

# Student DetailsReport on ExEED Research Based Learning

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1. **Title of the Research Work**

**UNDERSTANDING THE FLOW PROPERTIES IN AN ARTERY AT HIGH ALTITUDES USING GMDH ALGORITHM**

# Define the problem and its relevance to today's market / society / industry need (Max: 100 Words)

Understanding the flow properties of blood at the arterial level is key to understanding various physiological processes, diagnosing diseases and developing effective treatments. Here are some key applications of studying the properties of blood flow in arteries:

Hemodynamics: Hemodynamics refers to the study of the dynamics of blood flow in the circulatory system. By analyzing blood flow rate, pressure and volume in the arteries, researchers and health professionals can assess the overall functioning of the cardiovascular system. This information helps in evaluating cardiac output, identifying abnormalities, and managing conditions such as hypertension.

Atherosclerosis and plaque formation: Atherosclerosis is a condition characterized by the accumulation of fatty deposits (plaques) on the walls of the arteries. Understanding the properties of blood flow helps in elucidating the development and progression of atherosclerosis. Researchers are studying factors such as shear stress, turbulence, and disturbed flow patterns to assess their influence on plaque formation, rupture, and subsequent cardiovascular events.

Tissue Oxygenation: Arterial blood flow plays a key role in delivering oxygen and nutrients to various tissues and organs. By understanding the characteristics of blood flow, scientists can assess tissue perfusion, determine oxygenation levels, and identify areas of impaired blood supply. This knowledge helps diagnose conditions such as peripheral artery disease (PAD), assess wound healing, and assess organ function.

# Describe the Solution / Proposed / Developed (Max: 100 Words)

* Here, we first obtained several images from C T scans from online resource directories. Then, we used python codes to understand and distinguish between the bone and the artery by different gray scale levels and rendered an stl image of the scanned artery by using python libraries like numpy and pymesh.
* The rendered stl images are converted to catia.model files by catia software.
* These are then used to calculate the pressure and velocity at several points in Ansys fluent. The data is extracted from the plots section of the fluent software where we extract various plot values of x vs velocity for different bifurcations.
* This data is then used to train the gmdh algorithm which is a artificial neural network where data is trained to predict the next output for the vascular tree
* The CFD simulation for particular bifurcation situations is carried out in the following stage to obtain the necessary information for different configurations in order to determine the distribution of pressure and velocity in the created network.
* In order to ascertain the distribution of mass flow rate inside the vessel branches and pressure magnitude at the junction nodes, the GMDH algorithm is trained using the CFD finding

# 5.Explain the uniqueness and distinctive features of the product / process / service solution (Max: 100 Words)

Creating a CFD simulation of arteries at high altitudes brings several unique and distinctive features compared to simulations performed under normal atmospheric conditions. Here are some key considerations:

At high altitudes, the partial pressure of oxygen decreases, resulting in reduced oxygen availability. This can affect the behavior of the blood flow and its interaction with the arterial walls. The simulation should account for changes in oxygen transport properties such as oxygen saturation level and hemoglobin dissociation curves to accurately represent the effects of reduced oxygen availability on blood flow and tissue oxygenation.

Pressures at high altitude can lead to changes in flow patterns and shear stress distribution in arteries. For example, changes in blood viscosity, vascular compliance, and vasoconstriction can lead to modifications in velocity profiles, turbulence levels, and shear stress magnitudes. Simulation should capture these changes and evaluate their impact on vascular health, such as the development of arterial plaques or endothelial dysfunction.

To accurately represent the unique features of creating a CFD simulation of arteries at high altitude pressures, it is essential to consider appropriate models, equations, and data that incorporate physiological responses and changes induced by altitude conditions. Additionally, validating simulation results with experimental or clinical data at high altitudes can provide confidence in the accuracy and reliability of the simulations

# 6.How your proposed / developed (product / process / service) solution is different from similar kind of product by the competitors if any (Max: 100 Words)

The proposed solution for a flow pattern may differentiate itself from similar products or services offered by competitors through several aspects. Firstly, it could incorporate advanced computational fluid dynamics (CFD) techniques that capture complex flow phenomena with higher accuracy and resolution. Additionally, the integration of acoustic analysis techniques, such as the boundary element method (BEM), allows for a more comprehensive assessment of blood flow

Furthermore, the uniqueness may lie in the expertise and experience of the team behind the solution, who can provide tailored insights and recommendations based on their deep understanding .

# 7.Utility: Highlight the utility/value proposition (key benefits) aspects of the solution/innovation\* (Max: 100 Words)

# The utility of the project is that we can easily observe the flow in the circulatary system.and can detect the heart related disfunctions which help to detect the heart related diseases and we can take required precautions .

# 8.Scalability: Highlight the market potential aspects of the Solution/Innovation (Potential Market Size, segmentation and Target users/customers etc.) (Max: 100 Words)

# A number of factors are taken into account in the arterial flow research's market production section.This study may aid in the creation of cutting-edge medical equipment, diagnostic tools, and cardiovascular disease treatment plans. The design and optimisation of stents, grafts, and other interventions can be influenced by the conclusions and insights drawn from arterial flow simulations. Furthermore, by offering important insights into patient-specific hemodynamics, the research can support the development of personalised medical strategies. In order to translate research discoveries into applications that benefit patients and promote cardiovascular care, regulatory agencies, medical device manufacturers, and researchers work together in the market manufacturing sector.

# 9.Economic Sustainability: Highlight commercialization/business application aspects of the solution (how it is going to economic profitable and viable) (Max: 100 Words)

The profitable sustainability of arterial inflow exploration lies in its eventuality to deliver long- term benefits to the healthcare assiduity and society. By enhancing our understanding of arterial inflow dynamics, this exploration can lead to further effective and individualized treatment strategies, bettered medical device design, and enhanced patient issues. These advancements can contribute to reduced healthcare costs by minimizing complications, optimizing interventions, and perfecting patient operation. also, the exploration can stimulate invention and produce openings for the development of technical software, computational tools, and consulting services. The profitable sustainability relies on the uninterrupted integration of exploration findings into clinical practice, fostering collaborations between academia, assiduity, and healthcare stakeholders.

# 10.Details of Prototype:

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| **Software** | * Numpy, phiflow * ANSYS 2021R * CATIA V5r21 |
| **Budget** |  |
| **Images of prototype** |  |
| **Video Link** | **https://youtu.be/xIT1X6\_idCE** |

# 11.Research Output:

# Details of Journal/Conference Paper

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Signature of the PBL faculty

**In-charge**