Measurement of asymmetrical homogeneous object by using chain code algorithm and virtual center of gravity

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Abstract. Current methods of measurement of asymmetrical homogenous objects still largely involve various kinds of experimental analysis that are complicated and time-consuming. One of the experiments to measure an object’s center of mass is carried out by hanging the object by using pieces of rope in different positions. The point where the rope meet is taken as the object’s center of mass and weight. This research is purposed to develop a system to measure area, center of mass, and center of weight of an asymmetrically-shaped object by using digital image processing. The process is initiated by doing a pre-processing method that is purposed to increase the image quality. Then, a method of feature extraction of edge detection and chain code algorithm are used to measure the peripheral size and area of each side of the object. The result and analysis of the area are used to determine the object’s center of mass and weight. This digital application will determine the virtual center of mass and center of gravity that are needed to measure an asymmetrically-shaped object in a real-time mode. This application can also be used to measure an object indirectly if the object is not present physically.

1. Introduction

The difficulty of measuring surface area and mass center point of an irregular object is still interesting to observe both experimentally and theoretically. Several methods that have been used experimentally in the laboratory are still undergoing a long process with relatively small object sizes as shown in figure 1. One of the principles of Archimedes' measurements with which the fluid is transferred is variation of the weight of the object [1].

Figure 1. Experimentally in the laboratory using several methods such as experiments [6]
In general, the experiment determines the central point of the mass of the surface area of the object is something that has long been done by scientists. The current computer technology makes it easier for scientists to measure objects based on digital images. The segmentation process is used to separate objects by extraction of contours [3], edges of objects [2] and image decomposition analysis [4].

The segmented object area is very easy to do calculate. This is equivalent to the number of pixels inside the contour of the object. The object's threshold area can be defined in two different ways: 1) Write the area: the area that points to a point within the contour of the object including those that do not belong to the object according to the threshold, and, 2) the object area where the pixel, which does not display the pixel boundary object [5].

Once the objects of interest are segmented, they are measured for features. Features are a generic term for anything measured from any object, or even the whole image. Features can range from simple mean intensity measurement to multi-valued texture features, models fitting parameters, and so on [4]. To be specific about which kinds of features are discussed, the kind should be declared. These may be for example object features, image features or texture features [7].

2. Methods

The research is to analyze the extent of objects and the center of mass by using digital image processing methods based on the morphology of geometry features. As a supportive surface area analysis is required the extraction of object characteristics. Initial stage done some photo taking irregular object, then in pre-processing is improvement of image quality to clarify the object. The next stage is the object segmentation process to separate the motif from the background and the cropping process to obtain the part that want to be sampled data.

The feature extension phase is a detailed data retrieval process that will be used in the analysis process. The feature extraction process uses edge detection methods, feature morphology and chain code algorithms. Edge detection is used to bring the edge of the line to objects that are irregularly fielded. Then performed morphological operation is the process of obtaining the structure of an image in order to thicken (dilation) and attenuate from a contour line on the object. The results of this morphological process obtained improvement of the faint motive line (thin) or fix the edge of the motive is too thick.

After obtaining the shape and structure of the motive, the chain code process is used to calculate the pixel edge according to the wind codes from 0 to 7. The result of the chain code algorithm is used to calculate the circumference and the extent of the object, and then the process of eccentricity, metric and object center as shown in figure 2.
2.1. Chain code
Detection of an object in the form of lines, boxes and circles. The binary image shows the detection result in a general view that needs to be processed in more detail to obtain information that can be extracted in the shape of the object or contour edges. One contour algorithm is to use a chain code. This algorithm detects the edges of objects based on connections between straight line segments with direction and certain lengths [4]. The chain code can trace the boundary of an object clockwise with direction provisions in each pixel pairs connected. The direction is encoded based on the numbering scheme. The coding steps are like in the following figure 3.

2.2. Center of Gravity
The position of an object from an image expressed through Cartesian coordinate values is used to determine the position of an object such as the use of a square box to enclose rectangle precisely at the center point of an object area commonly referred to as the center of gravity on the object.

The center of the image area is the same as the center of mass when the intensity at one point is considered equal to the mass at that point [2] to calculate the position or the center point of an x
direction object used equation (1), and to determine the midpoint of the x-axis direction is used equation (2).

\[
X_x = \frac{\sum_i \sum_y f(x, y)x}{\sum_i \sum_y f(x, y)} \tag{1}
\]

\[
X_y = \frac{\sum_i \sum_y f(x, y)y}{\sum_i \sum_y f(x, y)} \tag{2}
\]

3. Results and Discussion

The results of the shots are used for input data and test data. Prior to use as input data the process of initial process or image quality improvement and selection of damaged images will be discarded. A good collection of images will be grouped into two groups: input data and test data.

The design validation process is a product design assessment process that provides rational thought, without field testing. Design validation is done by two people whose function is to provide inputs that can be made to improve the design. Design validation is done by holding discussion forum followed by some people, either from validated or also user, with first presented design of product made.

Table 1. The application product determines the mass center of a non-symmetric object in a digital image.
The advantages of this application allow to directly measure the image of the object diameter that has been processed with image processing. Such as in figure 4, a stone can be measured digitally 470.63 pixel high and the width is 472.13 pixels.

![Figure 4](image)

**Figure 4.** Determine the diameter of the object vertically and horizontally by drawn a straight line

4. **Conclusion**

The development of computer applications to determine the central point of the mass of the design process design until the implementation of the product has been appropriate to overcome the problems that existed for this that the difficulty of determining the point of mass of non-symmetrical objects by doing some treatment or experiment in a laboratory old and complicated. Results of product validation by a team of media experts and materials experts stated that this application is feasible to be tested with some revisions, among others; image capture, display and image processing. The weakness of this computer application program if the capture process is less than the maximum image because there is a shadow object then the edge detection process and the area will affect the position of the center point on the object, so it must be processed pre-processing first. Convert pixels to centimeters constrained on screen pixel on different monitor screens thereby affecting the measurements on actual objects.

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