Construction of University Intelligent Manufacturing Learning Factory Laboratory for Emerging Engineering

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Abstract. In order to meet the needs of intelligent manufacturing professional personnel training, from the new perspective of cultivating the ability of engineering project, combined with the present situation of laboratory construction in colleges and universities, through the analysis of the present stage laboratory experiment process, aiming at the present stage in the process of practical teaching of experiment course in the theory and the actual production contact less problems, put forward a kind of combining teaching with enterprise production line of intelligent manufacturing factory laboratory construction planning study. Taking the customization of personalized pen holder as an example, this paper expounds the process of laboratory construction and experimental work, the machining, visual identification, intelligent logistics, MES and organic combination of experimental projects, such as through a multidisciplinary integration of laboratory construction, lead the students to combining theory with practice, apply theory to the purpose of production, improve the innovative ability of undergraduate talents for colleges and universities.

1. Introduction

With the advent of a new round of scientific and technological revolution and industrial change, China has put forward a national strategy and plan for intelligent manufacturing to meet the development requirements of the times, trying to expand China's competitive advantage in the manufacturing industry through technological progress and industrial upgrading [1]. Transforming China from a big manufacturing country to a powerful manufacturing country, the key to realize the strategic goal lies in talents [2][3]. However, from the current situation of domestic engineering university education, the laboratory environment suitable for intelligent manufacturing training needs to be further improved [4][5]. The rapid development of the new economy urgently needs the support of new engineering laboratories for intelligent manufacturing to cultivate engineering and technological talents with innovation and entrepreneurship ability and cross-border integration ability. Therefore, in order to adapt to the new situation and challenges, it is necessary to put the laboratory construction oriented to the practice teaching of Intelligent Manufacturing in a more prominent position, and lay the foundation for training and bringing up a large number of compound intelligent manufacturing senior talents with professional theoretical knowledge and professional operation skills.

2. Laboratory Plan

The construction core of intelligent manufacturing learning factory laboratory is to train talents in the direction of intelligent manufacturing through the way of knowledge reconstruction and cross, learning and training integration. In this way, students are able to complete the experiment and practice of
corresponding courses of intelligent manufacturing professional training program to realize the task of intelligent manufacturing compound talents training. Intelligent manufacturing learning factory laboratory can support practical links of undergraduate mechanical specialties, including intelligent manufacturing engineering, mechanical engineering, mechanical electronic engineering, mechanical design and manufacturing and automation, process equipment and control engineering, electrical speciality, electrical engineering and automation, automation speciality, engineering training, professional experiment and production of robot, artificial intelligence, automation and other specialties. The covered specialties are shown in Figure 1.

Figure 1. Involved in professional

The intelligent manufacturing learning factory is built according to the intelligent manufacturing standard architecture, covering the four links of automation, informatization, Internet and intellectualization. Therefore, we have established an intelligent manufacturing training platform integrating demonstration, teaching and scientific research through the vertical, horizontal and end-to-end integration of the system, which adopts industrial robots, CNC machining centers, laser AGV, machine vision, artificial intelligence and other cutting-edge technologies. The experimental platform can support the mechanical majors to carry out such experimental courses as industrial robot integrated application, production data acquisition and monitoring, PLC programming and integrated debugging, machine vision application, intelligent storage and logistics, etc., and can also open general courses such as introduction to intelligent manufacturing for the whole school students. Moreover, the laboratory supplies the establishment of intelligent manufacturing foundation and intelligent manufacturing comprehensive application platform and other public elective experimental courses.

3. Laboratory Construction

The laboratory construction adopts the way of simulating the production line of enterprise manufacturing workshop. At the same time, in order to enhance students' interest, the production product is set to make personalized customized "hexagonal pen holder". Through the personalized customization of the six sides of the pen holder by the user, including the customization of carving
patterns and words, the selection and installation of clocks, thermometers and other accessories, the automatic production scheduling, processing, assembly, detection, transportation, delivery and other tasks of the system are completed.

![Figure 2. Equipment layout of production line](image)

The layout of laboratory production line equipment in intelligent manufacturing learning factory is shown in Figure 2. The intelligent warehouse workstation is used for storage management of product parts and finished products. The intelligent handling workstation is an intelligent AGV, which can automatically move to the intelligent storage workstation. The intelligent machining workstation is equipped with an intelligent robot and an intelligent machining center. The intelligent robot and sends the material blank to the intelligent machining center. According to the program, the drilling, milling, expanding, grinding and other processes are automatically completed, and then the intelligent robot puts the products back to the intelligent AGV. The intelligent AGV transports the processed materials to the intelligent laser marking workstation, where the intelligent laser marking machine marks the corresponding position of the product, which is used as the unique identification number of the product warehousing. After that, the intelligent AGV will transport the marked products to the intelligent assembly detection workstation, where the parts assembly is completed, that is, the parts of six sides of the pen barrel are loaded into the holes processed, and then the assembly is detected whether it meets the requirements through visual recognition. After this step, the complete product is picked up by the intelligent AGV and put into the corresponding area of the finished product warehouse, and the order completion information is sent. In this way, the whole process of a customized pen holder is finished. According to the size of the laboratory site and process requirements, the intelligent warehouse workstation can also be divided into two parts: the parts warehouse and the finished product warehouse, which are placed separately as shown in Figure 3.
Figure 3. Laboratory Layout

The entire workflow of the production line in the laboratory of an intelligent manufacturing learning factory is shown in Figure 4:

1. The user customizes the style of the six sides of the hexagonal pen holder in the single app;
2. MES system generates production plan and orders according to orders;
3. The blank parts of the pen holder and the accessories to be assembled are taken out from the storage station and put into the work tray;
4. The intelligent AGV transports the pallet to the intelligent machining center;
5. The feeding robot puts the pen container into the intelligent machining center;
6. According to the shape and size of the ornaments to be assembled, the intelligent machining center conducts drilling, reaming, grinding and other processing on each surface of the pen barrel;
7. The feeding robot takes out the finished pen container and puts it on the pallet of the intelligent AGV;
8. The intelligent AGV transports the pallet to the intelligent laser marking station;
9. The intelligent laser marking workstation carries out laser engraving on the pen holder according to the user-defined pattern;
10. The intelligent AGV transports the engraved pen container to the intelligent assembly and detection workstation;
11. According to the assembly requirements, the intelligent robot will install the accessories on the correct surface of the pen holder. In the process of installation, glue will be applied on the required surface of the pen holder through the dispensing machine to fix the accessories;
12. After the assembly, the intelligent assembly inspection workstation detects each surface through machine vision to judge whether it is consistent with the user's customized requirements;
13. The intelligent AGV transports the finished pen container back to the warehouse and store it in the finished product warehouse;
14. The order system informs the user that the pen holder is finished and ready for delivery.
4. Conclusions
The construction of intelligent manufacturing learning factory laboratory is based on the requirements of intelligent manufacturing curriculum system, which can provide students with more perfect curriculum experiment and practice conditions, and meet the needs of cultivating students' engineering
practice ability. The laboratory not only realizes the organic combination of course teaching and experimental teaching, but also perfectly integrates knowledge point learning and enterprise product production process. It plays a positive role in improving students' comprehensive practical ability, expanding students' innovative practice space, and improving students' professional composite skills training.

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