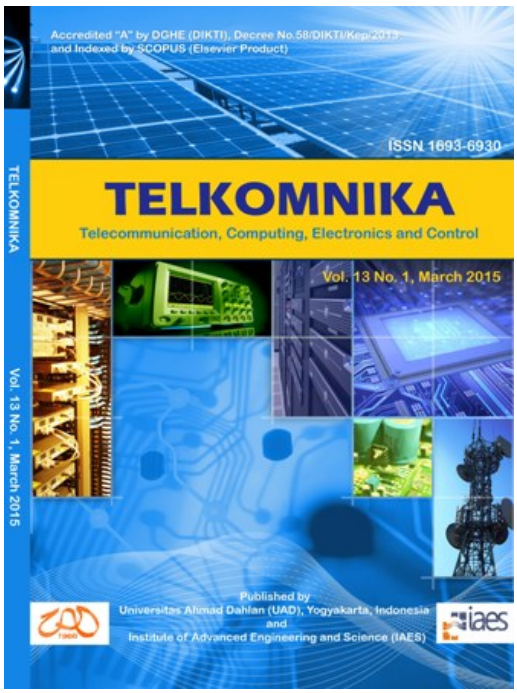
TELKOMNIKA (Telecommunication Computing Electronics and Control)

TELKOMNIKA (Telecommunication, Computing, Electronics and Control) ISSN: 1693-6930, e-ISSN: 2302-9293 is a peer-reviewed, scientific journal published by Universitas Ahmad Dahlan (UAD) in collaboration with Institute of Advanced Engineering and Science (IAES). The aim of this journal is to publish high-quality articles dedicated to all aspects of the latest outstanding developments in the field of electrical engineering. Its scope encompasses the applications of Telecommunication and Information Technology, Applied Computing and Computer, Instrumentation and Control, Electrical (Power), and Electronics Engineering. It was first published in 2003. Beginning with issue 1 of volume 16 (2018), TELKOMNIKA will be published as a bimonthly journal (6 issues/year). The journal registered in the CrossRef system with Digital Object Identifier (DOI) prefix 10.12928. The Journal has been indexed by SCOPUS, Google Scholar, Scholar Metrics etc; accredited 'A' Grade by DGHE (Ministry of Research, Technology and Higher Education, Republic of Indonesia); registered BASE - Bielefeld Academic Search Engine and CORE KMi, etc. The Journal also have a license agreement with ProQuest LLC and EBSCO Publishing.



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Announcements

Call for Editors

TELKOMNIKA Telecommunication, Computing, Electronics and Control (Scopus indexed journal) is a peer-reviewed scientific journal publishes high-quality articles dedicated to all aspects of the latest outstanding developments in the field of electrical engineering.

TELKOMNIKA TCEC is calling for academics with sound academic background and who want to leave their footprints on the sand of time to serve as editors. Applicants must have significant publishing his/her specific field of research and reviewing experience (min **H-index: 5** in Scopus/Thomson Reuters Web of Science database).

Posted: 2014-12-07 More...

More Announcements...

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Focus and Scope

TELKOMNIKA (Telecommunication Computing Electronics and Control) is a peer reviewed International Journal in English published four issues per year (March, June, September and December). The aim of TELKOMNIKA is to publish high-quality articles dedicated to all aspects of the latest outstanding developments in the field of electrical engineering.
Its scope encompasses the engineering of signal processing, electrical (power), electronics, instrumentation & control, telecommunication, computing and informatics which covers, but not limited to, the following scope:

Signal Processing: Signal Theory, Digital Signal & Data Processing, Stochastic Processes, Detection and Estimation, Spectral Analysis, Filtering, Signal Processing Systems, Environmental Signal Processing, Software Developments, Image Processing, Pattern Recognition, Optical Signal Processing, Digital Signal Processing, Multi-dimensional Signal Processing, Communication Signal Processing, Biomedical Signal Processing, Geophysical and Astrophysical Signal Processing, Earth Resources Signal Processing, Acoustic and Vibration Signal Processing, Data Processing, Remote Sensing, Signal Processing Technology, Speech Processing, Signal Processing for Audio, Visual and Performance Arts, Radar Signal Processing, Sonar Signal Processing, Seismic Signal Processing, Medical Imaging Equipment and Techniques, Biomedical Imaging and Image Processing, Video Processing, Industrial Applications, New Applications, etc

