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Ideas off Isaac Newton and their Computer Implementation

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Abstract

This article outlines Isaac Newton's most significant contributions to mathematics and physics and their computer implementation. The following two software tools were used to describe the results: Wolfram Mathematica and StereoMV (Java3D-based author's software). Isaac Newton laid the foundations of differential and integral calculus. Through the principles of the method of fluxes, he expresses the reciprocal nature of the operations of integration and differentiation. He is writing the integrals and derivatives in two columns. With the help of Wolfram Mathematica software, it is easy to confirm Newton's discovery by drawing graphs. At the same time, with this discovery, the scientist laid the foundations of numerical methods, which, as is known today, can be used with the help of the computer. Newton was the first to introduce the concept of limit, which is known to be used in mathematical analysis. He presents it by the method of limits in 12 lemmas. In this paper, a new approach based on the method is given, with the help of which the computer can draw a regular polygon, and its face can be calculated subsequently. The main goal of the proposed new boundary method is to reach the boundary of an inscribed regular polygon in a circle. The study begins by drawing a regular polygon with three vertices. After that, the number of vertices increases without limit until describing a circle. Newton explains this concept also physics-mathematically. Today his method is very relevant as it is directly related to the computer and its graphic capabilities. The Java programming language and specifically the Java3D library were used to describe these results.

Keywords: Boundary method • Method of fluxions • Isaac newton • Java3d • Wolfram mathematica

Introduction

For several months, from the spring to the fall of 1665, he worked out the principles of the method of fluxions, expressing the mutually inverse nature of the integration and differentiation of the operations, systematically writing down the integrals and derivatives in parallel columns, and applying his calculus to numerous problems. Newton was the first to introduce the concept of limit, which is known to be used in mathematical analysis [1,2]. In October 1666, Newton prepared the first systematic exposition of the abovementioned results. Crown of the new philosophy is the work of Sir Isaac Newton, in the book “Mathematical Principles of Natural Philosophy”, where he reveals the place assigned to mathematics in his physics. Also, Isaac Newton laid the foundations of numerical methods; he was the first to present an interpolation polynomial with finite and divided differences. Divided differences are the basis of numerical differentiation. Isaac Newton's greatest contributions to mathematical physics were made in the 17th century. This article presents the most significant discoveries that are still relevant today because they are connected directly to computers. With its great computing power and graphics capabilities. Newton laid the foundations of differential and integral calculus. In his book "Mathematical principles of natural philosophy" he reveals the method of limits in detail. It is represented in 12 lemmas. He explains it physics-mathematically. His approach was further developed by mathematicians who lived after the era of Isaac Newton.

Nowadays, with this method, it is possible to calculate the volumes and faces of geometric figures, both in planimetry and in stereometry. As an example, the volume of (cone, cylinder, sphere, prism, etc.) can be given. This paper presents a new method for drawing a regular polygon, which is based on the Limit's method of Isaac Newton. The purpose of this article is to present some of Isaac Newton's most significant discoveries and tracking their computer implementation proves the credibility of Isaac Newton's ideas. Through Wolfram Mathematica it is possible to visualize the reciprocal nature of the differentiation and integration of the operations. One of Newton's greatest discoveries is the Newtonian binomial. Previously untaught physical explains the concept of quadratic Wolfram mathematica. Mathematica is among the most potent modern computer systems for scientific computing. Everything that could be counted on by hand or with a computer from various mathematical disciplines, and applications of mathematics can be easily calculated with Mathematica.

The program has reasonable analytical calculation, good graphic capabilities, and an interactive style allowing animation of objects. It is helpful for teachers, students, university professors, and students. The strength of the program is in the graphics and animation. As is known, the more multimedia is used in the presentation of the information, the better it is understood by the listeners. With the help of the graphic, a visual representation of the corresponding electronic element is created. The leading multimedia is animation, which is a sequence of static pictures that alternate at high speed. It is one of the dynamically developing areas of computer graphics. Animated objects add a powerful impact to any multimedia presentation. That is why it is widely distributed in the curriculum of universities and schools worldwide.

