COOPERACIÓN E INVESTIGACIÓN EN AUTOMÁTICA Y ROBÓTICA PARA LA INDUSTRIA MARÍTIMA

IV JORNADAS DE AUTOMÁTICA MARÍTIMA
AUTOMAR 2010
Cartagena. 21-22 de octubre de 2010

ACTUADORES BIOMIMETICOS PARA ROBÓTICA MARÍTIMA

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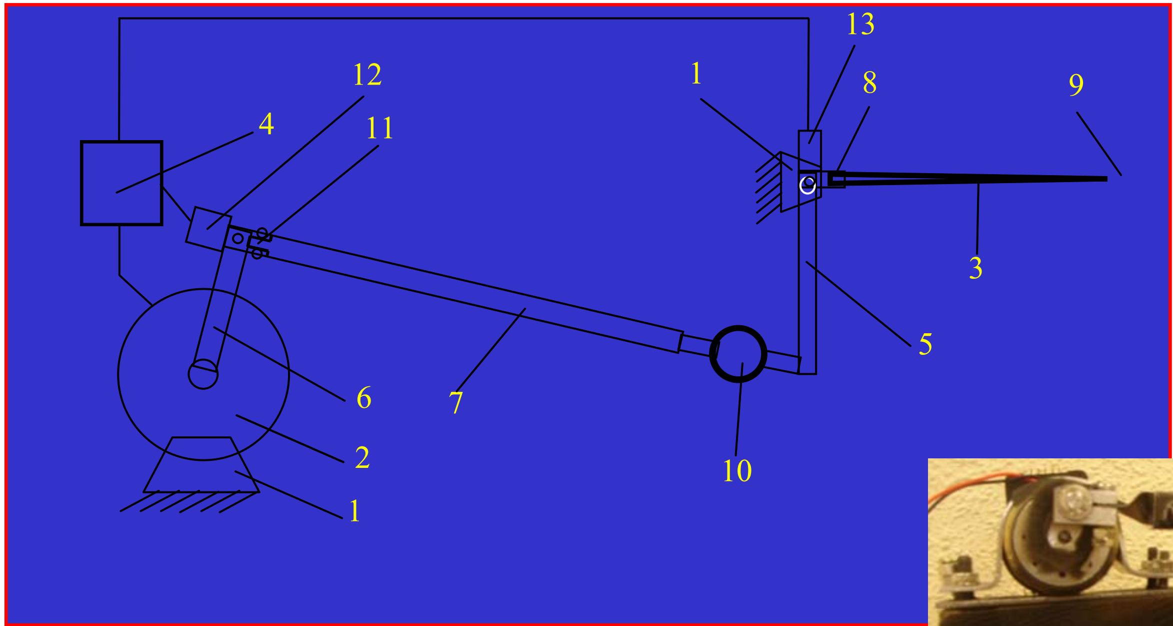
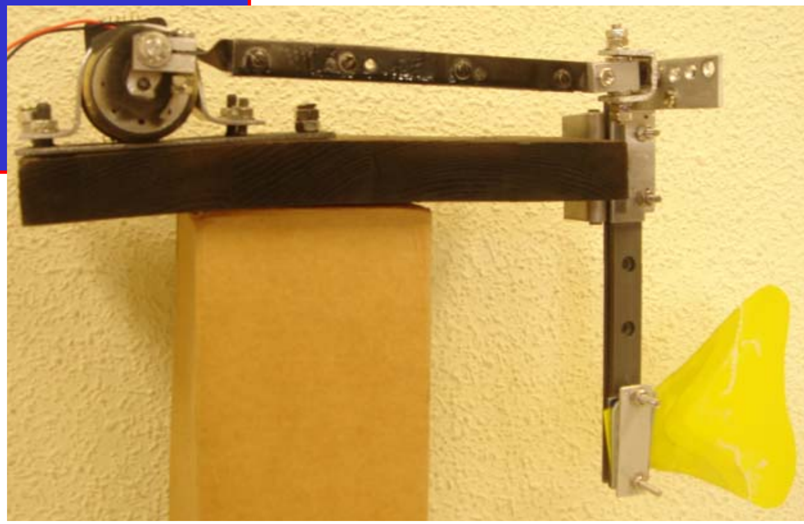
Centro de Automática y Robótica (CAR)

POLITÉCNICA

New design for the biologically inspired actuator for swimming robot and control algorithms are considered. The drive consists of an electric motor connected with a working element by kinematic coupling with a variable gear ratio. Experimental studies have been performed with working elements of different rigidity, including both absolutely rigid and relatively flexible working elements. It is shown that at low frequency of vibration, working elements (except absolutely rigid) vibrate according to the first form of vibrations; however, with frequency increasing, working element vibrations pass to the second, third, and the subsequent forms of vibration. Special control algorithms have been elaborated for the considered drive, taking into account its dynamic properties. These algorithms allow for varying a magnitude of useful force, developed by a drive, and for a change of a speed of movement of a robot. Additionally, the control algorithms allow for changing the direction of useful force and for maintenance of a rectilinear or curvilinear motion of a robot without the use of additional steering motor.