Electronics: Electronic Materials, Microelectronic System, Design and Implementation of Application Specific Integrated Circuits (ASIC), VLSI Design, System-on-a-Chip (SoC) and Electronic Instrumentation Using CAD Tools, Biomedical Transducers and instrumentation, Biomechanics and Rehabilitation Engineering, Transistor, MOSFET, CMOS, etc

Electrical: Electrical Engineering Materials, Electric Power Generation, Transmission and Distribution, Power Electronics, Power Quality, Power Economic, FACTS, Renewable Energy, Electric Traction, Electromagnetic Compatibility, High Voltage Insulation Technologies, High Voltage Apparatuses, Lightning Detection and Protection, Power System Analysis, SCADA, Electrical Measurements, etc

Telecommunication: Modulation and Signal Processing for Telecommunication, Information Theory and Coding, Antenna and Wave Propagation, Wireless and Mobile Communications, Radio Communication, Communication Electronics and Microwave, Radar Imaging, Distributed Platform, Communication Network and Systems, Telematics Services and Security Network, etc

Instrumentation & Control: Optimal, Robust and Adaptive Controls, Non Linear and Stochastic Controls, Modeling and Identification, Robotics, Image Based Control, Hybrid and Switching Control, Process Optimization and Scheduling, Control and Intelligent Systems, Artificial Intelligent and Expert System, Fuzzy Logic and Neural Network, Complex Adaptive Systems, etc

Computing and Informatics: Computer Architecture, Parallel and Distributed Computer, Pervasive Computing, Computer Network, Embedded System, Human—Computer Interaction, Virtual/Augmented Reality, Computer Security, Software Engineering (Software: Lifecycle, Management, Engineering Process, Engineering Tools and Methods), Programming (Programming Methodology and Paradigm), Data Engineering (Data and Knowledge level Modeling, Information Management (DB) practices, Knowledge Based Management System, Knowledge Discovery in Data), Network Traffic Modeling, Performance Modeling, Dependable Computing, High Performance Computing, Bioinformatics, Computer Security, Human-Machine Interface, Stochastic Systems, Information Theory, Intelligent Systems, IT Governance, Networking Technology, Optical Communication Technology, Next Generation Media, Robotic Instrumentation, Information Search Engine, Multimedia Security, Computer Vision, Information Retrieval, Intelligent System, Distributed Computing System, Mobile Processing, Next Network Generation, Computer Network Security, Natural Language Processing, Business Process, Cognitive Systems, etc

Section Policies

Telecommunication

This Section covers all topics in telecommunication engineering with specific emphasis on information theory, communication theory and techniques, modulation, source and channel coding, switching theory and techniques, communication protocols, optical communications, microwave theory and techniques, radar, sonar, antennas, wave propagation, etc.

Editors
Francis C.M. Lau
Andrea Morabito
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Lunchakorn Wuttisittikulkij
Zahriladha Zakaria

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Computer Science/Informatics and Information System

Computing and Informatics: Computer Architecture, Parallel and Distributed Computer, Pervasive Computing, Computer Network, Embedded System, Human—Computer Interaction, Virtual/Augmented Reality, Computer Security, Software Engineering (Software: Lifecycle, Management, Engineering Process, Engineering Tools and Methods), Programming (Programming Methodology and Paradigm), Data Engineering (Data and Knowledge level Modeling, Information Management (DB) practices, Knowledge Based Management System, Knowledge Discovery in Data), Network Traffic Modeling, Performance Modeling, Dependable Computing, High Performance Computing, Computer Security, Human-Machine Interface, Stochastic Systems, Information Theory, Intelligent Systems, IT Governance, Networking Technology, Optical Communication Technology, Next Generation Media, Robotic Instrumentation, Information Search Engine, Multimedia Security, Computer Vision, Information Retrieval, Intelligent System, Distributed Computing System, Mobile Processing, Next Network Generation, Computer Network Security, Natural Language Processing, Business Process, Cognitive Systems, etc

Editors

Franco Frattolillo, Ph.D.
Wanquan Liu
Yin Liu
G. Papakostas
Dr. Deris Stiawan

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Electronics

This Section covers all topics in electronics engineering with specific emphasis on Electronic Materials, Microelectronic System, semiconductor devices, analogue circuits, digital electronics, embedded systems, Design and Implementation of Application Specific Integrated Circuits (ASIC), VLSI Design, System-on-a-Chip (SoC) and Electronic Instrumentation Using CAD Tools, medical electronics, biomedical transducers and instrumentation, etc.

