Bipedal bimotor walking Robot

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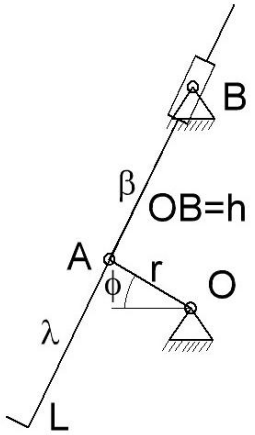
1 Some walking mechanisms

1.2.1 Simple Crank with sliding lever



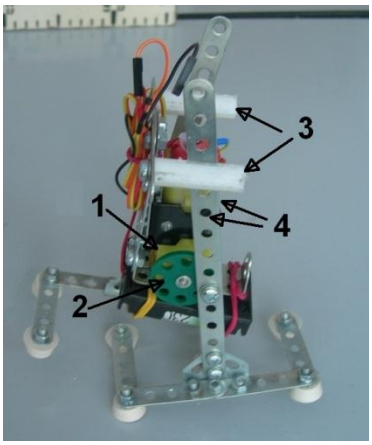


Fig. 1 Fig. 2

Suppose r=1, we get

B_x=0

B_y=h

A_x=-r cosϕ

A_y=r sinϕ

b= $\sqrt{r2 + h2 - 2hcos(\pi/2 - \varphi)}$ (Cosine Theorem)

L_x=A_x*(λ+β)/β

L_y=A_y-(B_y-A_y)*λ/β

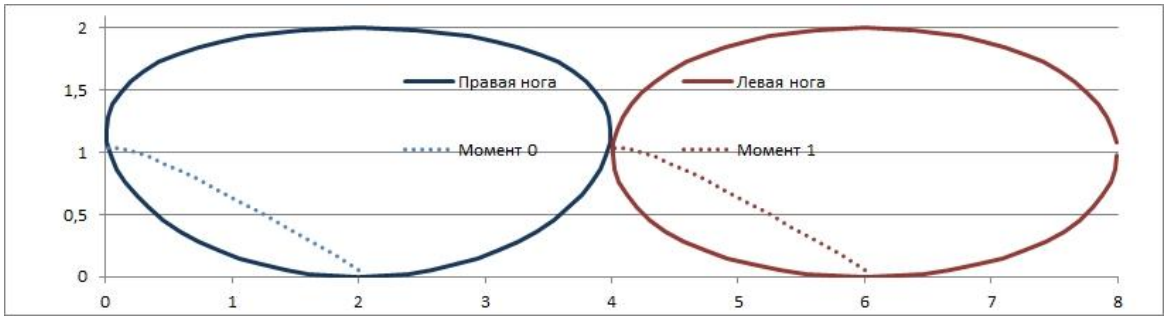
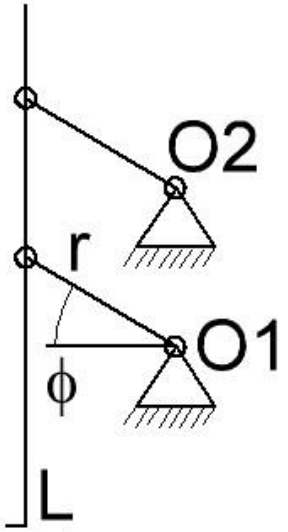


Fig. 3 Foot paths.

1.2.2 Double parallel crank mechanism.



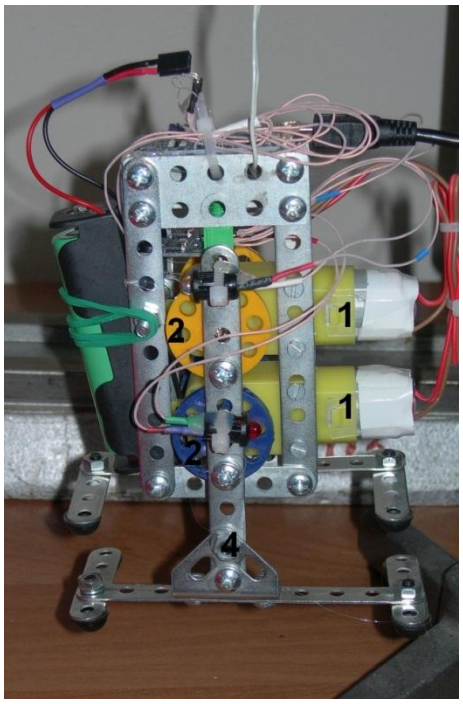


Fig. 4 Kinematics

Fig. 5. Mechanism Model

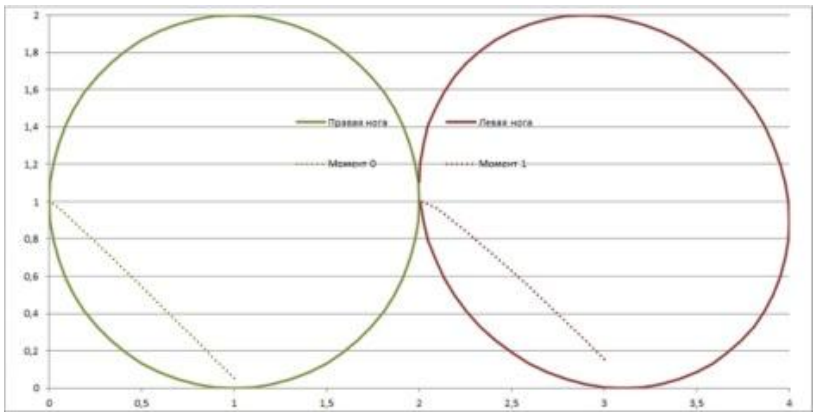


Fig. 6. The path (solid line) and momentum relative μ (dotted line).

