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DEVELOPMENT OF A VIRTUAL FORGING FACTORY FRAMEWORK

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Abstract

This paper presents the development of a virtual forging factory framework. The technologies of virtual reality and relational database had been integrated in the developed framework using Microsoft Windows® programming as the main technique so as to emulate a physical forging factory. The developed virtual forging factory consists of forging cells and a forging cell is comprised of forging machine, forging die, and forging operations forming a forging production line.

The technology of virtual reality had been successfully adopted in the production simulation of manufacturing such as CNC and robotics. However, the application in virtual forging factory seems to have not been studied yet. Potential application of a virtual forging factory can be beneficial to (1) computer aided instruction, (2) shorten the learning curve of a novice, (3) remote diagnosis and monitoring when remote monitoring and control technology and signal inspection is considered, (4) improve adverse forging environment when remote forging technology is applied, and (5) virtual reality application.

Keywords: Virtual Forging, Remote Manufacturing, Virtual Reality

1 Introduction

The technology of virtual reality is very promising to be used as an enabling technology towards industrial automation and e-Manufacturing in Taiwan. Historically, the evolution of the industry automation in Taiwan can be categorized into five stages: (1) low cost automation (turnkey system and flexible machining cell, ~1980), (2) industrial automation (FMS and assembly line, 1981~1986), (3) entire factory automation (factory automation and CIM, 1987~1990), (4) production automation and manufacturing automation (information technology and information flow, 1991~2000), and (5) electronic industry and automation (enterprise integration and automation through digital information technology, 2001~).

Therefore, the virtual reality technology is an appropriate tool currently since it is very appropriate to be adopted build up a virtual environment to educate and train novices who are interested in the forging industry.

The virtual reality (VR) is a 3D computer graphic technology. It can be used to create fictitious objects and events that simulate a realistic three-dimensional scene and allow segments of a scenario to be manipulated[1, 2, 3, 4, 5, 6]. The Virtual Reality Modeling Language (VRML)[1], External Authoring Interface (EAI) and relational database are the main techniques used in this system. The Microsoft Visual C++ (VC++) was used to integrate the whole main techniques to build the virtual forging factory software.

A typical forging system is shown in Figure 1. There are billet, plastic deformation, forging die, facilities, billet and die interface, and environment. The forging system is dominated by the designated forging processes. Therefore, a virtual forging factory must consider these characteristics. Furthermore, a typical forging factory flow, as shown in Figure 2, needs to be emulated to form a virtual forging factory.

