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## ABSTRACT

Master's thesis: 78 pages, 17 figures, 2 appendices, 30 sources.

MOBILE ROBOT, CORRELATION-EXTREME NAVIGATION SYSTEM, LOCALIZATION, BINDING OBJECT.

The major goal of this thesis is to develop an algorithm for layer-by-layer localization of reference objects.

Inertial and correlation-extreme navigation systems are analyzed in this thesis. The review-comparative method which is expedient to use in correlation-extreme navigation systems was reviewed. A crucial function of comparing the current image with the reference image was developed, on the basis of which the algorithm of layer-by-layer localization of the binding object was developed and the corresponding modeling was performed using the MATLAB software environment.

Based on the simulation results, the algorithm successfully completed its task by finding the binding object in the current image.

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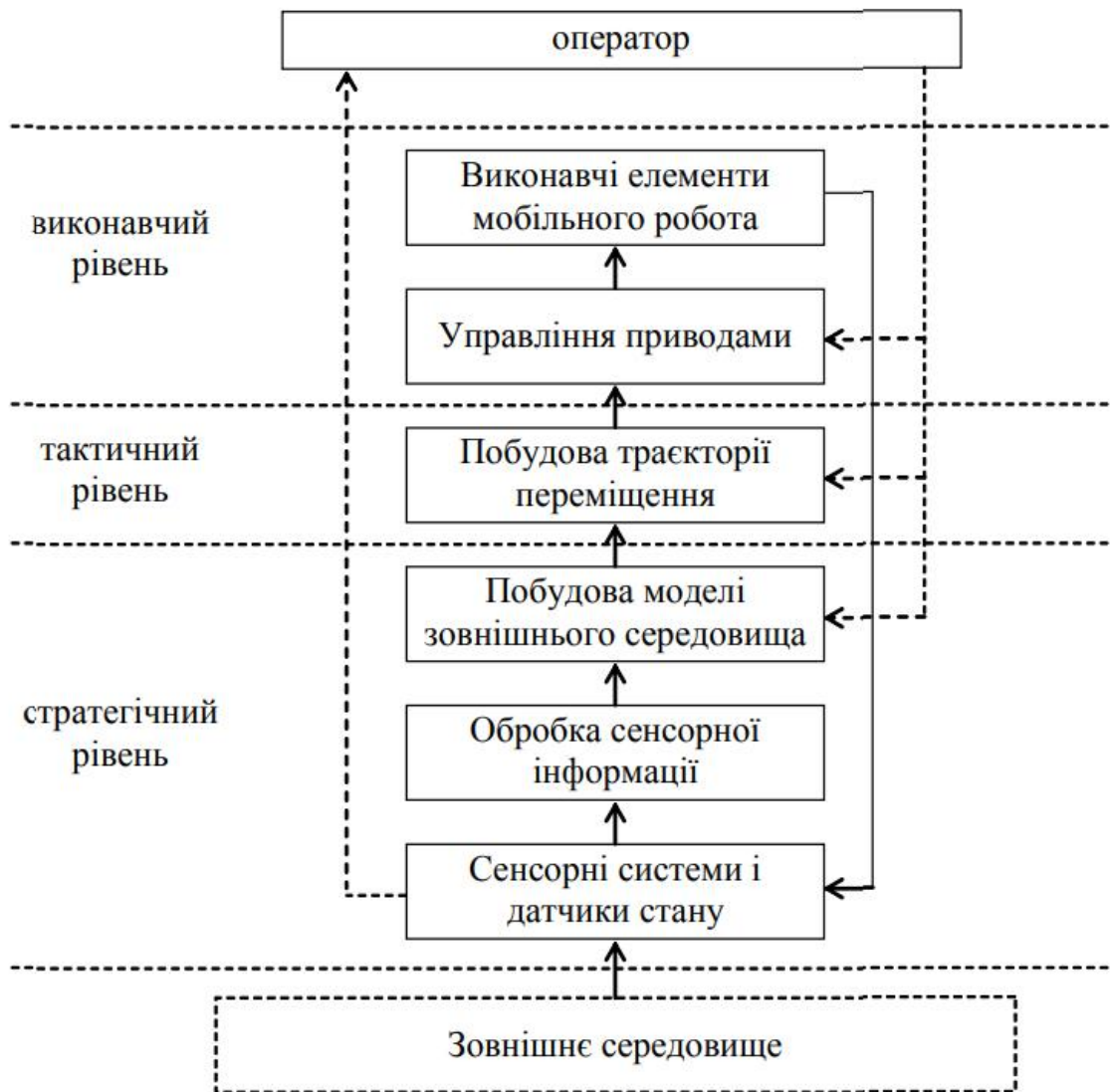
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$$V = \int_0^t a \, dt; S = \int_0^t V \, dt = \int_0^t \int_0^t a \, dt, \tag{2.1}$$

$$\begin{aligned} V - & \quad , \quad ; \\ t - & \quad ; \\ a - & \quad , \quad ; \\ S - & \quad . \end{aligned} \tag{2.1}$$