Figure 1: Design of biologically inspired actuator





Video 1: Design of biologically inspired actuator

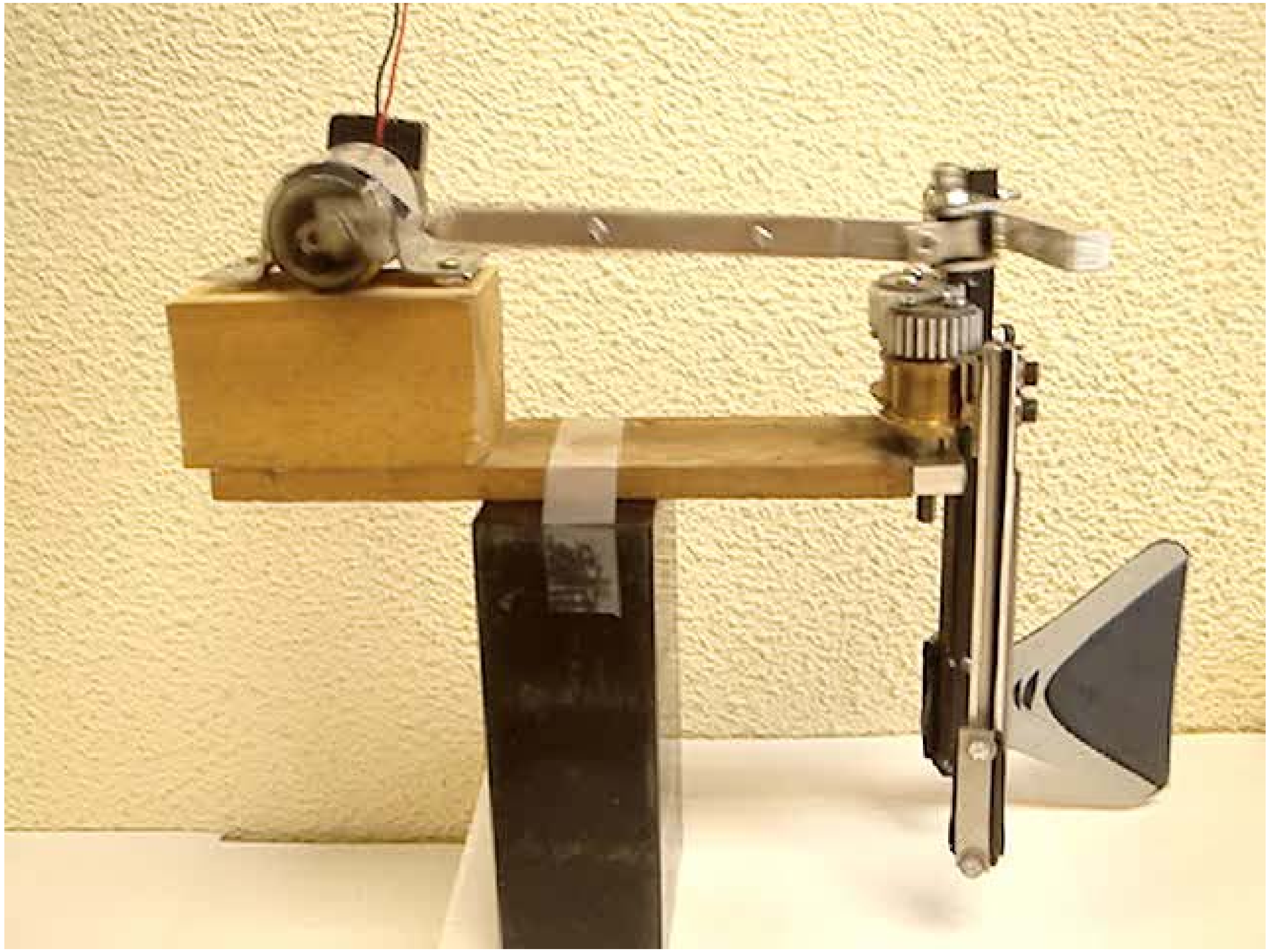
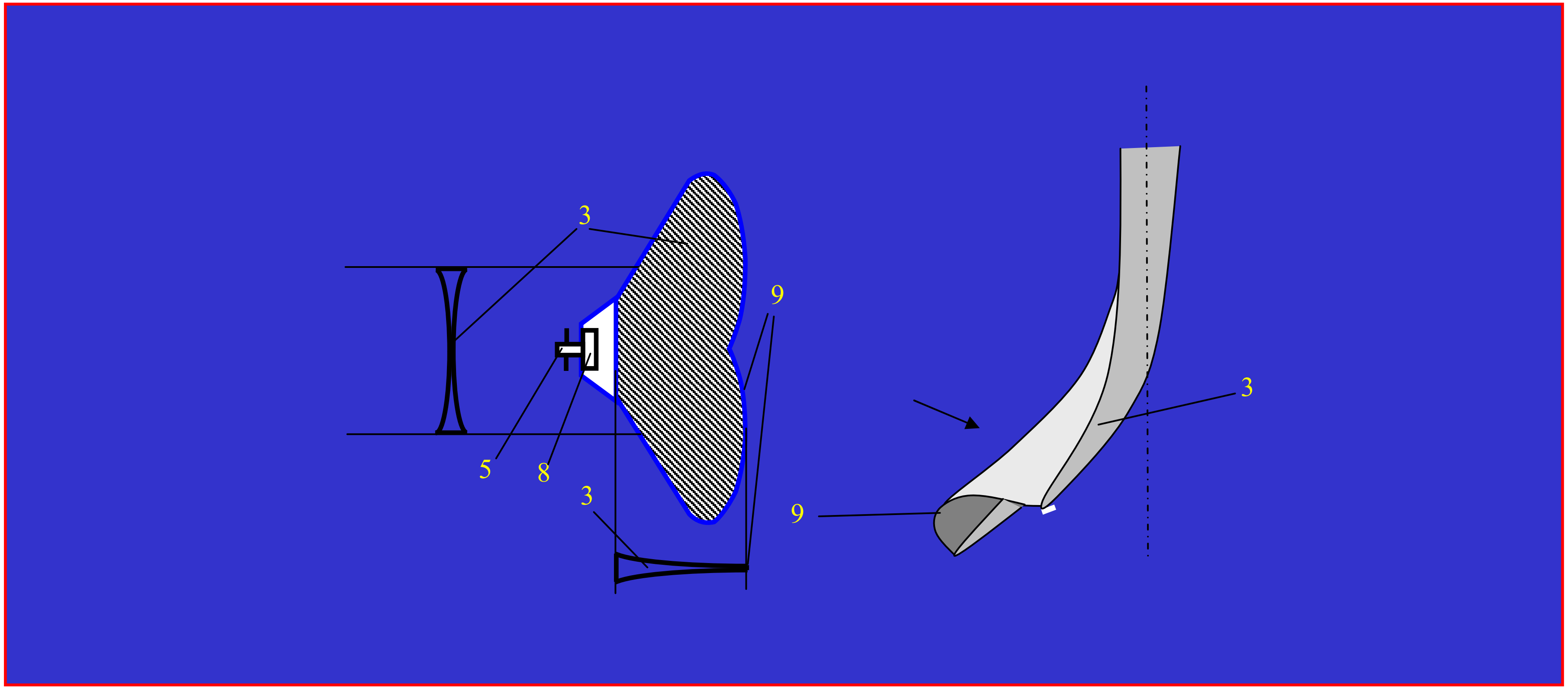