Editors

Faycal Djeffal
Mark Hooper
Munawar Riyadi

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Power Engineering

This Section covers all topics in power engineering with specific emphasis on Power System, Protection systems, Electrical Engineering Materials, Electric Power Generation, Transmission and Distribution, Power Quality, Power Economic, FACTS, Renewable Energy, Electric Traction, Electromagnetic Compatibility, High Voltage Insulation Technologies, High Voltage Apparatuses, Lightning Detection and Protection, Power System Analysis, SCADA, Electrical Measurements.

Editors

Tarek Bouktir
Mochammad Facta
Ahmad Samosir
Ahmet Teke

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Power Electronics and Drives

This Section covers all topics in Power Electronics and Drives with specific emphasis on power Electronic designs, inverter, converter, machine drives, etc.

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Yang Han
Shahrin Md Ayob
Nik Rumzi Nik Idris

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Signal Processing

This Section covers all topics in digital signal processing with specific emphasis on signal processing, image processing, video processing, pattern recognition, medical Imaging Equipment and techniques, biomedical Imaging and Image processing, signal and system, neural-network for signal processing, fuzzy logic for signal processing, etc.

Editors

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Supavadee Aramvith
Nidhal Bouaynaya
D. Jude Hemanth
Arianna Mencattini

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Control Engineering

This Section covers all topics in control & automation theory and its applications with specific emphasis on Control Theory; Control Applications; Robotics and Automation; Intelligent and Information Systems for control system; Optimal, Robust and Adaptive Controls; Non Linear and Stochastic Controls; Modeling and Identification; Robotics; Image Based Control; Hybrid and Switching Control; Process Optimization and Scheduling; Control and Intelligent Systems; Artificial Intelligent and Expert System, Fuzzy Logic and Neural Network for for Control systems; Complex Adaptive Control Systems; etc

Editors

Srinivasan Alavandar
Auzani Jidin
Omar Lengerke
Zhixiong Li
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Machine Learning, AI and Soft Computing

This section covers machine learning, machine intelligence and machine translation, evolutionary computing, evolutionary algorithms and genetic programming, computational models for machine intelligence, bee colony algorithm, harmony search algorithm, evolutionary and swarm algorithms, artificial intelligence (AI), intelligent search, reactive distributed AI, neural science and neural net systems, expert systems, fuzzy set theory and fuzzy systems, probabilistic reasoning, chaos theory and chaotic systems, hybrid intelligent systems, morphic Computing, rough sets, multi-agent systems, emotional intelligence, etc.

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Special Section: Recent Trends on Computing and Information Systems

This special issue summarizes some the recent trends in the Computing and Information Systems (IS) such as services, technologies, embedded devices and applications, and explores one key area of growth: Computing and Information Systems. To illustrate the role of Computing Applications and Web Services in the growth of services' industries, an example focusing on the learning, government and security are used. Recommendations for future areas of research are presented.

The goal of this special issue is to bring together researches and technical reports from the areas of artificial intelligence, databases, social networks, distributed computing, web engineering, data mining, information systems, and others to discuss the latest research trends in computing and IS such as:

- Embedded systems
- Modeling and building Web agents
- Using Web Technologies to solve problems in E-commerce and E-government
- IS applications, architectures and services

Computing and Web research can benefit from ideas and cross-fertilization with many other areas: Artificial Intelligence, Natural Language Processing, Databases and Information Systems, Information Retrieval, Multimedia, Distributed Systems, Social Networks and Web Engineering. Many advances within these areas can contribute towards the realization of the Web, Computing and IS.

This special issue will be intended for researchers and practitioners who are interested in issues that arise from using applications technologies of computing and information systems advancements. In addition, such issue is also targeted to anyone who wants to learn more about the computing research advancements in design and applications.

