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**Review on CAD Based Simulation**

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**Abstract**

*CAD (Computer Aided Design) is a software developed in 1980s to facilitate solid modeling that allows for easy assess and manipulation of different geometry. It helps designer to visualize idea of new product before it is actually manufactured. Simulation is imitation of operations of a real world process. Simulation is used for performance tuning, optimizing, safety engineering etc. It is attempt if model on computer so that it can be studied to see how system works. The case study mainly focuses on integration of simulation and CAD. We have discussed about its integration in pre-producing a part, in virtual surgical planning, in processes like milling, drilling, and turning etc.*

Keywords: Computer aided design, computer aided software, Finite Element Analysis, Computational , Virtual Surgical Planning

## Literature Survey:

[1] Marijn P. Zwieret al. focused on CAD which is used for solid modeling and integrating them with simulation tools OR CAE (Computer Aided Engineering) tools that includes FEA (Finite Element Analysis), CFD (Computational Fluid Dynamics), mechanism analysis etc. The main objective given was to integrate numerical simulation and CAD. To achieve goal of faster simulation, numerical simulation was added in early phase of design, which decreases computing cost and creates real time interface between design space and numerical solution space. They found that integrating FEA abd CAD decreases complexity and saves time. They researched and founded that PiD ( Physics in Design) approach can be used in which CAD model is converted into triangulated surface mesh, they are sub-structured into parts and processes like meshing, applying boundaries, solving load condition can be done using algorithm structure. Meshing can be done in CAD using voxelization algorithms which is most efficient technique. It is used mostly in straight structure as its accuracy decreases in FEA during curved structure. Models are divided into faces to find loads and boundaries condition.

They found that for real time numerical simulation model should be sub-parted and simulation accuracy should be reduced. Time required for meshing is reduced for hours to seconds. First simulation time required is same as FEA but re-applying loads and boundaries condition speeds up process.

[2] Rachel Gray et al. focused on integration VSP (Virtual Surgical Planning) and CAD to perform safe and precise craniofacial reconstruction in complex pediatrics cases with decrease in time. They studied about thirteen patients who went VSP with aid of 3D and CAD. Patients were of age group 44 month to 17 years.

These patients have been reported growth of fibula (leg bone on lateral side) and mandible (lower skull). Despite of it, this method was proved effective. Re-creating the lost bones, of exact size and with accuracy is only possible with 3D and CAD. This can also be used in midface recreation, in posterior vault expansion and inorbital reconstruction where it is highly complicated. CAD is used for designing process and 3D for creating exact copy of required part of bone with due accuracy.

[3] Lei Li et al. focused on integrating CAD and CFD in product development process. Colobrating fluid functional features, CAE boundary features, fluid and dynamics features which aids to reuse integrated CAD and physics CFD system. This approach uses parameters like velocity and pressure to find boundary conditions. Mach number is used to judge compressibility of flow and Reynolds Number is used to determine whether flow is turbulent or not. If flow is convergent lower order discretization models like UDS and Euler implicts can be selected to assist convergence. If simulation comes out to be convergent post-processing will be conducted to check expected accuracy and initial assumption are reached or not. They studied to find out how system works using OCD (Outflow control device) applied in SAGD process ( Steam Assisted Gravity Drainage). OCD regulates flow rates under a given pressure drop and protect device against sand in well. A experiment under standard conditions with dry steam temperature of 500 K, flow rate 0.25$m^3$/s, velocity of 14.1m/s and Reynolds number to be 1.66 * $10^6$. Which means flow is turbulent. Mach number is found to be 0.02 >> 0.3. So flow is assumed to be incompressible turbulent. This all is found by using ANSYS CFX but in reality mach number is greater than 0.3. So flow is compressible and this effect can't be ignored and thus fluid physics model for initial and final run can be predicted using simulation.

[4] Philipp Klimant et al. focused on simulation method for NC program to carry milling process. Using CAD based material removal simulation allows closed to reality simulation. This method is error free, least time is required and closed to reality parts can be produced with zero error and due accuracy. Instead of directly processing on work piece it is simulated on CAM software using simulation of chipping process using G-Codes. A program was developed which reads out values of machine simulator by using windows DDE Services. Its advantage is that no changes in CNC hardware is required. By this process user can get aware of problems life collision. They discussed about verification process using standard aluminium block with standard feed rate, spindle speed, depth and width of cut same as test workpiece used by NAS (National Aerospace Standard). Real time simulation is done using recorded program. Sweep GUI do not simulate forces or machine behaviour so uneven surface finish may occur. They claimed that in future, milling simulation will be enhanced by integrating forces and machine behaviour into offline simulation.

