Detection and Erasing Scribble Blackboard System Based on Hough-Transform Method Using Camera

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Abstract. Teachers of a secondary school in Semarang city are often exposed to blackboard chalk dust. This will give a significant impact if it occurs at a fairly frequent intensity and a long period of time. An automatic scratch detector and designing a device that can erase the blackboard is a preventive step that can reduce the long-term impact of chalk dust. The scratch detector uses a circle shape parameter as a mark of dirty position that needs to be erased. Light can affect the system performance. The system works properly at light intensities ranging from ± 160 to ± 200 lux. Testing the threshold value proves that the system can detect circles in the range of 40 - 55. The pixel size which is detected by the camera was 640x480 will allow the system to divide the blackboard into 9 mapping areas. The mapping area is differentiated into 9 sections so that the x and y coordinate positions of the blackboard dirty spot can be determined. A mechanical execution will erase the top and bottom areas according to the position of the detected mapping area. The success of scratch detector reaches 81.8%.

1. Introduction
In everyday life, work that was previously done by humans is now starting to be replaced by machines, if previously humans were expected to complete certain jobs, nowadays many automation has developed which have replaced human work. Robots have developed a lot in the industrial world, but currently there are also many robots being developed in the school environment, including the development of a blackboard eraser robot, this robot is designed because of the danger of continuous exposure to chalk dust and its relationship with lung performance has been researched. The research was conducted in one of the secondary schools in the city of Semarang with the subject being the teaching teacher at the school.

From the measurement results of the value of FVC, FEVi and the percentage of FEVi / FVC, it was found that out of 40 respondents it was found that 52.5% were restrictive, 2.5% obstructive, 2.5% mixed and 42.5% normal. The results showed that there was no significant relationship between dust exposure and decreased lung function capacity (FVC and FEVi) with p value for FVC = 0.633 and p value for FEVi = 0.618. however, the age and length of teaching hours per week had a significant relationship. From the results of statistical tests with tests, it was found that there was a significant difference between the lung capacity of teachers who taught science and those who taught non-science.[1]. In several jobs that involve humans as the main actors, currently robotic technology has been inserted to assist in doing work.

Descriptively in this study, it is explained about the disturbance due to dust exposure on the health condition of teachers so that it is suggested that protection against dust exposure be further improved by covering parts of the body that are prone to dust, as well as holding open health checks, making a tool in the form of an automatic blackboard eraser, possible to do[2]. In research conducted by Viviek D.Ugale, it has been able to make an automatic blackboard eraser, this tool can erase movements to
the right and left, but without being equipped with a detection for scribbles [3]. So automation in whiteboard cleaning is carried out to minimize physical contact between humans, and these objects (chalk), in this case emphasized during the scratch removal process on the board which generates a lot of dust. This system will turn on automatically along with the activities that occur in class and around the blackboard[4],[5].

Cameras are often used to detect an object, where the camera is the main sensor, as is done to detect a room door[6], to detect room numbers [7], to detect objects [8], and many others, so the importance of cameras as the main sensor of a system[9]. The data from the camera is processed on the PC which later identifies the detected target, the PC sends the data to a microcontroller, where this microcontroller has been developed in many fields, robotics [10], [11], for monitoring systems [12], control [13], and many others, so that the microcontroller is very suitable to be used as a control or the brain of the control system[14], [15]. From it the researcher build a system can be detect and eraser the scribble based on image processing.

2. Method

2.1. Design System

In this section, we will explain the procedure and also the steps taken in this study, which in this study includes several stages, including the research step, then mechanical design, then block diagrams of the system and work system flowcharts. This section describes the system block that is made, which includes, camera, PC, microcontroller, to actuator, the system block can be seen in Figure 1.

![Figure 1. Diagram Block](image-url)

In the design as seen in Figure 1, it consists of various parts including: The camera functions as an image catcher, as the system's main input, the results of the image capture by this camera will be processed on a PC. Portable computer functions as an image processor captured from the camera, where the PC processes the image into a form in accordance with predetermined parameters. Serial communication is used to send commands from the PC to the microcontroller, where the microcontroller processes the data received from the serial. The microcontroller is used as a data processor that is received by the serial, which then the microcontroller translates the command, which is then sent to the motor driver. The motor driver is used to convert the received command from the microcontroller into a command to move the motor forward, backward and stop.

2.2. Flowchart System

This research pad consists of several working parts, namely: software, electrical hardware and mechanical parts. The system flowchart illustrates the sequence of work processes. The overall workings of the system can be seen in the following figure 2.
3. Result and Discussion

3.1. Blockboard Mapping Area

Mapping the area is intended to determine the position of the scribble to be deleted, the position of the mapping area is determined based on the value of the coordinates captured by the camera. Figure 3 is blackboard mapping area.