From the spring of 1665 to the autumn of the same year, Newton developed the principles of the method of fluxions, clearly expressing the mutually opposite nature of the integration and differentiation of the operation; he systematically recorded the integrals and derivatives in parallel columns and applied his calculus to several tasks. In October 1666, Newton prepared the first systematic exposition of these results. This manuscript became known after 300 years. The title of the manuscript is: “To resolve Problems by Motion these following propositions are sufficient”. During these same years, they saw his basic ideas of mechanics, which he revealed thanks to his mathematical discoveries, namely fluxions [3-5]. There are two significant problems with the terms of the fluxions method, which are:

- Find the relationship between the fluxes based on a given relationship between the fluences. Which is the task of differentiating a function of several time- dependent variables.

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- At a given time that contains fluxes, find the relationship between the fluences. Which is the problem of integrating a first-order differential equation

Fluent is an old term introduced by Newton and expresses a variable quantity dependent on time. This can be a day, hour, minute or second. The rate of change he calls flux. Momentum is also a term introduced by Newton, which is an infinitesimal change in flux. In the fluxion's method, there are two main tasks.

- To determine the speed of the movement at a given moment along a given path (a task of differentiation).
- At a given speed of movement, to determine the path for a given time (a task of integral calculus)

Calculus with fluxes is used to solve differential calculus and geometry problems. To solve these problems, Newton applied his perhaps most significant discovery, differential calculus. According to some mathematicians, with this discovery alone, Newton acquired "the most powerful weapon ever found, by which the world can be subjugated to man." He proves that the entire universe is a complete system that is everywhere described by the same mathematical laws. With the help of fluxions, one can find a variety of methods for finding extrema, tangents, and normals, calculating radii and centres of curvature in Cartesian and polar coordinates, and finding straightening points.

Results and Discussion

This paper presents a new method for generating the regular polygon Figure 7. Specifically, a polygon with ten vertices is being built. This new method is based on Newton's limits. One can notice a dependence of parallel segments that divide the polygon by passing parallel lines. The rule applies to any regular polygon, and the number of vertices can grow to infinity, similar to Newton's method. This new method gives a much more accurate result than the traditional programming method, which uses a trigonometric dependency, such as a relationship between (sine, cosine, and radius). Based on these, new mathematics and programming polygons can be built more complex geometric objects, such as pyramids and prisms. To illustrate this process, the article shows how a regular decagon and pyramid can be constructed. Here it is necessary to know only the length of the base's side and the pyramid's height. Knowing the values of the parameter a, all vertices of the geometric object can be calculated, all thanks to the new method.

Algorithm for constructing a polygon with ten vertices: First, it is necessary to determine the relationships of the parallel segments Figure 7 that divide the polygon into four isosceles trapezoids. Their ratio is respectively 1:2:3:4:5=1:2.56:3.15:2.56:1. The center of the polygon is placed on the centre coordinate axis. Vertex calculations start from the first vertex located in the first quadrant. The required information in the case of a polygon with ten vertices is to determine the heights of 4 isosceles trapezoids. Which figures are two by two the same? Dependence between the lengths of an isosceles trapezoid's upper and lower bases is also used. From here, it can be observed that the values of the vertices are equivalent. The difference is that for some of them the values for the abscissa and ordinate are positive, and for others negative. Depending on which quadrant the vertices are in.

The triangle primitive is used to generate the polygon. When the vertices of the figure begin to crawl, they must be in the same direction. The results in this article are clockwise from where the topology of the geometric object is determined. A regular decagonal pyramid with a base length equal to the parameter a is represented in Figure 8. Table №1 presents the necessary information for generating a polywall using the new boundary method. Table №2 shows the precise values of a regular pyramid. Where the parameter a indicates the length of the base of the polyhedron, in this case, the value of the edge is a=1. In his book, Newton compared the method of limits with the method of indivisibles of the Italian mathematician Boenoventura Cavalieri, i.e. both approaches give the same result. A minor error may occur when determining the relationships of the parallel segments. In future work, this problem will be solved. The parameter h determines the height of the pyramid. Using the other two parameters on the abscissa and the ordinate, it is possible, with their help to set the result to be a tilted pyramid at a value other than zero. This article presents three of Newton's lemmas to clarify the concept of limit that he introduced (Tables 1 and 2 and Figures 1-8).