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$$m \frac{d^2 \vec{r}}{dt^2} = \vec{F}, \tag{2.2}$$

$m$  - ;  
 $\vec{r}$  - - ;  
 $\vec{F}$  - , .  
 , :

$$\vec{F} = \vec{F} + \vec{G}, \tag{2.3}$$

$\vec{F}$  - , ;  
 $\vec{G}$  - , .  
 (2.2) (2.3) :

$$m \frac{d^2 \vec{r}}{dt^2} = \vec{F} + \vec{G}. \tag{2.4}$$

(2.4)  $m$

, - , :

$$\vec{w} = \frac{\vec{F}}{m} + \frac{\vec{G}}{m},$$

:

$$\vec{w} = \vec{a} + \vec{g} . \tag{2.5}$$

$$(2.5) \quad :$$

$$\vec{a} = \vec{w} - \vec{g} , \tag{2.6}$$

$$\vec{a} - \quad , \quad ($$

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$$(2.6)$$

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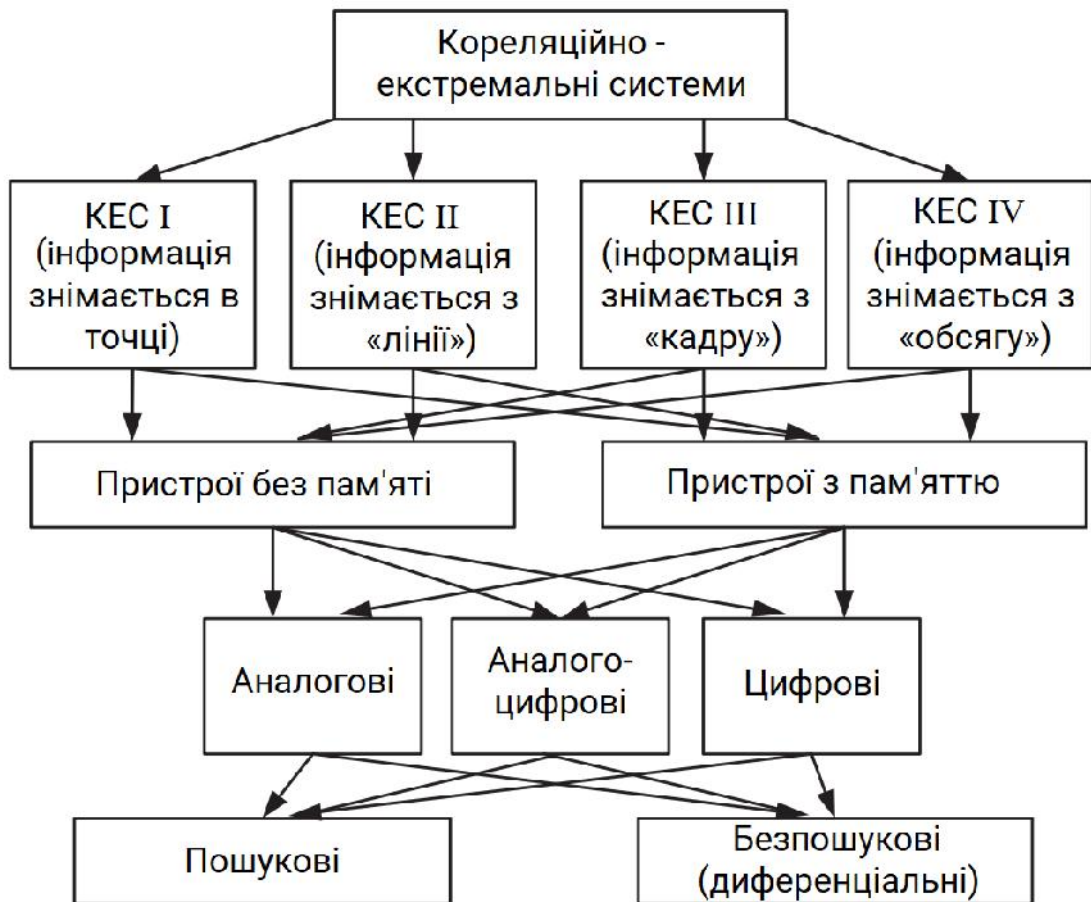
( IV).

