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Water Hyacinth Remover

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Abstract: ***The aquatic plant identified as the water hyacinth spreads fast and has entered water bodies all aroundtheworld. Wheneveritexpandsunchecked,itclogs lakes and rivers, affects local ecosystems, and produces complications for people by being in the means of transportation,boating,andfishing.Conventionalremoval techniques, including chemical treatments and hand extraction, have shown to be labour- intensive, harmful to the environment, and frequently ineffective over time. A more long-term solution to this issue is provided by mechanical water hyacinth removers, whose development and efficacy are examined in this article to address the challenges posed by water hyacinth infestations, we are developingamechatronicssystemdesignedfortheefficient removal of aquatic plants using a combinationof conveyor belts and cutters. In this paper, we have designed and fabricated a prototype of a water hyacinth remover. The design process involved creating and analysing key componentssuchastheshaft,conveyorsystem,floatersand cutters. We also designed both the primary frame and the secondary conveyor frame. The motor selection was based on detailed design calculations to ensure optimal performance. Additionally, we have integrated a wireless Wi-Fi connection to enhance operational control and monitoring of the system.***

Keywords: Water hyacinth, conveyor system, mechatronics system, IoT, Wi-Fi

I. INTRODUCTION

Worldwide, water hyacinth is a major issue in rivers, generating ecological disruption and making it more difficult to navigate waterways. The current techniques for getting rid of this invasive species are frequently time-consuming and ineffective. The water hyacinth, a perennial aquatic plant that floatsfreelyand is classifiedasahydrophyte,isindigenousto tropical and subtropical South America. Water hyacinth may have large, thick, glossy, ovate leaves up to one meter (three feet)abovethewater'ssurfaceinheight. Onastalk,theleaves are10-20cmindiameterandfloatsthankstobuoyantnodules that resemble bulbs at their base that are above the water's surface.Their lengthy,sponge typehair isbulbousstems. The plump, freely-dangling purple roots dark. A solitary 8-15'' spike is supported by an upright stalk strikingly beautiful blooms, primarily lavender to pink in hue, containing six petals.Waterhyacinthswereintroducedasanornamentalcrop tonumerousnationsoveracenturyagoduetoitsbeautiful appearanceandaesthetic significanceinthelandscape.Butits elegance is superficial and has evolved into an invasive speciesas a due to their adaptability to a range of freshwater surroundings and how they interfere with human activity. Thus,ithasanegativeimageofbeingamongtheworld'sworst aquatic weeds. Known as the "Florida Devil" in South Africa and the"German weed" in Bangladesh, India's"Terror of Bengal," and the " Japanese". A full prototype must be made andextensively tested, either within a controlled environment orthroughreal-lifescenarios.Theanalysiswillalsorevealthe ease of deployment and retrieval, how well each system performs at removing trash from waterways, and what effect theyhaveonboatstability.Linkstoimprovementinthedesign will be considered on the basis of these results. This project not only aids environmental conservation initiatives to maintain canals for tourism& recreation and the welfare of aquatic ecosystems, but also introduces a logical economic in removingwaterhyacinthinfestations.Thisresearchpresentsa new systemmounted on aboat that effectively removes water hyacinth from waterways. The design, development, and performance assessment of the system will be the main focus of the research. Optimizing removal devices (like cutting blades and conveyors), efficient storage options (like mesh containers or bins), and safe boat attachments are essential elements.Theselectionofmaterialswillbethoroughlythought out and supported by their robustness and usefulness. The building of a working prototype will be described after the design stage, emphasizing pertinent instruments and production techniques.

II. LITERATURE REVIEW

Prof.SunilS.Lembhe,Ms.RutujaVikasKenjale,Ms.Shweta Anil Nikam, Ms. Pallavi Pandurang Khatmode, Mr. Vinayak Anil Pawar, Mr. Arun Dashrath Chavan, and Mr. Pranav Ganpat Gole 2022. This paper presents a mechanical tool that will remove Eichhornia crassipes, or water hyacinth, from the water features of Ganpati Ghat, Wai.

