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COLLISION DETECTION AND ESTIMATION OF ITS SPOT FOR A FLEXIBLE BEAM USING RATIO OF MODE FUNCTIONS

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Abstract. *This paper presents an approach in collision detection and its spot estimation of a flexible beam with distributed random disturbance. The collision between the flexible beam and an unexpected obstacle is detected by using a Kalman filter for the augmented system whose state consists of modal displacements corresponding to the displacement of the beam and the strength of external force due to the collision (collision input). The collision spot is obtained based on a ratio of collision inputs in modal representation that gives a value of the ratio of mode functions. Finally several numerical results are provided.*
Keywords: Collision detection, Flexible beam, Kalman filter, Stochastic systems

1. **Introduction.** The motion control of robotic manipulators is an active area of research over the past two decades. Especially, in safe uses of robotic manipulators in human environment, real-time collision detection and avoidance capabilities are the significant technology. A lot of collision detection/avoidance approaches for rigid body manipulators have already been investigated. However, few researches on collision detection for flexible manipulators have been studied. In the near future, the flexible manipulators will be used in human environment, because the manipulators that have lightweight body and mechanical flexibility can safely be used more than the manipulators made with rigid-body. The importance of collision detection and avoidance for the flexible manipulators will be increased.

In general, there are two streams to give a controller of manipulator the prior knowledge that is required for operation in unstructured environment. One approach is based on vision systems that require high-performance computers to obtain the knowledge of moving obstacles in the workspace [1-3]. The other approaches are based on touch sensors or sensing skins [4-7] to give the robotic manipulator the knowledge of obstacle. These approaches require extra sensors for finding obstacles.

There are several researches on collision detection methods without extra sensors. Matsumoto and Kosuge [8] have proposed a collision detection method based on nonlinear