Blades, Papers, Creo 3.0, ANSYS15

I. INTRODUCTION

A paper shredder is a mechanical device used to cut paper into small strips. Government organizations, businesses and private individuals are used to destroy private, confidential, or otherwise sensitive documents into strips or fine particles. Paper shredder machine is utilized to shred the important documents which are misused by some unauthorized person. There are lots of people who spend their day through rummaging garbage to find personal information like social security number, account number, credit card application and other personal information about company to overcome these issues, paper shredders are used. The Paper Shredder is equipped by using all necessary items and method such as aluminium sheet metal, rivet, and skills in manufacturing machine to cut and bend the parts and etc. The process of development is started from designing the shape of the paper shredder by considering the function as well. In order to produce user friendly product that is suitable to the consumer, consideration to the ergonomic factor is taken into account. It involves the measurement process before the materials are cut into pieces before assemble together by using cutting and bending processes. The paper shredder is needed to test to check whether its mechanism is properly work or not work. This project title is “Design and Fabrication of Paper Shredder”. The project includes small analysis of the paper shredder and fabrication of the paper shredder itself with concerns regarding strength, portability, durability, ergonomic factor and convenience. Test need to be done to verify the strength of the paper shredder cutter before the fabrication process started. It is require more knowledge and skill of analysis. Skill how solve the problem is the most important and need to be improve when this project launched, as in [1]. Shredders range in size and price from small and inexpensive units designed for a certain amount of pages, to large units used by commercial shredding services that cost hundreds of thousands of dollars and can shred millions of documents per hour. While the very smallest shredders may be hand-cranked, most shredders are electrically powered. Shredders over time have added features to improve the shredder user's experience. Now many reject paper that is fed over capacity to prevent jams; others have safety features to reduce risks. Some shredders designed for use in shared workspaces or department copy rooms have noise reduction.

II. OBJECTIVES

A. The existing system of conventional shredder machine is based on manual operating so it consumes more time for operation. Our main objective is to reduce time for operation
B. To modify a machine this will produce less noise, vibrations and to reduce time consumption for shredding operation by modifying tool design.
C. To solve the problem of returning of paper.
D. To construct a machine which will shred approximately 15 sheets (A4 size) at one Stroke.

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III. LITERATURE REVIEW

Ming- Hui Ho In 2003, he has presented the paper shredder which had two rotary cutters each with multiple blades. Each blade had a first cutting blade with multiple first cutting edges and a second cutting blade with multiple cutting edges. Both the first and the second cutting blades were distributed in a non-equiangular manner and each of the first cutting edges was offset to each one of the second cutting edges, so that there was only one cutting edge that engaged with the paper to be shredded.

Joseph Y. Ko In 2000, presented a machine with automatic feeding mechanism capable of shredding 20 sheets with approx. 9 inches width. It had a three way switch i.e. On, Off and Auto. The blades were knife rollers which cut paper strips, but can be occasionally configured to have confetti-cuts of paper. Feeding mechanism contained a pair of roller to direct the paper. The rollers and the knife blades were driven by a single AC Motor and a belt drive.

Willi Strohmeyer In 1995, presented a blade and a stripper assembly for a paper shredder. Between the blades of each shaft in the cutter zone, stripper bars or fingers were provided to avoid the cut material get collected around the blade shaft. Here the stripper block had the row of stripper fingers received in the interstices between the blades. Requisite stability was attained since the fingers were engaged with the support ribs of the opposite housing. Stripper block was an injection moulding part, thus was simple construction and easy to fabricate and also had low cost.

I. M. Sanjay Kumar DR. T.R. Hemanth Kumar The scope of this project was to design and development of shredder machine focus on chopping of coconut leaves, areca leaves, this chopped powder to prepare the vermin compost. The project began with collection of information and data on user lifestyle and current process by which they perform their job. Concepts were developed with reference of four different shredder machine and operating processes. Concept was developed considering the safety factor users operating environment and maintenance. Eight cutters are mounted on two shafts, which rotate parallel driven by a spur gear. The power from the electrical motor is transmitted to cutter shaft through a belt drive.

