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SINGLEARMCOMPUTERAIDEDROBOTMODELLINGANDANALYSIS

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Abstract

Inpresentinvestigation,aSinglearmrobotisdesignedandanalysed.EquationsofKinematics are derived by using D-H notation. By this equation and inverse kinematicsparameters for the motion trajectory have been determined. Kinematic parameters are dividedintotwogroupsnamely,linkparametersandjointparameters.Geometricmodelandmotionof robotic humanoid arm with two link model with 3 Degree of freedom and arm with palmandfingerswith18degreeoffreedomhasbeenrealized.Virttualsimulationofthearmisalsofirststepi nactuallycontrollingthemechanicalstructureBasedonthedynamicfunctions, specifications of the system the main features of the robotic armareinitiallydetermined,the detail design study of roboticarm is done.The three-dimensional body of our design would be done on CATIA software and would beanalyzed with all the parameters using ANSYS software. Then FEA ANALYSIS for moredesignsindiverseareasofengineeringarebeinganalyzedthroughthesoftware.FEAprovidesthe ability to analyze the stresses and displacements of a part or assembly, total deformations,life, and damages as well as the reaction forces other elements are to be imposed. This thesisguides the path through Robotic arm design, and analysis the material selection process. TheFEA model is described to achieve a better understanding of the mesh type, mesh size andboundaryconditionsappliedtocompleteaneffectiveFEAmodel.Atlast,thedesignobjective could be simply to minimize cost of robotic arm by choosing the desirable materialandunderstandthelifeoftheroboticarm.

Keywords:Singlearmrobot,CADdesign,Analysis,FiniteElementAnalysis(FEA).

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1. INTRODUCTION

A robotic arm is a robotic manipulator, usually programmable, with similar functions to ahumanarm.Thelinksofsuchamanipulatorareconnectedbyjointsallowingeitherrotationalmotionortranslationaldisplacement.Thelinksofthemanipulatorcanbeconsideredtoformakinematicchainmanrobotmaybedesignedtoperformanydesiredtask such as welding, gripping, spinning etc., depending on the application. For examplerobot arms in automotive assembly lines perform a varietyof tasks such as welding andparts rotation and placement during assembly. A rotation of 99 degrees is given to the robotarm in a minimum time (.02seconds) by supplying power to the robot arm using a switch.Further the arm will settle down with critical damping to an angle of 90degrees. The FEmodalanalysishasbeenperformedfortheroboticarmtofindthenaturalfrequency. Transient analysis is performed to note the displacement, velocity and accelerations duringits Motion. However, the use of feedback can lead to an unstable system whose output mayoscillate or even go to infinity with a small input signal. Stability determination is thereforean important design consideration. One specification for absolute stability requires that thepoles of the transfer function must be in the left half of the s-plane. Absolute stability, oftenspecifiedinthefrequencydemineisessentialbutnotnecessarybutsufficient.A robotic arm is a robot manipulator, usually programmable, with similar functions to ahuman arm. The links of such a manipulator are connected by joints allowing either rotationalmotion (such as in an articulated robot) or translational (linear) displacement. The links of themanipulatorcanbeconsideredtoformakinematicchain.The end effectors can be designed to perform any desired task such as welding, gripping,spinning etc., depending on the application. The robot arms can be autonomous or controlledmanually and can be used to perform a variety of tasks with great accuracy. The robotic armcanbefixedormobile(i.e. wheeled)andcanbedesignedforindustrial or homeapplications.This report deals with a robotic arm whose objective is to

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imitate the movements of a humanarm using accelerometers as sensors for the data acquisition of the natural arm movements.Thismethodofcontrolallowsgreaterflexibilityincontrollingtheroboticarm ratherthanusing a controller where each actuator is controlled separately. The processing unit takes careof each actuator's control signal according to the inputs from accelerometer,in order toreplicate the movements of the human arm. the block diagram representation of the system tobedesigned and implemented.We decided to assign aluminium to all parts including part 1. Of course, we always havechoice to change the material. Our selection has been proven good as aluminium did good forparts 1,2,3 and 4. But, in the opposite case, we decided to assign Structural steel to the parts.Only part 5 showed lessload bearing capacity with aluminium but, we have triedchangingthe material to Carbon Fiber Reinforced Polymer. The reason for this is it is stronger andlighter material than aluminium. We cannot assign a material with more density. As densityincreases, weight increases and increase in weight of Part 5 might have bad effects on otherarms. The problem with CFRP is it is relatively expensive. But again, selection of materials isacompletely different study. Welimitourstudytotheusageofrequirements of industry.