1.2.3. 4 Linkage mechanism.

$Ax=-\cos\phi$

$Ay=\sin\phi$

$Bx=a-g\cos\psi$

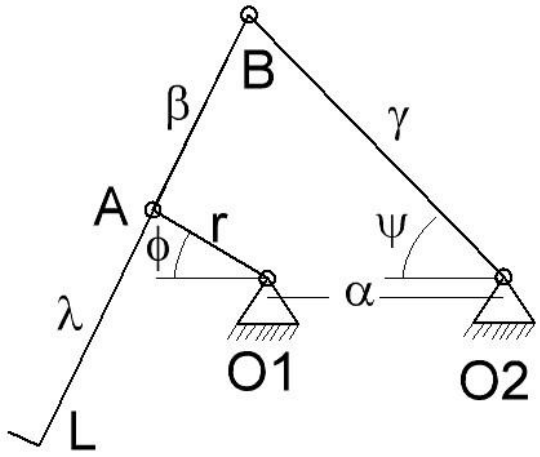
$By=g\sin\psi$

$\beta^2=(Ax-Bx)^2+(Ay-By)^2$

Или

$(Ax-Bx)^2+(Ay-By)^2 - \beta^2=0$

To calculate we assume α=4, β=4.98, γ=2, λ=4, and we got μ= 1.05 и $\kappa = 4/0.87$=4.60, V_s=2.085 (в единицах ωr).



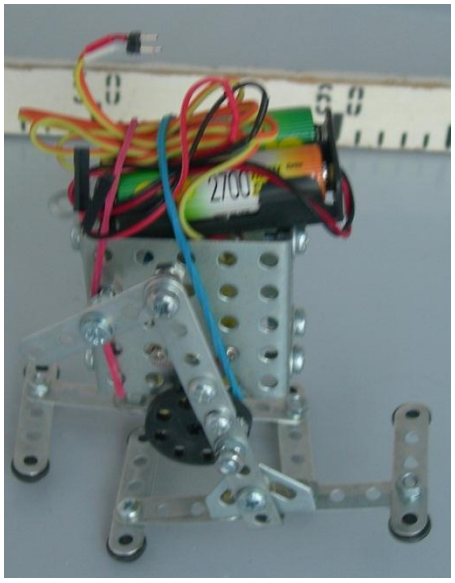


Fig. 7. 4- linkage mechanism

Fig. 8. 4- linkage 2- legs walking robot.

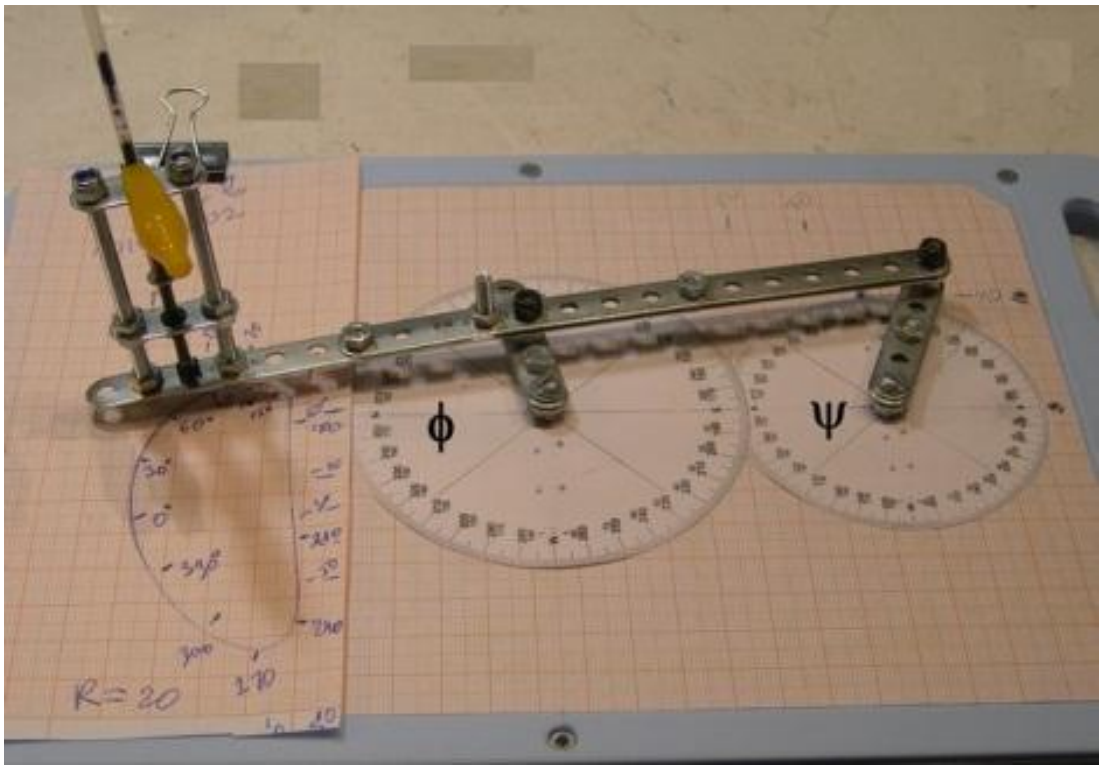


Fig. 9 The mechanism can draw the paths.

