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UNIVERSITI TEKNOLOGI MARA

2024
JOHOR INTERNATIONAL INNOVATION, INVENTION COMPETITION AND SYMPOSIUM

PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIIICaS 2024)

"Flourish and Nurturing Sustainable Innovation for a Prosperous Nation"

JIIICaS 2024
JOHOR INTERNATIONAL INNOVATION, INVENTION COMPETITION AND SYMPOSIUM

Editorial Board

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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 International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. 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 and get some ideas to develop future innovation products.

Foreword Rector

Assalamualaikum warahmatullahi Wabarakatuh, Salam Sejahtera, Salam Malaysia MADANI and Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most Merciful.

It is a great honor to welcome you to the Johor International Innovation, Invention, Competition, and Symposium 2024 (JIIICaS 2024). This event connects various disciplines, focusing on education and engaging educators, students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and determination to turn those ideas into reality. The remarkable projects showcased today highlight the dedication and spirit of all participants. Initiatives like this not only explore new technologies but also cultivate skills and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor Branch, we are fully committed to fostering a dynamic culture of innovation, promoting the commercialization of new products, and encouraging meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all sponsors, judges, the College of Computing, Informatics and Mathematics, UiTM Pasir Gudang Campus as the event organizer, as well as to the researchers and participants for their hard work in making this event a success. Let us continue striving for innovation and excellence. May the ideas presented today inspire us and lay the groundwork for future achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
Johor Branch

(A-ST169) A MATLAB APPLICATION TO VISUALIZE AND DESCRIBE A PARABOLOID SHAPED OBJECT

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ABSTRACT

The paraboloid is one of the most important three dimensional (3D) geometries in many real-life applications. In the fields of engineering and technology, paraboloid-shaped antennas are used for communications, while paraboloid solar dishes are designed to generate solar energy. The shape of a parabola is also investigated when studying the mechanics of a fluid inside a rotating bottle, as the fluid may form a parabolic surface due to the rotation. Besides, in architecture, parabola is used to build arches or domes of buildings. For some buildings, such as charcoal kilns, instead of using a straight flat roof, a paraboloid-shaped dome is placed on top to ensure faster heat circulation inside the building, resulting in better charcoal production. Due to these motivations, this project proposes an application that is able to easily visualize and describe a paraboloid-shaped object using MATLAB software. When using this application, users only need to specify the radius and the height of the object in order to display the 3D graph of a paraboloid with circular base that represents the object. The application will also present a two dimensional (2D) visualization of the paraboloid from either the top (the base of the paraboloid) or the front (the body of the paraboloid shaped object). For further characterization of the object, the surface area and the volume are also given by the application. We believe our proposed application has an advantage in visualizing and characterizing paraboloids, as it provides graphs, surface area, and volume within a single user-friendly interface that can be utilized in related applications in the future.

Keywords: multivariable functions, volume, surface area

1.0 INTRODUCTION

A paraboloid possesses several distinctive features that make it suitable for a range of applications. Its single extremum point is particularly useful in constructing satellite dishes, where it focuses signals to a single point, thereby enhancing precision and communication effectiveness. Similarly, paraboloid solar dishes use this focusing ability to concentrate sunlight onto a single focal point, leading to more efficient conversion of solar energy into heat or electricity. Additionally, understanding physical properties of a paraboloid, such as its surface area and volume, is useful for studying the mechanics of rotating water in a glass. This is because the forces acting on the water during rotation cause it to form a parabolic surface.

In architecture and structural design, a building with a paraboloid shape is chosen for its visually striking appearance and its ability to create an elegant, modern look. The paraboloid shape is ideal for constructing domes due to its inherent strength and efficient load distribution, allowing for minimal material use while maintaining stability. Additionally, from a mathematical perspective, the uniform curvature of the paraboloid simplifies the analysis of stress and load distribution, making it easier to work with in design and engineering.

