Similarity Assessment of Turned Components: An Approach to Feature Based 3-D Modelling

P.N.E.Naveen*, M.Yasaswi**
*(Department of Mechanical Engg, GIET, JNTUK, Rajahmundry)
** (Department of Mechanical Engg, GIET, JNTUK, Rajahmundry)

ABSTRACT

Feature based modelling has been considered an indispensable tool for integrating design and manufacturing processes. In contrast to the common approach of simply attaching manufacturing information to existing geometric models, the present work proposes a new approach to extracting machining features from a feature-based solid modelling, based on an integrated geometric modelling system that supports both feature-based modelling and feature recognition. As a result, feature information is directly available to downstream activities, and feature extraction or recognition is no longer needed. The proposed feature based modelling system provides a graphical environment for solid modelling in AutoCAD. This paper presents algorithms for feature based modelling. The feature types are used as basis for similarity assessment.

Keywords – AutoCAD, **Cylinders, Design, Modelling.**

1. INTRODUCTION

Present manufacturing industry demands more automation from design stage to manufacturing stage. There is much interest in manufacturing firms to automate the task of process planning using computer-aided process planning (CAPP) systems. CAPP is usually considered to be part of computer-aided manufacturing (CAM). However, this tends to imply that CAM is a stand-alone system. In fact, a synergy results when CAM is combined with computer-aided design to create a CAD/CAM system. In such a system, CAPP becomes the direct connection between design and manufacturing. Process planning includes identification of the processes, machine tools, cutting tools, setups and fixtures to produce the desired part, along with geometric information about the product. To achieve this computer integrated manufacturing (CIM) system, information about machining component is must. In this context, feature recognition plays an important role in the fully automated factory of the future. But, the recognition of machining features in a part with arbitrary feature interactions is a difficult task. Hence, The present work proposes a new approach to extracting machining features from a feature-based solid modelling, based on an integrated geometric modelling system that supports both feature-based modelling and feature recognition. As a result, feature extraction or recognition is no longer needed. The proposed feature based modelling system provides a graphical environment for solid modelling in AutoCAD. This paper presents algorithms for feature based modelling. The feature types are used as basis for similarity assessment.

2. LITERATURE REVIEW

Li [1] presented a methodology for recognizing manufacturing features from a design feature model. A feature recognition processor first translates the design feature model of a part into an intermediate manufacturing feature tree by handling design features and then final manufacturing tree is updated with some interpretations. In another work Yan [2] proposed algorithms based on progressive *Z*-maps for recognizing the machining features and feature topologies by analyzing NC programs. A new approach to extracting machining features from a feature-based design model is presented, which supports both feature-based modelling and feature recognition [3]. Feature recognition is achieved through an incremental feature converter. Jung [4] has given a novel feature finder, which automatically generates a part interpretation in terms of machining features, by utilizing information from a variety of sources such as nominal geometry, tolerances and attributes, and design features.

Martino [5] presents system architecture for feature-based modeling which is founded on integration that is obtained through the definition of a common feature library and an intermediate model, which plays the role of communication link between the geometric model and the feature-based model. Timo [6] proposed a novel feature-modeling system which implements a hybrid of feature-based design and feature recognition in a single framework. During the design process of a part, the user can modify interactively either the solid model or the feature model of the part while the system keeps the other model consistent with the changed one. This gives the user the freedom of choosing the most convenient means of expressing each required operation.

Duan [7] proposed a feature solid modeling tool in which geometry is associated with knowledge. Generalized sweeping has been developed as a unified method for defining various features with a dual representation schema of a CSG index and a B-rep index. Anthony Dean and Cheng Lin [8] presented a systematic approach using Autodesk Inventor to design assembly drawings with geometric dimensioning and tolerance (GD&T). Through the use of position tolerance in GD&T and the parameter data file in Auto Desk Inventor, this approach can generate the assembly drawing when specified with maximum material condition (MMC).

