Computer Aided Manufacturing

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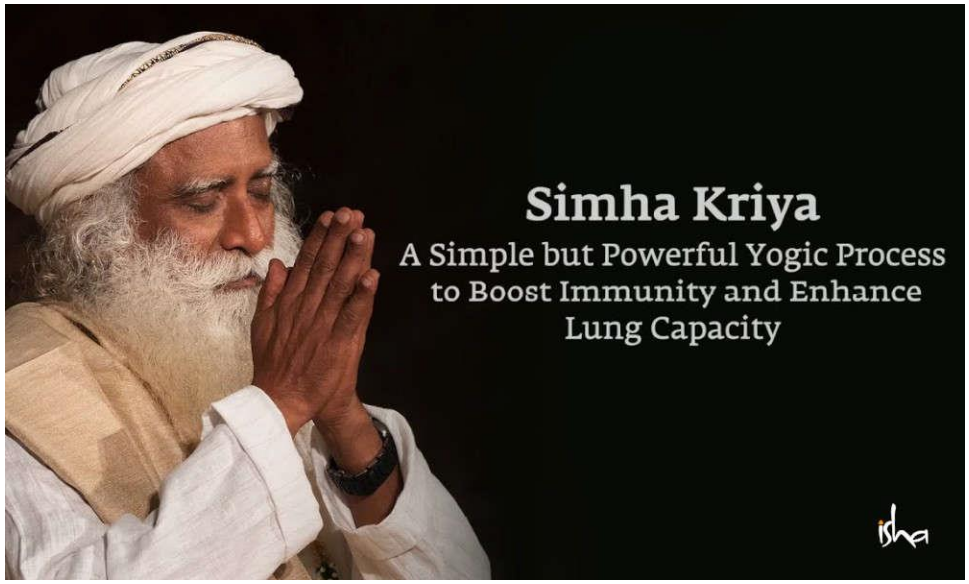
Topic :

CNC controller and Interpolator

Prerequisites Knowledge

- Control elements
- Drawings and coordinates

Immunity Boosting Breathing



1 min

Recap and review of previous class

5 mins

Evocation

2 to 5 mins

General Objective (GO)

- Students will be able to understand the role of controller and interpolations in CNC machines and analyze the two types of interpolation for curve fitting.

2 mins

Specific Objectives

- *Students will be able to*

- Identify the importance of CNC controller. (U / C) (E)
- Explain the three components in CNC controller. (U / C) (E)
- Exemplify the two types of interpolators. (U / C) (E)
- Differentiate the linear and circular interpolator based on accuracy and smoothness of curve. (An / C) (E)

35 mins

CNC CONTROLLER AND ITS IMPORTANCE

- The CNC controller is the brain of a CNC system.
- A controller completes the all-important link between a computer system and the mechanical components of a CNC machine.
- The controller's primary task is to receive conditioned signals from a computer or indexer and interpret those signals into mechanical motion through motor output.

- There are several components that make up a controller and each component works in unison to produce the desired motor movement.
- The word “controller” is a generic term that may refer to one of several devices, but usually refers to the complete machine control system.
- This system may include the protection circuitry, stepper or servo motor drivers, power source, limit switch interfaces, power controls, and other peripherals.
- Owners, operators, designers, and builders of CNC devices should understand the tasks performed by these components and how they affect machine performance.

MODERN CONTROLLERS

- Today, with the use of powerful microprocessors and computer systems, the NC controller now communicated directly to a computer system with a real time link. Today this is the standard CNC controller.
- The controllers today do far more than drive motors. Some controller systems have the capabilities to control spindle speeds, coolant flow, and other peripherals.
- Modern controllers still require operators to create a program for the controller to follow. Operators today receive help from Software such as Computer-Aided Design (CAD) packages and Computer-Aided Manufacturing (CAM) software along with the controller software to create the necessary numerical code such as G-code.
- The CNC controllers' today range from professional standalone systems, with their own keyboard and user interface, to relaxation CNC controllers that require a personal computer.

CNC CONTROLLER COMPONENTS

Components

There are three primary CNC controller components that make up a CNC controller

- power supply unit,
- circuitry protection system,
- motor driver.

