



دانشگاه صنعتی شاهرود
سایت دانشگاهی: www.shu.ac.ir



انجمن مهندسی
ساخت و تولید ایران

1



(UPM)

vahid.bagherpour@gmail.com

rolling

(Optic)

(Ultra Precision Machines)

(Aerostatic)

(UPM)

() IBM
[]

H. L. Wunch

[]

N.S.Grassam

Southampton

[]

CNC

()



[]

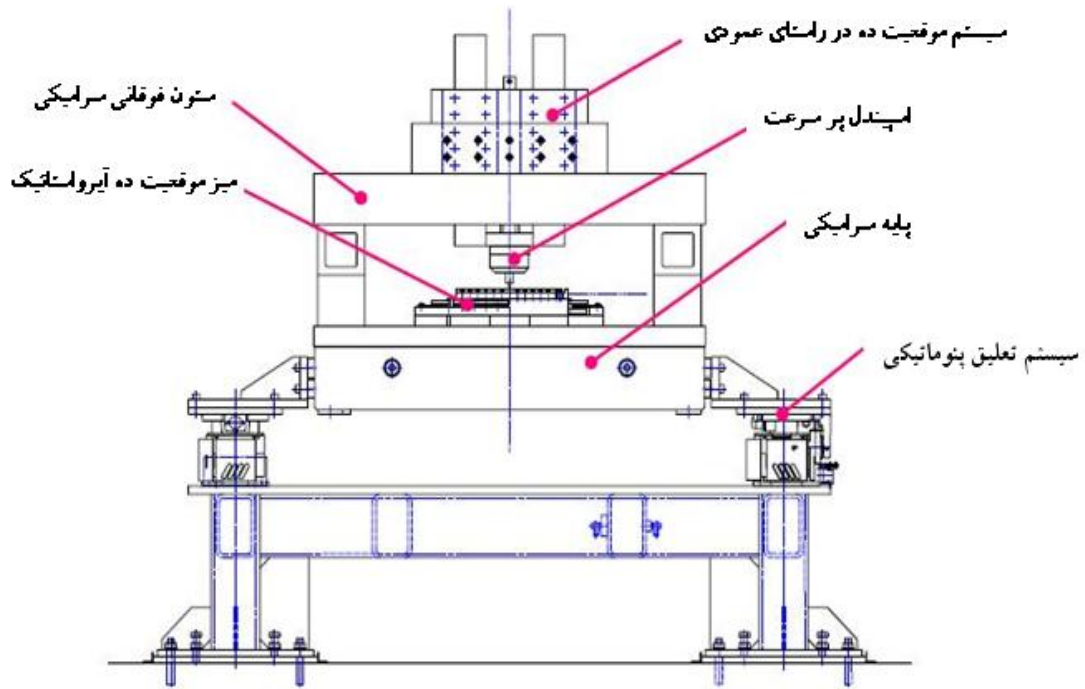
UPM

UPM

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UPM



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UPM

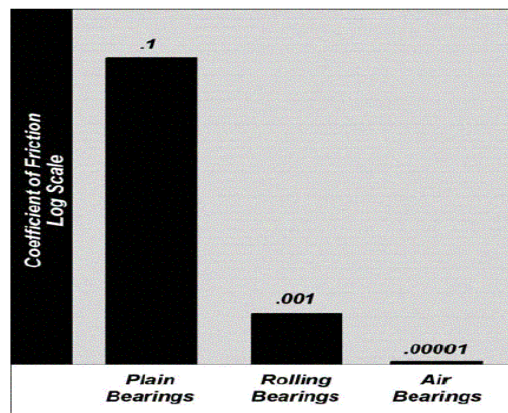
CMM

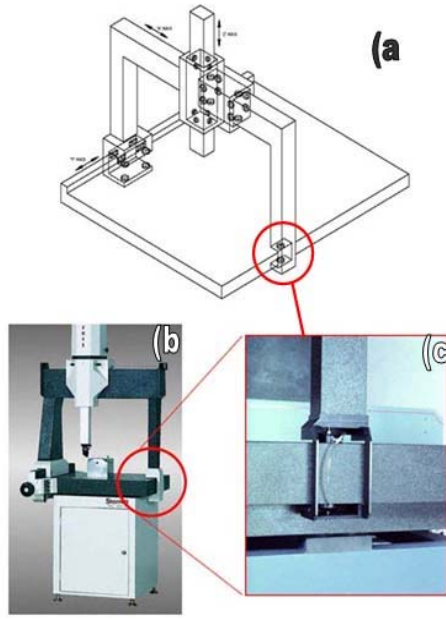
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UPM

()

[]





CMM

(a (CMM)

[]

