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Automated and Generic Finite Element Analysis for Industrial Robot Design

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Abstract - *In this exploration work our point is to build up a technique where dull and dreary structure forms are robotized. The plan of a modern robot bring down arm will be utilized as a proof of idea. The displaying is done in the CAD programming Solid Works and is assessed basically in the FEM programming ANSYS .The FE procedure in ANSYS is computerized by the utilization of the programming dialects Python and JavaScript. Besides a UI is made utilizing Microsoft Excel with Visual Basic. To permit programmed FEM, a parametric CAD model of a Robot bring down arm is developed. To approve its properties, the arm's mass properties are contrasted and the genuine non-parametric model of the Industrial Robot IRB6640. It is demonstrated that the parametric CAD model can be gotten with high exactness. It has likewise been conceivable to approve the mechanized structure and the parametric plan by looking at the Maximum Von Mises Stress of both arm models. Playing out a Design of Experiments it was conceivable to acquire the utilitarian connection between the Mesh Element Size and the FE results. The approval tests led further reinforce the speculation that dreary and monotonous structure procedures can be mechanized so as to decrease the outstanding task at hand of specialists.*

Key Words: CAD, FEM, SOLID WORK, ANSYS.

1. INTRODUCTION

To be aggressive in a changing business sector it is important to convey solid items in the most limited timeframe conceivable. Prior to the headway of PCs, just couple of foundations had the capacity to perform, making the structure procedure broad and elite in the vehicle and aerodynamic enterprises. These days the utilization of this instrument has turned into an everyday practice in various zones of building, as expressed by Turkiyyah & Fenves (1996) **[1]**. "FE strategies have turned into the standard methods for assessing the physical execution of basic frameworks in different designing applications". According to La Rocca & van Tooren (2007) **[4]** "Process automation is a way to go in order to relieve the operators from the continuous interaction with their software tools". Tarkian et al. **[2]** and Nezhadali **[3]** have done past work in the region; anyway they for the most part amassed in the general computerized configuration procedure of items. The focal point of this work is the means by which to robotize the FE procedure without trading off the nature of the examination. Moreover, in this work, a committed and top of the line FE programming is used, which requires considerable work so as to computerize.

As per the International Organization for Standardization the meaning of Industrial Robot is the accompanying: "naturally controlled,reprogrammable, multipurpose controller programmable in at least three or more" **[5]**. Tarkian et al. **[6]** have characterized an Industrial Robot as perplexing mechatronic framework which coordinates a few territories of information. It has a solid reliance between geometric, powerful execution, auxiliary quality, usefulness and cost. La Rocca et al. **[7]** proposed a Multi Model Generator, which utilizes KBE for producing consequently air ships geometries. La Rocca et al. **[4]** likewise proposed a programmed route for setting the wing geometries recently created so as to perform distinctive examination where a work demonstrate is required, for example, auxiliary investigation, CFD, and so forth Tarkian et al. **[6]** proposed the utilization of plan computerization philosophy for the Multidisciplinary Design Optimization of Modular Industrial Robots. Through the making of a library with various parts which coordinates the robots, diverse arrangements were naturally made and assessed so as to decide the ideal plans. The choice criteria for the best models depended on unique and auxiliary examination execution. While structuring the mechanical robots clients prerequisite ought to be fulfilled and its predominantly utilized in painting, collecting, situating, assessment, machining, and so on. One essential prerequisite of the robot is the level of opportunity, this will decide the working space of the robot and the conceivable autonomous developments the structure can do. The heap the robot can convey is called payload. As expressed above Industrial Robots are exceptionally mind boggling machines which require various examinations to acquired the ideal plan. After knowing the requirements the following design process is follow:

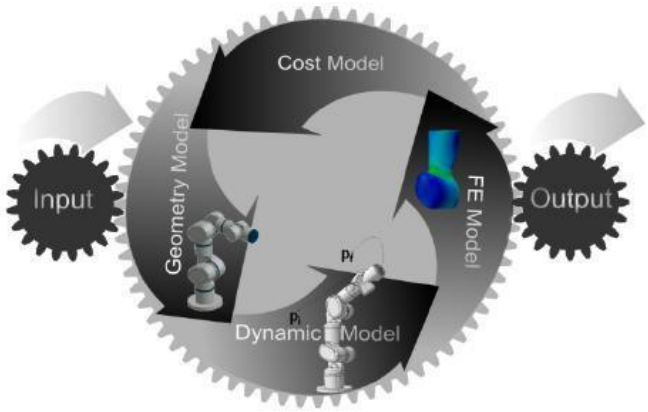

Fig- 1 - Industrial Robot Design Process [6]

In plan of mechanical robots which begins from contribution from the client too taking fundamental ideas from the past geometry model of the modern robots. This part of the procedure may require a lot of time, since it relies upon the inventiveness of the creator. The mass properties and the geometry of the model are imperative for the later phases of the cycle. After the geometry is concluded the following stage is to recognize through unique reenactments which actuators are appropriate. Here the mass properties of the geometry are utilized as information sources. From the dynamic model the most noteworthy load conditions in each joint will be determined and utilized as contribution for the FEM Model. In the FEM demonstrate the structure is assessed to decide whether it can deal with the heap conditions determined before in the dynamic model. It is essential to decide how solid the structure is. The geometry of the model is utilized for this square. This piece of the procedure will decide the progressions should have been done in the structure to have the capacity to have a solid structure. The last procedure of the wheel is cost estimation required to create and keeping up the mechanical robots it can't stop the large scale manufacturing and too cyclic technique until the end criteria are met in each square of the plan procedure. At last the yield is gotten and a model can be worked to approve the yields got from the plan procedure. According to Myung & Han (2001) **[8]** "The parametric displaying method is valuable when the geometric model ought to be changed as often as possible amid the plan procedure". Complex Non parametric CAD models may set aside impressive time for the client to alter the structure variations which can be a disadvantage in the plan procedure.

2. Parametric CAD models design

A nonexclusive and robotized Design system requires a parametric CAD demonstrate which can be rebuilt naturally and send the CAD geometry to the FEM programming. With an end goal to build up the reasonability of the computerized approach there is an extraordinary need to approve the outcomes as close as conceivable to the outcomes acquired from the current non robotized strategy.

The outcomes depend on the CAD display, a high precision of the model increment the likelihood of approving, which is the best way to check the attainability of the undertaking. The testing part is making the structure parametrically which can assist the client with changing the plan factors, for example, the thickness and length. Two methodologies were taken so as to develop parametric models; both depicted in underneath sub-areas. Comparable for the two methodologies, the model is disentangled by expelling a few highlights, for example, screws and fasteners which don't exact high discernible worries to lessen the recreation time. This is finished by doing a few examinations utilizing both the first model and the improved model. The disentanglement of the model has given comparative outcomes as far as the Stress esteems.

2.1. Approach 1

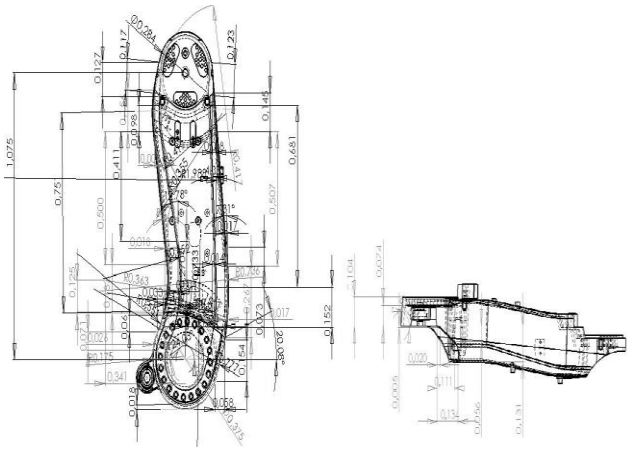

Fig- 2 - 2D Drawings

The principle thought of this methodology is to construct another parametric model as close as conceivable to the ABB show as far as mass properties. So amid the procedure of CAD demonstrating the mass properties are always looked into and the displaying strategy is continually changed until the attractive level of precision is accomplished.

