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A general algorithm for drilling holes lying in a matrix

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Abstract

Canned cycles provide a programming method of the motion of an axis of a CNC machine to accomplish repetitive machining operations, using the standard G-code. However, the standard canned cycles are limited in number and capability. For this reason, modern CNC units have the capability of creating similar cycles, called user-defined cycles, for different machining operations. The creation of user-defined cycles is not a simple task and needs much more technical experience and a lot of trails. This paper describes an investigation to develop a general programming algorithm in G-code for drilling holes lying in a matrix in an easy way. This algorithm may be used for creating user-defined cycle and/or subroutines for drilling holes lying in a normal matrix, a staggered matrix, a single row, and/or column. This programming algorithm is useful for machining boilerplates, drum and trammel screens, and separators. For testing the capability of this developed algorithm, several work-pieces are machined with satisfactory results. An example of such machined pieces is presented. The developed algorithm saves about 99% of the time required to prepare the part program in addition to reducing programming error.

Keywords: CNC machining; NC programming algorithms; Canned cycles; User-defined cycles

1. Introduction

Numerically controlled machine tools first appeared in industry around 1957. They have greatly increased the capabilities of machine tools as well as many related computer technological capabilities. Numerically controlled (NC) machines provide many advantages for today's manufacturing world. One of the biggest advantages is the reduced scrap rate. Errors due to start and stop operations, and operator fatigue are less likely to occur on NC machines. In one setting, NC machines can often perform a work that would normally require several conventional machines. Thus, big improvements in production planning and reduced machine operating hours can occur. And with fewer jigs and fixtures needed, storage space requirements are greatly reduced. The inspection process is also reduced, once the first machined part has passed inspection, minimal inspection is required on subsequent parts. Overall tooling costs are also lowered due to less need for complex jigs and fixtures. With quicker changeover times needed between operations, reduced lead-time between jobs is possible. Another big advantage of NC machines is their ability to make complex machining operations much more easy with remarkably consistent, and high-quality results due to advanced machine controls and programming capabilities.

Today, many opportunities will exist for individuals to develop programming algorithms for the control and operation of these machines. The knowledge of machine process-type skills along with the basic computer skills, especially in numerical controls used in manufacturing applications, are the minimum requirements. Generally an NC program, regardless of machine type, consists of the heading, machine tape information, and operation information. Machine tape information contains all

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information necessary for proper machine operation, such as function codes. This information will vary depending on the particular machine tool being used. The functions controlling NC are a part of the machine tape information. These functions consist of the following: sequence numbers; preparatory and miscellaneous functions; X, Y, and Z coordinate information; spindle speed; feed rate; and depth selection. Each word consists of alphanumeric codes, which relates to a specific register in the machine control unit and causes an appropriate machine tool movement or action to occur. The most famous preparatory function or cycle code used in CNC programming is the G-code, which determines the mode of the operation of the system. This code is widely used in the canned cycle. A canned cycle is a combination of machine moves resulting in a particular machining function such as drilling, milling, boring, and tapping. A control with canned cycles may be more expensive than one without, but there is a definite gain to offset this cost. By programming one cycle code number, as many as seven distinct movements may occur. These seven movements would normally take at least six blocks of programming on a control without canned cycles. Using canned cycles, it is possible to realize savings of up to 50% in programming time and up to one-third data processing time. Most control manufacturers today have both canned and non-canned