(c CMM

(b

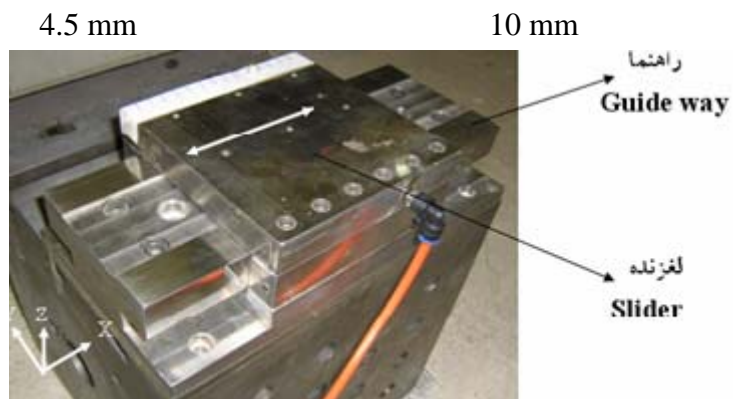
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UPM

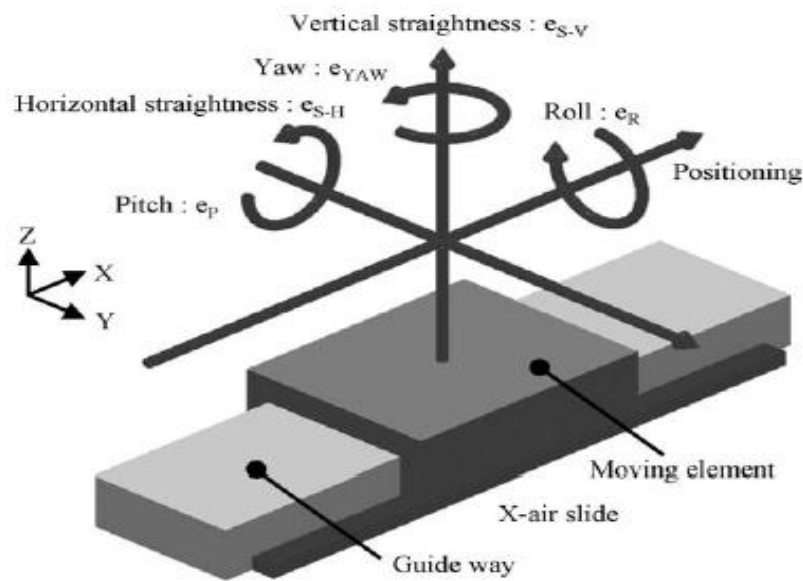
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[]



(Error Motion)

(Angular Error)		(Straightness Error)	
(X)	(Z Y)	(Z X)	(Y)
Yawing	Pitching Error	Rolling	
			Error
		Z	•
		Y	•
		X	•
		Y	•
		Z	•



[]

Z Y

X
M=2.5kg



سازمان تحقیقات
فناوری و نوآوری



انجمن مهندسی
ساخت و تولید ایران



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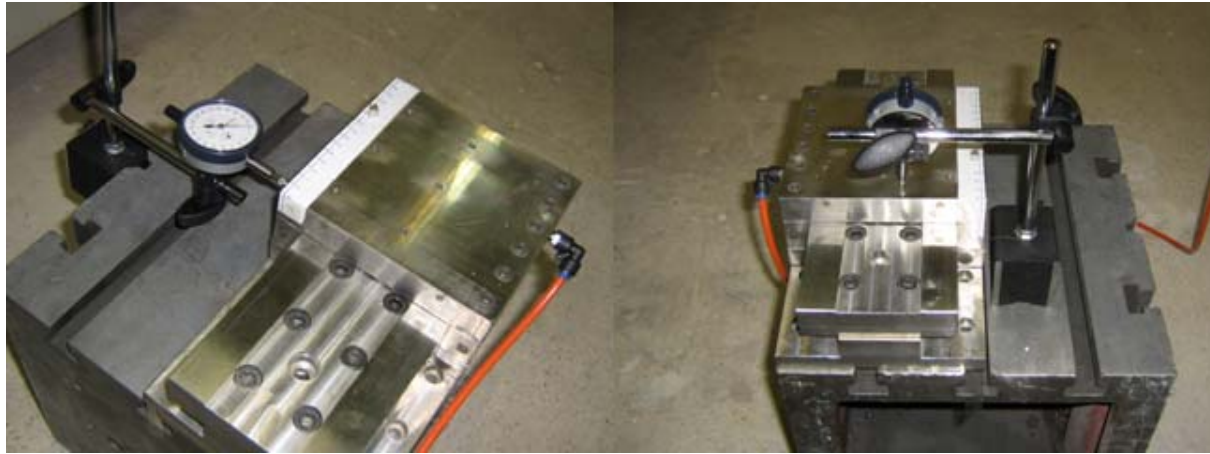
گروه مهندسی ساخت و تولید