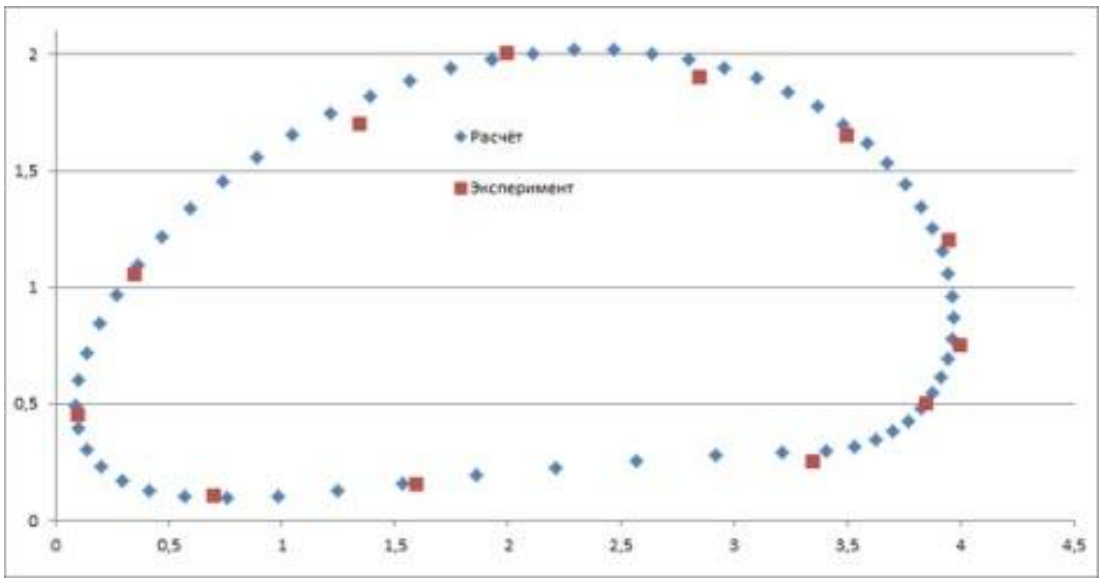


Fig. 10. Calculated and experimental data for path.

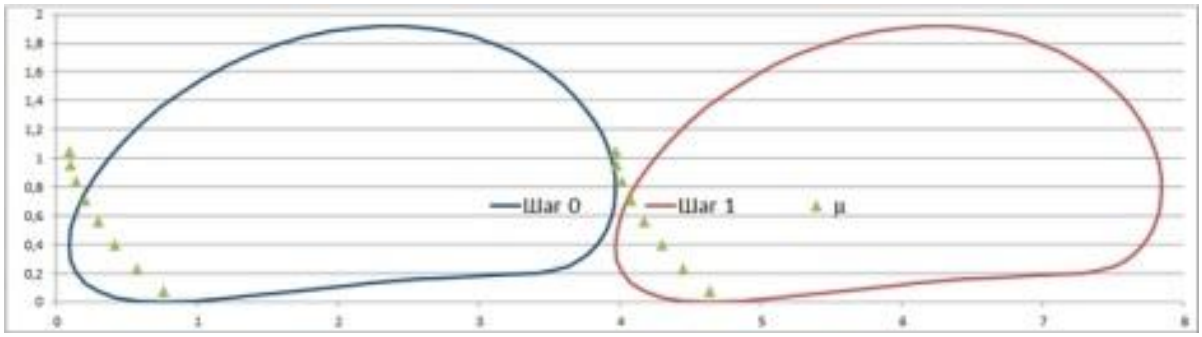


Fig.11. The paths of the left and right legs in r units.

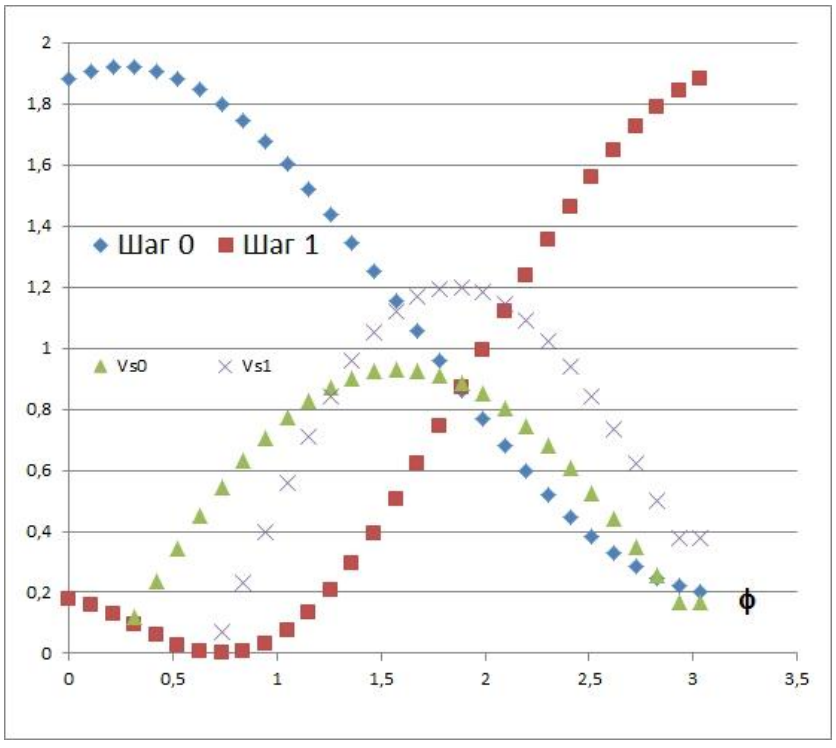


Fig. 12 The path is shown it the vicinity of legs change.