[5] Rozmarina Dubivska et al. focused on HSC machining and programming CNC machine with CAD system and about CATIA which has been proved to use materials efficiently to reduce cost. Cost gets reduced because of reduced machining time. They discussed about implementation of CAD/CAM CATIA to enable efficient use of material, to produce quality products at relatively lower cost. CAM can be used to process planning CNC part programming which can be done using three levels.

1. DIN ISO Programming: includes use of G-Codes and M-Codes.

2. Higher Workshop Programming: where all

information are entered graphically. Here simulation can be done.

3. CAD/CAM System: is capable of drawing 3D models of products. Simulation can be done and offers possibility to generate CNC codes to Design component.

They discussed method of simulation in CNC machining process which includes process like creating 3D models, creating a rough stock with all allowances. Going to machine mode to set tool parameters then definining strategy like determining allowances, tolerances, cutting speed feed etc. Then setting parameters of other cutting tools which will perform profiling. They discussed about two main type of HSM machining strategies,

1 Parellel Plane Strategy: machining feed direction is defined by parellel plane containing tool axis

2. Z – Level Strategy: machining feed direction is defined by parellel plane and perpendicular tool axis

They studied turning simulation in CATIA V5, which is software used in medium and large companies. They discussed model of designing model in CATIA Software.

[6] Panagiotis Kyratsis et al. focused on use of simulation in CAD to calculate developed thrust force on a drilling tool which involves total thrust force and thrust force due to action of chisel edge area. CAD based simulation was used to achieve higher level of verification and to reduce cost of experimemtaleffort. They studied about DRILL3D which creates 3D model and allows used to select feed rate, cutting speed etc and gives accurate thrust force. The twist drill fluted part is formed by sweeping helically using fluted cross section for straight cutting lips. They discussed about digital drilling process which can be of two type, first based on cutting action of cutting lips and second om cutting action of chisel ends. They discussed process of force extraction by segmenting 3D models of undeformed chip of achieve high accuracy. Number of geometrical parameters is directly calculated by DRILL3D and all data helps to find thrust force. They proposed model for calculating thrust force in which they used design of experiments (DoE) which is effective statistical. The RSM ( Response surface methodology) was also adopted as it is easy to build mathematical model. A polynomial mathematical model was used so that total thrust force and thrust force due to chisel action can be calculated. Combination of simulation based CAD method was used to achieve higher level of verification and RMS method was proved accurate and easy.

[7] Liang Chao Zhu et al. focused on real-time simulation using CAD. Any possible design with high accuracy was achieved by using offline generic solution. It worked for all topological changes without any need to remesh. They used PGD Model and R- function. PGD (Proper Generalized Decomposition) technique allows computation using offline generic solution. PGD can be applied for various linear and non-linear engineering problems like high dimensional problem, heat problems etc. R-Function can be used to represent solids interior, boundary and exterior. R-Function aids to solve high dimensional problem and makes PGD computation easy. This can be used to predict simulation of CAD model in boundary representation. R-models got advantage for fast prediction of physical properties of model undergoingparmanent modification without any need of remeshing combining PGD and R-Function integrate on a fixed mesh and can be applied on shapes and different dimensions undergoing large amount of deformations.

[8] Amit Kumar Bedaka et al. focused on simplification and joining OCC libraries and MFC dialogue based visual studio for CAD based robot path planning and simulation. OCC libraries are used to develop application oriented platform which aids to generate a path by usimg CAD functions like face, wire, edges etc and simulate it virtually. OCC extracts CAD Kernels and generates position and orientation of robot path using an end effector. This position and orientation acts as input into robot invert kimamatics to transform joint coordinates using equation for each joint of manipulator to perform simulation. This is flexible, as user can change tools for performing different industrial task for which glue dispensing tools are used. They used Denso 6556 robot having six degrees of freedom, PC, glue dispensing set and coordinate measuring machine (CMM). PC is used to perform simulation and to control robot.

**Future Scope:**

A software which can interact with human's in language we speak to produce a quality work with proper finish with zero error suggesting proper allowances and tools to be used. Integrating process forces and machine behaviour into offline simulation. Software can adjust feed rate, speed of spindle, depth of cut, width of cut etc based on materials and design to be produced. Cost of production will be reduced ny decreasing machining cost and wastages of material. An effective multi-simulation capable software will be developed.

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