2

FTD-ID(RS)T-0872-89

FOREIGN TECHNOLOGY DIVISION

HERALD OF THE LENINGRAD ORDER OF LENIN ELECTRICAL-ENGINEERING
INSTITUTE IMENI V.I. UL'YANOV (LENIN)

(Selected Articles)

Approved for public release;
Distribution unlimited.

FTD- ID(RS)T-0872-89

HUMAN TRANSLATION

FTD-ID(RS)T-0872-89 12 October 1989

MICROFICHE NR: FTD-89-C-000848

HERALD OF THE LENINGRAD ORDER OF LENIN ELECTRICAL-ENGINEERING INSTITUTE IMENI V.I. UL'YANOV (LENIN) (Selected Articles)

English pages: 13

Source: Izvestiya, Leningradskogo Ordena Lenina Elektro-Tekhnicheskogo Instituta imeni V.I. Ul'yanova (Lenina) Vol. 96, Leningrad, 1970, pp. 113-120

Country of origin: USSR
Translated by: Charles T. Ostertag, Jr.
Requester: FTD/TQTR/J.M. Finley

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.	PREPARED BY TRANSLATION DIVISION FOREIGN TECHNOLOGY DIVISION WPAFB, OHIO.

TABLE OF CONTENTS

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

HERALD OF THE LENINGRAD ORDER OF LENIN
ELECTRICAL-ENGINEERING INSTITUTE
IMENI V.I. UL'YANOV (LENIN)

(selected articles by Yegorov, Yu.V. and Naumov, K.P.,
pages 113-120)

CONVERSION OF SPACE-RECORDED CODES INTO ELECTRICAL BY THE OPTICAL METHOD

Yegorov, Yu.V., Naumov, K.P.

Correlation systems of the optical type [1, 2, 3], which recently have been used extensively for processing radar signals, can be used for the generation of complex electric signals. In a system of such a type (Fig. 1) the electric signal on the output of the photodetector is obtained as a result of the correlation of the signal which is spatially recorded on transparency T. The signal has a short radio pulse which is passing in a transparent sound duct of an ultrasonic light modulator (UZMS). Here the radio pulse "reads" the space signal from the transparency, converting it into a time [signal].

As is known [3], in the system which is shown in Figure 1 the output voltage will be

$$u_{\text{вых}}(\tau) = A \int u_1(x)\, u_2^*(x-\tau)\, dx \cdot \cos[\omega_0 \tau + \theta(\tau)] =$$
$$= A\, r_{12}(\tau) \cos[\omega_0 \tau + \theta(\tau)],$$

where $u_1(x)$, $u_2(x)$ - complex envelopes of the signal and the transparency; $r_{12}(\tau)$ - envelope of the correlation function of the initial signals; ω_0 - frequency of the carrier signal in the UZMS.

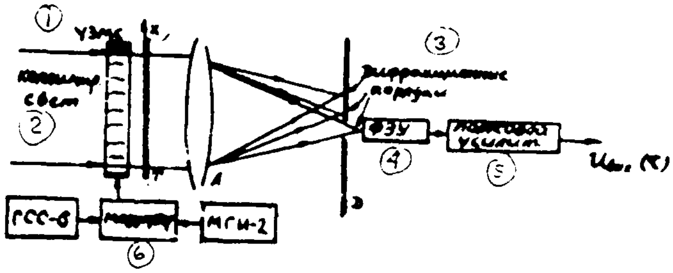

Figure 1.

Key: (1) UZMS; (2) Collimated light; (3) Diffraction orders; (4) FEU; (5) Band amplifier; (6) Modulator.

It is evident that undistorted read-out would be possible only when $u_2(x) =$ (x): if read-out takes place with a pulse of duration t_0, then, as can be obtained readily from the correlation integral, the minimum duration of the front of the signal which is read out is equal to t_0, and the minimal distance between two successive pulses (interruptions) of the transparency should be no less than $2\sqrt{t_0}$.

An experimental investigation was made of the read-out of a signal from a transparency which was made by the photo method in the form of an amplitude diffraction grating, manipulated in phase relative to the space carrier (5 1 mm) in conformity with the law of pseudorandom binary sequence with base 7; the overall length of the transparency was 171.45 mm. Figure 2 shows in a strongly magnified form a small portion of the transparency, illustrating its structure. The read-out pulse had a carrier of 6.35 MHz, pulse duration varied from 1 µs to 0.3 µs. The read-out was made of different sectors of the transparency with a length from 20 mm to 171.45 mm.

