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# Parameters Monitoring Automation Kiln Manufacture Based Optical Character Recognition (OCR) with The Template Matching Method

**Agustia Hananto[1*], Titik Khawa Abdul Rahman[2], Goenawan Brotosaputro[3], Ahmad Fauzi[4], April Lia Hananto[5], Bayu Priyatna[6]**

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**Abstract**: One of the pieces of equipment used in the combustion-based process of creating ceramic tiles is a kiln production machine or oven. To make sure the combustion process runs smoothly, 39 parameters on the kiln engine are closely monitored, and it is manually determined if the value of these parameters exceeds the minimum or maximum limits based on the data produced by the image on the kiln engine. Losses for the company are caused by human error, carelessness, and other characteristics while these metrics are being monitored. In order to minimize losses, a monitoring system that can automate the settings of ceramic tile combustion engines is required. The initial analysis's findings are obtained using a LAN (Local Area Network) sensor recorder, which displays parameter data that can be accessed as an image rather than as digital alphanumeric data that cannot be processed directly and must instead be converted into alphanumeric data as a data source. The image is turned into alphanumeric data using the template matching technique introduced with optical character recognition (OCR), and the generated data is then compared with the given minimum or maximum parameter values. This gadget will issue an early warning message if the conversion result is more than the minimum or maximum limit. The system prototype used in this study for converting image data into alphanumeric data achieved an accuracy of 100.00% and was able to send early warning notifications in accordance with parameters that were above the established minimum or maximum limits.

***Keyword:*** *Digital Image, Optical Character Recognition, Kiln Manufacturing, Early warning*

## 1 Introduction

The top producer of glazed ceramic tiles (and related items) is PT. XYZ. It burns up to a temperature of 1100 degrees Celsius in the kiln manufacturing machine or oven during one of the production steps to create high-quality, long-lasting ceramic tiles. A furnace, usually referred to as a kiln machine, is a device used for heating [1]. Its name is derived from the Latin fornax, which is also used to refer to a kiln. In a manufacturing facility, a kiln is a heating device that is installed or constructed to work with specific fuels[2].

Sensor data will be displayed as an image on a screen during the monitoring of the kiln producing machine (oven). This image will be refreshed every 5 seconds and must be watched at all times. The image shown on the oven machine screen will then be manually recorded and really needs to be watched closely. However, the monitoring results are significantly influenced by human endurance and physical condition[3], [4]. The kiln manufacturing machine (oven) only displays 39 parameter values on a screen in the form of an image that will be updated every 5 seconds, the data is stored in a small capacity recording machine, and the alphanumeric data cannot be accessed, according to the preliminary analysis of these issues. and cannot send alerts automatically if these parameters surpass the preset minimum and maximum ranges. To solve this issue, it is hoped that a system or tool can be developed that can turn an image into alphanumeric data that can provide real-time information (monitoring automation) and early warning, as well as the ability to read the data again and store it in a database for later viewing.

Researchers suggest adopting digital photos or image processing technologies as a solution to these issues. Image processing, according to Andono et al.[1], is a technique for converting photos into digital files for a particular use. OCR is a study of digital image processing that involves character recognition through preprocessing, segmentation, feature extraction, and recognition [4]–[6]. A topic of research in pattern recognition in digital images, optical character recognition (OCR) categorizes or defines an object based on quantitative measurements of its primary properties (characteristics)[7], [8]. In the meantime, according to Putra (2010), this is accomplished by comparing the input image with the preexisting image template and employing the Template Matching Correlation technique, which is a digital image processing technique

*[1,2]Information and Communication Technology, Asia E University, Malaysia*
*[1,4,5,6]Faculty of Computer Science, Universitas Buana Perjuangan Karawang, Indonesia*
*[3] Faculty of Information Technology, Universitas Budi Luhur, Indonesia*
*[1] agustia.hananto@ubpkarawang.ac.id, [1] C70109220002@aeu.edu.my, [2]titik.khawa@aeu.edu.my, [3]goenawan.brotosaputro@budiluhur.ac.id, [4]aprilia@ubpkarawang.ac.id, [5]afauzi@ubpkarawang.ac.id, [6]bayu.priyatna@ubpkarawang.ac.id.*

that works to match each part of an image with the template or reference image [9]. then employ certain rules to search for commonalities in the database.

With this research, it is expected to provide a solution to PT. XYZ so that the problems that exist in the kiln manufacturing machine (oven) can be resolved. Using this technique, images can be accessed via a LAN, optical character recognition (OCR) is performed, and images can then be converted into data in alphanumeric form as needed and stored in a database so that the system can determine if the data meets the required limit[8]. the system will issue an early alert once the value reaches the defined minimum and maximum. It is anticipated that the program will be able to give consumers information fast and accurately with this early warning [10]–[12]. The monitoring automation process functions effectively thanks to this application. Monitoring automation is a procedure or procedure for running a machine or an automated work procedure in the monitoring process in identifying and/or measuring the impact of work generated to anticipate problems that arise and/or will arise for action to be taken as early as possible by utilizing materials and resources efficiently[13], [14].

## 2 Methodology

This study applies the Optical Character Recognition (OCR) method to identify abnormalities in the kiln engine combustion process. Based on problem identification through field observations, literature studies and interviews, namely during the combustion process in kiln engines production failures often occur due to delays in anticipating abnormal conditions in the combustion process. With these problems in mind, an application system was created using the template matching-based Optical Character Recognition (OCR) method to convert image data into alphanumeric data, which then the conversion results become the basis for identification if it exceeds the minimum and maximum limits on the kiln machine.

In Figure 1 below, can be seen the flowchart of the research method.

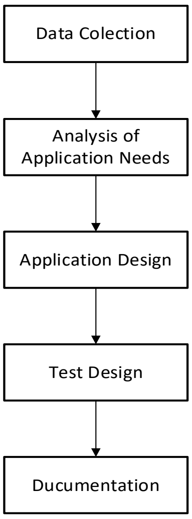



**Fig. 1** Research Flowchart Block

From the figure can be described as follows

### 2.1 Data Collection

Through observation and interviews with experts at PT. XYZ obtained data that will be carried out by research including recorders that can be accessed via LAN which are displayed with a web browser which will be captured periodically and converted using OCR, then the results of the conversion are compared with the parameters obtained from experts as a basis for identifying these parameters beyond the minimum limit and maximum. The identification results will be entered into the system database to be used as documentation and notification if a parameter exceeds the minimum and maximum limits.

### 2.2 Analysis of Application Needs

The application requirements analysis will explain the need to build an abnormal detection application system for monitoring kiln machines which includes hardware analysis, software analysis and method analysis.

