

Research Article

Determine the Area of a Non-Symmetrical Large Surface by Using Parametric Equation for Undergraduate Students

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Abstract: This prototype method was introduced to society for various purposes mainly for studies and construction management. The calculation of the area of non-symmetrical shapes often presents a challenge in mathematics and various fields of science and engineering. Traditional methods, such as integration and geometric decomposition, may become impractical and time consuming. In such case, parametric equations provide a powerful and versatile tool for area determination only by using Microsoft excel trendline. This abstract explores the application of parametric equations in calculating the area of non-symmetrical shapes. Furthermore, Microsoft excel trendline shows the abstract highlights practical applications of this technique in fields such as engineering, physics, computer graphics and biology, where complex and irregular shapes frequently arise. Examples of specific non-symmetrical shapes and their corresponding parametric equations will be presented, illustrating the versatility and efficiency of this method. Parametric equations describe the relationship between two or more variables using one or more parameters. Impact on this is they are particularly useful when dealing with shapes that cannot be conveniently expressed using standard functions. By parameterizing the coordinates of points and dividing the area by segment along the shape's boundary, the area enclosed by the curve can be determined through the application of substitution of definite integrals formula and the total area can be finalized by sum up all the area by segment of the surface.

Keywords: parametric equation, surface, area.

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1. INTRODUCTION

Parametric equations provide a powerful mathematical framework that allows user to describe the relationships between variables and parameter values. They find extensive use in the realm of geometry, enabling user to define curves and surfaces in a manner that can be challenging or

impossible with standard equations. This introduction delves into the concept of using parametric equations to calculate area, highlighting the significance of this approach and its diverse applications. This prototype ideas is to parametrically represent the boundary of a shape, such as a curve or a surface, by specifying coordinates as functions of one or more parameters by varying these parameters over a specified range denoted as α and β , it will then effectively trace the boundary of the shape. Subsequently, the area enclosed by the curve or surface can be determined through the application of substitution of definite integral. This method offers a powerful and versatile method for calculating area that very intractable due to their complexity and lack of symmetry.

In this exploration of calculating area using parametric equation, we use a map of University Technology Mara Shah Alam. We will delve into the methodology, practical applications and specific example of how this prototype method can be effective utilized. By the end, society will gain a deeper understanding of the power and potential of parametric equations in solving complex geometrical and irregular shape. Thus, people will appreciate their role in shaping advancement in various scientific and technological fields such as Microsoft excel trendline. Excel is primarily designed for spreadsheet and data analysis tasks, and it may not be the ideal method to calculate the exact and accurate value of the area for displaying parametric equations as mathematical expressions. However, excel can create a table of values generated from parametric equations and visualize the corresponding shapes.

Therefore, with the exposure of this prototype method creation, it can be use in learning and teaching process which related to course studies in the syllabus and also can used with any practical applications of this technique in fields such as engineering, physics, computer graphics and biology, where complex and irregular shapes.

2. METHOD & MATERIAL

First and foremost, this prototype method require several steps that need to be considered. The materials needed such as Microsoft excel trendline, strava apps, graph paper and a calculator. Strava is one of the suitable application of a mapping system that uses Global Positioning System (GPS) where user can track live performance data, such as distance and speed, time taken and also can record user's route map of their destination. Besides strava, google maps also suitable for this prototype method. Moreover, Microsoft excel trendline also the main tool of this prototype method. This is because, excel is widely used and user friendly which allows user to add trendline from the data obtained and provides users the equation of the trendline to predict the values based on the data collected. In this case, this material is used to get the approximation values of the area of a large surface around UiTM Shah Alam. Flowchart of the steps will be shown below:

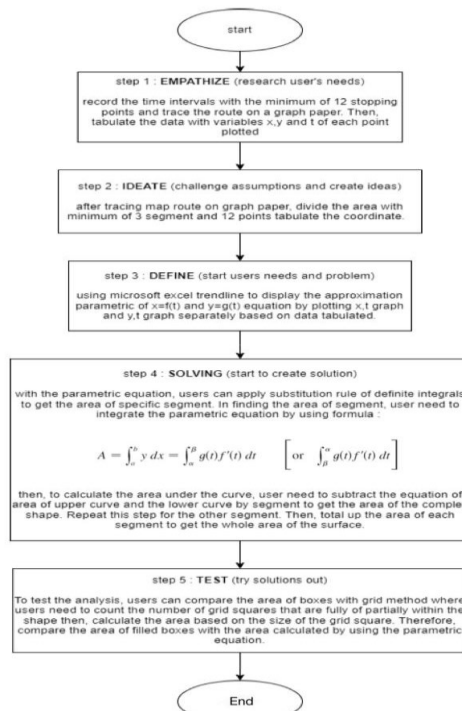
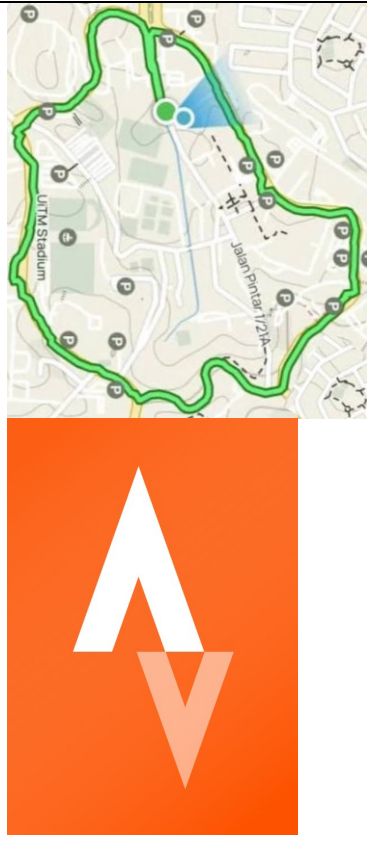
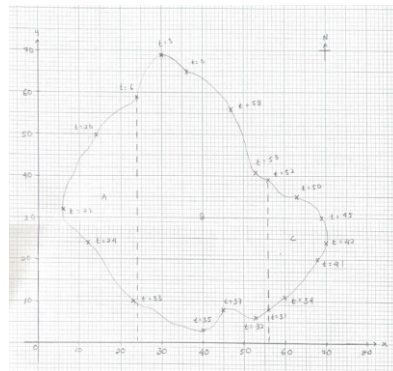


Figure 1: Flowchart of prototype method

MATERIAL	METHOD
<p>Step 1 : EMPATHIZE</p> <p>Install the strava app or use the strava website to record user's route map and record the time taken of each stopping point with minimum of 12 stopping point along the route.</p>	

Step 2 : IDEATE

Then, by using graph paper, trace the route map onto it and tabulate data of each coordinate of plotted stopping point and the time taken respectively. After tracing, divide the area with minimum of 3 segment labelled A,B and C.



t	x	y
6	6	32
20	14	50
22	24	59
33	24	10
24	24	24
22	22	32
0	36	0
3	30	0
6	24	0

Step 3 : DEFINE

Using microsoft excel trendline to plot graph by segment represent $x=f(t)$ and $y=g(t)$ based on data tabulated then, separately drag table $x=f(t)$ the click (insert) to get scatter with smooth line to display the curve and the approximation of the parametric equation. Do the same thing on $y=g(t)$.

t	x	y
6	6	32
20	14	50
22	24	59

t	y
6	32
20	50
22	59

t	x
33	24
24	12
22	6

t	y
33	10
24	24
22	32

t	x
0	36
3	30
6	24

Step 4 : SOLVING

With the parametric equation, users can apply substitution rule of definite integrals by using integral calculator on website to get the specific area of segment. In finding the area of segment, user need to integrate the parametric equation by using formula:

$$A = \int_a^b y \, dx = \int_a^b g(t)f'(t) \, dt \quad \left[\text{or} \quad \int_B^A g(t)f'(t) \, dt \right]$$

Calculate the Integral of ...

$(-0.778x^2+3.6667x+65)(-2)$ Go!

CLB + - x + ^ v √ π ()

This will be calculated:

$$\int_{24}^{36} -(-0.778x^2 + 3.6667x + 65) \cdot 2 \, dx$$

Not what you mean? Use parentheses! Set integration variable and bounds in "Options".

Configure the Integral Calculator:

Variable of integration: x

Upper bound (to): 36 +∞

Lower bound (from): 24 -∞

Integrate numerically only?

Simplify expressions?

Simplify all roots?

(√x² becomes x, not |x|)

Use complex domain (-)?

Keep decimals?

Upper B (part 1)

then, to calculate the area under the graph, user need to subtract the equation of area of upper graph and the lower graph by segment to get the area of the complex shape. Repeat this step for the other segment. Then total up the area of each segment to get the whole area of the surface.

*part 1 and part 2 method is used to get the accurate curve and parametric equation.

