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6. .1) (, , , ,) _____

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1		31.03.20 – 17.04.20	
2		20.04.20 – 2.05.20	
3		4.05.20 – 7.05.20	
4		8.05.20 – 11.05.20	
5		12.05.20 – 13.05.20	
6		14.05.20 – 15.05.20	

30 2020 .

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: 70 ., 42 ., 6

., 2 ., 18 .

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Arduino.

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ABSTRACT

Master's thesis: 70 pages, 42 figures, 6 tables, 2 appendices, 18 sources.

ROBOT, FUZZY LOGIC, SENSOR, MODEL, ARDUINO.

The major goal of this thesis models and methods of control of the wheeled robot to inflate the smog on the bases of the odd controller on the Arduino platforms.

In the course of the exhibition, the gallery of robots, their concepts and structures were examined. Conceptual model of the wheeled robot was considered, as well as the way of controlling wheeled robots on the basis of different methods and models. Research work of these models and methods is carried out . On the basis of the selected early date of acquisitions and sparkling weeks and perturbations. An example of software implementation of fuzzy control of robot movements along the lane is given.

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			11
1.1			11
1.2		13
1.3			20
1.3.1			21
1.3.2			25
1.4			26
1.5.			31
2	.			
			32
2.1.		32
2.2.				
			34
2.3			40
2.4.			45
2.5			50
3			51
3.1			51
3.1.1.				
			51

3.2.

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.....	59
.....	61
.....	69

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[2].

(1.2).



1.2 -

MESSENGER

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(1.3),
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1.3 – Xiaomi

1.2

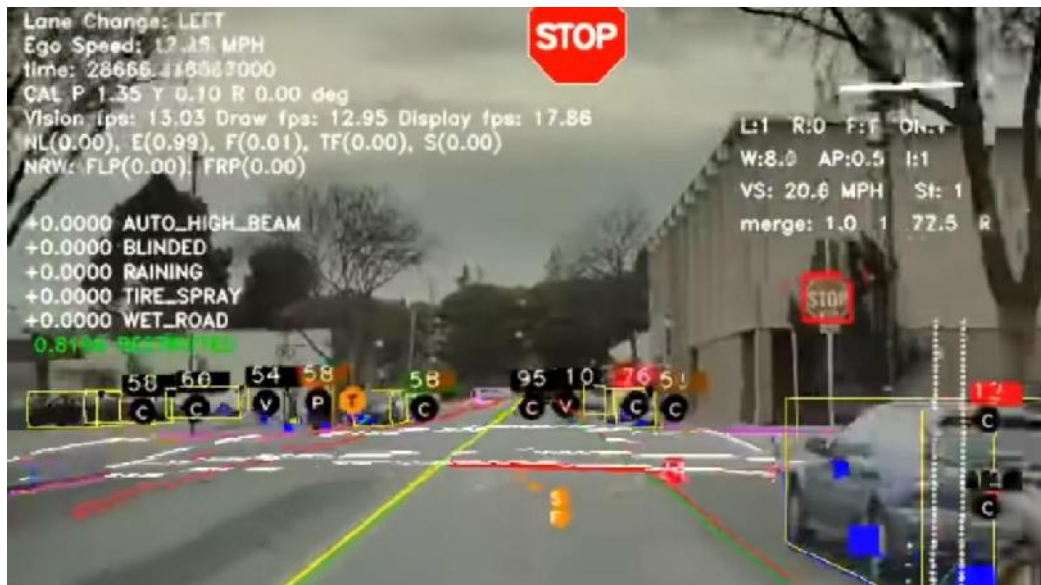


1.4 – Velox

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1.5 –

Tesla

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 (1.5).

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(1.6).

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1.6 –

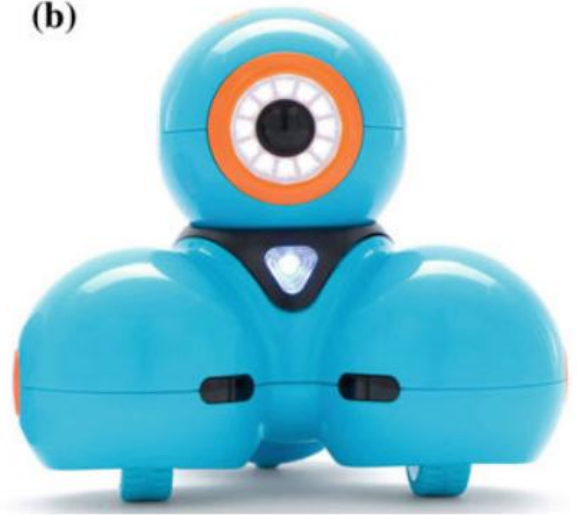
« »

«Uncanny valley»[3].

(a)



(b)



1.7 –)

«Thymio», b)

«Dash»

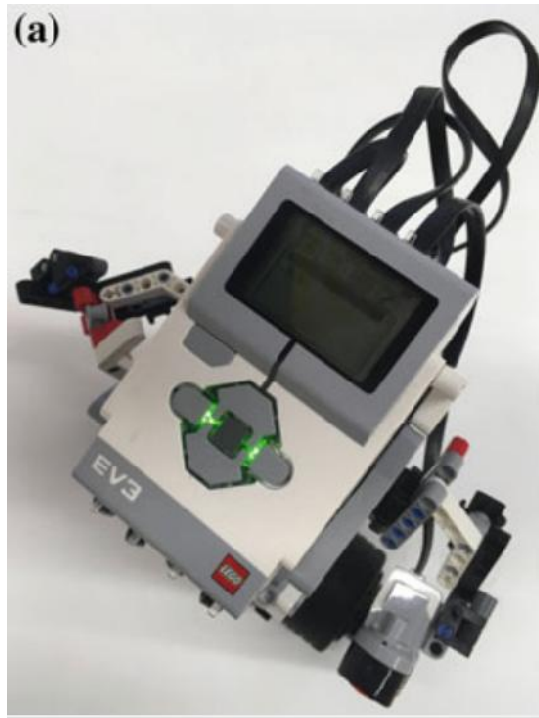
1.7

LEGO® (1.8).

1998 . 1.8

2014 [4].