A. Hardware Analysis

To create an application device that can run the OCR process, the following hardware is needed

1. Tinker Board S quad-core ARM-based CPU (Rockchip RK3288) 2GB.

2. Server Dell T40 Xeon E-2224G 8GB ITB Sata Power Edge.

3. Switch 8 Port.

4. Lan Cables and Accessories.

B. Software Analysis

In integrating all of these hardware components, software is needed, including:

1. Linux UBuntu 20.04
2. My Sql
3. Python 3.7.1
4. Tesseract OCR

C. Method Analysis

In this research, conversion processing from image to alphanumeric data uses OCR-based template matching method.

### 2.3 Application Design

A. Prototype Architecture Design

Figure 2 illustrates the automation prototype architecture for parameter monitoring in the kiln manufacture process to improve machine monitoring intensively.

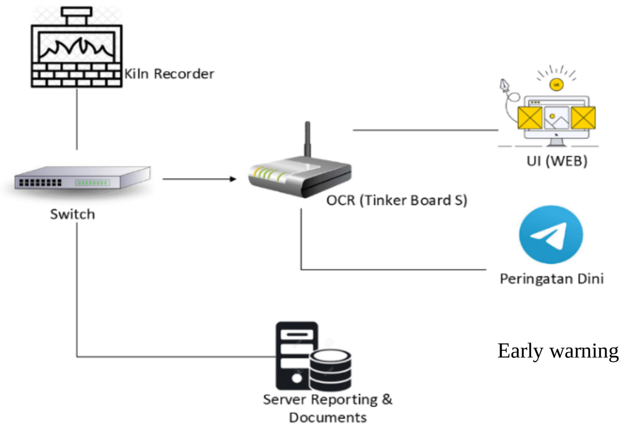



**Fig. 2** Prototype Architecture

From the figure it is explained that the recorder on the kiln machine is connected via a LAN switch, which is then processed by the OCR processing application on the tinker boards. In this process, the configuration of the input data and knowing the results of the image processing can be seen through the web browser interface and if the parameter exceeds the minimum and maximum limits it is sent to those concerned through an early warning system. All processing results carried out by tinker boards will be copied to a separate server for reporting and documentation processes. This is due to the limited storage capacity of the tinker boards.

B. Process Design

Process steps for the kiln machine abnormal detection system can be seen in Figure 3.

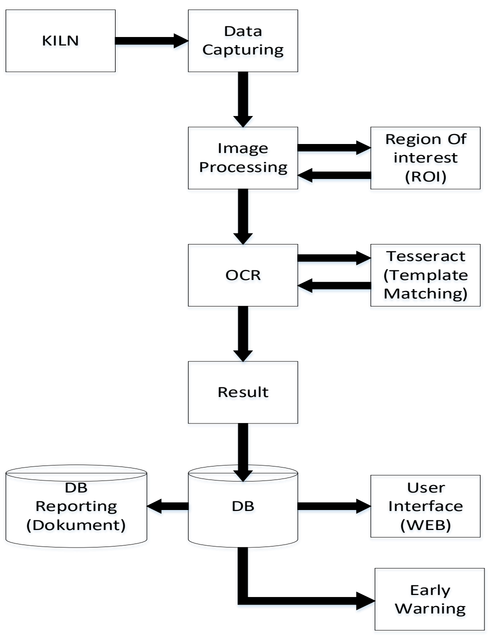



**Fig. 3** Design of the kiln machine abnormal detection system.

In the picture can be described as follows:

1. Sensor data stored in the kiln machine recorder can be accessed via the LAN in the form of images which are then captured (data capturing).
2. The image will be processed to obtain a region of interest (ROI) by means of gray scaling, binarization and crop and resizing for segmentation.
3. In the OCR system, data matching is carried out using Tesseract software which was previously trained using template matching. So, we get alphanumeric data in digital form.
4. The match results are stored in the OCR application database which can then be viewed or accessed through the user interface using a web browser.
5. At the time of processing the data, there is a parameter condition that exceeds the minimum and maximum limits, an early warning notification will be sent.
6. The data base on the OCR application will be automatically copied and stored in the database server as a backup or historical reporting.

In Figure 4 below, are the steps in creating a prototype OCR data processing application:

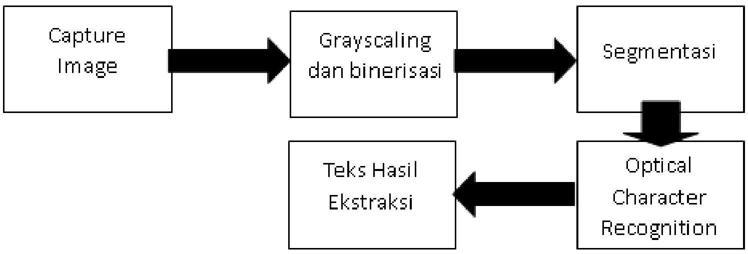



**Fig. 4** System Workflow

### 2.4 Test Design

Later, parameters or standards will be contained in the test results for the kiln machine abnormal detection application. These parameters are divided into two categories: those that cause OCR to convert image data into alphanumeric data and the requirement that they exceed the minimum and maximum values set out in the burning process.

The outcomes of this procedure will serve as the foundation for estimating the value that will be produced. To determine how accurate these predictions are, the outcomes of these factors are assessed and validated using a confusion matrix made up of accuracy, precision, and recall. The Confusion Matrix Table is shown in Table 1.

**Table 1** Table Confusion Matrix

| | | **True Value** | |
|---|---|---|---|
| | | **TRUE** | **FALSE** |
| **Predictive Value** | **TRUE** | TP *(True Positive)* *Corect Result* | FP *(False Positive)* *Unexpected Result* |
| | **FALSE** | FN *(False Negative)* *Missing Result* | TN *(True Negative)* *Corect Absence Of Result* |

so, in formulas 1, 2 and 3, can be seen Formula Precision, Recall and Accuracy

$$\text{Precision} = \frac{TP}{TP+FP} \quad (1)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (2)$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (3)$$

## 3 Results and Discussion

### 3.1 Preparation of Training Data and Test Data

In this study, 100 image data from the kiln machine were prepared for training data and test data in .png format. In addition, minimum and maximum value parameters are also prepared to determine the lower and upper thresholds for normal temperature conditions in the combustion process. An example of a kiln machine image capture can be seen in Figure 5 below,

