Sudan University of Science and Technology

College of Engineering

School of Mechanical Engineering – Department of production Engineering

A Thesis submitted for the Honor Degree of BACHELOR of mechanical Engineering

Title:

Position Control of a Micro Electro Mechanical Actuator By Using MATLAB And ANSYS

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List of Abbreviations and acronyms

MEMS	Micro Electro Mechanical System.
ANSYS	Analysis System.
DMD	Deformable Mirror Device.
DLP	Digital Light Processing.
SGI	Silicon Graphics International.
MATLAB	Matrix Laboratory.
PID	Proportional Integral Derivative.
3D	Three Dimension.
FEM	Finite Element Method.

NT	New Technology.
ME	Memorable Entertainment.

List of symbols

Q	Charge.
C	Capacitance.
V	Voltage.
W	Potential energy.
I	Current.
R	Resistance.
F	The electrostatic force acting between the plates.
□	Air permittivity.
A	Surface area of movable plate.
g	Gap between parallel plate.
F_e	The nonlinear electrostatic force.
F_b	Linear squeeze film damping force.
F_k	Linear mechanical spring force.
m	The mass of movable plate.
l	The length of movable plate.

t	The thickness of movable.
w	The Width of movable.
b	Viscous damping coefficient.
μ	Dynamic viscosity for air.
K	Spring constant.
E	Elasticity modules.
Vs	Normalized source voltage.
V_{eq}	Equilibrium source voltage.
V_{act}	Voltage across actuator.
W	Natural frequency.
X	Displacement.
x	Equilibrium displacement.
P	Power function (d the dissipation of energy in the system).
V_{pi}	Pull-in voltage.
q_{pi}	Pull-in charge.

Abstract

Electrostatic actuators have a large effect in many MEMS devices, e.g. sensors, actuators. The amount of applied voltage to an electrostatic actuator has a direct impact in the displacement of the cantilever between the movable plate and fixed plate, which affects on the displacement of the movable plate of electrostatic actuator. This research aims to control this displacement (position).

المستخلص

الصغر الميكانيكية متناهية الكهربائية الانظمة من كثير في هاما دورا الالكتروستاتيكي للمحرك مقدار الفولتية التي يتم تسليطها على المحرك الالكتروستاتيكي .والمحركات الحساسات المثال سبيل علي تؤثر على ازاحة (موضع) اللوح المتحرك . هذا البحث يهدف للتحكم في موضع هذا اللوح المتحرك باستخدام برنامج الماتلاب .

1.1 Introduction:

MEMS has been identified as one of the most promising technologies for the 21st Century and has the potential to revolutionize both industrial and consumer products by combining silicon-based microelectronics with micromachining technology. Its techniques and microsystem-based devices have the potential to dramatically affect of all of our lives and the way we live [1].

MEMS include different type of actuator such as electrostatic, electrothermal, and piezoelectric. This study well focus on electrostatic actuators (parallel plate type).

MEMS is:

- Micro (small)
- Electro (electric components/functionality)
- Mechanical (mechanical components/functionality)
- Systems (integrated, system-like functionality)

It also describes the range of MEMS sensors and actuators, the phenomena that can be sensed or acted upon with MEMS devices, and outlines the major challenges facing the industry.

A control system consists of subsystems and processes (or plants) assembled for the purpose of obtaining a desired output with desired performance. control system has ability to compensate for disturbances. Typically, control system used to control such variables as temperature in thermal systems, position and velocity in mechanical systems, and voltage, current, or frequency in electrical systems. The system must be able to yield the correct output even with a disturbance [7].

Position control of a micro elctromechanical actuator is aimed to control the position of movable plate of two parallel actuator.

1.2 Research problem:

MEMS capacitive type transducer are used in many application that use micro system actuator including robots particularly micro robots with characteristic dimension less than 1mm the term can also be used for robots capable of handling micro size.

One of the largest challenges in developing micro robots or all micro systems are they require to control their voltage that apply to the actuator so that to give the optimum performance (mechanical function such as displacement).

1.3 Objective:

- Modeling and analysis electrostatic actuator by using ANSYS.
- Position control of a micro-electrostatic actuator.

4 The methodology:

This project is sequenced as following:

- ANSYS software had used to model the electrostatic actuator.
- MATLAMB SIMULINK had used to model the open loop and close loop system.
- PID controller had been used to achieved close loop system.
- Many references and papers are used to model the equation of the transfer function.