IV. PROBLEM DEFINITION

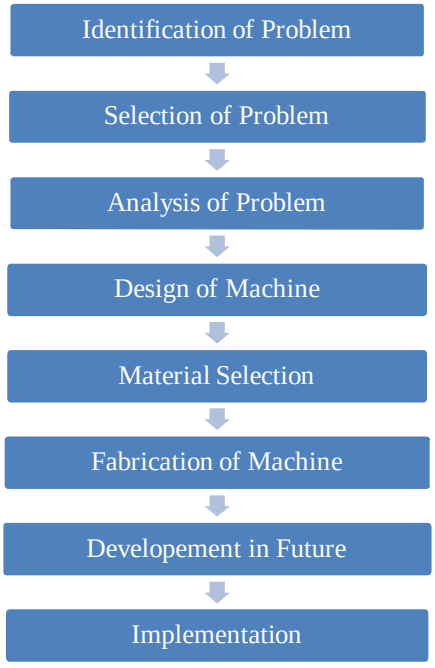
The existing system of conventional shredder machine is based on manual operating so it consumes more time for operation.

Only one paper can be cut at a time because of in appropriate manner power doesn't get to cutting system. That's why, more paper cannot introduce in cutting system.

Also there was a problem of back flow of paper along with cutting blades.

Due to un consistency in power by rotation of shaft unwanted forces is generates which leads to noise and some vibrations produce in machine.

V. METHODOLOGY



Flow chart: Methodology

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VI. SYSTEM DESIGN

Software used for designing is Creo 3.0.Paper shredder machine from design point of view consists of three main parts: machine construction, cutting system, transmission system.
Machine construction: Machine construction consists of stand, bearing support plates, nuts and bolts etc.

A. Stand/Frame

Fig.1 Stand/Frame

Construction machine consists of stand, bearing support plates, nuts and bolts. Frame is the supporting member which provides support for components like gear, shaft, blades etc. In order to get the required strength, two plates (Bearing support blades) are fixed with the help of nut and bolts. The machine frame with a size of 275X220X178 mm which will connect through fastening process. The material used for the machine frame is MS (Mild Steel).The analysis of frame was done to check whether it can support the load of the cutting and transmission system assembly. The analysis was done in ANSYS15. A36 has a density of 7,850 kg/m3.Design and manufacturing of frame to follows dimensions: Length (l) =275 mm, Width (w) =220 mm, Height (h) =178 mm.

B. Cutting blade

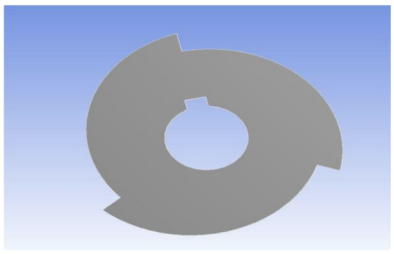

Fig.2 Cutting blade

Cutting system consists of the shafts, cutting blades, washers and gears. The cutting blade is round-shaped blade with 3 (three) cutting edges, given circle-shaped hole in the middle with keyway, mounted on the main shaft and main shaft move together ,as in [2]. In drawing of cutting blades in Creo 3.0 software, cutting blades are equally divided into certain degree of angle and each cutting edge of cutting blade is joined by arc to second cutting edge up to particular length of cutting edge. We design the cutting system in such a way that angle between keyway of each cutter blade is 40 degree. And cutting blades are placed in such a manner that after first blade apart 40 degree from second blade. This concept used in paper shredder machine. Because of that, power which was requiring to rotate the shaft was large. Now that power to rotate the shaft is lesser than previous. Material used for cutting blade is EN31 steel.
Analysis result:

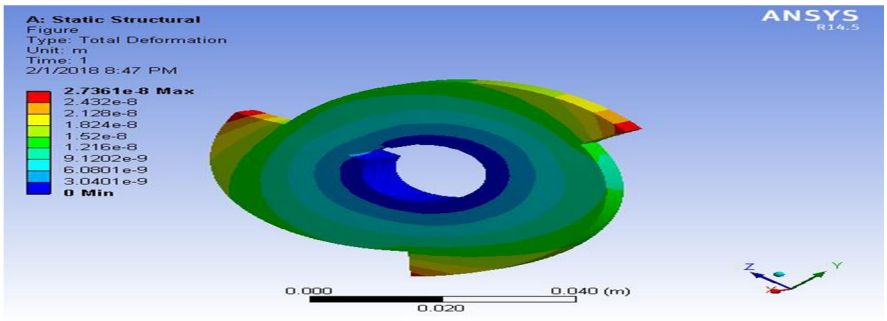

Fig.2.1 Total deformation of cutting blade

Total cutter on one shaft 15 and 15 cutter on other shaft
So that,
15 cutters divided in 5 set
Each set contain 3 cutter
Number of cutter=15
=15/3
=5 set
In one set, key way shifted to 40^0 after every cutter
Power requirement by cutting system to shred papers,
Cutting forces
$F_c = (Ks*S)/G$
$= (4*15)$
$F_c = 60N$
F_c=cutting forces of paper (kg)
K_s= tear strength of paper (n)
S=max paper load (sheet)
G=gravity (m/s^2)
$F_c = F_c$*no. of blade
$= 60*30$
$= 1800N$
$T = F_c*D/2$
$= 118.246*70/2$
$= 63N.M$
$T = 4138.63*9.81*10^{-3} = 40.6$ Nm
P=2*3.14*108*63/60=712.52watt

C. Shaft

Fig.3 Shaft

A shaft is rotating machine element, usually circular in cross section and which is used to transmit power from one part to another part or from a machine which is power producer to power machine, which absorbs power. The various members such as cutting blades, gears and pulley are mounted on it. Circular shaft is used with one keyway (square) has a circular cross section for cutting system. Material is used for shaft is EN31 steel. Shaft is manufactured and diameter of shaft is 21 mm.

D. Key

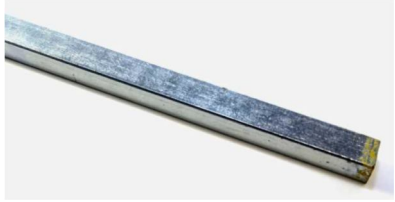

Fig.4 Key

A key is machine element used to connect a rotating machine element to shaft they key present relative rotation between the two pars and many enable torque transmission. Square key use in machine shaft. Material used for key is steel. Dimensions are obtained by designing of key: width of key=5.5mm, height of key=5.5mm, length of key=210mm.

E. Spur gear

Fig.5 Spur gear

A gear or cogwheel is a rotating machine part having cut teeth or cogs, which mesh with another toothed part to transmit torque. A geared device gives different desired speed, torque, and direction of a power source. The teeth on the two meshing gears all have the same shape, as in [6]. Material is used for spur gear is EN31 steel. Required gear ratio to cutting system is 1. So, spur gear designed and manufactured which have equal number of teeth and diameter of gear. One set of gears are used which has two spur gears.

Analysis result:

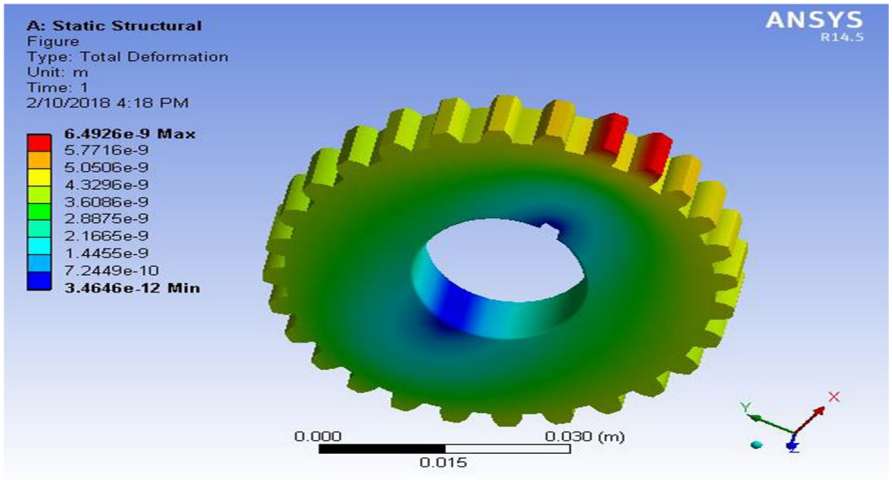

Fig.5.1 Total Deformation of spur gear

F. Gear box

Fig.6 Gear box

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A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear). Like other gear arrangements, a worm drive can decrease the rotational speed or transmit higher torque. Material is used for worm and worm gear box is MS (Mild Steel). Speed reduction ratio is kept 19.5 and centre distance is 100 mm. Diameter of input shaft = 25 mm output shaft = 32 mm for Gear box is obtained after designing.

