

Equation of motion for the plunger:

Since,

Magnetic Force:

Change in inductance w.r.t. time:

Magnetic Force with solenoid constants:

The solenoid constants, α and β, can be solved by taking two force and stroke measurements and solving the expression.

The rotational motion of the bowl feeder can be written as the torque:

The angular acceleration can be written:

So rewriting yields:

To find the force needed to create this torque on the bowl, the torque can be written as the product of the force and the radius from the axis of rotation:

Solving for the force yields:

Substituting this expression into the overall equation of motion:

Simplifying:

Solving for :

Defining state space variables, and :

Substituting state space variables into equation of motion: