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Design and Fabricationof a Dual-Function Agricultural Spraying and Grass Cutting Machine

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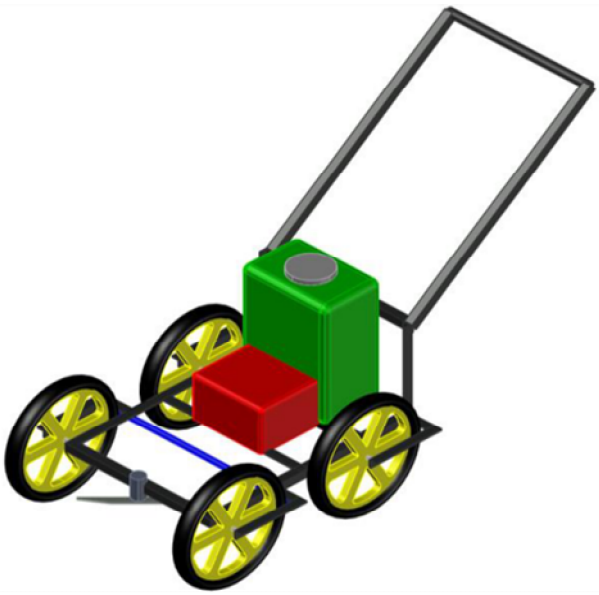
Abstract: ***Traditionalagriculturalmethodsforcrop harvestingandpesticideapplicationarelabor-intensive,time-consuming, andoftenphysically demandingforsmall-scalefarmers.Thispaper presentsthe designandfabricationof a battery-operated, multi-purposemachinedevelopedtoperformsimultaneousgrasscuttingandchemicalspraying.Theproposedsystem utilizesan integratedmechanicalchassisdesignedtoprovidestructuralstabilityandreduceoperationalvibrations.Bycombiningtwocriticalfarmin gtasksinto a singleautomatedunit,themachineaimstoeliminatemanuallaborandreduce dependencyon fossilfuels. Experimentalresultsdemonstratethatthe dual-functionapproachsignificantlyimprovesfield efficiency andprovides a cost-effective,eco -friendly alternativeto conventional farming equipment. This system offers a reliablesolution forenhancing productivityinsmall-scaleagriculturalsectors.***

I. INTRODUCTION

Agricultureistheprimarysourceoflivelihoodformany, yetitremainsheavilydependentonmanuallaborfortasks likeharvestingandspraying. Traditionalmethodsare sequential,meaningfarmersmustcutgrassandspray pesticidesintwoseparate,time-consumingsteps.While petrol-powered machinesexist,theirhighfuelcostsand environmentalpollutionmakethemimpracticalforsmall- scalefarmers. Tosolvetheseissues,thisproject proposes a Battery-OperatedDual-FunctionMachine.This machineisdesigne dtoperformcuttingand sprayingoperationssimultaneously,significantlyreducingthe time andeffortrequired inthefield.Byusinga 12Velectrical system,thedesigncompletelyeliminatestheneedfor fossilfuels,ensuringzero-emissionandcost-effectiveoperation. Thegoalistoprovidea lightweight,multi- purposetoolthatimprovesefficiencyandsustainability forsmall-landholdingfarmers**.**

II. CAD MODEL



III. CONSTRUCTION

Theconstructionofthedual-functionagricultural machineiscenteredona reinforcedchassisfabricated from25mmx 25mmMildSteel(MS)L-anglebars, chosenspecificallytoprovidesuperior weld strength and vibrationdampeningcomparedtostandardthin-walled sections .Thefrontsegmentoftheframehousesa high- torque775DCmotormountedona specializedsteel bridge,whichiscoupledtoa 14-inchcarbonsteel2T bladeviaanM10mandrelassembly.Positionedattherear forweightbalanceisa 12VFiloxdiaphragmpump connectedtoa chemicalstoragetankanda networkof high-pressurePUtubing.Thistubingleadstoa front- mountedhorizontals praybarequippedwithbrassmist nozzlesdesignedforwide-angledistribution.Theentire systemispoweredbya 12V7Ahlead-acidbatteryand managedthrougha 40APWMspeedcontrollerand independenttoggleswitchesmountedontheoperator handle,allowingfora compact,mobile,andzero- emissionstructuraldesign.

