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Design Fabrication and Analysis of Multipurpose Operational Machine

Prof.R.J.Shekapure[1], Tanay Shepal[2], Shubham Bhosale[3], Ayush Wadile[4]
Department of Mechanical Engineering & Datta Meghe College of Engineering, Airoli

***Abstract:** This project is about the design and development of a semi-automatic multipurpose machine, which can perform drilling,cutting,shearing,andpunchingoperationsusingdifferentattachments.Thisdesignwasinitiallydevelopedas an automatic machine using IR sensors. However, the design was modified based on safety issues, as the IR sensors could be triggered accidentally during metal cutting operations. The developed design uses a pedal for operating the machine, ensuring safety while operating the machine. A motor is included in the design, which is accompanied by a speed controller and safety stop features. The project includes detailed design calculations, fabrication steps, cost analysis, safety considerations, and performance evaluation. The results show that the system is highly suitable for small-scale industries, rural workshops, and educational institutions.*

***KEYWORDS:** Multipurposemachine,modularattachments,drilling,jigsaw,shearing,grinding,low-cost automation.*

I. INTRODUCTION

Small and medium enterprises (SMEs) often face constraints in terms of capital investment and workspace. Conventional machining setupsrequireseparatemachines for drilling, cutting, shearing, and Punching, grinding, increasing overall cost and maintenance requirements.

This research proposes a compact multipurpose machine integrating multiple operations using a single motor and modular attachment system. The design focuses on affordability,easeofoperation,andadaptabilityIndustrial manufacturing processes require multiple machines to perform different operations such as drilling, cutting, grinding, and shearing. This increases cost, complexity, and maintenance requirements.

A multipurpose machine solves this problem by combiningmultipleoperationsintoasingleunit.This project focuses on designing such a machine with an added foot switch safety feature.

Theconceptisparticularlyusefulin:

- Small-scaleindustries
- Rural workshops
- Educationallabs

II. COMPONENTS DESCRIPTION

1) Relay: The relay (Electromechanical Switch) is used as an electromechanical switch in the control circuit. Inthiscontrolcircuit,therelayisusedincombination with the foot pedal mechanism for controlling the motor. When the pedal is pressed, the relay switches onandallowscurrentflowtothemotorforoperation.

2) Thisensuresasemi-automaticcontrolforthemachine as it can only be run when the pedal is pressed.

3) The AC–DC converter used in the initial design was eliminatedinthefinalsystemtosimplifythecircuit,as the selected motor operates directly with a speed control unit.

4) Initially,theIRsensorwasusedforautomation,butit was removed because it was unsafe. This is because theIRsensorcanbeactivatedbyshadows.Apedal is included, which is safer.

III. ATTACHMENTS

The machine is designed in such a way that different attachments can be included for different operations. Initially,thechainsawattachmentwasincluded,butitwas removed because the table was short, which made it unsafe.

Drill Press Stand: The drill press stand is a mechanical attachmentusedtotransformahandheldelectricdrillinto a drilling machine. This attachment enables vertical motion of the electric drill.

Foot Pedal Control System: In some cases,the drillpress standiscontrolled usinga foot pedalcontrol system. The systemenablesthedrillpresstobecontrolledwithoutthe need to use the hands.

Drilling Attachment: It is employed to drill holes in wooden, plastic, and metallic sheet materials. This attachmentisdirectlydrivenbythemotorandisheldin place by a vertical drill stand to ensure precise drilling.

CuttingAttachment (Basic): It is a simplifiedcutting mechanism.Thismechanismisemployedtocutlight materials. This cutting attachment is different from other cuttingmechanisms.Itisemployedtodemonstratecutting actions.

Shearing Attachment: It is employed to cut sheet materials.Thismechanismisemployedtoconvertrotary motion to a straight force to achieve shearing action.

PunchingAttachment:Itisemployedtocreateholesin sheet materials by localized force. This attachment is employed to achieve punching actions.

Thefinalattachmentsincluded are:

Drilling–forholes

Cutting(basic)–forlightmaterials Shearing – for thin sheetsPunching – for holes

Grinding– optional

IV. WORKING PRINCIPLE

Themachineoperatesontheprincipleofpower transmission using a motor-driven shaft.

Step-by-stepoperation:

1) Powersupplyisgiven
2) Footswitchis pressed
3) Motorstartsrotating
4) Gearstransmitsmotiontoshaft
5) Selectedattachmentperformsoperation

This rotational motionis directlytransferred tothe central shaft without the use of a belt drive system, ensuring higher efficiency and reduced power loss. The shaft actsas the main driving element and transmits motion to the selected attachment. Depending on the attachment used, the rotary motion of the shaft can either be utilizeddirectly (as in drilling and grinding) or converted into reciprocatingmotion(asincuttingoperationssuchasajig saw or shear tool). The machine is designed with interchangeable attachments, allowing only one operation at a time, which ensures precise and controlled functioning. Proper alignment of the motor and shaft, along with the use of bearings, enables smooth rotation with minimal vibration and noise. Additionally, the foot switch mechanismprovideshands-freecontrol, enhancing operator safety and convenience. Overall, the system integrates multiple mechanical functions into a single compact unit, making it efficient, versatile, and suitable for various machining operations such as drilling, cutting, and grinding