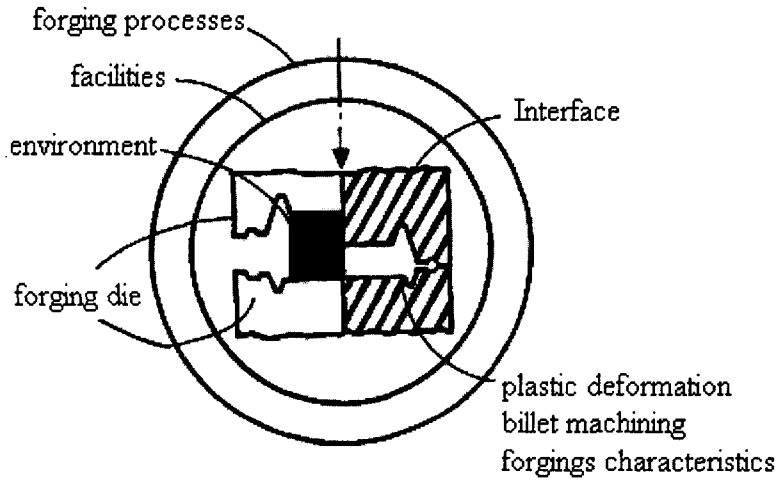


Figure 1 a typical forging system

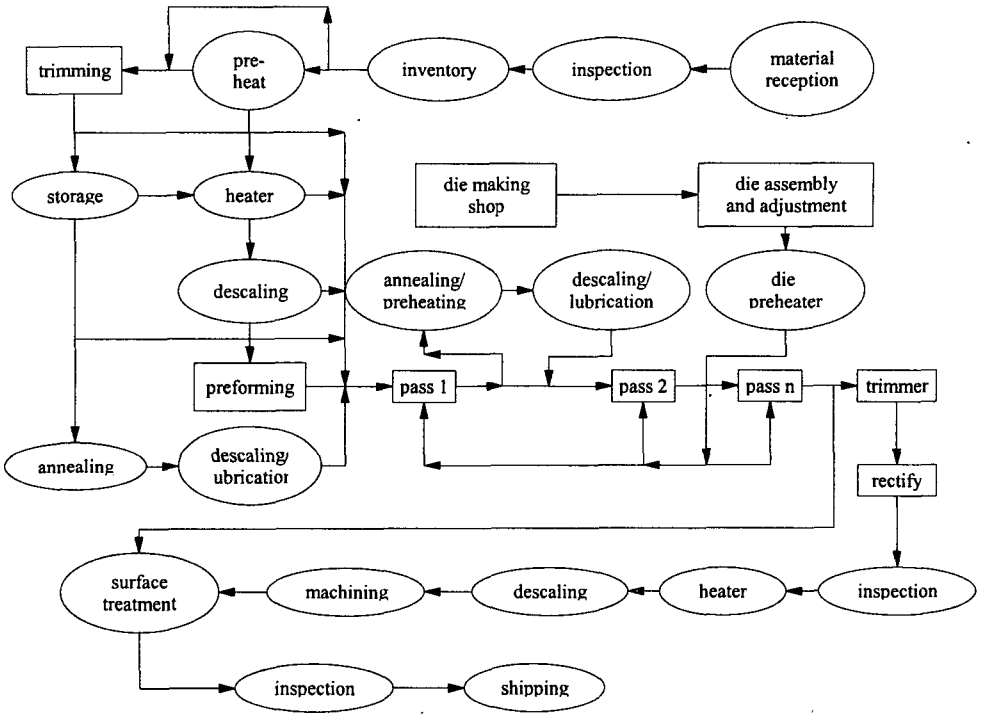


Figure 2 A typical forging factory flow

2 System configuration

The proposed system framework of the virtual forging factory is shown in Figure 3. Physical forging data were mapped to the simulated virtual forging factory. Physical facilities were mapped to virtual facilities, physical die to virtual die, production line to virtual production line, and factory flow to software flow simulation forming the virtual forging factory.

There are two divisions in the virtual forging production line, as shown in figure 4. The first division is "material storage and cutting" and the other is "forging machine" that has six sets. A virtual production line is composed of many processes such as material storage and cutting, transportation, heat treatment and forming, etc., and these processes were emulated through the developed programs under Windows environment so as to demonstrate the dynamic forging processes in 3D.

The process information in the virtual forging production line was based on the physical forging data. These data includes arrangement of incoming materials, die selection, production quantity evaluation, etc. Furthermore, the developed software must also be integrated with the scene of the whole virtual production line so as to emulate a physical forging factory.

