

Social Manufacturing Cloud Service Platform for the Mass Customization in Apparel Industry

Xiuqin Shang¹, Xiwei Liu², Gang Xiong²

1.The State Key Laboratory of Management and Control for Complex Systems,
Institute of Automation, Chinese Academy of Sciences
Beijing, China
Xiuqin.shang@ia.ac.cn
Xiwei.liu@ia.ac.cn

Changjian Cheng¹, Yonghong Ma³, Timo R. Nyberg⁴

2. Dongguan Research Institute of CASIA
Cloud Computing Center, Chinese Academy of Sciences
Dongguan, China
3. Dongguan KAIN Electronic Sci. & Tech. Co., Ltd,
Dongguan, China
4. BIT Research Centre, Aalto University, Finland

Abstract—Social Manufacturing is a novel manufacturing mode, which can be introduced in the apparel industry and other fashion industries for the mass customization, based on network, 3D fitting mirror and other technologies. In social manufacturing, the consumers are involved fully into the production process by the internet; the manufacturing equipments and the intelligent interactive service terminals (3D fitting mirrors) are online, forming the manufacture and service equipment network; to realize the social manufacturing, a powerful modern logistics system are needed to support the production and E-business. Therefore, the manufacture and service equipment network, mass-customization or mass-rent webs involving a large number of people, and modern logistics network are combined in the social manufacturing platform by using the network, cloud technology, and other technologies. In the near future everyone will need the novel manufacture mode and the traditional enterprises, such as apparel enterprises, will be transformed into the intelligent enterprises which can proactively perceive and respond the personalized demands of the large quantity of consumers, and realize the mass customization by the social manufacture cloud service platform.

Keywords—Social Manufacturing; Apparel Industry; Mass Customization; 3D fitting mirrors

I. INTRODUCTION

With the rapid development of Internet technology, the network connects the thousands of people together, which is the so-called network society. In the network society, the many activities that be done in the real world, can be achieved online. At present, the manufacture activity can be online, through the manufacturing equipments, such as 3D printers, connected directly on the net. At the same time, fitting activity also can be realized online by 3D fitting mirrors technology.

With these new technologies, the “social manufacturing” is becoming has become a reality. Social Manufacturing is a novel manufacturing mode, in which the consumers are involved fully into the production process by the internet, moreover, the manufacturing equipments (3D printers) and the smart-interactive terminal(3D fitting mirrors) connected directly on the network can make all the activites including

manufacturing, consuming and service realize online. As Internet brought the computing power to the society, the combination between manufacturing equipments and Internet will make the society own the manufacturing capacity to meet the demand for massive personalized products. The manufacture is moving in “Social Manufacturing” stage [1], driven by the increasing demand for the personalized products and the combination between additive manufacturing technology and network technology. In the social manufacturing times, the value of the "long tail" effect will be fully mined, the costs of the personalized products will be gradually reduced, and the customers' satisfaction to the products and the high quality services will be improved the competitiveness of manufacturing enterprises.

In apparel industry, rapidly increasing consumers' demand for personalized fashion products makes it necessary for garment enterprises to market needs with fast perception and even the ability to boot, in order to meet "mass customization" of business requirements. Meanwhile, the existing garment enterprises face fierce challenges and how to avoid the waste of resources caused by vicious competition is an important research topics. To solve those problem, social manufacturing cloud service platform for mass customization in apparel industry is created. At the beginning of the social manufacture, the main users focus on the architects, designers, and the DIY advocates, but in the near future everyone will need the novel manufacture mode and the traditional enterprises, will be transformed into the intelligent enterprises which can proactively perceive and respond the personalized demands of the large quantity of consumers, and realize the mass customization by the social manufacture cloud service platform.

The remainder of this paper is organized as follows: Social Manufacturing cloud service platform for mass customization in apparel industry is introduced and created in Section 2. The key technologies are described in Section3. A classical application is presented in Section4. Section5 gives a conclusion.

This work is supported by the Early Career Development Award of SKLMCCS.

II. SOCIAL MANUFACTURING

A. Social Manufacturing

In recent years, as the popularity of 3D printers and other equipment online, social manufacturing was proposed by scholars. In 2012, the Professor Feiyue Wang wrote a paper^[1] “From social calculation to social manufacturing: one coming industrial revolution”, introducing the social manufacturing. Social manufacturing refers to a novel manufacturing mode in which the consumers are involved fully into the production process by the internet, moreover, the manufacturing equipments (3D printers) and the smart-interactive terminal(3D fitting mirrors) connected directly on the network can make all the activates including manufacturing, consuming and service realize online. Professor Wang noted that the greatest feature of social manufacturing is that the consumer demand can be directly into the product, that is, “From the idea to the product”, allows anyone to participate the whole process of manufacturing and consuming through social media, mass rent, and other forms.

