MotionSolve-Activate Co-Simulation 사례

(Robot Arm Simulation)

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Agenda

1. Introduction
2. Modeling in MotionSolve
3. Modeling in Activate
4. Simulation Results
5. Robot Arm with Cable
1. Introduction

• Today’s products are complex
1. Introduction

- Complexity – How to Ensure It All Works?
1. Introduction

- Model Based Development
  - Simulation requires accurate multi-domain models be used in the process.
1. Introduction

• Model Based Development
  • Simulation Roles in Design
    • Exploring design options early in the process
    • Optimizing the system parameters
    • Driving requirements for subsystems and components
    • Providing verification testing to make sure the design meets desired requirements
1. Introduction

• Altair Math Solutions – Math and System Products
1. Introduction

• Master-Slave Algorithm
  • Activate is the master and MotionSolve is the slave
1. Introduction
2. Modeling in MotionSolve

• **MotionSolve – Plant Inputs / Outputs**

  • **Solver arrays** are used to define plant inputs / outputs by leveraging solver variables:
    • **Plant inputs** variables are usually applied as force or torque to the mechanical system
    • **Plant outputs** variables are usually mechanical system translational / rotational displacement / velocity measures
2. Modeling in MotionSolve

MBS Model

- Base
- Arm1
- Arm2
- Arm3
- Plate
- Hand
2. Modeling in MotionSolve

### Solver Variables

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3. Modeling in Activate

Main Block Diagram

- Base torque
- Arm1 torque
- Arm2 torque
- Arm3 torque

Torques

- Action
- MS Plant
- Motion

Robot dynamics

- Base order
- Base angle
- Arm1 order
- Arm1 angle
- Arm2 order
- Arm2 angle
- Arm3 order
- Arm3 angle

Angles

- From N°m

Torques

Robot controls

Design the Difference with Digital twin

ATC 2017
3. Modeling in Activate

MS Plant Block
3. Modeling in Activate

Robot Controls Super Block
3. Modeling in Activate

Controls Block

\[
\begin{align*}
\text{num}(s) &= \frac{\text{num}(s)}{\text{den}(s)} \\
\text{Base Control} & \quad \text{Coefficients of the numerator polynomial} \quad \{a_{Kp}\} \\
\text{Coefficients of the denominator polynomial} & \quad \{a_{Kd}, a_{K1}, 1\} \\
\end{align*}
\]
3. Modeling in Activate

Actuation Super Block

- Torque
- Plus
- Ground
- Minus

Rate
Command

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4. Simulation Results

In Activate

[Diagram showing simulation results with graphs and models]

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4. Simulation Results

In MotionSolve

Contour Plot
Stress/Strain/Mises, Max
Analysis system

Max = 1.442E+02
Min = 2.35E-02

Design the Difference with Digital twin
5. Robot Arm with Cable

• What is NLFE?
  • A general large-rotation, large-deformation Non-Linear Finite Element implementation based on Absolute Nodal Coordinate Formulation or ANCF
  • ANCF supports material non-linearity
  • No. of independent co-ordinates per grid = 12

\[ e(t) = \begin{bmatrix} r \\ r_x \\ r_y \\ r_z \end{bmatrix} \]
5. Robot Arm with Cable

- Cable Modeling by Using NLFE
5. Robot Arm with Cable

- Simulation Result in Activate
5. Robot Arm with Cable

- Simulation Result in MotionSolve
Thank You!