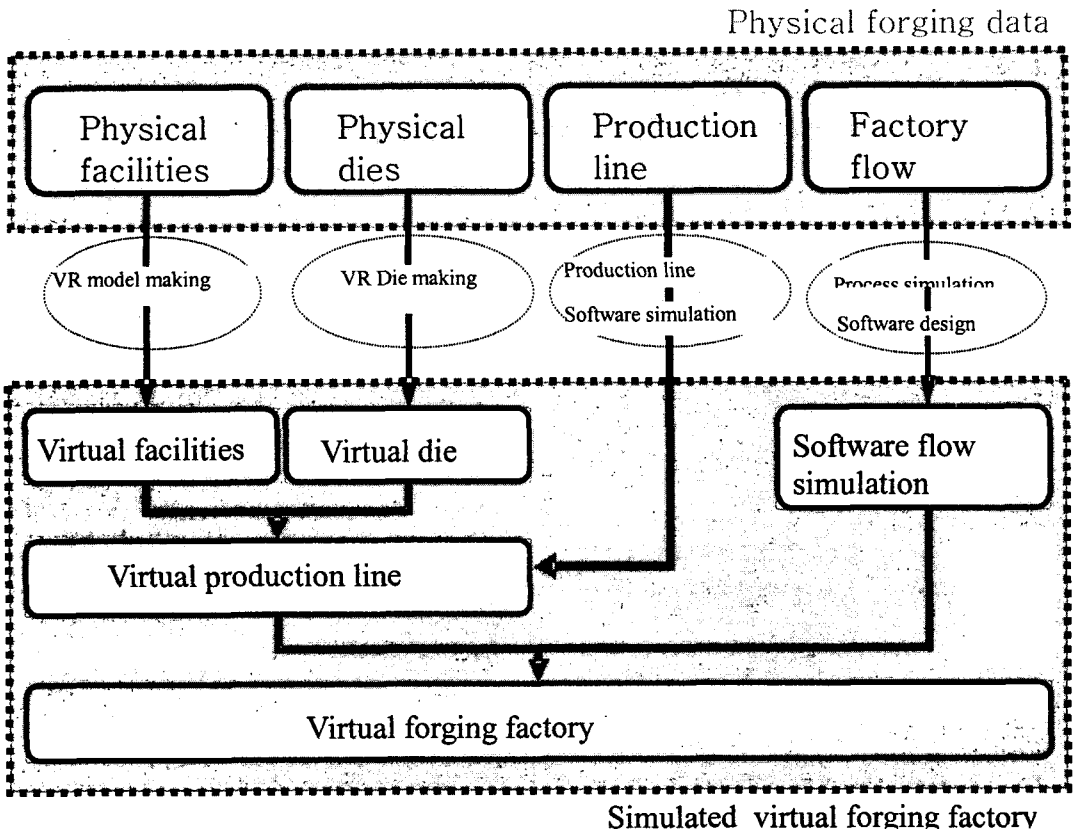


Figure 3 Framework of the virtual forging factory

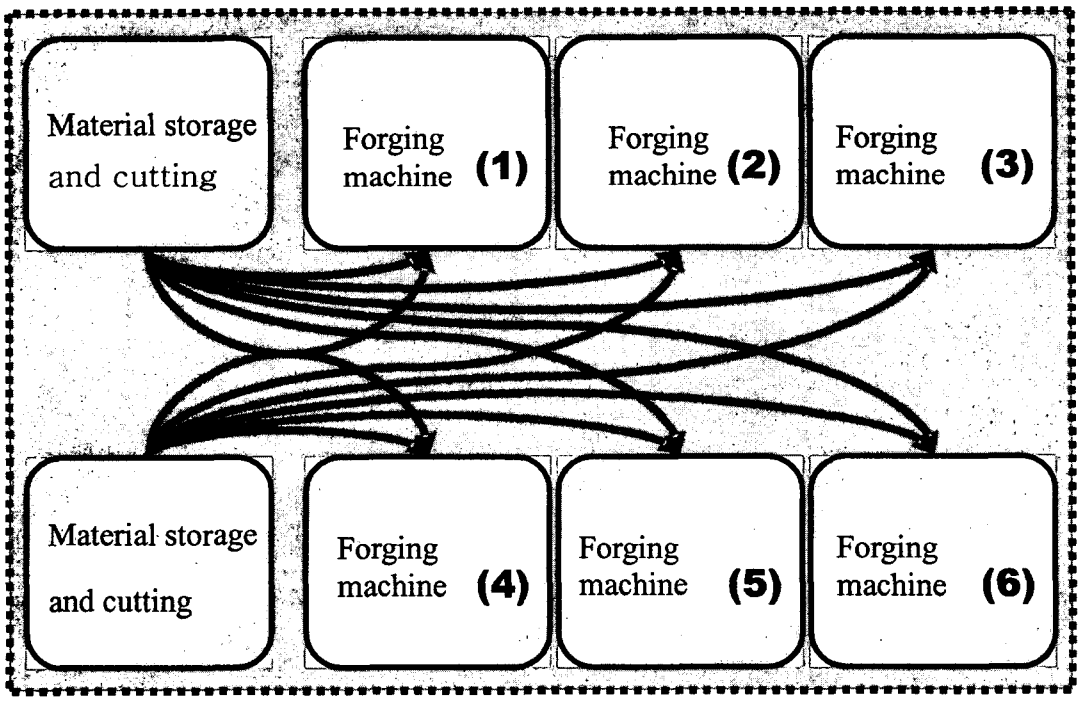


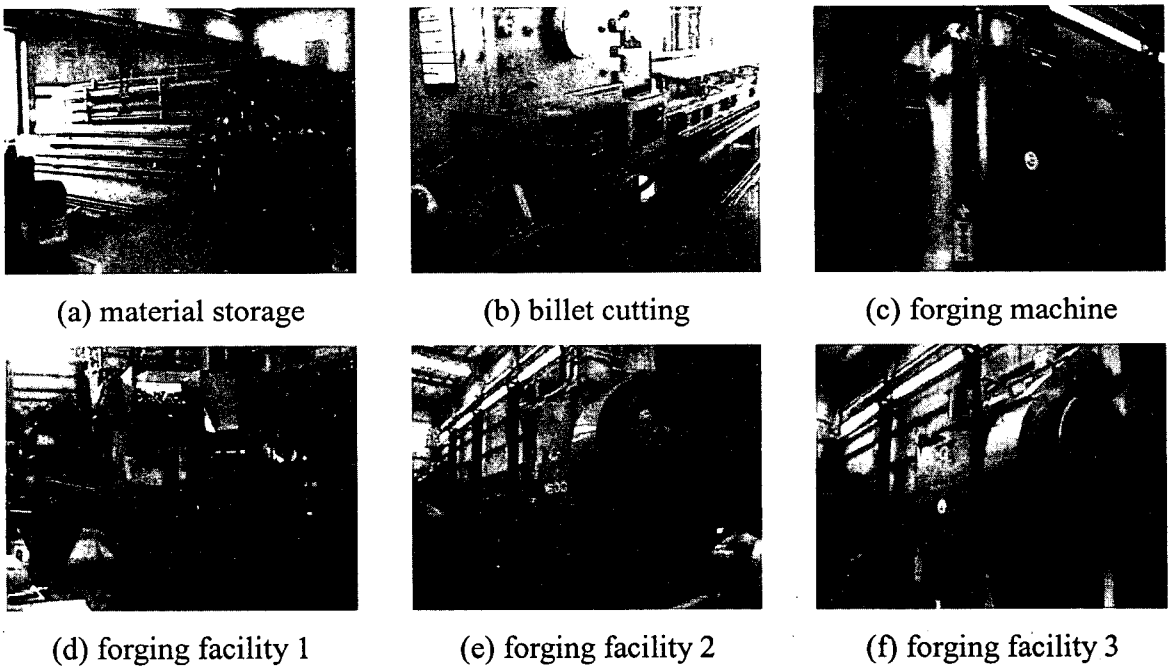
Figure 4 virtual forging production line

3 Realization of the proposed system

The virtual reality technology adopted in this paper used the standard VRML (Virtual Reality Modeling Language) as the basis to form the virtual forging factory. Firstly, a few static photos, as shown in Figure 5, and animation were taken in the physical factory. These images include the physical material storage, punch machine for cutting the billet, forging machines for the physical forging processes, etc. Three-dimensional modeling software such as 3DS MAX., AutoCAD, etc. was then applied to construct the digital virtual model considering both geometrical dimensions and external appearances.

The constructed virtual forging facilities and related model are shown in Figure 6. The virtual material storage model is shown in Figure 6(a), virtual billet in Figure 6(b), virtual cutting machine in Figure 6(c), virtual forging machine 1 in Figure 6(d), virtual forging machine 2 in Figure 6(e), and virtual forged product in Figure 6(f).