Compared with traditional manufacturing, the social manufacturing has differences. In the traditional manufacturing mode, the scale effect is considered to reduce the cost and gain more benefit, however, it is hard to meet the personalized needs of the consumers for the fashion products. This problem can be solved by the social manufacturing mode. In social manufacturing, by the using the multimedia information mining technology, the value of the “long tail effect” is mined, that is, the personalized needs are subdivided; the distributed collaboration is adopted to manufacture the production, so that the cost of production is decreased, the consumers’ need can be achieved, and the competition of the apparel enterprises is improved.

B. System Elements and Application Requirements

The social manufacturing cloud service platform involves every part of the apparel industry, mainly including the consumers, manufacturers, designers, retailers, and so on, as shown in the figure 1.

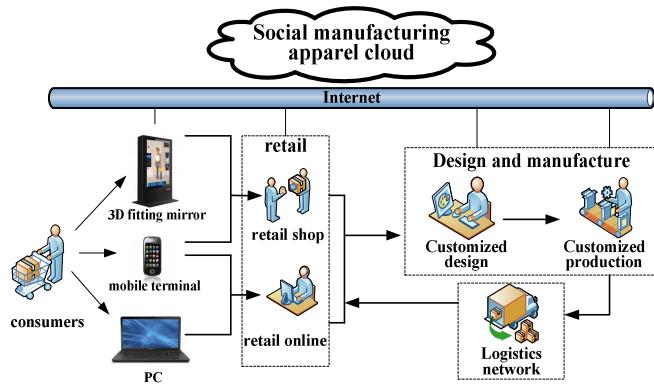


Figure 1. the system application components

i) For the consumers, they can customize their own fashion clothes using the technology of the 3D fitting mirrors in stores near their homes or on the net anywhere. They can customize the styles, materials, sizes of the dress, or modify the customization online, remaining within doors. All these

services will transform shopping to a convenient and comfortable experience.

ii) For the retailers, their service quality can be improved through combining online and offline sales modes together. In this way, the stocks will be reduced, the costs will be decreased, and more specific, professional, and characteristic services will be provided to the customers. On one hand, in the offline sales, the most physical stores which distribute widely among all districts of a city, can strengthen the customer’s perception for the production compared to the online sales, moreover, combining with the online sales, its stocks, rent cost can be diminished. Hence, the stores can be minimized and flexibly distributed in the city, even just near the customers’ home. All of the stores are connected by strong logistics network, forming a physical stores network. In each store, 3D fitting mirror is supplied, in order to fit conveniently and help customers to customize the dress. Getting undressed to try on clothes in shops could be a thing of the past thanks to the high-tech new innovation-3D fitting mirrors. Fashionistas can even change outfits without moving, simply swishing their hand on virtual buttons on the screen to switch clothes. On the other hand, the online sale can be improved the perception of the production with the help of offline sales. Moreover, setting up corresponding dressing rooms online can also help with collecting information and enhancing consumers’ customization experience.

iii) For the suppliers, business intelligence technology can be adopted to analyze the market requirement and tendency in accordance with consumers’ online and offline consumption data. This technology, therefore, will offer suppliers important information and direct them to make decisions. As a result, inventory level can be brought down and the pressure of market competition can be reduced.

iv) In the manufacturing terms, more targeted customization will make multi-varieties and small batch production planning clearer, bring the inventory level down, save raw materials and improve production efficiency. At the same time, information collected from the 3D fitting mirror (or dressing room) can be fed back to the manufacture part, which will provide reference to product designing. This makes the products easy to success, reduces operating risks and increases efficiency.

In conclusion, with the help of 3D smart interactive terminal and social manufacturing cloud service, all of manufacturers, suppliers, retailers and customers of clothing industry will gain great benefits. This platform will improve the efficiency of the whole industry and realize the rational and effective utilization of social resources. Besides clothing industry, social manufacturing, as it were, has a broad prospect even on the entire manufacturing industry.