Due to our current work involving paraboloid geometries, this research proposes an application, in which a MATLAB Graphical User Interface (GUI), that can visualize and compute the volume as well as the surface area of a paraboloid with a circular base. While there are many software programs that can visualize the graph of a paraboloid, they do not include functions to compute the surface area and volume of the paraboloid. Moreover, in order to use that software, users need to define the correct mathematical equation representing the parabola before any computation can be done. Therefore, the GUI has the advantage of incorporating graphs and several parameters of a parabola into only a single application while requires only two inputs for the computation, which are the radius of the base and the height of the paraboloid. Now, before introducing the GUI, the next section will review several mathematical formulas used in the computations

2.0 MATHEMATICAL FORMULAS

In this study, a circular parabola with height, h and radius, r, as given in Figure 1, is considered. In this case, the base of the parabola is a circle of radius, r. In order to visualize the paraboloid in the 3D Cartesian coordinate system, the solid G is used, so that G lies above the xy-plane and bounded above by the equation

$$z = -\frac{h}{r^2}(x^2 + y^2) + h. \quad (1)$$

A MATLAB code is then written to plot the graph using Eq. (1) for $0 \leq z \leq h$ for displaying the paraboloid with the proposed application. The application will also present the 2D visualization for the base of G as a circle using the equation

$$x^2 + y^2 = r^2, \text{ for } z = 0, \quad (2)$$

while the 2D visualization of G from the front is also given based on the equation

$$z = -h\frac{x^2}{r^2} + h \text{ or } z = -h\frac{y^2}{r^2} + h. \quad (3)$$

Either one of the two equation in (3) can be used to visualize the body of the paraboloid from the front as a parabola, depending on the position of the viewer.

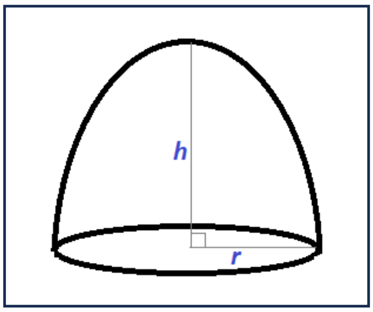

Figure 1: A schematic diagram of a circular parabola with height, h and radius, r

Next, in order to find the volume, V of the parabola given in Figure 1, the formula

$$V = \frac{\pi r^2 h}{2} \quad (4)$$

can be used. Meanwhile, the surface area, S of the parabola is given by

$$S = \frac{\pi r[(4h^2+r^2)^{3/2}-r^3]}{6h^2} + \pi r^2. \quad (5)$$

Both formulas (4) and (5) can actually be derived using triple integral and surface integral, respectively, where, they are topics from multivariable calculus (see Osman and Yaacob (2008) as an example).

3.0 THE PROPOSED MATLAB GUI

Figure 2 shows the interface of the application, which is a MATLAB GUI. The application has three main functions. First of all, it receives the values of radius and height from the user and then, after the button 'RUN' is clicked once both inputs are given, it calculates and gives the volume and the surface area of the paraboloid, as well as displaying the related graphs.