The invasive species known as water hyacinth is detrimental to the atmosphere becauseitclogsflows,lowersoxygen levels, and harmsaquatic life.Theremovaltechniquesusedtodayarefrequently pricey, ineffective, or harmful to the environment. The suggested gadget has a straightforward but functional design with a conveyor belt, DC motors, PVC pipes for flotation, a frame, and abattery. It improves the dissolved oxygen content of the water and is energy-efficient and lightweight. Particularly useful in rural locations where resources for water hyacinth eradication are scarce, is this economical decision [1]

Mr.M.Umashankar,etal–2022,haspresentedthedesign and thedevelopmentofanautomatedsystemtoremovewaste materials from ponds, rivers, and lakes, including plastic, algae, and other pollutants, is presented in this work. The system's goal was to increase the effectiveness of waste removal in water bodies by substituting a machine-controlled mechanism for manuallabor.Byliftinggarbagefromthesurfaceofwaterinto thestoragetank,thesuggestedmachine'sconveyormechanism contributes to the reduction of water pollution and its detrimental effects on the environment and aquatic life. The system can be easily operated using a mobile phone, is portable, and can be tailored and scaled for different uses. [2]

Prof. Rahul Udata et al. collaborated on publication in 2021.Their paper addresses the invasive spread of water hyacinth. Using GIS (Geographic Information System), Google Earth, and QGIS, the study estimates the cost and area for its removal. The objectives include mapping the distribution of water hyacinth, creating a cost-area factor, and suggesting removal strategies. Additionally, the paper explores the reuse ofwaterhyacinthinindustrieslikebriquetteproduction,biogas generation,andpapermanufacturing,emphasizingitspotential for environmental and economic benefits. [3]

Mr. Patange Ravikiran Vilas- 2024 has proposed a remote- operated tool called the Water Floating Trash Cleaning Machine (WFWCM), is intended to effectively clear plastic trash, detritus, and floating debris from bodies of water. It incorporates a number of essential parts, such as a conveyor system operated by a chain, propellers, receivers, and DC motors. Solid waste is caught by metal teeth-based jaws fixed on a frame, which let water pass through. Using a motorized shaft, the waste is periodically raised and emptied into a filter basket. By automating the cleaning process, this device improves safety and efficiency over the labor-intensive traditionaltechniques.Inordertolessenthenegativeeffectsof waste management operations on the environment and health hazardsassociatedwiththem,thedesignplacesahighpriority oneco-friendliness,lowpowerconsumption,andconvenience of use in rivers, gutters, and drains.[4]

Ms.A.SujathaReddyetal.havedesignedasystemwith the least amount of human involvement possible. The Water Cleaning Boat initiative aims to reduce pollution in water bodies by eliminating trash and suspended particles. The technologygathersgarbagefromwatersurfacesandstoresitin a container on the boat usinga conveyor beltthat resembles a treadmill and ispowered by a battery. The RF transmitter and receiver are used to control the boat. It has a camera to track movement, and users can control the boat with a smartphone app.TheArduinoUNO,DCmotors,amotordriver,PVCpipe, and a Bluetooth module are important parts. The project's objectives are to lower labor expenses, health hazards, and environmentaldamagefrommanualcleaningtechniqueswhile simultaneouslyimprovingwaterquality.Itprovidesascalable, environmentally friendly cleaning solution. [5]

Prasad V. Shastri, Abhishek V. Bende, et al. 2017. The difficulty of eliminating aquatic weeds, which havedetrimental effects on freshwater resources both environmentally and economically, is the subject of this article. The authors investigatemechanicaltechniques,suchasacuttersystemand conveyor belt, to get rid of water hyacinth instead of using chemicalsolutionsthatmighttaintwater and hurtaquatic life. [6]

Omofunmi,O.E,S.A.Ebifemi,andA.B.Eweina- 2016

To stop the water hyacinth's rapid growth in freshwater environments,theresearchersbuiltaharvester.Theycreateda devicedrivenbya2.0hpelectricmotorby applying scientific ideasandtheanatomyoftheplant.Amowerdiskweighing100 x 70 x 7.36 mm and a shaft with four stainless steel blades measuring 26 mm in diameter serve as vital parts. The harvester has a capacity of 10,646 tons per hour and runs at 3.04 m/s. Using local resources to fabricate it could improve water hyacinth management techniques already in place. [7]

S. Rezania, M. Ponraj, Amirreza Talaiekhozani, et al. published in Journal of Environmental Management-2015. The paper reviewsthepotentialofusingwaterhyacinthfortheremovalof organic, inorganic, and heavy metal pollutants from wastewater,whilealsodiscussingthepotentialbyproductsthat can be derived from water hyacinth and the need for sustainable management of this invasive plant species. [8]