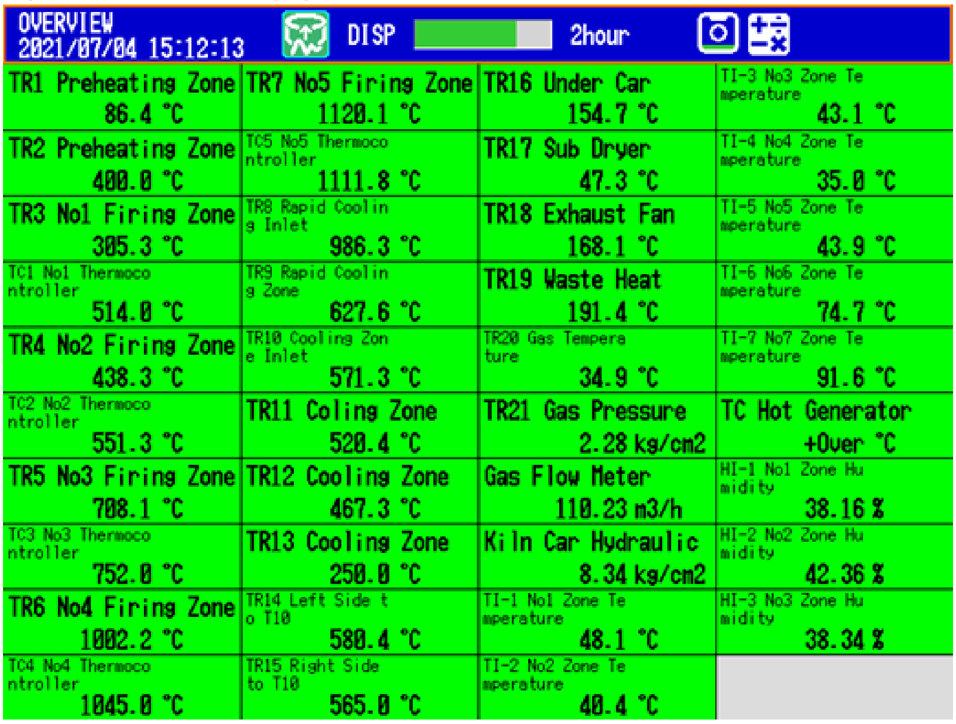



**Fig. 5.** Capture images from a kiln machine.

Figure 5 is the result of a web capture in.png form, which will later be converted into alphanumeric data. According to the reference set for each running product, the figure represents 39 parameters that must be closely monitored for a full 24 hours to ensure the process is operating as intended. These variables were determined by readings from sensors located at specific locations within the ceramic combustion engine. The sensor's readings of temperature, gas pressure, and air humidity are the data. In the writing of 39 parameters, 10 parameters were taken as samples for testing the conversion of images into alphanumeric data using OCR based on template matching. See table 2 below for more information.

**Table 2.** Description of the sample parameters for the OCR conversion process.

| NO | Parameter | Description |
|---|---|---|
| 1 | TR1 | Preheating Zone, the first portion or zone of the product Degrees Celsius (oC) are used as the units. |
| 2 | TR3 | Firing zone No. 1 is a high-temperature compaction (pressure) process that modifies the microstructure. Degrees Celsius (oC) are used as the units. |
| 3 | TC2 | Is firing zone no. 3 before thermocontroller parameter no. 2? oC, or degrees Celsius, is the unit. |
| 4 | TC3 | The temperature in the area prior to firing zone no. 4 is monitored using thermometer no. 3 during the combustion process. oC, or degrees Celsius, is the unit. |
| 5 | TR14 | Should the temperature be lowered before entering the sub-drier in cooling zone number three? Degrees Celsius (oC) are used as the |

| | | |
|---|---|---|
| | | units. |
| 6 | TR17 | area where the product is dried after cooling (sub-dryer). Degrees Celsius (oC) are used as the units. |
| 7 | KCH | The hydraulic pressure used to drive the conveyor while the machine is in operation is known as a hydraulic kiln car. The unit is kg/cm2. |
| 8 | TI3 | The temperature of the product that exits the machine after drying is measured using zone temperature no. 3. Degrees Celsius (oC) are used as the units. |
| 9 | TI7 | The temperature of the product that exits the machine after drying is measured using zone temperature no. 7. Degrees Celsius (oC) are used as the units. |
| 10 | HI3 | Zone No. 3 of the kiln machine's air humidity was measured (zone humidity). |

Meanwhile, to make early warning notifications, reference data is needed for minimum, maximum parameter values and references for each parameter which will later be compared with the conversion results from the OCR application. Each task or type of tile that is currently running or in the burning process has different minimum, maximum and reference parameter values for each task or type of tile that is in the process of burning. Of the several types of tasks, the author took samples of the rooftile Type A and MAROON 100918 tasks. The parameter values for these tasks can be seen in Table 3 below.

**Table 3** Minimum and maximum parameter threshold values.

| NO | Tasks (Type / type of tile that is burned) | Parameter | Minimum | Reference | Maximum |
|---|---|---|---|---|---|
| 1 | Genteng Type A | TR1 | 160 | 170 | 180 |
| 2 | Genteng Type A | TR3 | 475 | 485 | 495 |
| 3 | Genteng Type A | TC2 | 540 | 560 | 580 |
| 4 | Genteng Type A | TC3 | 700 | 720 | 740 |
| 5 | Genteng Type A | TR14 | 570 | 590 | 610 |
| 6 | Genteng Type A | TR17 | 40 | 75 | 110 |
| 7 | Genteng Type A | KCH | 0.00 | 5.00 | 10.00 |
| 8 | Genteng Type A | TI3 | 40 | 55 | 70 |
| 9 | Genteng Type A | TI7 | 90 | 110 | 130 |
| 10 | Genteng Type A | HI3 | 25 | 37 | 50 |
| 11 | MAROON 100918 | TR1 | 150 | 160 | 170 |
| 12 | MAROON 100918 | TR3 | 460 | 470 | 480 |
| 13 | MAROON 100918 | TC2 | 550 | 560 | 570 |
| 14 | MAROON 100918 | TC3 | 710 | 720 | 730 |
| 15 | MAROON 100918 | TR14 | 575 | 585 | 605 |
| 16 | MAROON 100918 | TR17 | 30 | 40 | 50 |
| 17 | MAROON 100918 | KCH | 0.00 | 5.00 | 10.00 |

| | | | | | |
|---|---|---|---|---|---|
| 18 | MAROON 100918 | TI3 | 40 | 55 | 70 |
| 19 | MAROON 100918 | TI7 | 90 | 110 | 130 |
| 20 | MAROON 100918 | HI3 | 25 | 37 | 50 |

Table 3 contains the parameter values of the rooftile Type A and MAROON 100918 tasks which we took as a sample of 10 parameters e out of a total of 39 parameters which are the reference used as the minimum and maximum thresholds, if the data from the OCR conversion results exceeds the minimum or maximum values it will used as the basis or data to send early warning notifications.

