الايـة

ِ الرَّحْمَنِ الرَّحِيمِ

لَّوْ كَانَ الْبَحْرُ مِدَادًا لِّكَلِمَاتِ رَبِّي لَنَفِدَ الْبَحْرُ
َن تَنفَدَ كَلِمَاتُ رَبِّي وَلَوْ جِئْنَا بِمِثْلِهِ مَدَدًا} ﴿١٠٨﴾

صدق الله العظيم

سورة الكهف

DEDICATION

The words and measures can never express my deepest gratitude to my parents. They have been a force of strength all along, and without them it would have been an uphill task for me to complete this work.

Last but not the least, 1am deeply indebted to my brothers, sisters and my friends; their incessant support made me achieve new heights in life and built my character and career.

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In the name of ALLAH, Most Gracious, And Most Merciful Praise is Almighty ALLAH (SubhanahuWaTa'la) who gave me the courage and patience to carry out this work.

I would like to express my deep gratitude to my supervisor, ***Dr. MusaabZaroug*** for his kindness, constant endeavor, guidance and the numerous moments of attention he devoted through this work.

Abstract

Electrostatic actuators have major role in many MEMS devices, e.g. sensors, actuators. The amount of applied voltage to an electrostatic micro-actuator has a direct impact on the amplitude of deflection throughout the cantilever , as well as the position of the upper electrode has a direct impact on the natural frequency of the micro-actuator.

This research aims to study the amplitude of deflection in a micro-cantilever at different applied voltagesas well as different position of the upper electrode and determine the critical points of the applied voltage (pull-in voltage) for different position of the electrode pad on the cantilever at which the amplitude of deflection exceedone-third(1µm) of the total gap (3µm), Also aims to study the natural frequency for different length of electrode pad that cover the actuator layer. Finite element method, ANSYS was used as a simulation tool.

As a result the range of the applied voltage(pull-in voltage) that caused this cantileverreach the critical point for amplitude of deflection is (32mV-89mV) for different positions of the electrode pad as well as the natural frequency decrease related to increase the upper electrode length.

المستخلص

للمحرك الكهروستاتيكى دورا هاما فى كثير من الانظمة الكهربية الميكانيكيه متناهية الصغر على سبيل المثال الحساسات والمحركات,لمقدار فرق الجهد المسلط على المحرك تأثيرعلى مقدار الانحراف للعارض الكابولى,كما ان موضع القطب الكهربائى فوق المحرك تأثير مباشر على التردد الطبيعى .

يهدف هذا البحث لدراسة مقدار الانحراف للعارض الكابولى تحت تأثير قيم مختلفه لفرق الجهد بالإضافة لمواضع مختلفه للقطب الكهربى, وكذلك تحديد الجهود الحرجة المسلطة على االقطب الكهربى بمختلف وضعياته على العارض الكابولى وذلك عندما يكون مقدار الانحراف فى العارض الكابولى مساويا لطول الفجوة بين العارض والقاعده,كما انه يهدف لدراسة التردد الطبيعى للعارض الكابولى عندما يكون القطب الكهربى بالكامل على طبقة المحرك.

تم استخدام طرق التحليل المحدود للعناصر ممثله فى ANSYS (APDL)كوسيلة للمحاكاة.

من أهم النتائج وجد أن مدى قيم فرق الجهد المسلط على المحرك الذى يتسبب فى وصول انحراف المحرك الى القيمة الحرجة هو(32mV-89mV) لمختلف الوضعيات للقطب الكهربى, وايضا وجد ان قيم التردد الطبيعى تتناقص بإذدياد طول القطب الكهربى.

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MEMS	Micro-Electro-Mechanical System
FEM	Finite Element Method
ANSYS	Analysis System
FEA	Finite Element Analysis
NT	New Technology
TE	transverse electric
SRR	split ring resonator
VLSI	very large-scale integration
IC	integrated circuit
MST	Microsystems technology
LIGA	the German acronym for Lithographie, Galvansformung, Abformung
DMD	digital mirror display
APDL	ANSYS Parametric Design Language