Real time Automatic Object Detection by using Template Matching for Protecting Pipelines

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Abstract— This research aims to design and develop the program that is capable of comparing the aerial photographs taken by drone for the oil pipeline surveying. This survey traditionally required the personnel to drive along the pipeline route and report any activities which might cause the damages to the pipelines back to the company. The survey in this nature will cause the smoke emitted from the car's exhaust pipe that affects the environment and pose a risk to the operating personnel.

The program has been designed and developed to enhance drone's flight capabilities as well as reduce a risk for the personnel in drive surveying and lessen down the working time. This photo comparison system is able to indicate the details of location including the province and district which has been trespassed and capable of alarming such trespassing so that the personnel may verify undertake necessary actions.

The test results suggested that the program can read the coordinate embedded with the video files and able to identify the trespass or the event that pose a potential risk to the pipeline.

Keywords— ***Aerial Image Analysis Software, Image Processing, Template Matching, Pipeline Monitoring***

I. INTRODUCTION

Petroleum transport of Thailand has been developed from transporting by car to transporting by pipeline system with length up to]1] 4,500 kilometers]2[. For safety of pipeline system, it is necessary to have a measure to check deterioration of pipe system in both external and internal sides regularly. Degenerations of the pipe include corrosion, leakage, and misshapen construction materials etc. With technique of UT Intelligent Pigging., the examination can be highly precise and equipment is portable that it can be used to do the test along the pipes conveniently. The working principle of pigging is that it requires high frequency provided that an officer will place UT Intelligent Pigging along the route of oil pipe. Such equipment will float over liquid in the pipe route ad it will inspect deteriorations of internal surface of the pipe for further analysis.

Fig. 1. route of above-ground oil pipe

Oil transport through pipeline system requires both internal and external inspection. The internal part will be examined once in five years by a foreign company. Furthermore, pipe route is also inspected as shown in "fig. 1." to prevent intrusion. Previously, a company that runs a business of oil pipeline system appointed drivers to drive along the pipe route and report activities that may affect underground oil pipe of the company such as soil digging and nearby construction etc. If the officer detects such activity, he/ she will inspect it thoroughly and be ready to solve a problem immediately. Such inspection is not suitable with extremely long pipeline or hardly accessible and unsafe pipeline.

Apart from inspection by using a vehicle, we can also use drone to fly surveying and analyzing images to reduce time and lessen risks of personnel that need to drive a car. However, there has been attempt to check pipe leakage by using acoustic system, employing drone of Amazon Company as well as utilizing drone in processing images such as automatic flying drone, flying survey and target tracking. So, it comes to believe that this technology can be applied with this matter. However, this processing principle has not been used for inspecting safety of oil pipe route. Thus, this project aims to develop image processing system to check such work more effectively.

According to such issue, the concept of exercising Unmanned Aerial Vehicle)UAV(is created to survey oil pipe route instead so that the officers can use video file from a drone in that day to detect suspicious objects that may be hazardous to underground oil pipe. It includes notification to the officers when detecting suspicious objects and indicating

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coordinates of that place. This system enables security officers that work along the pipe to have safety with decreased risks.

This system can display location of certain coordinates and provides notification by identifying coordinates of the place including province and district that is trespassed so that the officer can check by himself.

II. Related Theory and Study

This part will describe leakage check system of underground pipes that are currently used as well as explore major theories for detecting suspicious objects in video image.

A. Leakage check system of underground pipes

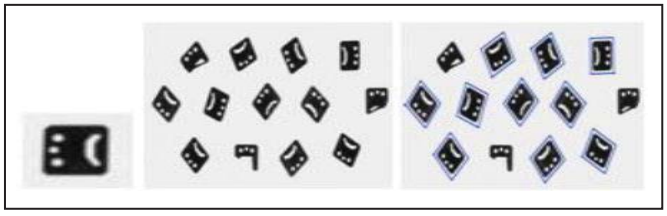
Although transporting petroleum or oil through pipeline is effective, it still requires complex supervision system. This system consists of tank, storage and treatment facilities, transmission line, plants such as natural gas processing facility, oil refinery and chemical plant along with Pump/ Compressor station [3[to increase pressure in transmitting liquid or gas along the pipeline system.