Table 1. Pyramid parametric values.

c	x	y	z	Wall
1	a/2	a*sqrt(0.40)+0.91*a	0	1,2,3,4,5,6,7,8,9,10
2	1.28*a	0.91*a	0	1,2,11
3	1.28*a+0.59/2*a	0	0	2,3,11
4	1.28*a	-0.91*a	0	3,4,11
5	a/2	-(a*sqrt(0.40)+0.91*a)	0	4,5,11
6	-a/2	-(a*sqrt(0.40)+0.91*a)	0	5,6,11
7	-1.28*a	-0.91*a	0	6,7,11
8	-(1.28*a+0.59/2*a)	0	0	7,8,11
9	-1.28*a	0.91*a	0	8,9,11
10	-a/2	a*sqrt(0.40)+0.91*a	0	9,10,11
11	h1	h2	h	10,1,11

Table 2. Pyramid with precise values.

Number of Vertex	x	y	z	Wall
1	0.5	1.542	0	1,2,3,4,5,6,7,8,9,10
2	1.28	0.91	0	1,2,11
3	1.575	0	0	2,3,11
4	1.28	-0.91	0	3,4,11
5	0.5	-1.542	0	4,5,11
6	-0.5	-1.542	0	5,6,11
7	-1.28	-0.91	0	6,7,11
8	-1.575	0	0	7,8,11
9	-1.28	0.91	0	8,9,11
10	-0.5	1.542	0	9,10,11
11	h1=0	h2=0	h=3	10,1,11

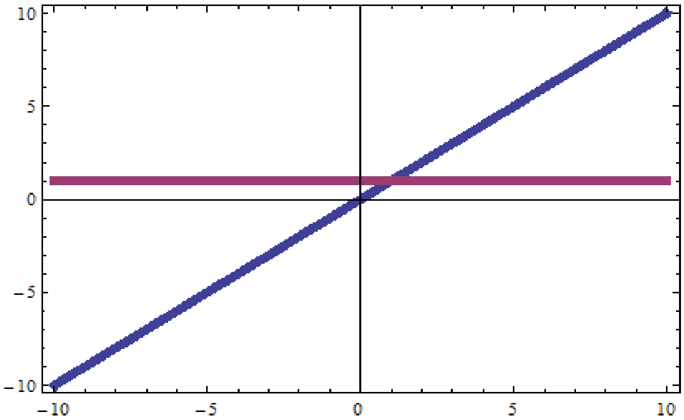

Figure 1. $(x)' = 1$

Lemma 1: quantities (magnitudes), as well as relations of quantities, constantly tend to equality during an arbitrary finite time. At the end of this time, the investigated quantities (quantities) approach each other closer than an arbitrarily set difference, and finally, they become equal [5]. Newton proves the lemma as follows:

We will prove the lemma by assuming the opposite. Let the quantities be unequal, and let their last difference be R. Therefore; they cannot approach equality more than a given difference R, which is contrary to the assumption.

Lemma 2: for similar figures, the lengths of the corresponding sides, both rectilinear and curvilinear, are proportional, and the faces of the figures are proportional to the squares of the sides [5].