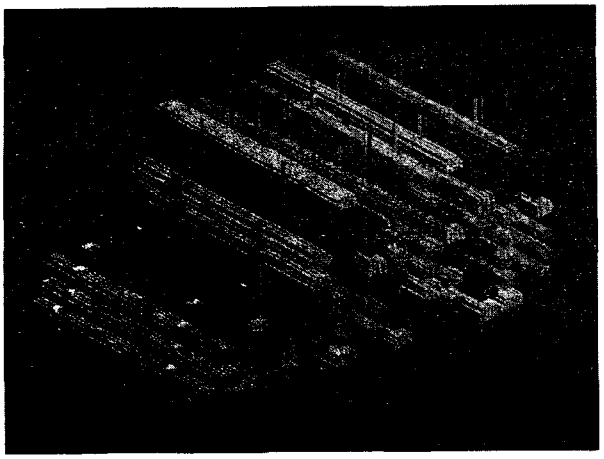
The completed virtual forging factory, as shown in Figure 7, has integrated the virtual forging facilities, as shown in Figure 6.



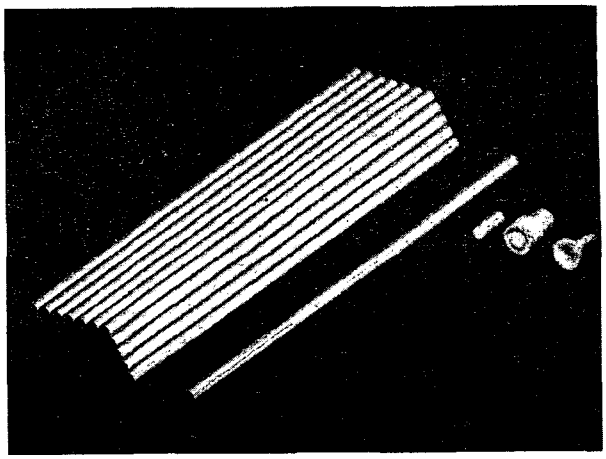
(a) material storage (b) billet cutting (c) forging machine

(d) forging facility 1 (e) forging facility 2 (f) forging facility 3

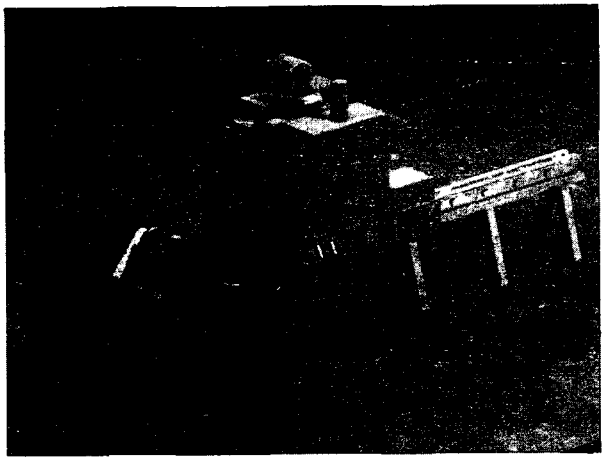
Figure 5 images taken from the physical forging factory