Figure 2. Flowchart System

Figure 3. Blackboard Mapping
To determine the coordinates of the x and y axes of each area, the camera is placed at a position 110 cm from the blackboard, and at a height of 81 cm from the ground. At that position, the smallest position of the x-axis will be 12, and the largest position of x is 636, the smallest position of the y-axis is 46, and the largest position of the y-axis is 452. Coordinate data for each area on the blackboard can be seen in the table below. Table 1. Coordinates of mapping area.

### Table 1. Coordinate Mapping Pixel Camera

| Area | Coordinate         |
|------|--------------------|
|      | X                  | Y                  |
| A    | X>=12 to X<=325    | Y>=46 to Y<=244    |
| B    | X>=325 to X<=636   | Y>=46 to Y<=244    |
| C    | X>=12 to X<=325    | Y>=244 to Y<=452  |
| D    | X>=325 to X<=636   | Y>=244 to Y<=452  |
| E    | X>=162 to X<=462   | Y>=46 to Y<=244    |
| F    | X>=162 to X<=462   | Y>=244 to Y<=454  |
| G    | X>=12 to X<=325    | Y>=146 to Y<=357  |
| H    | X>=325 to X<=632   | Y>=146 to Y<=632  |
| I    | X>=162 to X<=462   | Y>=146 to Y<=357  |

3.2. Circle Detection Result

To determine the response of the system to the threshold value set in the image processing program, a circle detection test is carried out by changing the threshold value in the system. The results obtained can be seen in the following table 2.

### Table 2. Setting Gray Threshold to Circle Detected

| Gray Threshold Value | Circle Detected / Not | Number of Circle Detected (Noise) |
|----------------------|-----------------------|-----------------------------------|
| 5                    | Detected              | 20                                |
| 10                   | Detected              | 20                                |
| 15                   | Detected              | 17                                |
| 20                   | Detected              | 15                                |
| 25                   | Detected              | 18                                |
| 30                   | Detected              | 7                                 |
| 35                   | Detected              | 5                                 |
| 40                   | Detected              | 1                                 |
| 45                   | Detected              | 1                                 |
| 50                   | Not                   | 0                                 |

Tests based on changes in the gray threshold value are intended to determine the exact value of the threshold in order to detect circles properly. The tests that have been carried out are documented in the form of the table above. The threshold value tested starts from the lowest value of 5 to the highest value of 75 with an increase of 5 changes, it will get 15 kinds of data with different results. From the results in the table, it can be seen that between the threshold values of 5 to 40, many circles were detected ranging from 20 to 5 circles. This is caused by the poor conversion process of threshold values so that indentations that are not actually circles are detected as circles by the image processing process.

A good threshold process is only seen if the input value is given between is 40 to 55, only 1 circle is detected. We can confirm that the circle object detected by the camera is a scribble on the blackboard. By providing the right threshold value, the designed system can detect the circle in question. Our next test gives a threshold value between is 60 to 75. However, the result is that no circles are detected. This is because the given threshold value is too high so that the process of changing the image to binary does not work well, the image that should be used as a binary image
(black and white) does not work, the image becomes black. From the test results, it has been obtained a definite value for the threshold.

### 3.3. Circle Detected based on Light Intensity Value

To find out the response of the system to the light that hits it, a circle detection test is carried out by placing the system in a place that has conditions of different light intensity. The results obtained can be observed in the following table 3.

| Light Intensity Value | Coordinate | Circle Detected / Not |
|-----------------------|------------|-----------------------|
| + 140                 | 0          | 0                     | Not                   |
| + 150                 | 105.5      | 316.5                 | Detected              |
| + 160                 | 328.5      | 122.5                 | Detected              |
| + 165                 | 455.5      | 224.5                 | Detected              |
| + 170                 | 558.5      | 97.5                  | Detected              |
| + 175                 | 262.5      | 328.5                 | Detected              |
| + 180                 | 373.5      | 322.5                 | Detected              |
| + 190                 | 454.5      | 227.5                 | Detected              |
| + 300                 | 0          | 0                     | Not                   |

Testing with light intensity values aims to determine the value of light intensity that is good for the system. So that the system can work properly and according to its function. In the data table above, the experimental value of light intensity uses direct light from the sun that enters the room. If it's late afternoon, the intensity value ranges from 120. We did a test by increasing the lighting using a flashlight and camera flash. From these data, it can be observed that the system can perform a detection function on the whiteboard with light intensity values ranging from 150 to 190. At this value, the camera can clearly detect the circle streaks on the blackboard. Figure 4 is circle detection result based on gray threshold and light intensity.