### 3.2 Modeling

The prototype is broken down into three pieces for this study. The first involves using a Tinker Board S with a quad-core ARM-based CPU (Rock chip RK3288), a unique 1.8 ARM-based GPU (Mali-T760 MP4), 2 GB of RAM, and 16 GB of internal storage to process OCR data. In Figure 6, you can see the prototype form.

**Fig. 6**. Kiln Machine OCR Prototype

In the tinker board device to support OCR applications, the author installs several software including

1. OS linux Armbian 21.05.4 Focal
2. Nginx
3. Python 3
4. PHP dan MySql
5. Tesseract-OCR
6. Pytesseract

Second, using the Oracle VM VirtualBox prototype made in the form of a dummy or imitation that represents the machine to display an image of the kiln machine, the display can be seen in Figure 7 below.

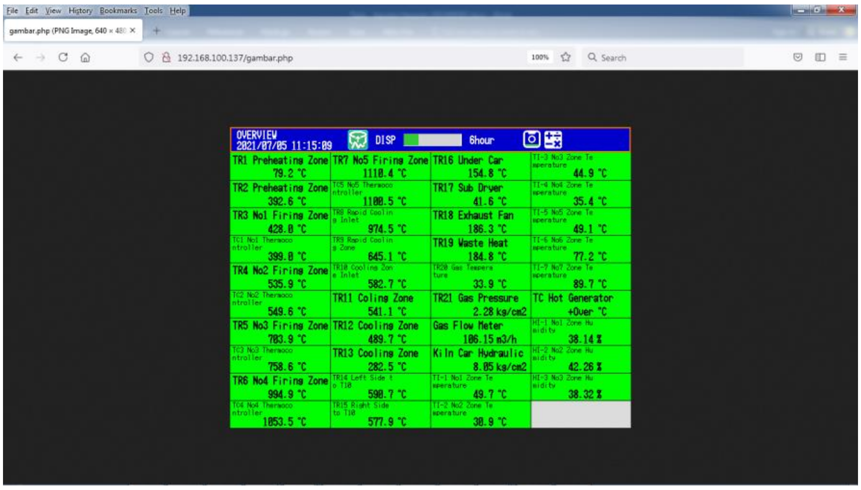



**Fig 7**. Typical Display of Kiln Machines

In the dummy image of the kiln machine to support displaying image test data, the author installs several software including them

1. OS linux Ubuntu 20.4 focal
2. Nginx
3. PHP and MySQL

Likewise, the third prototype using Oracle VM VirtualBox to represent the OCR application server and documentation server. The OCR application reporting display can be seen in Figure 8 below.

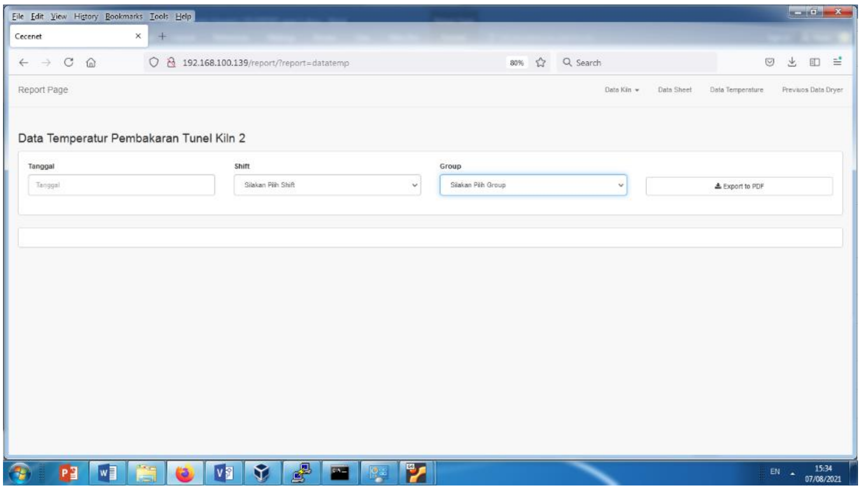



**Fig. 8.** Documentation and Reporting Interface.

In the prototype server to support the documentation and reporting process, the author installs some of the software

1. OS linux Ubuntu 20.4 focal
2. Nginx
3. PHP and MySQL

**A. Capture Image**

The image to be processed is obtained through a web capture process via a dummy ip address of the kiln machine, which later the image will have a png format with a size of 640 X 480 pixels as shown in Figure 7 above:

**B. Gray scaling and Binarization**

The image obtained will be converted to grayscale which is then binarized before segmentation. An overview of the grayscale conversion results can be seen in Figure 9 and Figure 10 is the result of binarization.

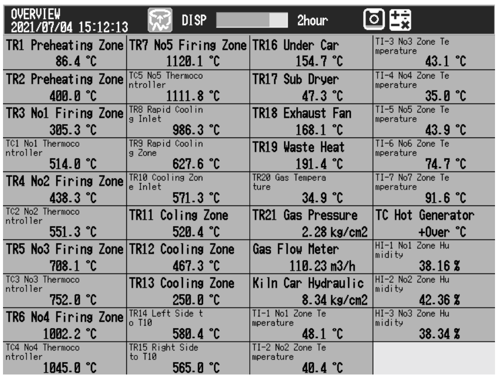



**Fig. 9.** Gray scaling Image


**Fig.** 10. Binarization image Image

### C. Segmentation

The segmentation process on the resulting binary conversion image is carried out to determine the parameters needed in the recognition process so that accurate data can be obtained. An example of segmentation results can be seen in Figure 11 below.

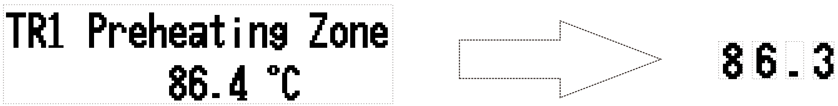


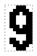

**Fig. 11**. Segmentation for TR1 parameter values

### D. Character Recognition

Tesseract OCR software, which runs on Python 3.7, was used to develop the OCR system to recognize converted and segmented binary pictures. After previously training the character templates, Tesseract OCR will identify each character from the segmentation results on the image. In order to obtain accurate detection results, a template is created as a source path as shown in Table 4 below. The process of recognizing the character of the kiln machine image against the template uses four parameters when it is initialized, namely data path, language, mode, and white list (Nunamaker et al., 2016).