II, II, IV

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IV

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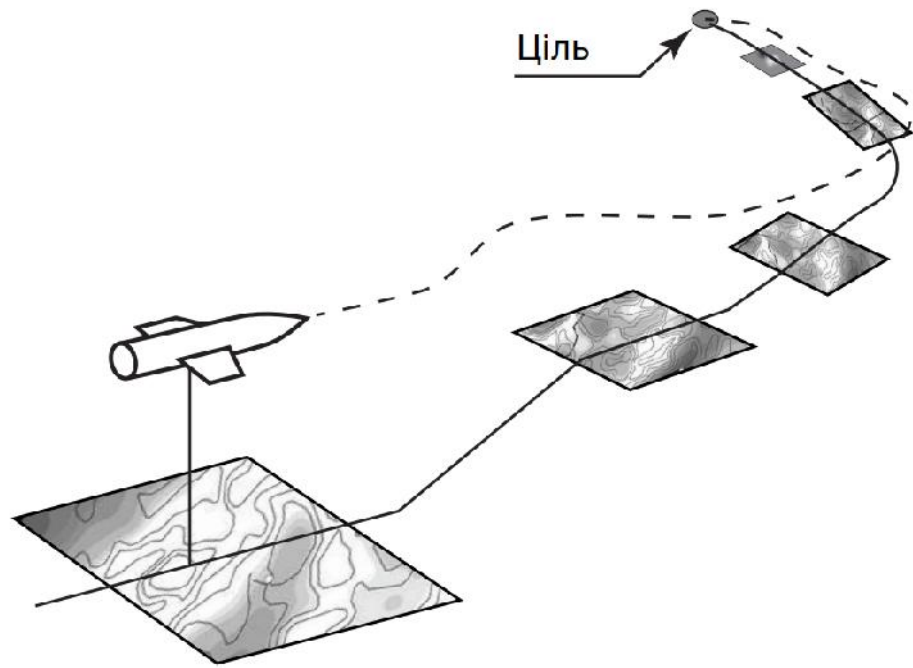
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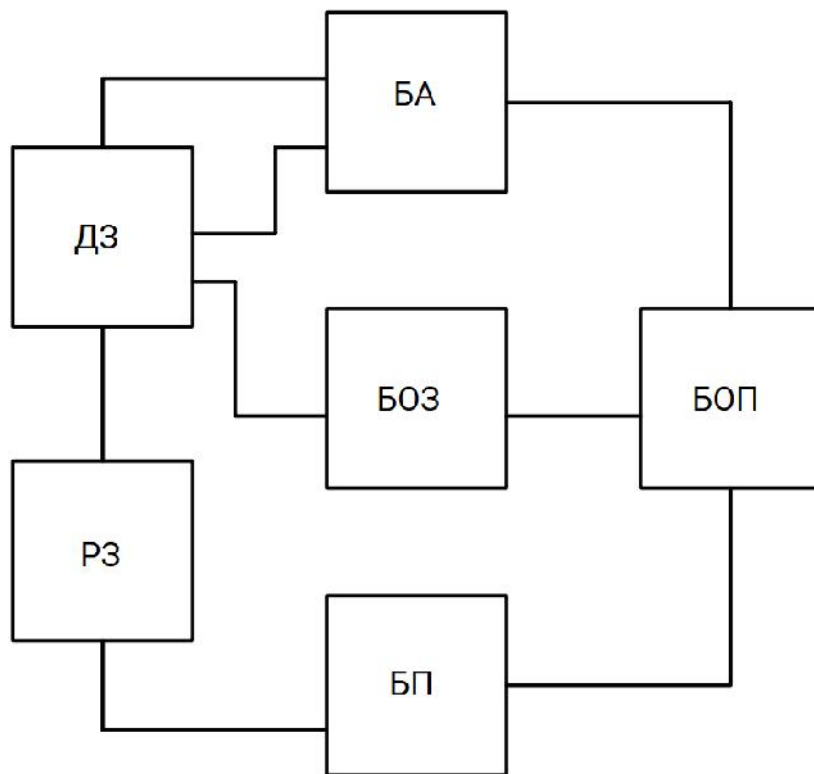
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$F_1(x_1, y_1)$  :

$F_1(x_1, y_1)$  -

$$x_1 = (x_2 - \xi) \cos \alpha + (y_2 - \eta) \sin \alpha; \tag{3.1}$$

$$y_1 = (y_2 - \eta) \cos \alpha + (x_2 - \xi) \sin \alpha, \tag{3.2}$$

[10].

(3.1, 3.2)

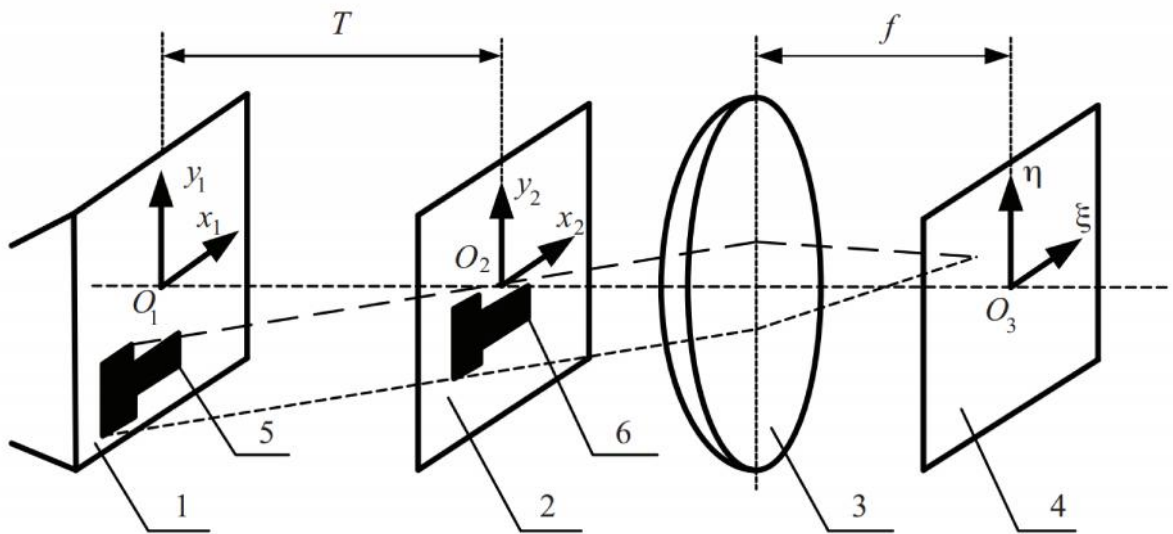
:

