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Exponential Stabilization of a Flexible Structure via a Delayed Boundary Control

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Abstract : The boundary stabilization problem of the rotating disk-beam system is a topic of interest in research studies. This system involves a flexible beam attached to the center of a disk, and the control and stabilization of this system have been extensively studied. This research focuses on the case where the center of mass is fixed in an inertial frame, and the rotation of the center is non-uniform. The system is represented by a set of nonlinear coupled partial differential equations and ordinary differential equations. The boundary stabilization problem of this system via a delayed boundary control is considered. We assume that the boundary control is either of a force type control or a moment type control and is subject to the presence of a constant time-delay. The aim of this research is threefold: First, we demonstrate that the rotating disk-beam system is well-posed in an appropriate functional space. Then, we establish the exponential stability property of the system. Finally, we provide numerical simulations that illustrate the theoretical findings. The research utilizes the semigroup theory to establish the well-posedness of the system. The resolvent method is then employed to prove the exponential stability property. Finally, the finite element method is used to demonstrate the theoretical results through numerical simulations. The research findings indicate that the rotating disk-beam system can be stabilized using a boundary control with a time delay. The proof of stability is based on the resolvent method and a variation of constants formula. The numerical simulations further illustrate the theoretical results. The findings have potential implications for the design and implementation of control strategies in similar systems. In conclusion, this research demonstrates that the rotating disk-beam system can be stabilized using a boundary control with time delay. The well-posedness and exponential stability properties are established through theoretical analysis, and these findings are further supported by numerical simulations. The research contributes to the understanding and practical application of control strategies for flexible structures, providing insights into the stability of rotating disk-beam systems.

Keywords : rotating disk-beam, delayed force control, delayed moment control, torque control, exponential stability
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