In the present work, a feature based modelling system is developed using VISUAL BASIC in integration with AutoCAD for turning components. This feature-based solid modelling based on an integrated geometric modelling system that supports both feature-based modelling and feature recognition. The information of the machining features is used in similarity assessment of the components.

3. FEATURE-BASED MODELING

The features that have been considered include plane cylinder, taper cylinder, blind hole, through hole and groove. Algorithms are developed for individual features and these algorithms are embedded in Visual Basic forms. As soon as the feature is selected from the list, the user is prompted to give the specifications of the selected one. Then the model is created in the AutoCAD window. The specifications are automatically recognized and are stored in the Visual Basic window. This integration is done, using a user integrated and development environment in VISUAL BASIC. The User integrated environments used in this work are VBAIDE (Visual Basic Automated Integrated Development Environment) and VLIDE (Visual Lisp Integrated Development Environment). These Environments integrate AutoCAD with Visual Basic, so that we can use them with considerable ease.

3.1 Algorithm for plane cylinder

The algorithm for modeling and storing plane cylinder based on the dimensions entered by the user is represented below. The model created and feature list stored is shown in the fig 1(a).

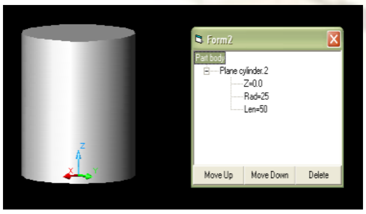

Fig 1(a) Plane Cylinder

- Declare length (le), radius(r) as integers and end point of the feature (p (0 to 2) as a double array) considering the feature section in ZX plane and feature name (rkey) as string, nodx (for identification of the feature in model tree) as node.
- Prompt the user to enter the value of 'p'.
- If no value in array 'p' is null then go to next step, else display "No values are given". This display prompts the user to enter the 'p' value again.
- Compute the values of radius(r) and length (le) from 'p' value.
- The starting point of the feature is computed from the previous feature history of the model. If the previous history is null then starts from reference point.
- Create the nodes Z (indicating the starting point of the feature), radius, length of the cylinder in the feature list window. (Note: All the features are considered co-axial. The value (Z+le) gives the starting point of the next feature on the axis)
- Create a cylinder in the AutoCAD window.
- Display the features length, radius, Z in a separate window.

3.2 Algorithm for taper cylinder

The algorithm for modeling and storing a taper cylinder feature is given below. The model created and feature list stored is presented in fig 1(b).

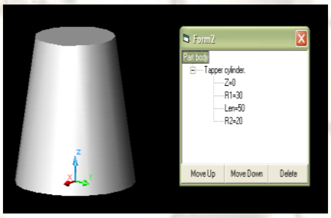

Fig 1(b) taper Cylinder

- Declare nox (for identification of the feature in model tree) as node, axes variables xv, yv, zv as double, aucs (AutoCAD user co-ordinate system) and acir (AutoCAD Circle)as acad variables and starting center point cp(0 to 2) as a string.
- Assign the values of axes variables.
- Declare rad1 (r11), rad2 (r12), length (le) and angle (ang) as double.
- Prompt the user to enter the values of r11, r12 and le.
- If r11, r12 and le are not equal to null then compute the value of cp using previous feature history. If the previous history is null then starts from reference point.
- Calculate taper angle.
- Create the nodes of the features rad1, rad2, length, Z for the taper cylinder in the feature list window under taper cylinder node.
- Create taper cylinder in AutoCAD window.
- Display the features length, radius 1, radius 2 and Z in a separate window.

3. 3 Algorithm for groove

The algorithm for modeling and storing a groove feature is explained in this section. Fig 1(c) shows the model created and feature list stored.

