2-Dimensional Simulation of Field Anomaly Gravity Based on Scratch Programming

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Abstract--The things behind of this research is to solve the problems faced by students in geophysics who have difficulty in making modeling of subsurface targets. To overcome this problem, gravity anomaly modeling software is offered based on SCRATCH programming. This program is named GRAVSYS. The input parameters used are the length of the object *l*, the radius of the object *r*, the depth of *z*, the angle *θ* formed by the object on the surface, and the density of the object *ρ*. The results of the study produced four models of anomalous objects consisting of spheres, horizontal cylinders, vertical cylinders, and oblique cylinders. The resulting response is directly proportional to the density and inversely proportional to the depth. The benefit of this research is to make it easier for students and technicians to understand the concept of gravity methods.

Keywords: gravitational anomaly, sphere, cylinder, Scratch

I. INTRODUCTION

One method that is often used in mineral exploration is the Gravity Method [1]. Gravity method is used to detect anomalies of local or residual gravity values. Gravity anomaly is caused by the lateral contrast of the rock layer density [2]. The process of proving a theory or understanding of the gravitational field anomaly requires a clear picture of the case under study [3] . One step to make an illustration is to make a modeling with a computer simulation [4]. Gravitational modeling is one method of interpretation of gravity data to describe the subsurface geometry structure based on the distribution of rock density [5]. The following is an illustrated image that shows a gravitational field anomaly (**Figure 1**).

The development of the world's technology provides more and more applications that offer various facilities for creating and designing a model or simulation [6]. One of them is Scratch, a program developed by the Massachusetts Institute of Technology (MIT)[7]. The advantages of Scratch is that it is a freeware that it does not burden usage fees for users or derivative program makers [8]. Thus, it can be embedded into HTML files which are the program languages used on the internet [9]. Another advantage of Scratch is the ability and compatibility that is owned on various Operating System platforms such as Windows, Mac, and Linux [10]. Scratch is a new programming language that can be used to create a game and animation [11]. Because its function can be used as an animation so that it can be used also to create a simple simulator about the gravity anomaly.

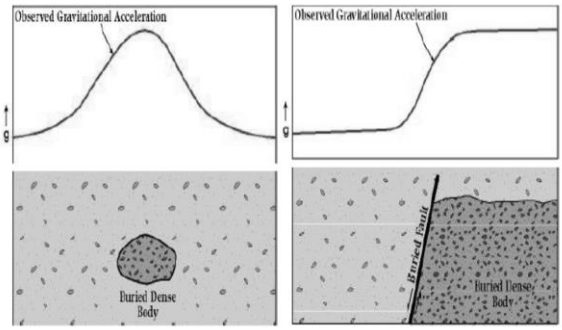

Figure 1. Illustration of Earth's Gravity Field Anomaly

In this study the researcher will make a gravity anomaly simulator so that it can be used as a simple application in the process of understanding the occurrence of a field anomaly gravity using the scratch programming language.

II. THEORETICAL FOUNDATION

Sphere

Anomalous spherical objects applied to the approach and the length dimension of the anomalous source is less than its depth [1]. The followings are anomalous components of spherical objects (**Figure 2**).

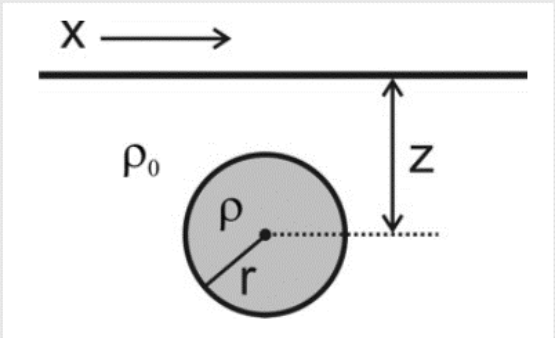

Figure 2. Anomalous Components of Spherical Object

The gravity component on the vertical axis of a spherical object at one point of mass can be given by the equation:

(1)

Horizontal Cylinder

The gravity component on the vertical axis of the horizontal cylinder (**Figure 3**) at one mass point can be given by the equation:

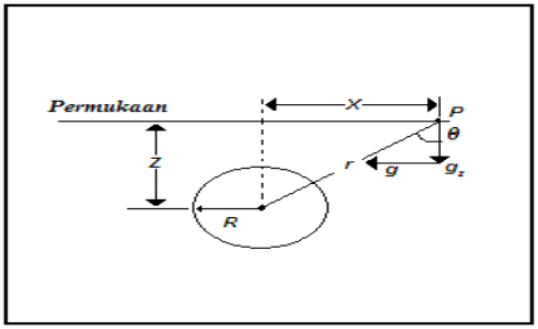

Figure 3. Components of gravity on the axis vertical of horizontal cylinder objects

(2)

with m is the cylinder mass, G is the setting of Newton's gravitational field, z is the depth of the object and r is the distance of the object with point P on the surface [11]. If the cylinder has a mass of ρ, it will be obtained:

(3)

Vertical Cylinder

The gravity response on the axis of a vertical cylinder (maximum value) is easy to calculate. (**Figure 4**) The calculation starts with a ring as wide as *dr*. $\delta m=2\pi\rho r\, dr\, dl$.

