

Suggestion and Modeling of a Novel Capsular Microrobot with Surface Forces

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ABSTRACT

For developing of endoscopic Capsular, a design of legged capsular microrobot with ionic polymer metal composite actuator is suggested in this paper. First locomotion of microrobot is explained then microrobot is modeled by envisage exerting surface forces and microactuator. Surface forces contain slip-friction, surface adhesion and resting adhesion and polymeric microactuator is ionic polymer metal composite. Time variant response of polymeric microactuator is modeled fundamental of coupled electromechanical equation and electric equivalent bulk gel polymeric.

Result simulation of dynamical model microrobot shows that best installation angle of legs is 60 degree, proper mass of microrobot is 2g and speed marching is 1 millimeter per second.

KEYWORDS : Microrobot, Endoscopy, Microactuator, Ionic Polymer Metal Composite, Resting Adhesion, Surface Adhesion, Modul.

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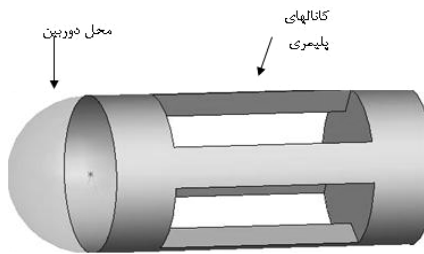
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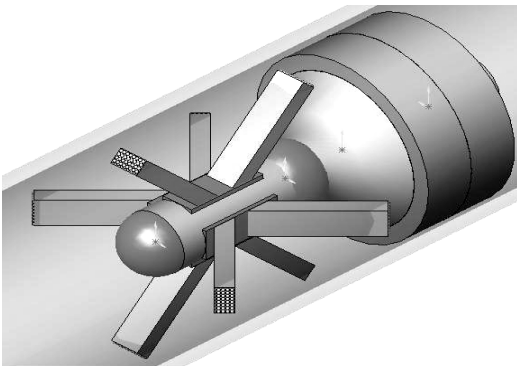


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Δx

نحوه راه رفتن

مدل سازی نیروهای سطحی

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R

چسبندگی سطحی

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F^{vdw}

F^e

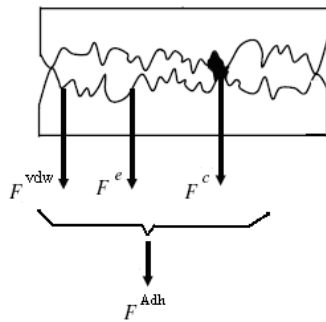
F^c

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$$F^{adh} = F^{ele} + F^c + F^{vdw}$$

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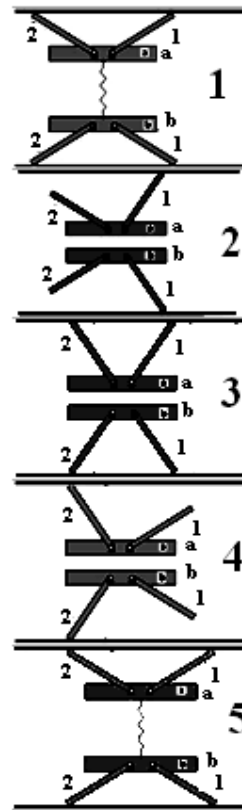
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۳-۱-۱- نیروی موینگی

Δx

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چسبندگی ایستای

$$F^c = \frac{4\pi R_{ball} \gamma_L}{1 + D_1} \quad (2)$$

R_{ball} γ_L D_1

$$F_f = \mu_e (F^{Adh} + L) \quad (1)$$

L F^{Adh}
 μ_e

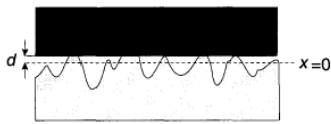
۳-۱-۲- نیروی واندروالسی

$$\mu_e = \frac{s}{P_e} \quad (1)$$

$$E = - \int_{V_1} dV_1 \int_{V_2} dV_2 \frac{q_1 q_2 \lambda_{12}}{H^6} \quad (2)$$

q_2 q_1 H λ_{12}
 V_2 V_1

(x) ()



[] ()