LEGO®



1.8 – LEGO® Mindstorms EV3

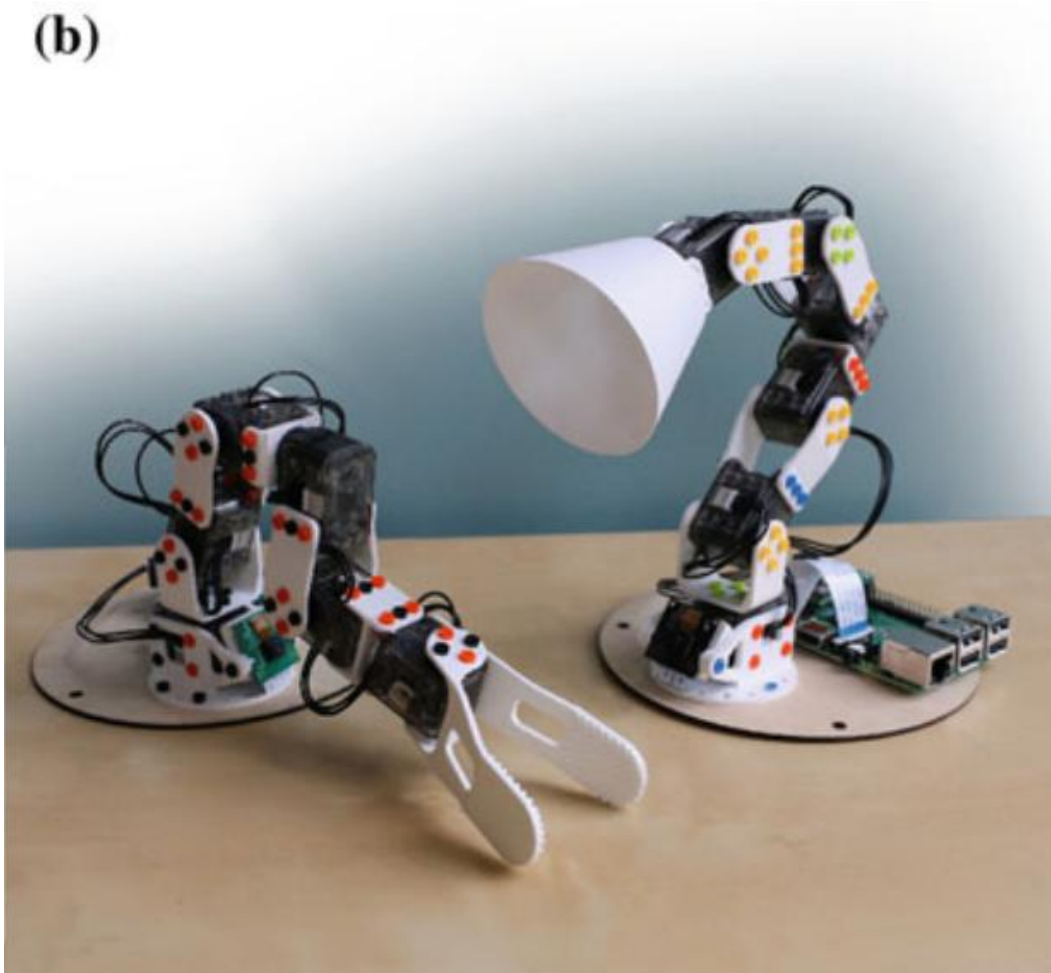
Ergo Jr» (1.9).

3D

«Poppy

3D

(b)



1.9 - «Poppy Ergo Jr»

1.3

, Java, Python. ,
: Scratch Blockly.
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1.3.1

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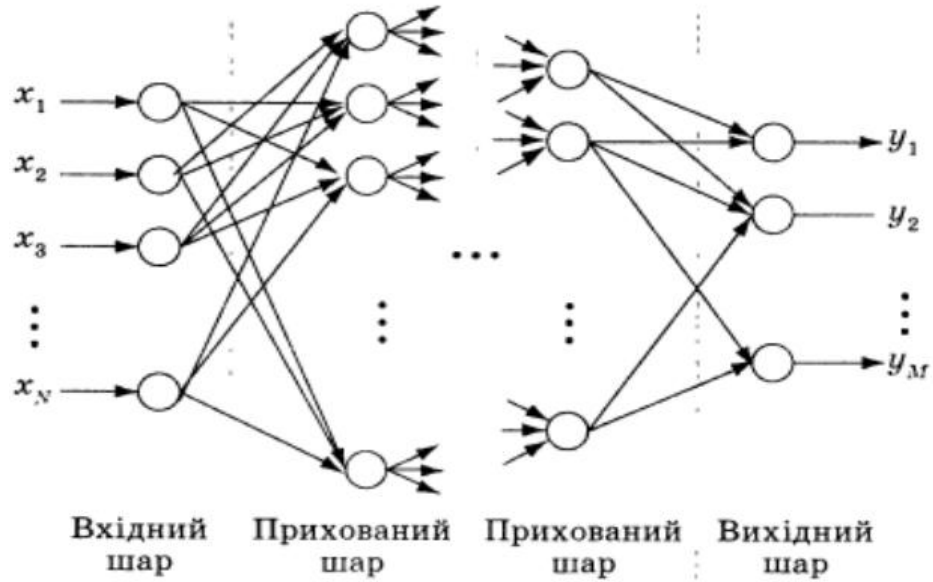
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(1.10).



1.10 –

,
 $W = [w_{ij}]$ $N \times N$, N —
 w_{ij} , i -
 j -
 - $w_{ij} = 0$ — , j - ;
 - $w_{ij} < 0$ — , ;
 - $w_{ij} > 0$ — () , .
 , , ,
 :
 - , (, Feed f rward);
 - , (, , ,

Feedback):

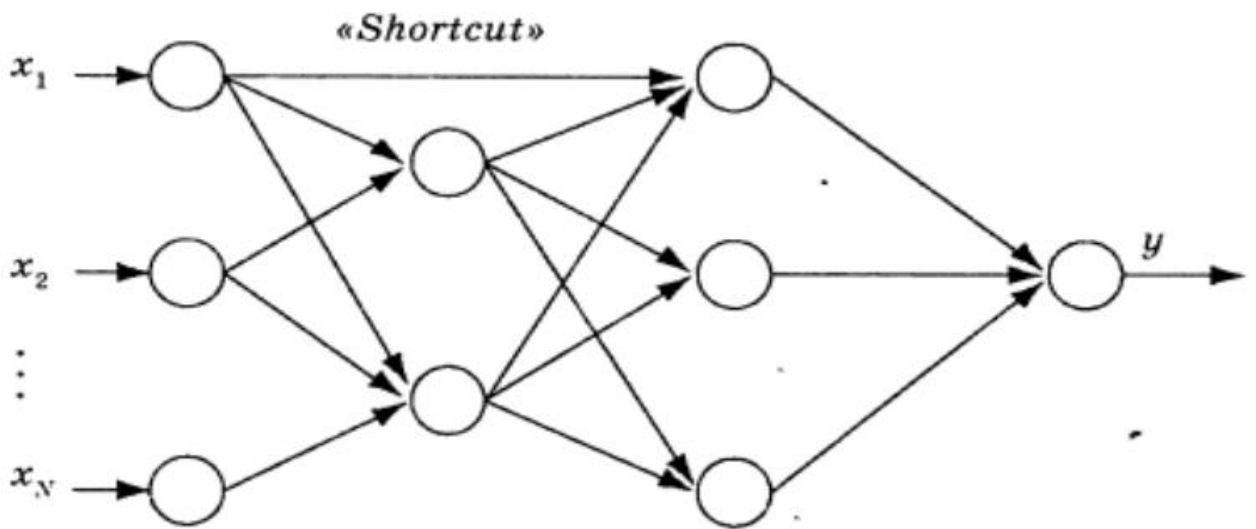
- a) , (direct feedback);
- b) , (indirect feedback);

c) , (lateral feedback);

d) , .