Figure 2: Design of operating member with changeable rigidity



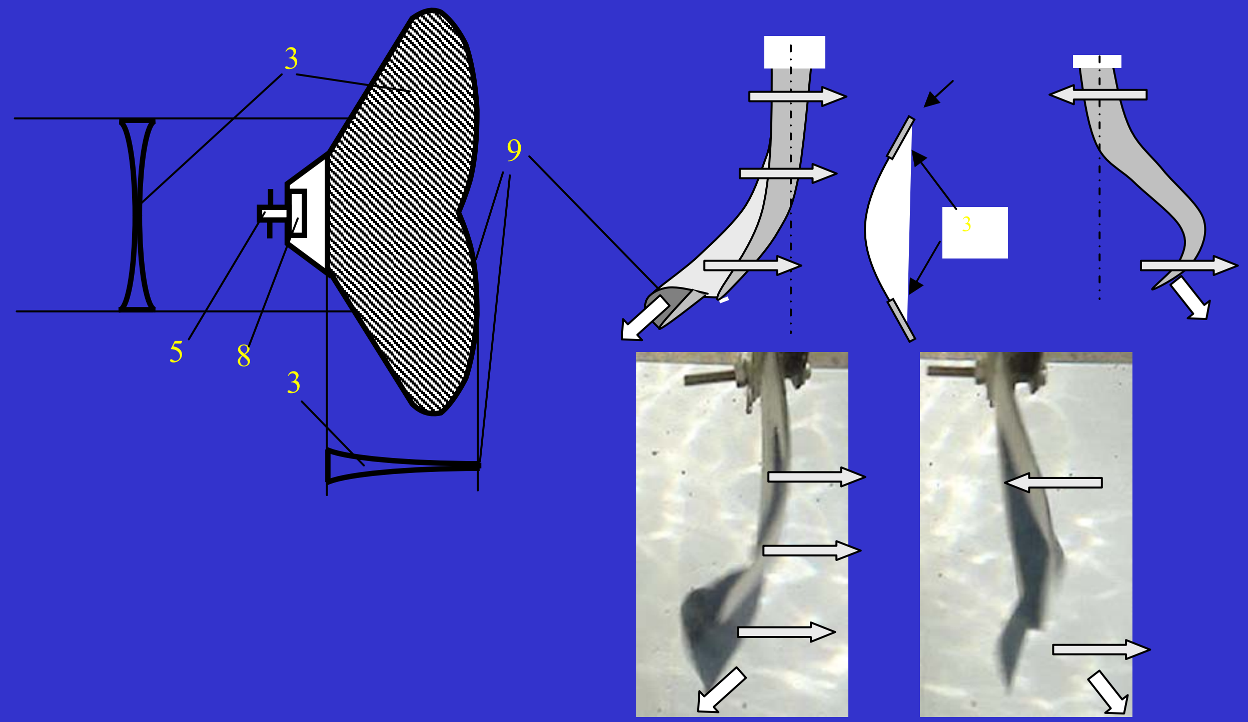


Figure 3: Design of operating member with changeable rigidity

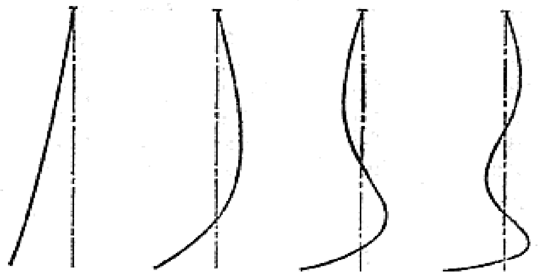
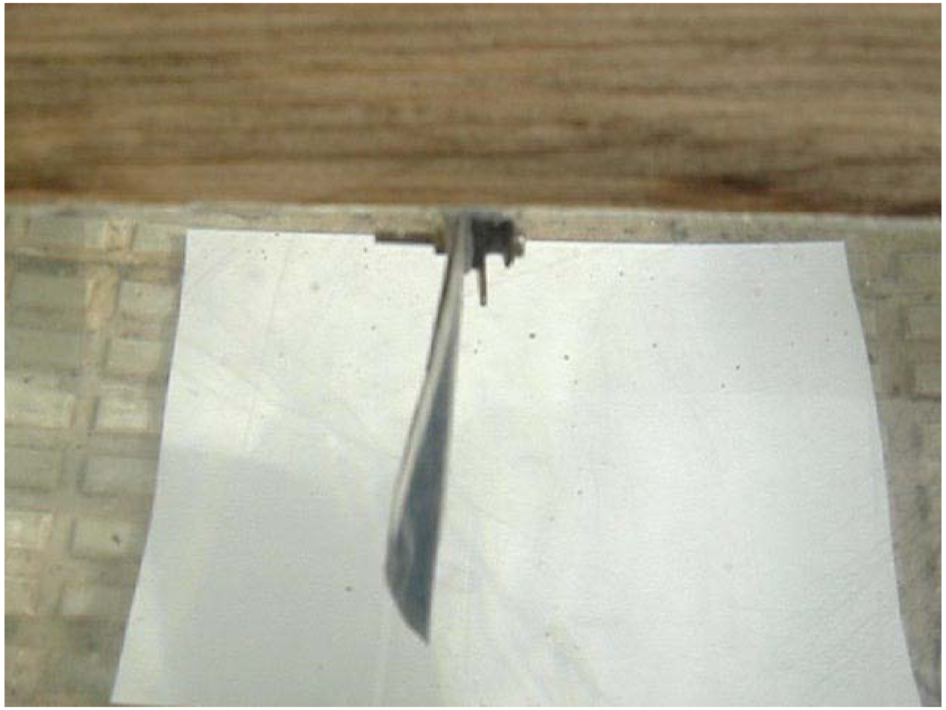


