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IMPROVED RECURSIVE INSTRUMENTAL VARIABLE PARAMETER ESTIMATOR IN THE SELF-TUNING CONTROL OF A COUPLE TANK SYSTEM

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Abstract. *The paper presents an improved recursive instrumental variable (RIV) estimation method known as the 'RIV with centre of triangle' (RIV+COT) estimator to be used in the self-tuning pole-placement (STPP) control of a coupled tank liquid level system. Estimating and tracking the parameters of a system operating in closed-loop, such as in the self-tuning control system is a challenging system identification problem due to the correlation between the disturbances and the control signal. The proposed RIV+COT estimation method aims to estimate and track the time-varying parameters of the couple tank system so that the controller is designed based on the current parameter values, providing better control of the plant. The main attractive features of the proposed estimator are its ability to produce smaller estimation overshoot and bias, and smoother steady-state estimates compared with the recursive least squares (RLS) and the basic RIV estimators. Furthermore, the algorithm is quite simple and therefore suitable for real-time applications such as in a self-tuning control system. Experimental results show that the RIV+COT estimator performs better than the RLS and the basic RIV estimators as well as more robust against variations in the controller specifications.*
Keywords: Recursive least squares, Recursive instrumental variable, Centre of triangle, Self-tuning pole placement

1. **Introduction.** Parameter estimation is a process of determining the values of coefficients relating different signals in a system and is needed when the parameters of the system are time varying and that tracking of this variation is required. Various estimation methods are available including those for systems represented by transfer function [1] or state-space [2] models, in frequency domain [3] or time domain [4], and using conventional [5] or artificial intelligence (AI) technique [6].

The most popular application of parameter estimation in control engineering is in the online tuning of controller parameters of time-varying plants. For instance, in a self-tuning controller shown in Figure 1, process model parameters are estimated from the control input and output signals data. The estimated parameters are then utilised to calculate the parameters of the control algorithm [7]. This gives a feedback gain that is designed based on the current values of the plant parameters, providing better control. The control signal is then generated and fed into the process/plant. In this type of application, the parameter estimation process has to be done in an online manner where the parameters are estimated recursively as the input and output data are obtained.

In real-time applications, complicated recursive estimation algorithms should be avoided as computational complexity and time may cause problems especially for systems requiring very high sampling frequencies. This is why control system designers always resort to