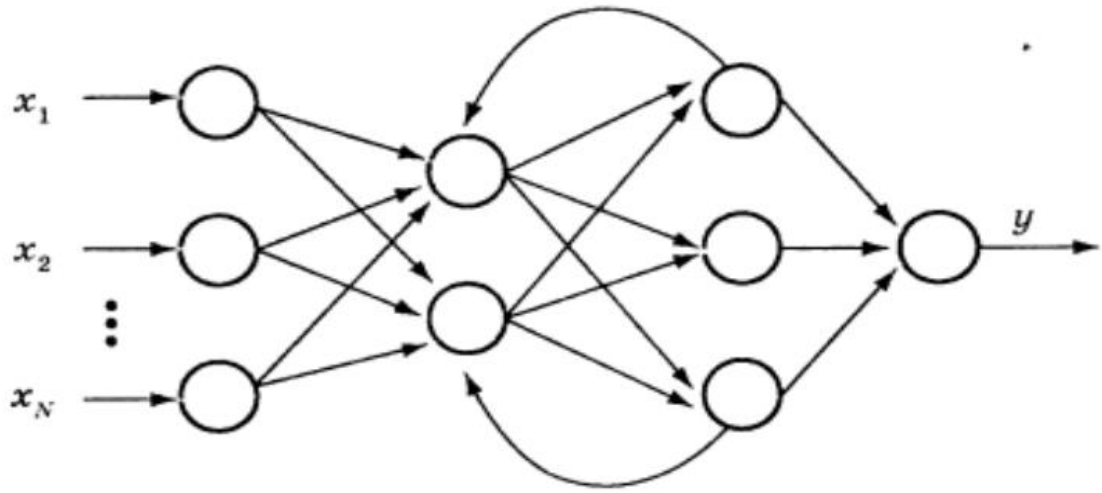
, , - (+1)- .
 , , (+1)- ,
 , - (+1)-
 , - (+1)- , $l > 1$.

«shortcut» (1.11).



1.11 –

, (1.12) -



1.12 -

, ().

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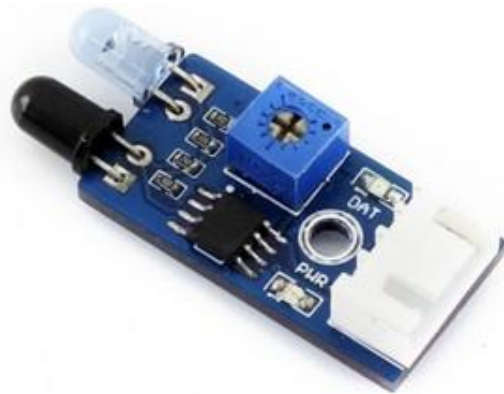
1.3.2

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1.4

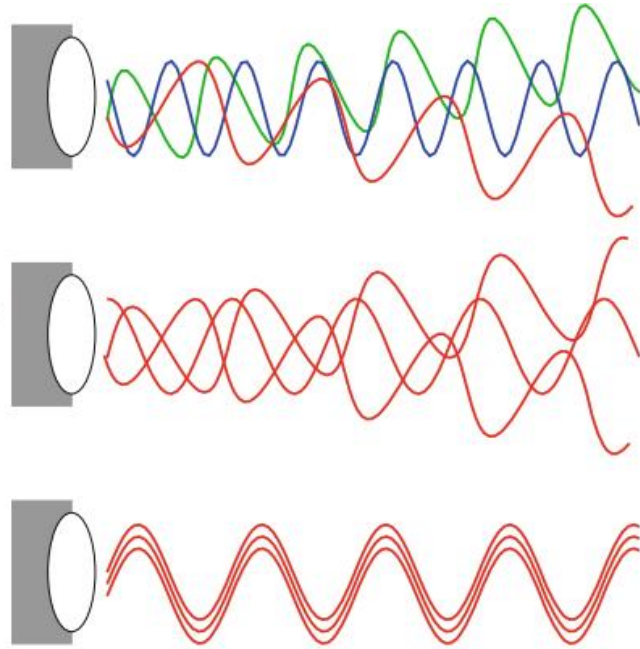
[6].

1.13.



1.13 –

).



1.15 – , ()

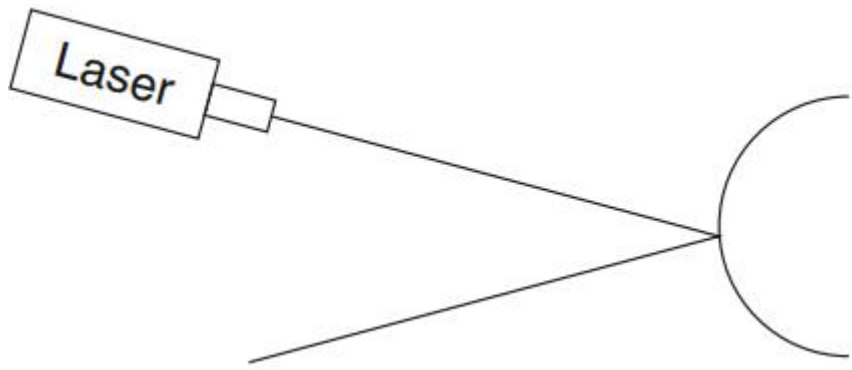
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(1.15).

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, , , , , , (1.16).



1.16 –

(1.17),

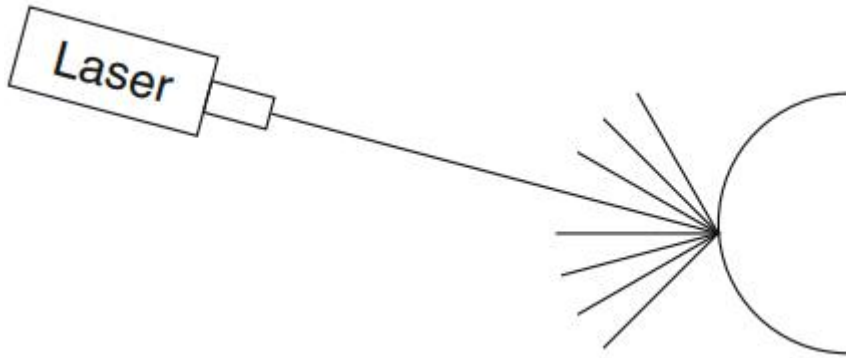
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.[7]



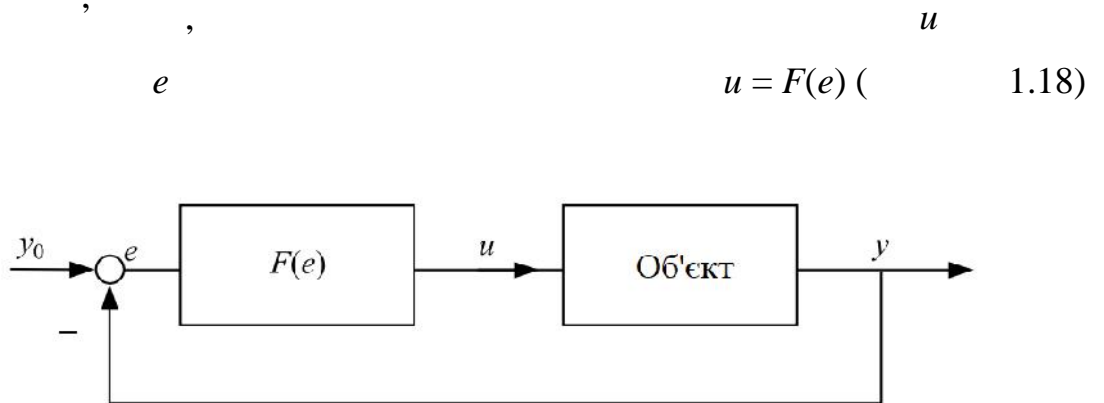
1.17 –

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1.5.

[8].



