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A NEW RECURSIVE FORMULATION FOR FAST ESTIMATION OF TIME-VARYING UNKNOWN INPUT. APPLICATION FOR ESTIMATING A PARTICLE ACCELERATION

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Abstract. *This paper proposes an extension of the Recursive Input Estimation (RIE) for estimating time-varying unknown input. This extension is based on modifications of the Least Squares (LS) algorithm of the RIE, which increase its capability to track time varying unknown input. These modifications consist in inserting a forgetting factor into the LS algorithm and adding an integral effect. Moreover, alternative formulations are proposed, allowing the reduction of computation time in the case where the number of inputs to estimate is lower than the number of measurements. The different tools obtained are tested and compared on a three-dimensional tracking application.*
Keywords: Unknown input estimation, Kalman filtering, Least squares, Recursive algorithm, Integral effect, Computation, Tracking

1. **Introduction.** In engineering science, inverse problems involve determining the unknown causes of known consequences. Considering a “system”, the link between unknown values and known ones, the solution to such a problem requires obtaining a model of the system, that is to say a mathematical representation reflecting the system’s behavior closely. Indeed, a model yields dynamic equations linking unknown values (to be estimated) to known ones. In addition, in a more general setting, a model can also be useful in other applications such as controlling the considered system or in diagnosing faults.

In a given system, there are two main types of inverse problems: First, the estimation of the system input when the system model and output are known; second, the estimation of the model parameters from the input and output measurements of the system. In this paper, we are concerned with the first kind of inverse problem and more exactly with estimating both the state and the input of a linear or linearized dynamic system from noisy measurements. This problem has long been the subject of intensive research. The solution to this very difficult problem can be applied to areas such as fault isolation and diagnosis [1, 2, 3], control and fault tolerant control (through actuator bias detection and estimation) [4, 5, 6], synchronization of chaotic systems [7] or in specific industrial fields such as manoeuvering target tracking [8, 9, 10], evaluation of reaction rates in chemical reactors [11], estimation of attitude or orientation [12, 13, 14], or estimation of accelerometer and gyroscope errors in inertial navigation [15, 16].