$$J(\xi, \eta, \alpha) = \int_S F_1(x_1, y_1) F_2(x_2, y_2) ds, \quad (3.3)$$

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[10].



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$K_s^*, K_e^*, \Delta S^*$  – ( )  
 $K_s, K_e, \Delta S$  ( )  
 $K_s, K_e, \Delta S$  ).  
 ,  $K_s, K_e$  , ,  $K'_s, \Delta S$  -  
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 $K_s, K_e, K'_s, \Delta S$  -  
 .

[17, 20]:

- 1-  $K_s \leq K_s^*; K_e \leq K_e^*; K'_s \leq K_s^*; \Delta S \leq \Delta S^*$ ;
- 2-  $K_s > K_s^*; K_e > K_e^*; K'_s \leq K_s^*; \Delta S \leq \Delta S^*$ ,  
 , ;
- 3-  $K_s > K_s^*; K_e > K_e^*; K'_s > K_s^*; \Delta S > \Delta S^*$ ;
- 4- ,  
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- 5- ,  
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- 6- ,  $K_s > K_s^*; \Delta S > \Delta S^*$ .

$K_s^*, K_e^*, K'_s, \Delta S$   
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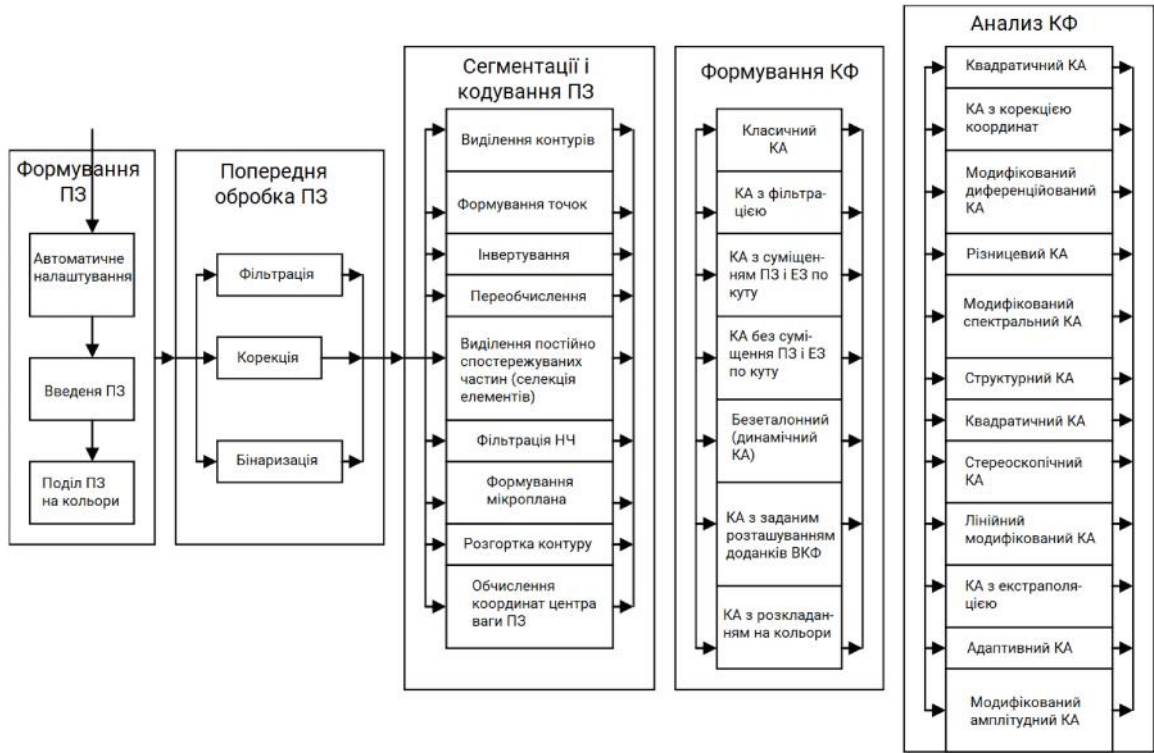
[21].

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[17, 18].



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[17].

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### 3.6

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«warping»



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[24].

$f(x)$   $m$ -  
 $n$ -  
 $:$

$$f(x) = f(x_1, \dots, x_n) \subseteq \mathbb{R}^n \rightarrow Z(f) \subseteq \mathbb{R}^m. \tag{4.1}$$

$:$

$$B(p) : X(f) \times Z(f) \rightarrow \{0,1\}, \tag{4.2}$$

$(n + m)$ -

$$p = \langle x, z \rangle, x \in X, z \in Z$$

$( \quad )$   $f(x)$ .

