ABSTRACT
A precise reverse engineering method generating 2.5D embossed models from images is proposed through the 2.5D reconstruction methods. To generate 2.5D TechArt models from the artistic images, edges are extracted through the image preprocessing and automatic boundary following techniques. Accurate NURBS interpolation of boundary pixels generates TechArt CAD models well. Performance of the developed system has been confirmed through the quick turnaround 2.5D engraving simulation linked with the commercial CAD/CAM system.

Key Words: 2.5D embossing, Aesthetic images, Dies and molds, Image processing, NURBS, TechArt

INTRODUCTION
Recently, aesthetic and artistic design is important for upgrading quality of products and manufacturing high value-added goods. This generates TechArt technology in the IT, digital appliance, and auto industries. TechArt means a design technology to transform engineering items to products with aesthetic design features. Using the artistic design patterns, design quality of commercial products is significantly upgraded. Valuation of IT, digital appliance and auto products is improved as well [1].

Since most image patterns are complex, screen printing of 2D application has been applied for implementation of complex images so far. On the other hand, the precision reverse engineering of 2.5D and 3D replicas of the complex images has been not only time-consuming processes for CAD developers, but also requires much lead-time for the application of product design process now. Several kinds of contact and non-contact 3D digitizers linked with specific surface modelers have been applied to construct 3D CAD data from a real model. However, they are expensive, inaccurate and complex for application of the product design as well.

In this paper, an accurate and rapid reverse engineering tool applicable to construction of embossed CAD data from any kinds of artistic pictures or images is studied. Automatic linking of edge pixels generates boundary curves of the images. To smooth and modify the identified boundary curves, NURBS interpolation is conducted. In addition, to maximize the interfacing flexibility with commercial CAD/CAM systems, IGES translation is applied for the CAD/CAM interface. Embossed 2.5D artistic CAD models for aesthetic fabrication of molds and dies are then generated from 2D complex images through the 2.5D reconstruction method. Performance of the developed system is verified through the CAD/CAM system.

IMAGE PROCESSING
Images are contaminated by noise. It deteriorates quality of reconstructed 2.5D CAD models. To reduce the noise, color images are transformed to gray images first. To remove impulse and salt-and-paper noises without blurring of the image, an adaptive median filter [2] is applied to the image. Then binary image is obtained through multiple threshold according to designer’s intention. In the application of the adaptive median filter, selection of the proper window size is important to enhance clearness of the image. Fig. 1 shows the image processed binary image.

AUTOMATIC BOUNDARY FOLLOWER
To get 2.5D solid CAD models from an image, edge information should be extracted from the image first. In this paper, the automatic boundary follower (ABF) is devised from the simple boundary following (SBF) algorithm [3]. Fig. 2 describes it tracing a boundary curve from the start point $P$ in the clockwise (CW) direction. If intensity 1 pixel (gray in Fig. 2) is detected when the ABF is scanning a binary image from the top left pixel to the right direction, a follower $S$ is triggered at pixel $P$. It moves to upward, and then turns to the right direction for the CW trace when