Calculate the Integral of ...
 $(0.3319x+63.776)(0.00018e^{0.0064x})$ **Go!**

This will be calculated:

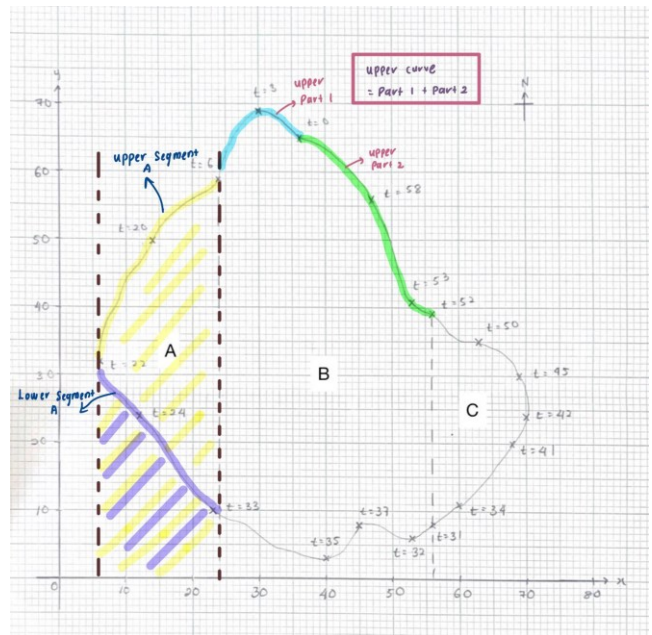
$$\int_{36}^{56} (0.3319x + 63.776) \cdot 0.00018e^{0.0064x} dx$$

Not what you mean? Use parentheses! Set integration variable and bounds in "Options".

About Help Examples Options

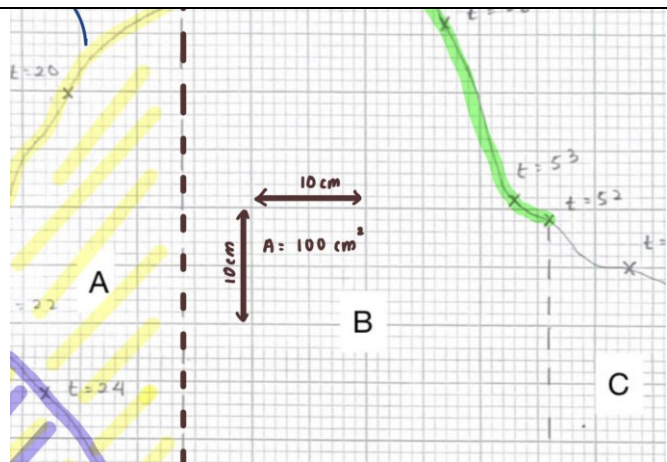
Configure the Integral Calculator:
 Variable of integration: x
 Upper bound (to): 56
 Lower bound (from): 36
 Integrate numerically only?
 Simplify expressions?
 Simplify all roots?
 (\sqrt{x} becomes x , not $|x|$)
 Use complex domain (-)?
 Keep decimals?

Upper b (part 2)



Step 5 : TEST

To test this analysis, user can compare the area of boxes with grid method where user need to count the number of grid squares that are fully or partially within the shape. Then, calculate the area based on the size of the grid square. Therefore, compare the area of filled boxes with the area calculated by using parametric equation.



3. FINDINGS

Calculating the area of a non-symmetrical shape can often be achieved by finding the area between two curves, where one curve represents the upper boundary of the shape, and the other curves represents the lower boundary. The area between these two curves can be calculated by subtracting the area of definite integral of the upper boundary and the area of the lower boundary after calculating the curve of parametric equation over specified range. This method is known as the “area between the curve” approach. Calculate the area by using substitution of definite integral formula as below:

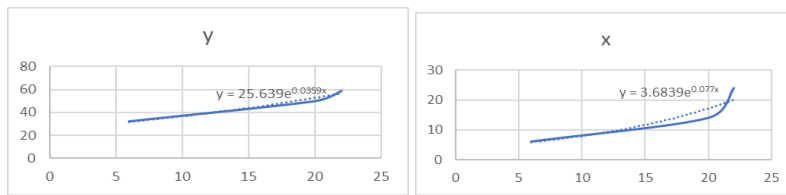
$$A = \int_a^b y \, dx = \int_a^\beta g(t)f'(t) \, dt \quad \left[\text{or} \quad \int_\beta^\alpha g(t)f'(t) \, dt \right]$$