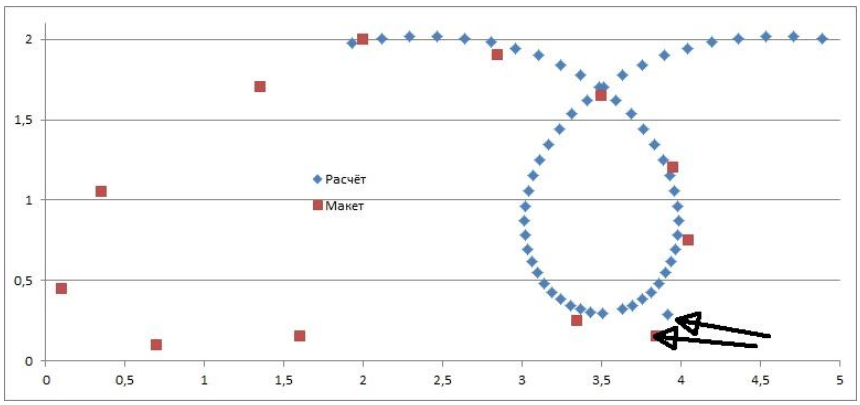


Fig. 13. 4- linkage mechanism can shoe chaos.

1.2.4. 4-х звенный механизм Хойкена.

	α	β	γ	λ
λ- Tchebyshev Mechanism	2,21 r	2.82r	2.82r	5.64 r
Mechanism of Hoeken	2 r	2.5 r	2.5 r	5 r

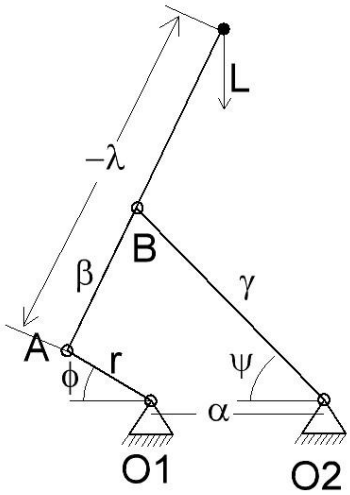


Fig. 14

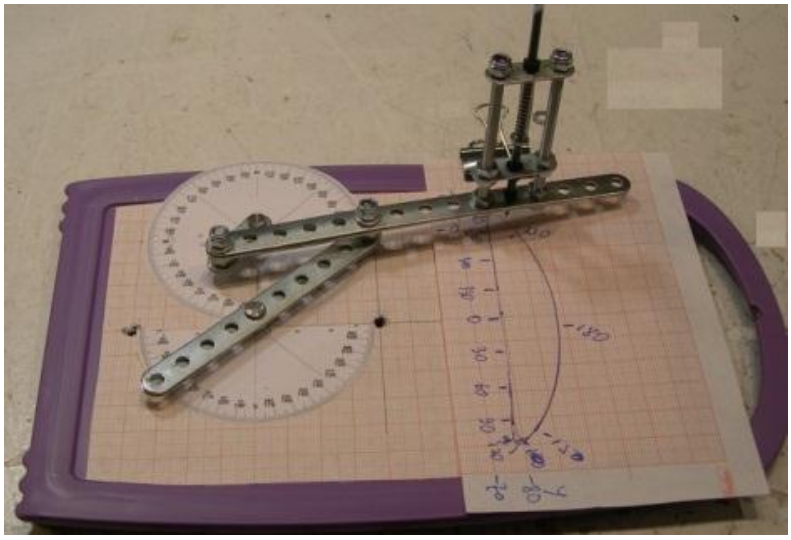


Fig. 15

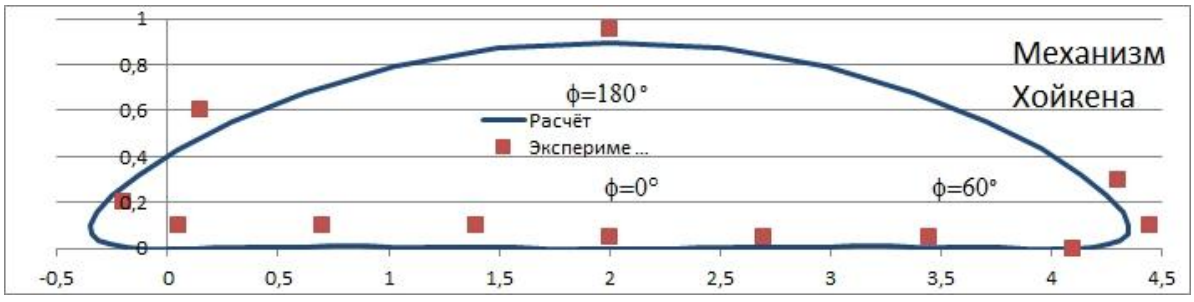


Fig. 16 Calculated and experimental path of Hoeken mechanism. Experimental data is shown for every 30 °.