Figure 4: Modes of oscillations: first, second, third and fourth



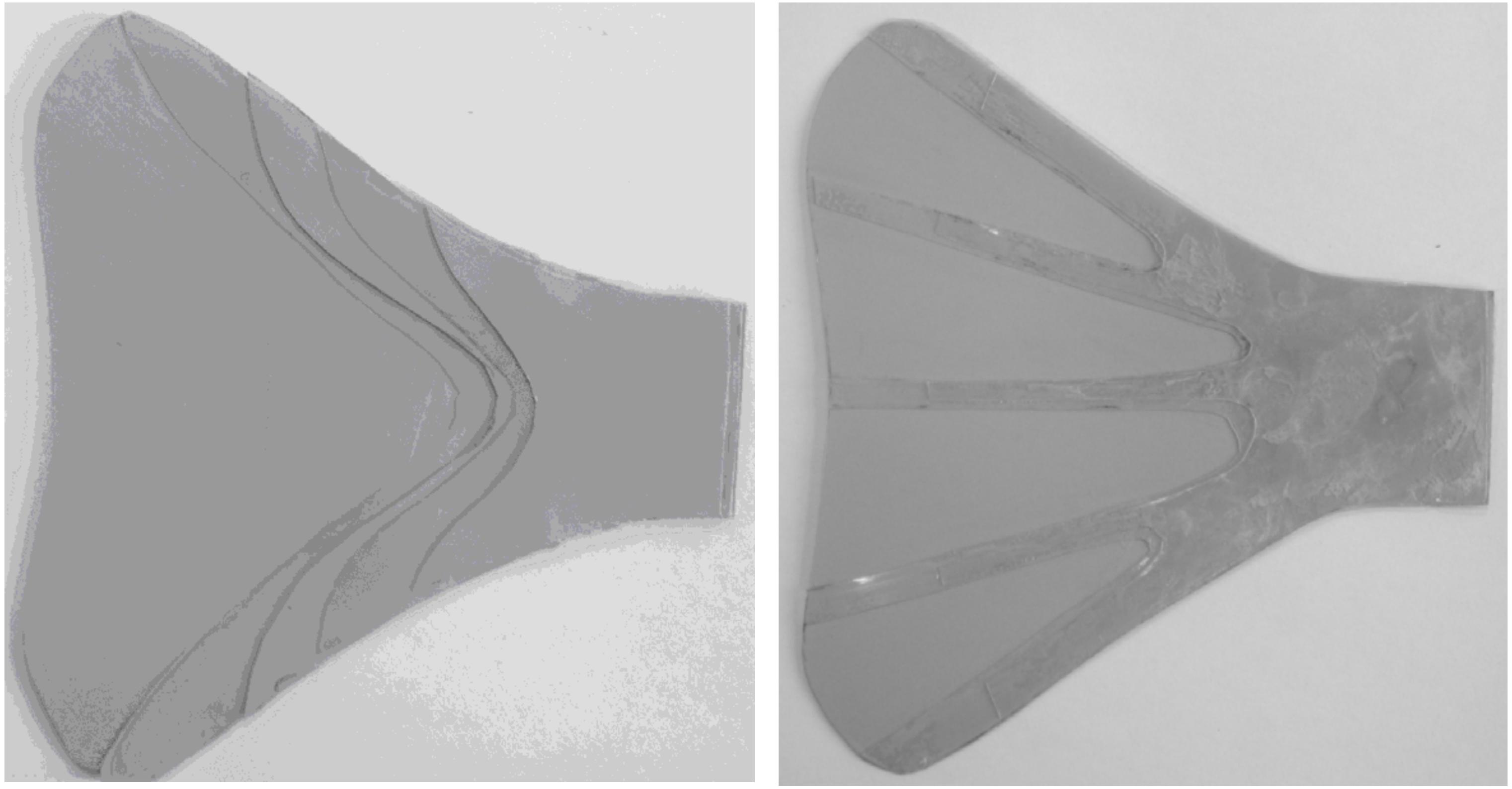
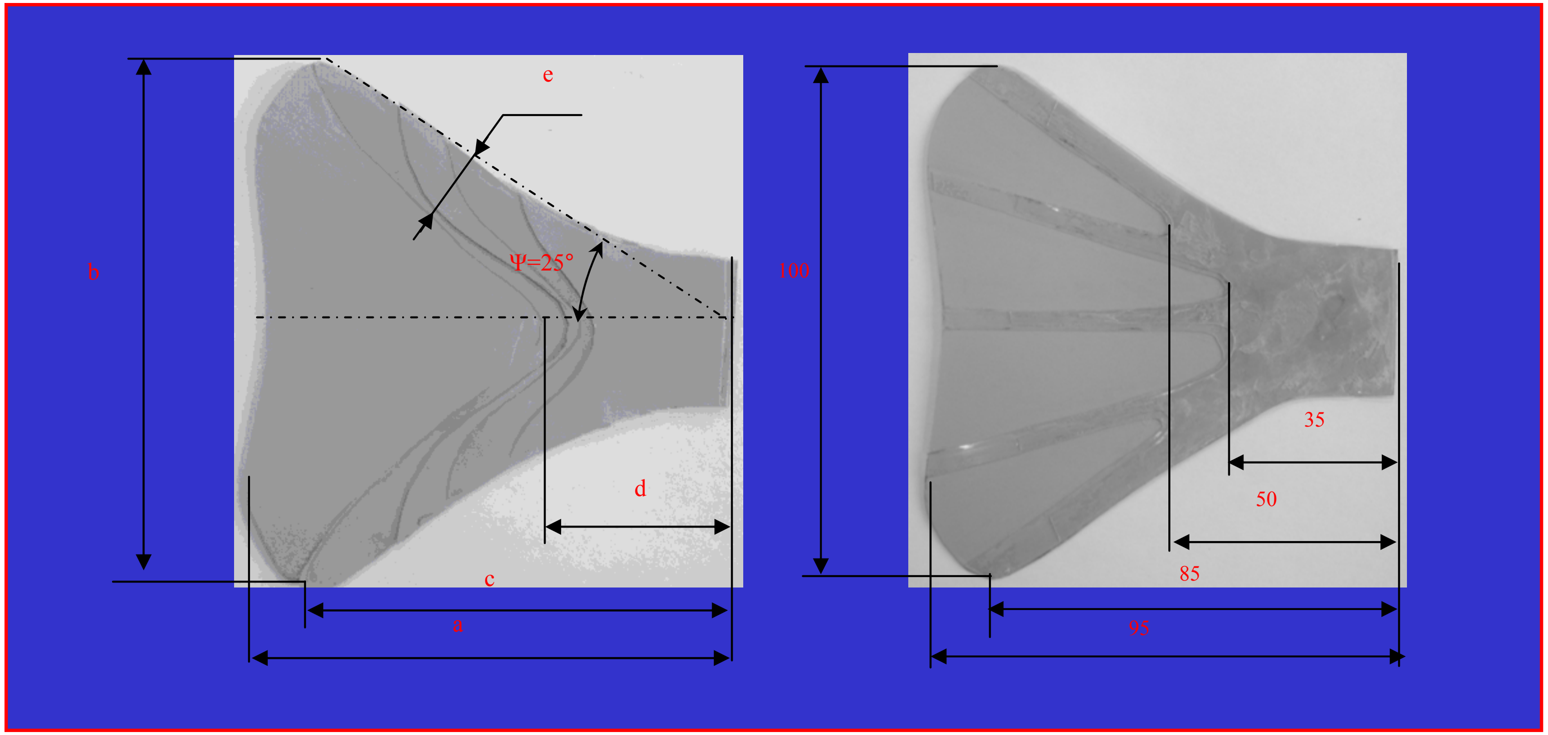


Figure 5: Photos of tail type A and type C



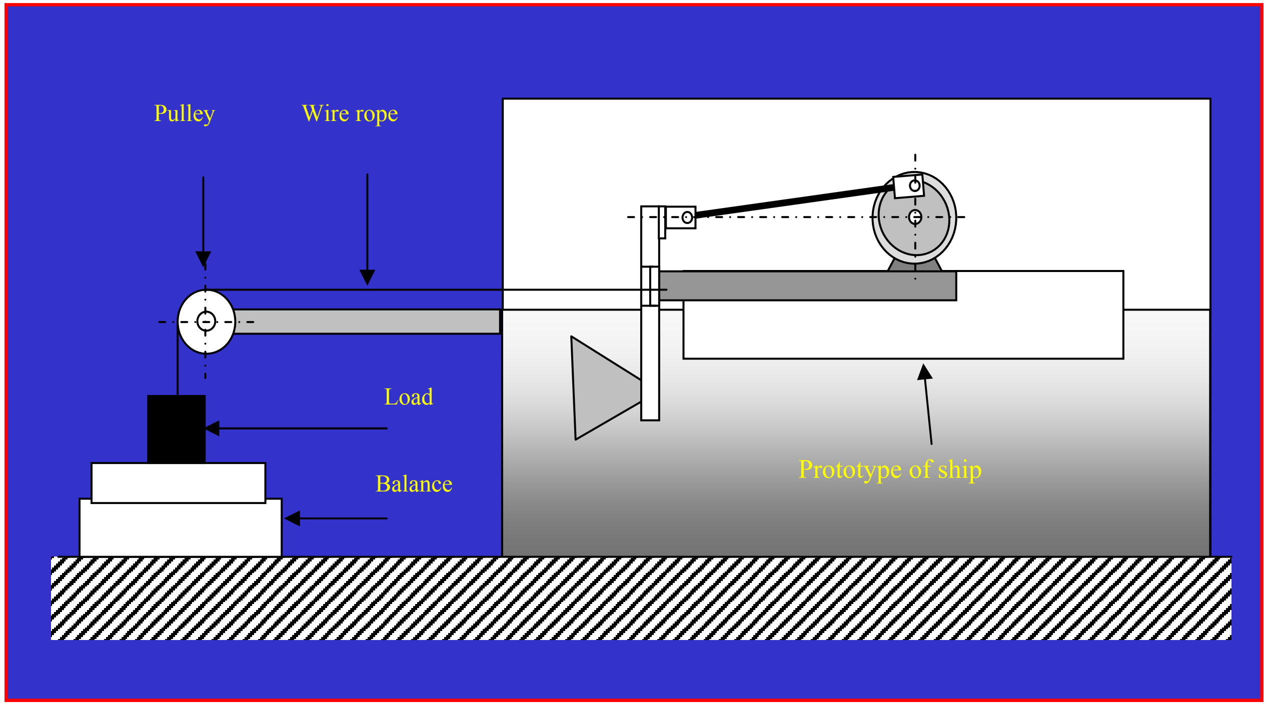
Thickness of compound plates f = 0,15 mm.