Lemma 3: A body moving in space under the influence of some forces,

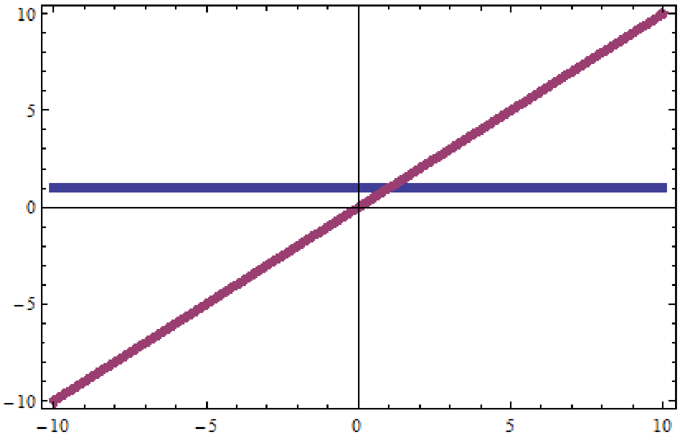

Figure 2. $\int 1.dx = x + c$

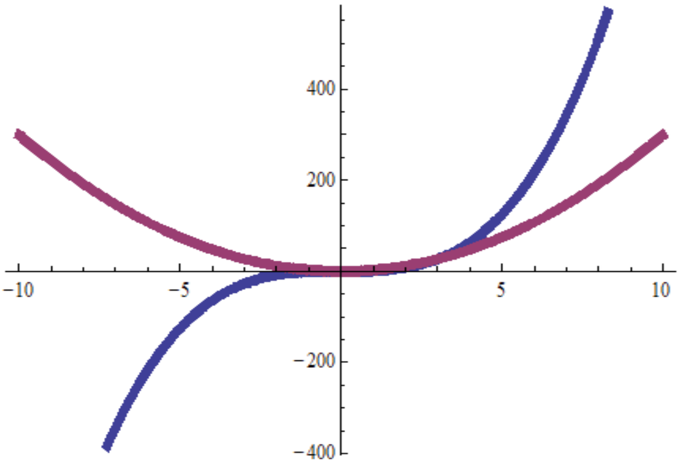

Figure 3. $(x^{\alpha})' = ax^{\alpha-1}$

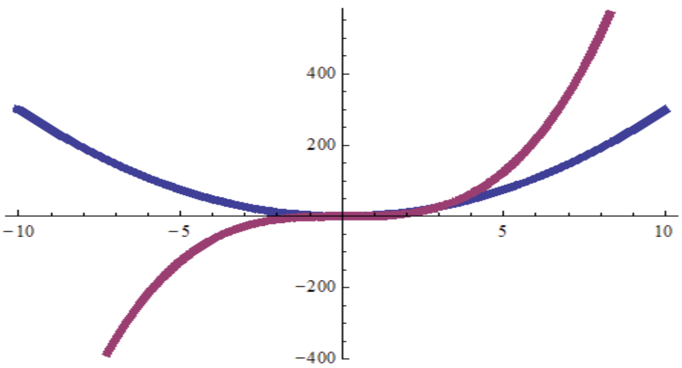

Figure 4. $\int ax^{\alpha-1}.dx = x^{\alpha} + C \; for \; \alpha = 3$

regardless of whether the forces are constant or non-constant - its speed will increase or decrease in proportion to the square of the time and the movement [1].

In this article, the concept of boundary is explained primarily through physics. The equivalent in mathematics is that if the quantities, for example (the vertices of a polygon) are increased to infinity, then the face of the regular polygon will coincide with the face of the circle described around it. In other words, in mathematics, to reach the limit of several numbers in a specific relationship, the quantities themselves must be reduced or increased to infinity. The method of limitations is also known as set and vanishing quantities. It can be explained as follows. The final speed is the speed with which the body moves not until reaching the last place when the movement stops and not after that, but at the very moment of its arrival,