Farah Amalina, et al. published in the Journal named HazardousMaterialsAdvances–2022.Waterhyacinthcanbe used as an adsorbent to remove organic contaminants, especiallyorganicdyes,fromwater,andfutureresearchinthis area could aid in water resource management. [9]

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P. Galgali, Supriya Palimkar, A. Adhikari, R. Patel, J. Routh International Journal of Phytoremediation - 2022. Water hyacinth,aprevalentaquaticweed,servesasanefficientagentfortheremovalofpotentiallytoxicelements(PTEs)andothercontamina nts from wastewater. This is achieved through the environmentallysustainableandeconomicallyviableapproach of phytoremediation, utilizing either the live plant or its derivatives, including dried powder, biochar, or activated carbon.[12]

V. Guna, M. Ilangovan, M. Prasad, N. Reddy- 2017. Water hyacinth, a ubiquitous weed, has many unique and advantageous properties that can be leveraged to develop a variety of sustainable materials and products. [13]

A. Degaga Journal of NaturalSciences Research-2019. Water hyacinth is an invasive aquatic weed that is challenging the ecological stability of freshwater ecosystems, with negative impacts on biodiversity, the economy, and human well-being, and the best approach to control it is prevention through education and legislation. [14]

F.Karouach,W.BenBakrim,andcolleaguespublishedapaper in Frontiers in Environmental Science in 2022 that offers an extensivereviewofcurrentstrategiesformanagingthespreadoftheinvasivewaterhyacinth.Theauthorsassessthebenefits andlimitationsoftheprimarycontroltechniquesandadvocateforacombinedstrategythatintegratesbiologicalandphysical methods, identifying it as the most sustainable and economically viable solution. [15]

NagassaDechassaJournalofEnvironmentandEarthScience- 2020. Water hyacinth is recognized as one of the most problematic invasive species globally, having expanded from its indigenous habitat in South America to numerous tropical and subtropical areas. This expansion has led to considerable economic and environmental consequences. However, its proliferation can be addressed through a range of control strategies, including manual, mechanical, biological, and chemical methods. [16]

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Thispaperreviewstheallocation,challenges,andstrategiesfor management of the invasive aquatic weed water hyacinth in Ethiopia. [17]

L. B. Carvalho, W. R. C. Junior Communications in Plant Sciences-2019.Waterhyacinthisaninvasiveaquaticweedthat isdifficulttocontrol,butmechanical,chemical,andbiological methods have been used with varying degrees of success and tradeoffs. [18]

AnujaSharma,N.Aggarwal,A.Saini,A.Yadav-2016.Water hyacinth, an invasive aquatic weed, can be utilized in various applications rather than just being controlled through conventional methods. [19]

M. A. Bote, V. R. Naik, K. Jagadeeshgouda-2020. The paper reviewstheresearchonusingwaterhyacinth,anaquaticweed, asapotentialbiofuelcroptoproduceusefulsourcesofenergy, giventhenuisancecausedbytheproliferationofthisplant.[20]

C. Mahamadi-2012. Water hyacinth has potential as a biosorbent for removing heavy and precious metals from aquatic environments. [21]

Zhi Wang, Zhiyong Zhang, et al. have described the massive use of water hyacinth can effectively remove nutrients from eutrophic Lake Dianchi in China with minimal impact on macro zoo benthos and zooplankton. [22]

N.M.DushanNalaka,H.H.DisalBuddhima,A.B.D.Priyasad, Jr. Gamage, Lu Subasinghe Moratuwa Engineering Research Conference-2024. The paper presents the development of a water hyacinth removal machine that uses a cutting mill and screw press to improve the efficiency of mechanical removal and reduce reformation of new plants. [23]

M. Djihouessi, M. Olokotum, Louis Claude Chabi, F. Mouftaou, M. Aina Environmental Challenges-2023. The paperreviewsthechallengesinsustainablemanagementofthe invasive water hyacinth plant and highlights the need for an integrated,ecosystem-basedapproachthatconsiderseconomic analysis and research innovation. [24]

H. M. Saleh. 2016. This review covers the use of water hyacinth as a biological agent for remediating hazardous pollutants, including heavy metals and radioactive wastes. [25]

III. METHODOLOGY

The process of designing a water hyacinth removal and prevention machine involved several key steps:

We understood the characteristics of water hyacinth and assessed its impact on the environment and water bodies.

