THE DROPLET MEASUREMENT APPLICATION SOFTWARE OF JET PULSE SYSTEM PORTABLE FOGGING MACHINE USING IMAGE PROCESSING

SOFTWARE APLIKASI PENGUKURAN TETES (DROPLET) MESIN PENGASAP JINJING SISTEM PULSA JET DENGAN MENGGUNAKAN IMAGE PROCESSING

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ABSTRACT

Jet pulse system portable fogging machine is used to control pest, vector, damaging micro organism and unpleasant odor. The machine produces and sprays out fog. One of the fogging machine testing parameters is droplet size accuracy level testing complying with SNI-05-7190-2006. At the moment, the droplet measurement is done by manual estimation using scaled microscope, but this method is not effective. Therefore, a new method is needed to support the testing effectively and efficiently. As a result, application software to measure droplet diameter of the fogging machine is made. The droplet diameter measurement result has been tested and it is certain that the result is close to the values of manual estimation. Therefore, the software can also be used to support the conduction of fogging machine testing.

Keywords: fogging machine, SNI-05-7190-2006, droplet, testing

ABSTRAK


Kata kunci: mesin pengasap, SNI-05-7190-2006, droplet, pengujian

1. INTRODUCTION

In order to be recognized nationally and internationally, Testing Laboratory, Testing Technology Division, Research Center for Quality System and Testing Technology, LIPI, must have both electrical/electrochemical and non-electrical/electrochemical based products testing equipment in accordance with the standard requirements. The requirements of IEC, ISO, CISPR, and SNI standards with their derivatives have to be fulfilled so that the tested products are safe to be used and not hazardous both to the operators and users and also in order to optimize the performances of those products.

Fogging machine is one of the products/equipments to be tested in the testing laboratory. To supervise and to maintain the performance of jet pulse system fogging machine sold in the market, the testing is conducted to design an automatic droplet measurement testing system based on SNI 05-7190-2006. This measurement method is not existed yet in Indonesia. At the moment, the droplet measurement is carried out by manual estimation using scaled microscope.

Droplet size is the diameter of insecticide fluid particles on silicon layered glass slide. The fogging machine droplets have to be in the size required by the SNI-05-7190-2006 which
is 8–20 micron so that the material would form perfect fog and also to maintain the efficiency of materials used in the jet pulse fogging machine and to exterminate pests effectively.\(^1\)

The purpose of the research is to design an automatic jet pulse system fogging machine droplet measurement. The software would be able to support the conduction of jet pulse system fogging machine testing.

## 2. THEORY

Fogging machine produces and sprays out fog to control pest, vector, damaging micro organism and unpleasant odor. This portable machine consists of formulation tank contains solar mixed with insecticide, flow controller, fuel tank, carburetor, expansion chamber, exhaust nozzle, sparking plug, batteries and coil. The portable fogging machine testing based on SNI-05-7190-2006 is conducted using the following supporting equipment:

- Portable fogging machine
- Metal box with dimension 0.5m × 0.5m × 0.5m, opened at one side
- Silicon layered glass slide with dimension 2.5 × 7.5 cm

In the fogging machine testing, the image of droplets on the glass slide would be taken using digital microscope. Generally, the droplet diameter is manually measured using human visual ability, but it is not efficient\(^3\) because it is conducted by estimating the droplet diameter compared to the determined scale for each droplet. This method is not effective due to the limitation of human visual ability. To overcome such shortage, this research proposes an automatic measurement of the droplet diameter.

The research uses a laptop with specification Pentium Dual Core CPU T4400 2.20 GHz RAM 2GB and Windows 7 32-bit operating system, VGA Nvidia GeForce 512MB. This research is also conducted using several software i.e. OpenCV as library, C++ as programming language and Qt Creator to make graphical user interface. The details for each software are as follow.

### 2.1 QT Creator

Qt Creator is a complete integrated development environment to create an application with Qt application work frame. Qt is designed to develop the application and user interface and deploy it to several desktops and mobile operating systems.\(^3\)

One of the main advantages of Qt Creator is that it allows developer team to share a project through different platforms development (Microsoft Windows, Mac OS X, and Linux), since t-Project is a cross-platform application.

### 2.2 OpenCV

OpenCV is an open source application and used as a library algorithm. It was designed to be efficient for computational use with strong focus on real time application. OpenCV has the interfaces of C, C++, Phyton, and Java. It supports Windows, Linux, Mac OS, iOS and Android operating systems.\(^4,5,6,7\) The OpenCV data location needs to be defined on the program that would be designed.