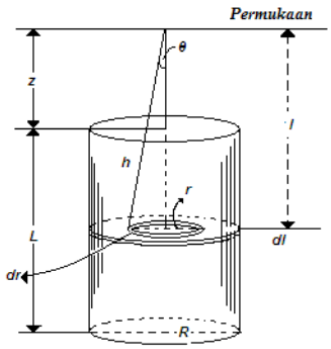

Figure 4. Gravitational anomalies of vertical cylinder

What will be calculated here is the gravitational anomaly on the z axis only to get:

(4)

(5)

Equation is initialized initially from $\theta = 0$ to $\tan^{-1}$ (R/L) for the ring disc then $l=z$ to $z+L$, gravitational value on the cylinder axis will be obtained:

(6)

(7)

Oblique Cylinder

Component on a certain slope object that forms an angle equal to the object in an upright position [12]. Then the formulation of the response to gravity on a sloping object (**Figure 5**) can be given as:

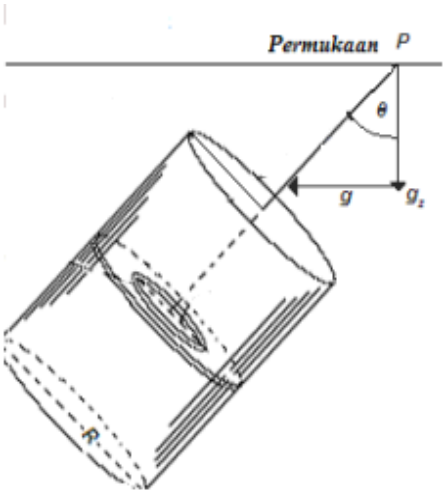

Figure 5. Gravitational anomaly of the oblique

$$gz = g \cos \theta \quad (8)$$

(9)

III. RESEARCH METHODS

The design of this program uses the SCRATCH programming language. Scratch is one of the programming languages developed by the Lifelong Kindergarten Group at MIT (Massachusetts Institute of Technology) Media Lab, United States. Scratch is a visual language that is making projects using intermediaries in the form of images [13].

The pattern of programming with images is a distinction between Scratch and other text-based programming languages such as PHP, C, and Pearl which seem more complicated [14]. Next is the Scratch application interface (**Figure 6**).

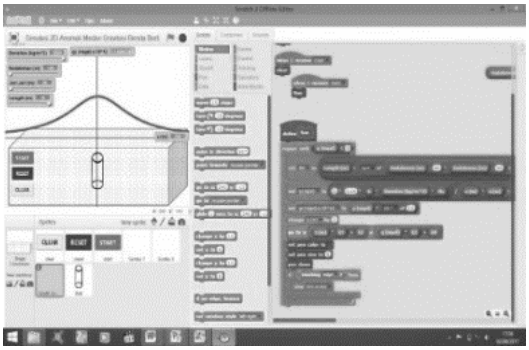

Figure 6 Interface of Scratch Applications.

Here is the main program flow diagram (**Figure 7**).

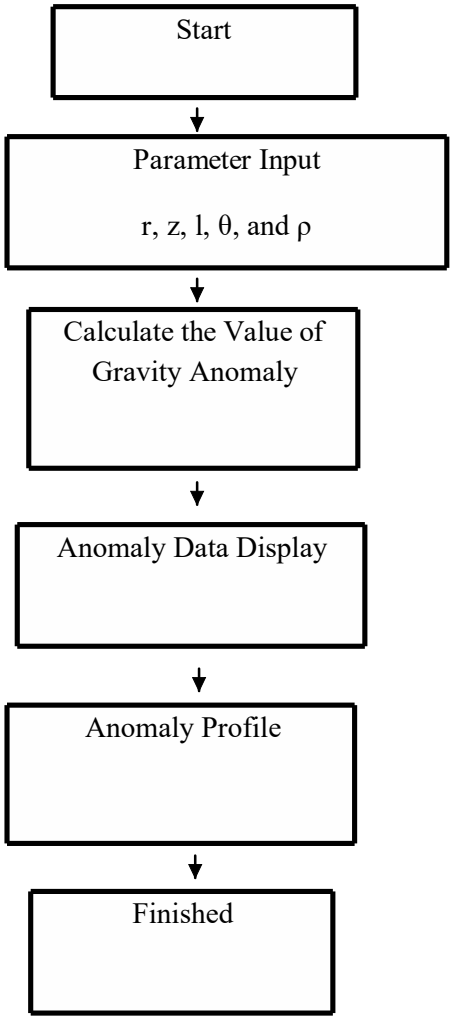

Figure 7. Flow diagram

IV. RESULTS AND DISCUSSION

Spherical Objects

Anomalous profiles generated by the GRAVSYS modeling program with spherical objects can be seen in the **Figure 8** below:

