SYSTEM AND METHOD FOR IMPROVED MESH GENERATION AND PCBA MESH GENERATION

Field of the Invention

[0001] The present invention generally relates to simulation of solid components using finite element method. In particular, the invention relates to methods and systems for improved pre-processing of input data files before mesh generation and improved mesh generation for PCB assemblies for drop test simulation.

Background of the Invention

[0002] Consumer products are often designed for functionality, ease of use and in today's markets the aesthetics as well. In addition, the designers today have also begun to make considerations for "consumer proofing" of products.

[0003] Mechanical reliability, structural strength and resistance to impact are just some variables that engineers are beginning to factor in when "consumer proofing".

[0004] One particular test for assessing the durability of such consumer products is the "Drop Test". Mobile phones and Personal Digital Assistants (PDAs) for example are consumer products that are often subjected to such drop tests. However, instead of the expensive drop tests where actual products are dropped, simulated drop tests using computer models are now possible.

[0005] Models of such products are first generated using a variety of methods. One of the most popular methods involve the techniques of "meshing" or generating a "mesh" to represent the actual product. This mesh comprises a representation using finite elements to represent the geometric data of the actual product. The geometric data is usually obtained from commercially-available computer-aided

design (CAD) software. There are numerous types of finite element models for meshing and some non limiting examples are: shell, tetrahedral, and hexahedral meshes. Each type of mesh has its own inherent characteristics and the basic element is in the shape as described by the name, with corresponding number of nodes terminating in each of the corners or edges of the element.

[0006] Typically, every component in the consumer product such as the PDA is first represented by a series of CAD drawings or their equivalents. The CAD drawings then undergo a transformation or meshing to convert the CAD drawings into a mesh of the actual product.

[0007] However, generating such meshes is a long and tedious process and requires that the engineer performing the generation be skilled. After the mesh is generated, further details such as the boundary conditions which define interaction between finite elements of the mesh need to be assigned by the engineers. Some of the boundary conditions that need to be factored in are: contact pairs, ground constraints, multi-point constraints (MPC), velocities and impact orientations. Other details include the definition of the material properties appropriate to loading regime must also be included in the model.

[0008] The resulting mesh, material definition and boundary conditions are then subject to a computer simulated crash or drop test to then assess the durability and survivability of the product.

[0009] Commercially available softwares such MSC-Dytran and LS-Dyna (commonly referred to as "solvers") are often used for these simulations. They are however still dependent on the meshing and assigning of boundary conditions before the simulation can be performed.

[0010] Many of such consumer products comprise of a variety of components and modules. They can be broadly classified into for example: plastic housing covers, Printed Circuit Board Assemblies (PCBAs), Liquid Crystal Displays (LCDs), metal frames, and power modules. These different modules and components have different characteristics and meshing them with different techniques result in different results.

[0011] Engineers and designers often compromise by using one single most convenient mesh type or a mesh type that is most suitable to most of the components for meshing. However, this disadvantageously results in some of the components not being meshed correctly for simulation purposes. An example of which is making use of a tetrahedral automatic mesh generator available in commercial applications to create a mesh quickly. Such meshes usually result in meshes comprising either very distorted elements or very small tetrahedral elements. When these meshes are submitted to the commercial solvers, the model will either not run at all, or result in unacceptably runtimes of several days.

[0012] One of the more difficult parts to mesh is a PCBA. The PCBA may comprise of as many as a few hundred components. Generating a mesh for a PCBA is more often than not one of the most time consuming and tedious tasks. Important or tall components, be it resistors, capacitors, diodes or chips, have to be individually meshed and then assigned a relationship to the meshed PCB.

[0013] It can thus be seen that there exists a need for a easier and faster methods and systems for improved pre-processing of input data files before mesh generation and improved mesh generation for PCB assemblies.

Summary of the Invention

[0014] The present invention seeks to provide methods and systems for improved pre-processing of input data files before mesh generation and improved mesh generation for PCB assemblies.