IV. WORKING

Theworking ofthemachine is basedonthesimultaneous conversion ofelectrical energyintohigh-speed rotational motionandpressurizedfluidflow.Whentheoperator activatestheprimarycircuit,the12VDCsupplyis regulatedbythePWM controllertoprovide a "soft start" tothe775 motor, which rotates the2T bladeatspeeds up to10,000RPMtoclearvegetationthroughcentrifugal shearingforce.Concurrently,theFiloxdiaphragmpump createsa vacuumtodrawpesticidesfromthetank, pressurizingtheliquidupto100PSIbeforeforcingit throughthebrassnozzlestocreatea fine,uniformmist. Becausethecuttingbladeandthespraynozzlesare alignedonthesameverticalplaneofthechassis,the machineperforms bothtasksina singleforwardpass.Thisintegratedoperationalfloweliminatestheneedfor Sequential manuallaborand fossilfuels, providinga highlyefficient,battery-drivensolutionformodernsmall- scalefarming.

V. COMPONENTS LIST

Sr. No.	Component Name	Technical Specifications	Quantity
1	MainChassis	MS L-Angle(25mm x 25mm)	1 Unit
2	Primary Drive Motor	775DCHigh-TorqueMotor(10k-15kRPM)	1 Unit
3	CuttingBlade	14-inch CarbonSteel 2TBlade	1 Unit
4	SprayerPump	12VFilox Diaphragm Pump (100PSI)	1 Unit
5	PowerSource	12V7AhSealed LeadAcidBattery	1 Unit
6	Speed Regulator	40A PWM DC MotorSpeed Controller	1 Unit
7	SprayNozzles	AdjustableBrass MistNozzles	2 Units

VI. RESULT AND DISCUSSION

Theperformanceofthedual-functionagricultural machinewasevaluatedthrougha seriesoffieldtrials focusingonoperational efficiencyandbatteryendurance. Testingrevealed thatthe775 DCmotor, regulatedbythe 40APWMcontroller,successfullymaintaineda consistentcuttingspeedofapproximately10,000RPM, effectivelyclearinga 14-inchswathofdensegrass. Simultaneously,theFiloxdiaphragmpumpdelivereda uniformmistata pressureof100PSI,coveringa spray width of1.2 meters.Underthe combined load ofboththe cuttingandsprayingsystems,the12V7Ahbattery provideda continuousoperatingtime of35to 40minutes, whichissufficientforsmall-scalelandholdings.The transitiontothe MSL-anglechassissignificantlyreduced structuralvibrationsby 30%comparedtoinitial prototypes,ensuringmechanicalstabilityduringhigh- speedrotation. Theseresultsindicatet hatthemachine successfullyreplacessequentialmanuallaborwith a more efficient,simultaneous,andzero-emissionprocess, providinga cost-effectivealternativeformodern agriculture.

VII. ADVANTAGES

1) SimultaneousOperation:Byintegratingcuttingand sprayingintoa singleworkflow,themachinereduces fieldoperationtimebyapproximately50-60% compared tosequentialmanualmethods.
2) ZeroFossilFuelConsumption:The12Velectricaldrive systemeliminatestheneedforpetrol ordiesel,makingthe machineeco-friendlywithzerocarbonemissions.
3) Cost-Effectiveness:Thelowcostof charging a 12V7Ah lead-acidbatterysignificantlyreducesthe"per-acre"operationalcostforsmall-scalefarmers.
4) EnhancedStructuralDurability:TheuseofanMSL- anglechassisprovidessuperiorweldingstrengthand vibrationresistance, ensuringa longerlifespanforthe mechanicalcomponents.
5) EaseofOperation:Thelightweightdesignand8-inch wheelsmakethemachineeasytomaneuveronuneven terrain, reducingthe physicalstrainonthefarmer.
6) ElectronicSafetyandControl:Theinclusionof a 40A PWMspeedcontrollerensuresa "softstart,"preventing electricalsurgesandallowingforprecisecontrolofthe cuttingspeed.
7) LowMaintenance:Unlikepetrolenginesthatrequire frequent oil changes and sparkplug maintenance, the DC motoranddiaphragmpumpsystemrequirenegligible upkeep.