After that, we have reviewed existing methods and solutions for cleaning water hyacinth to identify their limitations and strengths. Further, we have explored ways to enhance the mechanical efficiency of current machines used for similar purposes.After theexploringprocess, wehave chosenstandard parts that meet the design requirements. Selected appropriate materialsforconstructingthemachinetoensuredurabilityand effectiveness.Decidedonthebasicmechanismsandprinciples that would drive the machine's operations. Created a detailed model of individual components for the machine. Conducted forceanalysisonthecomponentstoensuretheycanwithstand operational stresses. Finally, we built a prototype to test and refine the design for full-scale implementation.

Thewaterhyacinthremoval'sdesignconsistsofdifferentparts such as: Conveyor, Floaters, Propeller, Storage Tank, Microcontroller, Motor Driver, Cutter, DC Motor.

Conveyor: Function: The conveyor system is responsible for transferring the collected water hyacinth from the collection point to the storage tank. Working: Typically, conveyors in suchapplicationsaredesignedwithdurablematerialsresistant to waterandplantmatter.They usea continuousbeltor series of paddles to move the biomass efficiently. The conveyor is poweredbythemachine'smotor,ensuringasteadyflowofthe collected weeds towards subsequent processing or disposal areas.

Floater:Function:Thefloaterprovidesbuoyancyandstability to the machine on water surfaces. For floaters we have used finOlexpipes.Working:Floaterdesigninvolvesmaterialsand constructionmethodsthatensuresufficientbuoyancyto support the weight of the machine, including the harvested biomass. It prevents the machine from sinking, even when laden with waterhyacinth, and helpsmaintain stability during operation.

Propeller: Function: The propeller generates thrust to propel the machinethroughthewater.Working:Connecteddirectlytothe motor, the propeller converts the rotational energy from the motor into forward or reverse thrust. Its design and size are optimized to provide sufficient propulsion force to move the machine effectively through various water conditions, including areas with dense water hyacinth coverage.

StorageTank:Function:Thestoragetanktemporarilyholdsthe collected water hyacinth biomass. Working: It is designed to accommodatelargevolumesofbiomassefficiently.Thetank's capacityandconstructionmaterialsarechosentowithstandthe weight and potential decomposition of the biomass without compromising the machine's buoyancy or stability. It allows for continuousoperationbyprovidingaplacetostorethecollected weeds until they can be unloaded or further processed. Microcontroller (e.g., ESP 8266NODEMCU) Function: Acts as thebrainofthemachine,controllingvariousoperationssuchas motor control, data collection, and communication. Working: Programs can be written to automate the movement of the machine, monitor sensors, and control actuators.

MotorDrivers (e.g., L298N)Function: Interfacesbetween the microcontroller and motors, allowing control of motor speed and direction. Working: Controls the propeller motors and conveyor system motors based on signals from the microcontroller.

Cutter Function: The ramp cutter cuts and gathers floating waterhyacinth,guidingitintothecollectionsystem.Working: Positionedatthefrontofthemachine,therampcutterfeatures sharp bladesor paddles that slice through dense mats of water hyacinth. As the machine moves forward, the ramp cutter collectsthecutweedsandchannelsthemtowardstheconveyor or directly into the storage tank. It is designed to effectively manage and control the accumulation of water hyacinth, ensuring efficient collection and removal from water bodies. DC Motors (e.g., 12V DC Motors) Function: Provides the necessary power to drive the propellers, conveyor, and other moving parts of the machine. Working: Propels the machine through water and operates the conveyor system.

Fig.1.ModelofWaterHyacinthRemover

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The water hyacinth remover illustrated in Fig. 1, consists of three primary sections: the front assembly and the back assembly and power supply.

1) Front Assembly:

Astoragetankforgatheringand keepingthemovedhyacinths isintended tobe housedinthefrontportion.Tomakemoving waterhyacinthsintothestoragetankeasier,aconveyorsystem isincludedbetweenthefrontandbacksections.L298Nmotor driver power the conveyor system, guaranteeing effective material transportation.

2) Back Assembly:

Theelectroniccontrolsystem,whichisbasedontheESP8266microcontroller,isincorporatedinthebackpart.Thisassemblycommunicates with the motor drivers and control system functioning. To give the front body structural support and allow fordirectionalcontrol,stabilizingfinsareinstalledattheright and left side of model, while finOlex pipes are employed as a floateratthebottom.12VDCmotorswitharatedspeedof100RPMareusedtooperatethefins,enablingthegadgettomoveforwardandbackward.Inadditiontothis,aupperpartcutteris used to cut the incoming water hyacinths.