C. Main Research Problems

Based on existing clothing manufacturing informatization construction status and actual demand in the market, the system supplies the whole solution for the apparel industry, mainly including 3D fitting mirror technology, personalized design and customization, and service mode combining online and

offline sales. For realizing this novel social manufacturing, the main research contents are shown in the figure2:

- i) 3D fitting mirror technology;
- ii) clothing customization subsystem;
- iii) collaborative production management facing the customization;
- iv) other supplying technologies, for example, cloud computing.

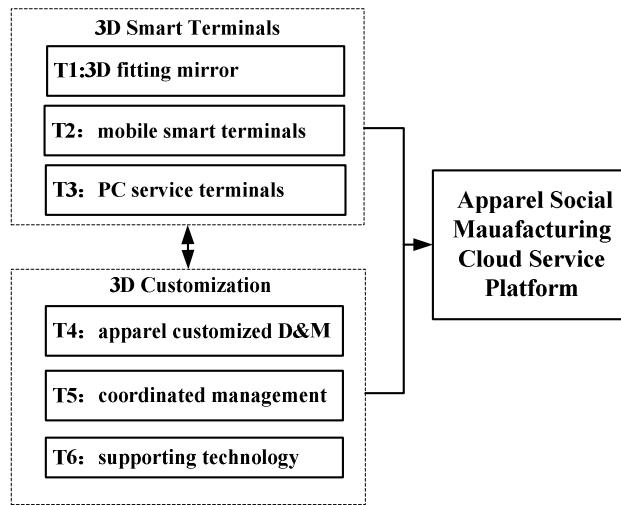


Figure2.the key research problems.

III. KEY TECHNOLOGIES

A. 3D Fitting Mirror Technology

At present, the 3D fitting mirror is used to get undressed to try on clothes in shops. However, in this paper, the 3D fitting mirror is improved the customization portals, combining with the customization function.

Recently, the 3D fitting mirror technology continues to improve on behalf of the dressing mirror from Russian AR DOOR company. The Russian company has invented what it calls a 'virtual fitting room', which projects a 3D image of the item of clothing onto the shopper as they stand before a screen. The company has used game-playing hardware to create the invention with an Xbox 360 console, complete with its Kinect motion-sensor technology, hooked up to a large video screen which resembles a full-length mirror. The Kinect camera is able to monitor the customer's movements and tell when they turn around in order to show them the back of the garment too.

In this paper, the 3D mirror technology is used as not only a fitting mirror but also the customization gateway through increasing the customizing function. In fact, the 3D fitting mirror refers to the computer aided fashion design(CAD), computer aided manufacturing(CAM), virtual clothing store, virtual reality and other domains. In the apparel industry, this technology can support the customer's preferences, the size, the effect examination information to the designer, and help the 2D garment cutting sewing work such as inspections, garment manufacturing check and so on. In the virtual clothing

stores, it can help customers to achieve the virtual fitting, customization, and decision support. In the virtual reality area, this technology can simulate the reality of the fabric decoration effect, clothes dressing effect, and so on. This paper mainly research application of the 3D fitting mirror technology to the clothing customization, as shown in the figure3.

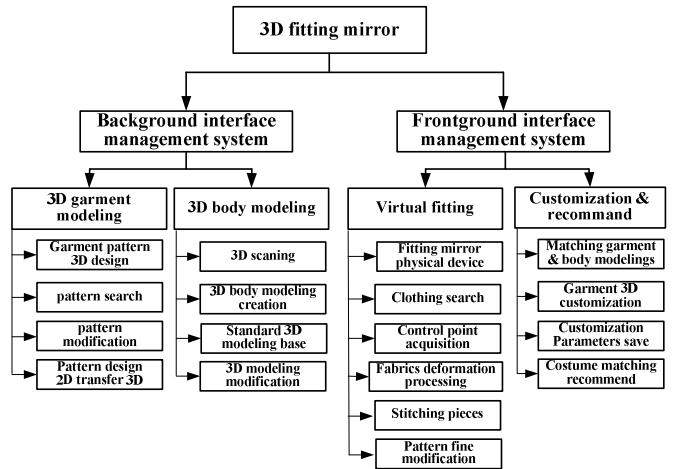


figure 3. The main functions of the 3D fitting mirror

- Image-forming principle

simulating the principle of binocular parallax positioning, 3D images are synthesized by the image data from the two binocular camera. However, this binocular stereo vision technology has shortcomings: i) due to the separation of front and back surfaces of the human body, data in the transitional region is insufficient; ii) compared to the point cloud in the vertical direction, the cloud in the horizontal direction is sparse; iii) some disturbances and deficiencies in the data cause the gaps and distortions in the body image. In order to overcome the above-mentioned shortcomings, the subject uses image recognition and data mining technologies, model matching, in order to realize three-dimensional reconstruction and reconstruction of human models.