Z Y ()

1cm

14cm

P=2 bar P=0.5 bar



()

()

z

(y

(

()

$$\alpha = 3600 \times \text{tg}^{-1} \left(\frac{s_2 - s_1}{d} \right) \quad ()$$

()

: d
: α
: S_1
: S_2

() Roll

1cm

12.5cm

Pitch

()

2bar 0.5bar

15cm

Yaw

30cm

15cm

30*30*300mm

1cm



دانشگاه سوادکوه
سایت دانشگاه سوادکوه



انجمن مهندسی
ساخت و تولید ایران



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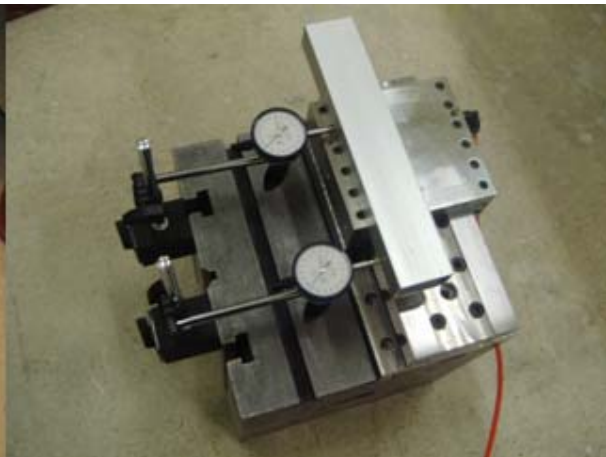
کمیته علمی مهندسی، ساخت و تولید
شاهروود



(Roll) x



()
(Yaw) z



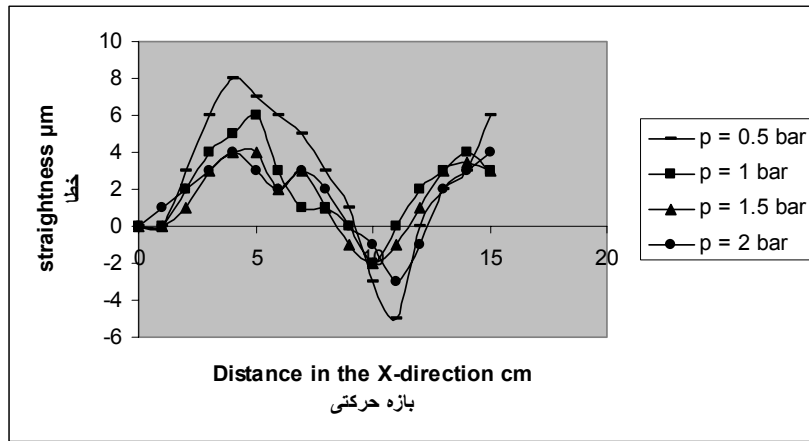
()
(Pitch) y

Pitching Rolling

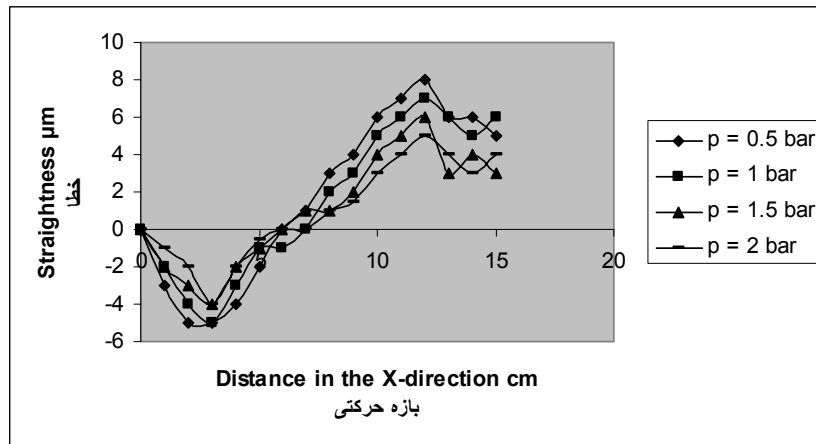
() ()