**Table 4.** Implementation of the Tesseract OCR Template

| No | Segmentation Result Image | Template | Character |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 1 | 1 | 1 |
| 3 | 2 | 2 | 2 |
| 4 | 3 | 3 | 3 |
| 5 | 4 | 4 | 4 |
| 6 | 5 | 5 | 5 |
| 7 | 6 | 6 | 6 |
| 8 | 7 | 7 | 7 |
| 9 | 8 | 8 | 8 |

| | | | |
|---|---|---|---|
| 10 |  |  | 9 |
| 11 |  |  | . |

To facilitate reading in the introduction of parameters in the program language, parameter id and pixel coordinate points are determined to read the results of binarization and segmentation as listed in table 5 below.

**Table 5.** Parameter Id Table and pixel coordinates.

| No | Parameter | ID Parameter | Pixel Coordinate Point | | | |
|---|---|---|---|---|---|---|
| | | | x1 | y1 | x2 | y2 |
| 1 | TR1 | 1 | 50 | 105 | 64 | 84 |
| 2 | TR3 | 3 | 50 | 105 | 152 | 172 |
| 3 | TC2 | 6 | 50 | 105 | 284 | 304 |
| 4 | TC3 | 8 | 50 | 105 | 372 | 392 |
| 5 | TR14 | 19 | 210 | 265 | 416 | 436 |
| 6 | TR17 | 23 | 370 | 424 | 108 | 128 |
| 7 | KCH | 29 | 368 | 422 | 372 | 392 |
| 8 | TI3 | 32 | 530 | 585 | 64 | 84 |
| 9 | TI7 | 36 | 530 | 585 | 240 | 260 |
| 10 | HI3 | 40 | 530 | 585 | 416 | 436 |

## E. Implementation

Implementation of tesseract OCR for reading kiln machine data in the form of a website-based model by acquiring images on a mock display of kiln machines using web capture that reads local area network Ip. In Figure 12 below you can see the menu for the image reader data that comes from a mock kiln machine display

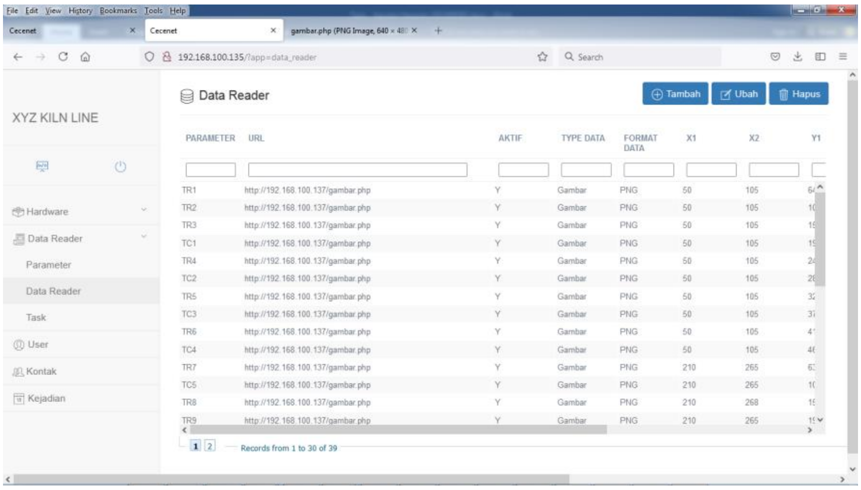



**Fig. 12**. Display of Data Reader Parameter Settings.

To input the minimum maximum parameter reference value, and the parameter reference that has been determined according to the product / task that is currently running can be seen in Figure 13 below

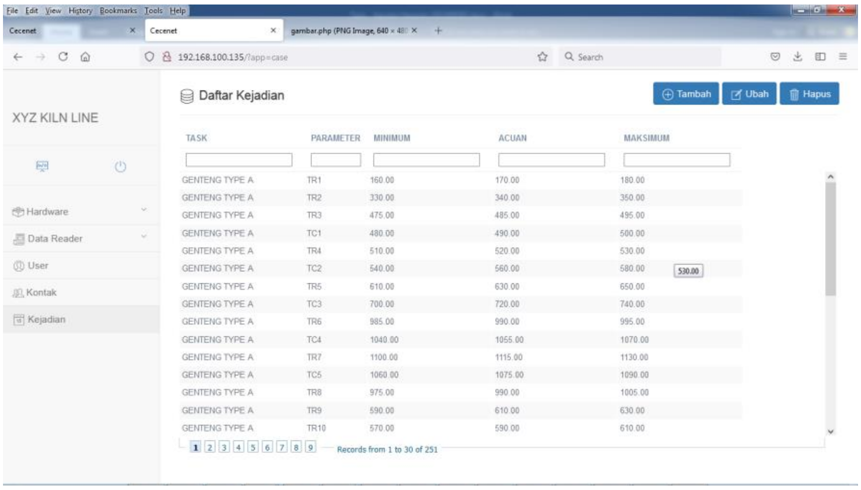



**Fig. 13**. Display of Reference Settings, Maximum and Minimum parameters.

After the parameters, upper and lower threshold references and notification recipients have been set, the OCR application on this prototype can be run by determining what products will run, setting time intervals (seconds) and starting time for recognition and recording of kiln machine data as can be seen in Figure 14 below.

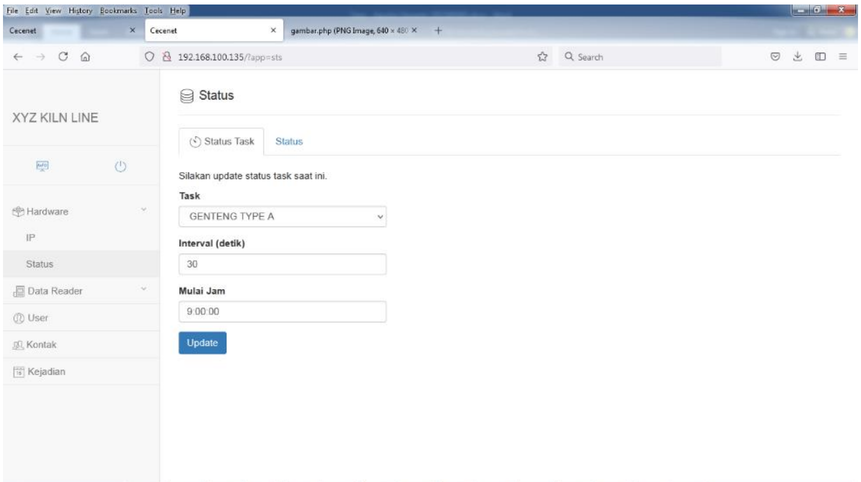



**Fig. 14**. Display of Product Settings Before the System Runs.

When the OCR recording status is already running, the results of the OCR system are automatically entered into the data base to be stored and can be processed according to the needs of stakeholders. The conversion results can be seen in access yyyymmdd.log as shown in Figure 15. below:

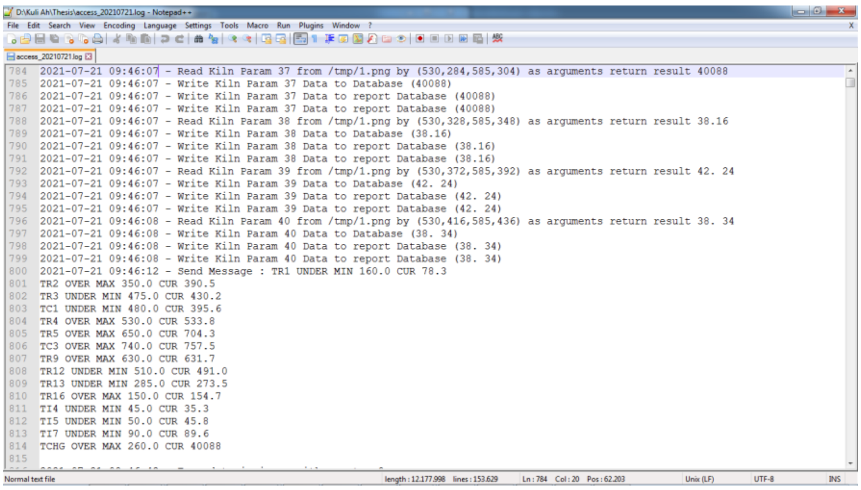



**Fig. 15.** OCR System Conversion Result Log

For monitoring the parameters in the combustion process in the kiln engine can be seen in Figure 16 below.

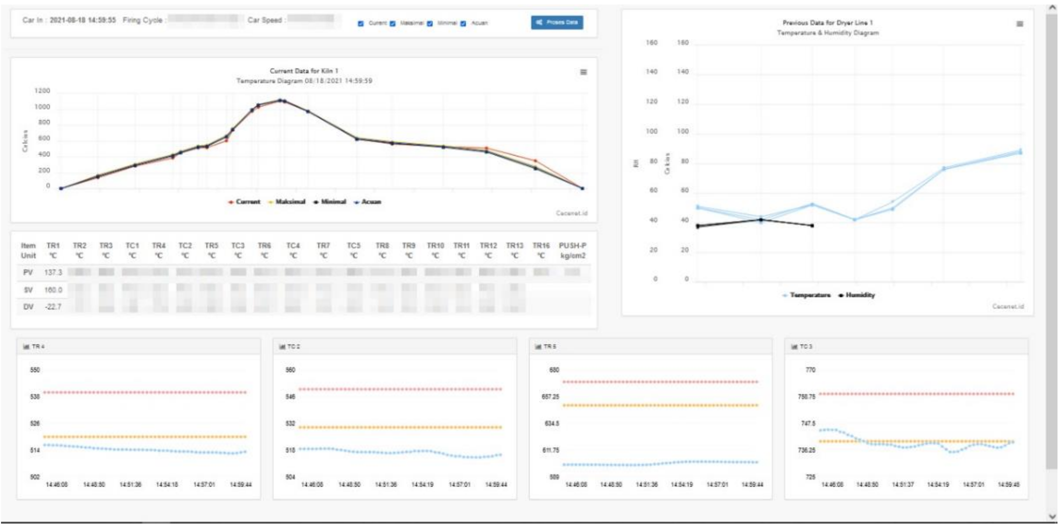


**Fig. 16.** Graphical image for parameter monitoring.

If it passes the minimum or maximum threshold, stakeholders will receive a telegram notification as shown in Figure 17. below.


**Fig. 17**. Telegram Notifications

### 3.3 Research Results on the Application of OCR

The results of the prototype model research on the MAROON 100918 product and Type A tile obtained the results of data conversion using ocr on the kiln machine of PT. XYZ can be seen from table 6 for Type Adan tile products, table 7 for the MAROON 100918 product below:

**Table 6.** OCR conversion results for Type A tile products

| No | Image | TR1 | | TR3 | | TC2 | | TC3 | | TR14 | | TR17 | | KCH | | TI3 | | TI7 | | HI3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil |
| 1 | 104223 | 78.2 | 78.2 | 429.1 | 429.1 | 547.9 | 547.9 | 753.8 | 753.8 | 595.5 | 595.5 | 41.6 | 41.6 | 0.52 | 0.52 | 44.7 | 44.7 | 89.3 | 89.3 | 38.32 | 38.32 |
| 2 | 104323 | 78.3 | 78.3 | 430.2 | 430.2 | 549.3 | 549.3 | 757.5 | 757.5 | 595.6 | 595.6 | 41.6 | 41.6 | 0.36 | 0.36 | 45.3 | 45.3 | 89.6 | 89.6 | 38.32 | 38.32 |
| 3 | 104423 | 78.5 | 78.5 | 430.2 | 430.2 | 550.3 | 550.3 | 763.9 | 763.9 | 595.4 | 595.4 | 41.5 | 41.5 | 8.18 | 8.18 | 45.7 | 45.7 | 89.7 | 89.7 | 38.30 | 38.30 |
| 4 | 104526 | 78.5 | 78.5 | 428.9 | 428.9 | 550.8 | 550.8 | 769.3 | 769.3 | 595.4 | 595.4 | 41.5 | 41.5 | 8.55 | 8.55 | 44.8 | 44.8 | 89.4 | 89.4 | 38.32 | 38.32 |
| 5 | 104628 | 78.6 | 78.6 | 427.9 | 427.9 | 551.4 | 551.4 | 770.0 | 770.0 | 565.6 | 565.6 | 41.5 | 41.5 | 9.02 | 9.02 | 43.9 | 43.9 | 89.1 | 89.1 | 38.34 | 38.34 |
| 6 | 104729 | 78.7 | 78.7 | 427.2 | 427.2 | 551.4 | 551.4 | 769.4 | 769.4 | 595.7 | 595.7 | 41.4 | 41.4 | 9.24 | 9.24 | 44.1 | 44.1 | 89.5 | 89.5 | 38.32 | 38.32 |
| 7 | 104823 | 78.8 | 78.8 | 427.0 | 427.0 | 550.9 | 550.9 | 768.5 | 768.5 | 595.4 | 595.4 | 41.4 | 41.4 | 8.51 | 8.51 | 43.7 | 43.7 | 89.4 | 89.4 | 38.32 | 38.32 |
| 8 | 104929 | 79.0 | 79.0 | 426.8 | 426.8 | 550.6 | 550.6 | 766.1 | 766.1 | 595.5 | 595.5 | 41.4 | 41.4 | 9.03 | 9.03 | 44.5 | 44.5 | 89.7 | 89.7 | 38.32 | 38.32 |
| 9 | 105031 | 79.1 | 79.1 | 426.3 | 426.3 | 550.0 | 550.0 | 763.8 | 763.8 | 595.4 | 595.4 | 41.5 | 41.5 | 9.67 | 9.67 | 44.7 | 44.7 | 90.0 | 90.0 | 38.32 | 38.32 |
| 10 | 105133 | 79.1 | 79.1 | 425.9 | 425.9 | 548.8 | 548.8 | 762.1 | 762.1 | 595.2 | 595.2 | 41.5 | 41.5 | 9.13 | 9.13 | 44.8 | 44.8 | 90.2 | 90.2 | 38.32 | 38.32 |
| 11 | 105234 | 79.2 | 79.2 | 425.7 | 425.7 | 548.0 | 548.0 | 761.3 | 761.3 | 595.5 | 595.5 | 41.5 | 41.5 | 9.00 | 9.00 | 44.9 | 44.9 | 90.5 | 90.5 | 38.32 | 38.32 |
| 12 | 105334 | 79.2 | 79.2 | 425.6 | 425.6 | 547.8 | 547.8 | 761.2 | 761.2 | 596.5 | 596.5 | 41.5 | 41.5 | 8.56 | 8.56 | 44.5 | 44.5 | 90.4 | 90.4 | 38.32 | 38.32 |
| 13 | 105435 | 79.1 | 79.1 | 425.6 | 425.6 | 547.6 | 547.6 | 759.8 | 759.8 | 597.3 | 597.3 | 41.5 | 41.5 | 8.82 | 8.82 | 44.6 | 44.6 | 89.7 | 89.7 | 38.32 | 38.32 |
| 14 | 105538 | 79.2 | 79.2 | 425.6 | 425.6 | 547.5 | 547.5 | 756.5 | 756.5 | 597.4 | 597.4 | 41.5 | 41.5 | 9.10 | 9.10 | 43.9 | 43.9 | 89.5 | 89.5 | 38.32 | 38.32 |
| 15 | 105638 | 79.2 | 79.2 | 425.7 | 425.7 | 547.2 | 547.2 | 755.8 | 755.8 | 597.3 | 597.3 | 41.4 | 41.4 | 9.11 | 9.11 | 44.3 | 44.3 | 89.7 | 89.7 | 38.32 | 38.32 |
| 16 | 105739 | 79.2 | 79.2 | 425.8 | 425.8 | 547.8 | 547.8 | 757.4 | 757.4 | 597.0 | 597.0 | 41.5 | 41.5 | 9.60 | 9.60 | 44.3 | 44.3 | 89.8 | 89.8 | 38.32 | 38.32 |
| 17 | 105839 | 79.1 | 79.1 | 425.8 | 425.8 | 548.1 | 548.1 | 757.4 | 757.4 | 596.9 | 596.9 | 41.6 | 41.6 | 8.07 | 8.07 | 44.5 | 44.5 | 90.0 | 90.0 | 38.32 | 38.32 |
| 18 | 105942 | 79.2 | 79.2 | 426.0 | 426.0 | 548.0 | 548.0 | 752.4 | 752.4 | 596.8 | 596.8 | 41.7 | 41.7 | 8.60 | 8.60 | 44.6 | 44.6 | 90.1 | 90.1 | 38.32 | 38.32 |
| 19 | 110044 | 79.1 | 79.1 | 426.2 | 426.2 | 548.6 | 548.6 | 753.4 | 753.4 | 596.0 | 596.0 | 41.7 | 41.7 | 8.46 | 8.46 | 45.2 | 45.2 | 90.4 | 90.4 | 38.32 | 38.32 |
| 20 | 110145 | 79.1 | 79.1 | 426.1 | 426.1 | 549.3 | 549.3 | 755.2 | 755.2 | 595.2 | 595.2 | 41.7 | 41.7 | 9.55 | 9.55 | 45.8 | 45.8 | 90.3 | 90.3 | 38.32 | 38.32 |

