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IDENTIFICATION OF FALSE IMPULSES IN THE BINARY COMPONENTS OF NOISY SIGNAL

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The position-width-impulse analysis (PWI-analysis) is one of effective methods for signal processing. It was developed in 90th years of the last century [1]. In some works the PWI-analysis is also called position-binary technology. Concepts of the PWI-analysis are described in [2, p.25].

The results of computing experiments showed that using the PWI-analysis algorithms sometimes give erroneous results.

Such errors take place when the noise fluctuation occurs at the moment when the useful constituent of the signal's binary component shifts from one state to other one i.e., when the code digit meaning of the useful signal changes from "0" to "1" or vice versa (Fig.1 and 2).

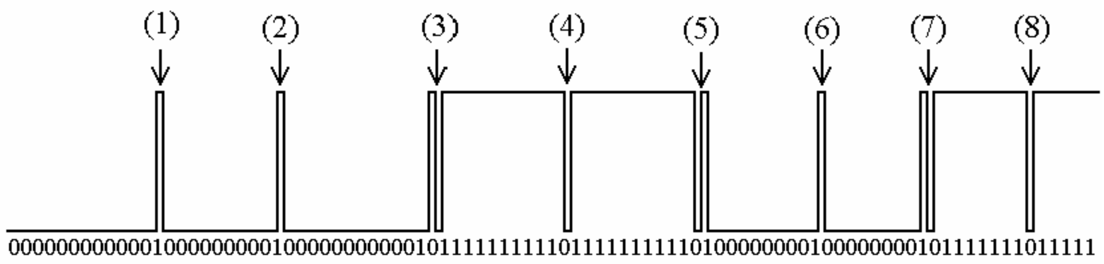


Fig.1. One of the binary components of the noisy signal.

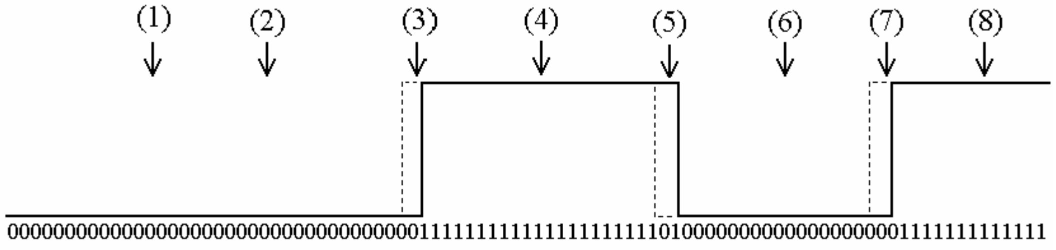
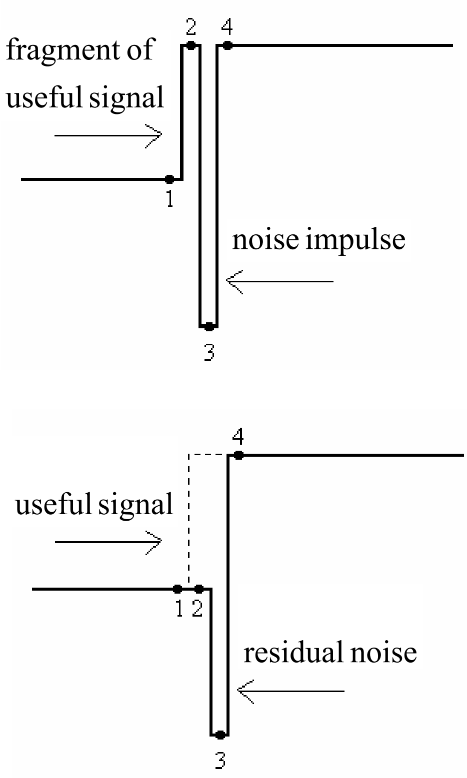


Fig. 2. The binary component after position selected filtration.

In the Fig. 1 a fragment of a binary component of signal is depicted. In the segments 1-8 we can see short-term impulses. Using filtration algorithms [3] results in the binary component filtered of noise impulses (Fig. 2). However from Fig.1 we can see that ambiguities appear in the segments 3, 5 and 7 two impulses occur in each of them: in segment 3 – positive-negative, in segment 5 – negative-positive and in segment 7 – positive-negative ones. In each of the couples one impulse is false one. During filtration the first impulse is removed from each couple. And we can see from Fig. 2 that there can be cases when shifts of the "useful" binary component to right take place: possible real shifts of the useful signal's binary components are shown with dashed line. It is evident from Fig. 2 that there is shift for $2\Delta t$.

Not only separating the impulse noise can distort the signal's binary component but also leave residual impulses in it (Fig. 3 b). In such a case repeated "iteration" filtration can be done. However this does not correct distortion (the dashed line in Fig. 3 b).



(a)

(b)

Fig. 3. The fragment of the digital signal $x(i\Delta t)$ before filtration and after it.

Thus when using filtration algorithms a problem appears: to recognize false impulses in the signal's binary components. To solve this problem the following algorithm is suggested:
if

$$\left| x((i-1)\Delta t) - x((i+1)\Delta t) \right| < \left| x(i\Delta t) - x((i+2)\Delta t) \right|, \tag{1}$$

then

$$x(i\Delta t) = x((i-1)\Delta t). \tag{2}$$

Validity of formulae (1) and 2 is evident from Fig.3. Let there be four serial signal samples $x((i-1)\Delta t)$, $x(i\Delta t)$, $x((i+1)\Delta t)$ and $x((i+2)\Delta t)$ that correspond to points 1, 2, 3 and 4 in Fig. 3 (a). Assume that we have to recognize which of the impulses is false one: the one in point 2 or the one in point. Taking into account that in this case impulse is a short-term and significant shift of the signal we should find which of points 2 and 3 has the closest nearby values. The maximal proximity of the signal values means the minimal modulus of their difference. The nearby points for point 2 (sample $x(i\Delta t)$) are points 1 (sample $x((i-1)\Delta t)$) and 3 (sample $x((i+1)\Delta t)$). The nearby points for point 3 (sample $x((i+1)\Delta t)$) are points 2 (sample $x(i\Delta t)$) and 4 (sample $x((i+2)\Delta t)$).

Thus if the difference modulus of the signal values at points 1 and 3 is less than the difference modulus at points 2 and 4 it means that impulse 2 is real and impulse 3 is false. In Fig 3(a) points 2 and 4 have closer values than 1 and 3. Therefore in this case in Fig. 3(a) impulse 2 is false and 3 is real one.

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