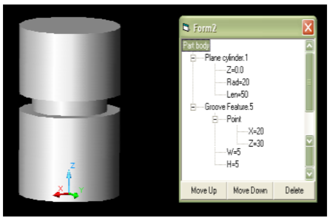

Fig 1(c) groove

- Declare the variables width (w1), height (h1), starting point (sp1) and ending point (sp2) as double variables, nodx & nox (for identification of the feature in model tree) as Nodes ,a3d as Acad3Dsolid, .
- If the base component exists in the acad window then go to next step. Else display “No features to extract”.
- Prompt the user to enter the values of sp1, values of width and height of the groove relative to sp1.
- Compute the values of sp2.
- Copy the values for sp1, sp2, width, height to the respective sub-nodes under the groove node in feature list window.
- Create the groove feature in AutoCAD window.
- Display the features width, height, X and Z in a separate window.

3.4 Algorithm for through hole

The following algorithm gives information about modeling and storing the feature data of a through hole. The model created and feature list stored is shown in the fig 1(d).

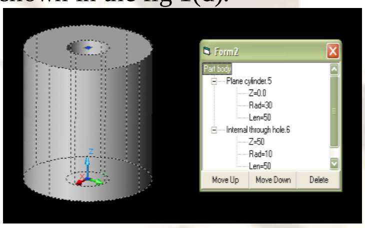

Fig 1(d) through hole

- Declare a3d, ac Acad3DSolid variables, nodx & nox (for identification of the feature in model tree) as Nodes, end point of the feature pt (0 to 2) as array.
- Specify the value of radius of the hole.
- Compute the values of pt.
- Create a hole with specified dimensions.
- Save the features radius and length of the hole in the feature list window using nodes.

3.5 Algorithm for blind hole

The algorithm for a blind hole is explained with the help of fig 1(e).

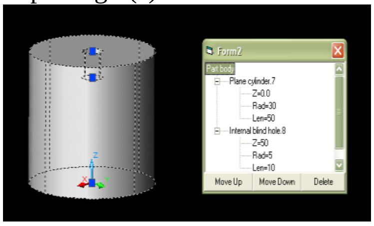

Fig 1(e) Blind hole with its feature list.

- Declare a3d, ac Acad3DSolid variables, nodx & nox (for identification of the feature in model tree) as Nodes, end point of the feature pt (0 to 2) as array.
- Give the values of length and radius of the hole.
- Compute the values of pt.
- Create the hole with specified dimensions.
- Save the features radius and length of the hole in the feature list window using nodes.

4. SIMILARITY ASSESSMENT

Similarity assessment is a manufacturing technique in which the components with similar features are recognized and grouped together. Components are modelled with developed system, in which the features are given as input. The dimensional parameters of these features are given by the user and the components are created in the AutoCAD window. After recognizing the features of the above modelled components, they are grouped according to similarity in features. The components may differ in the size but, they are assessed based on the features. Here, the components are assessed mainly into three groups. They are Components with cylindrical faces, Components with holes and Components with grooves.

In the first group, the components with only cylindrical features i.e either plane cylinder or taper cylinder are considered. Fig. 2 gives a group of components which are assessed as similar from a data base created by the developed system. Fig.3 shows a group of components with hole features. In this group, the components with hole along with cylindrical features are considered. In the third group, the components with groove features along with other features are considered. Fig. 4 gives a group of components which are assessed as similar from a data base created by the developed system. Present system gives first priority to grooves, second priority to holes and third priority to cylindrical features. This type of similarity assessment is considered only to show the working of developed system. This can be extended to any type of similarity assessment once the features are stored along with solid model.