G. Pulley and Belt

Fig.7 Pulley and Belt

V-belt pulleys (also called vee belt sheaves) are devices that transmit power between axles by the use of a v-belt, a mechanical linkage with a trapezoidal cross-section. V-belt pulleys are solely used for transmitting power between two parallel axels. The v-belt and its complementing pulley create the most efficient belt drive known (sometimes achieving 98%) transmission. Material is used for pulley and belt respectively mild steel and rubber. Large pulley diameter (D) = 100 mm, Small pulley diameter (d) = 71 mm and distance between two pulleys=300mm sufficient to get power requirement by gearbox from motor. Speed ratio between two pulleys is 1.5. So, design the belt to diameter and area (cross sectional) respectively is 869.30 mm and 80.70 mm. So, from the table get belt no.A32/849 is selected. Belt and pulley is design to pitch line velocity which is 11 m/s.

H. Motor

Fig.8 Motor

Electric motor is electrical device that converts electrical energy into mechanical energy. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

Motor Specification:

1) Type-3 Phase Induction motor
2) Input power - 550 watt/1 HP
3) Input speed - 1405 rpm
4) Input torque - 3.738 Nm

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I. Jaw type coupling

Fig.9 Jaw type coupling

A jaw coupling is a type of general purpose power transmission coupling that also can be used in motion control (servo) applications. It is designed to transmit torque (by connecting two shafts) while damping system vibrations and accommodating misalignment, which protects other components from damage. Jaw couplings are composed of three parts which are consisting of two metallic hubs and an elastomer insert called an element, but commonly referred to as a "spider". Considerations for elastomer selection include ability to dampen vibration, ability to handle misalignment, operational temperature range, speed of equipment, and chemical conditions. Jaw couplings are considered "fail-safe" because, should the elastomer fail or wear away, the jaw coupling hub teeth will mate, much like teeth on two gears, and continue to transmit torque. Material is used for jaw type coupling is .On the basis of design torque which is 113.34 Nm compare the design torque with chart and find maximum bore diameter. Jaw type coupling is designed and selected to bore diameter of 22 mm.

J. Bearing

Fig.10 Bearing

A bearing is a machine element that constraint that constraint relatively motion to only the desired motion to only the desired motion and reduced friction a machine element that a bearing being a machine element that allows one part to bear another. Material is used for bearing is steel. From the chart bearing no.6204 is selected by obtaining C=13.50(Cr<C).So, bearing no.6204 is suitable and it is selected.

VII. RESULT

As we made the design according to requirements, the necessary calculations were also carried out. We designed the other shredding elements such as spur gear, shaft, cutting blade, jaw type coupling, bearing, key and frame etc. Main elements which are gear box and motor this are most important to shred the paper more efficiently than previous. Also, because of design and automation time for operation is reducing to greater extent than previous one. Therefore this machine was less time consuming as compared to manual shredder.

And also capacity of shredding papers by machine has increased to more papers (up to 15 papers) in one stroke as compared to manual shredder or office shredder. Manual paper shredder was shreds up to only 3-4 paper in one stroke.

Noise and vibrations also reduced by proper designing and rubber material used for insulation of vibration (appropriate damping capacity).

In the last stage i.e. checking whether the machine runs properly or not, it was observed that the paper was getting cut into strips but it was returning again with the blades. This did not allow us to put the other sheet. If other sheet was put, the machine used to stop automatically. This problem was eliminated by using the component called as "Stripper Fingers". These fingers restricted the return path of the paper. Thus paper had no other option but to enter the bin.

VIII. CONCLUSION

To minimize the limitation of conventional paper shredder machine, the atomize paper shredder machine is more applicable and economically feasible. We are developing a prototype model to fulfill the requirement. So, this project will more applicable in company application. After discussing with industrial person and after discussion of literature review, it was found that the conventional machine has more limitation. To minimize the limitation of conventional machine, some modification is suggested in review paper, on the basis of the information, we are developing a prototype model of paper shredder machine. Such paper shredder machine is useful for destroying important documents (which is insecure in working environment) or tool drawings or other things in company or any sector.

