

# Chapter one

## Introduction

### 1.1. General introduction:

Micro-electromechanical systems (MEMS) are a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batch processing techniques and can range in size from a few micrometers to millimeters. These devices (or systems) have the ability to sense, Control and actuate on the micro scale, and generate effects on the micro scale [1]. In the last decade, extensive developments of micro electromechanical systems [2]. The main ideas taken in this research Microactuators with capability of providing dynamic motion or static displacement had enabled and demonstrated many applications, such as electrothermal microactuator, electrostatic microactuator, electromagnetic microactuator and shape memory alloy microactuator [3]. electrothermal microactuator have been known as their large displacement and high force output. It can be classified to V-beam actuator (Gianchandani and Najafi 1996; Que et al. 2001) and U-shaped actuator (Pan and Hsu 1997; Huang and Lee 1999) are the two most cited and characterized electrothermal actuators, while two new sorts of electrothermal actuators, i.e., X-shaped and H-shaped electrothermal actuators, have been reported recently (Lee and Yeh 2005; Lee 2006a) [2].

MEMS technology has emerged to be the promising one for V-beam microactuators due to the advantages of high precision, small size and low cost, large displacement, high force output, action fast, easy to operate, simple fabrication process and so on [3]. The large displacement, force output and response time are the key factors to evaluate the performance of microactuators [4].

The development of a systematic and rather optimal design methodology for microelectromechanical system (MEMS) very important in satisfying the current thermal necessities and for successful heat distribution in the future generations of critical electronic components.

The idea of this research to using the entropy generation rate to estimate the heat transfer enhancement as a performance assessment criterion for thermal efficiency of systems.

This research proposes optimal method particle swarm optimization (PSO) to design fillet shape of electrothermal V-beam microactuator by decreasing beam entropy generation rate and simulation is used by MATLAB.

PSO is a population-based stochastic optimization technique developed by Kennedy and Eberhart[5,6 ], and it has been inspired by the behavior of schools of fish and flocks of birds. In general, PSO is based on a relatively simple Concept and can be implemented in a few lines of computer code, PSO has also been proved to perform well in test functions used in EA and may be used to solve many problems similar to those in EA and It appears to be a promising approach, and early testing has found the implementation to be effective with complex practical problems. However, PSO does not suffer from some of the difficulties of EAs.For example, a PS system has memory, which the genetic algorithms (GA) do not have [7,8 ]. In summary, compared with other methods, PSO has the following advantages [9]:

- Faster and more efficient: PSO may get results of the same quality insignificantly fewer fitness and constraint evaluations.
- Better and more accurate: In demonstrations and various application results, PSO is found to give better and more accurate results than other algorithms reported in the literature.

- Less expensive and easier to implement: The algorithm is intuitive and does not need specific domain knowledge to solve the problem.

## **1.2. Problem Statement:**

Determination the optimal number of beam thickness  $h$ , gap between beam & substrate  $g$ , v beam width  $w$ , v beam length  $L$ , current density  $J$  developing more effective optimization techniques to achieve maximum angular displacement & output force using entropy generation rate which was not achieve in past designs by generating a new variant promising approach in industry to increase efficiency and reduce cost.

## **1.3. Objective:**

This research presents a novel approach to verify and optimize surface of V beam micro electrothermal actuator using particle swarm optimization by MATLAB, aim to:

1. Find optimal parameters to maximize actuation displacement angle and output force. Which will led to:
  - Firstly: Increase v-beam efficiency & performance.
  - Secondly: Reduce running & manufacturing costs.

## **1.4. Methodology:**

Results will obtain using (PSO) optimization by MATLAB; several run will carry out for parameters to get the optimized solution.

## **1.5. Thesis outlines:**

First chapter, we introduce MEMS & PSO, specially electrothermal type during this chapter discuss problem Statement which determination the optimal number of beam thickness  $h$ , gap between beam & substrate  $g$ , v beam width  $w$ , v beam length  $L$ , current density  $J$ . The research aim to Find optimal parameters, Increase

v-beam efficiency & performance, Reduce running & manufacturing costs and Study a new optimizer tool in MEMS design. The methodology used to obtain Results using PSO optimization by MATLAB, several run will carry out for parameters to get the optimized solution.

Second chapter, quick literate review for MEMS design optimization flowed by overview in MEMS & PSO discuss definition, classification, application, the development & features of electothermal actuator specially and PSO implementation.

Third chapter, V-shaped beam design and simulations from steady state heat equation we develop formula govern heat dissipation (entropy) to generate mathematical model which implement PSO by MATLAB codes we take some consideration to implement the method during this chapter.

Fourth chapter, we discuss result were obtained in PSO method by MATLAB for any parameter and we give an example for PSO calculation and we compared our results to results obtained by Chengkuo Lee.

Fifth chapter, we conclude the results were obtained compared to other study with further work and recommendations.