V. EXPERIMENTALSETUP

The experimental setup consists of a motor-driven multi- purpose machine mounted on a rigid base frame to ensure stabilityduringoperation.Themotorisdirectlycoupledto a central shaft, which drives various interchangeable attachments such as drilling, cutting, Point punching and grinding tools. A foot switch is provided to control the operation of the motor, allowing hands-free usage. Proper alignmentofcomponentsandsecurefixingofattachments are maintained to ensure accurate performance. The setup is tested under different working conditions by selecting appropriate attachments, and observations are recorded to evaluate the efficiency and functionality of the machine.

VI. EXPERIMENTAL RESULTS

Operation	Efficiency	Observation
Drilling	90%	Accurateholesup to10mm
Cutting	85%	Smoothcuttingin wood/plastic
Shearing	80%	Effectiveforthinsheets(<2 mm)
Punching	70%	Thinesheets (Tin, GIsheets)
Grinding	88%	Goodsurface finish

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VII. MATERIAL SELECTION

The selection of materials for testing is carried out based on their physical properties and behaviour under operationalconditions.Differenttypesofmaterialssuchas metal balls, rocks, granules, and ceramics are chosen as test materials to evaluate their response during machine operation. The sample size is carefully defined by determining the quantity and weight of materials used in eachtesttoensureconsistencyandaccuratecomparisonof results.

VIII. DESIGN CALCULATION

A. MOTOR

P = 2πNT/60
Where:
P=Power(W)
N=Speed(RPM) T = Torque (Nm) Assuming:
N= 1440 RPM
T=3 Nm P≈452W(~0.6 HP)

B. ShaftDesign

Usingtorsion equation:
$T=(\pi/16)tau*d^3$
Assumingallowableshearstress=40MPa, Calculated shaft diameter ≈ 15–18 mm

C. BeltDriveCalculation

Velocityratio:
N1/N2 = D2/D1
Optimizedforspeedvariationbetweenattachments.

IX. SYSTEMDESIGN AND ARCHITECTURE

A. System Components

- ElectricMotor(0.5–1HP)
- BeltandPulleyTransmissionSystem
- ShaftandBearingAssembly
- InterchangeableToolHolder

- StructuralFrame(MildSteel)

B. Attachments

- DrillingHead
- JigSawMechanism(crank-slider)
- ShearingTool
- GrindingWheelAttachment
- PointPunch

X. RESULT

The experimental results demonstrate that the machine operatesefficientlyunderdifferentmaterialconditionsand attachment configurations. It was observed that materials with different shapes and surface characteristics exhibited varying responses during operation, where spherical materialsshowedsmoothermotionwhileangularmaterials resulted in higher resistance and interaction. The machine performed allintended operationssuchasdrilling,cutting, and grinding effectively with stable performance and minimal vibration. Consistent results were obtained for different sample sizes, indicating reliable power transmission and uniform working of the shaft-driven system. Overall, the machine proved to be versatile, efficient, and suitable for handling a variety of materials with satisfactory performance.

XI. BOM

Sr.No.	Component	Approx.Cost
1	Electricmotor	3000
2	Frame	1500
3	ShaftandBearings	1200~1500
4	Attachments (Drill, shearing,punch,cutter)	3000
5	Pedalmechanism&relay	1000
6	Miscellaneous(Wiring, Fasteners,Fabrication)	1000

XII. FUTURE SCOPE

1) Automationofthemachinecanbeachievedusing PLC or microcontroller systems for improved accuracy and reduced manual effort.
2) IntegrationofanIoT-basedmonitoringsystemcan enable real-time performance tracking and remote control.
3) Implementationofsafetyinterlocksandprotective guards can enhance operator safety during operation.
4) Development of a battery-powered or solar- poweredversioncanimproveportabilityand energy efficiency.
5) Additionofspeedcontrolmechanismscanallow better adaptability for different operations.
6) Advancedsensorintegrationcanhelpinautomatic fault detection and maintenance alerts.
7) Designoptimizationcanbedonetoreduceweight and improve overall machine efficiency.
8) Multi-attachmentsimultaneousoperationcanbe explored for increased productivity.

XIII. APPLICATION

1) Small-scaleworkshops
2) Ruralfabrication units
3) Educationalinstitutions
4) DIYmanufacturingsetups

XIV. CONCLUSIONS

The developed multipurpose machine demonstrates an efficient and economical solution for performing multiple machiningoperations usinga single system. The design is particularly beneficial for SMEs and rural industrieswhere cost and space are critical constraints**.** The multipurposemachineisaneffectivesolutionforreducing cost and improving efficiency in small-scale industries.

Theadditionofafootswitchenhancessafetyand usability.