The module of elasticity of compound plates of type I: E = 4,1 x 103 MPa.

The module of elasticity of compound plates of type II: E = 2,8 x 103 MPa.

Figure 5b: Photos of tail type A and type C

Type tail	Type plate	№ plate	a, mm	b, mm	c, mm	d, mm	e, mm	f, thickness plates, mm
A	Polyester	1	95	100	95	95	-	0,08
	II	2			95	38	13	0.6
		3			76	37	12	0.95
		4			69	36	11	1.35
B	Polyester	1	95	100	95	95	-	0,08
	II	2			95	44	14.5	0.6
		3			81	35	12	0.94
		4			63	31	10	1.35
D	I	1	95	100	85	90	-	0.15
		2			64	34	15	0.48
		3			54	27	9	0.84
E	I	1	95	100	85	90	-	0.15
		2			70	45	20	0.48
		3			60	40	18	0.85
F	II	1	95	100	85	90	-	0.15
		2			87	35	14	0.48
		3			68	31	12	0.84
		4			58	28	10	1.20
		5			45	25	10	1.45
G	II	1	95	100	85	90	-	0.14
		2			78	34	13	0.47
		3			60	30	9.5	0.83
		4			47	23	8	1.3
H	I	1	95	100	85	87	-	0.15
		2			83	64	20	0.49
		3			70	46	16	0.85
I	I	1	95	100	95	87	-	0.15



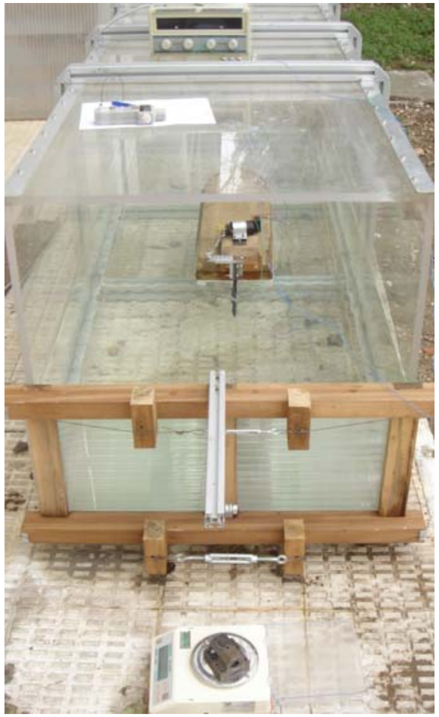
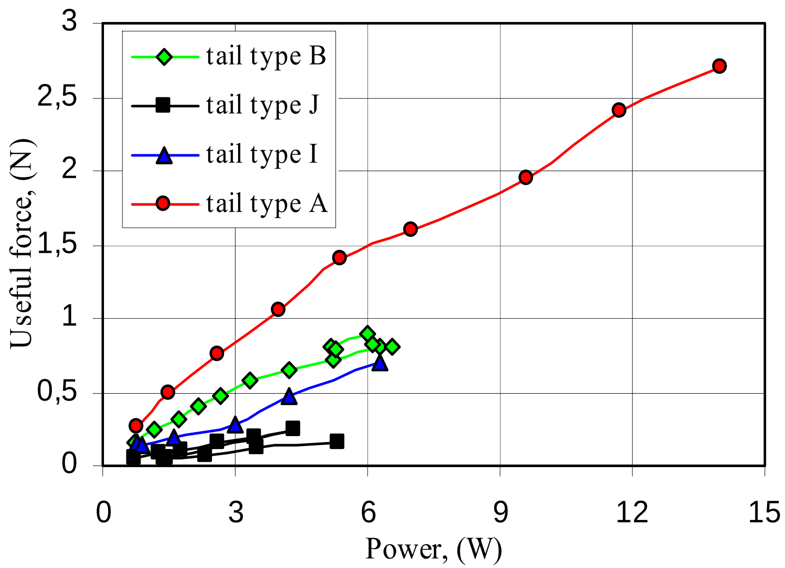