Power Supply Unit

- Plug Small Drive to CNC machine Internal power source – Flash drive ex Pen drive
- Plug Large Drive to CNC machine External power source – Printer
- This condition means that you have to plug that device into the computer as usual, but you also have to plug a second line to an auxiliary power source, such as the 110V outlet on your wall.
- The same conditions are true for CNC devices. They require a low-voltage communication line, through which the computer tells the machine what to do, and a power source that provides the power for moving, cutting, and other such operations.
- A power converter, usually referred to as the "power supply unit (PSU)," is often used to change the form of the supplied power from alternating current (AC) from the power grid, to direct current (DC) that is more easily used by the machine's drive motors.
- The power supply handles large voltages and currents that could be harmful to the NC circuitry. Therefore, the power source, motor drivers, and motors are often separated from the computer with a circuitry protection system that isolates surges in electrical power.

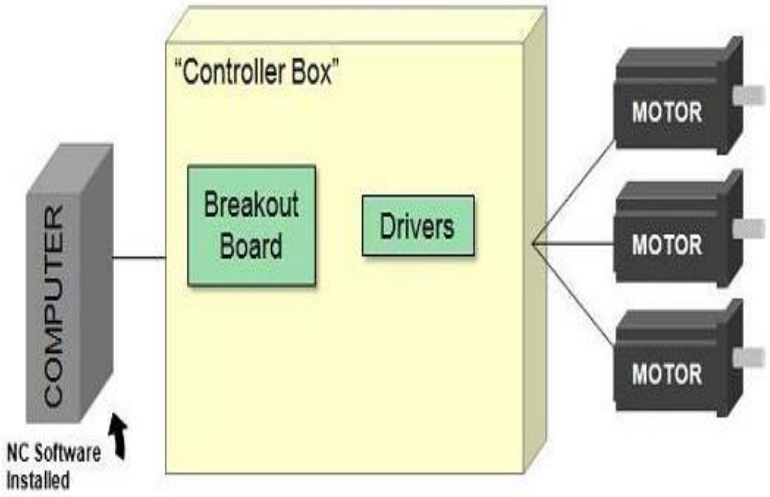
The Circuitry Protection System

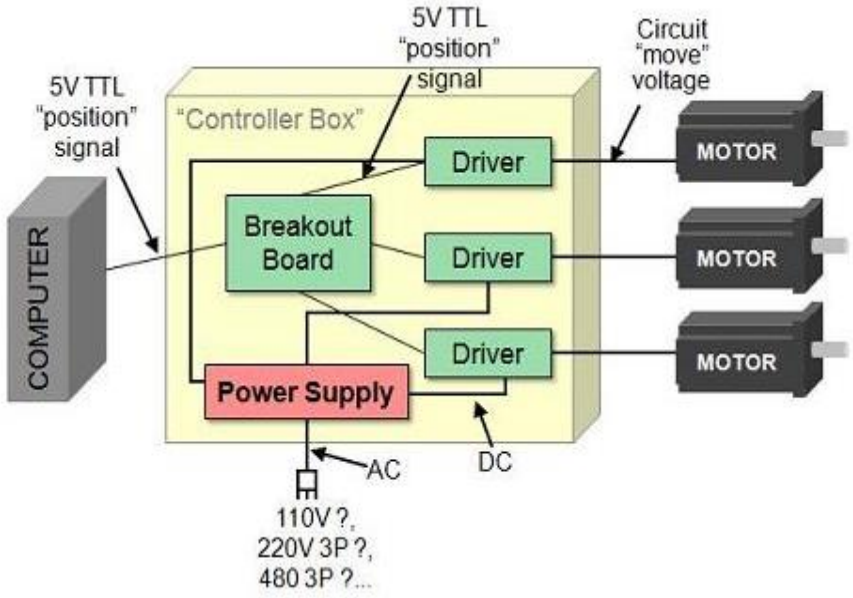
- The circuitry protection system contains a **breakout board** to isolate signals from the computer
- Distribute the signals to the desired drivers, and also allows easy hook up of peripherals such as **limit switches** that feed information back to the computer.
- **Fuses** are also part of the circuitry protection system.
- **Fuses** could save the equipment in case of **electrical spikes, shorts, or faulty wiring.**
- A low-voltage communication signal passes from the computer through the breakout board unchanged to the motor drivers. This isolated your computer from the CNC controller circuit but allows the signals to carry through to your motor drivers.

Motor drivers

- The motor drivers receives the communication signal and then coordinates pulses of the desired current and voltage to produce the movement in the drive motors.
- The motor drivers may communicate position information one way to the motor (open loop system), or send and receive position information(closed loop system), depending on the user's choice of drive system.
- More on these systems may be found in the drivers sections.