1.18 –

2

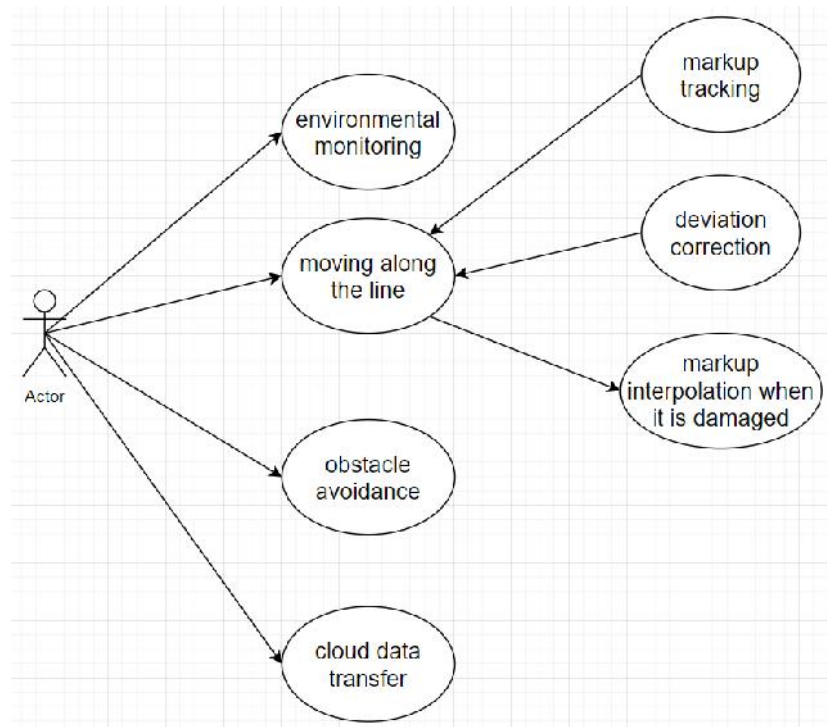
2.1.

- environmental monitoring –
- moving along the line –

:

- 1) markup tracking –
- 2) deviation correction –
- 3) markup interpolation when it is damaged –

- obstacle avoidance –
- cloud data transfer –



2.1 –

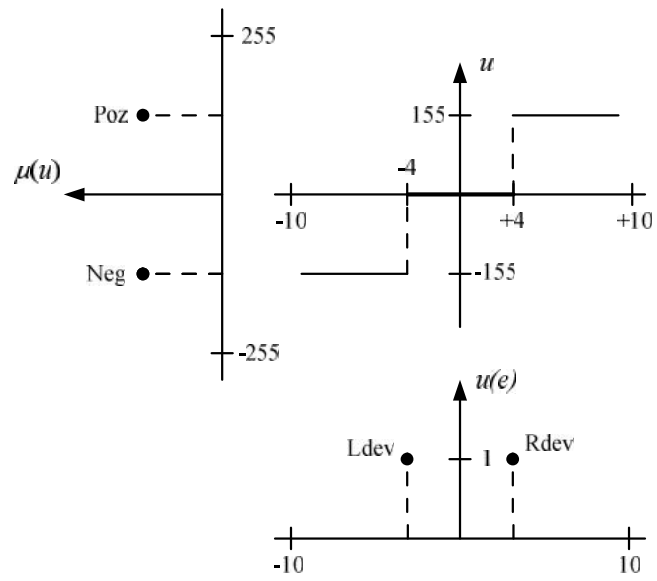
1 0

[9]

2.2.

[10].

(2.2)



2.2 –

() ,

- IF ($e = Ldev$) THEN ($u = Rdev$);
- IF ($e = Rdev$) THEN ($u = Ldev$).

- $e - ()$;
- $u - ()$.

Fuzzy Logic Toolbox MATLAB

(Misstep) – (e)

U_R $U_L - (u)$

($e = -8$),

U_L^t 0 125. ,

U_R^t

[11]:

$$U_R^t = U_R^{t-1} + \Delta U_R \tag{2.1}$$

$$U_L^t = U_L^{t-1} + \Delta U_L \tag{2.2}$$

: (/):

$$V^t = 25 \text{ cm/сек} * \left(\frac{m (U_R^t, U_L^t)}{2} \right) \tag{2.3}$$

, (/):

$$\omega^t = 60^\circ / \text{сек} * \left(\frac{|U_R^t| - |U_L^t|}{2} \right) \tag{2.4}$$

():

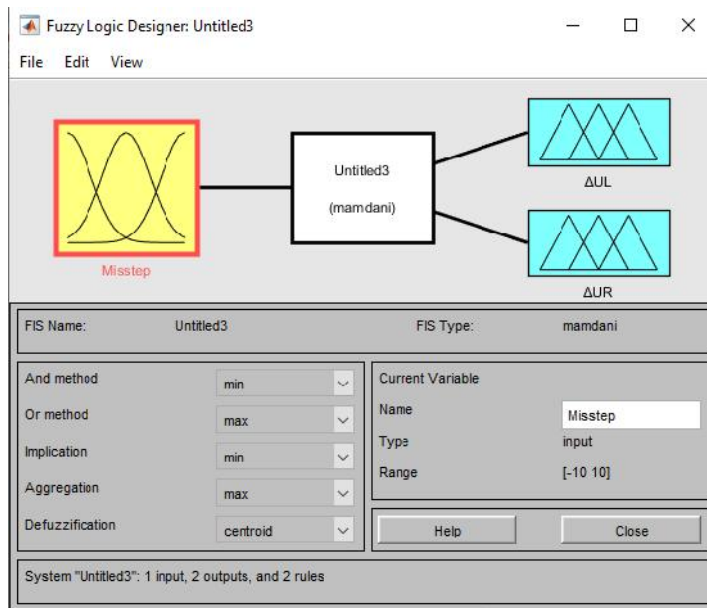
$$S^t = V^t \quad t \tag{2.5}$$

():

$$\alpha^t = \omega^t \quad t \tag{2.6}$$

:

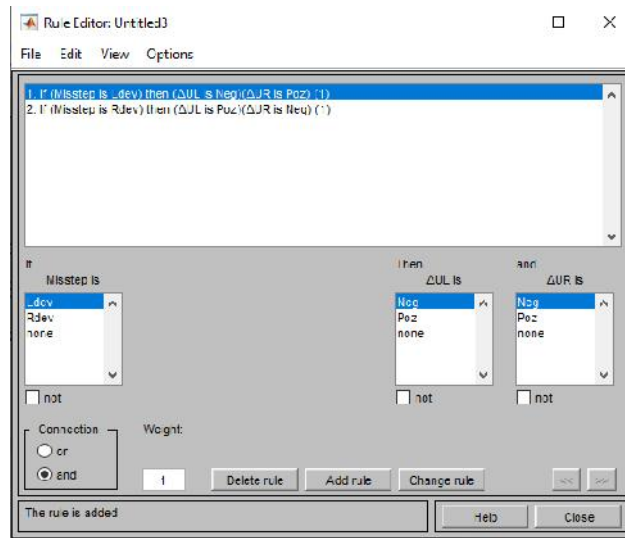
$$e^t = e^{t-1} + \frac{S^t s \alpha^t}{1}, \tag{2.7}$$



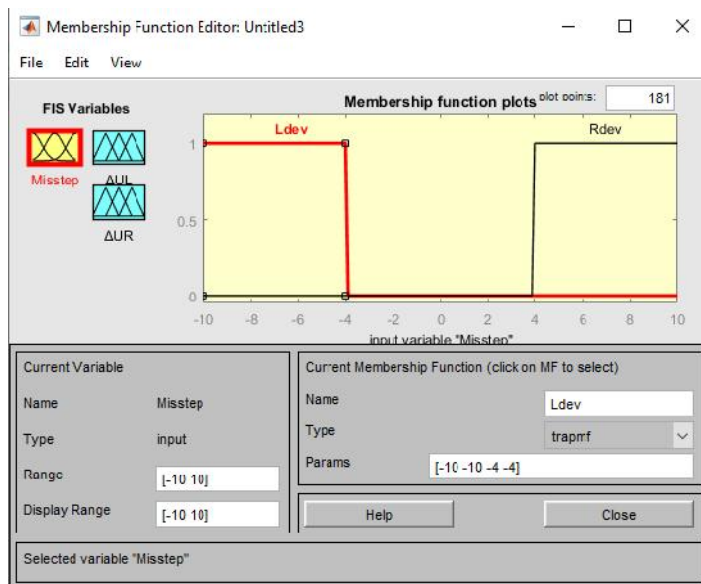
2.3 –

(Misstep) (U_R, U_L) (2.3).