To have a decent guide for making the geometry a 2D Engineering drawing (Figure 9) has been done of ABB IRB 6640 lower arm [9]. Measurements of the format are plotted and with this reference the parametric CAD demonstrate in Solid Works is manufactured.

2.2. Approach 2

The second methodology is done adjust a nonparametric CAD demonstrate from ABB and dole out parameters to the measurement which are should have been controlled. These measurements are connected to whatever is left of the elements of the model to make the whole model parametric. The parameters which are utilized in this CAD demonstrate are appeared Figure 3.

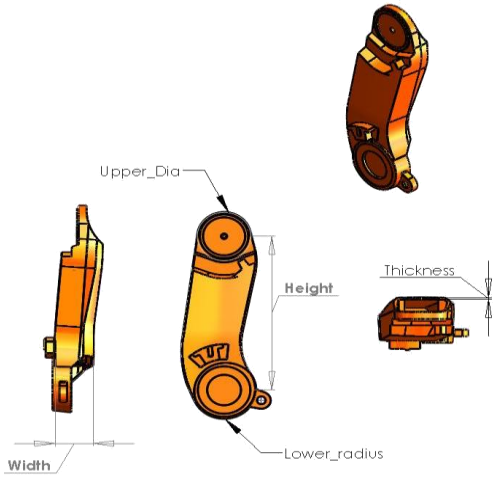

Fig- 3– Drawing with global parameters

3. Results and Discussion

The outcomes acquired utilizing the distinctive methodologies clarified above are displayed beneath.

- By utilizing of methodology 1. 96% of exactness was accomplished regarding ABB CAD show as far as Mass, Volume and surface zone. Be that as it may, in parametric CAD Model 63% exact were happened.
- The parametric CAD display through methodology 2 accomplished over 97% exactness as far as every single mass property regarding the Non parametric CAD demonstrate from ABB after the models are disentangled for FEA reason. The model can encourage the parametric difference in Height, Thickness, Width, Lower_Dia and Upper_Dia of the Lower arm.
- Mesh Evaluation for FEM reenactment of the Parametric CAD show created through methodology 1. Stress esteems acquired in any event work measure which is 1.30 mm is approximated as the precise esteem. The client can assess an exactness of 98 % at 2 mm work estimate, 85% precision at 3 mm work measure, 71 % precision at 4 mm work measure, etc. Also, for methodology 2. Stress esteems got in any event work estimate which is 1.30 mm is approximated as the exact esteem. The client can appraise an exactness of 86 % at 2 mm work estimate, 73% precision at 3 mm work measure, 67 % precision at 4 mm work estimate, etc.

4. Conclusions

The most imperative target of this Master Thesis is to attempt to limit tedious work at industry performing programmed FEA. To computerize the FEA procedure in ANSYS was not straight forward since the documentation about mechanization with Python and JavaScript was thin. In the wake of building up how to robotize the procedure, it was important to make a nonexclusive structure, where new arm models could be broke down naturally. By utilizing Microsoft Excel and Visual Basic, it was conceivable to make this system. Changes on an ANSYS Workbench venture record recently made were additionally conceivable through the programmed structure. Two parametric CAD models of a modern robot bring down arm are developed. These two are made by utilizing two distinctive displaying methodologies and they are approved with the first model from ABB. The models are looked at utilizing the mechanized system and it very well may be inferred that the mass properties are adequately near one another.

The parametric model acquired with methodology 1 did not give near Von Mises Stress results with the first CAD demonstrate from ABB. Approach 2 then again has given attractive outcomes in the examination. This test further reinforces the speculation that parametric CAD models together with mechanized FEA are an effective option to non-parametric CAD and manual FE forms. Work assessments have been performed in both the parametric CAD models and the practical connection between Mesh Element Size and the yields has been evaluated. Utilizing this estimation it is conceivable to pick between the recreation time and the ideal level of exactness in the outcomes.

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