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Chen *et al.* (1996) developed a new and effective design algorithm for disturbance decoupling fault detection filters via the unknown input observer principle. Their idea was shown to be very applicable. However, the conditions for fault detection given in Definition 2 and Definition 4 are too restrictive. In Definition 2 they said that the condition for maintaining a residual in a fixed direction is 'equivalent' to

$$\operatorname{rank}\left(\begin{bmatrix} l_i & (\mathbf{A}-\mathbf{KC})l_i & \cdots & (\mathbf{A}-\mathbf{KC})^{n-1}l_i \end{bmatrix}\right) = 1$$

However, as previously shown by Massoumnia (1986) and White and Speyer (1987), to maintain a residual in a fixed direction, the controllability matrix spanned by l_i should only be a subspace of the detection space, and should not necessarily be one-dimensional. For the same reason, the mutual isolability (detectability) condition given as Definition 4 by Chen *et al.* could be misleading. In fact, determination of mutual isolability requires a few more procedures (Massoumnia 1986, White and Speyer 1987). The following well-known example first introduced by Beard (1971) can be used as an illustrative example to clarify this.

Consider a system with **A**, **C** and **L** as below:

$$\mathbf{A} = \begin{bmatrix} 0 & 3 & 4 \\ 1 & 2 & 3 \\ 0 & 2 & 5 \end{bmatrix}, \quad \mathbf{C} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad \mathbf{L} = \begin{bmatrix} l_1 & l_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ 1 & -1/2 \\ 0 & 1/2 \end{bmatrix}$$

Any design algorithm for a fault detection filter might be used. We design one which is identical to that of White and Speyer (1987).

$$\mathbf{K} = \begin{bmatrix} 9 & 18 \\ 7 & 6 \\ 2 & 9 \end{bmatrix}$$

$$\operatorname{rank}\left(\begin{bmatrix} l_1 & (\mathbf{A}-\mathbf{KC})l_1 & (\mathbf{A}-\mathbf{KC})^2 l_1 \end{bmatrix}\right) = 2$$

As shown above, although the rank of controllability matrix associated with l_1 is 2, not 1, the detection and mutual isolation are clearly achieved. This contradicts the definitions of Chen *et al.*

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References

Beard, R. V., 1971, Failure accommodation in linear system through self reorganization. Ph.D. thesis, Department of Aeronautics and Astronautics, MIT, Cambridge, Massachusetts, U.S.A.

Chen, J., Patton, R. J., and Zhang, H.-Y., 1996, Design of unknown input observers and robust fault detection filters. *International Journal of Control*, **63**, 85–105.

Massoumnia, M.-A., 1986, A geometric approach to the synthesis of failure detection filters. *IEEE Transactions on Automatic Control*, **31**, 839–846.

White, J. E., and Speyer, J. L., 1987, Detection filter design: spectral theory and algorithm. *IEEE Transactions on Automatic Control*, **32**, 593–603.