

Imaging and Programming Based Computation of Logistic Package Volumes Application on Automatic Mail Machines

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ABSTRACT

At present the determination of weight and volume has been widely used to assist in the process of determining costs for freight forwarding services. Shipping costs are determined by the weight of the goods, but the weight of the goods consists of two types, namely actual weight and volume weight. The weight of the weighing will be used directly if the item or box is small, but if the item is large but the weight is real then the weight of the volume will be used. Algorithms that combine triangulation and 2D measurement techniques can be used to build 3D surfaces so they can measure the volume of a product. Determination of volume in the optical scoring system can be done using the laser triangulation method and the area of 2D image measurement, then using a computer algorithm to get the results of 3D images to determine the volume of the object. The calculation process used in this study uses MATLAB software. MATLAB is the most efficient software for matrix-based numerical calculations and is widely used in mathematical calculations, development and algorithms, programming modeling, prototyping and simulation, data analysis, exploration and visualization, numerical and statistical analysis, and technical application development. The results of the study using MATLAB include students becoming more interested in learning and more independent in learning mathematics, can visualize data graphically to help analyze the data analyzed, and help in modeling the characteristics of variations in fuel mixtures which include density, viscosity, dynamic and kinematic viscosity.

KEY WORDS: *Camera, imaging, triangulation method, volume, MATLAB.*

1.0 INTRODUCTION

Development of image processing technology nowadays is moving fast. It develops and grows rapidly so far gives many advantages to various fields such as security system, medical application, agriculture, robotics etc. The technology is conducted with processing mechanism and analysis based on image and picture. The mechanism utilises digital technology in form of digital image processing. In order the computer capable of analysing captured images or pictures. Within thirty last decades application of digital image processing is not only for a single user device but also it is combined with several apparatus for producing multi-outputs. However, mostly the application of digital image processing is embedded with a huge and fixed machine as it found in airport and cargo services.

Instead of fix-installed of huge machine vision, a portable and small size machine vision could be very attractive. Combination of digital camera imaging and laser beam as a detector and analyzer an object is considered. It's development for mail and parcel system shortage application and services. It can increase service performance and simultaneously reduce cost and time.

A triangulating method based on laser beam exposure and the digital camera automatically capture object appearance. This system is able to determine object volume. This method is a high performance which makes the user capable of working faster and easier. However, most small scale parcel service company

The method has been using for delivery cost determination by mail or parcel services based on parcel weight and volume. However, for a small firm and local parcel delivery stores it is done manually, therefore it spends time. Application of this method on a portable automatic machine vision is considered will be able to give advantages for both, money, time and services.

Arduino microcontroller in combine with MATLAB is utilized for operating the machine.

2.0 METHODOLOGY

2.1 Triangulasi method on machine vision

Application of laser-based 3-D triangulation method on the high-speed production line is known as a very powerful way to obtain a rapid accurate measurement of product shape and dimensions. In most industrial application, the method might be employed in a different way and techniques (Callen.D, 2017). Adopting the method, this work employs the method in combining with load cell to build a measurement system not only measuring packages volume but also their wight simultaneously. Based upon both parameters the cost of delivery service is determined. MATLAB application program on the microcontroller in such way computing packages delivery cost must be paid by the costumers.

The diagram below illustrates the graphical method of the triangular computing mechanism based upon laser beam and digital image processing by the digital camera.

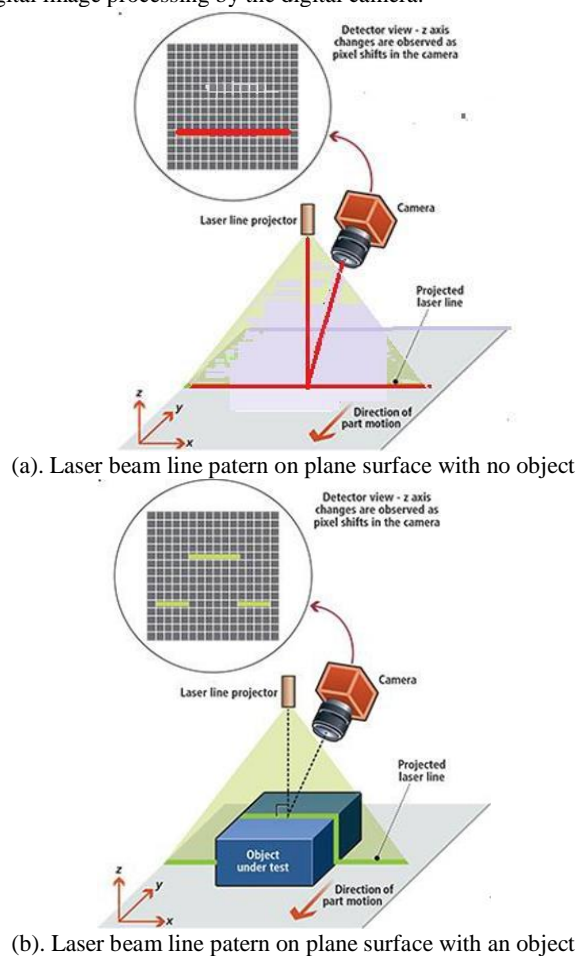


Figure 1: Pulse pattern of laser beam by camarea digital image analysis.

During operation, the camera always detects and record the laser beam on the surface of the target. A pattern of laser beam line recorded by the camera will tell the shape of the object as is shown by the above figure 1 (a) and (b).

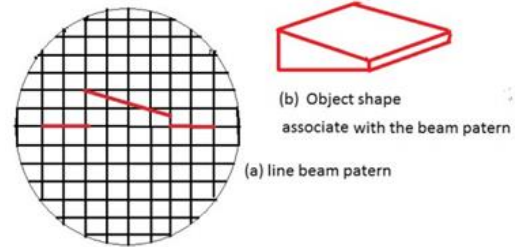


Figure 2: Laser beam line presented by digital image processing associate with the object shape. (a) pattern of laser beam, (b) object shape associate with the beam pattern.

In the triangulation shown in Figure 1, the laser line is projected onto a part, and the camera looks at the line and analyzes its shape dynamically to reconstruct the dimensions of the object. But there are some basic triangulation configurations, the most widely used configurations, which are called standard geometry positions. In this configuration, the laser is directly above and perpendicular to the object being measured, as shown in figure 1 (b) and configuration a laser with a 45° angle to the object being measured, as shown in figure 2 (a).

The most important characteristic of this configuration is that object height variations move the projected line in the object's Z axis only. This simplifies the calculations required to derive object shape, resulting in a system that is faster, more accurate and easier to calibrate during setup.

2.2 Computing object volume.

Projected laser line on the object surface causes laser line shifting associate with object surface properties and shape. The shifting value of laser line on the object surface is equal to the height or the thick ness of the object (figure 1 (b), 2(a)). If the length of object is obtained from movement speed (v) within time (t) therefor object length $x = v.t$ in meter. Meanwhile the wide of object dimension is equal to the length of laser line projection on object surface (y), shifting distance of laser line from the base of object tray to the object surface tell the height of object (z). So the volume of object (V) is equal to $V = x.y.z$ in meter³. Based on that formulation the volume of the object is automatically computed.

The computing height of the object (H) represented by the z -axle length can be illustrated by the geometric projection shown in the figure 3 below.

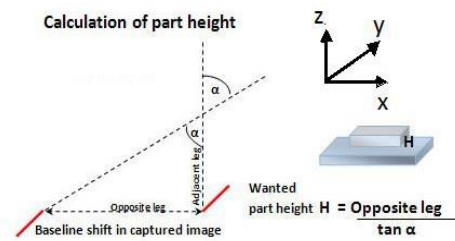


Figure 3: Geometric projection on z-axle for part height computation.

The computing mechanism of object volume illustrated on the above method is then presented into a computing algorithm based on MATLAB.

3.0 RESULTS AND DISCUSSION

3.1. Object size measurement of logistic package

The system of the machine is a portable design consists of sensors, drivers, a microcontroller, based tray, laser and digital camera, an electronic system interface for apparatus handshake mechanism. Experimental and apparatus arrangement for measurement in this work applies reverse geometry as shown in figure 4. below.

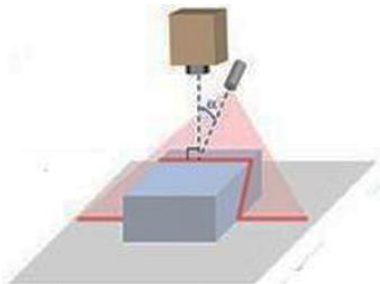


Figure 4: Reverse geometry arrangement of laser-camera employed by machine vision.