3.0 Data tabulation

Table 1. Table of findings

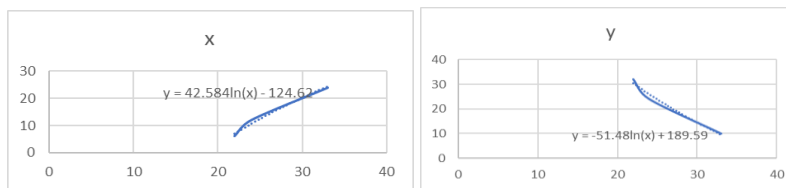
<i>x-axis</i>	<i>y-axis</i>	<i>Time,t</i>
36	65	0
30	69	3
24	59	6
14	50	20
6	32	22
12	24	24
24	10	33
40	3	35
45	8	37
53	6	32
56	8	31
60	11	34
68	20	41
70	24	42
69	30	45
63	35	50
56	39	52
53	41	53
47	56	58

3.1 Area segment A



$$\int_6^{24} (25.639e^{0.0359x})(0.2837e^{0.077x}) dx$$

Upper boundary A

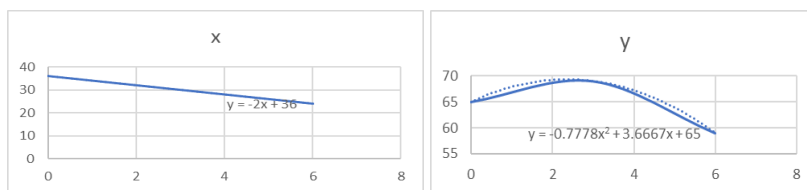


$$\int_6^{24} (-51.481 \ln(x) + 189.59) \left(\frac{5323}{125x}\right) dx$$

Lower boundary A

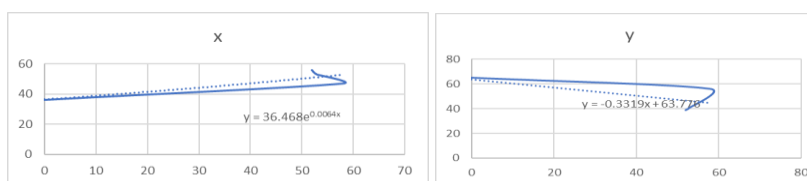
Parametric equation of upper boundary A are $X=f(t)$, $y = 25.639e^{0.0359x}$ and $Y=g(t)$, $y = y = 3.6839e^{0.077x}$. While the lower boundary A are $X=f(t)$, $y = 42.584\ln(x) - 124.62$ and $Y=g(t)$, $y = -51.48\ln(x) + 189.59$. Hence, by using substitution of definite integral formula and integral calculator on website we can get the answer of upper boundary which 841.06031 m^2 and lower boundary 539968 m^2 that will make the area of segment A is 539126.9397 m^2 .

3.2 Area segment B



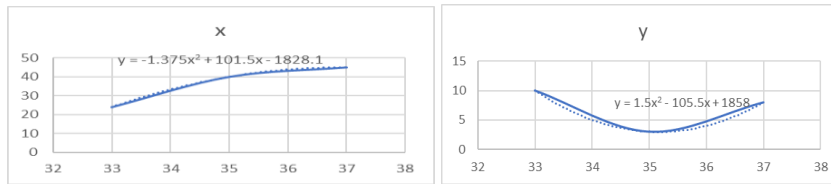
$$\int_{24}^{36} (-0.778x^2 + 3.6667x + 65)(-2) dx$$

Upper boundary B (part 1)



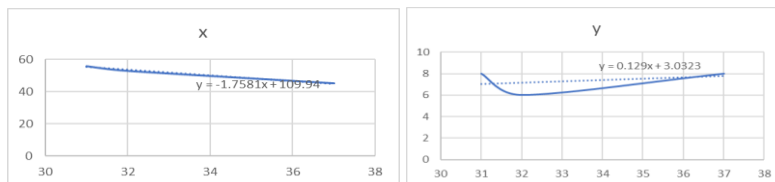
$$\int_{36}^{56} (0.3319x + 63.776) \left(\frac{0.0064}{36.468} e^{0.0064x} \right) dx$$

Upper boundary B (part 2)



$$\int_{24}^{45} (1.5x^2 - 105.5x + 1858) [(2) - 1.375x + 101.5] dx$$

Lower boundary B (part 1)

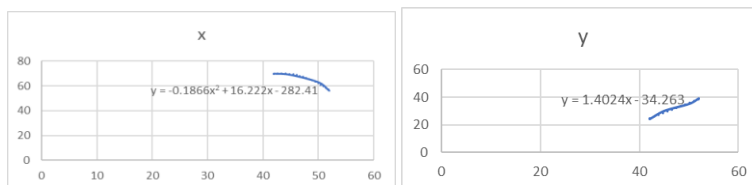


$$\int_{45}^{56} (0.129x + 3.0323)(-1.7581) dx$$

Lower boundary B (part 2)