$B(p)$ ,

$(n + m)$ -

$X \times Z$ :

$$B = \{p : B(p) = 1\}. \tag{4.3}$$

—

$:$

$$b(x) : X \rightarrow \{0,1\}, \tag{4.4}$$

$$(Z \in \{0,1\}),$$

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 ,  
 (dot pattern).

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:

$$B(f(x)) = \{p = \langle x, z \rangle : x \in X, z \in Z, f(x) = z\}. \tag{4.5}$$

(umbra)

:

$$B(f(x)) = \{p = \langle x, z \rangle : x \in X, z \in \mathbb{R}, f(x) \geq z\}. \tag{4.6}$$

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$$\rho(f, g) = \left[ \sum_{\langle x, y \rangle \in X} |f(x, y) - g(x, y)|^\alpha \right]^{1/\alpha}, \quad (4.7)$$

$f(x, y) - g(x, y) -$  ;  
 $X -$  .  
 $\in [1, )$   
 $= 2$   
 $L^2(x, y)$   $X$  .  
 $n$   $\{f_i\}, i = 1, \dots, n,$   
 $i-$  .  $g$   
 $j$  , ,  
 $:$   
 $j = \arg \min_i \rho(g, f_i).$  (4.8)

$$f' = af + b.$$

$$R(f, g) = \frac{\sum_{\langle x, y \rangle \in X} (f(x, y) - f^0)(g(x, y) - g^0)}{\sqrt{\sum_{\langle x, y \rangle \in X} (f(x, y) - f^0)^2} \sqrt{\sum_{\langle x, y \rangle \in X} (g(x, y) - g^0)^2}}, \quad (4.9)$$

$f^0, g^0$  —  $f, g$

.

:

- 1)  $-1 \leq R(f, g) \leq 1, \forall f, g$ ;
- 2)  $(R(f, g) = 1) \Leftrightarrow (g = af + b, a > 0, \forall b)$ ;
- 3)  $(R(f, g) = -1) \Leftrightarrow (g = af + b, a < 0, \forall b)$ .

«  
 $\{f_i\}, i = 1, \dots, n,$   
 $i-$   $g$   
 ».

$$j = \arg \max_i R(g, f_i). \quad (4.10)$$

,

$$R(g, f_i) \geq R_{\min}, \quad (4.11)$$

$R_{\min}$  —

$$(4.11)$$

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[28, 29].

(4.10).



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Google Maps ( 4.1).

( 4.2).



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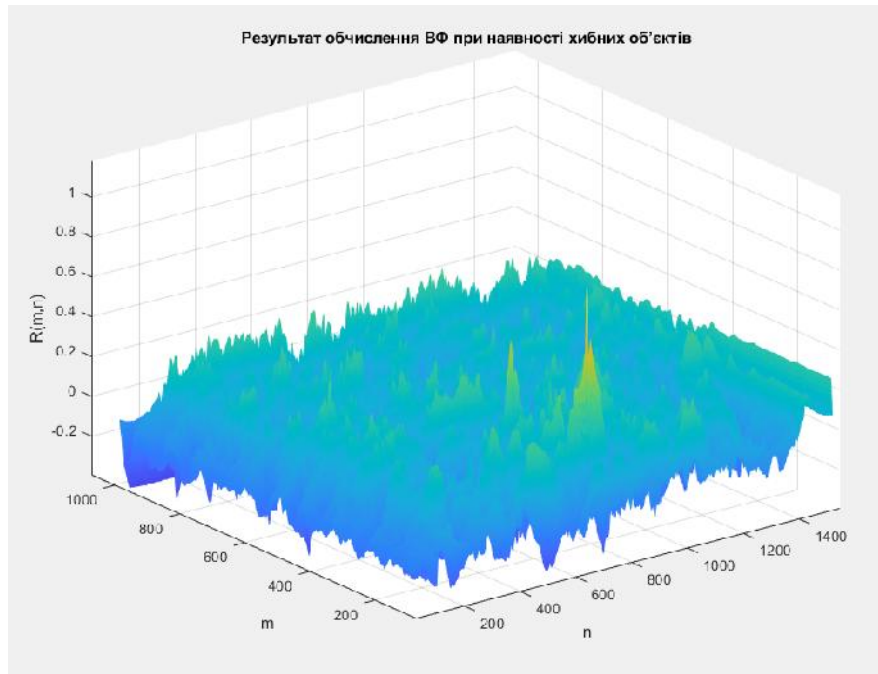
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- 1)
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[27];

(4.9)



