ME451
Kinematics and Dynamics of Machine Systems

Velocity and Acc. Analysis 3.6

Singular Configurations of Mechanisms

Newton-Raphson Method 4.5

March 3, 2009

Before we get started…

- Last Time
  - Discussed driving constraints
    - In Kinematics, it's what it takes to get the mechanism moving
  - Discussed position analysis
    - Set of nonlinear equations, finding solution is not straightforward
  - Implicit Function Theorem
    - Provides sufficient condition for position analysis to locally have a unique solution

- Today:
  - Kinematic Analysis: Velocity and Acceleration Stages (3.6)
  - Discuss Newton-Raphson Method (4.5 – needed for take-home)
  - Singular configuration of mechanisms (3.7, likely on Th)

- Take-home component of the exam available on the website
  - Due on Friday, March 13 at 11:59 PM
  - Exam in one week (March 10)
  - Review session in this room, Monday, 7:15 PM

- No HW assigned

Velocity Analysis

- This is simple. What is the framework?

- You just found **q** at time *t*, that is, the location and orientation of each component of the mechanism at time t, and now you want to find the velocity of each component (body) of the mechanism

- Taking one time derivative of the constraints leads to the velocity equation:

$$\mathbf{\Phi}(\mathbf{q}, t) = \mathbf{0} \quad \Rightarrow \quad \dot{\mathbf{\Phi}}(\mathbf{q}, t) = \mathbf{0} \quad \Leftrightarrow \quad \mathbf{\Phi}_{\mathbf{q}}(\mathbf{q}, t) \cdot \dot{\mathbf{q}} = \nu$$

- In layman's words, once you have $\mathbf{q}_{(k)}$ you can find $\dot{\mathbf{q}}_{(k)}$ at time t_k by solving the linear system

$$\mathbf{\Phi}_{\mathbf{q}}(\mathbf{q}_{(k)}, t_k) \cdot \dot{\mathbf{q}}_{(k)} = \nu_{(k)}$$