

THE CNC VIRTUAL AS TEACHING AND TRAINING AID OF CNC PROGRAMMING

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Abstract

CNC machine tools is the most important practical means of teaching and training of CNC Programming in Vocational High School. Its relatively-high price causes the incapabilty of the school for getting it, so the teaching of CNC programming in Vocational High School mostly doesn't use CNC machine. The effect is many students can't reach the standard competence of applied CNC programming.

The unavailability of CNC machine tools in teaching of CNC programming in Vocational High School is treated by using CNC Simulator. The CNC Simulator consist Virtual CNC, and CNC Machine Simulator. It's a media to simulate of NC Part Program execution. The simulation of NC Part Program execution are displayed tool path a machining process at monitor. NC Part Program has been simulated can be sent to unit control of CNC Machine Simulator.

Implementation of CNC Simulator in teaching and training of CNC programming begins from building CNC Virtual. The CNC Virtual is a software which provides a visual effect of environment of CNC machine in the monitor. The building uses Research and Development (R&D) method. Implementation of CNC Simulator in teaching of CNC programming shows; (1) the students are very interested and excited to use the virtual CNC which provides a visual effect of environment of CNC machine in the monitor, actively trying the simulation of numpad virtual in the monitor, inputting data on the panel virtual, and making simulation or execution of the CNC program at CNC Machine Simulator, (2) the students practice to make and execute the CNC programming individually in the classroom or outdoor class. (3) CNC Virtual can be used as teaching and training media classically (in classroom), individually learning, even e-learning.

Keywords: cnc-simulator, teaching-aid, cnc programming

1. Introduction

National Education Government had decided that Education Development concerns with three sectors, one of them is relevance and competitive education quality improvement. The improvement of relevance and competitive education quality is done by addapting the curriculum of education to the need of people which is dynamically develop. That addaptation must really exist in the form of teaching, guiding, and training. Teaching is for giving knowledge, guiding is for stimulating constructive behaviour, whereas training is for improving skills.

One of the sectors which develops fast, especially in the industries, is system of production process automation. Nowadays, almost all of industries is always expanding production process automation and replacing manufacturer tools which are used with machines and tools which can be controlled automatically for supporting the automation.

For improving the relevance and competitive education quality, this automation system is included to the curriculum, especially in the machine engineering education curriculum, starting from Machine Production department in the

Vocational School to the Machine Engineering department in the universities. However, including production automation system to the curriculum is not easy for many factors.

Stated by Indra Djati Sidi (2001 : 37), that based on the some education researches, teacher is one of the dominant factors which influences much learners success in transforming science and technology, also morality and ethics internalization. According to Winarni Surakhmad's opinion (Pannen, dkk, 1999 : 6), holding education needs certain requirement. Besides profesional teachers, it also needs cost and proper education infastructure. If education is held without considering the requirements, there will be bad condition which can cause the process not to be qualified and the learning goal will not be achieved.

Not-proper infastructure condition can be found often in the reality. The most is in the learning process of CNC pro-gramming, that is one of the automation, in the universities or machine engineering department of Vocational School.

CNC machine which is the main facility for forming competence of CNC operating and programming is less than the number of students, even many machine engineering departments don't have one.

The consequence causes learning process of CNC is held in group and in turn when operate the machine. For machine engineering departments which don't have one, the process is held without CNC machine. Those condition cause students don't have chance for having interaction to the machine then they don't have experience in operating machine that ability in making CNC program can't reach the standard.

Quality improvement of CNC learning can be done by giving chance as much as possible to each student for practising making CNC program and applying them to the CNC machine. However, to provide CNC machine as many as the students number needs high cost and not every machine engineering department is capable. Therefore, to fulfil the need of CNC programming learning, virtual reality CNC needs to develop.

Virtual reality CNC media is a computer program and when it runs, on the screen there will be two dimensions image of CNC machine completed with operating buttons resembling to the real CNC machine. Virtual operating buttons on the screen can have the function as the real buttons on the real CNC machine. This media is the representation of the CNC machine, functioned (1) to simulate buttons functions on the control panel, (2) simulate inputting CNC program (data input) as input data to the control system of CNC machine, and (3) simulate CNC program execution as animation of machine process in the CNC machine.

Problems in using virtual reality as CNC programming learning media are:

How is virtual reality development which can show the real environment visualization of a CNC machine on the computer screen?

How is the feasibility of the virtual reality as CNC programming learning media?

This article will explain; (1) building process of a virtual reality CNC which can perceive input and can react as the real CNC machine, (2) the result of that virtual reality CNC feasibility as CNC programming learning media.

Technology improvement, especially computer, should also be used in learning media. The using of computer in learning especially as interaction media and learning application, they are drill and practise, simulation, discovery, tutorial, problem solving, and games.