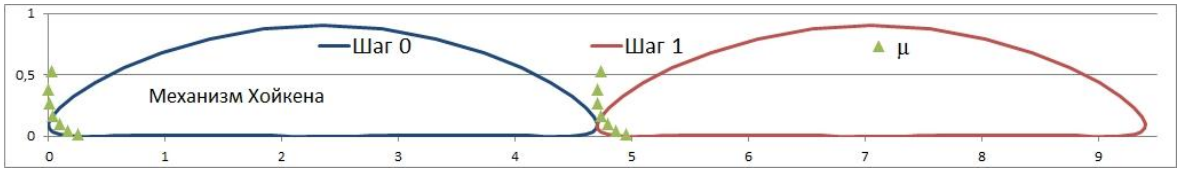


Fig. 17 Effective lever for Hoeken Linkages. μ=0.53,

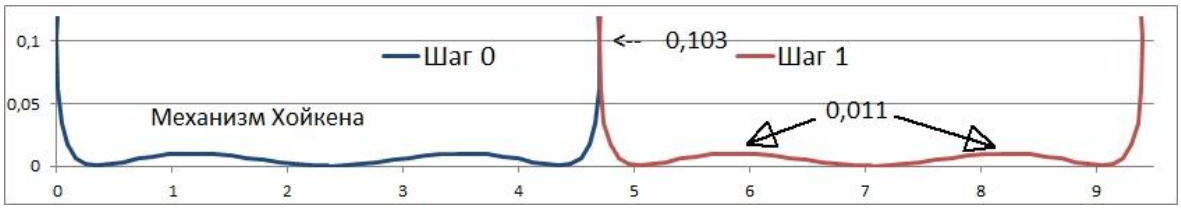


Fig. 18. κ=9.5 / (0.103+0.011+0.011)=76.

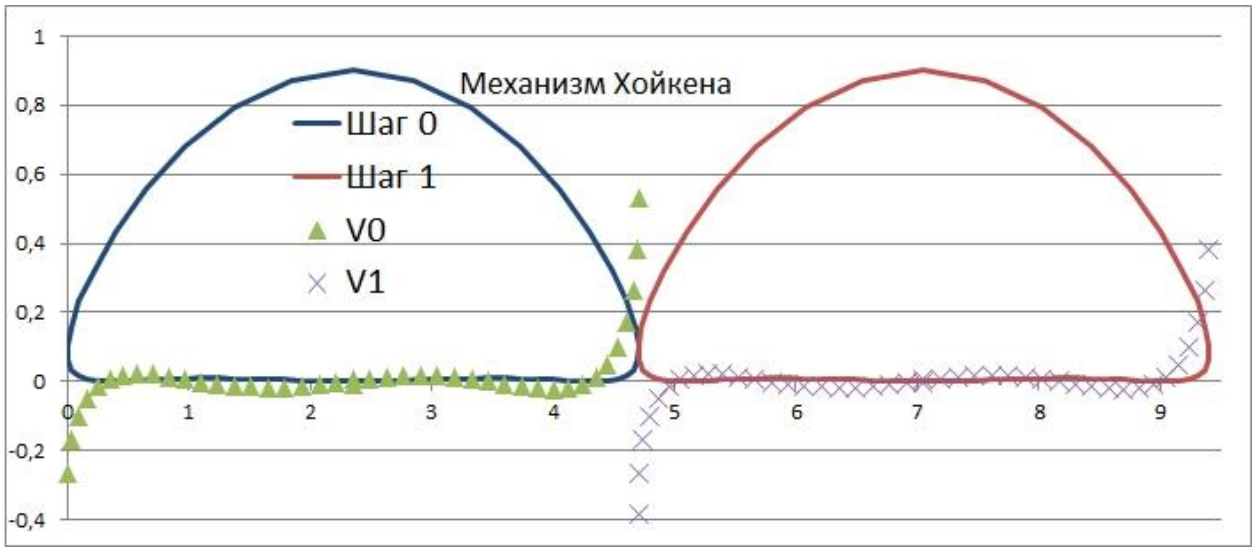


Fig.19.The relative speed of foots (the foot exchange strike to the floor) Vs=0.53+0.384=0 ωr