Figure 6: Special experimental setup



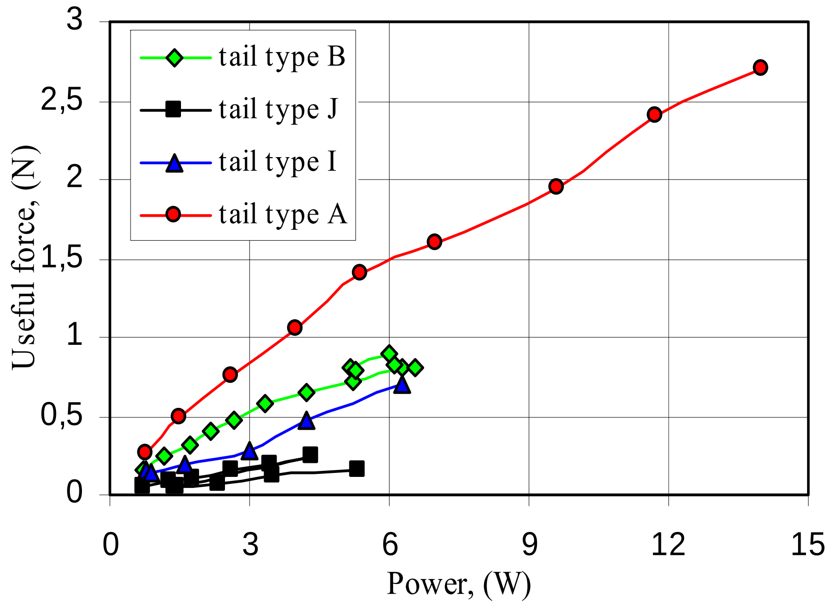
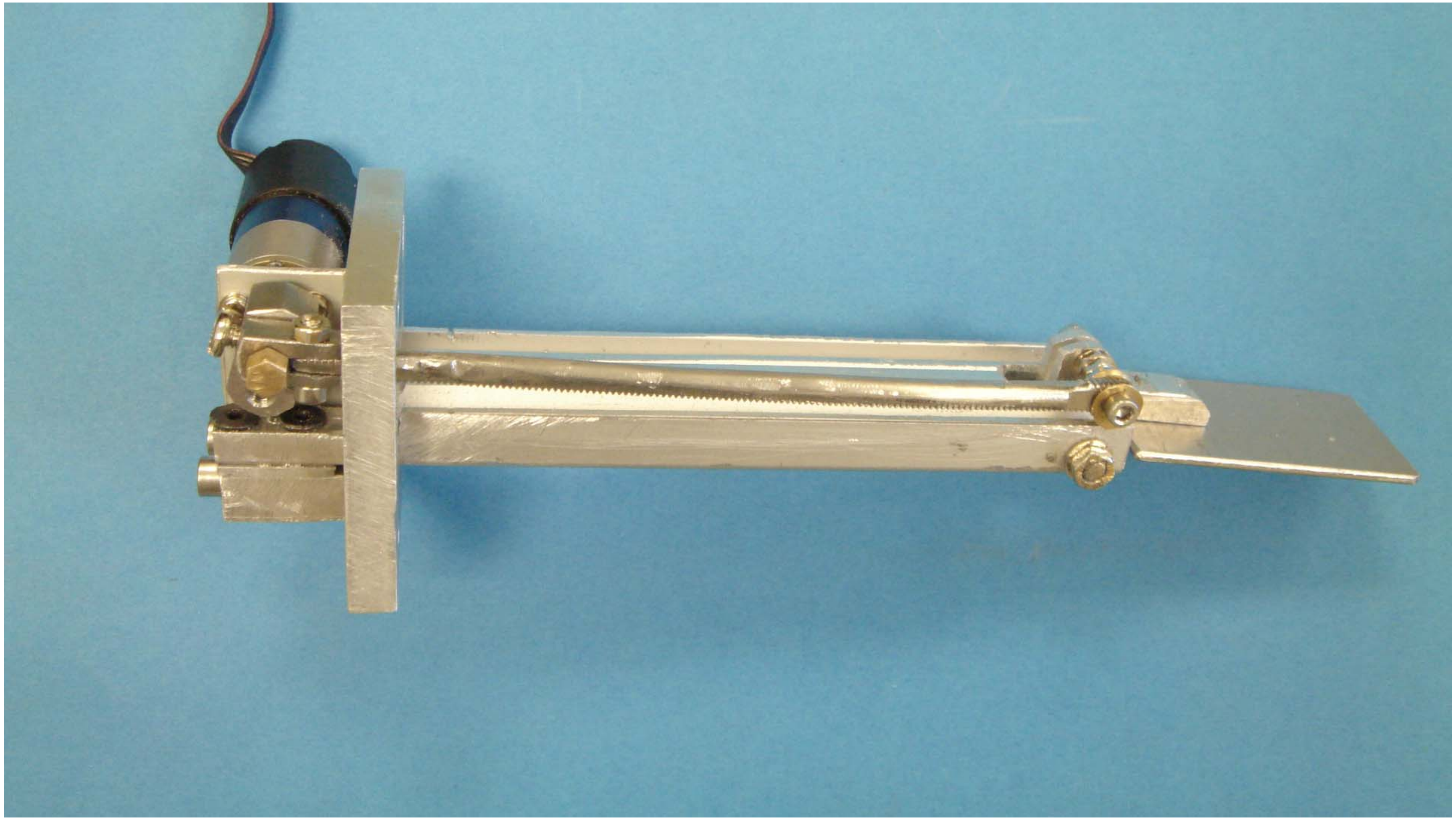


Figure 7: Traction force versus power and frequency for several types of operating members

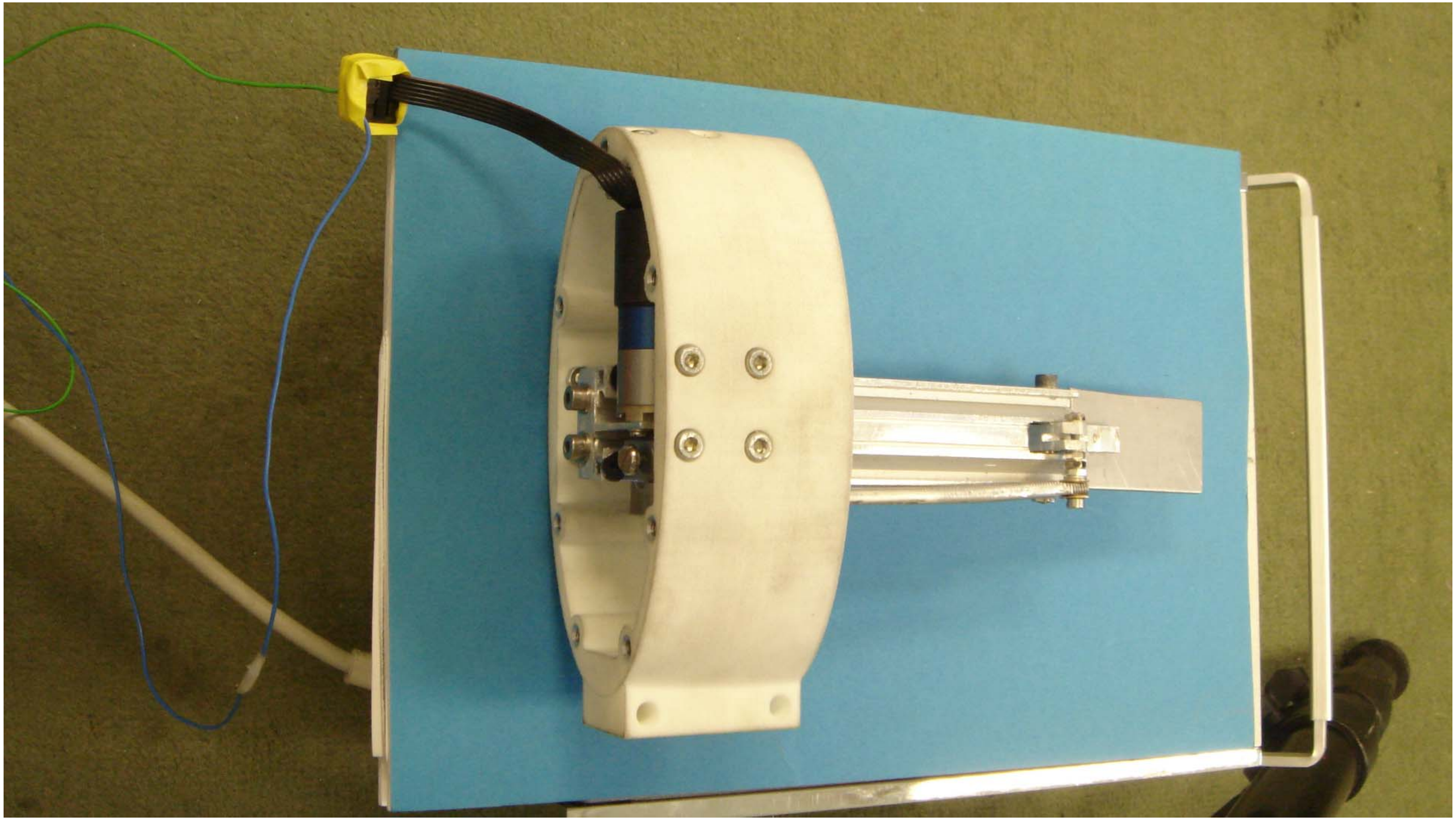
For the full-scale testing, a specially designed ship has been made of 2 kg mass, 0,5 m length, and with the above described drive and type a operating member. The ship was moving at a speed of 0.3 m/s at a power consumption of 1.5 watt; at a power of 11.7 watts it developed a speed of 1 m/s. Note that in the latter case, the efficiency of the drive was 20%.