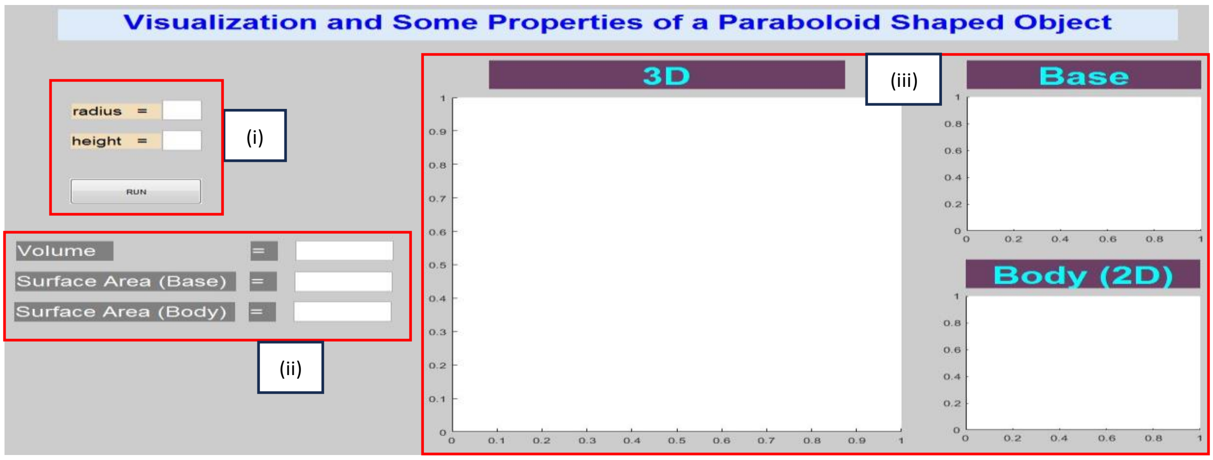

Figure 2: The interface of the proposed MATLAB GUI that has three main functions : (i) receiving inputs from a user and a push button called 'RUN' is provided to execute all calculations after it is clicked, (ii) displaying some properties of the paraboloid shaped object, which are the volume and the surface area, (iii) presenting the 3D graph and 2D graphs of the paraboloid shaped object

In this application, the surface area is divided into the surface area of the base and the surface area of the body. This division is necessary because the paraboloid shaped object might not be open at the bottom. Therefore, if the object is closed at the bottom, the user needs to manually add both surface areas to get the total surface area of the object. Furthermore, for convenience, besides the 3D graphs of the object, the application also provides the graph of the object when the object is viewed from above, which displays the base as a circle. In addition, the 2D graph of the body, which is the graph of the object when viewed from the font or from the side, is also given.

4.0 EXAMPLES

This section provides three examples on using the proposed application. First of all, the application is used to alternatively investigate part of the dome of the building Palau Güell in Barcelona, Spain (see Cortés et. al. (2020)). The graphs of the dome after they are generated by the application, together with the surface area and the volume of the dome, are shown in Figure 3. Here, the inputs used are scaled according to the graph used by Cortés et. al. (2020). Note that the model provided by our application differs from the one in Cortés et al. (2020), which considers an elliptic paraboloid.

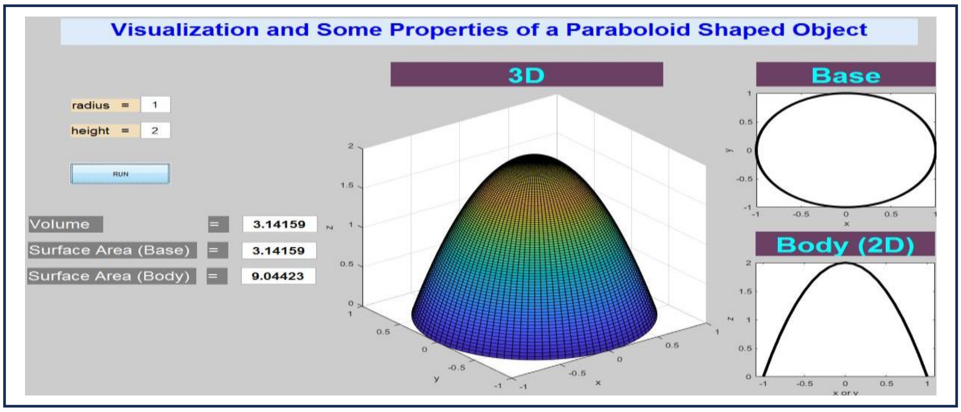

Figure 3: The outputs of the proposed MATLAB GUI after it is run with inputs radius, $r = 1$ and height, $h = 2$, where the graph is a model of a dome of Palau Güell in Cortés et. al. (2020) that has dimension approximately $h = 2r$

In Figure 4, the graphs that model a satellite dish is given together with the values for its surface area and volume. The satellite also appears as an application of parabola in the online study of algebra at https://www.algebra.com/. While the application maintains the 3D shape of the parabola, a clear justification that it is a satellite dish can be seen from the 2D view of the body. Here, our application extends the parameters of the satellite dish presented in the website by considering it as a 3D object and not a 2D object. The only difference between the dish in the website and the dish modelled here is the website shows an upward opening parabola, whereas our application displays a downward opening parabola.

