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**JOHOR
INNOVATION
INVENTION
COMPETITION
AND
SYMPOSIUM
2023**



"Innovation Inspires a Society
to be Critical and Creative"

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**AHMAD KHUDZAIRI KHALID
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**Cawangan Johor
Kampus Pasir Gudang**

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor Innovation Invention Competition and Symposium 2023 (JIICaS2023), where JIICaS2023 is a virtual platform for all creative minds to share and present their invention and innovation. The extended abstracts are divided into two categories, which are Category A (Higher Educational Student/ Any Recognized Institutional Students in Malaysia) and Category B (Primary/ Secondary School Students / Special Education School Students in Johor). Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students from both categories and get some ideas to develop future innovation products.



SPHEROIDAL FIRST ORDER POLARIZATION TENSOR CALCULATOR (SFOPT)

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ABSTRACT

Polarization Tensor (PT) has been applied in various applications involving metal detection, electrical imaging, and the study of electrosensing fish. In these applications, PT is able to capture significant information, such as material, shape, and orientation about the related objects. Previous studies have shown that most objects can be related to ellipsoid. However, this project aims to focus on spheroids, which are prolate and oblate spheroids, such that they are two different types of ellipsoids. This project intends to invent a standalone application, namely the Spheroidal First Order Polarization Tensor Calculator (SFOPT). SFOPT will provide quick access to calculate the first order PT for a spheroid when the researcher enters required information, such as its semi axes and conductivity. Additionally, the size (also known as semi axes) of the spheroid can be determined from the given first order PT by fixing the conductivity of the spheroid. The application will act as a reference for the researcher to determine the first order PT of a spheroid and to obtain the size of the spheroid from a given first order PT.

Keywords: first order polarization tensor, spheroid, semi axes, conductivity

1.0 INTRODUCTION

Polarization Tensor (PT) has been implemented in numerous applications, including biomedical engineering to enhance electrical imaging, security scanning for metal detection, landmine detection, and the investigation of electrosensing fish. In these applications, PT is used to capture important information about the object, such as its material, shape, and orientation. The study from [1] shows that the PT for most of the objects can be represented as the PT of an ellipsoid. Considering the previous invention, the Ellipsoidal First Order Polarization Tensor (EFOPT) Calculator, there are some limitations to the calculator, such as the fact that it is not user-friendly to non-Matlab users and that the functions of the calculator are limited to determine the first order PT only. There is no specific application to determine the size of the object, particularly when the object is a spheroid, in the literature. Therefore, a standalone application called Spheroidal First Order Polarization Tensor Calculator (SFOPT) is invented to provide easy access to calculate the first order Polarization Tensor for spheroid as well as obtaining the size of the spheroid based on the given first order Polarization Tensor. Since spheroids are one type of ellipsoid (ellipsoid with two equal semi-axes), it is significant to study the PT for a spheroid, and this application will include a prolate and an oblate spheroid.

2.0 OBJECTIVES

The main purpose of inventing this application is to provide a standalone calculator to calculate the first order PT for a spheroid and determine the size of the spheroid based on the first order Polarization Tensor. Furthermore, SFOPT provides a quick access application for researchers by only inserting the required information. Additionally, the invention of SFOPT can be used as a reference for other researchers in order to determine the first order PT for a spheroid and the size of the spheroid based on the first order Polarization Tensor.

3.0 DESCRIPTION OF INNOVATION/METHODOLOGY

The application is first developed using MATLAB software, and then it is converted into a standalone application (see Figure 1). This application can be used to calculate the first order PT for a spheroid and the size of the spheroid from the given first order PT without even writing the code. Figure 2 shows the interface of the Spheroidal First Order Polarization Tensor (SFOPT) Calculator. Any researcher can simply insert the required information regarding the spheroid, such as the value of its semi axes, represented as a and b , together with the conductivity, to obtain its first order PT. In order to calculate the size of the spheroid, the information required is the given first order PT in the form of M_{11} and M_{22} , as well as the conductivity, k , of the spheroid, which can be fixed according to findings from [3]. Examples of inserting all required information to calculate the first order PT of the spheroid and the size of the spheroid can be found in Figure 3 and Figure 4 respectively.