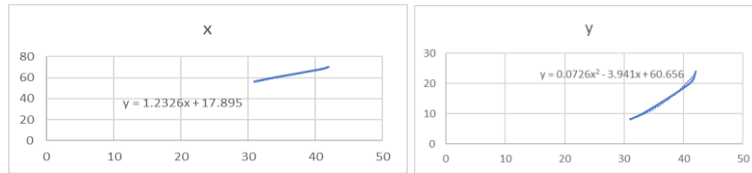
Parametric equation of upper boundary B are $X=f(t)$, $y = -2x + 36$ and $Y=g(t)$, $y = -0.7778x^2 + 3.6667x + 65$ (part 1) with $X=f(t)$, $y = 36.468e^{0.0064x}$ and $Y=g(t)$, $y = -0.3319x + 63.776$ (part 2). while the lower boundary B are $X=f(t)$, $y = -1.375x^2 + 101.5x - 1828.1$ and $Y=g(t)$, $y = 1.5x^2 - 105.5x + 1858$ (part 1) with $X=f(t)$, $y = -1.7581x + 109.94$ and $Y=g(t)$, $y = 0.129x + 3.0323$ (part 2). Hence, by using substitution of definite integral formula and integral calculator on website, we can get the answer of upper boundary which 12829.22257 m^2 and lower boundary 137784.6265 m^2 that will make the area of segment B is 124955.4039 m^2 .

3.3 Area segment C



$$\int_{56}^{70} (1.4024x - 34.263) [(2)(-0.1866x) + 16.222] dx$$

Upper boundary c



$$\int_{56}^{70} (0.0726x^2 - 3.941x + 60.656)(1.2326) dx$$

Lower boundary c

Parametric equation of upper boundary C are $X=f(t)$, $y = -0.1866x^2 + 16.222x - 282.41$ and $Y=g(t)$, $y = 1.4024x - 34.263$. While the lower boundary C are $X=f(t)$, $y = 1.2326x + 17.895$ and $Y=g(t)$, $y = 0.0726x^2 - 3.941x + 60.656$. Hence, by using substitution of definite integral formula and integral calculator on website we can get the answer of upper boundary which **38030.78368 m²** and lower boundary **1755.130835 m²** that will make the area of segment C is **36275.65285 m²**.

Therefore, to get the final area of this non-symmetrical surface we can sum up the area of segment A + segment B + segment C which will give the answer of **668971.4717 m²**. To ensure the correctness of this analysis is grid method was done to compare the calculation of area of a non-symmetrical large surface and the area of the grid squares on graph paper. In this case, the grid of graph paper represent 2cm : 10 units which will give the area of **2539 m²** of a filled boxes in the surface.

4. DISCUSSION

4.1 research explanation

The explanation on finding upon this research that we have obtain is clearly need to be done accurately to avoid any findings error that will affect the final answer. To ensure this accuracy, few procedure need to be done without error. A significant difference between calculations obtained by comparing two different methods, such as parametric equation and a grid-based approach. It is important to investigate the reasons behind this discrepancy some common factors that can lead to substantial differences in result will be explain below.

Based on the result, we can clearly see the error that affect the final answer. The graph traced is non-symmetrical shape made the equation become slightly not accurate. This is because, the coordinate of the stopping point is not enough to shape the exact and accurate complex graph. Increasing the number of data points can lead to a more accurate representation so Microsoft excel trendline can display more accurate parametric equation such as a linear, logarithmic, exponential, polynomial and more based on data obtain. To obtain precise results, it's important to ensure that the graph accurately represent the data or function being analysed. In this case, since the route map is a complex surface, more stopping point might need to shape a correct curve. Since the graph obtain is very inflexible to get shaped, we have to divide the segment into 3 segment which represent segment A, segment B and segment C.

Moreover, with the use of the segment division, we can simply get the approximation of the complex surface. This step is useful to get the final answer after being total up area of segment. This is

because, the accuracy of the area calculation heavily depends on the accuracy of the parametric equations. Constructing precise parametric equations can be challenging for complex shapes.

5. CONCLUSION

In conclusion, parametric equation is a valuable approach for calculating the area of a non-symmetrical shapes, and it is also able to handle complex and irregular shapes that may not have simple analytical representation. When the parametric equation is well-constructed and accurately describe the shape, they can provide highly precise area calculations. Thus, always consider verifying your results through multiple methods or software tools to ensure the correctness of the area calculations.

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