The manuscript must not be under consideration for publication elsewhere. Conference papers may only be submitted if the paper was completely re-written or substantially extended (50%). For additional questions please contact the guest editors.

Editors

Shadi Aljawarneh
Juan Alfonso Lara Torralbo

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Submitted papers are evaluated by anonymous referees by double blind peer review for contribution, originality, relevance, and presentation. The Editor shall inform you of the results of the review as soon as possible, hopefully in 3 months. Please notice that because of the great number of submissions that TELKOMNIKA TCEC has received during the last few months the duration of the review process can be up to 5 months.

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3. is your title adequate and is your abstract correctly written? The title of paper is max 10 words, without Acronym or abbreviation. The Abstract (MAX 200 WORDS) should be informative and completely **self-explanatory (no citation in abstract)**, provide a clear statement of the **problem**, the **proposed** approach or solution, and point out **major findings** and conclusions.
4. Authors are suggested to present their articles in the sections structure**: Introduction - The Proposed Method/Algorithm/Procedure specifically designed (optional) - Research Method - Results and Discussion – Conclusion.** Authors may present complex proofs of theorems or non-obvious proofs of correctness of algorithms after introduction section (obvious theorems & straightforward proofs of existing theorems are NOT needed).
5. Introduction section: explain the context of the study and state the precise objective. An Introduction should contain the following three parts:
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8. Conclusion section: Summarize sentences the primary outcomes of the study in a paragraph. Are the claims in this section supported by the results, do they seem reasonable? Have the authors indicated how the results relate to expectations and to earlier research? Does the article support or contradict previous theories? Does the conclusion explain how the research has moved the body of scientific knowledge forward?
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    Figures:
    a. All figures appearing in article must be numbered in the order that they appear in the text.
    b. Each figure must have a caption fully explaining the content
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    Tables:
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    d. Each column must have a clear and concise heading
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    f. All tables must be referred to in the body of the article
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TELKOMNIKA Telecommunication, Computing, Electronics and Control - Google Scholar Citations

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Detection air pollution based on infrared image processing

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Abstract

This paper proposes a method of detecting air pollution in a region using image processing techniques. The image used is the infrared image that obtained using a modified digital camera by mounting the SRS filter. Image processing technique used is to utilize wavelet transformation. Pollutants are detected based on the average number of white pixels that appear on the image. This white pixel appears due to the reflection of the wavelength of the pollutant that hits the sensor on the camera. From the results of the proposed method detection is known that the highest pollution occurs in 12.00 which is the busiest traffic time and the lowest pollution occurred in 08.00 where the traffic passing through the area has not been crowded.

Keywords*: detection, infrared image, pollution, SRS filter, wavelet*

1. Introduction

Air pollution is a condition of air contaminated by chemicals, substances/particles, and other biological materials that could endanger the health of living beings and other organisms. Air pollution could be caused by motor vehicle fumes, a factory fumes or the forest fires. The negative impact of air pollution on health is could be caused breathing problems or inflammation of the respiratory tract, skin health disorders, and stress. This negative impact is what drives the need for research about air pollution detection. This research aims to identify the presence of air pollution in one place by using digital image processing in real time. Image processing in this research conducted in the frequency domain. Therefore, the previous done the transformation of the spatial domain to the frequency domain using wavelet transforms. After the image transformation results obtained, hence can be done analysis further. The use of image processing basically utilizes the electronic visual sensor (camera) which replaces the human visual system (eye). The advantages of the electronic visual sensor are to have a wavelength range that is larger than the human eye. In addition, an electronic visual sensor is also more sensitive in distinguishing the degree of intensity of each pixel of the image. By using image processing the little difference of the pixel intensity between pollutants and air through this sensor can be differentiated.

A lot of research about the detection of air pollution has been done before. Wang has been doing research about the rendering process of air pollutants based on image processing [1-3]. In contrast to the research conducted by Wang, this research uses wavelet transformation to detect air pollution from an infrared image. Joans has been used images diffusion process and ratio factor to analysis polluted images. The Infrared imagery-based research has been done before by doing image segmentation in infrared images to determine the environmental conditions [4]. The infrared image obtained by using SRS filters whose characteristics known from the previous research [5-7]. The SRS filter is a filter that transmits infrared waves made from cellulose films.The other research that has been done is the detection of indoor air pollution on wet or moist walls using a thermal camera [8]. This proposed research is done outdoors by taking infrared images using a camera. The other research that has been done is the detection of air pollution on satellite images [9-13].