Table1.1MaterialsAndConditions

Material	Elastic Modulus(Pa)	Poisson's ratio	Density(kglm)
Cast iron	1.5E11	0.32	7300
Structural steel	2.06El 1	0.32	7850
Aluminium 6061 alloy	6.89E10	0.35	2770

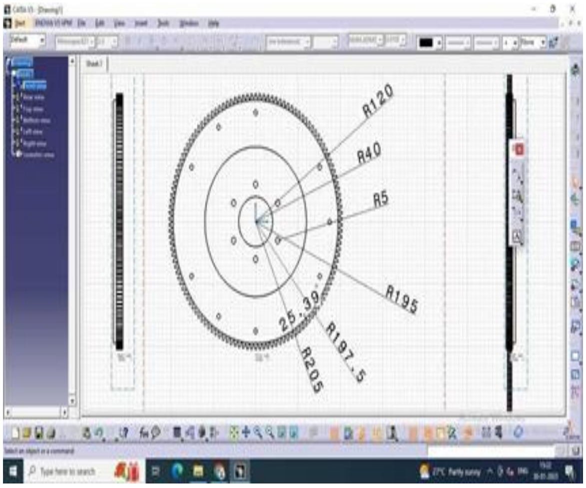

Figure 1 Sketch For The Base. After sketch. Go to features and select shaft boss/base . In shaft, sketch above profile as a object to revolve and specify axis of revolutions Then click ok or click on right mark.

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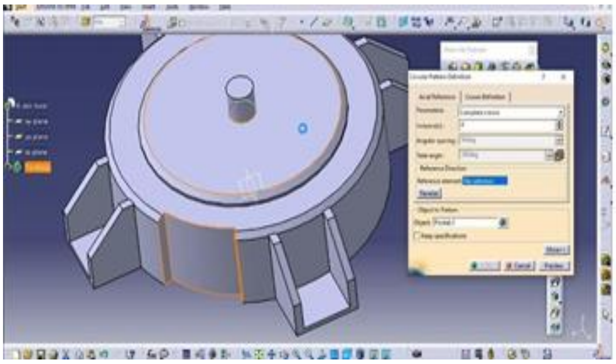

Figure 2 Base On part module go to sketch. And select sketch, then create sketch as shown in figure in below Later select on exit sketcher

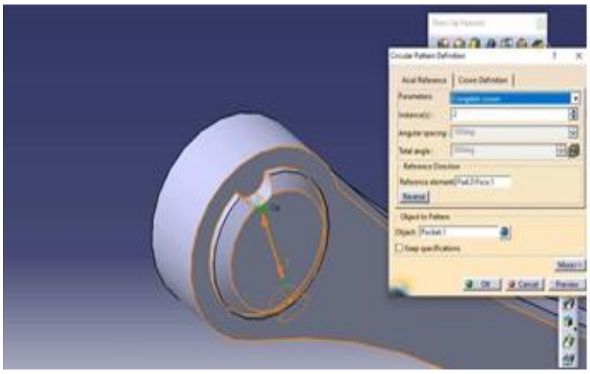

Figure 3 Circular PatternAfter sketch. Go to features and select Pocket cut .In Circular pattern, sketch above profile as a object to depth and specify directionThen click ok or click on right mark.

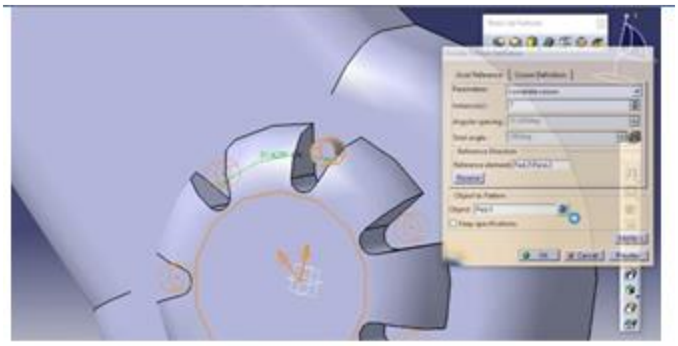

Figure 4 pocket Cut And Circular Pattern

After pocket cut, go to plane in reference and select front plane as a reference and specify offset distance 0.45metre.

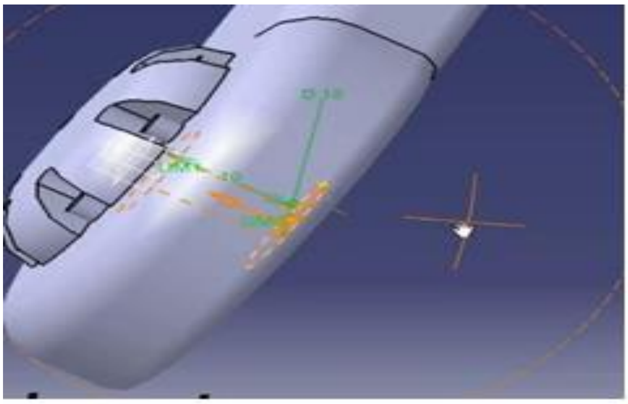

Figure 5 Sketch ForElbowOn part module go to sketch. And select sketch, then create sketch as shown in figureinbelowLaterselectonexitsketcher