CNC CONTROLLER COMPONENTS SETUP





INTERPOLATOR & ITS FUNCTION

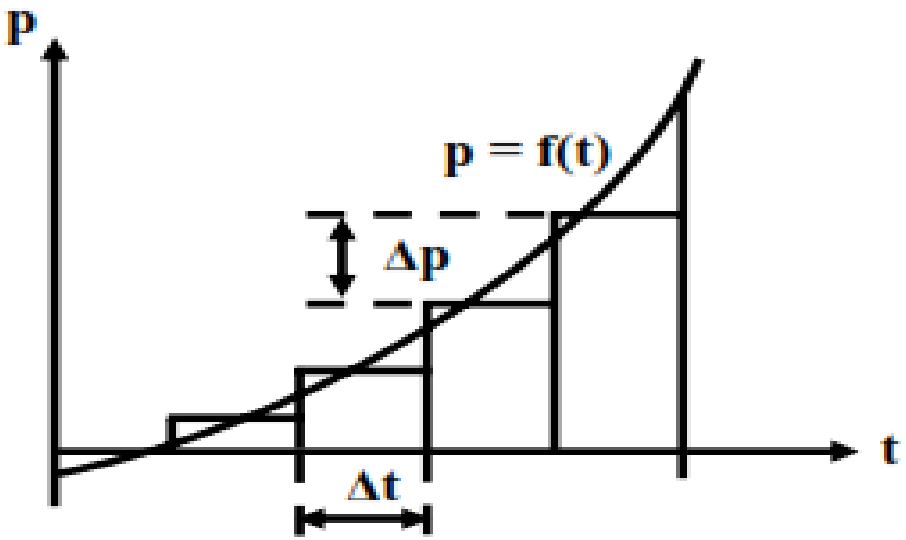
- **Function of interpolator** in a CNC machine controller is to coordinate feed rates of axes

CONTOUR GENERATION BY INTERPOLATION

- In contouring systems the machining path is usually constructed from a combination of linear and circular segments.
- It is only necessary to specify the coordinates of the initial and final points of each segment, and the feed rate.
- The operation of producing the required shape based on this information is termed interpolation and the corresponding unit is the "interpolator".
- The interpolator coordinates the motion along the machine axes, which are separately driven, by providing reference positions instant by instant for the position-and velocity-control loops, to generate the required machining path. Typical interpolators are capable of generating linear and circular paths.

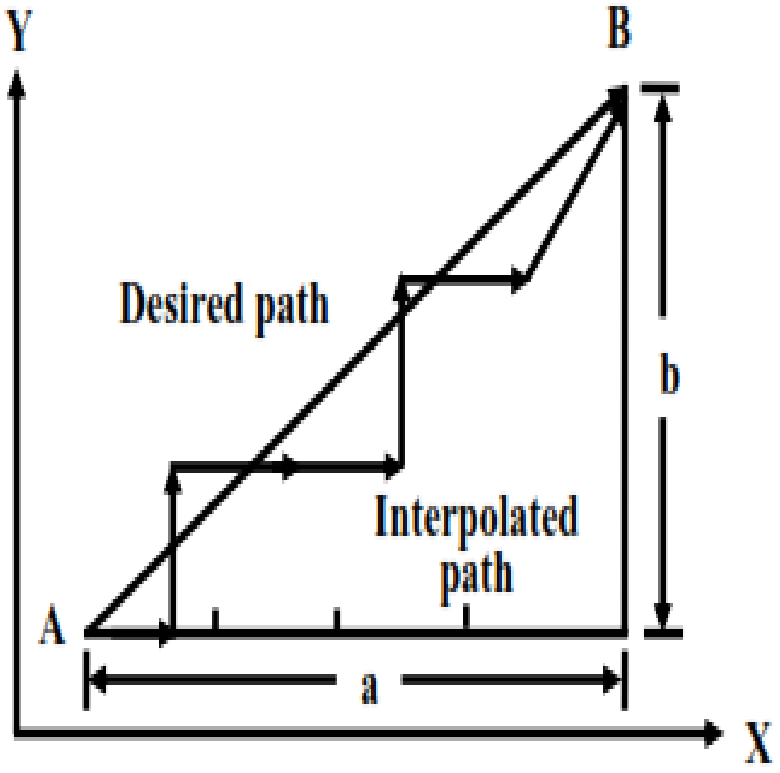
DDA ALGORITHM
(Digital Differential Analyzer)