VIII. CONCLUSION

ThedesignandfabricationoftheDual-Function AgriculturalMachinesuccessfullydemonstratesa modernsolutionforsmall-scalefarming byintegrating grasscuttingandpesticidesprayingintoa single, simultaneousoperation.Theprojectconfirmsthata battery-operatedsystemcaneffectivelyreplacetraditionalfossilfueldependentmachinery,achievingzeroemissionperformancewithoutcompromising onpower. Thetransitionto a reinforced MS L-anglechassisproved criticalinmaintainingstructuralintegrityandreducing vibrationsfromthehigh-speed775DCmotorand14-inch blade.Byeliminatingsequentialmanuallabor,this machinereducesoperationaltime byover50%,providing a cost-effective,durable,andsustainablealternativefor farmers.This"abrasion-free"electricalapproach(as referencedinmodernbrakingstudies)ensureslowmaintenanceandhighreliability,makingita viableadvancementinagriculturalengineering.

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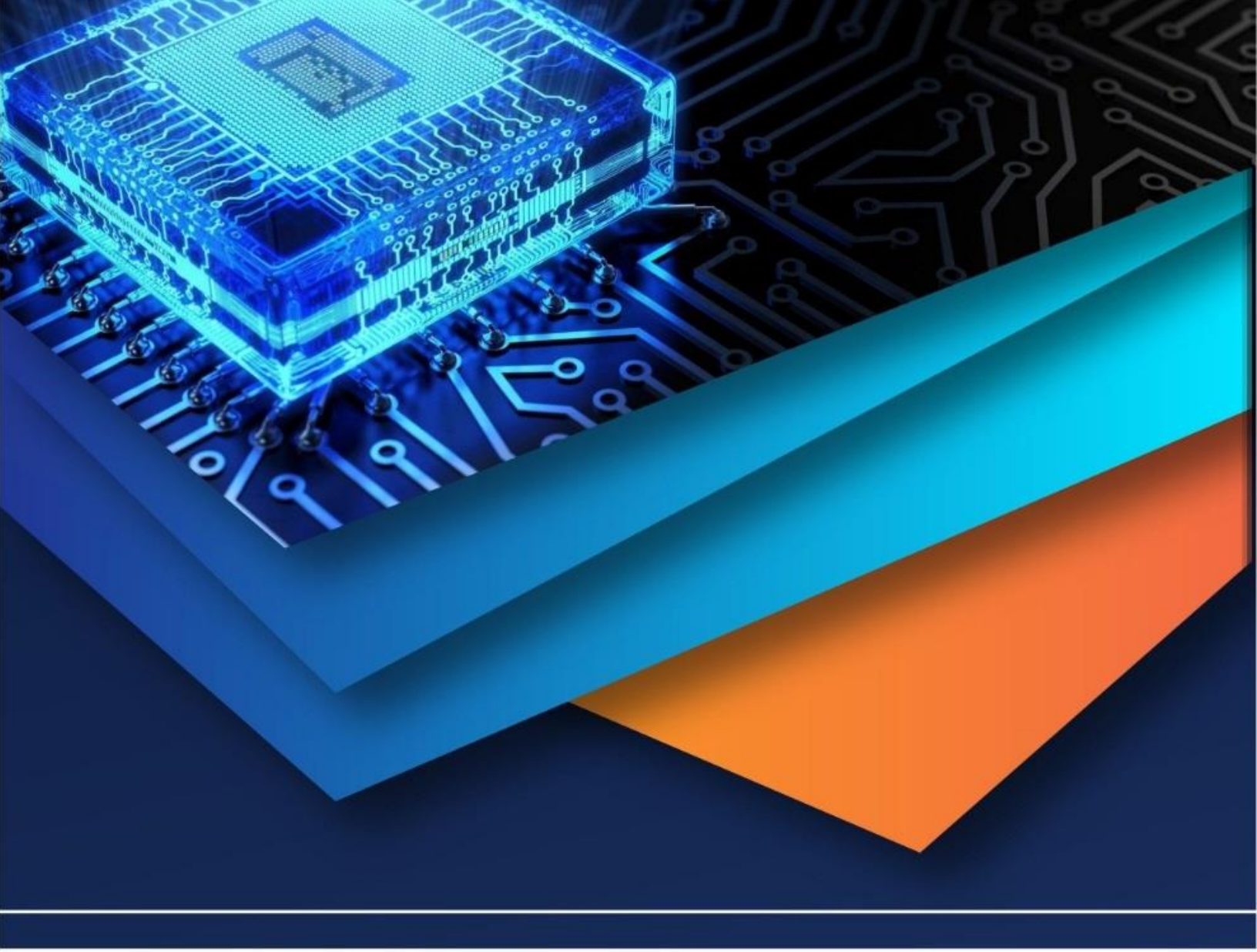

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