GENERATION OF 3D MODELS FROM ORTHOGRAPHIC PROJECTIONS FOR PRISMATIC COMPONENTS

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The design data of components in most of the industries are still in orthographic representations. Interpretation of orthographic projections requires skill whereas 3D models provide concise and unambiguous representation of part geometry. This necessitates the existing drawings to be converted into 3D models. A system that can automatically transform the orthographic projections of components into 3D models will greatly reduce the time required for transformation and will also be cost effective [1,3]. In this paper, an approach for automatic reconstruction of solid models from orthographic projections is presented.

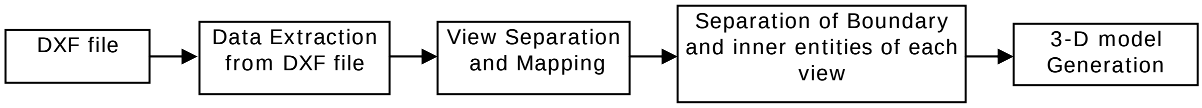


Fig 1. Structure Of The System

The general structure of the system is shown in Fig 1. The orthographic projections of a typical component are shown in Fig 2. The data of all the entities in the drawing are first extracted from the DXF file and the entities belonging to each view are sorted as per views. A view separation methodology as explained by Shunmugam et al [2] is used to separate the entities belonging to each view by first determining the top left corner *P* of the top view. Then the entities are sorted based on their *x* and *y* coordinates of the start and end points with respect to the point *P*. Each entity is checked for intersection by any other entity. If intersection is found, then the selected entity is split at the point of intersection. In Fig.6(a), the topmost line in the top view is intersected by two lines L5 and L7. Hence the top most line is split into 3 lines L9, L8 and L10. After sorting, the entities belonging to each view are mapped to the corresponding orthogonal planes. i.e. the plan, elevation and side view entities are mapped into XY, XZ and YZ planes correspondingly. The maximum length (L), breadth (B) and height (H) of the solid are identified from the orthographic projections. Then the loop of entities that form the outer boundary of plan, elevation and side view are identified and extruded along their normal according to their model height, breadth and length respectively. These extruded solids intersect each other as shown in Fig 3 and the solid model so formed partly represents the initial 3-D model. In order to construct the final model, the pockets, slots and bosses if any are identified from the orthographic projections.

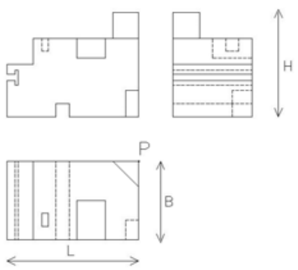


Fig. 2 Orthographic Projections Of A Typical Component

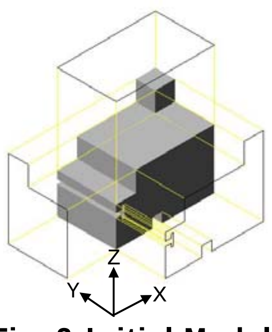


Fig. 3 Initial Model

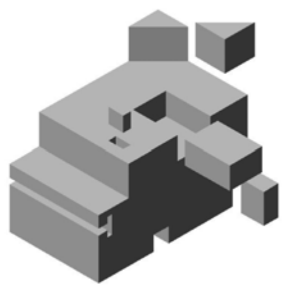
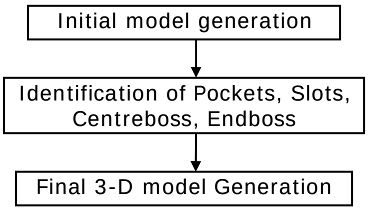
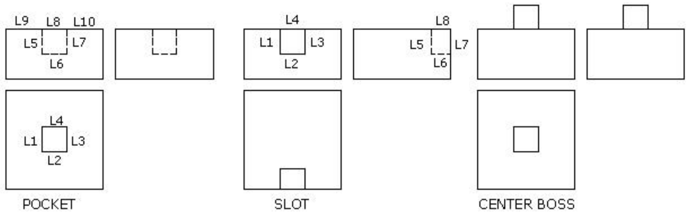


Fig. 4 Final Model With Subtracted Solids

Most of the geometric features can be grouped into two general classes namely protrusion and depression. Pockets and slots are depressions whereas bosses are protrusions. Pockets are depressions that start from one face whereas slots are depressions that connect one or more faces. Bosses can be classified into two types namely centreboss and endboss. These are identified from the inner entities. Pockets are identified by checking for any closed loops among the inner entities in any one of the orthographic views. In Fig.6(a), lines L1, L2, L3 and L4 form a closed loop in the top view. Then the other orthographic views are checked for any open loops among the inner entities. These open loop entities must be hidden lines, and can be closed by including one or more boundary entities. Hidden lines L5, L6 and L7 form a open loop in the front view. By including the boundary line L8, the open loop in the front view can be closed. Similarly, the open loop in the side view is also closed and all the three loops are extracted and extruded along their normal. This forms an intersection solid, which is subtracted from the initial solid model to incorporate the pocket in the final model.

Most of the through slots get included in the initial model itself whereas blind slots and corner slots are not included in the initial model. In order to identify these slots, it is checked whether there are any open loops among the inner entities that can be closed by including one or more boundary entities. For the bind slot shown in Fig.6(b), lines L1, L2 and L3 form an open loop that can be closed by line L4 to form a closed loop. Lines L5 and L6 form a closed loop by including L7 and L8. Then the corresponding loop in the other views are identified and extruded along their normal. This intersection solid thus obtained is subtracted from the initial model to include these slots in the final model.





(a) (b) (c)

Fig. 5 3-D Model Generation

Fig. 6 Typical Depressions and Protrusions

Centrebosses are identified by closed loops among inner entities in one view and with corresponding open loops among the boundary entities in the other views, which can be closed by including one or more inner entities. Endbosses are similar to that of centrebosses except that an open loop among inner entities is closed by boundary entities in one view and corresponding open loops among the boundary entities. Rectangular bosses get included directly in the initial model itself but non-rectangular bosses as shown in Fig. 2 need extra processing. The solid representing the boss as obtained in the initial model can be seen in Fig. 3. It contains excess solid, which has to be removed. In order to remove the excess solid, a rectangle enclosing the closed loop (inner entity loop) is extruded along its normal. Then the boss profile is also extruded and subtracted from the previous solid. Corresponding loops in other views are also extruded to their normal and the resultant solid gives the excess solid that is to be subtracted from the initial model to obtain the actual shape of the boss. Thus both protrusions and depressions are incorporated.

The system is developed using “C” using 2D drawing in DXF format as input and generates the 3D model in Mechanical Desktop. The system is tested with a large number of drawings of prismatic components and the system effectively generates the corresponding 3D models for all the drawings. Similar methodology can be used to identify cylindrical and curved depressions and protrusions.

References:

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3. M.S. Shunmugam and T.R. Kannan, “Automatic Flat Pattern Development of Sheet Metal Components From Orthographic Projections” International Journal of Machine Tools and Manufacture, Vol 42, p 1415-1425, 2002