Report 4
Modeling and Identification

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1 Estimation of Parameters for Given System

System that we gonna work on is shown on the figure 1. This is Linear Time Invariant system with disturbances added to its output. The equations that describe this system:

$$v_k = a^* v_{k-1} + b^* u_k$$
$$y_k = a^* v_{k-1} + b^* u_k + z_k$$

True values of a and b:

$$a^* = 0.8$$
$$b^* = 1$$

The input u_k and the noise z_k are independent, uniformly distributed random variables.

The goal of this exercises is to estimate parameters a and b with use of Least Square Method and the Instrumental Variable Method both in Off-line and On-line way.

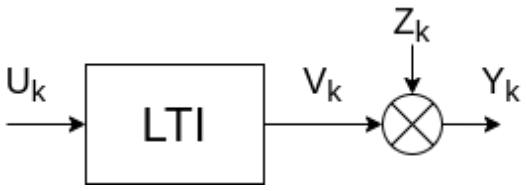

Figure 1: Considered system.

1.1 Off-line Method

This method uses all data to calculate estimation for each point. Both Least Square Method and the Instrumental Variable Method were tested during experiments. Results of estimation error for both method along with numbers of data points are shown on Figure 2.

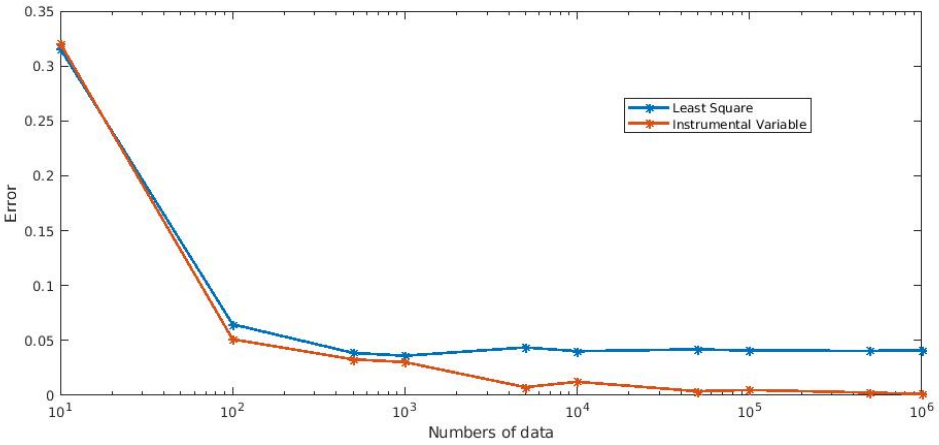

Figure 2: Results for Off-line Method.

1.2 On-line Method

This method uses estimation calculated before to calculate estimation for next point, so does not need to use all data every time. It allows to estimate system which changes in time. For parameters estimation Least Square Method was used.

At the beginning parameters had value: $a = 0.8$, $b = 1$, after half of iteration parameter a changed its value to 0.3. Results of experiments for $\lambda = 0.999$ are shown on Figure 3, and for $\lambda = 0.995$ on Figure 4.

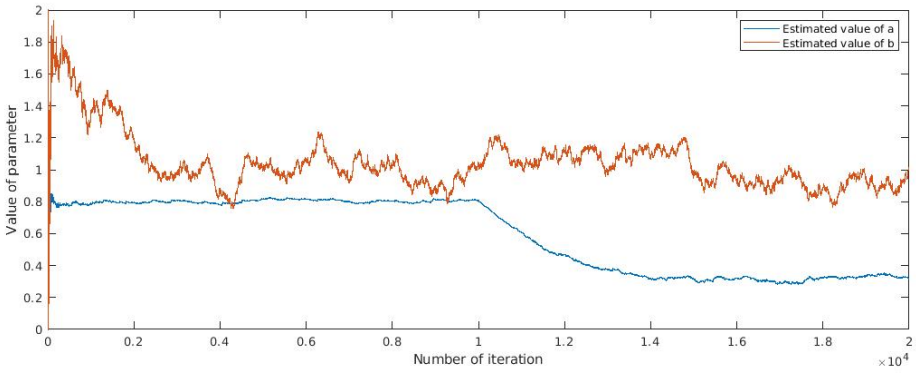

Figure 3: Results for On-line Method for $\lambda = 0.999$

2 Conclusions

For Off-line method during experiments with LSM, we can see that error does not converges to 0, this is because this kind of estimation has some bias. IVM has error

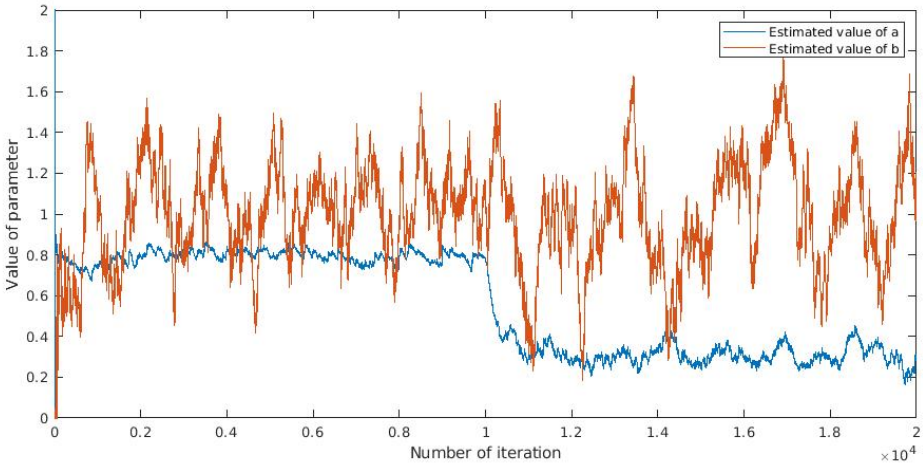

Figure 4: Results for On-line Method for $\lambda = 0.995$

which converges to 0.

For On-line method we can see that value converges to true value after some iteration. If $\lambda = 0.999$ we can see that it takes more time to get close to true value but values have small variance. For $\lambda = 0.995$ estimation works faster but values have larger variance.