i.e. the speed with which the body goes to its last place and the movement

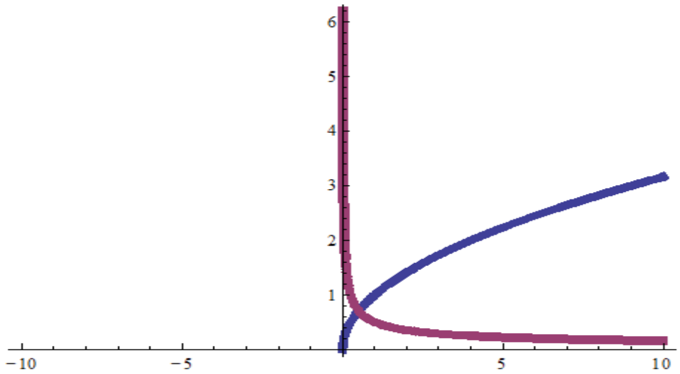

Figure 5. $(\sqrt{x})' = \frac{1}{2\sqrt{x}}$

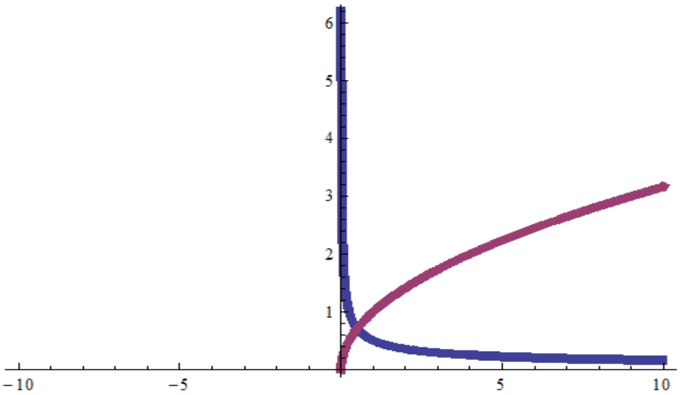

Figure 6. $\int \frac{1}{2\sqrt{x}}.dx = \sqrt{x} + C$

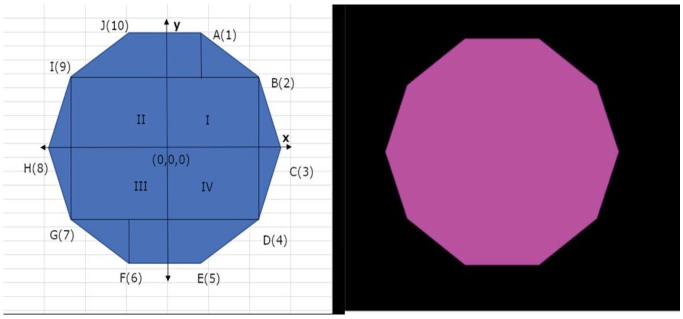

Figure 7. Regular polygon with 10 vertices.

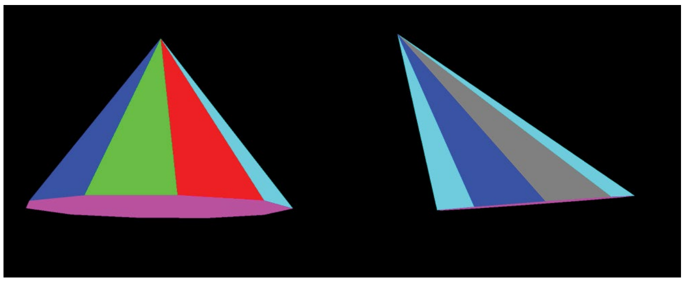

Figure 8. Pyramid straight and tilted.

stops. The final ratio of the vanishing quantities is understood to be precisely the ratio of the quantities with which they disappear.

Using the Wolfram Mathematica, the reciprocal nature of the operations differentiation and integration can be shown. First, the derivatives and integrals will be written in parallel columns, and then the reciprocal relationship between integration and differentiation will be shown by creating graphs through the Wolfram Mathematica. To demonstrate the reverse nature of the differentiation and integration of the operations through the principal derivatives of an elementary function of the derivatives and integrals. It is necessary to draw their reciprocall graphs: The first is the main base graph, and the second is the function's graph, which represents the function's derivative with variable x. This action is repeated in the integral calculus. Thanks to the new boundary method, it is possible for the objects that are created through it to be visualized by Through 3D active and passive technologies. And devices like the CAVE and HMD systems. At the same time, thanks to the Java programming language and specifically, the Java3D library, it is possible to convert geometric figures into a file with the extension .obj. Afterwards, they can be printed on a 3D printer or processed by a 3D modelling program. augmented and mixed reality devices, which includes immersive and non- immersive virtual reality systems.

Conclusion

This article presents the basic concepts of Isaac Newton and computer development. The Wolfram Mathematica and Java3D programming environment were used to describe the results. The main and constructive multimedia for understanding new information are graphics and animation. In his book "Mathematical Principles of Natural Philosophy" Isaac Newton describes his most significant discoveries. There he presents the method of the limit in 12 lemmas. He explains it mathematically and physically, thus making his method as accessible as possible. At the same time, he compared his discovery with that of the indivisible by Italian mathematician Boenoventura Cavalieri. Newton laid the foundations of mathematical analysis. The method of fluxes shows the reciprocal nature of the operations of differentiation and integration. In this paper, a new boundary method is presented, based on the Newton's technique. Through it, it is possible to draw a regular polygon and calculate its face. In particular, a regular decagon is considered. But the same rules can be applied to any regular polygon. Thanks to modern computer technology, the credibility of Newton's discoveries can be demonstrated.

Isaac Newton's methods presented in this article are relevant even today, as they are directly related to the computer. The proposed in this study new for programming polygons can participate in modelling various and complex geometric shapes to be included in a 3D project. In future will be developed extreme games creating a stressful situation. During the game, recording an ECG at time intervals will be possible. They were followed by mathematical analysis and determination of the patient's condition.

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