[0015] Accordingly, in one aspect, the present invention provides, a method for improved pre-processing of input CAD data files before mesh generation for a computer simulated drop test, comprising the step: checking the input CAD data files for a predetermined characterization identifier; and characterizing and assigning mesh type to the CAD input data file in accordance to the predetermined characterization identifier; wherein the predetermined file format further comprises a predetermined characterization identifier.

[0016] In another aspect, the present invention provides, a system for improved pre-processing of input CAD data file before mesh generation for a computer simulated drop test, the system comprising: a file checker module for receiving and checking the input CAD data file for a predetermined characterization identifier; a characterization database for storing data of predetermined characterization identifiers and data of corresponding mesh types of the predetermined characterization identifiers; a file characterization module coupled to and for accessing the characterization database for assigning the corresponding mesh type to the input CAD data file from the file checker module; a simulation details instruction module for receiving the corresponding mesh type and for providing meshing and simulation instructions; a meshing module for meshing data from input CAD data file in accordance with the meshing and simulation instructions from the coupled simulation details instruction module.

[0017] In yet another aspect, the present invention provides, a method for improved mesh generation for PCBA comprising the steps: receiving PCBA CAD files; determining PCB of the PCBA; determining baseline of PCB; determining plurality of PCBA components mounted on the PCB; determining base surfaces and their corresponding surface areas for the plurality of PCBA components; determining heights of the plurality of PCBA components; and generating instructions for meshing the plurality of PCBA components on the PCB.

[0018] In a further aspect, the present invention provides, a system for improved mesh generation for PCBA comprising: a PCB determinator for receiving a PCBA CAD file and for determining a PCB from the PCBA CAD file; a PCBA component determinator for determining all PCBA components; a irregular PCBA component determinator for determining all irregular PCBA components; a PCBA component base surface area determinator for determining surface areas of base surfaces of the PCBA components; a point mass component determinator for determining small components below a predetermined size and for assigning a point mass to the small component during meshing; a PCBA component height determinator for determining the heights of the PCBA components; a user input means for user input of irregular PCBA component data; and a PCBA simulation detail instruction module for providing and consolidating data for meshing and simulation.

Brief Description of the Drawings

[0019] A preferred embodiment of the present invention will now be more fully described, with reference to the drawings of which:

[0020] FIG.1 illustrates a block diagram of a system for improved pre-processing for input data files before mesh generation;

[0021] FIG. 2 illustrates a flow chart for a method using the system in FIG. 2;

[0022] FIG. 3 illustrates a block diagram of a system for a system for improved mesh generation for PCB assemblies;

[0023] FIG. 4 illustrates a flow chart for a method using the system in FIG. 3;

Detailed description of the Drawings

[0024] A system and method for improved pre-processing of input data files before mesh generation and improved mesh generation for PCB assemblies. In the following description, details are provided to describe the preferred and the alternate embodiment. It shall be apparent to one skilled in the art, however that the invention may be practiced without such details. Some of the details may not be described at length so as not to obscure the invention.

[0025] The system for improved pre-processing of input data files before mesh generation in accordance with the present invention uses a file characterization module for characterizing the input data files that are received by the system. A characterization database is referred to for the selection of the best mesh type to be applied given the nature of the input data files. The input data files are often Computer Aided Drawing (CAD) files of an item or consumer product which a drop test simulation is desired. The CAD file would comprise representations of all the surfaces of the consumer product. Such systems may readily be performed on a computer and one skilled in the art would readily be familiar with the working aspects and application of the computer.

[0026] There are different mesh types and they are suitable for simulating different materials and components having a variety of different characteristics. The consumer products for drop testing usually comprises of a few main components. They may for example be categorized into groups like: front cover, back cover, LCD, PCBA, power module, and metal frame. Since these groups all have their distinct characteristics, they would also respond differently to meshing with different mesh types.