3) Power Supply:

The system is powered by a 3.7V Lithium-ion rechargeable cells. To ensure compatibility with control electronics, an inbuiltvoltageregulatorpresentinL298Nmotordriverisused to cut down the 12V supply to 3.3V because the ESP8266 microcontroller operates at the lower voltage 3.3V.

Water hyacinths may be removed and collected efficiently because to the integrated design, which skillfully blends mechanical and electronic components.

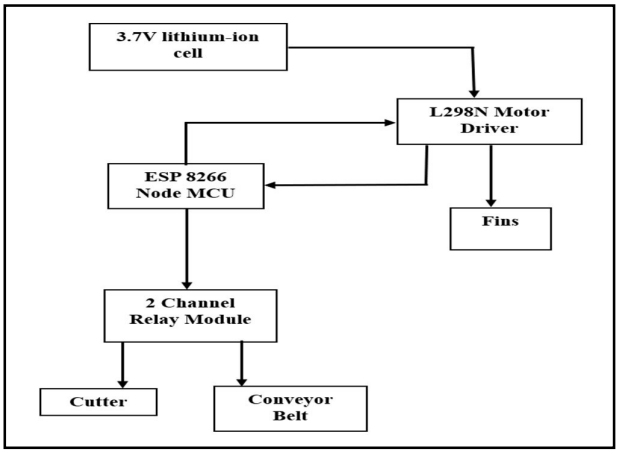

Fig.2.BlockDiagramofWaterHyacinthRemover

Thewaterhyacinthremoversystemrunsbythree3.7Vlithium- ion cells connected in series, leading to a total voltage around 12V,asshown inFig.2.TheL298Nmotordrivermoduletakes power from this 12V source of power. Then motor driver processes signals and give output to ESP8266 which interacts withtheinterfaceinmobileoncetheuser typeIPaddress192.
168.4.1andconnectswi-fi;theESP8266operatesasthebrain, controlling the motors. The 12V DC motors that powers and movesthefinspositionedonthe twosidesoftheboatisoneof this motor driver's main duties.

Additionally, the L298N module includes a built-in voltage regulator that steps down the voltage to 3.3V. This regulated voltage is used to power the ESP8266 microcontroller, which serves as the central control unit of the system. The ESP8266 generates control signals for a relay module, which is responsible for starting the conveyor belt and the cutter mechanism. These components work together to collect and cut water hyacinth efficiently during operation.

IV. DESIGN CALCULATION

A12V,100RPMDCmotorisahighlyversatilemotorsuitable for various applications, including propeller drive, cutting mechanisms,andconveyor systems.Withitsoptimalspeedand torque, it provides an efficient solution without requiring modifications. Below, we analyze its performance for each application and demonstrate why it is the best choice.

Voltage:12VSpeed:100RPM
Angularvelocity(ω)isgivenby:
ω=2πN /60 N=100RPM π≈3.1416
ω=2×3.1416×100/60
ω=628.32/60=0.174rad/s
Electricalpowerisgivenby:
PE=V×I PE=12V×5A=60W
Torqueiscalculatedusing:
τ=P/ω τ=60/0.174 τ=344.82cm
Themotoroffersaneffectivecombinationofspeedandtorque, rendering it appropriate for a range of applications, including the operation of a propeller, cutter, or conveyor.

V. TESTING AND RESULT

Wetestedthewaterhyacinthremovalinagenuinewaterbody onceitwasconstructedto assesshowwellitworked. Without becoming stuck, the model collected and removed floating hyacinths by moving efficiently across the water.

Fig.4.TestedModel

As shown in Fig.4, water hyacinth remover model is successfullytestedat‘PawnaRiver’,Chinchwad, Pune,India.
We managed to guide it into areas of the plant through its remote operation, thus rendering control simpler. The collection mechanism collected the plants and placed them in the relevant compartment with ease. The model successfully removedasizableareaofthewater'ssurfaceduringseveraltest runs, signalling that it would be a workable way to deal with invasive water hyacinths.