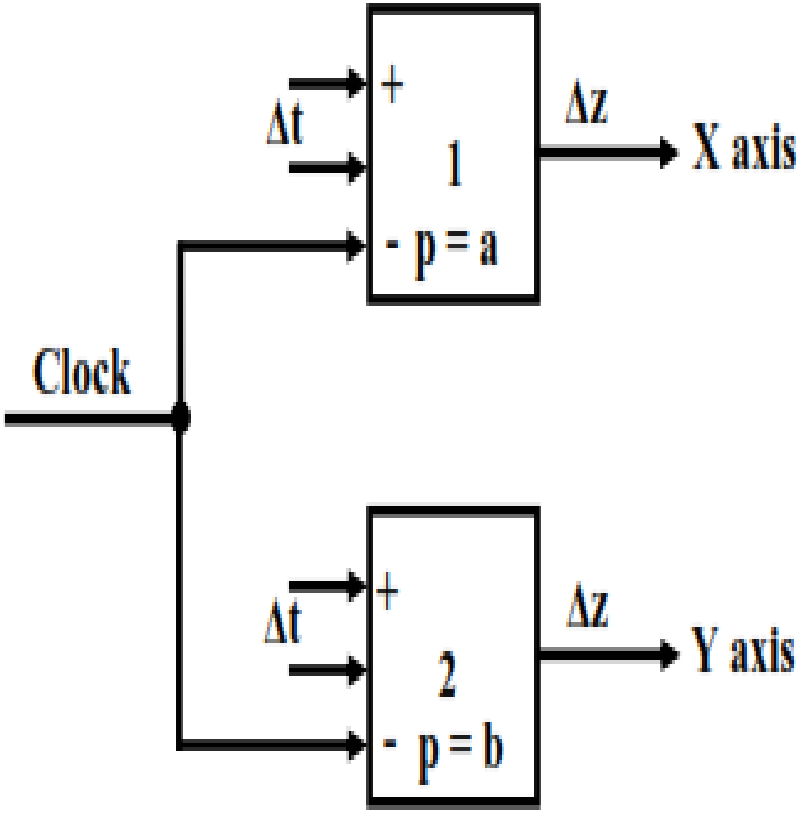
- Lines, triangles, polygons and Quadratic curves
- DDA is essentially an algorithm for digital integration and generates a pulse train varying in frequency.
- Digital integration is performed by successive additions using an Euler approximation method shown in Fig.



LINEAR REFERENCE PULSE INTERPOLATION

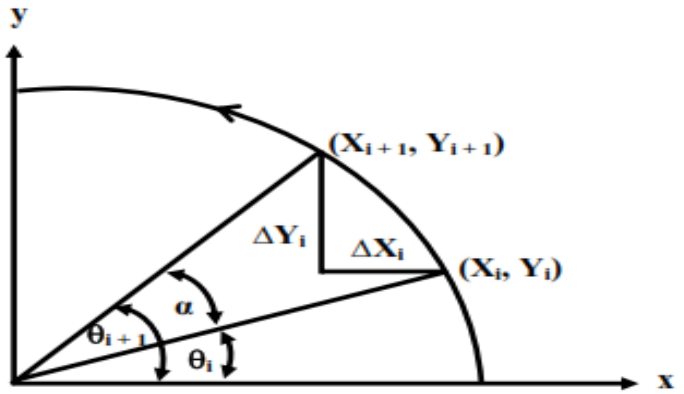
- The ability to control the movement along a straight line between given initial and final coordinates is termed linear interpolation.
- A 2-D linear interpolator supplies velocity commands, in pulses per second, simultaneously to two machine axes, and adjusts the ratio between the pulse frequencies depending on the slope of the trajectory.
- For example, consider the case in Fig, where a straight path has to be cut between points A and B.
- Note that movement along each axis takes place by 1 BLU for every reference pulse along the axis.
- The interpolator therefore has to provide pulses to each axis at definite rates (say, from Figure, a and b pulses per second, along X and y axes respectively) with respect to time.