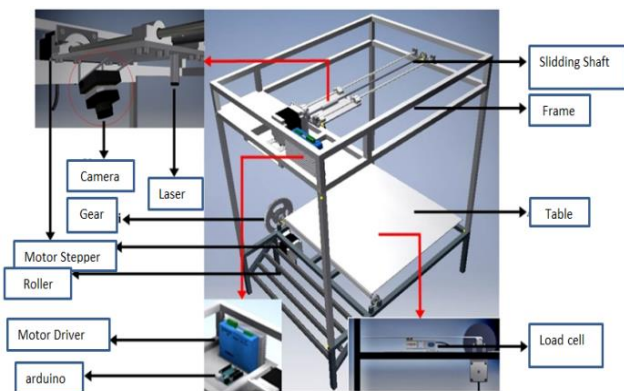


Figure 5: Prototype of Machine Vision produced in this work.

Measurement of the logistic package is carried out automatically. As soon as the package is put on the based tray of the machine, load sensor under the tray turn on power system of the machine. Driver motor starts working and activates the laser and digital camera simultaneously and starts capturing object dimension, measuring the volume based on laser projection profile on an object surface. The computer algorithm that was embedded in the microcontroller computes the volume of logistics package. Based upon the volume and weight detected by a load sensor under the tray become inputs parameters for calculating the cost of logistic package service.

The equation is dynamic. It depends on transportation, infrastructure quality, current price index, a distance of delivery service. Tariff constant and unit cost are adjustable. It is influenced by market competitiveness of package services, and

number of competitors.

The following is an example of MATLAB script for object volume computation as shown in figure 5.

```
private void jbhitungActionPerformed(java.awt.event.ActionEvent evt) {
    double p, l, t, luas, volume;

    p = Double.parseDouble(jtpanjang.getText());
    l = Double.parseDouble(jtlebar.getText());
    t = Double.parseDouble(jtinggi.getText());

    luas = (2 * (l * t)) + (2 * (p * t)) + (2 * (p * l));
    volume = p * l * t;

    if (jcluas.isSelected()) {
        jtluas.setText(String.valueOf(luas));
    }
    else {
        jtluas.setText("");
    }
    if (jcvolume.isSelected()) {
        jtvolume.setText(String.valueOf(volume));
    }
    else {
        jtvolume.setText("");
    }
}
```

Figure 6: Example of MATLAB script for object volume computation

For randomize volume value of various size box-shape and weight object associated with delivery service cost (DSC) given in the following table.

| <i>p</i> length | <i>l</i> wide | <i>t</i> height | <i>V</i> volume | <i>W</i> weight | DSC (delivery service cost) |
|--------------------|------------------|--------------------|--------------------|--------------------|--------------------------------|
| 0,40 | 0,20 | 0,10 | 0,00800 | 4,0 | Rp112.336,00 |
| 0,30 | 0,15 | 0,08 | 0,00360 | 3,0 | Rp84.151,20 |
| 0,25 | 0,20 | 0,05 | 0,00250 | 3,5 | Rp98.105,00 |
| 0,35 | 0,12 | 0,08 | 0,00336 | 1,8 | Rp50.541,12 |
| 0,20 | 0,14 | 0,04 | 0,00112 | 2,4 | Rp67.247,04 |
| 0,27 | 0,12 | 0,08 | 0,002592 | 1,3 | Rp36.508,86 |
| 0,34 | 0,15 | 0,02 | 0,00102 | 0,8 | Rp22.442,84 |
| 0,15 | 0,10 | 0,03 | 0,00045 | 1,5 | Rp42.018,90 |
| 0,24 | 0,10 | 0,06 | 0,00144 | 2,8 | Rp78.460,48 |

Practically the DCS appears on mail document of delivery service automatically. Implementation of this method for logistic package delivery system is able not only to reduce time-consuming during services but also to give a fair price for the delivery service.

4.0 CONCLUSION

Implementation of the triangular method based on laser and digital camera imaging technology significantly able to enhance and improve package delivery service performance of parcel and package service companies. The improvement is not only able to provide company better services but also its service quality and price.

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