Yawing

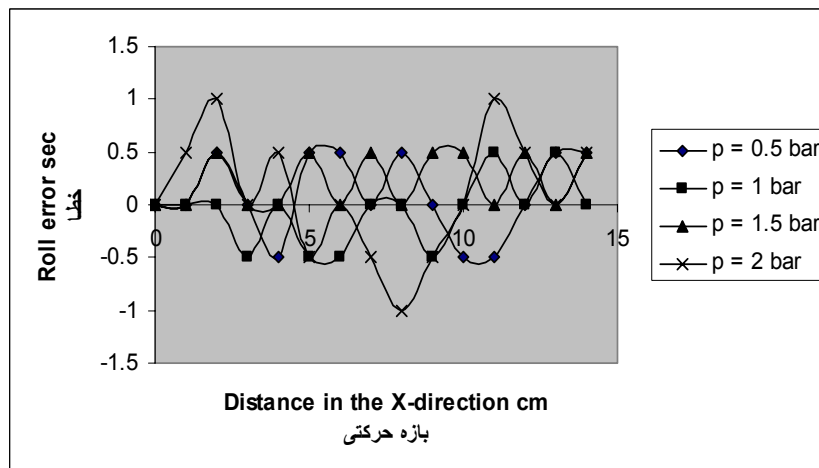
X
2bar 0.5bar



x

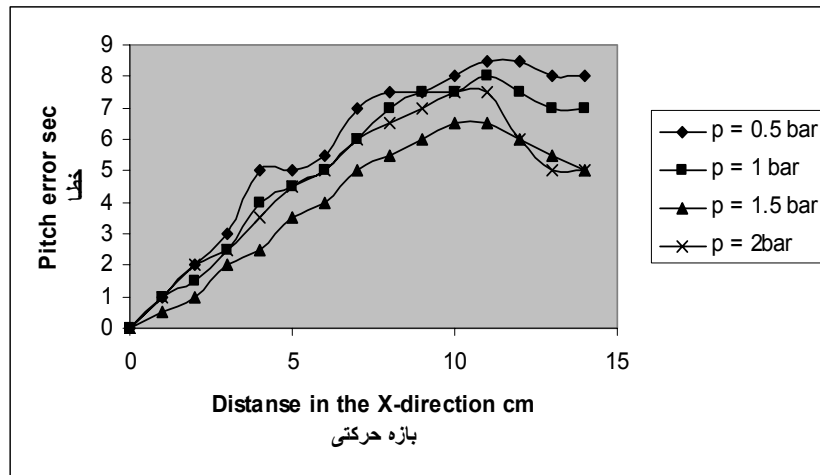


x

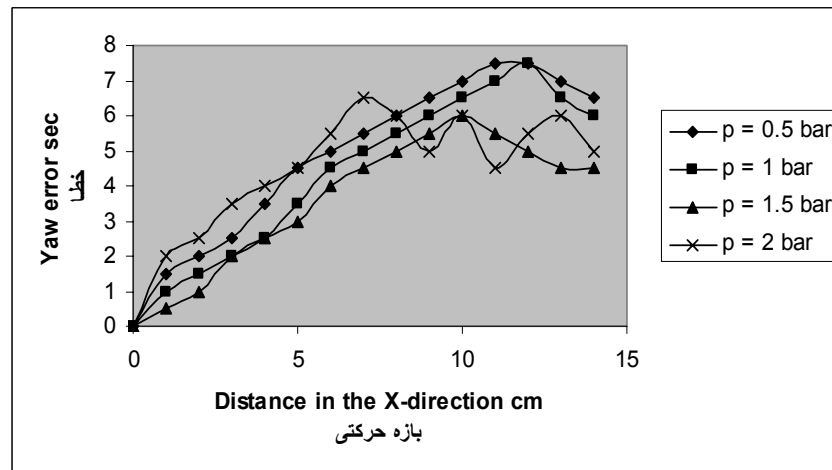


x

roll



x pitch



x yaw

•
•
•
•
•

2.5bar

2bar

(Pneumatic Instability)



سازمان فناوری اطلاعات
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انجمن مهندسی
ساخت و تولید ایران



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(Critical Pressure)

2bar

2bar

() ()

rolling ()

yawing pitching () ()

P=2bar

yawing pitching

rolling

yawing pitching

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2- Powell, J.W. "Design of Aerostatic Bearing". The Machinery Publishing Co .LTD

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4- "Ultra-precision Machining Systems"; an Enabling Technology for Perfect Surfaces Gavin Chapman Moore Nanotechnology Systems LLC, PO Box 605, 426a Winchester Street, Keene,NH 03431, USA

5- Hashizume. "An ultra precision machine tool for micro-machining". Precision and Intelligence Laboratory .Tokyo Institute of Technology.2006

6- "Machine Tools for Ultra-Precision and Micro Manufacturing Moore Nanotechnology Systems", LLC By Dr. Sinan Badrawy Workshop on Micro Manufacturing, NSF, August 12, 2004

"(UPM)

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8- Wei Gao, Yoshikazu Arai, Atsushi Shibuya, Satoshi Kiyono. "Measurement of multi-degree-of-freedom error motions of a precision linear air-bearing stage". Precision Engineering 30 (2006) 96–103.