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TEST RIG FOR DRILLING DYNAMICAL SYSTEM: IDENTIFICATION AND NONLINEAR ACTIVE CONTROL UNDER UNCERTAINTIES

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Abstract. Part of the process of exploration and development of an oil field consists of the drilling operations for oil and gas wells. Particularly for deep water and ultra-deep water wells, the operation requires the control of a very flexible structure which is subjected to complex boundary conditions such as the nonlinear interactions between drill bit and rock formation and between the drillstring and borehole wall. Concerning this complexity, the stick-slip phenomenon is a major complication. It is related to the torsional vibration and it can excite both axial and lateral vibrations that may cause premature failure of the equipment. So, the reduction and, when possible, avoidance of stick-slip oscillations are very valuable objetives in terms of savings in drilling process. With these intentions, this study has the main goal of confronting the torsional-vibration problem using a real-time robust control strategy.

The test rig is composed by a shaft, a rotor, and a DC-motor with a gear box and a PI control. The simple model used to describe the torsional vibrations is a system with three degrees of freedom, the two angular displacements on the extremities of the shaft and the armature current of the motor.

A Bayesian technique is used in the estimation process, to take into account the uncertainties and variabilities intrinsic to the measurement taken, which are modeled as a noise of Gaussian nature.

Then, three different situations of friction forces on the simulated drill bit are analyzed. The Extended Kalman Filter is used to estimate the parameters of each friction models.

After that, the estimated friction model is used to design the nonlinear model based controller by the EFK to compensate the friction torque effects.

Finally, the experimental simulation of the nonlinear controller by EFK is performed and compared with the previous theoretical simulation, providing a stable and satisfactory result of drilling simulations.