(2.4). ()



2.4 –



2.5 –

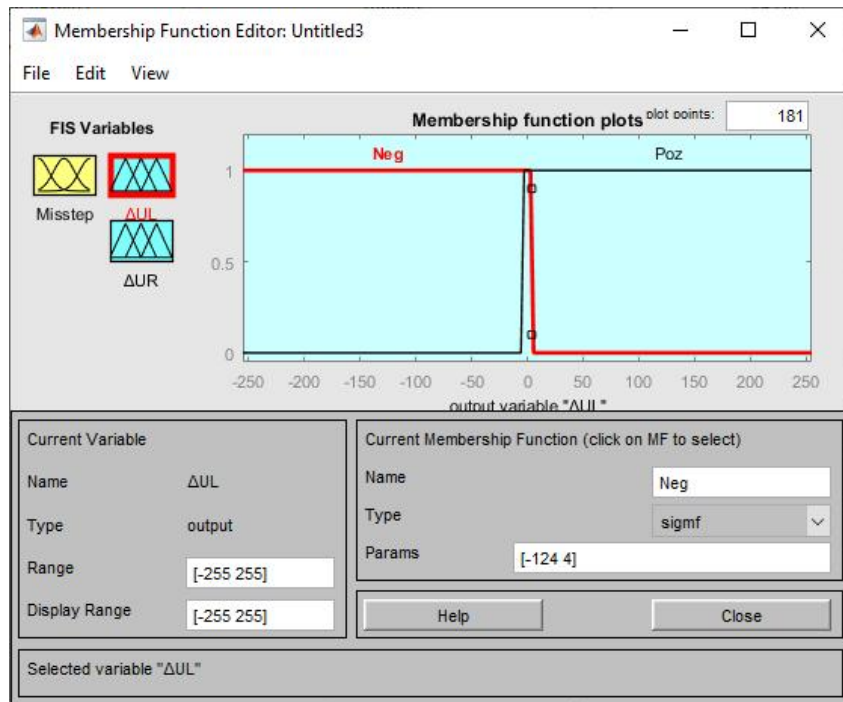
(),

(2.5).

Neg

Poz

(2.6).



2.6 –

255 1

50 ,

[12].

[13].

()

{-10, -8, -6, -4, -2, 0, +2, +4, +6, +8, +10}

(2.7)

(2.1).



2.7 –

Misstep = -8

2.1 –

Misstep	-10	-8	-6	-4	-2	0
U_R	127	127	127	127	0	0
U_L	-128	-128	-128	-128	0	0
Misstep	+10	+8	+6	+4	+2	0
U_R	-128	-128	-128	-128	-62.6	0
U_L	127	127	127	127	62.6	0

(2.2)

2.2 -

t	U_R^t	U_L^t	V^t	ω^t	S^t	α^t	e^t
0	125	125	0	0	0	0	-8
1	252	0	0	59,29	0	59,29	-8
2	255	0	0	60	0	60	-8
3	255	0	0	60	0	60	-8
4	255	0	0	60	0	60	-8
5	255	0	0	60	0	60	-8
6	255	0	0	60	0	60	-8
7	255	0	0	60	0	60	-8
8	255	0	0	60	0	60	-8
9	255	0	0	60	0	60	-8
10	255	0	0	60	0	60	-8
11	255	0	0	60	0	60	-8

(2.2)

Misstep

« »

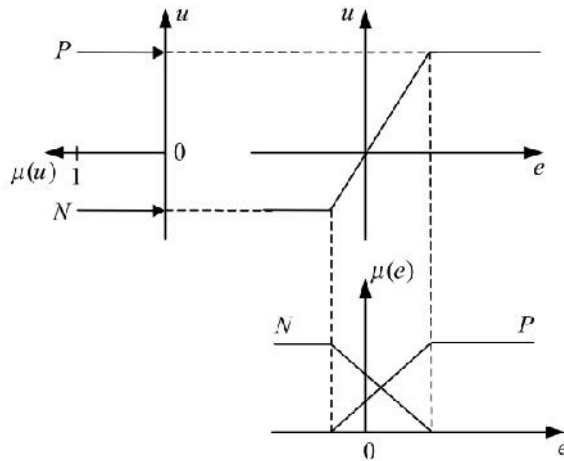
2.3

(2.8)

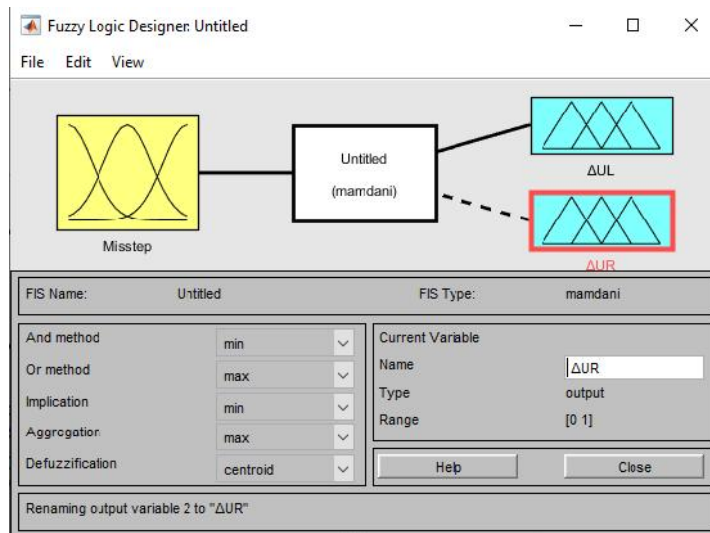
[14].

:

- IF ($e = N$) THEN ($u = N$);
- IF ($e = P$) THEN ($u = P$).



2.8 –



2.9 –

:

- e – () ;
- u – .

(Misstep) –

(e)

$U_R \quad U_L - \quad (u)$

(2.9)[15].

