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Computationally efficient multibody simulation of hydraulic machinery

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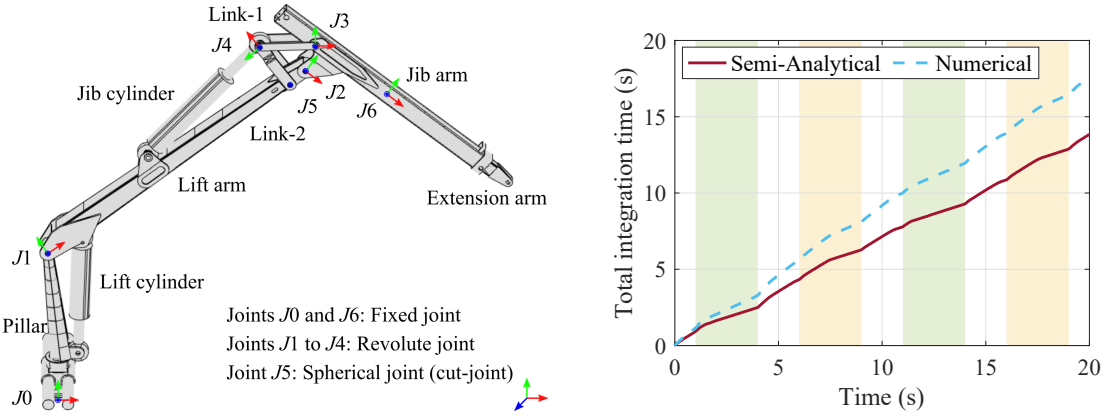
ABSTRACT

Computer simulation of hydraulic machinery can assist manufacturers to develop design and features and optimize operational activities. In practice, it can be performed using multibody dynamics, where the equations of motion can be described using various multibody methods with different computational efficiencies [1]. The objective of this study is to monolithically couple multibody dynamics and hydraulic actuators by using semi-analytical and numerical methods of computing the system Jacobian in the framework of topological multibody methods. This study hypothesis that the introduced coupled simulation is computationally efficient and it allows the system to be solved in real-time. A simulation model of a forestry log crane as shown in Fig. 1a is illustrated as a case study. The mechanical and hydraulic subsystems are respectively described using an index-3 augmented Lagrangian-based semi-recursive method [1] and the lumped fluid method [2].

The effectiveness of the proposed method is demonstrated based on a work cycle of lifting and tilting the lift and jib arms of the log crane model. In both methods, the relative joint positions and hydraulic pressures are relatively in good agreement. Furthermore, the energy balances are similar and the loop-closure constraints in both methods are accurately full-filled. Even though the iteration counts are similar, the semi-analytical method illustrated better computational efficiency compared with the numerical method as shown in Fig. 1b. The better computational efficiency is attributed to an efficient solution of the system Jacobian in the semi-analytical method.



(a) Numerical example of a forestry log crane model.

(b) Computational cost during a simulation cycle.

Figure 1: Computationally efficient multibody simulation of a forestry log crane model.

Keywords: multibody dynamics, hydraulic actuators, hydraulic crane, real-time simulation.

REFERENCES

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