Figure 8: Experiments with swimming robot

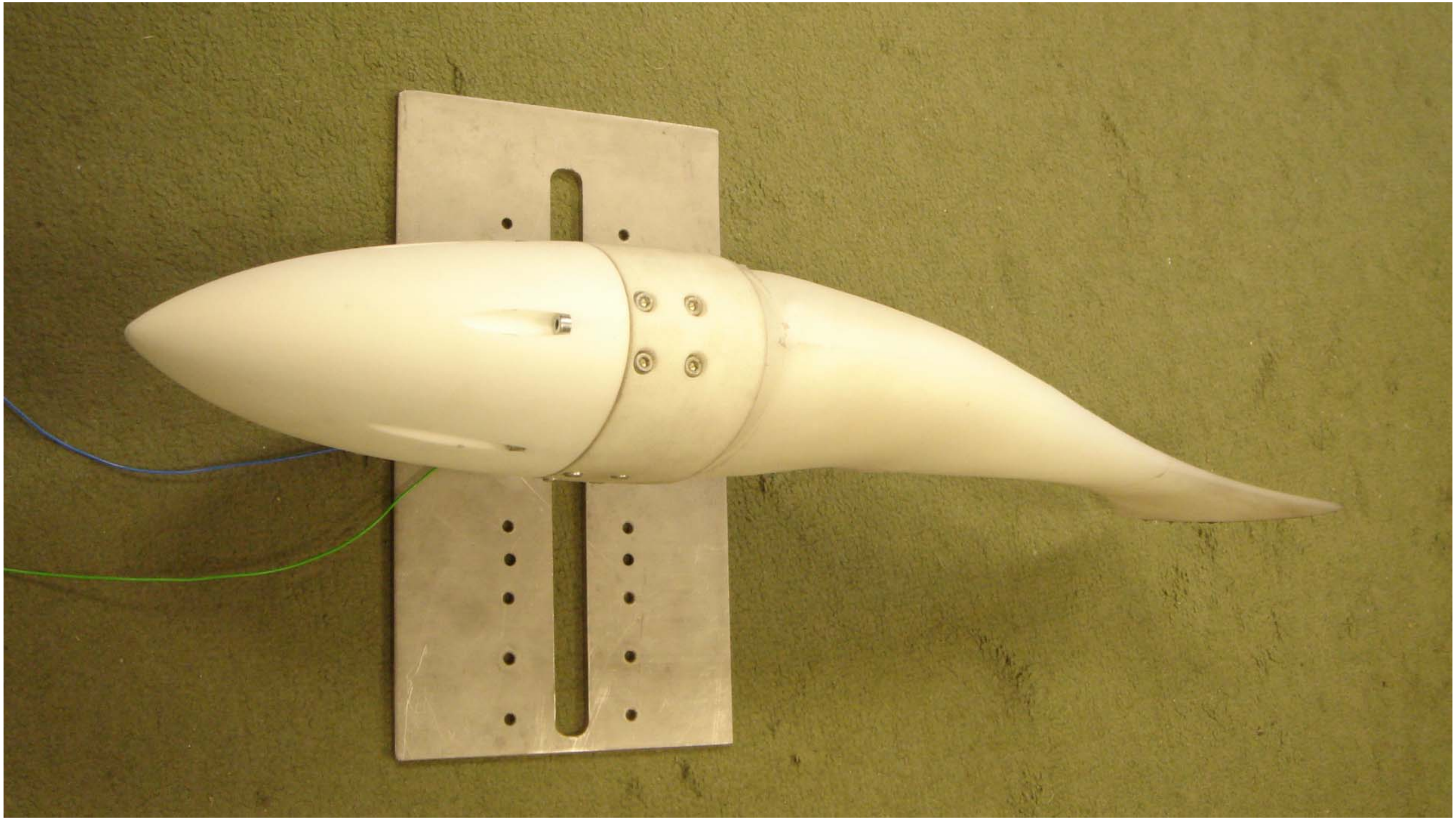
BIOMIMETIC FISH



BIOMIMETIC FISH



BIOMIMETIC FISH



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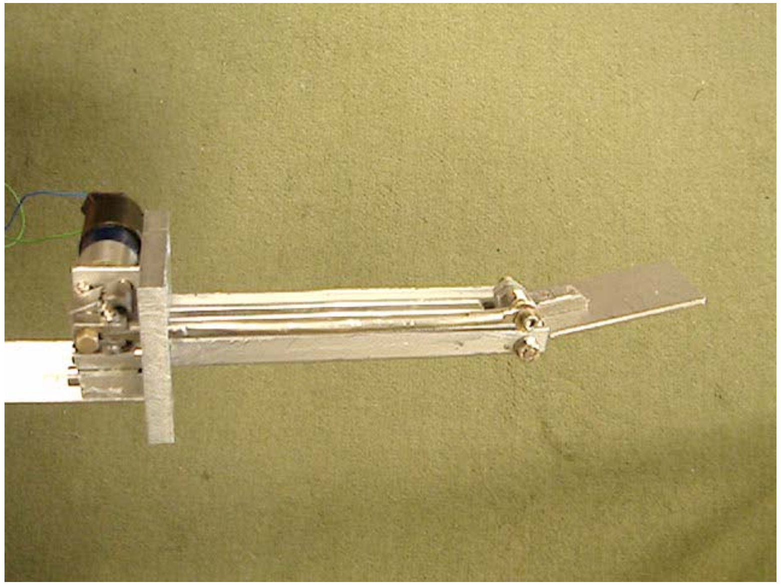

