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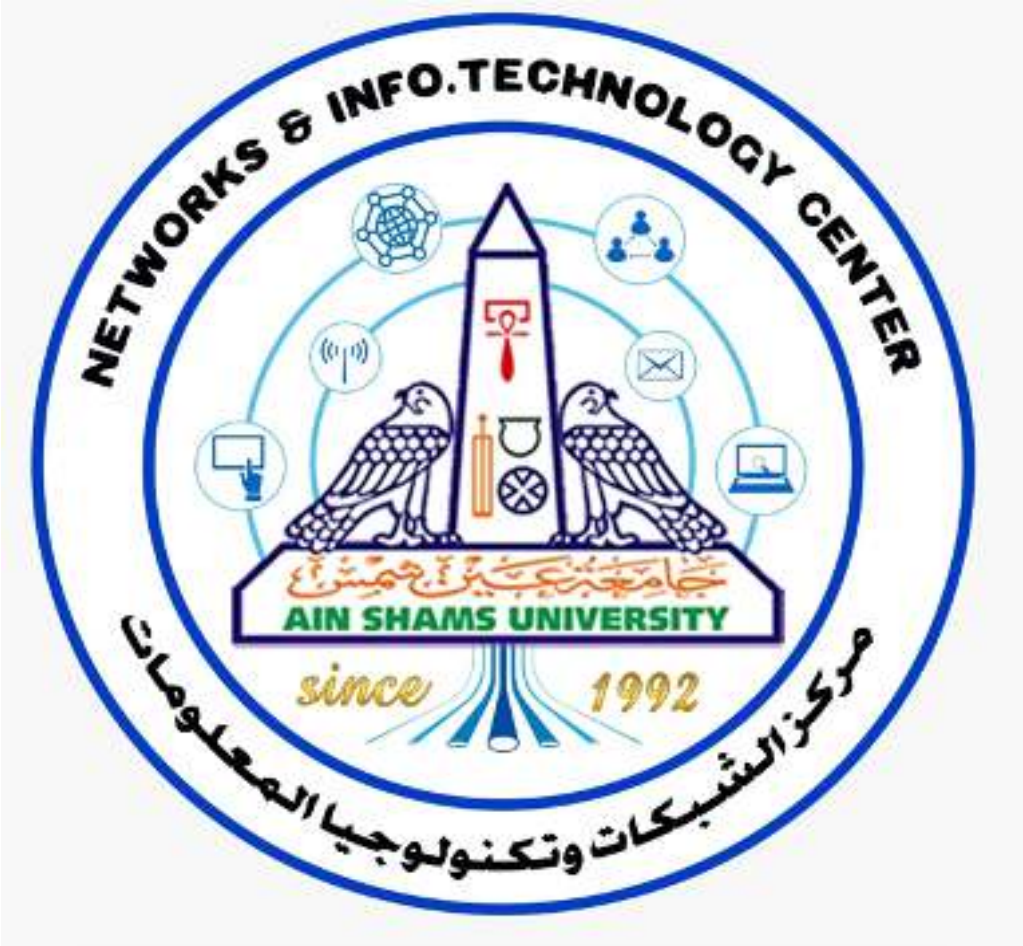
بسم اللّه الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



Mona Maghraby

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم باللّه العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

Mechanics of Human Red Blood Cell at the Onset and Progression Stages of Plasmodium Falciparum Malaria Parasite

By

Mohamed Tawfik Ahmed Eraky

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Aerospace Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

MECHANICS OF HUMAN RED BLOOD CELL AT THE ONSET AND PROGRESSION STAGES OF PLASMODIUM FALCIPARUM MALARIA PARASITE

Key Words:

Human Red Blood Cells, Malaria, Plasmodium Falciparum, Shear modulus, Skalak model

Summary:

This thesis aims to get insight into the mechanics of human red blood cell in healthy case and during the progression of Plasmodium Falciparum malaria parasite. As the computed results in previous studies using previous models in both cases did not agree with the in-vitro stretching tests, Skalak's hyperelastic constitutive model is used. This model achieved a remarkable agreement with stretching tests in the healthy case. During infection the cell membrane is patched with one infected patch with high shear modulus whereas the remaining membrane segment is represented with a lower shear modulus. The infection progression is represented by increasing the patch diameter. In the all infection simulation, the geometry mutation of the infected cell from the biconcave shape to the spherical-like shape in the last infection stage is considered. Present simulation results using ABAQUS explicit showed an accurate agreement with in-vitro stretching optical tweezers tests.

Disclaimer

I hereby confirm that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute. I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Date:

Signature:

Dedication

I would like to dedicate this work to help humanity. Malaria is one of the intransigent diseases which claims the life of around 500,000 humans per year. This work could help to tackle Malaria infection by engineering human organs, early detection of infection and diagnosing infection during different progression stages.

Acknowledgments

I would like to avail this moment to thank Dr. Mohamed Madbouli for his continuous support, supervision and guidance while working on my thesis. His comments on my thesis helped to shed light on the connection between Engineering work and Biology. Also, he oriented me towards focusing on employing Engineering to solve one of the intransigent medical issues. His requirement to do a fluid-solid interaction simulation for single cell in blood vessel taught me how to establish one of the unique simulations by coupling between two different softwares. Special appreciation goes to Dr. Ahmed Ibrahim, who introduces me to a new state-of-the-art interdisciplinary topic between Engineering and Biology. He taught me how to efficiently think about the problem and provide an efficacious technique to overcome the issue that I confronted during the thesis work, specifically during model derivation and implementation. He also guided me though writing and editing a professional Journal publication. Apart from that, he taught me how to write using LaTeX, which saved considerable amount of time during writing my thesis and papers. I would like to express my special gratitude for Dr. Mostafa Shazly, who supports me during establishing the required simulations on ABAQUS, also, he came out with the idea of patching the cell membrane with different shear moduli during modeling infection. His guidance helped to work on a professional level. I am so grateful for Dr. Amr Gamal, who taught me the Continuum Mechanics course, which helped me to go through necessary mathematical derivation during the implementation of continuum models.

I am so grateful for my beloved family for their continuous support during my coursework exams and my hardship during thesis work. Thanks for everyone who helped me to go through this research and maximize the output within considerable short amount of time.

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