IX. ACKNOWLEDGEMENT

It gives us immense pleasure to present our research paper titled "Design and Fabrication of Paper Shredder Machine". We are thankful to our honorable principal Prof. T. S. Sutar and HOD R. R. Chakule Department of Mechanical Engineering from Loknete Gopinathji Munde Institute of Engineering Education & Research, Nashik for his support and encouragement.

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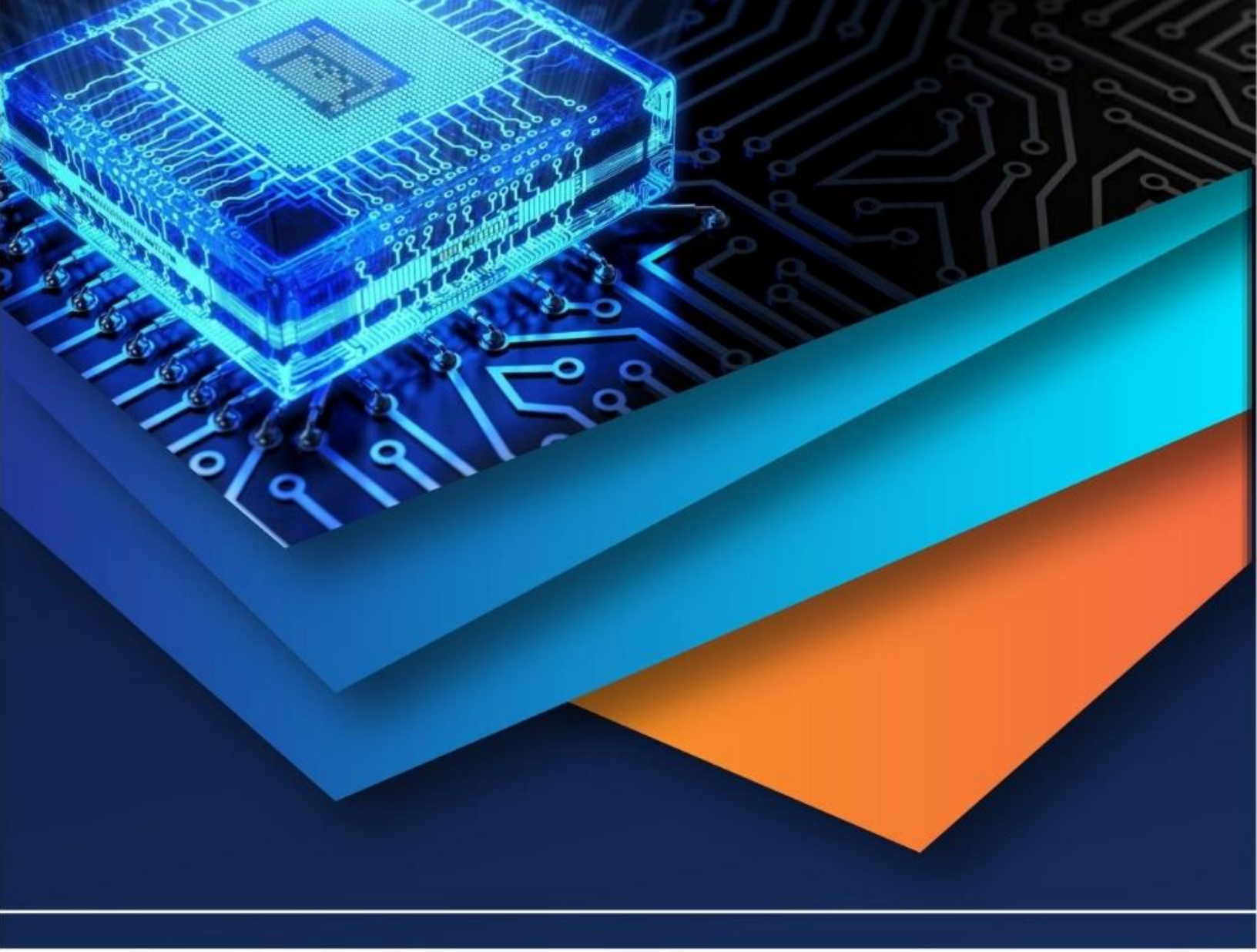

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