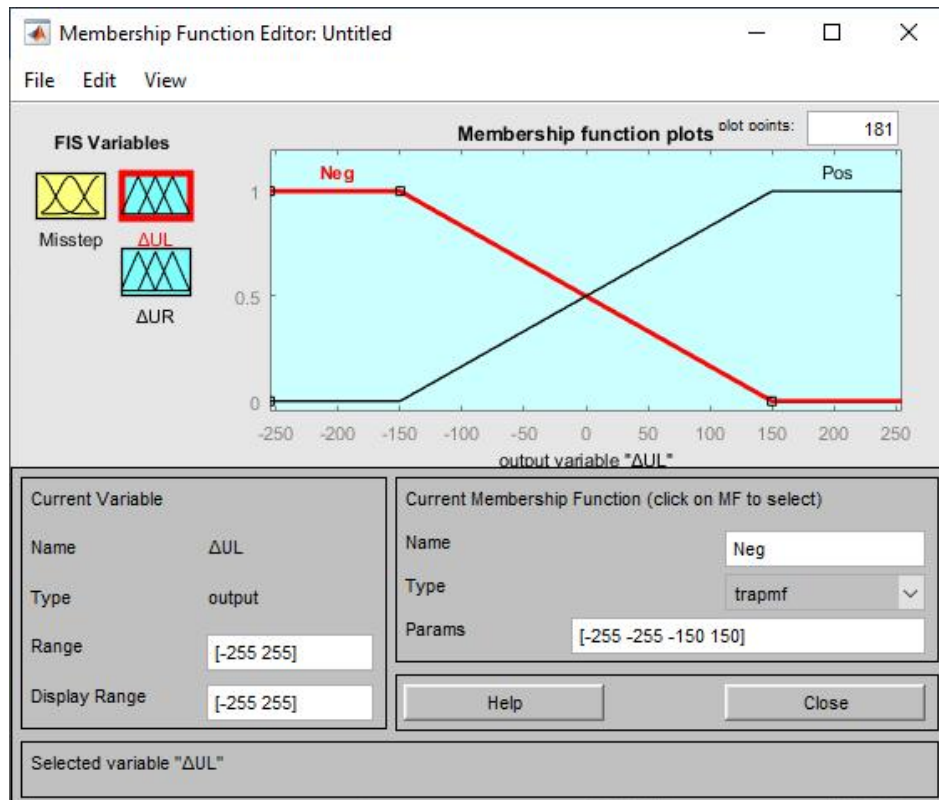
[-20; 20].

[-255; 255].

Neg,

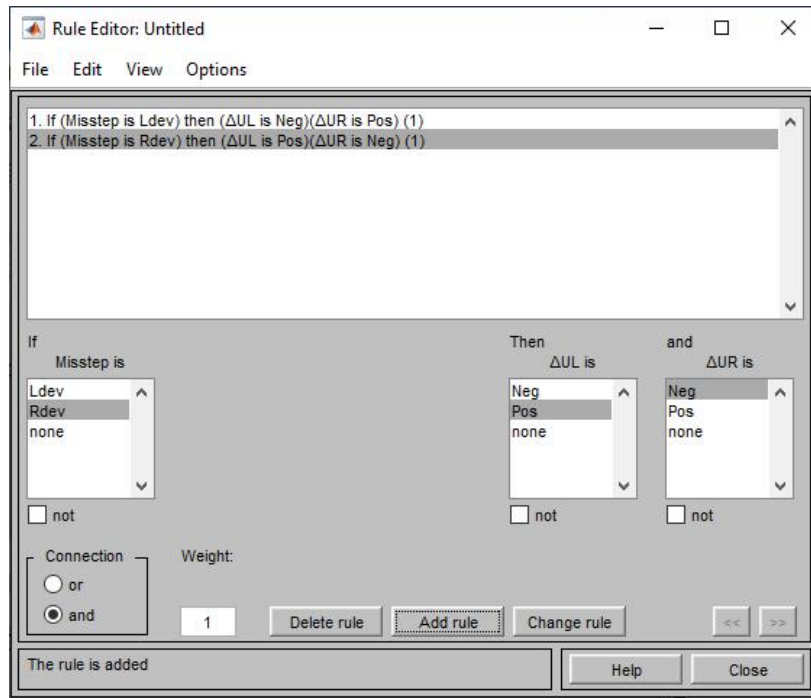
Poz

(2.10).

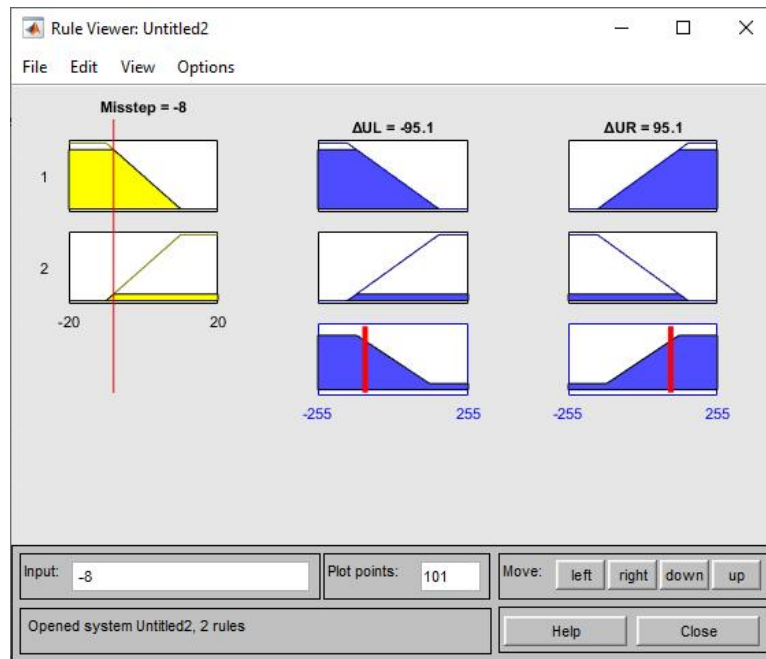


2.10 –

(2.11).



2.11 –



2.12 –

Misstep = -8

[16], , 255 1 50

()
 {-10, -8, -6, -4, -2, 0, +2, +4, +6, +8, +10}

(2.12) (2.3).

2.3 –

Misstep	-10	-8	-6	-4	-2	0
U_R	113	95.1	73.9	50.5	25.6	0
U_L	-113	-95.1	-73.9	-50.5	-25.6	0
Misstep	+10	+8	+6	+4	+2	0
U_R	-113	-95.1	-73.9	-50.5	-25.6	0
U_L	113	95.1	73.9	50.5	25.6	0

(Misstep = -8),

U_L^t 0 125.

U_R^t

2.4 -

t	U_R^t	U_L^t	V^t	ω^t	S^t	α^t	e^t
0	125	125	0	0	0	0	8
1	29	220,1	2,9	-44,8	2,9	-44,8	6
2	0	255	0	-60	0	-60	6
3	0	255	0	-60	0	-60	6
4	0	255	0	-60	0	-60	6
5	0	255	0	-60	0	-60	6
6	0	255	0	-60	0	-60	6
7	0	255	0	-60	0	-60	6
8	0	255	0	-60	0	-60	6
9	0	255	0	-60	0	-60	6
10	0	255	0	-60	0	-60	6
11	0	255	0	-60	0	-60	6

2.4.

(2.13) ,

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[17].

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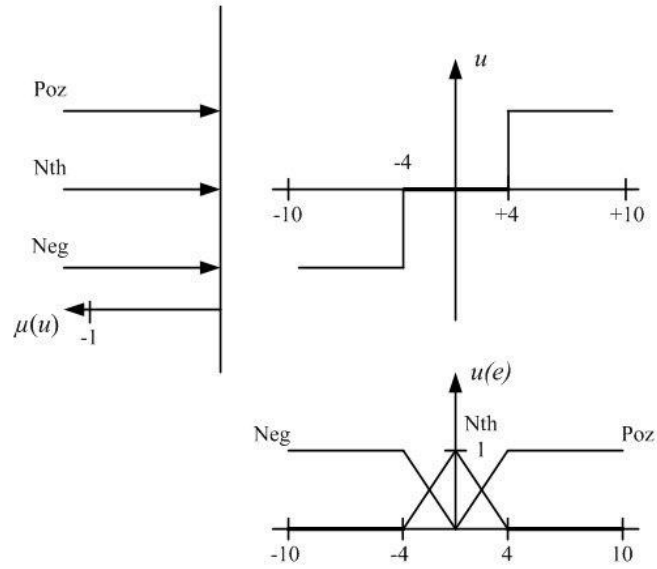
 e