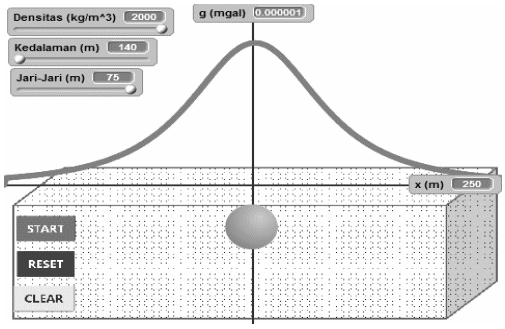

Figure 8. Gravity Anomalies of Spherical Objects.

Vertical Cylinder

Anomalous profiles generated by the GRAVSYS modeling program with vertical cylinder positions can be seen in the **Figure 9** below:

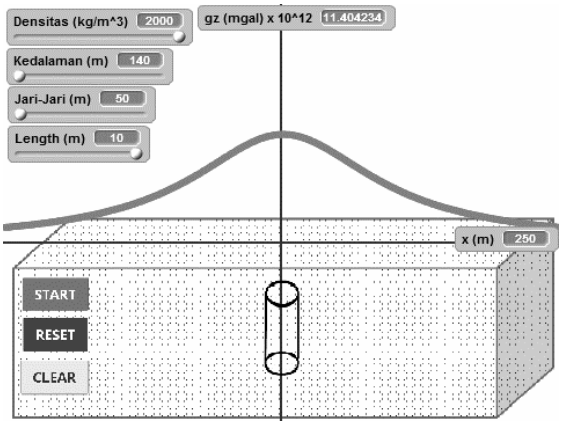

Figure 9. Gravity Anomalies of Vertical Cylinder

Horizontal Cylinder

Anomalous profiles generated by the GRAVSYS modeling program with horizontal cylinder positions can be seen in the **Figure 10** below:

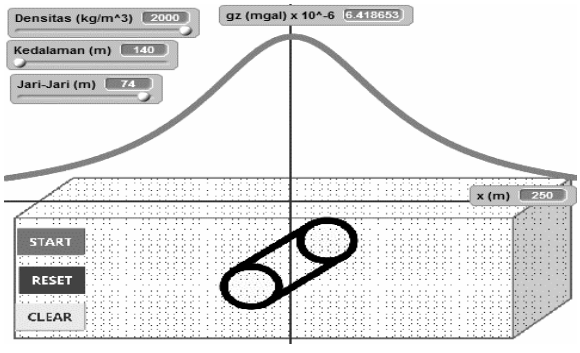

Figure 10. Gravity Anomalies of Horizontal Cylinder

Oblique Cylinder

Anomalous profiles generated by the GRAVSYS modeling program with a sloping cylinder position can be seen in the **Figure 11** below.

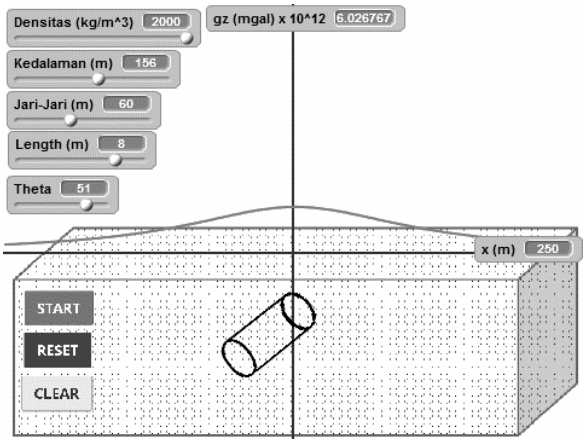

Figure 11. Gravity Anomalies of Oblique Cylinder

V. CONCLUSION

It can be concluded that the gravity anomaly modeling program has been successfully made with the approach of spherical and cylindrical objects. This can be seen from the suitability of the program output results in the form of anomalous data and profiles with references.

Also obtained from modeling is that: With the same object, the closer the surface, the greater the gravitational anomaly of the object, and vice versa. The length of the object will greatly affect the value of the gravity anomaly, the longer the object the greater the anomalous value.The radius of the object is greater then the gravitational anomaly will also be enlarged. The position of an object influences the shape and magnitude of the gravitational anomaly it causes.

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