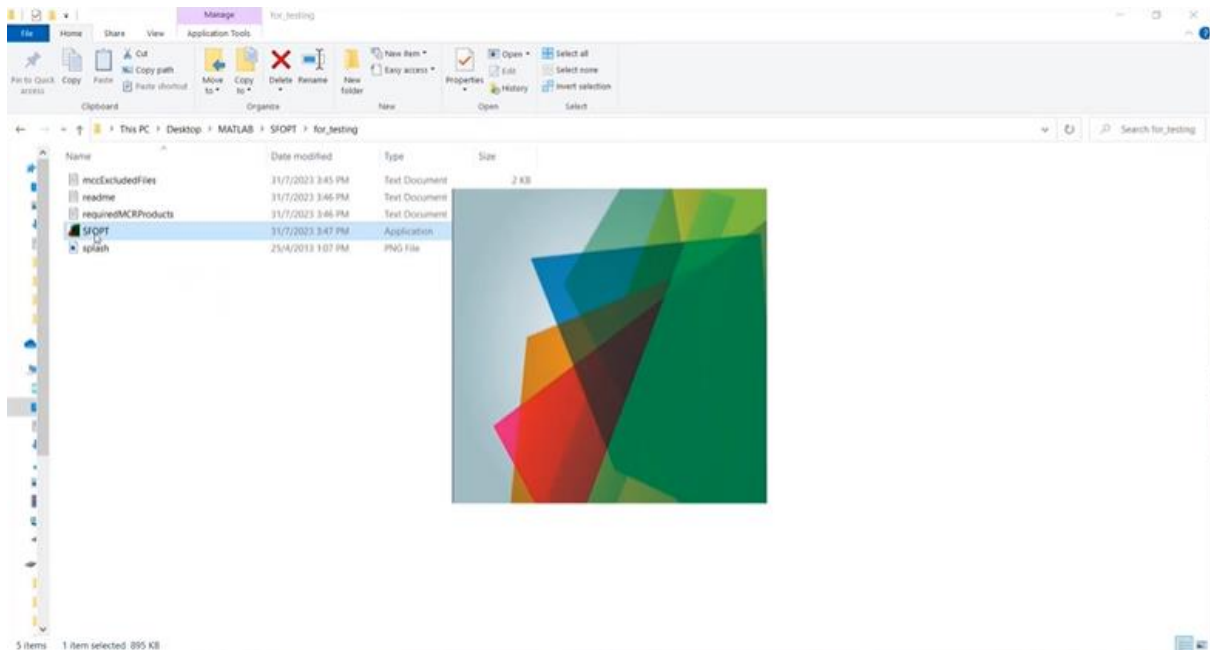


Figure 1: The standalone application of Spheroidal First Order Polarization Tensor (SFOPT) Calculator

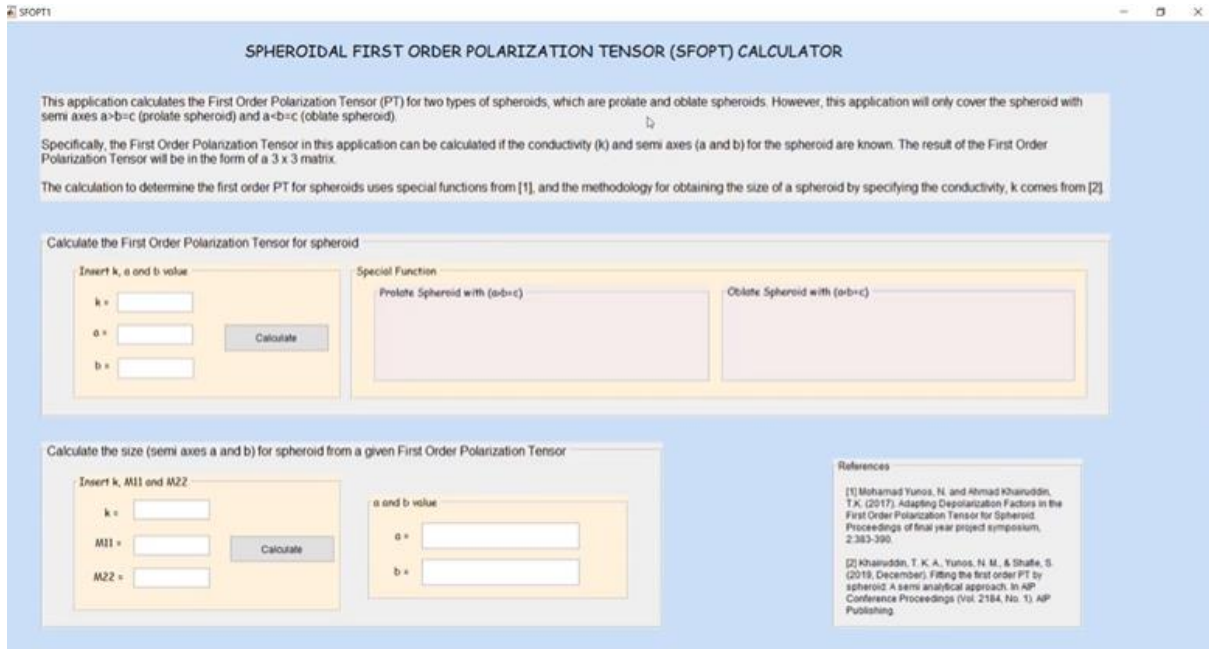


Figure 2: The interface of Spheroidal First Order Polarization Tensor (SFOPT) Calculator