:

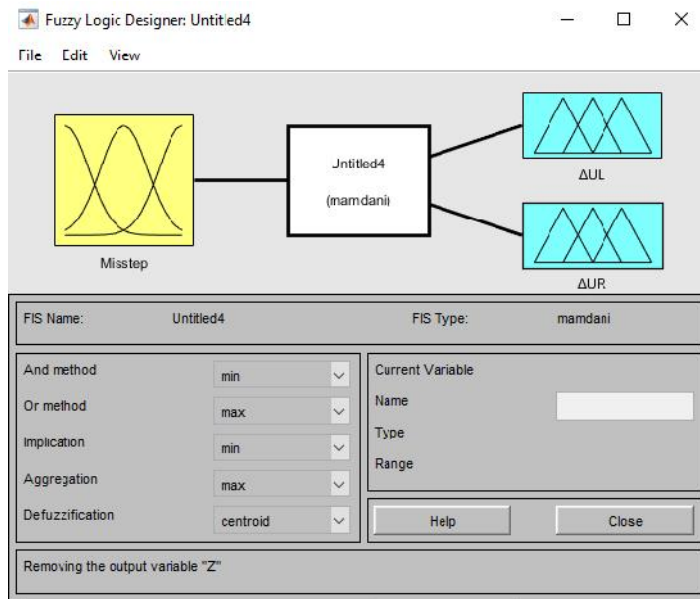
- IF ($e = N$) THEN ($u = N$);
- IF ($e = Z$) THEN ($u = Z$);
- IF ($e = P$) THEN ($u = P$).

,

(2.14).



2.13 –



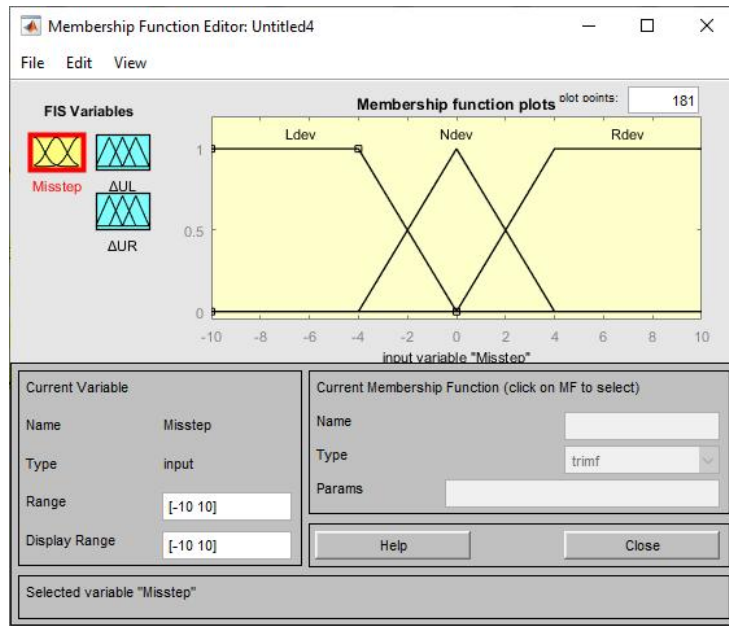
2.14 –

$[-10 +10]$.

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Ndev

(2.15).



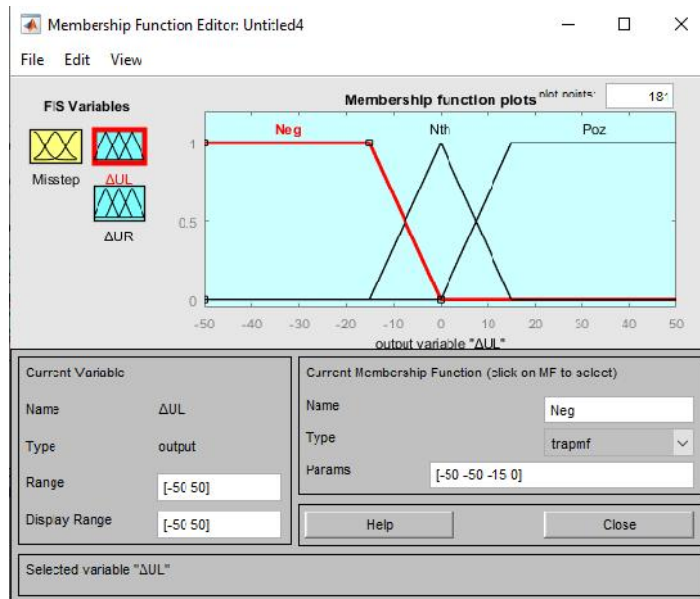
2.15 –

(Z),

(2.16).

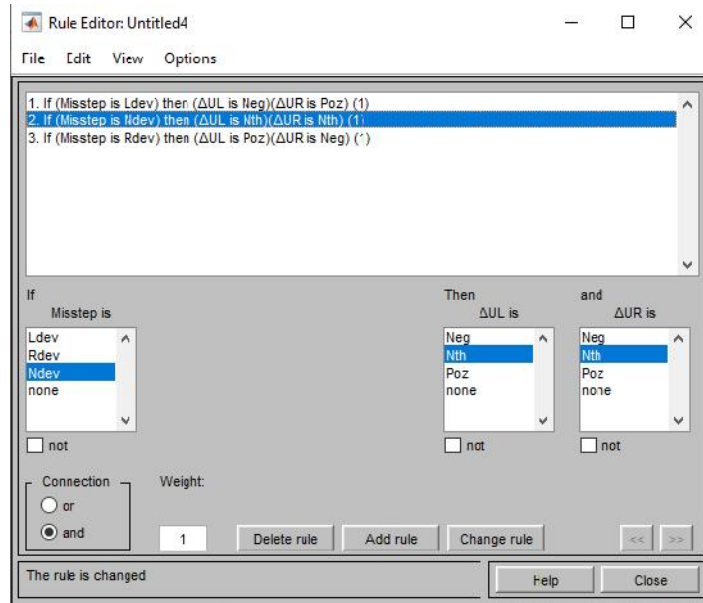
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[18].

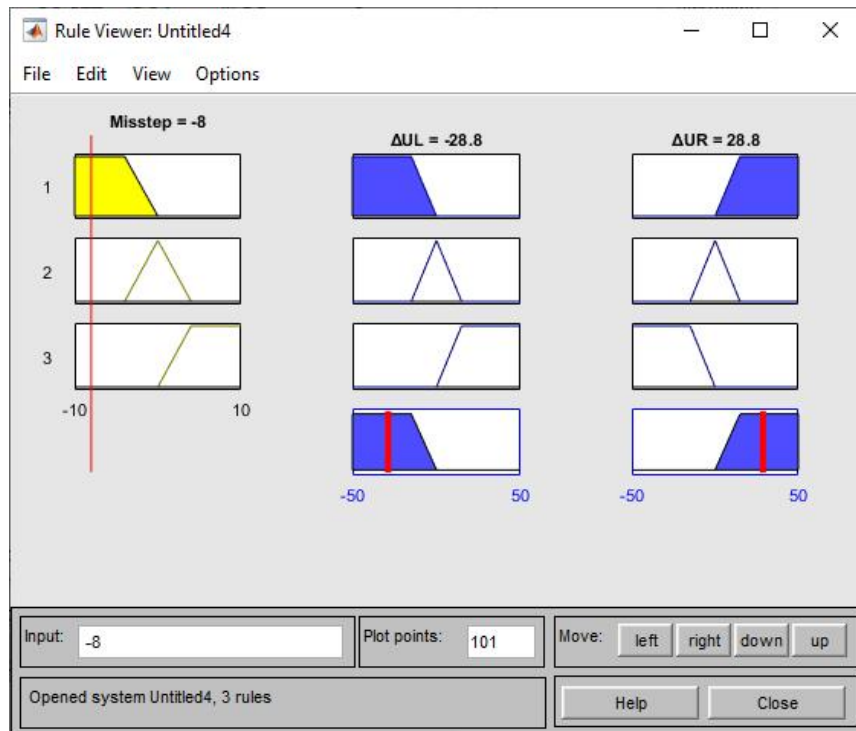


2.16 –

(2.17).