4.5 –

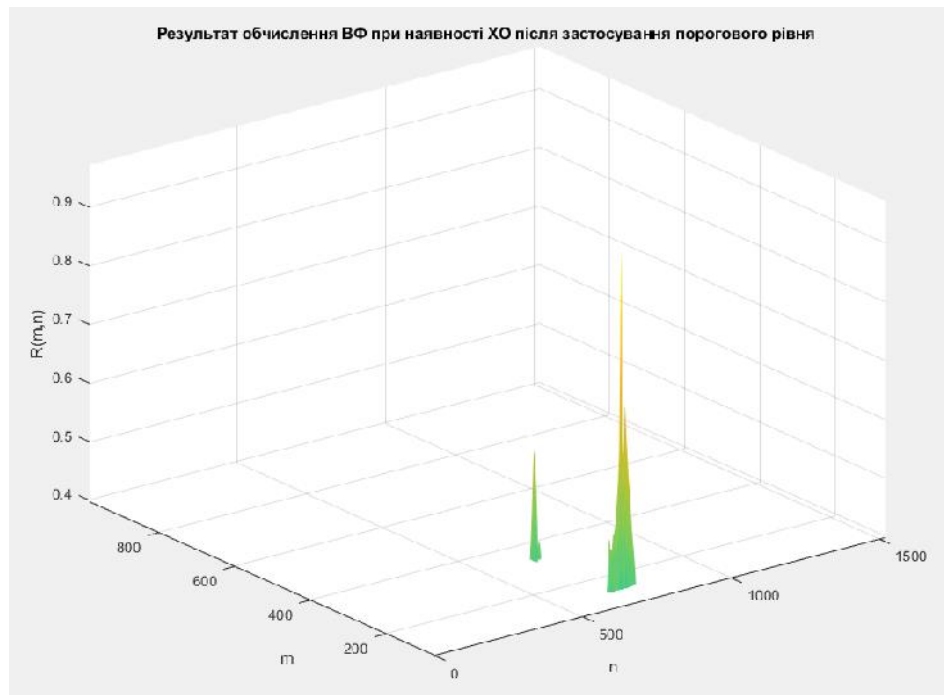
(4.11),

$R_{\min}$

(4.10),

$$n \quad j_1, j_2, \dots, j_n$$

[30].