**Table 7.** OCR conversion results for product MAROON100918

| No | Image | TR1 | | TR3 | | TC2 | | TC3 | | TR14 | | TR17 | | KCH | | TI3 | | TI7 | | HI3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Source | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil | Actual | Hasil |
| 1 | 095345 | 77.1 | 77.1 | 426.4 | 426.4 | 547.1 | 547.1 | 754.2 | 754.2 | 599.4 | 599.4 | 41.3 | 41.3 | 5.79 | 5.79 | 42.4 | 42.4 | 87.7 | 87.7 | 38.28 | 38.28 |
| 2 | 095447 | 77.4 | 77.4 | 427.8 | 427.8 | 547.8 | 547.8 | 756.3 | 756.3 | 599.3 | 599.3 | 41.3 | 41.3 | 0.65 | 0.65 | 42.4 | 42.4 | 87.6 | 87.6 | 38.28 | 38.28 |
| 3 | 095548 | 77.4 | 77.4 | 428.8 | 428.8 | 548.8 | 548.8 | 758.6 | 758.6 | 599.2 | 599.2 | 41.4 | 41.4 | 0.35 | 0.35 | 42.3 | 42.3 | 87.9 | 87.9 | 38.28 | 38.28 |
| 4 | 095648 | 77.7 | 77.7 | 429.7 | 429.7 | 550.1 | 550.1 | 762.4 | 762.4 | 599.0 | 599.0 | 41.4 | 41.4 | 0.44 | 0.44 | 42.8 | 42.8 | 87.9 | 87.9 | 38.28 | 38.28 |
| 5 | 095748 | 77.8 | 77.8 | 429.7 | 429.7 | 551.0 | 551.0 | 765.6 | 765.6 | 598.4 | 598.4 | 41.3 | 41.3 | 8.60 | 8.60 | 44.4 | 44.4 | 88.2 | 88.2 | 38.26 | 38.26 |
| 6 | 095851 | 77.9 | 77.9 | 429.3 | 429.3 | 550.8 | 550.8 | 766.2 | 766.2 | 598.1 | 598.1 | 41.4 | 41.4 | 9.57 | 9.57 | 44.2 | 44.2 | 88.4 | 88.4 | 38.28 | 38.28 |
| 7 | 095951 | 78.0 | 78.0 | 428.8 | 428.8 | 550.3 | 550.3 | 765.4 | 765.4 | 597.9 | 597.9 | 41.4 | 41.4 | 9.50 | 9.50 | 43.5 | 43.5 | 88.4 | 88.4 | 38.26 | 38.26 |
| 8 | 100052 | 78.0 | 78.0 | 428.8 | 428.8 | 549.2 | 549.2 | 763.1 | 763.1 | 597.5 | 597.5 | 41.4 | 41.4 | 9.52 | 9.52 | 42.8 | 42.8 | 88.2 | 88.2 | 38.28 | 38.28 |
| 9 | 100152 | 78.0 | 78.0 | 428.5 | 428.5 | 548.2 | 548.2 | 761.2 | 761.2 | 596.9 | 596.9 | 41.4 | 41.4 | 8.89 | 8.89 | 41.7 | 41.7 | 88.1 | 88.1 | 38.28 | 38.28 |
| 10 | 100254 | 78.2 | 78.2 | 428.2 | 428.2 | 547.9 | 547.9 | 759.9 | 759.9 | 596.2 | 596.2 | 41.4 | 41.4 | 9.49 | 9.49 | 42.8 | 42.8 | 88.0 | 88.0 | 38.28 | 38.28 |
| 11 | 100355 | 78.3 | 78.3 | 427.7 | 427.7 | 547.2 | 547.2 | 758.3 | 758.3 | 595.6 | 595.6 | 41.4 | 41.4 | 8.69 | 8.69 | 41.7 | 41.7 | 88.3 | 88.3 | 38.28 | 38.28 |
| 12 | 100455 | 78.2 | 78.2 | 427.2 | 427.2 | 546.7 | 546.7 | 757.1 | 757.1 | 594.7 | 594.7 | 41.5 | 41.5 | 8.69 | 8.69 | 42.4 | 42.4 | 88.1 | 88.1 | 38.28 | 38.28 |
| 13 | 100555 | 78.3 | 78.3 | 426.9 | 426.9 | 546.1 | 546.1 | 756.5 | 756.5 | 595.2 | 595.2 | 41.5 | 41.5 | 8.95 | 8.95 | 43.6 | 43.6 | 88.4 | 88.4 | 38.28 | 38.28 |
| 14 | 100657 | 78.2 | 78.2 | 426.3 | 426.3 | 546.1 | 546.1 | 757.1 | 757.1 | 595.8 | 595.8 | 41.5 | 41.5 | 7.77 | 7.77 | 43.1 | 43.1 | 88.7 | 88.7 | 38.28 | 38.28 |
| 15 | 100800 | 78.1 | 78.1 | 425.9 | 425.9 | 547.2 | 547.2 | 756.3 | 756.3 | 595.8 | 595.8 | 41.5 | 41.5 | 8.67 | 8.67 | 42.8 | 42.8 | 88.8 | 88.8 | 38.28 | 38.28 |
| 16 | 100901 | 78.1 | 78.1 | 425.9 | 425.9 | 547.8 | 547.8 | 756.3 | 756.3 | 595.8 | 595.8 | 41.6 | 41.6 | 9.68 | 9.68 | 43.8 | 43.8 | 89.1 | 89.1 | 38.30 | 38.30 |
| 17 | 101001 | 78.0 | 78.0 | 426.4 | 426.4 | 548.5 | 548.5 | 757.1 | 757.1 | 595.6 | 595.6 | 41.6 | 41.6 | 9.85 | 9.85 | 43.1 | 43.1 | 88.6 | 88.6 | 38.30 | 38.30 |
| 18 | 101101 | 78.0 | 78.0 | 426.2 | 426.2 | 549.3 | 549.3 | 759.1 | 759.1 | 595.6 | 595.6 | 41.6 | 41.6 | 9.95 | 9.95 | 42.8 | 42.8 | 88.3 | 88.3 | 38.28 | 38.28 |
| 19 | 101202 | 78.0 | 78.0 | 425.6 | 425.6 | 549.6 | 549.6 | 759.9 | 759.9 | 595.8 | 595.8 | 41.6 | 41.6 | 9.63 | 9.63 | 43.0 | 43.0 | 88.3 | 88.3 | 38.30 | 38.30 |
| 20 | 101302 | 77.9 | 77.9 | 425.3 | 425.3 | 549.1 | 549.1 | 756.4 | 756.4 | 596.0 | 596.0 | 41.6 | 41.6 | 8.89 | 8.89 | 42.6 | 42.6 | 88.3 | 88.3 | 38.30 | 38.30 |

Based on table 6, in a sample of 52 .png images as test data for Type A tile products, each image is divided into 10 parameters which are read with accurate results according to actual data. Of the 520 conversions or parameter readings, it can be ascertained that there are no errors in the data conversion. Whereas for the MAROON 100918 product listed in table 7 of the 48-sample image .png it can also be ensured that the OCR conversion results did not find any errors.

### 3.4 OCR Application Test Results

Table 6 contains up to 520 parameters for type A tile products and Table 7 contains 480 parameters for tile product Maroon 100918. The test results were obtained using 11 training data models, as shown in Table 4, and 100 test data containing 1000 parameters, which are divided into two types of tasks or products. Table 8 below shows the outcomes of evaluating the use of OCR using the OCR conversion prototype on the built-in kiln machine.

**Table 8** Confusion Matrix Test Results

| | | True Value | |
|---|---|---|---|
| | | **TRUE** | **FALSE** |
| **Predictive Value** | **TRUE** | **520** | **0** |
| | **FALSE** | **0** | **480** |

Accurate conversion results are acquired from the conversion results, which are shown in tables 6 and 7 above for both the Maroon 100918 tile product parameters and the Type A tile, and it is ensured that there are no unsuitable parameters. Table 8 provides the accuracy that is shown below:

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$$

$$= \frac{520+480}{520+480+0+0}$$

$$= \frac{1000}{1000}$$

$$= 1 \text{ x } 100\%$$

$$= 100\ \%$$

Based on the results of these calculations, an accuracy of 100.00% is obtained.

## 4 Conclusions

The application model for abnormal detection using the template matching-based optical character recognition (OCR) method obtained an accuracy of 100.00%, can monitor automatically, can identify parameters that exceed the minimum and maximum, and can send early warning notifications, according to the conclusion based on the discussion of research results and research testing mentioned above. The best accuracy can be acquired for detecting abnormal circumstances in the kiln combustion engine at PT. XYZ, however it is advised that further research using different methods be carried out to obtain superior accuracy or to compare accuracy.

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