Figure 2.

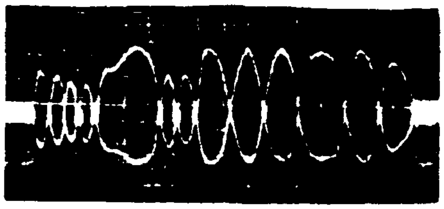

Figure 3.

Figure 3 shows the oscillogram of the signal which was read out from an aperture of 31 mm with a pulse t_0=0.5 μs. The result of the read-out is a phase-manipulated radio signal, the changes of state of phase of the carrier (6.35 MHz) conform to the passing of the envelopes through zero, and the duration of the pulse fronts is equal to t_0=0.5 μs (one large division on the oscillogram corresponds to 2.5 μs).

The first four pulses (on the left) correspond to the four phase interruptions on that particular segment of the transparency (Fig. 2).

The experiment confirms the possibility of generating electric signals by the optical method, and the structure and type of signal generated are determined only by the structure and type of transparency. This distinguishes this method of signal generation favorably from the known radio-engineering methods.

Bibliography

1. Slobodin, L., TIIER, v 51, 1963, No 12, p 1753.

2. Arm, M., Lambert, L., Veysman, I., TIIER, v 52, 1964, No 7, p 897.

3. Felstid, Ye.B., Zarubezhnaya radioelektronika (Foreign Radioelectronics), 1969, No 3, p 3.

CORRELATION PROCESSING OF PERIODIC BINARY PSEUDORANDOM CODES BY THE OPTICAL METHOD

Yegorov, Yu.V., Naumov, K.P.

Optical systems of correlation processing of radio signals [1, 2, 3] have advantages over radio engineering in their multichanneling (resulting from the two-dimensional nature of the first) and simplicity in obtaining correlation functions of complex signals. The results of an experiment on the correlation processing of a binary pseudorandom code are described in this work.

Figure 1 shows the layout of the installation.

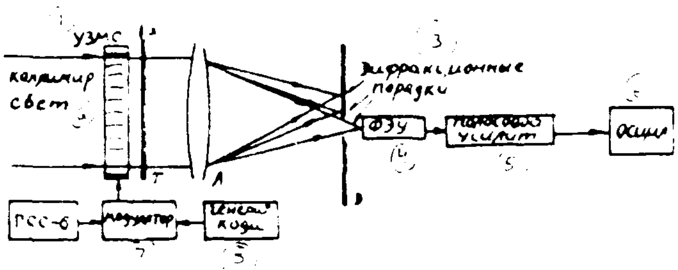

Figure 1.

Key: (1) UZMS; (2) Collimated light; (3) Diffraction orders; (4) FEU; (5) Band amplifier; (6) Oscillograph; (7) Modulator; (8) Code generator.

The code generator forms a binary sequence of pulses according to the rule [4]:

$$d_i = -d_{i-1} d_{i-2} d_{i-3} d_{i-4} d_{i-6} d_{i-7} ,$$

where i=7 8, 9, and $d_1 = d_2 = \ldots = d_6 = -1$, $d_7 = +1$.

The duration of the code is equal to 127 t_o, where t_o - duration of cycle, equal to 1 μs. After the balance modulator a phase-manipulated radio signal (f of carrier = 6.35 mHz) is obtained which enters the ultrasonic light modulator (UZMS). The modulator is a cuvette with alcohol in which a piezoceramic element (type TsTS-19) excites ultrasonic waves. Figure 2 shows the oscillogram of a portion of the signal which is being processed. In conformity with the code the transparency was made in the form of an amplitude diffraction grating, phase-modulated relative to the space carrier and equal to 5 1/mm.

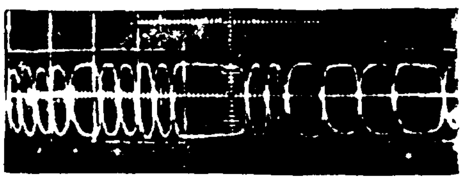

Figure 2.