![Figure 4. Circle Detection Result](image)
3.4. Circle Detected Based Area Mapping

Testing the system process in detecting circles according to the specified mapping area aims to find out whether the detection carried out can be executed properly by the mechanical system. The results obtained can be observed in table 4.

| Coordinate | Area |
|------------|------|
| X          | Y    | Area |
| 111.5      | 169  | “A”  |
| 111.5      | 301  | “B”  |
| 179.5      | 238.5| “C”  |
| 332        | 127  | “D”  |
| 504.5      | 138.5| “E”  |
| 337        | 357  | “F”  |
| 499.5      | 241  | “G”  |
| 498        | 314.5| “H”  |
| 322.5      | 273  | “I”  |

The circle scribble detection test is intended to determine whether the system created can detect scribbles if the scribbles are in the map position on the blackboard in accordance with the designed map position. So that we can find out whether or not the test is appropriate, table 4 above needs to be compared with table 1. Table 1 has information on the range of values for the x-axis and y-axis coordinates for each mapping area. Let’s take an example of some data, in table 4 the test in the area G the x-axis has a coordinate value of 179.5 and the y-axis coordinates 238.5. If we match the data with table 1, area “G” has x coordinates >= 12, <= 325 and y coordinates <= 357, >= 146. So if we match the data in table 4 with the data in table 1 the two data match, then the system is running fine. Another example of data, in table 4, the test in the area “F” of the x-axis has a coordinate value of 337.5 and a coordinate of the y-axis 357.5. If we match the data with table 1, area F has x coordinates >= 162, <= 462 and y coordinates <=454, >= 244. So, if we match the data in table 4 with the data in table 1, the two data match. Fig 5 circle detection in “G” area.

Figure 5. Circle Detection in “G” area
Detection and Erasing Scribble System Result

After testing the sending and receiving of serial data on the system, then proceed with testing the motor movement. The motor movement in question is the mechanical movement of the blackboard. Do the movement according to the detected area. The results of the motor movement test can be seen in table 6.

**Table 6. System Result**

| Area | Detection Camera | PC Transmitter data | Atmega16 Receive data | Scribble Erasing Motor | Result |
|------|------------------|---------------------|-----------------------|------------------------|--------|
| A    | “A”              | “A”              |                       |                        |        |
| A    | “A”              | “A”              |                       |                        |        |
| B    | “B”              | “B”              |                       |                        |        |
| -    | -                | -                |                       |                        |        |
| B    | “B”              | “B”              |                       |                        |        |
| C    | “C”              | “C”              |                       |                        |        |
| C    | “C”              | “C”              |                       |                        |        |
| -    | -                | -                |                       |                        |        |
| D    | “D”              | “D”              |                       |                        |        |
| D    | “D”              | “D”              |                       |                        |        |
| E    | “E”              | “E”              |                       |                        |        |
| E    | “E”              | “E”              |                       |                        |        |
| F    | “F”              | “F”              |                       |                        |        |
| F    | “F”              | “F”              |                       |                        |        |
| G    | “G”              | “G”              |                       |                        |        |
| G    | “G”              | “G”              |                       |                        |        |
| H    | “H”              | “H”              |                       |                        |        |
| H    | “H”              | “H”              |                       |                        |        |
| H    | “H”              | “H”              |                       |                        |        |
| I    | “I”              | “I”              |                       |                        |        |
| I    | “I”              | “I”              |                       |                        |        |

There are 22 test data in the table above. The test is carried out by scribbling on the mapping area randomly. In the data above, there is a successful/failed test column that is filled with failure. This is caused by the detection that failed from the start, so that the data sent or received by the hardware also does not exist. Of the 22 tests carried out, there were 4 tests that were not in accordance with the results. Which means that the success rate of the system is 81.8%. The failure of the system to carry out the process was caused by several things, including failure to send serial data, to failure because the mechanics were unable to reach the area where there were streaks.

4. Conclusion

Based on the results of research conducted, it can be concluded, based on the testing of the image processing software system for detecting circles on the blackboard, out of 11 tests carried out, the system succeeded in detecting 9 times so that the system had an 81.8% success rate in detecting areas that contained streaks and the system was able to determine the position of the detected circle strokes. Based on the overall system test, the division of the eraser mechanical system into two areas is still not effective, so there are still areas on the blackboard that cannot be reached. Researchers hope that with this system that has been designed it can help in erasing the whiteboard automatically to help humans in carrying out activities.
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