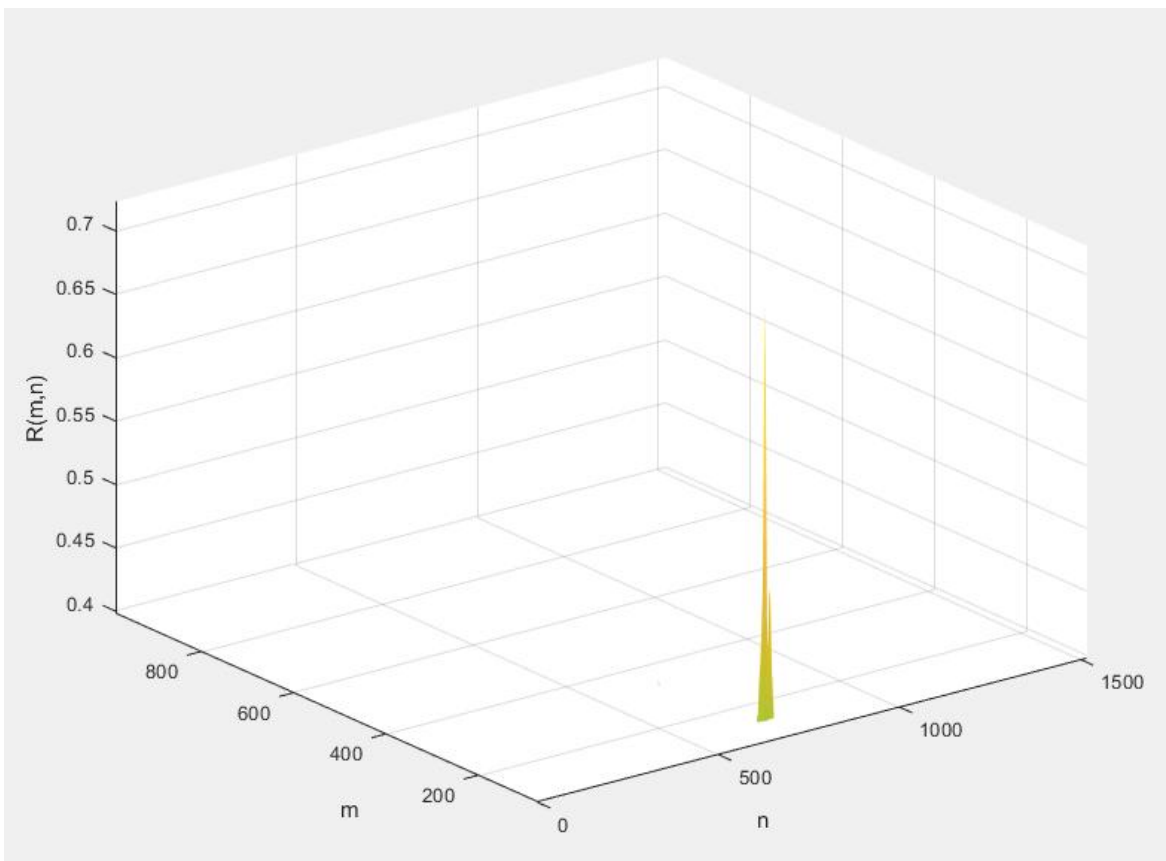


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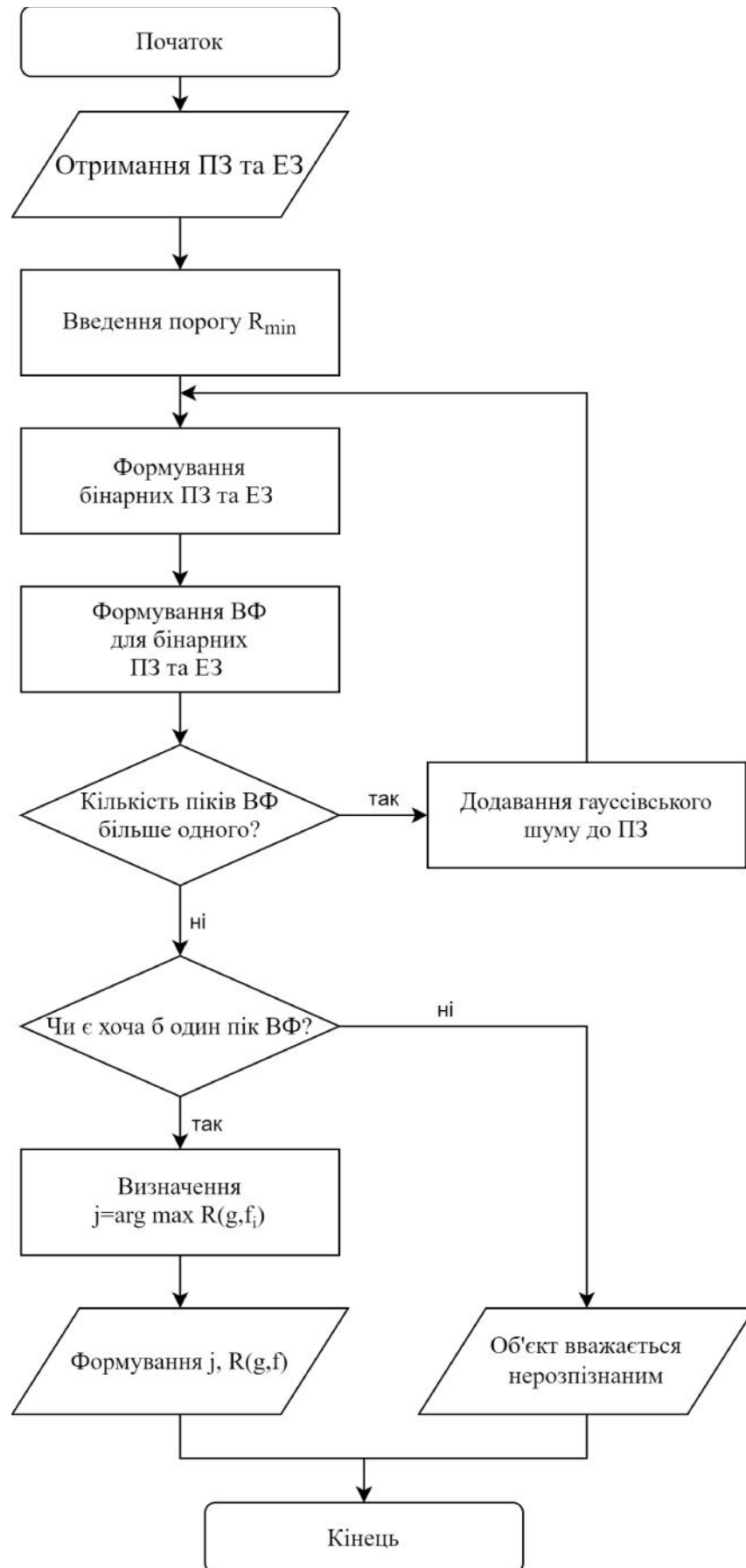
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 $p$   $z$   
 :

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}, \quad (4.11)$$

$z$  – ;  
 $\mu$  – ;  
 $\sigma$  – .

