What is Inversion-Based Control?

Consider a System --- My Nephew
Let the desired output be, say, eat dinner!
What is Inversion-Based Control?

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**Question:** What input should you apply?

(negotiate, encourage, bribe?)
The Inversion-Problem

Prior Knowledge

Invert the known system model (\(G_0\)) to find input.
Input = \(G_0^{-1}\) [ Desired Output]
Invert the known system model \(G_0\) to find input. 
Input = \(G_0^{-1} \left[ \text{Desired Output} \right] \)

(His Mom know’s how --- she has a reasonable model)
The Control method using Inversion

Use Inverse input as the feedforward input to system

Feedforward is Common in Human Systems

Examples:
Walking, Playing Baseball, Driving a Car
Problem --- model uncertainty

Is Desired output = Output?
Yes if we know the model perfectly!
But, we rarely know a system perfectly ($G_0 \neq G$, $G_0^{-1} \neq G^{-1}$)
Resolution: Addition of Feedback

Exploit knowledge of the system through feedforward input
Account for errors (uncertainties, perturbations) using feedback
Feedforward under Uncertainty?

As the kid grows up the model gets lousy! \[ \Delta (\omega) = G_0 (\omega) - G (\omega) \]
Maybe it is better to use pure feedback without feedforward?
Feedforward under Uncertainty?

Let the Error in model be $\Delta (\omega) = G_0 (\omega) - G (\omega)$

For SISO Case, Feedforward always improves output tracking for any feedback if $|\Delta (\omega)| < |G_0 (\omega)|$

Re-Cap

• **Key Idea: Feedforward Input is found using System Inversion**

(1) Feedforward input uses system knowledge to control the output
(2) Feedforward should be integrated with feedback
(3) Performance better than the use of feedback alone if uncertainty is not too large \( |\Delta(\omega)| < |G_0(\omega)| \)