Y
B
Desired path
b
Interpolated
path
A
a
X

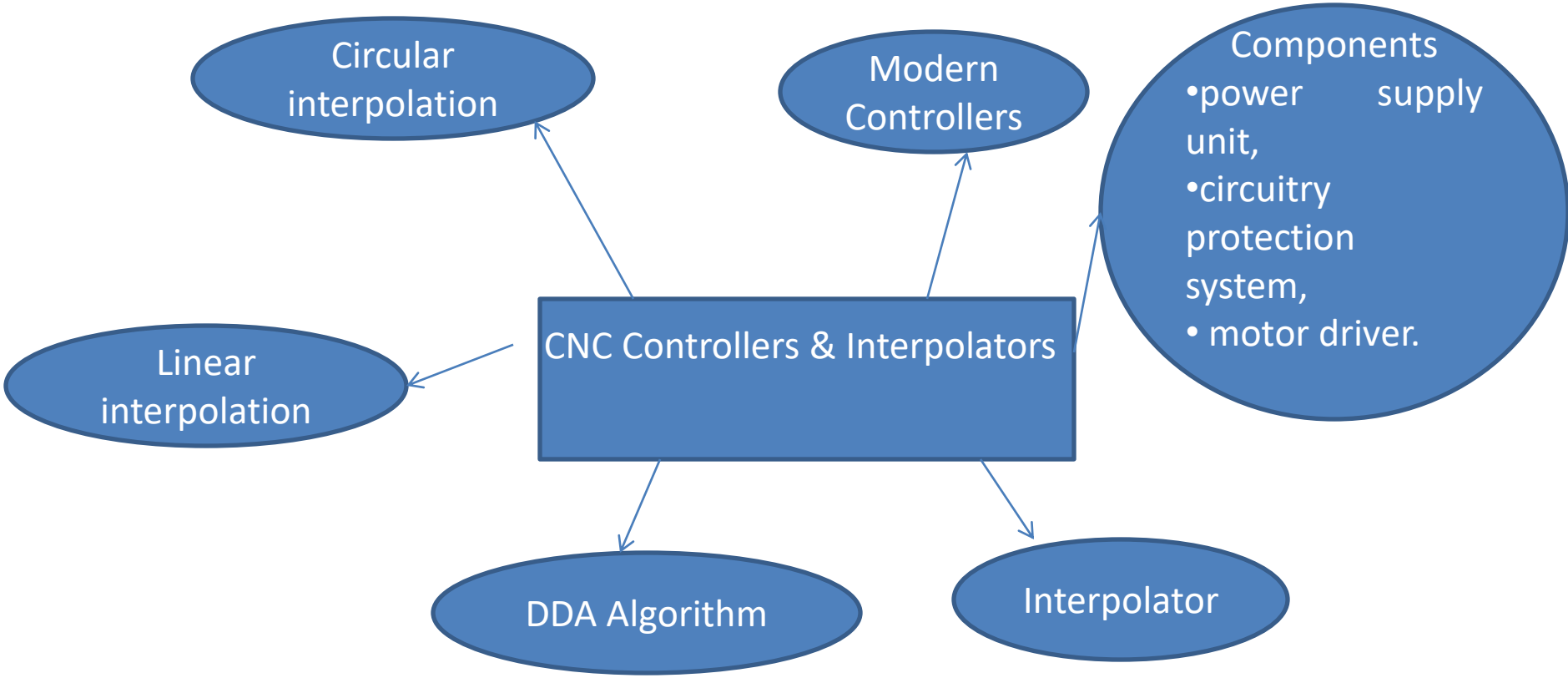

Δt
+
1
- p = a
Δz
X axis
Clock
Δt
+
2
- p = b
Δz
Y axis

CIRCULAR INTERPOLATORS

- In reference pulse systems a pulse train of varying frequency is output to the servo control module.
- The servo system for an axis causes an incremental displacement along the axis, for each pulse. As mentioned before, this can cause a speed limitation for the CNC, depending on the execution speed of the interpolation loop.
- In contrast, in reference word interpolation systems the maximum velocity is not limited by the execution speed of the processor.
- The interpolation subroutines continuously provide velocity set points to the servo system, which realizes it through the drive.
- In a circular interpolation using the reference word method. This require the use of a "controlled speed drive" rather than a "position servo".
- In circular interpolation, at a constant tangential velocity, *V* and radius *R*, the axial velocities.



Concept Map


Circular interpolation
Modern Controllers
Components
•power supply unit,
•circuitry protection system,
• motor driver.
Linear interpolation
CNC Controllers & Interpolators
DDA Algorithm
Interpolator

Discussion

10 mins