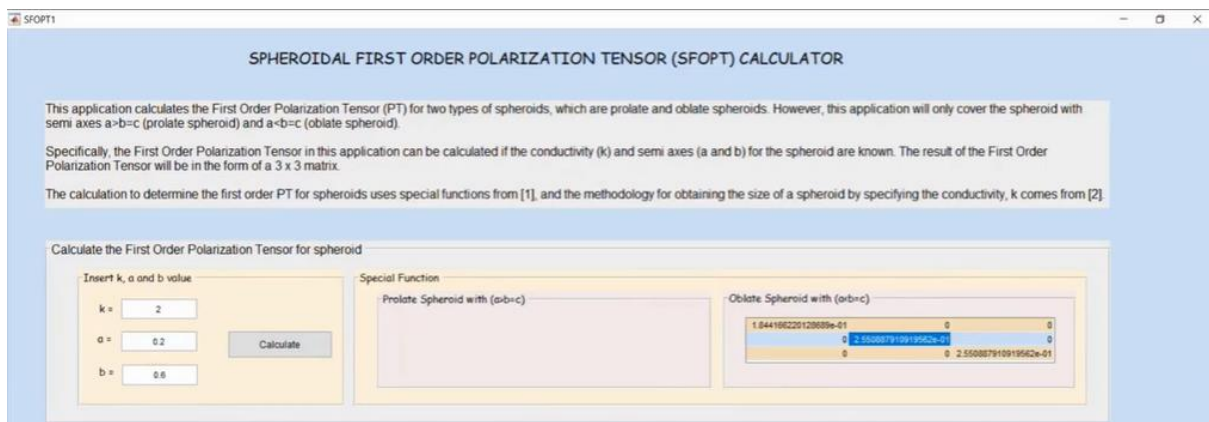


Figure 3: The semi axes of the spheroid with $a=0.2$, $b=0.6$, and $k=2$. The first order PT is calculated using special function formula for spheroid

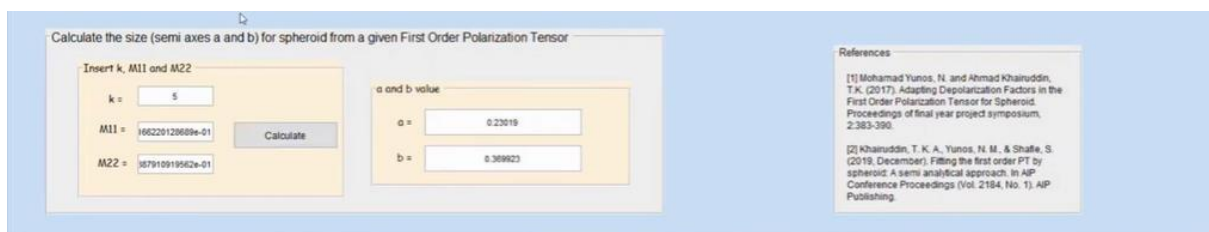


Figure 4: The value of $M11 = 1.8442 \times 10^{-1}$, $M22 = 2.5509 \times 10^{-1}$, and $k = 5$. The size of spheroid (in terms of a and b) is calculated based on the formula in [3]

4.0 ADVANTAGE/IMPACT/RESULTS/NOVELTY

SFOPT is innovated based on the mathematical formulations from [2] and [3] to calculate the first order PT for a spheroid and to obtain the size of the spheroid from a given first order PT. This application will be a useful aid for the other researcher who did research related to the first order PT.

5.0 CONCLUSION

In conclusion, the invention of the Spheroidal First Order Polarization Tensor (SFOPT) Calculator provides a user-friendly application to calculate the first order Polarization Tensor for spheroid as well as obtain the size of the spheroid based on the given first order Polarization Tensor of the spheroid. Additionally, this application will help the researchers save time by not writing the code themselves to calculate.

6.0 REFERENCES

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