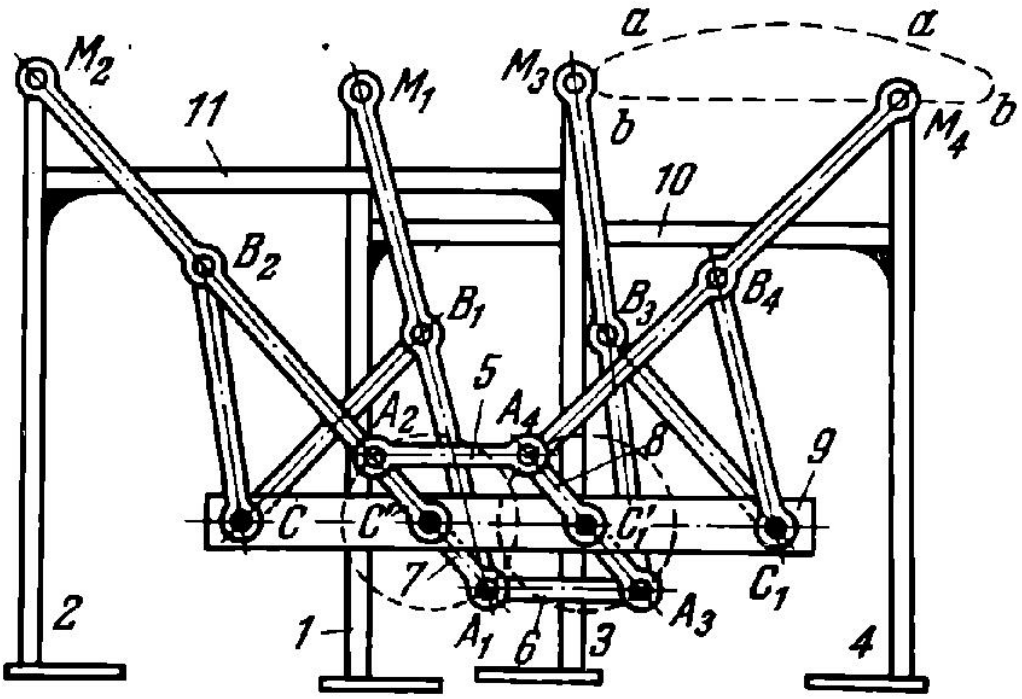


Fig. 20. λ- mechanism (Tchebyshev) [6].

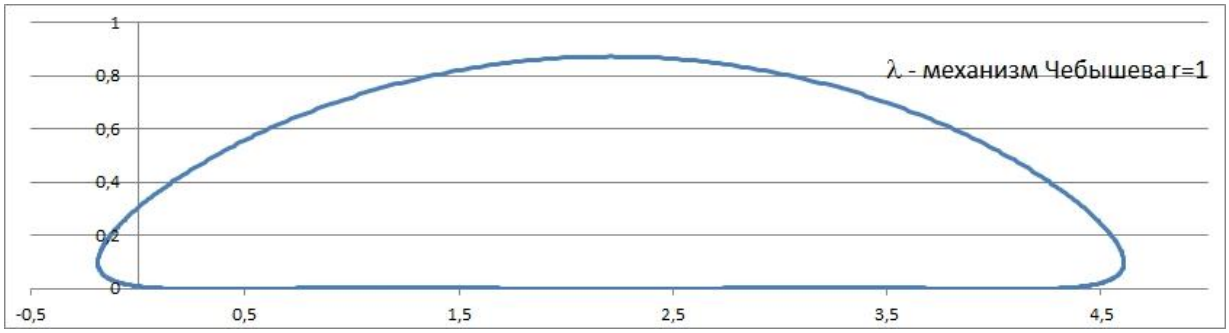


Fig. 21 Path in λ- mechanism (Tchebyshev).