In the optical system shown in Figure 1 the voltage on the output of the band amplifier is equal to [3]:

$$
U_{out}(\tau) = A \int u_1(x) u_2^*(x-\tau)\,dx \cdot \cos[\omega_0 \tau + \theta(\tau)] =
$$
$$
= A\, r_{12}(\tau) \cos[\omega_0 \tau + \theta(\tau)],
$$

where $u_1(x)$ and $u_2(x)$ - complex envelopes of the signal of the UZMS and the transparency: $r_{12}(\tau)$ - envelope of the correlation function of these signals: ω_0 - carrier frequency.

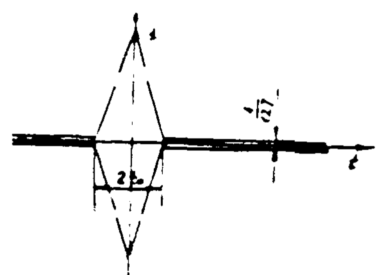

Figure 3.

The theoretical form of the envelope of the autocorrelation function of the radio signal, manipulated in phase by a pseudorandom binary sequence with a code base seven [4], is shown in Figure 3.

The correlation function of the signal and the transparency which was obtained experimentally is shown in Figure 4. The observed difference in the experimental correlation functions and theoretical is explained by the following factors: the imperfect form of the radio signal (Fig. 2), nonideal conformity of the transparency to the signal, the filtering properties of the band amplifier and the aberrations of the optical system. The influence of these factors on the correlation function can be calculated theoretically.

Figure 4.

Thus the experiment confirms the possibility of correlation processing of complex lengthy radio signals (signal length 127 μs against [illegible].2 us in work [3]) by the optical method. With replacement of lens $\mathcal{J}l$ by an astigmatic pair the system is converted to multichannel, and the transition to the processing of another signal is connected only with replacement of the transparency.

BIBLIOGRAPHY

1. Slobdin, L., TIIER, v 51m 1963, No 12, p 1753.

2. [illegible] L.I., et al., Zarubezhnaya radioelektronika, [illegible], No [illegible], p 3.

3. Felstid, Ye.F., Zarubezhnaya radioelektronika, 1969, No 3, p 3.

4. Lezin, Yu.S., Optimal'nyye fil'try i nakopiteli impul'snykh signalov (Optical Filters and Accumulators of Pulsed Signals). "Sovetskoye radio," Moscow, 1969.

DIFFRACTION SPATIAL OPTICAL LIGHT MODULATOR
WITH CROSSED ULTRASONIC FIELDS

Yegorov, Yu.V., Naumov, K.P.,

Diffraction ultrasonic light filters (UZMS) are the most effective means for entering radio signals into operational optical processing systems. In this work a review is made of the technical feasibility of an astigmatic optical processing system using crossed UZMS instead of the single-dimensional modulator which is usually used.

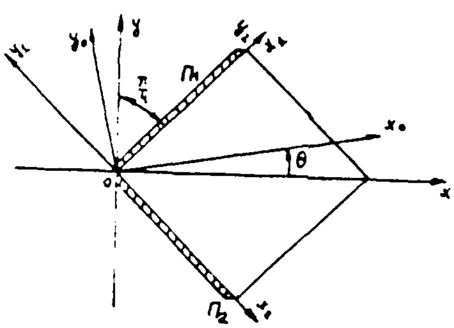

Figure 1.

Figure 1 shows the layout of the modulator, the modulating field of which is formed by two orthogonally crossed ultrasonic traveling waves with envelopes u_1 and u_2, excited by converters P_1 and P_2. In the accepted system of coordinates the envelopes u_1 and u_2 have the form of waves

$$U_1\left(t_1+\frac{y_1}{v}\right)\quad,\quad u_2\left(t_2-\frac{y_2}{v}\right). \tag{1}$$

The collimated light, directed perpendicular to the plane of the modulator, is modulated by waves (1) and enters the lens astigmatic pair with axes x_o, y_o such that x_o - the coordinate along which the Fourier transform is fulfilled, and y_o - the coordinate, relative to which the actual image is formed in the plane of the photodetector. If the system of coordinates (x_o, y_o) is turned relative to the system (x, y) by the angle θ, then after the conversions of the coordinates the waves (1) are reduced to the form:

$$u_1\left(\frac{\ell_1+Cy_o-Sx_o}{v_g}\right);\quad u_2\left(\frac{\ell_2-Sy_o-Cx_o}{v_g}\right), \tag{2}$$

where $S=\sqrt{2}\,\sin(\xi-\theta)$, $C=\sqrt{2}\cos(\xi-\theta)$, $\ell_{1,2}=t_{1,2}v_g$

$v=\frac{v_g}{\sqrt{2}}$ - speed of ultrasound.