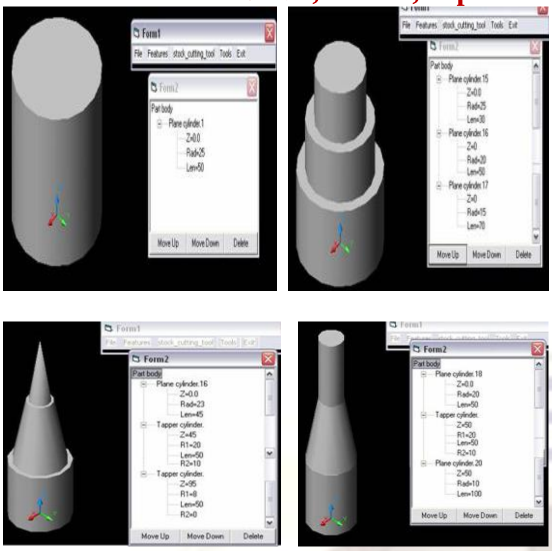

Fig. 2. Example of components with cylindrical features

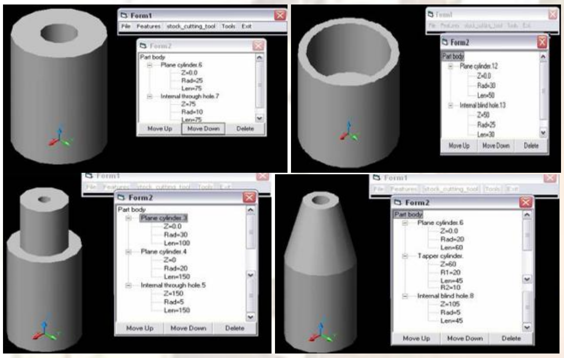

Fig. 3.Example of components with hole features

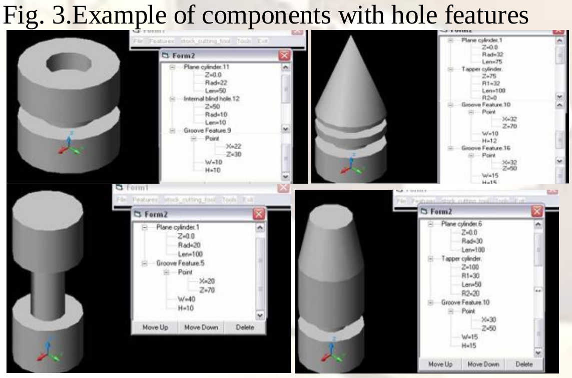

Fig. 4.Example of components with groove features

5. CONCLUSIONS

This work attempts to develop algorithms for modelling the components through the input of features. This feature based modelling approach eliminates extraction of features from the programs of the already drawn components. As a result, feature information is directly available to downstream activities, and feature extraction or recognition is no longer needed. Hence, it is economical in terms of time and cost compared to available feature based techniques.

The feature based approach described is capable to perform similarity assessment of the turning components based on the input features given in modelling. This system is very simple compared to other methods available for similarity assessment i.e edge boundary techniques, Z-maps, graphs, diagrams etc. Once the components are assessed into similar groups based on the features, this process can be extended for Automated Process Planning, Automated Machining Setup Generation and Automated Measuring Setup Generation.

In this work, five features namely plane cylinder, taper cylinder, through hole, blind hole and groove are currently considered. For the system to handle wide variety of parts more features need to be considered.

REFERENCES

[1] W D Li, S K Ong and A Y C Nee, Recognizing manufacturing features from a design-by-feature model, Computer aided design, vol 36(11) 2002, 849-868.

[2] Yan , Yamazaki and Liu, Recognition of machining features and feature topologies from NC programs, Computer aided design, vol 32(10) 2000, 605-616.

[3] Jae Yeol Lee and Kwangsoo Kim, A feature-based approach to extracting machining features, Computer aided design, vol 30(13) 1998, 1019-1035.

[4] Jung Hyun Han and Aristides AG Requicha , Integration of feature based design and feature recognition, Computer aided design, vol 29(5) 1997, 393-403.

[5] T De Martino, B Falcidieno, F Giannini, S Hassinger and J Ovtcharova, Feature-based modeling by integrating design and recognition approaches, Computer aided design, vol 26(8) 1994, 646-653.

[6] Timo Laakko and Martti Mantyla, Feature modeling by incremental feature recognition, Computer aided design, vol 25(8) 1993, 479-492.

[7] W Duan, J Zhou and K La, FSMT: a feature solid-modeling tool for feature-based design and manufacture, Computer aided design, vol 25(1) 1993, 29-38.

[8] Anthony Dean, Cheng Lin, Assembly CAD Design using Position Tolerance in Geometric Dimensioning & Tolerancing, SME- Technical Papers, 7 pp, Nov, 2005.