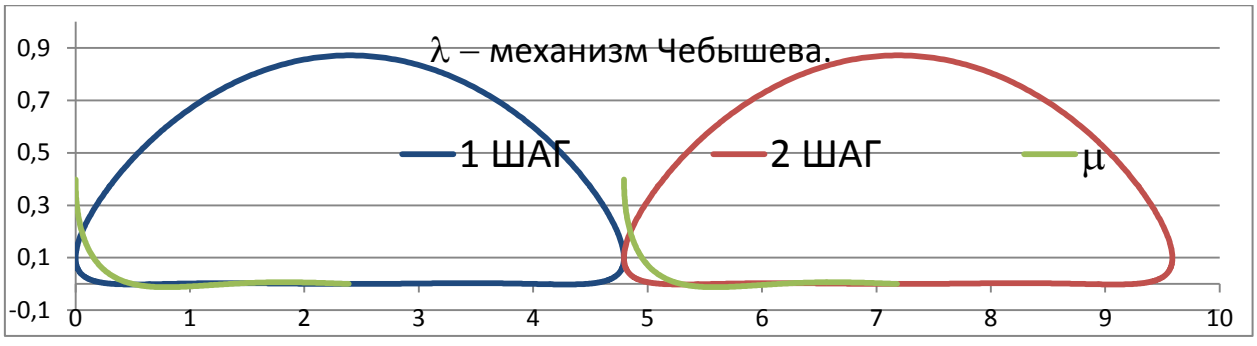


Fig. 22. For λ- mechanism (Tchebyshev) we got μ=0.399

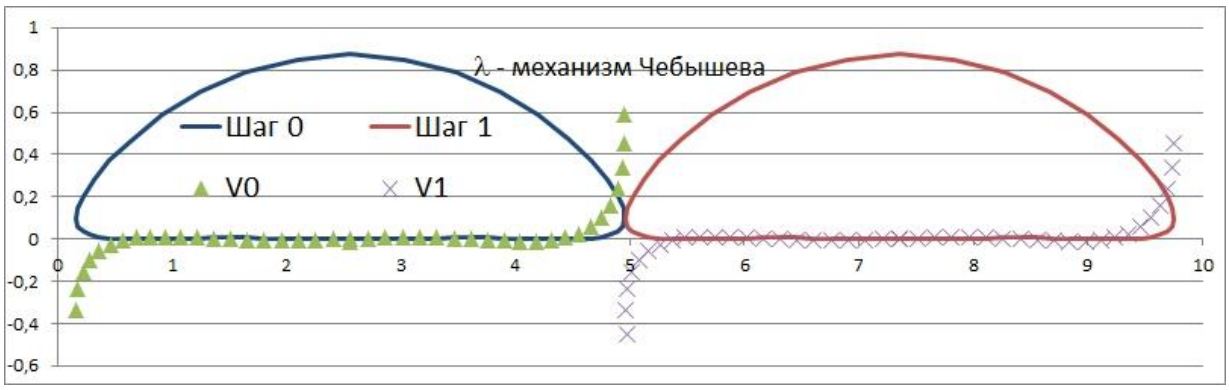


Fig.23. Relative foot speed λ- mechanism (Tchebyshev). V_s=0.586+0.451=1.037 ωr.

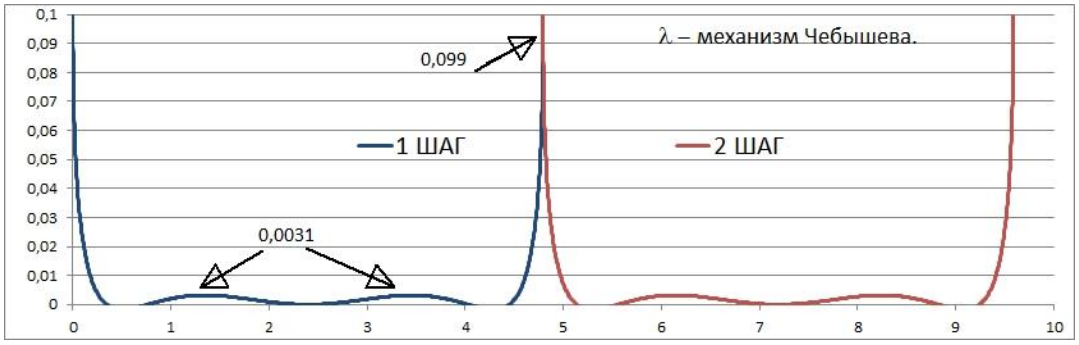


Fig. 24. κ = 9.5/ (0.0031+0.0031+0.099)=590 .