Furthermore, the last example given in Figure 5 describes the possible full form, as well as the surface area and the volume of a charcoal kiln in Kubang Badak at the Langkawi Island. The information could be useful for rebuilding the charcoal kiln, which is only partially remaining on the island, to further boost tourism prospects. The inputs are based on our previous research in Ahmad Khairuddin et. al. (2023).

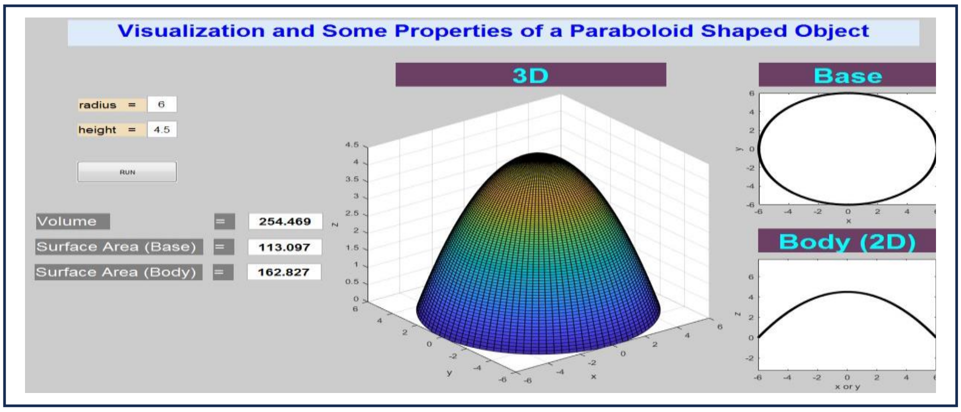

Figure 4: The outputs of the proposed MATLAB GUI after it is run with inputs radius, $r = 6$ and height, $h = 4.5$, where the graph is a model of the satellite dish used in the study of algebra from https://www.algebra.com/

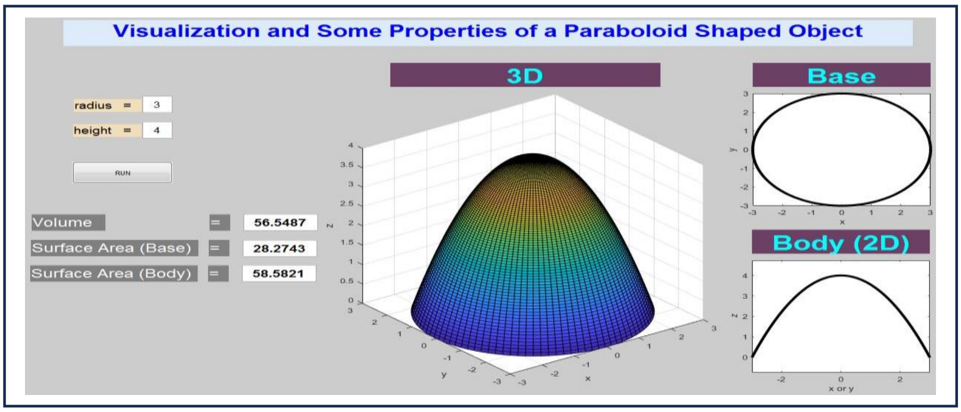

Figure 5: The outputs of the proposed MATLAB GUI that alternatively models the full form of a charcoal kiln described in Ahmad Khairuddin et. al. (2023)

5.0 CONCLUSION

The suggested application as a MATLAB GUI might be useful not only in academia but also for real world problems. It can serve as a tool to enhance the teaching of science and engineering courses in school and higher level of institution. At the same time, the information provided by the GUI might be referred by professionals for many purposes such as to build or describe the paraboloid shaped object.

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