We introduce the orthogonal periodic sequences (OPSSs), a family of deterministic signals, for the identification of functional link polynomial (FLIP) filters. The OPSSs share many characteristics of the perfect periodic sequences (PPSSs). As the PPSSs, they allow the perfect identification of a FLIP filter on a finite time interval with the cross-correlation method. In contrast to PPSSs, OPSSs can identify also non-orthogonal FLIP filters, as the Volterra filters. With OPSSs, the input sequence can be any persistently exciting sequence and can also be quantized. OPSSs can often identify FLIP filters with a sequence period and a computational complexity much smaller than that of PPSSs.

**FLIP filters**

FLIP filters are a class of linear-in-the-parameters (LIP) nonlinear filters. They are a linear combination of basis functions, product of nonlinear expansions of delayed input samples. In diagonal form:

\[
y(n) = \sum_{p=0}^{P} \sum_{m=0}^{M} h_p(m) f_p(n-m)
\]

where \( f_p(n) \) are the zero lag basis functions, with \( f_p(n) \in \{1, g_1[x(n)], g_2[x(n)], g_3[x(n)], g_4[x(n)] g_5[x(n-1)], \ldots, g_1[x(n)] g_2[x(n-D)], g_3[x(n)], \ldots \} \).

When \( g_i(x) \), \( i \), satisfy the Stone-Weierstrass theorem, the FLIP filters are universal approximators.

They include many families of polynomial filters, as the Volterra for \( g_i(x) = x^2 \), the Legendre nonlinear (LN), \( g_i(x) \in \{1, x, (3x^2 - 1)/2, x(5x^2 - 3)/2, \ldots \} \), the Wiener nonlinear (WN), \( g_i(x) \in \{1, x^2, \ldots, x^2, \ldots \} \).

Some FLIP filters have orthogonal basis functions for some input distribution, e.g., LN and WN, thus allowing the identification of the coefficients using the cross-correlation method.

**OUTPUT NOISE EFFECT**

We study the effect of an additive output noise \( \nu(n) \).

The mean square deviation (MSD) of journal of linear system is

\[
\text{MSD}_{i,j} = E[(h_{i,j})^2] = E[(<n(n)z(n)z(n)j > L)^2].
\]

MSD is proportional to the noise power \( \sigma^2 \) and inversely proportional to \( f_i^2(n) \).

To compare the OPSSs we define the noise gain.

\[
G_{i,j} = \text{MSD}_{i,j} / f_i^2(n) > L / E[\nu(n)^2].
\]

For OPSSs, it can be proved \( G_{i,j} \) is always 1.

**REFERENCES**