2.17 –



2.18 –

Misstep = -8

(2.5) ,

e (Misstep)

0 (2.18) (Z).

2.5 –

Misstep	-10	-8	-6	-4	-2	0
U_R	28.8	28.8	28.8	28.8	19.6	0
U_L	-28.8	-28.8	-28.8	-28.8	-19.6	0
Misstep	+10	+8	+6	+4	+2	0
U_R	-28.8	-28.8	-28.8	-28.8	-19.6	0
U_L	28.8	28.8	28.8	28.8	19.6	0

2.6 –

t	U_R^t	U_L^t	V^t	ω^t	S^t	α^t	e^t
0	125	125	0	0	0	0	-8
1	153,8	96,2	9,431	13,553	9,431	13,553	-6
2	182,6	67,4	6,608	27,106	6,608	27,106	-2
3	202,2	47,8	4,686	36,329	4,686	36,329	0
4	202,2	47,8	4,686	36,329	4,686	36,329	0
5	202,2	47,8	4,686	36,329	4,686	36,329	2
6	182,6	67,4	6,608	27,106	6,608	27,106	6
7	153,8	96,2	9,431	13,553	9,431	13,553	10
8	125	125	12,255	0,000	12,255	0,000	10
9	96,2	153,8	9,431	-13,553	9,431	-13,553	8
10	67,4	182,6	6,608	-27,106	6,608	-27,106	6
11	38,6	211,4	3,784	-40,659	3,784	-40,659	2

(2.6).

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(*Misstep*).

2.5

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(

2.6) *Misstep*= $f(U_R, U_L)$

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Arduino

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U_R, U_L

Misstep

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3.1

3.1.1.



3.1 –

DG-012ATV

DG-012ATV (

3.1), - 48:1
 78
 , Li-Pol .
 Arduino Mega 2560
 (3.2). ATmega2560.



3.2 – Arduino Mega 2560

3.1 – Arduino Mega 2560

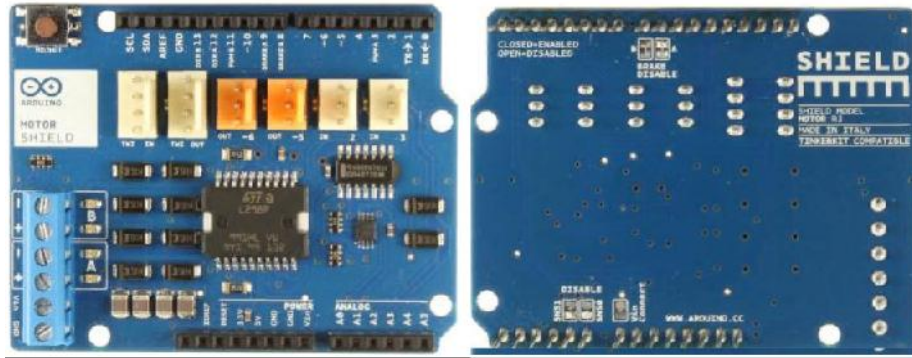
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3.3	50
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	16

Uno Duemilianove. (3.1)

USB

Arduino Motor Shield (3.3).

Arduino.



3.3 – Arduino Motor Shield

033.

KY-033 (3.4) –

(/).

KY-

- : +/-20 , ;
- : 3.3 – 5 ;
- : 18 – 20 (5V);

- : $-10 - 50^\circ$;
- : $46 - 10$;
- : 0 () 1 () ;
- : 35° .



3.4 –

KY-033

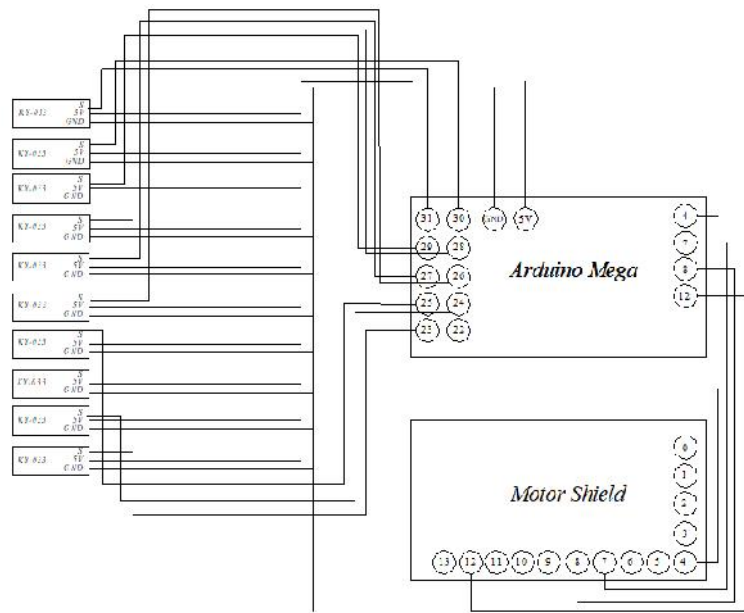
Y-033

, : ± 20 , , : 35° . (10)

Motor Shield

Arduino MEGA

. 3.5.



3.5 –

MotorShield

Arduino MEGA.

3.2.

C,

Arduino - Arduino IDE.

(3.6),



3.6 -

Arduino IDE.

Arduino

:

- setup() –

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- loop() –

,

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-

,

setup()

.setSpeed()

vpr ∈ [0, 255]

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-

.

.run()

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-

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:

- FORWARD –

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- RELEASE –

;

- BACKWARD –

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AFMotor

AF_DCMotor.

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(2.6)

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Arduino

Arduino.

```

    If (kCoef <=-4) and (kCoef =>-10) then ((maxLevyi = -28.8) and (maxPraviy
=28.8));
    If else (kCoef =-2) then ((maxLevyi = -19.6) and (maxPraviy =19.6));
    If else (kCoef =0) then ((maxLevyi =0) and (maxPraviy =0));
    If else (kCoef =2) then ((maxLevyi = 19.6) and (maxPraviy =-19.6));
    If else (kCoef =>4) and (kCoef =>10) then ((maxLevyi = 28.8) and (maxPraviy
=-28.8));

    baseSpeedMaxLeviy = baseSpeed - (kCoef * maxLeviy);
    baseSpeedMaxPraviy = baseSpeed - (kCoef * maxPraviy);

```

—

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() ,

1. Oxford English Dictionary Second edition on CD-ROM Version 4.0: Includes 500,000 words with 2.5 million source quotations, 7,000 new words and meanings. Includes Vocabulary from OED 2nd Edition and all 3 Additions volumes. Supports Windows 2000-7 and Mac OS X 10.4–10.5). Flash-based dictionary. Full version (ISBN 0-19-956383-7/ISBN 978-0-19-956383-8)
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