Under the assumption of the properties indicated for the optical system it can be shown that the optical or electrical signal recorded on the output is proportional to the integral

$$J_{12}(y_o)=-v_g\int_A u_1(\tau_1+St)u_2(\tau_2+Ct)dt \tag{3}$$

Here: $t = -\frac{y_0}{v_g}$, $\tau_1 = \frac{1}{v_g}(l_0 + C y_0)$, $\tau_2 = \frac{1}{v_g}(l_2 - S y_0)$,

A - aperture of the optical system.

The integral transformation (3) which is made by the optical system has a different mathematical meaning with different methods of indication of light distribution.

Actually, if 1/ θ=0 (i.e., S=1, C=1), then

$$J_a(\tau) = -v_g \int_A u_1(t) u_2(t+\tau) dt \equiv u_1 * u_2 = R_{12}(\tau), \qquad (4)$$

where $\tau = (t_2 - t_1) - \frac{\sqrt{2}}{v} y_0$.

Thus in this case the distribution of light in the output plane will be described by a function of mutual correlation of the envelopes u_1 and u_2, the maximum of which has the coordinate $\frac{t_2 - t_1}{\sqrt{2}} v$.

If 2/ $\theta = \frac{\pi}{2}$ (S=-1, C=1), then in the case of using spatial photoelectric integration in the photodetector and band-pass filtration the envelope of the radio signal will be proportional to the integral [2]:

$$J_{12} = v_g \int_A u_1(t') u_2[(t_2 - t_1) - t'] dt' \equiv u_1(t) \otimes u_2(t), \qquad (5)$$

which is the convolution function of the envelopes. It is interesting that in this case the dependence of the integral on y_0 disappears.

If $3/\ -\frac{\pi}{4} < \theta \leq \frac{\pi}{4}$ $(0 < c < \sqrt{2}\ ;\sqrt{2} > s > 0)$, then the light distribution on the output will be described by the integral

$$J_{12}(y_0) = -\frac{v_g}{c} \int_A u_1(mt') u_2 \left[t' + \left(t_2 - t_1 - \frac{s+c}{v_g} y_0 \right) \right] dt', \qquad (6)$$

where $t' = ct$. Consequently the distribution is determined by the function of mutual correlation of u_1 and u_2 with the variable scale coefficient m relative to the variable t, and

$$m = s/c = tg\left(\frac{\pi}{4} - \theta\right).$$

Thus the use of the device described in an optical system makes it possible: 1/ to carry out correlation processing of radio signals with a spatial separation of the output signal (including in the case of variable time scales of the signals); 2/ to distinguish the time signal which is proportional to the convolution function of the signals (or the function of mutual correlation of the two "mirror" signals).

BIBLIOGRAPHY

1. Katrona, L.D., et al., Zarubezhnaya radioelektronika (Foreign Radioelectronics), 1962, No 10, p 3.

2. Felstid, Ye.B., Zarubezhnaya radioelektronika, 1969, No 3, p 3.

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
A205 DMAHTC	1
C509 BALLISTIC RES LAB	1
C510 R&T LABS/AVEADCOM	1
C513 ARRADCOM	1
C535 AVRADCOM/TSARCOM	1
C539 TRASANA	1
C591 FSTC	4
C619 MIA REDSTONE	1
D008 MISC	1
E053 HQ USAF/INET	1
E404 AEDC/DOF	1
E408 AFWL	1
E410 AD/IND	1
F429 SD/IND	1
P005 DOE/ISA/DDI	1
P050 CIA/OCR/ADD/SD	2
AFIT/LDE	1
NOIC/OIC-9	1
CCV	1
MIA/PHS	1
LLYL/CODE L-309	1
NASA/NST-44	1
NSA/T513/TDL	2
ASD/FTD/TQIA	1
FSL	1