	Mesh Type	**Geometry**	**Expected Contact Interaction**	**Sensitivity to Deformation**
1	Shell	Thin & regular	Direct impact normal to surface	Highly sensitive
2	Tetrahedral	Thin & regular	Oblique and edge impact to surface	Low sensitivity
3	Hexahedral	Thick & regular	Oblique and edge impact to surface	Medium to high sensitivity

Table. 1

[0027] By providing a file characterization module, the guesswork required to assign a mesh type to a particular component or material is taken out. Referring to Table 1, an example of the available mesh types for a few variables are considered and recommended. For example, a front cover of a PDA would likely be better meshed if using tetrahedral meshing.

[0028] The user while preparing the CAD files, would first prepare and categorize the CAD files according to how the CAD files may be characterized by the File Characterization Module 20. The predetermined format for the CAD file 11 further comprises a Characterization Identifier which may be appended to the CAD file 11 name for ease of identification and processing.

[0029] Referring to FIG. 1, a typical system 10 in accordance with the present invention comprises a file checker module 13 which receives an input of CAD (computer aided drawing) files 11. The CAD file 11 is prepared in a predetermined format for ease of identification of the contents. The predetermined format for the CAD file 11 comprises at least one Characterization Identifier.

[0030] The Characterization Identifier may be implemented simply by a matter of naming the CAD file 11 name in a predetermined manner. Alternatively, the Characterization Identifier may be a predetermined term inserted into the file header of the CAD file 11.

[0031] The file checker module 13 is coupled to a file characterization module 20 which receives the CAD file 11 from the file checker module 13. The file checker module 13 checks to ensure that the CAD file 11 has a predetermined characterization Identifier. If the CAD file 11 does not, the CAD file is sent to the User selection module 15.

[0032] The file characterization module 20 references data in a characterization database 22 to find the best mesh type for generating a mesh for the particular CAD file 11 in the predetermined format.

	Characterization Identifier	**Type of Component**	**Mesh Type**
1	_FrontCover	Front Cover of PDA	Tetrahedral element
2	_LCD	LCD display of PDA	hexahedral element
3	_MetalFrame	Metal Frame of PDA	Shell element or tetrahedral element

Table 2

[0033] A non limiting example of the contents of a characterization database 22 is shown in Table 2.

[0034] The appropriate mesh type is then assigned to the CAD file 11 and simulation details are further added in the Simulation Instruction Module 24. The output from the Simulation Instruction Module 24 is a data file comprising the original CAD file with the appropriate mesh type and the simulation details added. This output file is sometime referred to as the input deck. The input deck is then sent to the meshing module for the generation of a mesh to represent the contents of the CAD file 11. The meshing module 26 is coupled to the simulation module 28 for running the simulation of the input deck to produce an output or analysis deck showing the results of the simulated drop test.

[0035] Referring to FIG. 2, the method 200 in accordance with the present invention starts with the receiving 210 of the CAD file 11. The CAD file 11 then undergoes checking 215 for the predetermined file format by the file checker module 13.

[0036] If the predetermined file format is present in the CAD file 11, the method 200 proceeds to the next step of characterizing 225 and assigning a mesh type to the CAD file 11. This step is performed by the File Characterization module 20 by looking up the necessary data in the Characterization database 22. A non limiting example for a CAD file 11 name for a front cover of a PDA having a Characterization Identifier appended may be "XXX_FrontCover", where "XXX" is the file name and "_FrontCover" is the appended Characterization Identifier. The File Characterization Module 20 would then automatically assign the mesh type of tetrahedral mesh to this CAD file 11 and the meshing module 26 would then mesh the CAD file 11 in accordance to the mesh type assigned.

[0037] Next, the step of receiving 230 simulation instructions is carried out. The user will have to provide details such as boundary conditions, material properties, densities and other contact information.

[0038] Following which, the simulation instructions comprising geometry definition and characteristics are sent 235 for mesh generation. Afterwhich, the simulation input file is sent for simulation 240 to generate 245 an output analysis deck.