Computer use in learning activity, at least, has three purposes, they are cognitive, psychomotor, and affective. For cognitive purpose, computer can teach the concepts, principle, steps, process, and complex calculation. Computer is also able to explain that concepts simply by using combination of animated audio and visual so it will be suitable for independent learning.

For psychomotor purpose, computer is also able to serve learning process which is presented in the form of games and simulation which are so good for creating work condition. Some examples are; simulation of aeroplane landing, simulation of war in the worst condition, etc. For affective purpose can be done when the program is designed well by giving sound or video clip which can be a trigger. Then, behaviour learning/affective can be done by using computer.

Generally, there are three kinds of simulation. One, interactive and physical simulation. Physical simulation refers more to the physical object simulation for replacing the real system. This physical object is often chosen for it is smaller or cheaper than real system or objects, as the flying simulator.

Two, computer simulation. Computer simulation is an effort to duplicate real situation in a computer, so the situation can be learned for watching how it works. By changing variable, possibility of prediction can be made about the behaviour of that system. Three, simulation in training. Simulation is often used in the civil and military training. This, generally, happens when the cost is high or it's too dangerous for allowing training participants to use real tools in the real world.

Simulation about real environment which is made by computer, and user can have interaction with the result which shows the content of reality environment is called virtual reality. Virtual reality is an human-computer interaction format where a real or imaginative environment is formulated and the users can be connected and run that world. In the most successful virtual environment, the users feel that they really exist in the simulated world and that their experiences in the virtual world is equivalent to what they experience in the real environment.

Virtual reality can be applied in many sectors. In the engineering and scientific research, virtual environment is used visually for identifying everything happens to the physical world that is in the observation. Training for work in the dangerous environment or with expensive tools is better done by using simulation. For example, pilot practises by using flying simulation. Virtual reality may let medicals for practising the procedure of new surgery to the imitation human.

One of the senses which is often used for getting information from the environment is seeing sense. Seeing sense is used more often than others in processing information. Many psychology researches show that there are more information can be understood when it's served in the visual form than in nonvisual form.

Training by using virtual reality can reduce the cost compared with common training. Need of

expensive training tools in the real laboratory, or additional tools for training can be eliminated. The advantages of using virtual reality as training tools are; (1) reducing duration of the training in the real environment, (2) can hold a training in the very dangerous condition, (3) save more cost to the same training, (4) providing unlimited access to the expensive tools, (5) omit the cost for going to the training center, (6) cost of repairing/replacing of expensive machines can be eliminated.

CNC (Computer Numerical Control) machine is a machine which of the operating process is controlled by CNC system, that is a control system which of the controlling is done by using command in the form of alpha-numeric-code. Set of commands in the alpha-numeric-code and used for controlling machine operation of a product is called CNC program.

2. Discussion

Development of CNC virtual reality is done by using research and development method. As the reference of development is CNC lathe machine training type EMCO, made by EMCO Maier Austria. CNC virtual reality is developed by using Visual Basic 6 software, with Windows XP Operating System. The result is a computer program which can present physical environment visualization of CNC machine on the computer screen. Physical environment of CNC machine which is displayed is control panel, monitor, and clamping of work-piece on the machine. Look at Figure 1.

View design of the control panel is made resembling to the control panel of CNC machine TU-2A. This aims the situation and feeling of the user is same as they are in front of the real control panel of CNC machine TU-2A. Besides feeling comfortable in using that also feeling the sensation of the challenge as they use the real machine.

Not all of the function of visualized panels and buttons on the control panel can be simulated, some are only images or accessory for giving sensation of reality and interactive sensation. Switch and buttons which of the function can be simulated are:

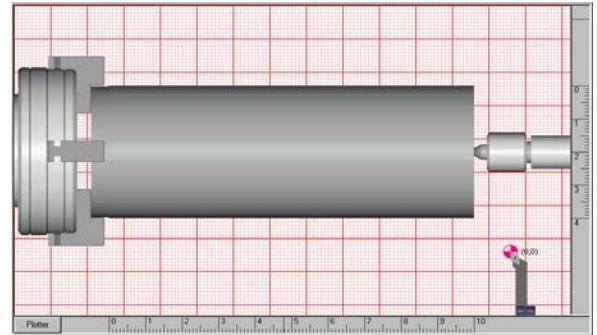


Figure 1. Display of CNC Virtual Reality on the Monitor Screen

1. Main switch. This switch can be simulated in two positions, those are "0" and "1" (ON/OFF). The function of main switch is for turning on and off the CNC machine.
2. Main spindle switch. This switch can be simulated in three positions, those are "0", "1", and "CNC". The function of the switch is for turning the main spindle whether in the CNC operating function and manual operation function.
3. Manually operating button, that is button for moving the chisel on the X and Z axis manually.
4. CNC operating button, that is Numpad for writing the code and number (NC program) which is made on the computer screen and put in the memory, and buttons functioned in the program editing, those are DEL for deleting written character, REV for moving the cursor to the previous line, and FWD for moving the cursor to the next line.
5. Start button, for starting running the written program.
6. Animation window, in this part, animation of chiseling is shown. Animation is constructed by some main components and supporting components. The main components are; (1) chuck, (2) workpiece, (3) live center, (4) and tools holder.