VI. CONCLUSION

The creation of the water hyacinth remover shows how mechanical design and electronic control systems may be successfully integrated to solve the problem of removing aquaticvegetation.Thesystemachievesoperationalefficiency by fusing a well-structured bottom assembly for mobility and controlwithasturdyupperassemblyforcollectingandstorage. TheuseoftheESP8266microcontroller,L298Nmotordrivers, and 100 RPM DC motors ensure precise automation and movement. Powered by a 12V Lithium-ion cells with a regulated voltage supply, the system is reliable and adaptable for real-world applications. This work provides a practical solutiontomanagingwaterhyacinthinfestations,contributing to improved waterway maintenance and environmental management.

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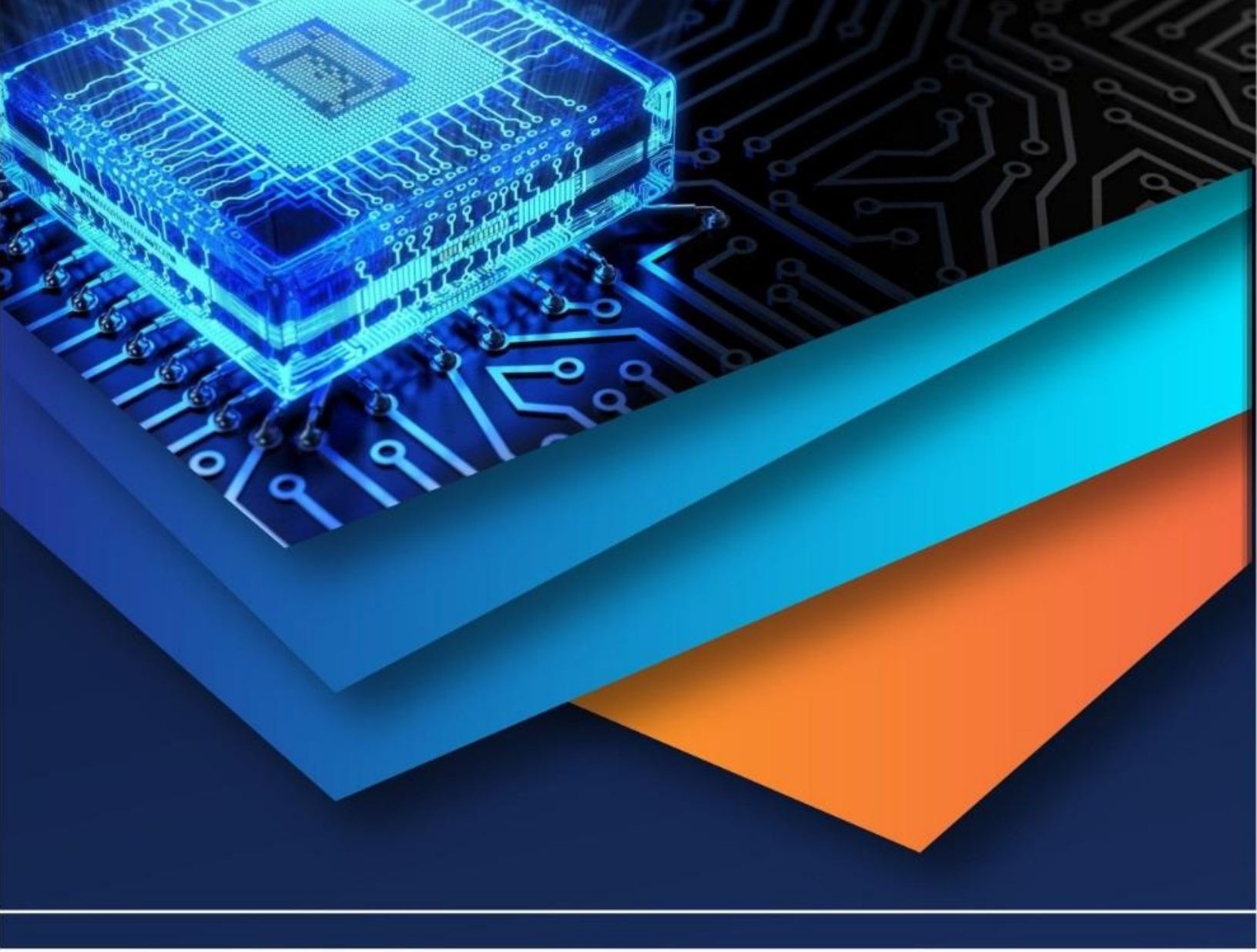

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