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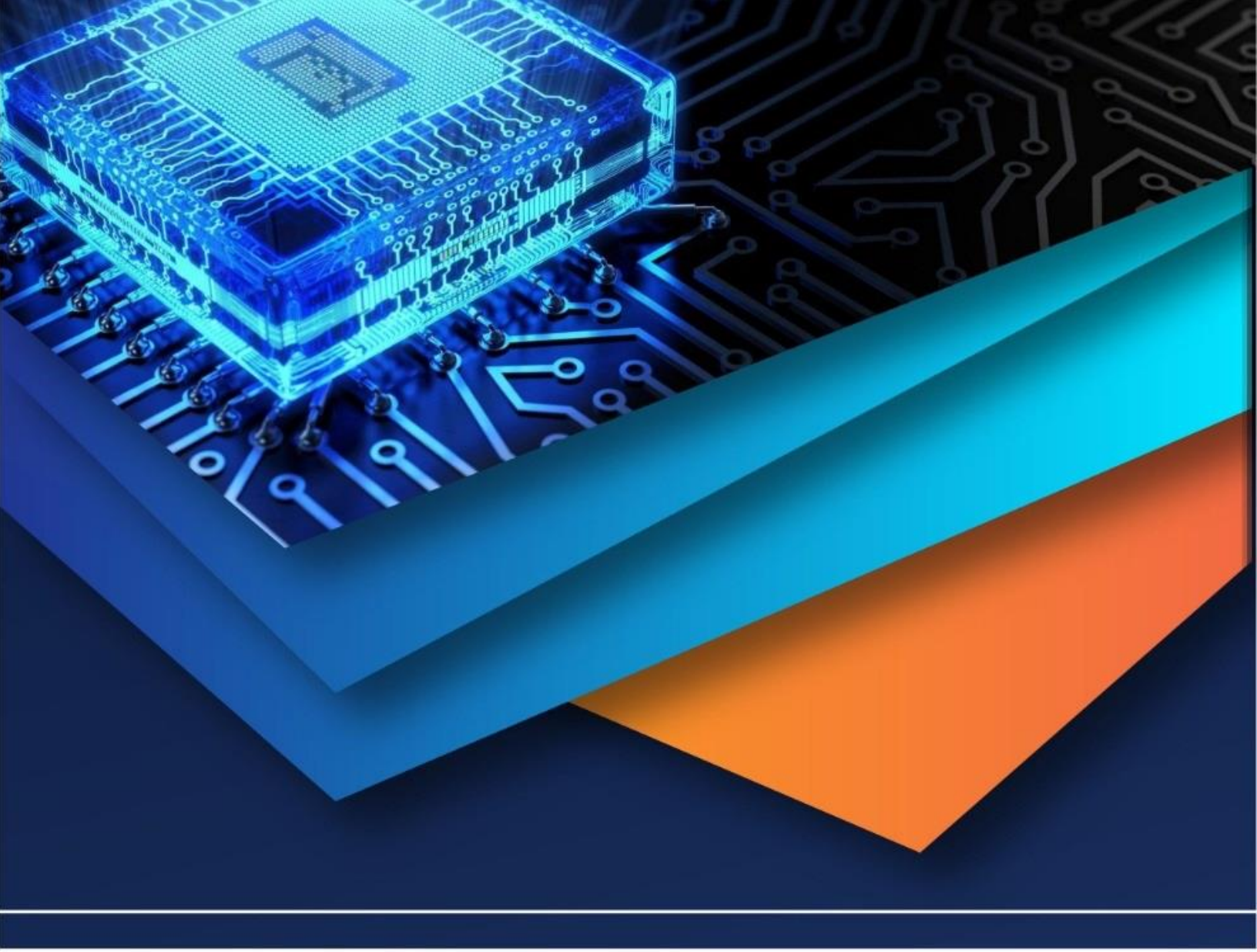
REFERENCES

[1] S.Kalpakjian,"ManufacturingEngineeringand Technology," Pearson, 2018.
[2] R.K.Jain,"ProductionTechnology,"Khanna Publishers, 2019.
[3] IEEEStd1012-2016,"SystemDesignStandards."
[4] M.P.Groover,"Automation,ProductionSystems, and Computer-Integrated Manufacturing," Pearson Education, 2008.
[5] S.KalpakjianandS.R.Schmid,"Manufacturing Processes for Engineering Materials," Pearson Education, 2014.
[6] P.N.Rao,"ManufacturingTechnology,"Tata McGraw-Hill, 2013.
[7] P.C.Sharma,"ATextbookofProduction Technology," S. Chand Publications, 2007.
[8] M.C.Shaw,"MetalCuttingPrinciples,"Oxford University Press, 2005.
[9] V.K.Jain,"AdvancedMachiningProcesses,"Allied Publishers, 2005.
[10] Y.Koren,"ComputerControlofManufacturing Systems," McGraw-Hill, 1983.
[11] E.ObergandF.D.Jones,"Machinery's Handbook," Industrial Press, 2020.
[12] A.M.Sadeghetal.,"Marks'StandardHandbook for Mechanical Engineers," McGraw-Hill, 2017.



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