Typing buttons on the monitor screen (virtual buttons), those are numeric buttons "0" to "9", "INP", "DEL", "REV", and "FWD", can be functioned to write the CNC program on the virtual monitor. It goes the same as "START", and main switch ON/OFF can be operated identical to that button on the CNC machine. One of the excess of the developed product is being able to save written CNC program, recall saved program for being activated and shown on the screen.

Besides, written CNC program on the writing window of CNC program also can run. Written program is the input which can be processed into output. response or the output of the given input, is visualized as the run of CNC program reading by machine unit control. The run of CNC program can

be observed by simulating the move of slicing tools on the animation window on the computer screen.

Response from the input which is command (code) of CNC programming can be simulated by using animation of relative lathe chiseling to the work stuff. CNC programming code which can be processed and animated are still limited, it is limited only for command code which is often used in the beginning of making CNC program training for CNC machine TU-2A. Those command codes are: "G00", "G01", "G02", "G03", "G92", "M03", "M05", AND "M30". The animation result of the run of the CNC part program can be seen in the Figure 2.

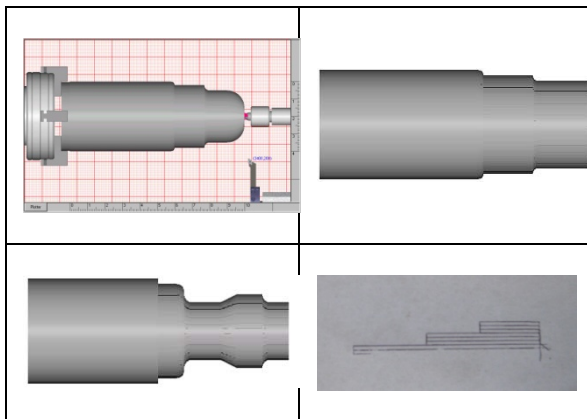


Figure 2. The Animation Result of the Running the CNC Part Program

Can be concluded that this research succeeded developing CNC virtual software, that is a computer program which can present the visual effect of CNC machine TU-2A operating principle on the computer screen. The program can initiate, translate, and respond to each input well. Respons (output) as the result of initiation and translation from the input in the form of command codes in NC program, visually in not different from the respons which is done by the real CNC machine if the machine system control gets the same input.

Although in the product development, especially the view is successful, the development produk has not been able to show the animation of program run for all command codes. Effort for developing translation of CNC program to the animation has been able to be made though it's limited to the some basic and simple codes, so the new product can be used for training basic CNC programming.

CNC virtual reality is able to fulfil the criteria as a learning media in two things; (1) product is able to give the image and visual effect of operational function of CNC machine so it can be a media which can give experience to the users, and (2) the product is able to explain clearly about the concepts of learning materials so it can help the users in understanding learning materials well.

Based on the product criteria as the media which visualize CNC machine, it can be stated that the product has good view, especially the view format, matching shape and colour, and the suitability to the control panel of the real machine. Besides, the product which is developed is also easy to be used/operated, and be able to build interaction well between the users and used media. Therefore, the product can be a tools of making CNC program training, tools of direct interaction, and tools which let the users learn independently well.

Based on the criteria as the media which can help explaining clearly the concepts of materials, it's known that the product which of the materials are developed is able to explain clearly the concepts of materials well, for the visualized materials have suitability to the learning materials of NC Machine, for example the materials about programming code, and making NC program. Besides the suitability of taught materials, there is also suitability between the chisel moving animation done by the product to the real chisel moving in the CNC machine. This causes users become easier to understand materials of programming concept, for the concepts can be directly visualized by using animation on the developed product.

3. Conclusion

1. CNC Simulator with Virtual CNC which can show the physical environment visualization of CNC turning machine; control panel completed by accessories and operating buttons, clamping system of work stuff, lathe chisel, operation function simulation, and the animation of machine process from the executed NC program, be able to generate students individually to be active in making NC part program and running that NC part program on CNC virtual and CNC machine simulator whether inside and outside the classroom.
2. For being used as teaching aid of CNC programming, CNC simulator which is developed has completed the requirements as education media, for:
 - a. Having view quality, navigation, operating, being able to stimulate users to keep interacting with CNC virtual.
 - b. The contents of CNC Simulator with virtual CNC are good, especially for the basic elementary of CNC programming. The quality of content, this media is able to show the simulation of tool-path as the result of the running of CNC part program on the basic program code, where the users are able to combine the program codes which is put in as well as they want for seeing the result of the given input.

- c. CNC simulator can be used as the teaching, learning, and training media of CNC programming in the class, individual, outside the classroom, and by e-learning.

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