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Obtaining an integratable, compatible, low cost mechanical energy source providing a sufficient quantity of easily accessible energy within a miniaturised system has been an ongoing challenge for decades. The urgency and interests of such systems will continue to increase with the development of portable microsystems. The conventional approach to mechanical actuation is based on electromagnetic machines. This option is very efficient but difficult to integrate at microscopic scales. Actuation making use of piezo-electric elements became widespread starting from the 1990s, and this is an important step forward for microsystems since it is very easy to integrate, it is relatively powerful and easy to use. Obviously there is still a real actuator need to be satisfied for integrated and high power actuation. Today the trend which is the extreme system miniaturisation and complexification leads to new technological and material challenges.

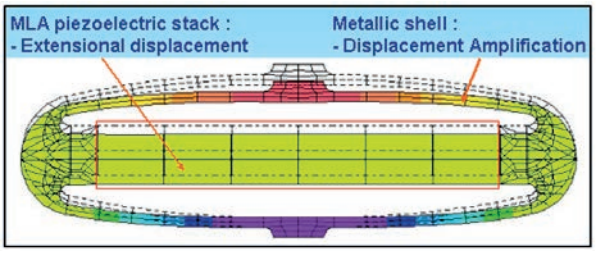

Fig. 1: APA® FEM Deformed structure

OBJECTIVE

In the frame of the MUFLY FP6 EC project, which targets a 20g micro-helicopter, new miniature piezo actuators and driving electronic of less than 0.2g are required. In that regard, ultra-light weight actuators with a high power to mass ratio have been developed. In addition a miniature driver for piezo-electric actuators addresses the issues of compact micro embedded components.

Fig. 2: View of the APA µXS

DESCRIPTION

These new miniature actuators are based on the concept of the standard Amplified Piezo Actuators. The APA® utilises the metallic shell to amplified motions from the piezo stack and to pre-stress it (Fig.1). This pre-stress is required to withstand large external vibrations.

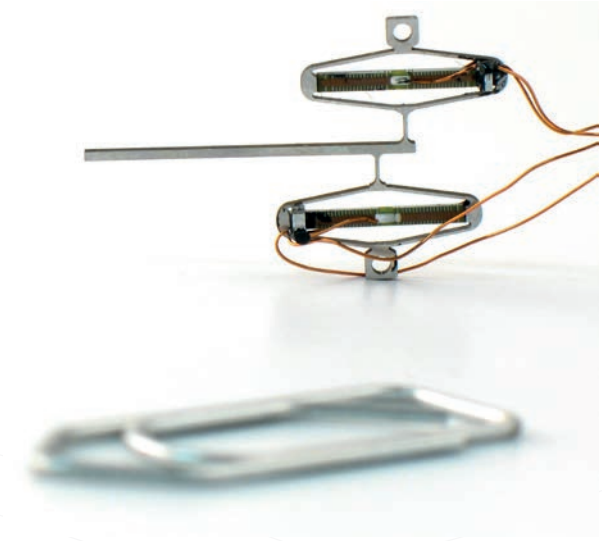

Fig. 3: View of the Tilt µXS

> MICRO AMPLIFIED PIEZO ACTUATOR: APAµXS

The APA µXS (Fig.2) is the smallest actuator of the range of CEDRAT TECHNOLOGIES' APA® . Since they are based on tiny MLA, special care was provided in the design. They offer the following features:

- Ultra light weight,
- Small and Compact,
- Great Stroke,
- High bandwidth,
- Robust design,
- Low cost.

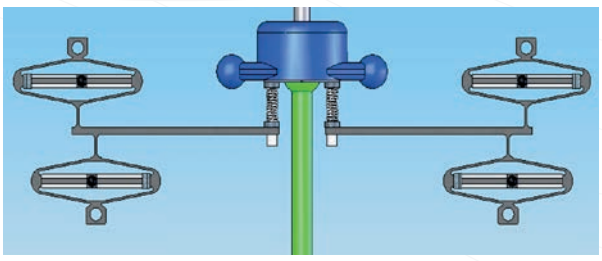

Fig. 4: CAD View of the DTT µXS

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MICRO TILT: TILTµXS

The new micro tilt (Fig.3) of CEDRAT TECHNOLOGIES, so called Tilt µXS, is based on two APA µXS's and a level arm realised in a monolithic part. Thickness, hinge Length and the pivot point pitch are optimised to allow the maximum deflection amplification on the arm tip. Indeed, the level of stroke amplification in relation to the APA µXS is up to 6.