A_r

[] L

$$F^{vdw} = \frac{\partial E}{\partial H} \quad (1)$$

$$F^{vdw} = \frac{AR}{6D^2} \quad (2)$$

D R

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۳-۱-۳- نیروی الکترواستاتیکی

$$A^* = \frac{A_r}{\eta R \sigma_1 A_a} = \pi F_1(h) \quad (1)$$

$$L^* = \frac{DL}{\eta A_a R^{1/2} \sigma_1^{3/2}} \quad (2)$$

$$= F_{3/2}(h) - \frac{2\pi}{\theta_1} F_0(h)$$

() θ_1

$F^{ele} \neq$ $F^{ele} =$

$$\theta_1 = \frac{\sigma_1^{3/2} R^{1/2}}{D w_a R} \quad (1)$$

d, x

w_a

$F^{ele} \neq$

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$$h = d/\sigma_1 \quad y = x/\sigma_1$$



$$\frac{dz}{dt} = v - \frac{|v|}{g(v)} z \quad ()$$

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$$F_{sl} = \sigma_0 g(v) \operatorname{sgn}(v) - \frac{\sigma_0 g(v)}{|v|} \cdot \frac{dz}{dt} + \sigma_1 \frac{dz}{dt} + \sigma_2 v \quad ()$$

$$\frac{dz}{dt} = 0$$

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$$F_{sl} = F_c \operatorname{sgn}(\dot{x}) + (F_s - F_c) e^{-\left(\frac{\dot{x}}{v_s}\right)^2} \operatorname{sgn}(\dot{x}) + \sigma_2 \dot{x} \quad ()$$

$$F_n(h) = A_r L \quad ()$$

$$P_e = \frac{L}{A_r} = \frac{\sigma_1^{1/2} \left(F_{3/2}(h) - \frac{2\pi}{\theta_1} F_0(h) \right)}{\pi R^{1/2} D F_1(h)} \quad ()$$

(11)

$$= \sqrt{\frac{\sigma_1}{R}} \cdot \frac{\left(F_{3/2}(h) - \frac{2\pi}{\theta_1} F_0(h) \right)}{\pi D F_1(h)} \quad ()$$

() n

$$F_n(h) = \frac{1}{\sqrt{2\pi}} \cdot \int_h^\infty (y-h)^n e^{-\frac{y^2}{2}} dy \quad ()$$

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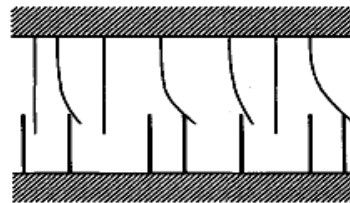
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اصطکاک لغزشی

مدل سازی میکروعملگر پلیمر یونی کامپوزیت

فلزی

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$$\Gamma = \frac{1}{12} \cdot \frac{1-2\sigma_p}{1-\sigma_p} \cdot \frac{L_1 h^3}{K_1} \quad ()$$

$$T = \Gamma \times w \quad ()$$

$$T = \frac{w}{12} \cdot \frac{1-2\sigma_p}{1-\sigma_p} \cdot \frac{L_1 h^3}{K_1} \quad ()$$

$$\cdot \frac{0.5 V_A}{h} \cdot \left\{ \begin{array}{l} 1 - \frac{R_2}{R_2 + 2R_1} \\ \frac{2R_1 \cdot R_2}{R_2(R_2 + 2R_1)} \\ \cdot \exp\left(-\left(\frac{R_2 + 2R_1}{R_1 \cdot R_2 \cdot C}\right)t\right) \end{array} \right\} \quad ()$$

$$\Gamma = \frac{1}{12} \cdot \frac{1-2\sigma_p}{1-\sigma_p} \cdot \frac{L_1 h^3}{K_1} \quad ()$$

$$\cdot \frac{0.5 V_A}{h} \cdot \left\{ \begin{array}{l} 1 - \frac{R_2}{R_2 + 2R_1} \\ \frac{2R_1 \cdot R_2}{R_2(R_2 + 2R_1)} \\ \cdot \exp\left(-\left(\frac{R_2 + 2R_1}{R_1 \cdot R_2 \cdot C}\right)t\right) \end{array} \right\} \quad ()$$

مدل سازی حرکت میکروروبات

نتایج حاصل از شبیه سازی

[] : ()