- 3D clothing modeling

The 3D fitting simulation process can be divided into two steps, the 3D surface construction of rigid garments, and 3D surface construction of flexible garments. X Provot Spring-Mass Model is introduced, in which three dimensional garment fitting models can be simulated by solving the equations of the fabric motion and collision detection, and static drape effect of the dress upper body can be realistically reproduced.

B. 3D Customization

Combined with 3D fitting mirror technology, 3D customization can be realized more easily, which can simplify the garment process and provide dressmaking efficiency. Existing garment process is divided into design, choosing fabrics, playing board, cutting, making, ironing and other steps. For the design step, the 3D CAD has already been used, and there are so many special design software in the garment industry, so that this part is not discussed more in this paper. Besides, as the one of the most important section, Garment Playing board means to decompose the clothing into

pieces according to the design drawing, and then drawn into a structure (pattern), including body, sleeve, collar and etc. After checking, the fabric is cut according to the pattern of contour cropping garment piece, then a ready-made clothes can be made after sewing the pieces. due to the 3D technology, the effect of the ready-made clothes can be displayed virtually. In this way, the clothing play board can be realized on the computers totally or partially.

Compared with manual customization, 3D customization with 3D fitting mirror can realize decreasing the producing cost of design, making-board, and so on for the small batch and more variety production.

C. Coordinated Management technology

In the social manufacturing, one of the most important technology is coordinated management. In order to keep the regular and efficient running condition of the social manufacturing modeling framework, coordinated management become the valid approach, especially in the work flow coordinated management. The workflow coordinated management have an effect on the dynamic cyber citizen management, social manufacturing equipment control and management, and the logistics management.

In this paper, the work flow coordinated management is realized by the ACP approach^[2-6], which is an intelligent computing approach, including artificial system, computing experiment, parallel execution three parts. In the artificial system, the artificial modeling of the social manufacturing is created; based on the modelings, computing experiment can be realize, for optimizing the running condition; through the parallel execution, the artificial system can be more precise, and the property of the approach can be improve. Analyzing the experimental results concluded that the best demand supply matching and manufacturing resources configuration, finally will be the best match and the feedback configuration to the business, to guide social production optimization operation.

In the social manufacturing, the service oriented information system framework and the business environment of the crowdsourcing put forward many new requirements for the workflow, which need that the workflow engine can support collaborative crowdsourcing process, the interaction between internet population and computers, invocation and combination of the service. Meanwhile, the in the service-oriented framework of parallel control and management for social manufacuturing system, workflow execution service itself can also be considered as a process service.

IV. SYSTEM CONSTRUCTION

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

Based on the above technologies, the system structure is divided into six layers, as shown in the figure 4.

Basic application layer: this layer includes information network using the 3D intelligent terminals, modern logistics network, heterogeneous operating system and TCP/IP network. In this layer, 3D intelligent terminals' perceptual and interactional function can be provided for the outside; the modern logistics network offers logistics capability; additionally, the TCP/IP network avoids all kinds of physical connection, and provides transparent information communicating services. Therefore, various distributed heterogeneous information systems and databases can be integrally encapsulated on the basis of SOA, and realize operation through services. This layer plays an important role of terminal communication and product shipment in social manufacturing.

Service infrastructure layer: This layer contains service encapsulation, service registration, service discovery, service date management, service management and fusion middleware management.

- Service encapsulation module encapsulates the current application system's function, data and staff integrally through adapter pattern, and converts them to the service that can be accessed by applicants in standard mode.
- Service registration module classifies and publishes the current service by UDDI protocol. Services can be published by service providers, while users can search available services with the help of this module. There are three subdivisions in this module, namely, business services, business function services and technique function services.
- Service discovery module classifies information and the functional description of service based on the previous module. This module helps search relevant services for specific demands that come from customers and the service bus.
- Service data management module provides management and accessing to heterogeneous data in the frame of SOA, which comprises accessing and mapping to relational databases as well as accessing and operation of business objects.
- Service management module includes version management, product lifecycle management and so forth.
- Fusion middleware management administrates various adaptor interfaces uniformly, and realizes more value-added services by integrating current applications and information.

Service bus layer: This layer consists of dynamic searching service, message-passing service, routing & switching service, protocol switching service, security service and other standard services.