MICRO DOUBLE TILT TRANSLATOR: DTTµXS

Using the same approach of amplification, a three level of amplification device, so called DTT µXS (Fig.4), has been developed. It is based on four Tilts µXS's: The stroke of the two pairs of APA® are amplified angularly around a pivot point to produce a large stoke around Rx, Ry and Tz.

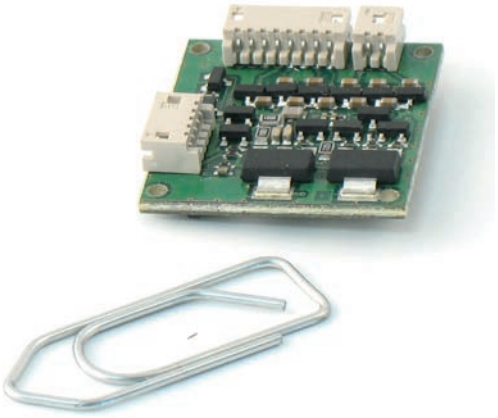

Fig. 5: View of the CAµ10

MINIATURE DRIVER FOR PIEZO-ELECTRIC ACTUATORS: CAµ10

The piezo-electric driver CAµ10 (Fig.5) consists in a small Printed Circuit Board and dedicated connections with the piezoelectric actuators. It includes the following main electronic functions:

- A DC/DC converter,
- A linear amplifier able to magnify an input analogue order,
- A SPI digital to analogue converter able to convert 12 bits words in analogue signal for the linear amplifier. Optional inputs can be connected if necessary to shunt the SPI bus and send directly the analogue order on the linear amplifiers.

PERFORMANCE

Typical performances are given in the following table. This table is not exhaustive as many other actuators can be designed by CEDRAT TECHNOLOGIES using its design tools, lab facilities and technological know-how.

REFERENCES	UNIT	APAµXS	TILTµXS	DTTµXS
Notes		**Preliminary**		
Linea stroke	µm	60	320	320
Angular stroke	°	-	-	10
Blocked force	N	1.4	1	4
Voltage	V	0-150	0-150	0-150
Maximal frequency Blocked - Free	Hz	3500	800	-
Stiffness	N/m	25 000	3 000	12 000
Dimension	mm	5x12x1	16x25x1	-
MAss	g	0.15	0.35	1.5
Electrical interface		2 wires AWG	4 wires AWG	16 wires AWG
Mechanical interface		1x1 flat square	2x M1 drilled holes	2x4 M1 drilled holes

Table 1: Micro actuators performances

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REFERENCES	UNIT	CAμ10
› Notes		**Preliminary**
Number of channel		2 channels + push-pull version
Output voltage	V	5 to 150
Output current (a)	mA	5per channel
Total Harmonic Distortion (b)	%	0.2
Signal to noise ratio (c)	dB	70
Output load	µF	0.025 to 40
Amplifier quiescent current	µA	900 per channel
Gain (d)	V/V	45
Order Input range	V	2.7 to 5.5
Bandwidth (e)	Hz	min 450
Converter efficiency (f)	%	80
Input voltage	DC Volt	3.3 to 15.5
Maximun average input power (g)	W	up to 1.5
Maximum peak inpt power (h)	W	up to 3
Mechanicals Interfaces		4 holes Ø1.6mm
Electrical Interfaces		Power input lines, actuator output lines and command lines (analogue or via SPI link) with solder pads
Dimensions	mm	19.5x23x7
Weight	g	2.2

Table 2: CAμ10 performances