Research paper on computer numerical control methods used in manufacturing

Business, Manufacturing

Computer Numerical Control

Computer Numerical Control (CNC), initially known as Numerical Control (NC), is the process of automating operations of a manufacturing machine depending on coding of letters, numbers and special characters. It involves the operation of conceptually programmed commands on a storage medium. It uses computers on a very large scale of the control where a set of coded commands or instructions are used to execute operation. The instructions are referred to as programs which are translated into electrical signals for input to motors that run the machines (Hauth 2011). The process of creating programs using numerical control is known as computer aided programming. This is where end-to end component designs are highly automated using computer aided design (CAD). The ideology behind computer numerical control was applied long ago in the nineteenth century where it was used to control textile looms and play pianos. However, it has been largely been modified and changed to suit the modern technological aspect. The focus of this paper is discussing the basic concepts of the computer numerical control as well as the hardware configuration used to develop the program.

A computer numerical control machine is a soft wired or rather uses software to encode the machine functions into the computer at the time of manufacture. These functions are stored in the computer's memory known as the ROM (read only memory). The CNC machine is basically a modification of the numerical control machine where some features have been added such as the computer. The computer added is referred to as the machine control unit (MCU) (Kief, 2011). The NC uses hardware or rather the function is controlled using physical electronic elements built into the controller. The

MCU (machine control unit) consists of an alphanumeric keyboard that enables direct or manual input of data also referred to as MDI of partial programs. These programs are then stored in the random access memory part of the computer storage. This is done in order to allow replay, editing and processing by the control (Krar 2001). The random access memory only stores data temporarily and thus these programs can be stored on other devices such as the punched tape, magnetic tape or even magnetic disks. However, these devices have been developed and now they can be stored on hard disks, CD’s or flash drives. The current machine control units or rather computers have screens/monitors that display the computer numerical control program and even the paths formulated. This will enable rectification of any errors or modification.

The current computer numerical control machines being used have a wide variety and thus it is next to impossible to specify on any particular types. However, this paper will focus on the main methods of CNC programming used in manufacturing. The basic methods of developing CNC programs involved include; manual programming, conversational programming and CAM programming. Manual programming involves executing commands physically which is an important requirement for all CNC programmers (Kief 2011). This can be related to carrying out arithmetic calculations whereby students are required to understand the performance of arithmetic calculations manually. After getting the concept, tools such as calculators can be used to evaluate the calculation procedure. This method is convenient as it eradicates errors in most instances and is regarded easier than the other methods.

The next programming method involves conversation. It requires the programmer to check whether various inputs are correct in accordance to how the program was created. After this, most conversational controls even reveal to the programmer a tool path plan of what will take place during the actual process. Most conversational controls also regarded to as shop-floor; provide a convenient way of generating part programs for a single machine. The programming process requires conversationally programming at the machine only. The current CNC machines are able to operate in a conversational mode and even accept externally generated G-code programs (Krar 2001). This method is recommendable for companies which do not employ a large number of workers. Many large manufacturing companies today adopt this method as a way to keep the computer numerical control machine operating for much longer. These companies employ staff members of support to maintain the CNC machines running. One person prepares tools for the next job while the current job is still taking place. The other person makes the work holding setup while another one is writing and verifying the program. The operator in this case is only expected to load and offload work pieces.

The basic factors that determine if a conversational control is an advisable adventure are the operator incentive and the number of different pieces of work that need to be programmed. The operator incentive requires the person operating a conversational control to be highly motivated as he/she has a huge effect on the success of the company. Through motivation, conversational programmers can perform even better than manual programmers and that is why they are mostly preferred in small companies

(Kief, 2011). The other factor that affects the benefit of using conversational controls involves the number of different pieces of work to be programmed. A limited number of pieces of work in the computer numerical control is not convenient for conversational programming.

The third method of programming used in manufacturing is called the CAM programming. This method allows computer numerical control programming to be achieved at higher levels. It helps the programmer in three basic areas. It prevents the programmer from carrying out mathematical calculations; it also facilitates programming in different types of machines using the same basic language and lastly it assists in various basic machine practicing functions. The CAM programming system requires the programmer to have a computer that will enable them to prepare the computer numerical control program. It will also formulate a G-code level program similar to the CNC program that has been created using manual techniques. After the program has been completed, it will be transferred directly to the computer numerical control machine tool (Krar 2001). The CAM system can be categorized into two basic categories; the word address CAM system and the graphic Cam system. The word address system involves programs written in a language that is similar to BASIC, C language or any other computer programming language. They require that the program should be written in a similar way to the manual program. Well these programs are the most powerful CAM systems but also the most difficult to use (Smid 2010).

The other category is the graphic CAM systems which are commonly programmed interactively. They allow the programmer to have visual feedback at every step of the programming task. This is important as it

makes the graphic CAM systems easy to work with. There are several ways in which CAM system programming should be done. The first steps require the programmer to give some general information which includes documentation information such as part name, part number, date and program file name. In this case the programmer might also be required to place the graphic display size foe scaling purposes, rough stock shape and material for the piece of work (Smid 2010).

The second step involves defining and trimming geometry. This is where the programmer is required to use some geometry definition methods to describe the shape of the piece of work. The CAM system allows the programmer to basically show every geometric element as it is described. The programmer will also be able to choose from a variety of defining methods and select the one that makes it easier to define the work-piece shape. After defining geometry, the geometry will be trimmed to match the actual shape of the work-piece to be machined as required by the CAM systems. Trimming is done to the lines that run off the screen in both directions in order to form lines segments while circles are trimmed to form a radius (Hauth 2011).

The third step is bypassing the geometry creation. This step requires that the drawing created in the computer aided design to be to scale. It also requires that there will only be a portion of the CAD system drawing that will be useful to the CAM system programmer. The computer aided design system engineer should give minimum consideration to the location of the CAM system programmer’s program zero point. The origin of the drawing can be the drawing’s lower left hand corner. Most CAM systems expect geometry to

be in a particular format for machining (Smid 2010).

These methods are effective for manufacturing and should be adopted in companies. The computer numerical control machines used in manufacturing portray various advantages and disadvantages. The advantages of these machines are that: they can be used continuously throughout the year round and only need to be switched off occasionally for maintenance purposes. The other advantage is that these machines are programmed with a design that can be manufactured over and over again. In addition to this, people without any training or less skilled can operate computer numerical controls unlike other machines such as the manual machines (Hauth 2011). These machines can be programmed using advanced design software to enable them manufacture products that cannot be made manually. They can also be updated by improving/ updating the software used to drive them. Another advantage is that virtual software available in the machines enables training in the use of computer numerical controls. The current design software enables the designer to formulate their own manufacturing ideas and only one person is needed to supervise many computer numerical controls since once they are programmed they can be left to operate by themselves. Computer numerical controls only require one skilled engineer to make multiple components of the same kind (Hauth 2011).

Computer numerical controls used in manufacturing also have various disadvantages in the application. One of them is that, these machines are very expensive although prices have subsidized over the years. The operators of these machines only need the basic training techniques to enable them to operate and supervise several machines. Similarly, fewer

workers are required to operate CNC machines. The school syllabus used today does not entail the teaching of students on how to operate manual machines which is a basic requirement.

The main tips to be used by manufacturing companies in order to grow their machining businesses are: they should develop partnerships, target their segment of the marketplace, avoid rushing for expansion, diversify according to demand, remain open for any new form of technology, react to any form competition, ensure flexibility in the multi-stage processes, they should integrate their operations, initiate scalable growth and add value step by step.

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