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SUBSYSTEM BASED RECURSIVE FORMULATION FOR REPEATED TOPOLOGY OF MULTIBODY SYSTEMS

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ABSTRACT

The subsystem synthesis method has been developed for a multibody system which has several identical subsystems with a common base body. Since the subsystem synthesis method provides a mean to solve the equations of motion of the common base body and the equations of motion of each subsystem separately, it gains the computational efficiency by solving several small sized equations of motion rather than solving one large equation of motion for an entire multibody system. Thus, this method has been applied to the real-time computation of a vehicle system with identical suspension subsystems [1].

In this paper, we propose the subsystem based recursive formulation for repeated topology of multibody systems by extending the subsystem synthesis method described above. In the subsystem synthesis method [1], once the motion of the subsystem's reference body is given, the rest of the body and joint motions within the subsystem can be then computed based on the recursive kinematics relationship. Equations of motion will be formed with the joint relative coordinates for each subsystem. The dynamic effect of one subsystem toward its reference body is also obtained through the effective inertia matrix and the effective force vector of the subsystem. When we have a repeated topology as shown in Fig. 1, the proposed method computes the 1st subsystem position and velocity. Then having obtained the 2nd subsystem's reference body motion, it calculates position and velocity of the 2nd subsystem. In this way, all the subsystem motion can be obtained from the 1st to the nth subsystem recursively. For dynamic analysis, equations of motion of the nth subsystem are formed first and the accelerations of joints in the nth subsystem are solved. Then the effective inertia matrix and the effective force vector of the nth subsystem are computed and transferred into the (n-1)th subsystem. In the backward recursive manner, equations of motion of the subsystems are formed from the nth subsystem to the 1st subsystem.

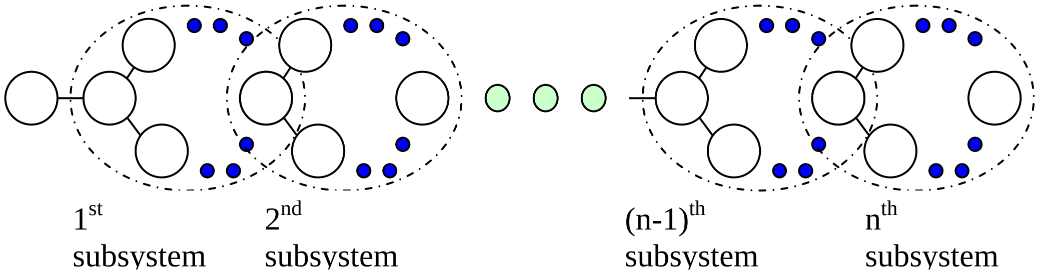

Figure 1. Repeated Topology of Multibody Systems

In order to investigate the effectiveness of the proposed method, an excavator manipulator arm which consists of three repeated subsystem topologies has been modelled and implemented in using the Matlab code. To verify the solutions from the proposed method, they have been compared with those from ADAMS model as shown in Figure 2.

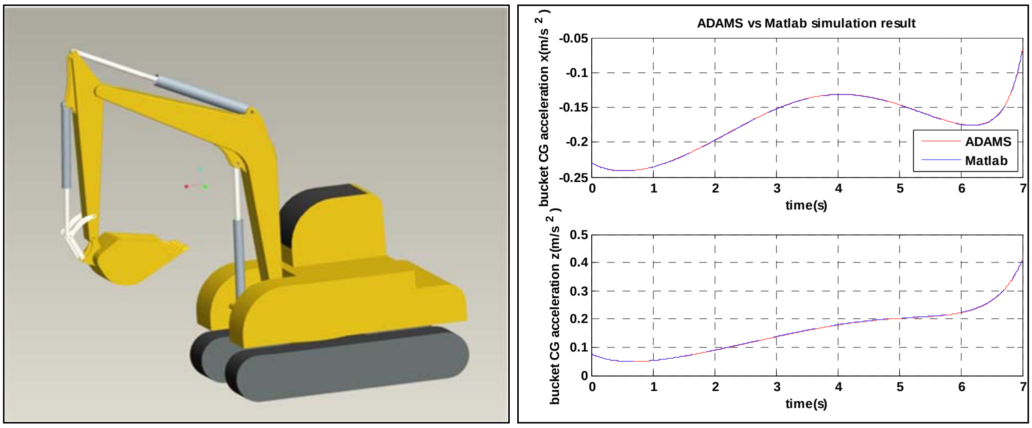

Figure 2. Solution comparison between the proposed method and ADAMS model

In order to verify the efficiency of the proposed method, the proposed method is compared with the conventional recursive formulation [3] by measuring CPU time.

REFERENCES

[1] Kim, Sung-Soo, "A Subsystem Synthesis Method for Efficient Vehicle Multibody Dynamics," *Multibody System Dynamics*, Vol 7, pp. 189-207, (2002).

[2] Kim, Sung-Soo and Wang, J.H., "A Subsystem Synthesis Method with Independent Coordinates for Real-Time Multibody Dynmaics," *Journal of Mechanical Science and Technology*, Vol. 19, No. 1, pp. 312-319, (2005).

[3] Tsai. F.F. and Haug, E.J., Automated Methods for High Speed Simulation of Multibody Dynamic Systems. Technical Report R-47, Center for Computer Aided Design, the University of Iowa, 1989.

[4] Haug, E. J., Computer-Aided Kinematics and Dynamics of Mechanical Systems, Allyn and Bacon, 1989.

[5] Haug, E. J., *Intermediate Dynamics*, Prentice Hall, Englewood Cliffs, 1992.

[6] Atkinson, K., *Numerical analysis.* John Wiley & Sons, 1988.