There are a number of studies related to the in-pipe survey such as research that checked leakage of water supply pipe fining numerous leaks]4, 5]. This research monitored and detected leakage of pipe with surface of underground drinking water pipe by implementing acoustic system and proximity sensor which was the employment of sound and vibration of noise during water leaking from the leaked pipe. It also predicted leak magnitude by using on-line artificial neural networks]5[which required noise with frequency of 1 kHz, 5 kHz and 9 kHz as an input for neural model to determine size of leaks. In addition, another work mentioned the gas leakage detection system in pipe by exercising acoustic [6] method in pipes with stable air pressure. When leak emerged, pressure would change instantly causing different friction of gas transmitted along the pipe. The detection system could detect it and it would be considered whether the pipe was leaked.

B. Object detection with template matching technique

There was a research study that used theory of Template Matching to explore objects in image such as finding pin in the image of plug and socket, finding a fruit in an image of assorted vegetables and fruits]7[. This literature presented such technique consisting of

1. Grayscale based Matching that could find Pattern in the image without recognizing direction because when we calculate, we just rotate the direction. With this technique, it can be applied in various works such as computer animation and movement analysis of human as shown in “fig. 2.”



(1) (2) (3)

Fig. 2. (1) Pattern Image (2) Input Image (3) Result of multi-angle matching

2. Edge based matching: this will be calculation of only edge space of object instead of matching with patterns. This process will elicit the edge and do matching from near pixels. This process takes less time than Gray-scale-based Matching.

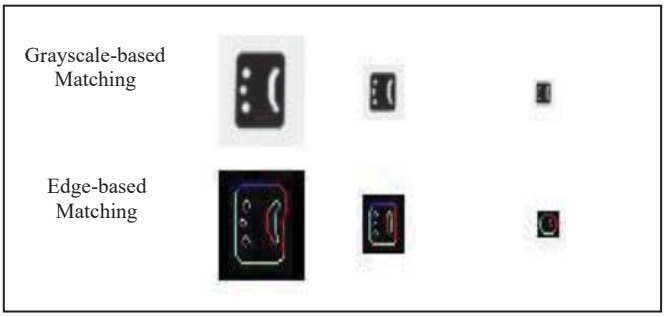


Fig. 3. Grayscale-based Matching and Edge-based Matching

Counting number of house from an image with remote sensing([8[can be done by using high-speed matching algorithm to calculate value on MATLAB program. It was found that Convolution technique and Normalized Cross-Correlation)NCC(technique can detect objects effectively.

Normalized Cross-Correlation (NCC(is a method of simple template matching which evaluates position of a pattern to be presented in function of template T in 2D function I. The template will be scanned thoroughly to generate correlation plane so as to indicate the position of templates that are mostly matched with input image. Highest correlation will indicate position of target object as well Coefficient of NCC will be totally kept in correlation matrix R(x,y) which can be written as follows:

$$R(x,y) = \frac{\sum_{x',y'}(T(x',y')\cdot I(x+x',y+y'))}{\sqrt{\sum_{x',y'} T(x',y')^2 \cdot \sum_{x',y'} I(x+x',y+y')^2}} \quad (1)$$

Additional explanation

)x, y(represents coordinates of input image

)x', y'(represents coordinates of template

Additional explanation: from equation 1, it means the sum of multiplication of every point in image between the input image and template which has been normalized to adjust brightness of both images.

According to the example of previous studies detecting objects with Template Matching this present study employs Normalized Cross-Correlation) NCC(because this technique is popular and the duration of calculation is as close as other methods.

III. Methodology

The overview of all program system of this research is shown in “fig. 4.”

