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MODEL FOR DEVELOPING A FEATURE RECOGNTION SYSTEM FOR A RECONFIGURABLE BENDING PRESS MACHINE

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Abstract

Sheet metal products are often designed without a systematic consideration of downstream product development requirements, such as process planning, manufacturability, production scheduling and manufacturing optimization. This can often result in a lot of expensive and time consuming reworks. Consequently, it affects the quality, cost and delivery time of the product. In this paper, a framework for developing a web - based feature recognition system (FRS) has been proposed to recognise bending features on a reconfigurable bending press machine (RBPM). The research explores the current literature and design approaches used to develop feature recognition systems in the current manufacturing industries. This model will help to offer a suitable method for designing a web based feature recognition system for sheet metal bending using RBPMs. This model will be applied to feature recognition systems in other manufacturing industries. The model consists of the integrated platform system, information model, part model, geometric modelling and the feature model. The proposed models will aid the designer right at the design stage with useful design and the feature recognition system. The designer will be able to relate process technology to product design instead of specifying the geometric definition alone. Design of these models will provide a more convenient design environment and an easier way to integrate CAD/ CAM activities. After developing the model the designer will be able to use the CAD software to develop patterns, interpret drawings and transfer dimensions to sheet materials and sections to meet the required specification.

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Keywords: Sheet metal, feature recognition, bending

1. Introduction

Nowadays the production of high quality products of the lowest possible cost is the main objective of manufacturing companies. Increased competition has forced industries to search for other possibilities to the modern approaches to design, manufacturing and management. Competition is now stiff in the sheet metal production sector, in order to lower the production cost and shorten the delivery times whilst retaining a large market share, companies need to change their production planning systems [1].

Gwangwava et al. [2], proposed a new design of a reconfigurable bending press machine (RBPM). The design, which is scalable, customizable and flexible, is a means of increasing sheet metal bending productivity by increasing the capability of the manufacturer to deal with mass customization. The RBPM design has two major objectives, namely geometric transformation and productivity adjustment. Geometric transformation is achieved through vertical and horizontal configurability, while productivity adjustment is enabled by plug and produce devices [2].

This work mainly focuses on developing a model which will aid in the design of a feature recognition system for a reconfigurable bending press machine. This paper is organized as follows: Section 2 presents the literature review on feature recognition, feature extraction and CADCAM systems. The structure of the sheet metal bend is discussed in section 3.

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Section 4 describes the feature classification approach. The summary of this research is concluded in section 6.

2. Literature Review

2.1. Feature recognition

Previous research on feature recognition focus on the issues of intersecting features and multiple interpretations, but do not address the problem of custom features representation [3]. Feature recognition has been an important research area over the past decade. Much effort has been conducted in this area and many kinds of feature recognition approaches have been proposed. On the other hand, due to the difficulty of feature recognition, there are still many problems with the current feature recognition methods, which need to be solved to make feature recognition more powerful [4].

Feature recognition is the process of transforming a CAD model into a feature model with manufacturing information attached to it. Feature recognition can be further decomposed into manageable modules, which are Translate model, surface feature recognition, relate surfaces, extract features and validate features [5].

Marchetta & Forradellas. [6] presented a hybrid procedural and knowledge-based approach based on artificial intelligence planning , it addressed both classic feature interpretation and also feature representation problems. STEP designs are presented as case studies in order to demonstrate the effectiveness of the mode.

Han et al [7] designed a system that recognizes only manufacturable features by consulting the tool database, and simultaneously constructs dependencies among the features. Then, the A* algorithm was used to search for an optimal machining sequence by the aid of the feature dependencies and a manufacturing cost function. An effort for integrating the two activities: feature-based machining sequence generation primarily based on tool capabilities was designed [7].

Nasr and Kamrani [8] proposed an intelligent feature recognition methodology (IFRM) that develops a feature recognition system which has the ability to communicate with various CAD/CAM systems. The proposed methodology was developed for 3D prismatic parts that are created by using solid modelling package by using CSG technique as a drawing tool. The system takes a neutral file in Initial Graphics Exchange Specification (IGES) format as input and translates the information in the file to manufacturing information.

Han et al [9] defined feature recognition as sub-discipline of solid modelling that focuses on the design and implementation of algorithms for detecting manufacturing information from solid models produced by computer-aided design (CAD) systems

2.2. Feature Extraction

Research on computer integrated design and manufacture based on feature extraction (FE) so far has been largely focused on finding all or some possible features, and the task of manufacturing analysis is shifted to process planners [10].

A feature extractor based on the directional maximum is proposed to estimate the nose tip location and the pose angle simultaneously [11]. Gupta and Gurumoorthy [12] proposed a new algorithm for extracting Free-Form Surface Features (FFSFs) from a surface model. Automated feature recognition has been an active research area in solid modelling for many years and is considered to be a critical component for integration of CAD and computer-aided manufacturing [8]

The design and implementation of a system for automatic recognition of features from freeform surface CAD models of sheet metal parts represented in STL format was developed and it contains three major steps viz. STL model preprocessing, Region segmentation and automated feature recognition [13].

2.3. CAD/CAM systems

Representation of features is an important aspect for making feature recognition more applicable in practice. Process planning plays a key role by linking CAD and CAM. Its front-end is feature recognition, but feature recognition research has not been in accord with the requirements of process planning. A new approach to introduce computer aided process planning into sheet metal blanking dies industry was described [14]. The proposed system consists of two modules which are the CAD module and CAPP module.

A new hybrid (graph + rule based) approach for recognizing the interacting features from B-Rep CAD models of prismatic machined parts was designed. The developed algorithm considers variable topology features and handles both adjacent and volumetric feature interactions to provide a single interpretation for the latter [15]. A methodology for implementing the feature recognition system for achieving the Computer Aided Design/ Computer Aided Manufacturing (CAD/CAM) integration goals was designed [16]. Current 2D face recognition systems encounter difficulties in recognizing faces with large pose variations. Many two-dimensional (2D) feature recognition systems have recently been developed to salvage the massive store of engineering knowledge in 2D form and bring the benefit of computer-aided design (CAD)-computer-aided manufacturing (CAM) integration to 2D CAD users [17]. There are many computer-aided design (CAD) systems to take care of product design, computer-aided process planning (CAPP) systems to generate optimal tool paths and plans and computer-aided manufacturing (CAM) systems for various manufacturing requirements [18].

3. Sheet metal bending

3.1. Feature representation for sheet metal bending

Sheet metal product design, processes planning and manufacturing are normally carried out in a sequence of stages using different computer-aided software tools [18]. In order to describe sheet metal part features, the parts can be divided into several planar components and curved components.