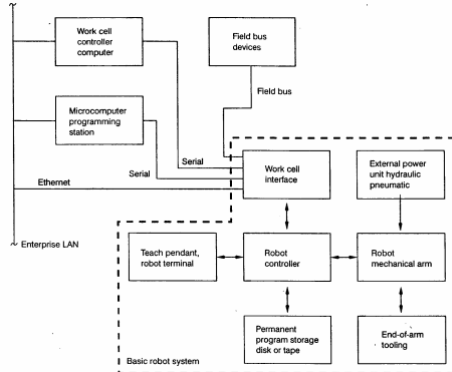


Architettura di controllo



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p.1

Modalità di programmazione

Need to find the Inverse Kinematics

Tipi di controllo

- Point-to-point
- Linear interpolation
- Circular interpolation
- Complex curve interpolation
 - B-spline
 - Cubic spline

Link Space

n variables
($q_1 \dots q_n$)

Forward K

Tool Space

6 variables
(x, y, z, q_x, q_y, q_z)

Inverse K

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Modalità di programmazione

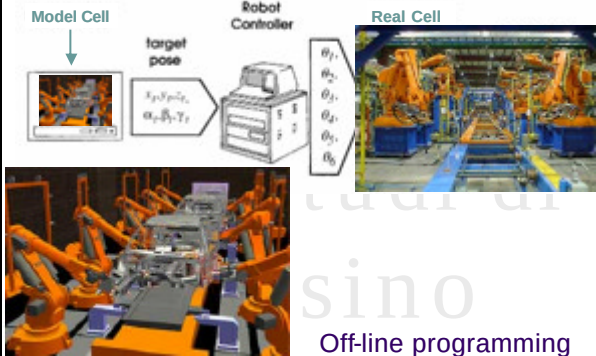
- On-line programming
 - skill
 - down-time
 - accurate
- Off-line programming (OLP)
 - graphic tools
 - less down-time
 - less accurate



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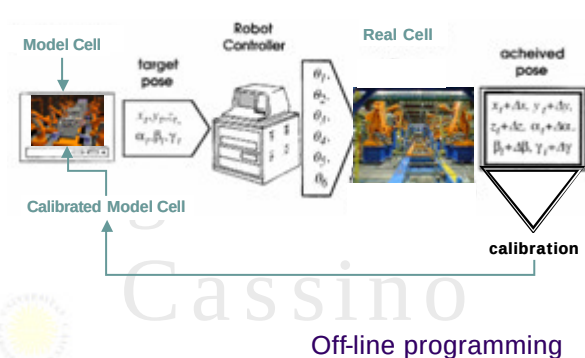
Modalità di programmazione



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Modalità di programmazione



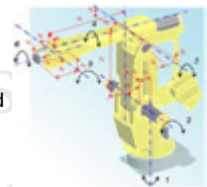
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Modalità di programmazione

Calibration

- Significato
 - Mastered to zero encoder values
 - consideration for all geometric and non-geometric parameters
 - for high absolute accuracy applications
- Processo di calibrazione
 - identifying (i.e. measuring) the accurate geometry of the robot
 - compensating the robot's programmed positions considering the actual geometry to eliminate the impact of manufacturing tolerances for that particular robot



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Modalità di programmazione

• Off-line programming

- vantaggi
 - Effective programming of program logics
 - calculations with state-of-the-art debugging facilities
 - Process support tools for instance selection of welding parameters
 - Verification of program through simulation and visualization
 - Well documented through simulation model with appropriate programs
 - Reuse of existing CAD data
 - Cost independent of production
 - Production can continue while programming
- svantaggi
 - Investimento iniziale nel software e per costi/tempi di apprendimento
 - Necessità di calibrazione

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Modalità di programmazione

• A robot program consists mainly of two parts

- Locations
 - (position and alignment)
- program logics
 - (controller structures, communication, calculations)
- **hybrid programming**
 - OFF LINE
 - The program logics
 - effective debugging and simulation facilities are available
 - The major part of movement commands
 - reuse of CAD data and interaction of the programmer
 - ON LINE
 - Movement commands to locating the placement of the piece in the robot's workcell

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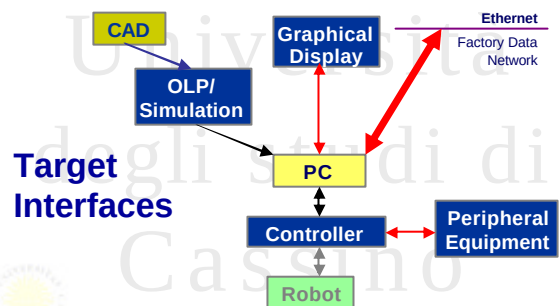
Implementazione cella (1)

Interoperability Costs

- Installed robot systems cost 3 to 5 times the amount of the robot
- Software integration costs are at least 25% of total
 - much of that cost could be avoided with appropriate standards
- Esempio:
 - Aerospace manufacturing cell with \$10M in capital equipment takes 100 person-years to integrate

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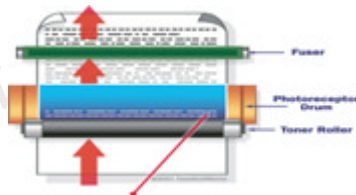
Implementazione cella (1)



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esempio (2) di reparto robotizzato

- Fuser rollers for laser printers



In laser printing the image is inscribed on a photoreceptive drum which then takes toner powder where the image is and transfers it to the paper. The paper is then passes through two heated fuser rollers to fuse the powder into the fibers of the paper.

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esempio (2) di reparto robotizzato

- staubli RX130
 - Technical Specs
 - 6 Degrees of freedom
 - 12kg Nominal Load Capacity
 - 20kg Maximum Load
 - 1.36 m reach
- work cells
 - 3 Robots and 5 CNC Lathes
 - 2 end robots feed 2 end finishing lathes each
 - Middle robot services one finishing lathe



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esempio (2) di reparto robotizzato



1. Load the part



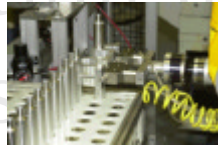
2. Remove and transfer



3. Transfer stand



4. Finish turning



5. Transfer tote