## 3. METHODOLOGY

In this research, fogging machine droplet diameter measurement algorithm is developed using image processing. C++ programming language and edge detector or optimal detector canny algorithm are used.

There are three criteria relevant to edge detector performance as explained by Canny:\(^8\)

- **Low error rate**: good detector for real edge to minimize error rate.
- **Good localization**: the distance between detected edge pixels and the real edge pixels could be minimized.
- **Minimal response**: only one detector response for a single edge.

Figure 1 is droplet image on silicon layered glass slide with black background taken by digital microscope. On the image, a scale bar (white bar) with certain value is added. The data are used to convert the number of pixels from the measured image into the real length (diameter).
The image processing starts by inputting the droplet image taken by digital microscope. The next process is to copy the image to be converted into grayscale form. Next, the image is smoothed to reduce or to filter the noise within the image using Gaussian filter. The next process is the application of canny edge detector algorithm. The flow chart of the image processing is shown on Figure 2.

The next process is threshold arrangement to clarify which spot is edge and which is not. Once the spot is clarified, the spot of the image which is intended to be measured is determined. The determination is carried out by minimum circle covering all previously detected contours (edge). The diameter of the circle is then measured.

Outlined, the software algorithm starts by image processing. The droplet diameter is further measured using the value obtained from pixel value measurement of the determined scale as shown in Figure 3.

\[
d_{\text{real}} = \frac{d_{\text{scale(real)}} \times d_{\text{pixel}}}{d_{\text{scale(pixel)}}}
\]  

where:
- \(d_{\text{scale(real)}}\) = real scale length (mm)
- \(d_{\text{scale(pixel)}}\) = multiplier constant (in software display) = scale length (pixel)
- \(d_{\text{real}}\) = real droplet diameter (mm)
- \(d_{\text{pixel}}\) = droplet diameter (pixel)
- \(r\) = radius
4. RESULT AND DISCUSSION

The software is designed using Qt Creator and C++ programming language and OpenCV as the library.

On the fogging machine testing, the image of droplets on glass slide is taken by digital microscope. In this research, two different images of the sample are used to prove the effectiveness of the software. Two image samples are then input to be processed using the program. The image processing starts by converting the image into grayscale form, as shown in Figure 4.

![Figure 4. Image Display](image1)

![Figure 5. Sample 1 Image Display with Canny Algorithm](image2)

To reduce noise, the image is then smoothed. Afterward, canny algorithm is applied to detect the image edge as shown in Figure 5. The spot is cleared to define the edge; those without edge will be deleted. The process is done by setting the threshold on the software. A minimum circle covering all the detected contours (edge) is then made by checking “find spot”. The radius of each circle (in pixel) is obtained.

The diameter of the scale is the biggest pixel among the circles, so it is determined as multiplier constant. The diameter for each image will be measured using this multiplier constant. The real droplet diameter is calculated using formula 1.

![Figure 6. Image Droplet Diameter Measurement Result](image3)

For calculation, take one droplet as an example (from figure 6 take 6th circle) to measure the diameter.

From the image (Figure 6) we get:

- The real scale length = \( d_{\text{real}} = 0.1 \) mm
- Multiplier constant = \( d_{\text{pixel}} = 34 \) which mean 340 for 1 mm real scale length
- \( d_{\text{pixel}} \) of circle 6 (6th droplet) = 3.64

so that, the real droplet diameter is

\[
d_{\text{real}} = \frac{(1 \times 3.64)}{340} = 0.0107 \text{ mm}
\]

The calculation for other droplets is carried out using the same process.

![Figure 7. Sample 2 Image Display with Canny Algorithm](image4)
Figure 8. Sample 2 Measurement Result

Therefore, the measuring scale is not included in the next image processing because the multiplier constant has been obtained for the calculations, as shown in Figure 7 and Figure 8.

Table 1 below shows the measurement of droplet diameter both by manual estimation and by image processing for sample 1 and 2.

As shown in Table 1, the measured droplet diameter by image processing for sample 1 ranges between 5.5 micron to 36 micron (one droplet is above 21 micron), while that of sample 2 ranges between 2.9 micron to 18.8 micron. Table 1 also shows droplet diameter by manual estimation. The manual estimation is conducted by pointing the mouse to both ends of the droplet image on the application software of digital microscope and also by comparing the size of each droplet to the size of the scale. Figure 9 and 10 show the graph of droplet diameter both measured manually and by image processing.

As shown at Figure 9 and 10, if the result of the graph by manual processing is compared to the result by image processing, it can be said that it is certain that the result by image processing is close to the values of manual estimation.

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6. ACKNOWLEDGEMENT

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REFERENCES