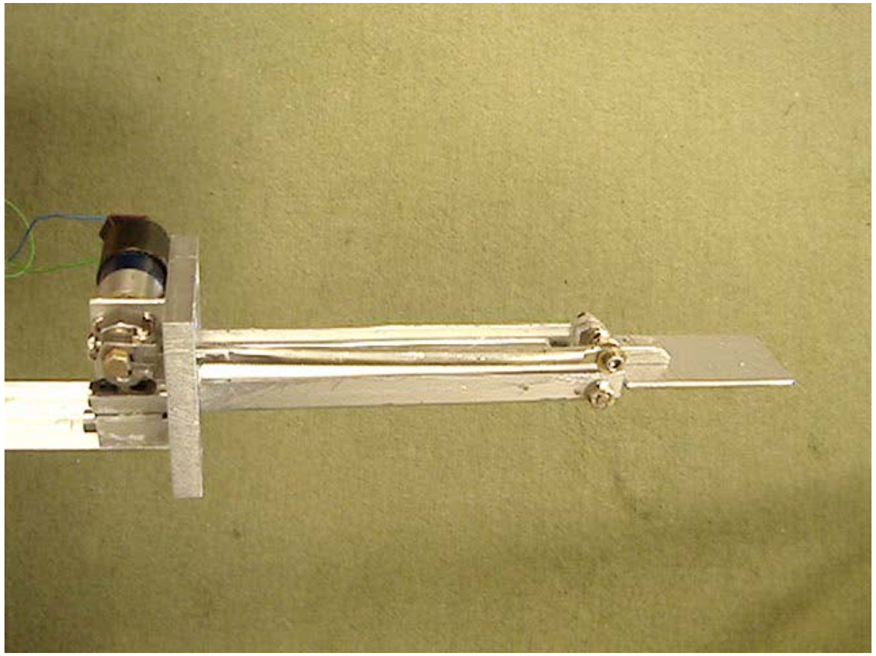

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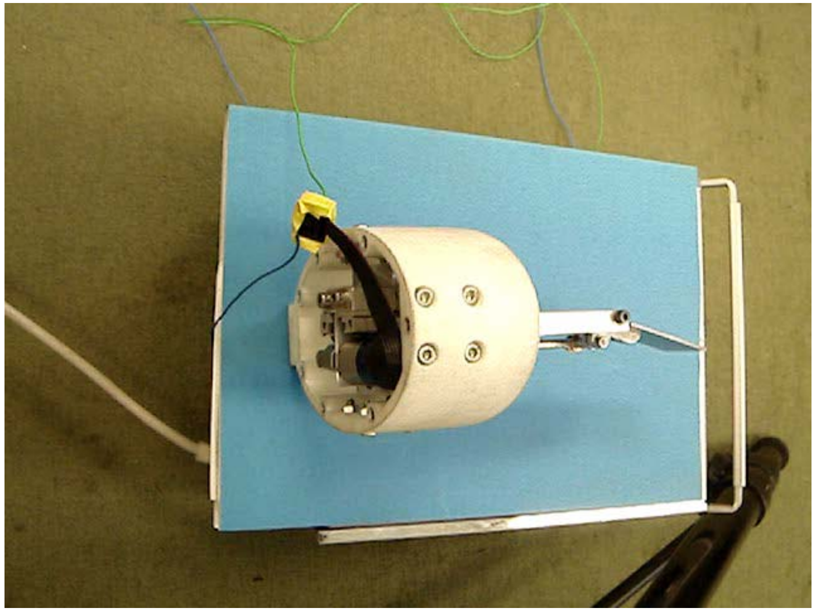

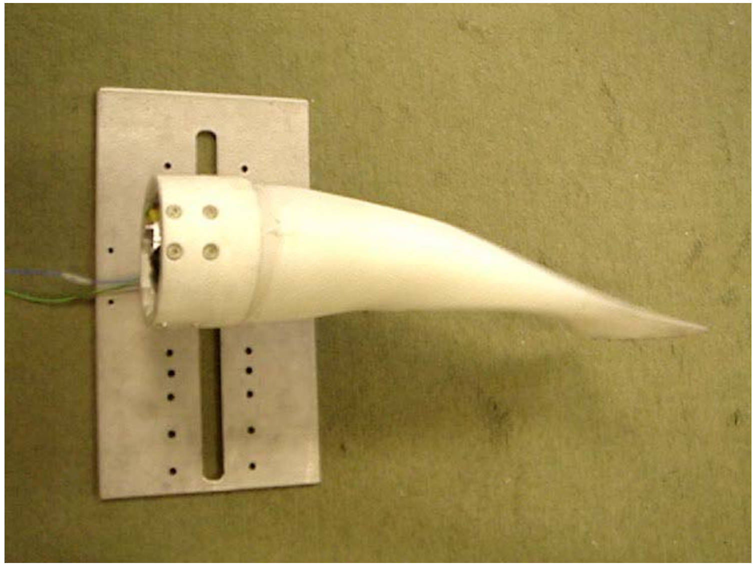

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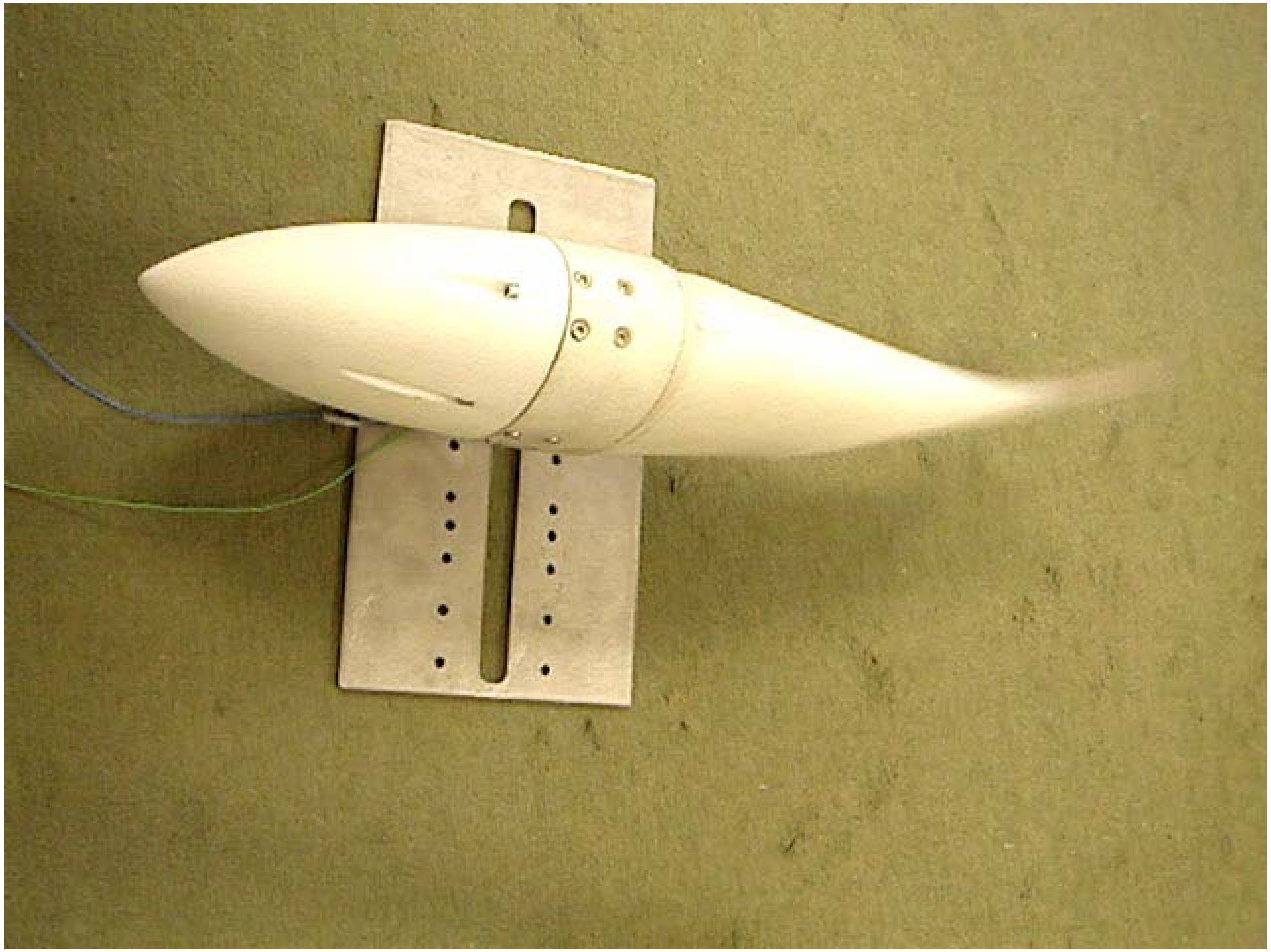

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