[0039] This applies to almost all types of components except the PCBA. If the PCBA file is encountered, the system 30 for improved mesh generation for PCB assemblies in FIG. 3 is used.

[0040] If the predetermined file format is NOT present in the CAD file 11, the method 200 proceeds to the next step of receiving 250 user selection for a mesh type for meshing the CAD file 11 in the User selection module 15.

[0041] Referring to FIG. 3, the system 30 in accordance with the present invention for improved mesh generation for PCBA comprises a PCB Determinator 43 which receives the PCBA CAD file 41 and determines the one component or surface that is the PCB. The PCB determinator 43 does this by searching through all components and surfaces in the PCBA CAD file 41 for one with the largest surface area and then designating this component or surface as the PCB.

[0042] The system further comprises a PCBA component determinator 45 for determining all the PCBA components mounted on the PCB. All components or surfaces that the PCB determinator 43 did not consider to be the PCB will be considered to be PCBA components 45.

[0043] An irregular PCBA component determinator 46, a PCBA component base surface area determinator 48 and a point mass component determinator 50 are further coupled to the PCBA component determinator 45. The irregular PCBA component determinator 46 scans the PCBA CAD file 41 and searches for components with irregular shapes or surfaces. The PCBA component base surface area determinator 48 determines the base surface of all the PCBA components and the base surface areas of all the PCBA components. The base surface of the PCBA components is one surface of the PCBA components which is substantially planar to one surface of the PCB having the largest surface area.

[0044] The point mass component determinator 50 determines PCBA components having a surface area less than a predetermined surface area and assigns a point mass to that component. The value of the point mass would be available from the PCBA CAD file 41. This allows small PCBA components with negligible size and bulk to still be considered during meshing and simulation. Examples of such small PCBA components might be Surface Mounted capacitors and resistors.

[0045] A PCBA component height determinator 52 for determining the height of the PCBA components on the PCB is further coupled to the component base surface area determinator 48. The PCBA component height determinator 52 serves to extract the height information of the regular sized PCBA components. PCBA components determined by the Irregular PCBA component determinator 46 and the point mass PCBA component determinator 50 will not have their height information extracted.

[0046] The system 30 further comprises a PCBA simulation detail instruction module 54 which consolidates the data from the various determinators to formulate an instruction set for meshing the PCBA.

[0047] A user input for irregular PCBA component data 47 is provided for and is coupled to the PCBA simulation detail instruction module 54. Data required for simulating these irregular PCBA components will then be separately entered by the user.

[0048] Referring to FIG. 4, the method 400 for improved mesh generation for PCBA starts with the receiving 410 of a PCBA CAD file 41. Next, the step of determining the PCB 415 from the PCBA CAD file 41 is performed. The PCBA CAD file 41 is scanned to determine the component or surface with the largest surface area. This surface or component is most likely the PCB of the PCBA.

[0049] The step of determining the baseline 420 of the PCB is then performed by determining the thickness of the PCB and selecting the middle of this thickness as the baseline of the PCB. All the PCBA components mounted on the PCB are then determined 425 by extracting the relevant information from the PCBA CAD file 41.

[0050] Next, all surface area of base surfaces of PCBA components mounted on the PCB are determined 430. This is performed by selecting a predetermined offset distance from the baseline of the PCB and capturing all PCBA component base surfaces substantially planar with the surface of the PCB which fall within the space between the offset distance to the baseline.

[0051] Next, the determining 435 of the heights of the PCBA components is performed and the required data is also obtained from the PCBA CAD file 41. Then, the step of generating 440 instructions for meshing the components mounted on the PCBA is performed.

[0052] The base surface area and height of each of the PCBA components has already been determined. The instructions for generating 440 the mesh for each of

the PCBA components is a matter of projecting the base surface from the PCBA component's base up to the known height of the PCBA component. During mesh generation only the mesh of the base surface of each PCBA component would be meshed and then extrapolated by the known height of the component. This advantageously cuts down on the calculations and time spent in generating a mesh for every surface of the PCBA components.