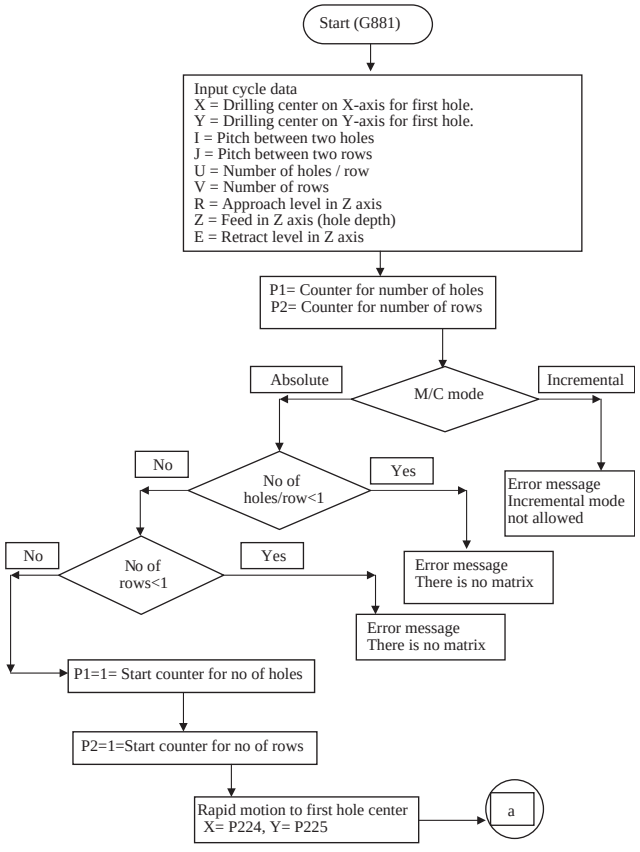

Fig. 1. A general algorithm for user-defined cycle G881.

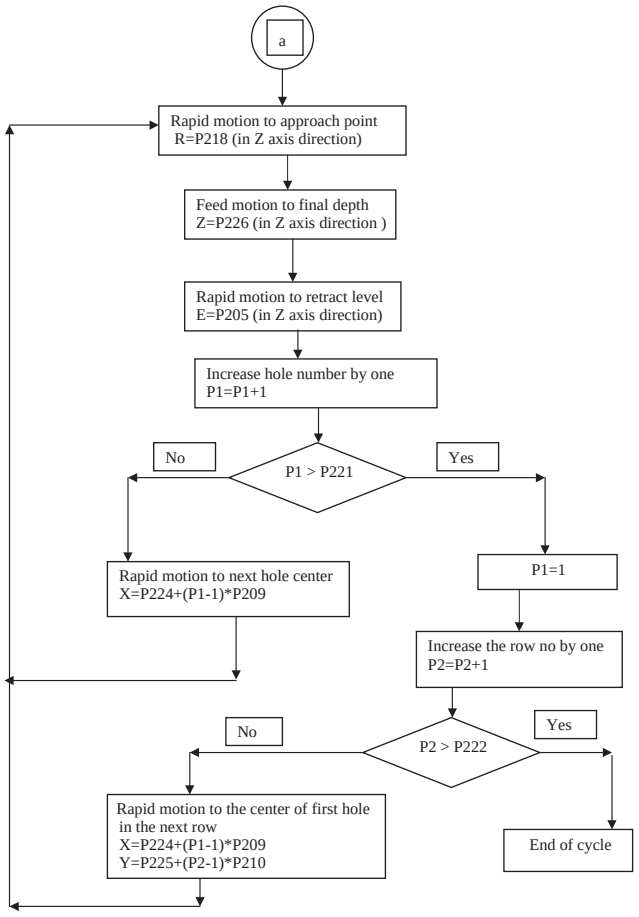

Fig. 1. (*Continued*)

cycles as part of their standard control package [1,2]. However, the standard canned cycles are limited in their number and capability. For this reason, modern CNC units have the capability of creating similar cycles, called user-defined cycles, for different machining operations. The creation of user-defined cycles is not a simple task and needs much more technical experience and a lot of trials. The programmer of these machines will face many difficulties, as there is neither detailed description of programming methods in literature nor in their manuals. A user-defined cycle is a global subroutine developed by the user for any special manufacturing process. This developed cycle can be stored in the part program storage memory with the other stored programs. User-defined cycles are modal subroutines, which get called every block, similar to canned cycles. Comparing the regular CNC programming method, to a user-defined cycle (as shown in Application part (3)) a savings of 99% in programming time was realized along with more than two-thirds in data processing time [3–7].

This paper describes an investigation to develop a general programming algorithm in G-code for drilling holes lying in a matrix. This algorithm may be used for creating user-defined cycles or subroutines for drilling holes lying in a normal matrix, a staggered matrix, a