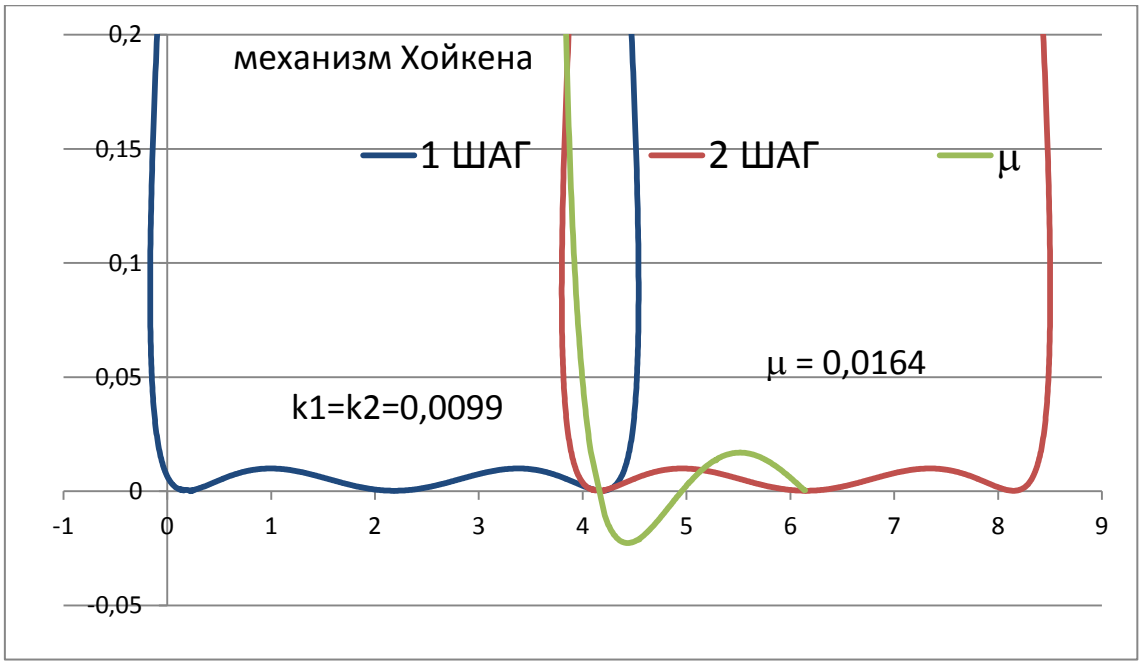
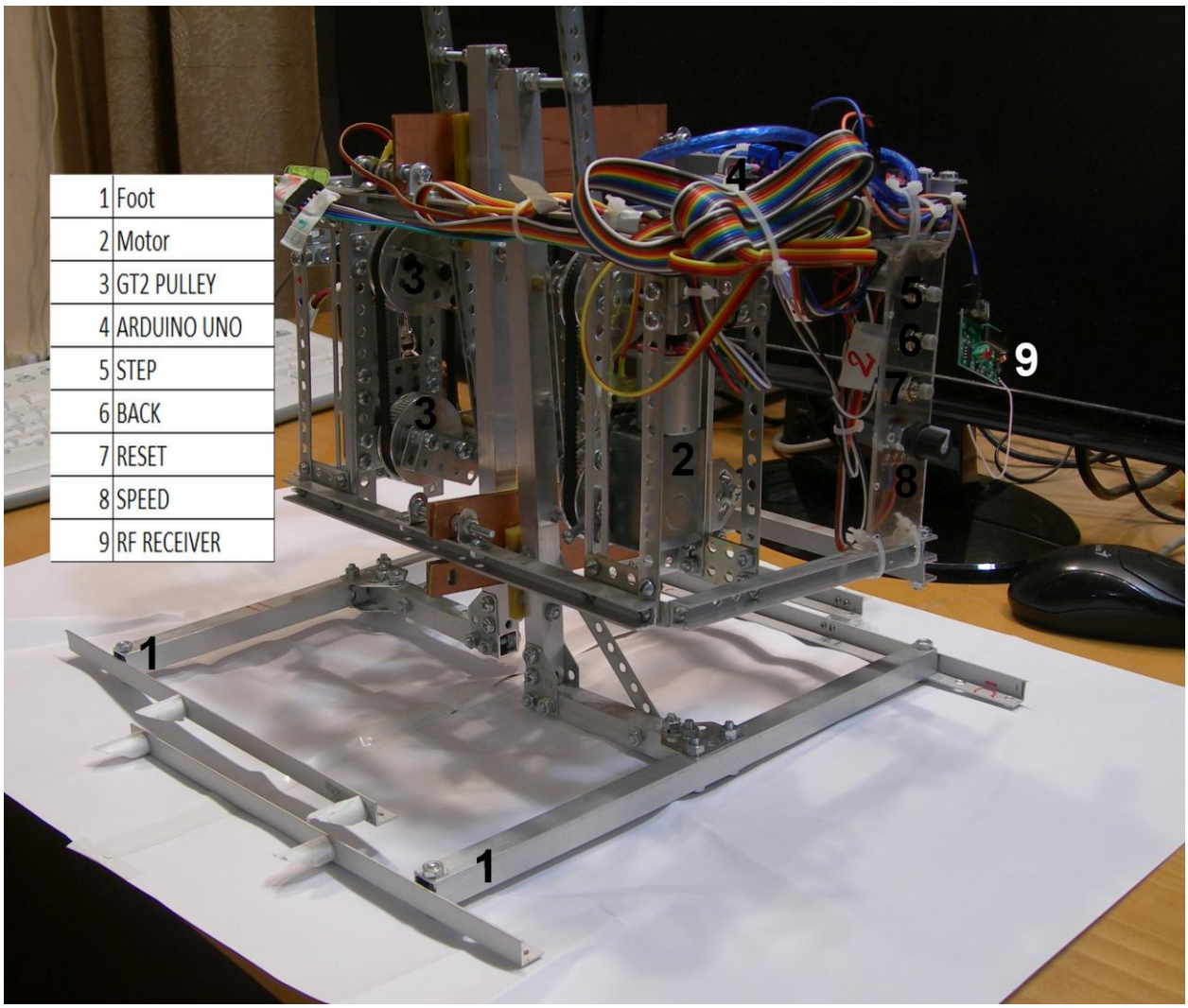


Fig. 25. Hoeken Mechanism modification.μ = 0.0164 и κ = 0.0198.

	Speed km per h	effectivity κ	The relative lever μ_y	Relative speed of foot strike to the floor Vs
Man walking*	5	16,22		
Man running*	7	6,79		
Man running *	9	2,33		
Bycicle*	9	58,3		0
Bycicle *	18	29,2		0
Double Crank Robot		2	1	2
Sliding Lever Robot		4	1	2,03
4- Linkage Robot		4,6	1,05	2,09
λ mechanism (Tchebyshev) Robot		590	0,4	1,037
Hoeken Mechanism Robot		76	0,53	0,914
Modified Hoeken Mechanism Robot		404	0,0164	0

Table 1.



1. A method for calculating the dynamics of the mechanisms of bipedal movement with arbitrary 4-linkages mechanisms has been developed.
2. The method allowsto calculate all the necessary movement parameters for the construction. To verify the calculations, the models of the Hoeken mechanism and the 4- linkages mechanism designed to draw trajectories on millimeter paper were designed and made.
3. The mechanism of Hoeken and the Chebyshev are considered.
4. A modification of the movement mechanisms is proposed, which allows to significantly increase the efficiency of bipedal movement, and also significantly reduce the loads on the elements of the mechanism and the required power of the drive motor.
5. It is shown that the proposed modification allows to reduce the impact speed practically to zero with the change of the supporting leg, which is extremely important for complex and easily destructible soils (especially disturbance of the tundra ecosystem).
6. A functional, block diagram and a basic diagram of the robot platform have been developed. Based on the theoretical study of the model, a control algorithm is created, and based on the algorithm, the code is written in the Arduino ide.
7. The model of the bipedal platform is assembled, the test is conducted, the algorithms for controlling the power elements of the platform are tested.
8. On the basis of mathematical and model modeling a prototype is constructed with the following

parameters:
-effectiveness of movement - lifting of the center of gravity does not exceed 0.5% of the traveled path The maximum torque required for motion is less than 0.01 of the product of weight by the step length
-relative speed of supports during the change of legs is reduced to zero.

5. References

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