[0053] Following that, the nodes on the base surface of the meshed components are then assigned 440 MPCs to the nodes nearest to the meshed PCB. This simplifies the step of assigning contact pairs by the user.

[0054] The method 400 as described caters mainly to regular shaped PCBA components. For irregular PCBA components, they are determined by the irregular PCBA component determinator 46 and will require a step of a user input of the geometry and other characteristics for the meshing and simulation.

[0055] Small PCBA components such as surface mounted resistors will also be addressed by having a step to assign a point mass to the small PCBA component without performing any meshing.

[0056] It will be appreciated that various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention.

Claims

1. A method for improved pre-processing of input CAD data files before mesh generation for a computer simulated drop test, comprising the step:

a. checking said input CAD data files for a predetermined characterization identifier; and

b. characterizing and assigning mesh type to said CAD input data file in accordance to said predetermined characterization identifier;

wherein said predetermined file format further comprises a predetermined characterization identifier.

2. The method in accordance with claim 1, prior to step b. wherein step c. comprises:

c. checking a characterization database to retrieve mesh type for assigning to said CAD input data file.

3. A system for improved pre-processing of input CAD data file before mesh generation for a computer simulated drop test, said system comprising:

a file checker module for receiving and checking said input CAD data file for a predetermined characterization identifier;

a characterization database for storing data of predetermined characterization identifiers and data of corresponding mesh types of said predetermined characterization identifiers;

a file characterization module coupled to and for accessing said characterization database for assigning said corresponding mesh type to said input CAD data file from said file checker module;

a simulation details instruction module for receiving said corresponding mesh type and for providing meshing and simulation instructions;

a meshing module for meshing data from input CAD data file in accordance with said meshing and simulation instructions from said coupled simulation details instruction module.

4. The system in accordance with claim 3, wherein said system further comprises: a user selection module for user input of mesh type when input CAD data file does not have a predetermined characterization identifier.

5. A method for improved mesh generation for PCBA comprising the steps:

a. receiving PCBA CAD files;

b. determining PCB of said PCBA;

c. determining baseline of PCB;

d. determining plurality of PCBA components mounted on said PCB;

e. determining base surfaces and their corresponding surface areas for said plurality of PCBA components;

f. determining heights of said plurality of PCBA components; and

g. generating instructions for meshing said plurality of PCBA components on said PCB.

6. The method in accordance with claim 5, wherein said step b. comprises:

b1. searching said PCBA CAD file for a surface having a largest surface area; and

b2 designating component having said surface as a PCB.

7. The method in accordance with claim 5, wherein said step g. further comprises:

g1. meshing said base surfaces of said plurality of PCBA components; and

g2. meshing said plurality of said PCBA components by extrapolating said base surface by said height of said plurality of PCBA components.

8. The method in accordance with claim 5, further comprising step h. of assigning a point mass to very small PCBA components without meshing them.

9. A system for improved mesh generation for PCBA comprising:

a PCB determinator for receiving a PCBA CAD file and for determining a PCB from said PCBA CAD file;

a PCBA component determinator for determining all PCBA components;

a PCBA component base surface area determinator for determining surface areas of base surfaces of said PCBA components;

a PCBA component height determinator for determining the heights of said PCBA components; and

a PCBA simulation detail instruction module for providing and consolidating instructions and data for meshing and simulation;

wherein said instructions for meshing said PCBA components comprises meshing said base surfaces of said PCBA components and extrapolating by said heights of said PCBA components.

10. The system in accordance with claim 9, further comprising a irregular PCBA component determinator for determining all irregular PCBA components.

11. The system in accordance with claim 9, further comprising a point mass component determinator for determining small components below a predetermined size and for assigning a point mass to said small component during meshing;

12. The system in accordance with claim 9, further comprising a user input means for user input of irregular PCBA component data.