	σ_p	K_1	$h(\mu m)$	L_1
	/	/ ×		
	R_1	R_2	$C(F)$	$V_A(v)$
	/		/	

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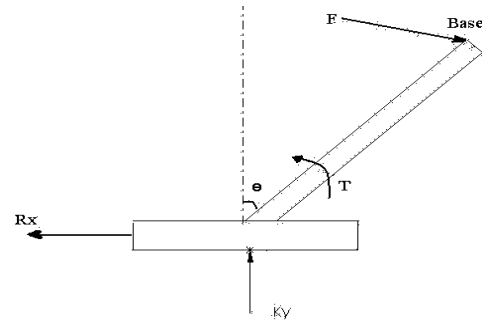
	V_s	F_s	F_c	F_v
	/	/ ×		/

[] : ()

	$\eta(m^2)$	$R(\mu m)$	$\gamma\Delta (J.m^2)$
	×	/	/
	$\sigma(\mu m)$	$D(P_a^{-1})$	$A_a(\mu m^2)$
	/	/ ×	

[] : ()

پارامتر	$w(mm)$ عرض پا	$L(mm)$ طول پا	m (gr) جرم	$K(\mu N/\mu m)$ فنریت واسط	(Degree) θ زاویه پا
مقدار	۱	۴	۱	۰/۰۲	۶۰



[] : ()

R_x

F_y, F_x

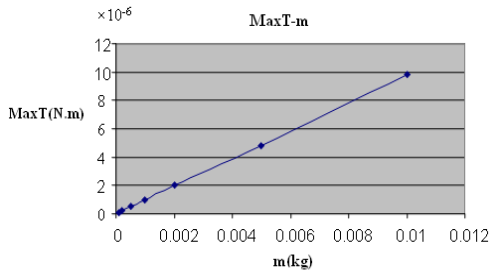
T

y

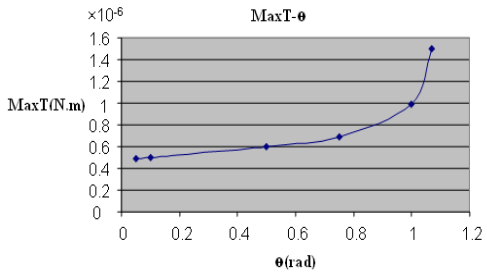
$$\ddot{x} = T - \frac{1}{4} L \cos(\theta) R_x - KL \sin(\theta) \tan(\theta) x \quad ()$$

$$R_x = F_c + (F_s - F_c) e^{-\left(\frac{\dot{x}}{V_s}\right)^2} + F_v \dot{x} \quad ()$$

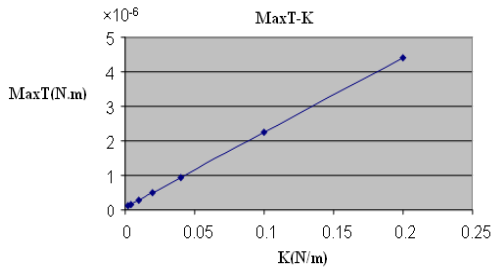




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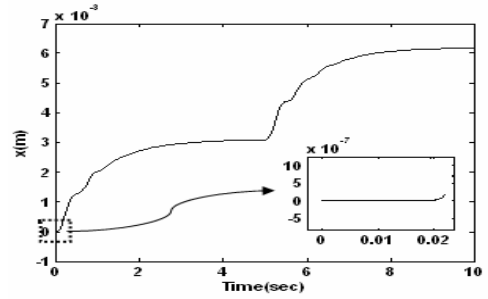


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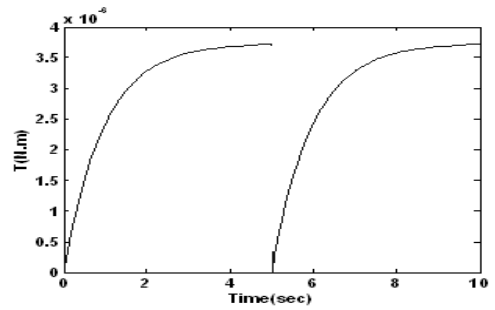


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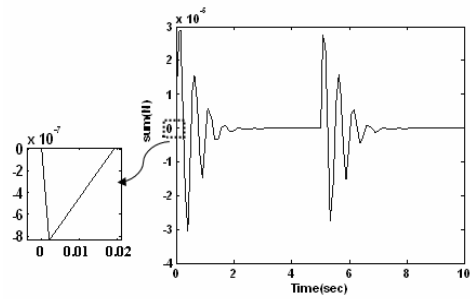
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تقدير و تشكر

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