A FREQUENCY DOMAIN DESIGN TECHNIQUE TO AUTO-TUNE PID CONTROLLERS FOR SECOND ORDER INTEGRATOR PROCESSES

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Auto tuners belong to a special class of adaptive controllers where the parameters of a controller such as PID controller, are automatically tuned. The processes to be autotuned are mainly divided into two broad classes, namely processes with self regulation and processes with integration.

There are enough design techniques available in literature to auto tune processes with self regulation, and are based on frequency domain designs. On the other hand there are not many design techniques in frequency domain that gives good results for processes with integration. Moreover it can be seen that most industrial processes are second order integrator processes.

In this research, the suitability of a well established method for auto tuning is investigated for second order integrator processes, and demonstrated their limitations. This method is based on estimating the critical point in the Nyquist plot using a relay experiment and reshaping the nyquist plot by shifting this point to a specified point using a PID controller. To overcome the limitations in the existing method, an approach where an arbitrary point of the Nyquist plot is identified using a hysterisis relay and is shifted to a specified point given by $(0.5,85^{o})$. Both simulation investigations and the experiments with a lab setup show that this modification provides satisfactory performance when applied to second order integrator processes.

The issue of computing a point on the Nyquist plot using the hysterisis relay is also investigated in this study. Using the hysterisis has a filtering effect on the noisy signals and hence a zero crossing technique can be employed to detect the period. A notch filter was utilized to extract the harmonic component and a recursive least squares was used to estimate the amplitude. Although Extended kalman filter provided better results, the convergence was slower. In the practical application where there was asymmetric oscillations, Fourier analysis combined with zero crossing detection was more efficient in computing the point in the Nyquist plot accurately.