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# Design and Analysis of Mechanical Micro-Swimmers

***Mr. M. Raghuvaran [1] and Mr. L. Bhavani Shankar [1], R.T.V. Satya sai[2], P. Eswara Rao[3], R. Jagadeesh[4], N. Aravind Naidu[5]***

[1]M. Tech, Assistant Professors, Department of Mechanical Engineering.

[2,3,4,5] - Department of Mechanical Engineering.

[1,2,3,4,5]Avanthi Institute of Engineering & Technology (Afflicted by Jawaharlal Nehru technology university, Kakinada) Cherukupalli, Bhogapuram, Vizianagaram Dist, AP.

**ABSTRACT**

*Research is currently becoming more and more interested in studying microswimmers. When compared to the macroscopic world, the motion or mobility of an object in the microscopic world is distinctive and challenging to comprehend. In this research, we look into these little microswimmers, also known as swimmers. The fundamental design of a swimmer was initially presented as a three-sphere model, and it is frequently used extensively in theoretical, computational, and experimental study. In order to learn more about and gain insight into several general concepts of microswimmers, we have modified and developed the helical spring model in two ways.*

*An ideal design is produced in this research which is a conical shaped head with a helical spring as its tail. The current research work compares the analytical analysis of two models of microswimmers with different head designs. The values of numerous parameters, such as deformations, velocities, accelerations, stresses & strains etc., for micro-swimmer will be found in the current research effort. We can create the best design for a helical spring micro-swimmer by examining the data.*

**Keywords: Microswimmers, ansys fluent, self-propulsion, micro robots.**

## 1. INTRODUCTION

This study focuses on mechanically propelled micro swimmers, commonly known as "swimmers." These are miniscule, as the name suggests. They can swim or move forward independently in fluids by using mechanical forces. Despite being at the micro level, there is no precise restriction. Micro swimmers include the majority of biological microorganisms, including bacteria, algae, archaea, and protozoa. This type of biomass on earth was reportedly included in some studies. There are numerous manufactured devices that are already in existence that are of microscopic size that swim in fluid environments, making them instances of micro swimmers in addition to these natural species. We shall focus our attention on the movements of mechanical microswimmers. The impact of microbes (also known as microorganisms) on the health of other creatures has been extensively investigated. Comparably, in order to use artificial micro swimmers effectively and securely for their intended uses, it is essential to thoroughly comprehend and forecast the features of their motion. At low Reynolds numbers, where fluid friction and viscosity prevail over inertia, swimming occurs at the microscopic scale. Evolution produced propulsion devices that combat drag and even take advantage of it. Numerous bacteria use rotating helical flagella as a means of propulsion, and sperm and algae use eukaryotic flagella that move in a manner like to a whip or snake.

The drug delivery mechanism that swims on its own in the direction of cancer cells before releasing its therapeutic load. A rapidly developing scientific field with numerous potential medicinal uses is autonomous swimming. When the bacteria is found then it enters the cancer cells, the medicine is internally released. Doxorubicin kills the invaded cancer cell and destroyed the carrier once it was liberated from the liposomes. Chemotaxis is the ability of motile cells to respond to chemical gradients in their environment and to migrate in one direction—either toward higher concentrations of chemoattractant or lower concentrations of chemorepellent—in order to do so. It can serve as a useful tool for laboratory investigations as well as be crucial in practical applications. To increase the forward-backward motion symmetry, a double-end helical swimmer is built on the common single-end helical one. Additionally, the ideal design and motion properties of sub-millimeter helical swimmers were examined. The outcomes will soon be confirmed on smaller helical micro swimmers. A promising development for the treatment of diseases is the development of intelligent nanomaterials therapeutic systems based on nanomaterials have the potential to outperform current molecular therapeutic and diagnostic approaches.

### *1.1 Fundamental concept of Reynold's Number:*

The Reynolds number is the ratio of inertia forces to viscous forces. The Reynolds number is a dimensionless number used to categorize the fluids systems in which the effect of viscosity is important in controlling the velocities or the flow pattern of a fluid. Mathematically, the Reynolds number, $N_{Re}$, is defined as