- With the help of service registration and service discovery module, the first four services in this layer help internal information of an enterprise transfers not only accurately but also efficiently and safely in accordance with applicants' requests. These four services smooth out technical differences among applications, and enable them to cooperate and communicate successfully.

- Security service and other standard services guarantee the loose coupling between
- applicants and service providers, and make they interact in dynamic ways which are safe and efficient.

Parallel operation layer: This layer contains computing environment, manual system computing environment, coordinated operation environment, cooperative monitoring management, information analyzing environment and optimization environment.

Business configuration layer: This layer consists of physical clothing stores, internet-based clothing stores, social media information platform, data acquisition and analyzing platform, business intelligence platform, collaborative manufacturing management platform and logistics supervising platform.

System accessing layer: This layer includes entry of business accessing and configuration as well as entry of platform and model management. Therefore, customers can access the system in different ways and are allowed to accomplish specific settings and configurations. Based on Portal techniques, this layer realizes content aggregation, customized views, customization, collaboration features, internationalization, support of various web browsers, PDA and so on.

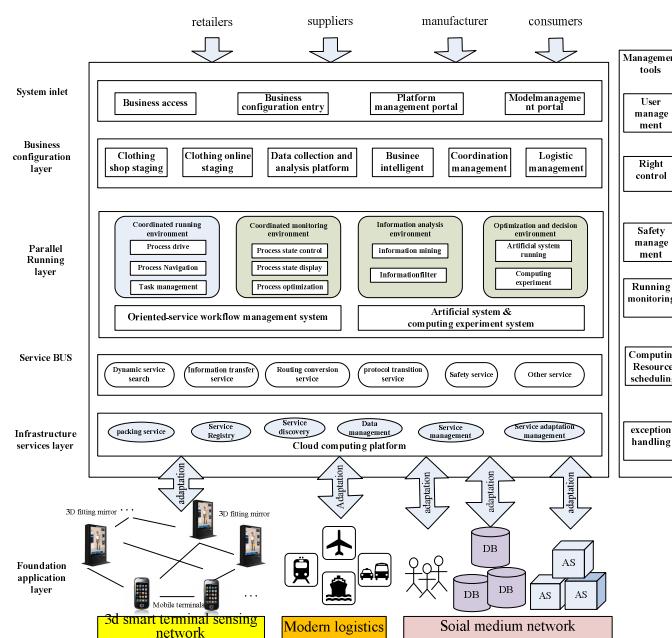


Figure 4. the system construction

V. CONCLUSION

This system can realize the innovation on enterprise management model. Combining online and offline services together and taking full advantage of minor enterprises, “Social Manufacturing” release clothing enterprises’ stress of customization and costs, and solve the problem of Information network management. The project will bring enterprises a change from order-oriented to service-oriented, and promote their whole competitiveness and intelligence level. Importing techniques like 3D smart interactive terminal help enterprises perceive the market tendency better, and realize global optimization and local optimization of integrated services. Moreover, it also enable clothing enterprises’ information integration and technique innovation, meet the needs of “mass customization”, and come up with an integrated solution of advanced international level.

ACKNOWLEDGMENT

This work is supported by Natural Science Foundation of China Projects (71232006, 61233001, 91024030, 61104054), Courtyard Cooperation Project(2F12N02) and the Early Career Development Award of SKLMCCS. Special thanks go to Professor Feiyue Wang, who originated the research of social manufacturing.

REFERENCES

- [1] Wang, F-Y. From social calculation to social manufacturing: one coming industrial revolution. Bulletin of Chinese Academy of Sciences, 2012, 27(6): pp.658-669.
- [2] Wang, F-Y., and T. Shunning. Artificial societies for integrated and sustainable development of metropolitan systems. IEEE Intelligent Systems, 2004. 19(4).
- [3] Wang, F-Y. Agent-based control for networked traffic management systems. Intelligent Systems, IEEE, 2005. 20(5): p92-96.
- [4] Wang, F-Y. Toward a Paradigm Shift in Social Computing: The ACP Approach. Intelligent Systems, IEEE, 2007. 22(5): p65-67.
- [5] Wang, F.Y. et al. Social computing: From social informatics to social intelligence. IEEE Intelligent Systems, 2007. 22(2): p79-83.
- [6] Wang F-Y. The Emergence of Intelligent Enterprises: From CPS to CPSS. IEEE Intelligent Systems.2010,25 (4):p85-88.