

## Image Analysis Using ImageTool to Detect Dangerous Object in Airport Baggage Scanner

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### Abstract

Airport is one of the vital places that need very extra security level. The major problem is how to optimize current airport security system to increase security and flight passenger's comfort. In this paper we suggest an idea to increase airport security by implementation of image mining in scanner machine as an early warning if there are dangerous object.

ImageTool software is one of the open source product that provide analysis process to find pattern of dangerous object. Those pattern will be compared to look up table by using image representation.

Keywords : ImageTool, Image Mining, Lookup Table, Patern Analysis

### 1. Introduction

Air transportation is an effective and efficient form of transportation for archipelago country like Indonesia. Therefore, airport is one of the most important places that should have a highly security level. Growing of domestic and international flight influence criminal or terrorist to find chance of using it to help their criminal or terrorism activities, such as to carry narcotics, explosives, or other dangerous things. All of these cases have given the airport an obligation to increase the security system.

The standard airport security procedure nowadays is by using metal detector and x-ray scanner tool for knowing the content of passenger baggage. It is still not quite enough because x-ray scanner tool still works manually that require officer to analyze the scan result. For some reason, we can not depend on security officer because it is vulnerable due to

human errors, such as a too tired officer, the lack of experience that the officer have, or how sophisticated the criminal technique to hide the objects [2].

	Type of errors	Potential reasons
1	Baggage is presented for viewing but security official decides not to observe it.	Competing and more attractive attentional cues from nearby Prolonged time in task Fatigue or eyestrain Workplace layout Low expectation of finding dangerous items Low motivation
2	Security official fails to perceive any potentially dangerous items when these are presented in the baggage	Insufficient time for search Movement speed too fast Poor search strategies Inadequate display conditions
3	A potentially dangerous item is perceived but the security official incorrectly decides that it is acceptable	Unclear or variable standards Lack of time False alarms are penalized or are perceived as being, especially because of the possible reactions of the passengers Rejection involves more effort
4	Security official locates a dangerous item but this is then not identified during unpacking	Personnel who are responsible for unpacking the baggage are unaware of the reasons for security checkers suspicions

Figure 1. List of Typical Error Made and The Reason

Based on the condition, it obliges the airport management to increase the security level. Only by adding more security officer and scanner are not appropriate solution. In the future, we can not depend on a system that work manually (still need the help of human to operate). That is why we need a smarter idea in scanning process, one of the idea is by adding artificial intelligence in x-ray scanner. The scanner can do detection to passenger baggage and can give early warning to officer to check the suspected baggage accurately. This system can help security officer to analyze

the baggage and can improve the scanning process to a more efficient and effective.

In this paper we discuss an artificial intelligence using Image Mining which is implemented in x-ray scanner to increase security checking in airport. The result that we get from the analysis object pattern on airport scanning machine is manual technical supported scanning process from passenger baggage at the airport. With the early detection, we hope that it can reduce airplane accident rate and increase comfortable and secure feeling for airplane passengers.

## 2. Nowadays Approach For Image Mining and Pattern Detection

In data mining, if we compare it with another type (like text mining or web mining), image mining still has not been explored well. Especially about the implementation of image mining in airport x-ray scanner. In paper "Application of Data Mining Techniques for Medical Image Classification" Maria Luiza Antonie, Coman A and Zaine explain that there are three step to do image mining.[3]

1. Collecting grouping data and feature extraction process to analyze image pattern.
2. Neural Network is a step to grouping result pattern based on criteria or kind of the object.
3. Association Rule Mining is an algorithm to find similarity between identified pattern with pattern in database.

More detailed Patricia G Foschi in paper "Feature Extraction for Image Mining" explain about elements that are normally used in feature extraction are color, texture and edge detection[5]. Edge detection has been widely studied in the context of digital image processing. Jahne Bernd from his book "Digital Image Processing" explain that Filtering is one of the most common approaches to detecting edges in images. To determine whether an image pixel is at an edge or not, this approach applies a filter to values of a set of neighboring pixels [4]. Therefore, these techniques can be directly applied to localized edge detection.

## 3. ImageTool

The ImageTool is an open source tool for image processing and analysis program which was made by Department of Dental Diagnostic Science at The University of Texas Health Science Center, San Antonio, Texas. The program was developed by Dr. C. Donald Wilcox, DSc, Dr. S. Brent Dove, DDS, Dr. W. Doss McDavid, PhD and

David B. Greer. ImageTool was designed with an open architecture that provides extensibility via a variety of plug-ins. ImageTool was written using Borland's C++ version 5.02 and Support for image acquisition using either Adobe Photoshop plug-ins or TWAIN scanners is likewise built-in. Custom analysis and processing plug-ins can be developed using the software development kit (SDK) provided (with source code). This approach makes it possible to solve almost any data acquisition or analysis problem with ImageTool.

ImageTool can acquire, display, edit, analyze, process, compress, save and print 8 and 16 gray scale and up to 24 bit color images. ImageTool can read and write over 22 common file formats including BMP, PCX, TIF, and JPEG, and also provides a generic import function that makes it possible to view image data from many unsupported file formats. Image analysis functions include dimensional (distance, angle, perimeter, area) and gray scale measurements (point, line and area histogram with statistics). ImageTool supports standard image processing functions such as contrast manipulation, sharpening, smoothing, edge detection, median filtering and spatial convolutions with user-defined convolution masks. ImageTool also has a powerful scripting language to facilitate the development of additional processing and analysis tools.

A powerful built-in scripting language makes it even easier to enhance ImageTool. The scripting language is more than just an automation tool: with looping and conditional statements, variables, procedures and over 200 commands, the scripting language is a programming language that has all the power of ImageTool built-in.

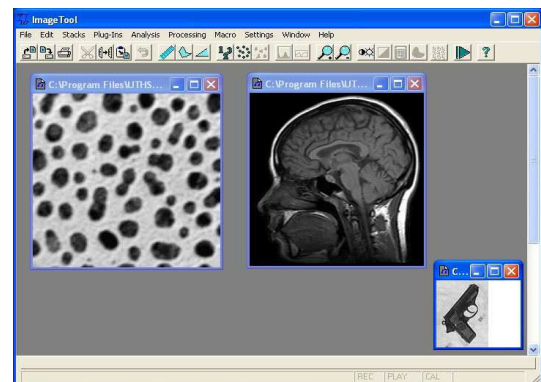
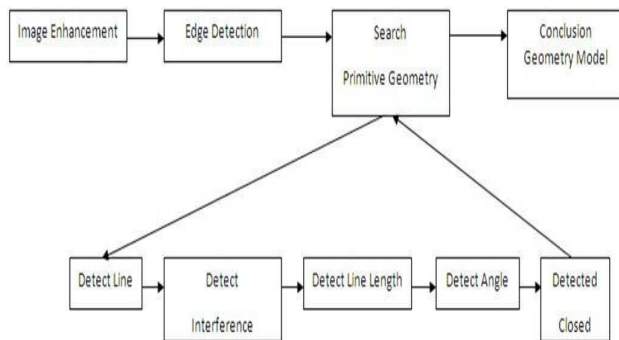


Figure 2. Screenshot of ImageTool

## 4. Approach For Image Pattern Detection

Implementation of intelligence toward scanning sensor is not easy to be done. Because of that, one of the method to implement intelligence is by using the concept of image

mining. Image mining is a concept concerning gathering a collection of data image which could be processed for our purposes. Image mining have two objective, which is mining the image collection and combine the result with the information that we need. At image mining, for the first step images are grouped based on definite group, then look for main pattern to seek more easy.



**Figure 3. Flow Image Pattern Detection**

The first thing that we have to do in this research is collecting data of image considering illegal objects or dangerous objects from the result of scanner machine. The result consists of three color image, depend on the materials of the object. The difference that occurred is due to absorption toward radiation which is different in every material. Orange is color that occurred because of explosive materials or narcotic which made from organic materials, while green and blue are color that occurred because of materials that made from metals or un-organic materials. The result color can be very useful, but in this paper we only use the shape of the object.

The next step is image enhancement. In computer graphic, image enhancement is a process to improve the quality from digital image by image manipulation using selected software. There are many approaches that can be used to gain better quality image, like managing the level of brightness of the image, the level of contrast, or select a certain filters as according to requirement. This route is done to eliminate noise from image, therefore we got good quality of image. After image enhancement step is done, the next step is Edge Detection. For this process, we will use an open source software called ImageTool. ImageTool have many utilities for image analysis, one of that is edge detection. Another way to find edge of object we can use some filters and do threshold to the image.

The following step is searching the pattern of the image. Pattern to be seen is related to primitive geometry shape like circle, triangle, square, and rectangle. This step consist of five process, which is :

#### 1. Line Detection

Line detection is step where lines formed of shallow objects that we got after edge detection process.

#### 2. Interference Detection (Intersection)

Intersection is detection step of dots formed from the result of lines intersection that previously have been detect.

#### 3. Length Line Detection

Length line detection is measurement step of length line formed at first step. The length of line later will be useful for determining the primitive geometry that formed.

#### 4. Angle Detection

Angle detection is a step of detecting the width of the angle that formed between two intersection lines.

#### 5. Closed Detection

Closed detection is step where lines detection is done, whether the line that formed is closed (formed some structure) or not.

Final step is determination of the primitive geometry pattern that formed. The determination of primitive geometry model that formed is base on the analysis result that has been done at the five stages before. ImageTool can't undertake the two last step. Further, the pattern will be divided into look-up table. In this case, pattern will be divided based on primitive geometry formation that formed.

The patterns that we got from the scanning result of dangerous objects then will be used at the scanning process in the airport. The baggage will be scan in the same process with the dangerous object, then compare the image result with the database to check whether the object is a dangerous object or not.

This methods still have probability of error in identifying objects. For example if a toy gun is scanning, then will be resulted a pattern of primitive geometry that look like original gun. So that toy gun will also identified as a dangerous objects.

## 5. Result and Discussion

After collecting data of images considering illegal objects or dangerous objects from the result of scanner machine, we should change the image into grayscale. Image processing function in ImageTool only works if the image is in grayscale. In this paper we want to compare the result from latest version (ImageTool 3.00) of Image tool with the previous version (ImageTool 1.27). The image which will



Figure 4. Grenade Figure



Figure 5. Gun Figure



Figure 7. Grenade With Filtering version 3.00



Figure 8. Gun With Edge Detection

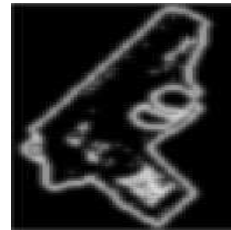


Figure 9. Gun With Filtering version 3.00



Figure 10. Grenade With Filtering version 1.27



Figure 6. Grenade With Edge Detection

be looked for its pattern is a gun and a grenade shown in figure 4

To find edge of gun and grenade, we should do threshold to the image. Threshold is used to create a binary image from a gray scale image, typically as a prelude to further object analysis. The threshold produces an image in which all pixels in these regions are represented by the same gray level, one that is approximately the mean level for the entire region. In Imagetool we can manage the value of threshold manually or automatically, in this case we choose automatic. After that we do some filter to get the edge of shape like Gaussian 5x5 and Hat 5x5. But in ImageTool 3.00 include with edge detection function. The result of edge detection are shown in figure 6-11

There are six result of gun and grenade image pattern detection steps. From figure above we get the differences between the result from ImageTool version 3.00 and ImageTool version 1.27. In edge detection ImageTool version 3.00 both with edge detection function and filtering process give result image with noise. Noise will be a problem in an-



Figure 11. Gun With Filtering version 1.27

alyzing result image. Although ImageTool 3.00 is the improvement of ImageTool 1.27 but in this case, ImageTool 1.27 gave the better result for edge detection.

The next step is by doing the image analysis to know the image shaper pattern including of line detection, intersection point, angle detection, line length, and closed process. Those process will be done manually, because ImageTool doesn't have function to do those process except angle detection. In ImageTool angles are drawn by clicking on three points: the vertex and two additional points on the rays subtending the angle to be measured. The result are shown in figure 12&13

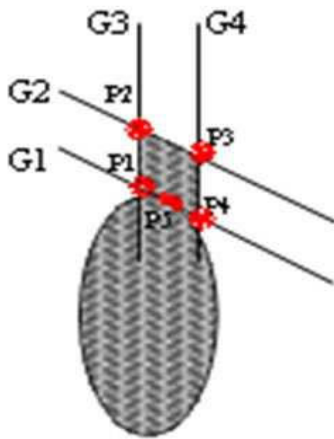


Figure 12. Grenade Pattern Analysis

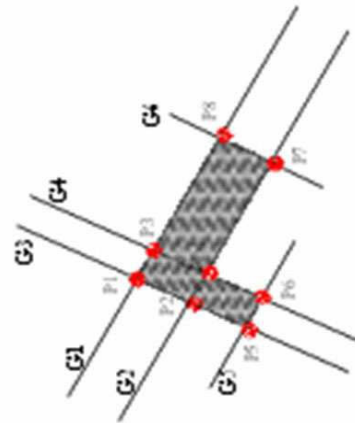


Figure 13. Gun Pattern Analysis

Image analysis process gives us the result of a gun image in 6 lines formation, which will mutually closed and there are intersections at point of p1 until p8, like showed in figure 13. At the intersection of G1 and G3, and also at the intersection of G2 and G4 will form 90 degree angle. Beside that, the formed line length between point P1-P8 and P2-P7 have equal length. This also happened in point between P1-P5 and P3-P6.

Meanwhile, a grenade image will formed 4 lines and 1 ellipse. Those lines formed intersection at point P1, P2, P3, and P4 where formed an equal angle that is  $P1 = P3 > 90$  degree,  $P2 = P4 < 90$  degree. Beside that G1 also touch ellipse at point P5. Those lines also have equal length between G1 and G2, and also G3 and G4 like showed in figure 12.

From the result analysis of figure 12 and 13, we can see that a pistol will have pattern of 2 length square which intersect mutually at the point of P2 and P4, and also form  $\pm 90$  degree angle. Meanwhile, grenade image will form an ellipse and parallelogram which is mutually acquainted at point of P5. This result will be added into the lookup table.

## 6. Conclusion

Edge detection by using ImageTool software in analysis pattern of dangerous object in passenger baggage is able to give the expected result. From this paper we also found fact that ImageTool 3.00 is not better than ImageTool 1.27 especially in edge detection. ImageTool is a very useful open source tools for image analysis because ImageTool can acquire, display, edit, analyze, process, compress, save and print 8 and 16 gray scale and up to 24 bit color images. The one weakness, the ImageTool only run in MS Windows operating system.

By implementing our method, we can see that any ob-

ject, including dangerous objects for flight, can be described with traditional geometry. If the result implement in x-ray scanner machine, then when the machine found object that have a same pattern like in the database it will be detect as dangerous thing, although it is just a plastic toy or made from wood, which is far from dangerous. The scanner machine will give an early warning to the security officer so can increase accuracy in baggage checking. Thus this system can be an "Extra Officer" in airport security system, thus can increase security and comfortable.

In future we hope this system can be better to the fully automatization baggage scanning system by using color based on materials from the scanning object. With new system we hope can accelerate scanning process and can increase accuracy in airport baggage checking.

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