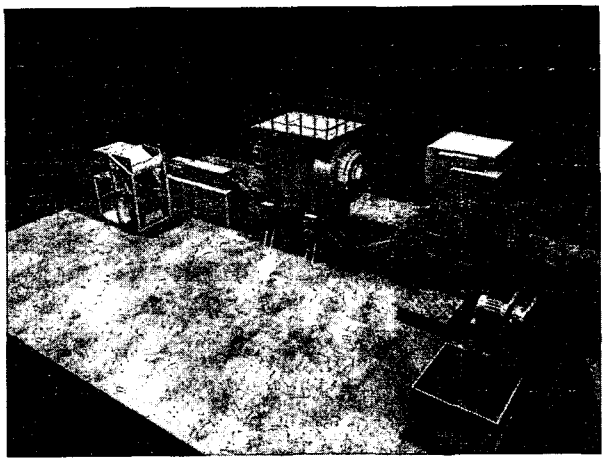
(a) material storage



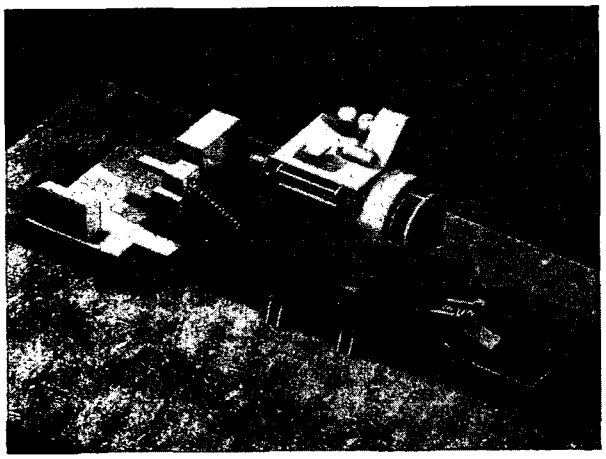
(b) virtual billet



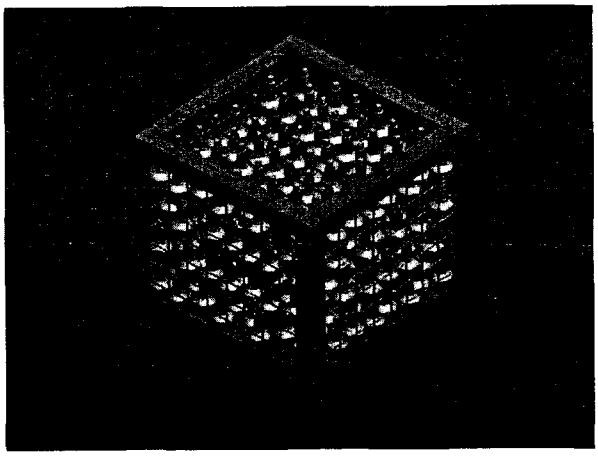
(c) virtual cutting machine



(d) virtual forging machine 1



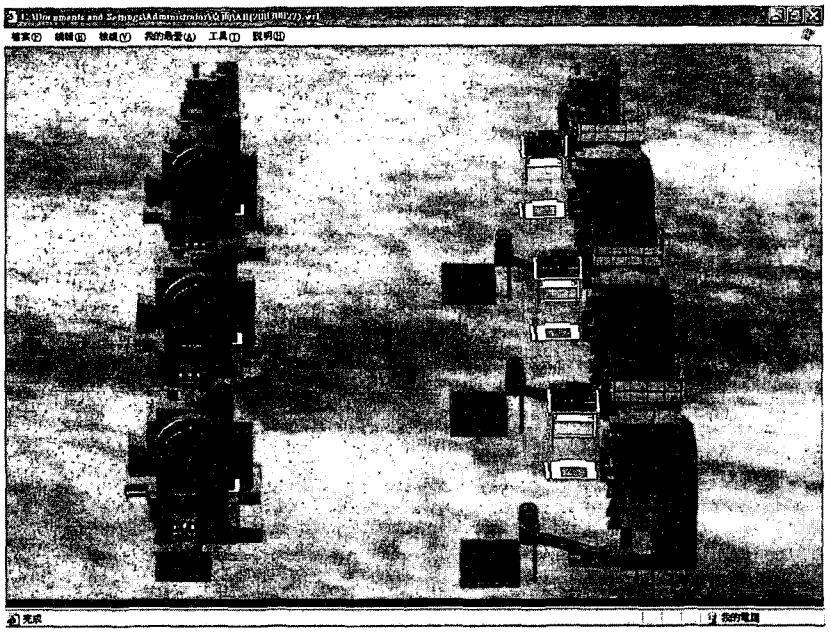
(e) virtual forging machine 2



(f)virtual forged product

Figure 6 The constructed virtual model

(a) virtual forging factory 1



(b) virtual forging factory 2

Figure 7 virtual forging factory

4 Discussion and conclusion

A virtual forging factory framework has been implemented by referencing a physical forging factory and its physical operation. The related forging facilities were constructed based on VRML technology towards an integrated three-dimensional VR digital model. The result shows that it is very promising and very feasible to construct a virtual forging factory.

However, the dynamic process flow of the implemented virtual forging factory has not been implemented yet. Further development will incorporate die design and process planning, etc. to integrate relational database including process variables [8] such as transportation time and forging parameters, etc.

Acknowledgement

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