Fig. 4. Overview of suspicious object detection system in oil pipeline

Figure 4 can be explained as follows

1. Reference is video file and text file as data of each video frame collected from drone.

2. Image Processing

2.1 Detection program for suspicious object like a car in 2-minute video shows that each frame of video has width x length of 1920x1080 pixels and template size has width x length of 85x50 pixels with a red frame with size of 300 x 400 pixels moving along the oil pipeline. The position is specified from the middle part of video

2.2 Each frame is processed based on data characteristics from a theory of Template Matching. It learns object appearance and compares with objects inside the frame.

3. It shows Graphical User Interface in a part the system is processing) left(and notification part that will be activated after the system detects a suspicious object and gives coordinates of the place where the suspicious object is found)right(.

The method is that we employ the theory of Template Matching [9[and we implement OpenCV function called matchTemplate to do Image patch in input image. That is to say, it means the image of the car and oil pipeline whether the car exists in the oil pipeline image. In addition, we also apply OpenCV function called minMaxLoc to find the minimum and maximum value along with position in the mage which is stored in array form.

Function

2 images are employed including

1. Template which is an image we need to find in video as shown in “fig. 5.”

Fig. 5. Template

2. Input video is a video image we hope to find as same as the template as shown in “fig. 6.”

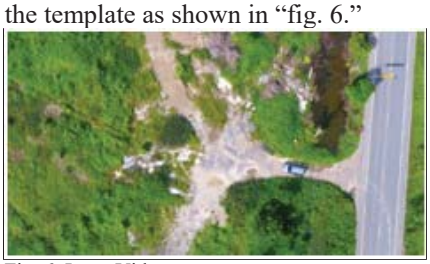


Fig. 6. Input Video

Moving template)car(in a frame from video as shown in “fig. 7.”

Fig. 7. Movement of template in each pixel)from left to right or from high to low(

According to figure 7, in each pixel, when we calculate a matrix, we can see how much matching is consistent.

When calculating image in coordinates (x,y), we will move template in x axis to calculate next points and move it down. Value from each coordinate will be retained in matrix R by using equation formula (1).

When the system detects a suspicious object, it will notify and display coordinates of the lace where the suspicious object is found as shown in “fig. 8.”

Fig. 8 . Notification of coordinates of the place where a suspicious object is detected

IV. EXPERIMENTAL RESULT

Using software for data analysis of still images or motion pictures from the Unmanned Aerial Vehicle (UAV) survey to determine differences, including changes to reference images. They also alerted the authorities when they detected something that could harm the oil pipeline. The results are as follows.

1. The system can store video files.

2. The system can design and develop a program to read video files to determine the coordinates of the map.
3. Image Analysis and Processing System It can detect large objects like cars.
4. The image analysis system can find a marker to replace the position of the oil filament at the appropriate level to create a frame and to determine the breadth of the frame for the search.
5. The system can store image coordinates and display images.
6. The system can display the starting and ending coordinates of the data in the text file and find the shortest time
7. The system can be compared to the database created in Microsoft Office Excel to find the location of each district and each province.
8. Display the date, date, video, height and speed recorded.
9. The system can process one frame at a time. By learning the features of the object. Then compare the objects within the frame.
10. The system can record coordinates. Data capture and coordinates, and display the program page

By use an equipment and instruments as follows:
1. Microsoft Visual Studio 2013 Program
2. Language C++/C#/OpenCV
3. Microsoft Office Excel 2013 program
4. DJI Phantom 4 Pro drone
   4.1 Flying at 70-meter altitude
   4.2 Specifying the suspicious object as a car
   4.3 200-meter Flying distance
   4.4 Stable speed at 1.4 meter/ second
5 . Image processing is used by implementing a theory of template matching

currently, images are mainly employed in comparison but a program that can compare video image from high angle has not been available. this video image comparison program can detect a large-scale object that may be hazardous to underground oil pipeline such as cars; however, the work scope is still limited because the obtained video images are just the cars that the program can detect. in addition, flying speed is relatively slow that needs to be further developed.

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