Figure 6Model With All Parts

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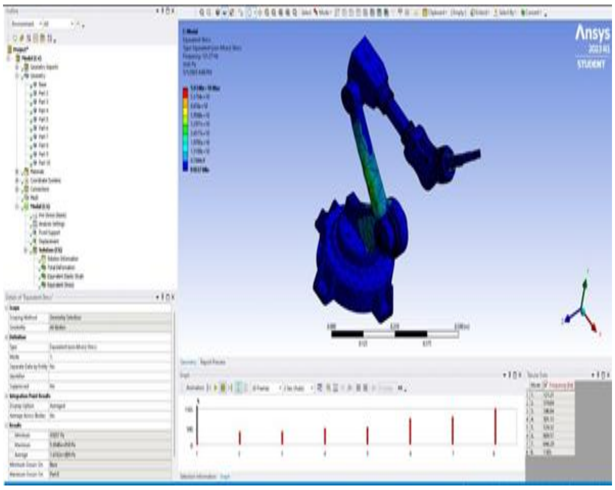

Figure 7 Equivalent Stress analysis of Aluminium alloy. Select the solution node in the tree outline; the graph and tabular data windows are displayed, refer to figure.

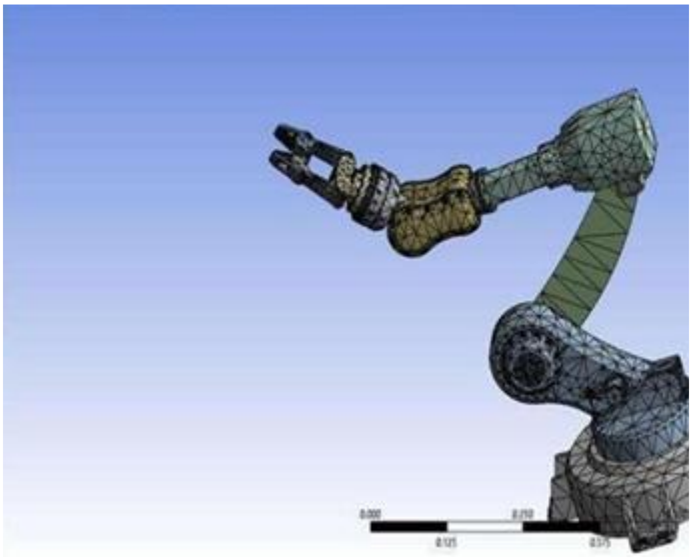

Figure 8 Mesh Generated With Default Mesh Controls Expand the statistics node in the details of "mesh" window to display the total number of elements created. On doing so, you will find that the total number of**elements.RESULTS**

Table:1ModalAnalysisResults:

Material	Mode 1	Frequency	Mode 2	Frequency	Mode 3	Frequenc
Aluminium alloy 6061	15.711	121.27	15.05	379.89	22.146	398.842
Structural steel	15.712	501.13	15.54	539.31	22.143	809.566
Grey cast iron	31.48	846.28	42.747	1103.0	74.594	1133.01

From the above table we can observe that G.C Iron has increased natural frequency124percentwhen comparedtotheAluminium alloy6061 &Sturctural Steel.

Table:2StaticAnalysisResults

Material	Total Deformation (mm)	Stress (N/mm^2)	Strain
Aluminium alloy 6061	0.01240	0.8953	4.63e-5
Structural steel	0.00950	0.68964	3.544e-6
Grey cast iron	0.006208	0.44976	2.31e-6

We obtained varied stress and strain & total deformation values when evaluating modelsMade of various materials & we can determine that G.C Iron is best as it has lessdeformation,stress& strain compareto other materials.

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Table:3FatigueAnalysisResults

Material	Safety factor
Aluminium alloy 6061	0.958
Structural steel	1.2499
Grey cast iron	1.9166

FromtheabovetableitisobservedthatG.CIronhasgreatestFactorOf Safety .

CONCLUSION

In this research, a robot arm was constructed and valuatedutilizingaCAD-toolwithreal-time boundary conditions using three different materials (Al 6061 , Structural steel ,GCiron).The results of deformation and stress, as well as shear stress and strain, frequency values,were displayed and analyzed for all models. We'll determine which material has the leastweightand the least numberofstressvaluesbasedonallofthesefindings.We obtained varied stress and strain values when evaluating models made of variousmaterials. When comparing robotic arm by materials, we can conclude that the GC ironarmrobothasdecreasedtotalstressby50% andincreasednaturalfrequencyby124percent when compared to theAluminium alloy 6061 arm robot.In comparison to other materials, GC iron creates significantly less stress and has a highnaturalfrequency.Asaresult,we know thatcompositematerialsaretypicallyhigh-strengthbut also costly materials.When comparing the different materials used in arm robots, we can see that GC iron is 47percentlighter thanAluminium alloy 6061 andalsolighter than other materials.Wediscovered that structural steel has a longer life and a higher safety factor, indicating thatstructural steel is the best material for high fatigue strength. As a result, we can infer thatthe design and material of the robot arm have been adjusted for effective operation usingGCironcompositematerial.

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