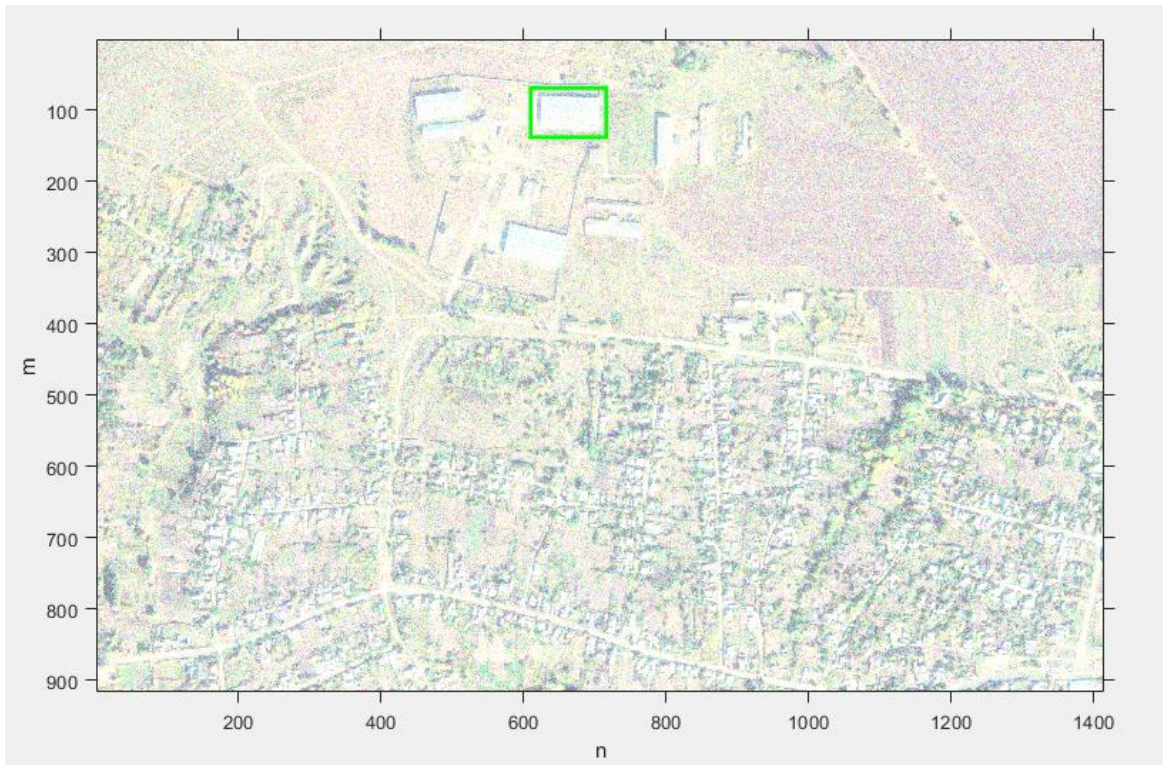


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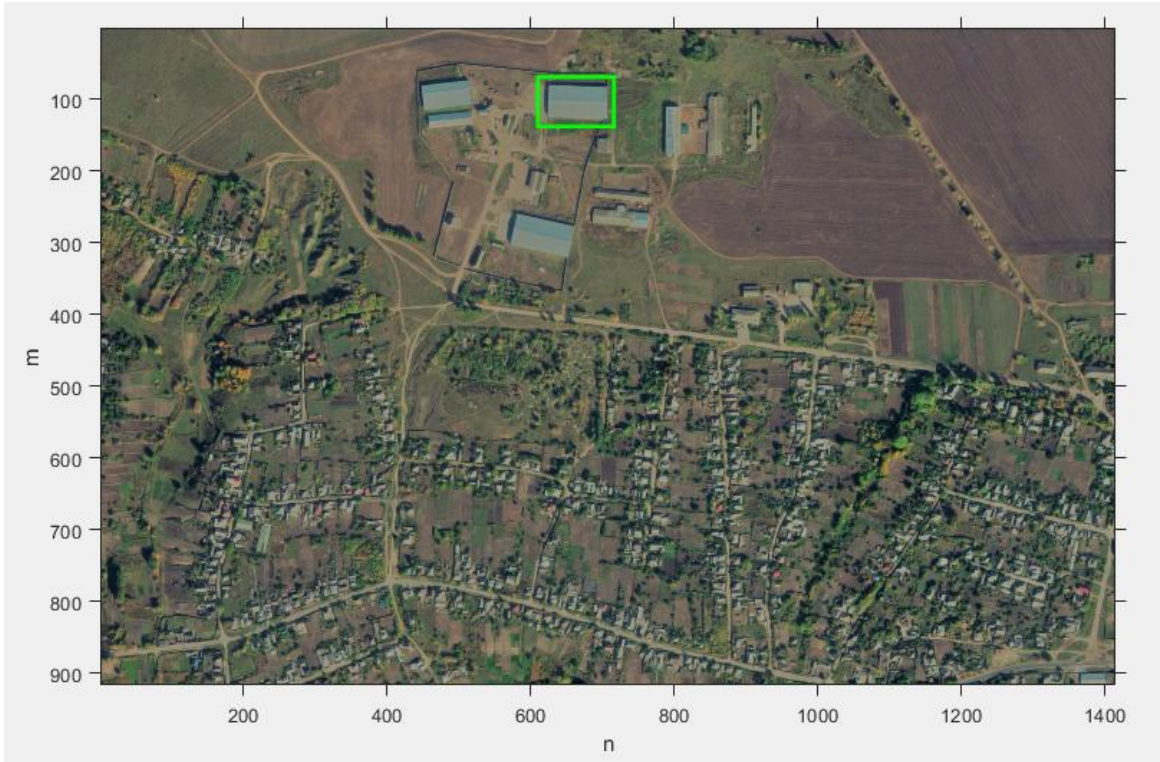


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- . ./ . . - .: ,1984. - .17. - . 251 - 293.
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- A. M. , . . , . . ; . A. M.
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