The difference with this research is the method used. In this experiment, the image processing is done in the frequency domain while the research that has been conducted using the image processing in the spatial domain. Another difference is in the coverage area of the image based research has been done before by doing image segmentation in infrared

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images to determine the environmental conditions. The infrared image obtained by using SRS filters. The SRS filter (the name of creator) is a filter that transmits infrared waves made from cellulose films whose characteristics known from the previous research. This proposed research is done outdoors by taking infrared images using a camera. The difference with this research is the method used. In this experiment, the image processing is done in the frequency domain while the research that has been conducted using the image processing in the spatial domain. Another difference is in the coverage area of the image.

2. Research Method

Air pollution is a condition in which air is polluted by chemical or biological particles that can harm the health of living things. The particles that pollute the air are also called pollutants. In urban areas, sources of the pollutants come from vehicle fumes and industrial factory smoke. At low pollution levels, the number of particles in the outdoor air can reach 5,000-10,000 particles/cm^3. At high pollution levels, for example, when high traffic volume can reach 300,000-1,000,000 particles/cm^3 [14]. This particle size is very small namely less than 2.5 mm so the human eye cannot see it directly [15]. The existence of these particles can be detected using a digital camera. These particles will be captured by the camera as noise. The principle of pollutant detection using a digital camera is shown in Figure 1.

The previous research on the use of infrared images has been widely done. Sulistiyanti has been conducted research on infrared image enhancement [16, 17]. The infrared images can be used to obtain the thermal condition information of an object by performing a spatial filtering of an object [18-21]. Another research was to use an infrared image captured by digital cameras to determine isothermal calorimeter [22]. In addition, the other research used infrared images to determine the ignition point from the magnesium chip cutting temperature [23], and object discrimination [24]. Furthermore, practical applications for national security used this image processing [25].

In this research, the image was taken using a 5 MP digital camera mounted a SRS infrared filter. The usefulness of this filter is to pass the infrared light and to filter the other light. The image data were taken around the Bambu Kuning market, Bandar Lampung between 08:00 until 16:00 and intervals of data collected every 2 hours. The infrared images are images that obtained from a camera that uses filters to block visible light and allowed a near infrared light (infrared photography). The wavelength ranges used in infrared photography is about from 700 nm to 900 nm, shown in Figure 2. To get this image, the digital camera is modified by installing an infrared filter. The infrared filter used in this research is the SRS filter.

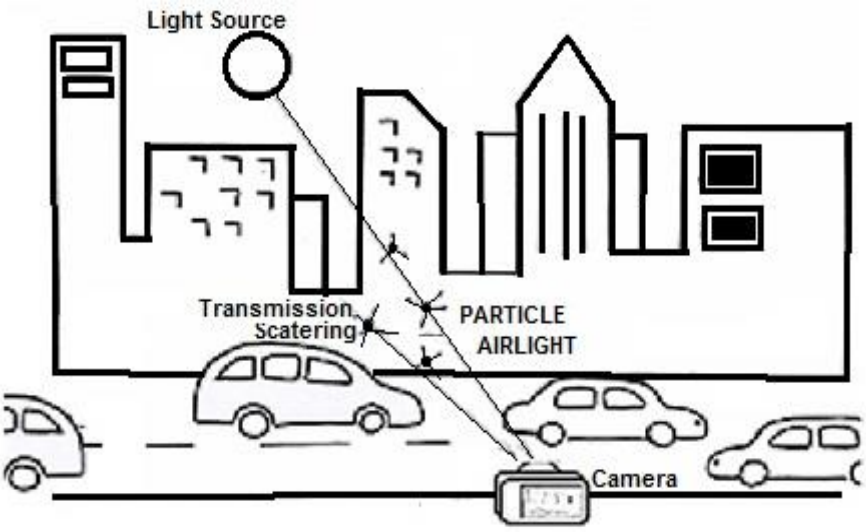

Figure 1. The radiance reaching the camera is the summation of the transmitted light from the object and light from the sun after scattering by particles

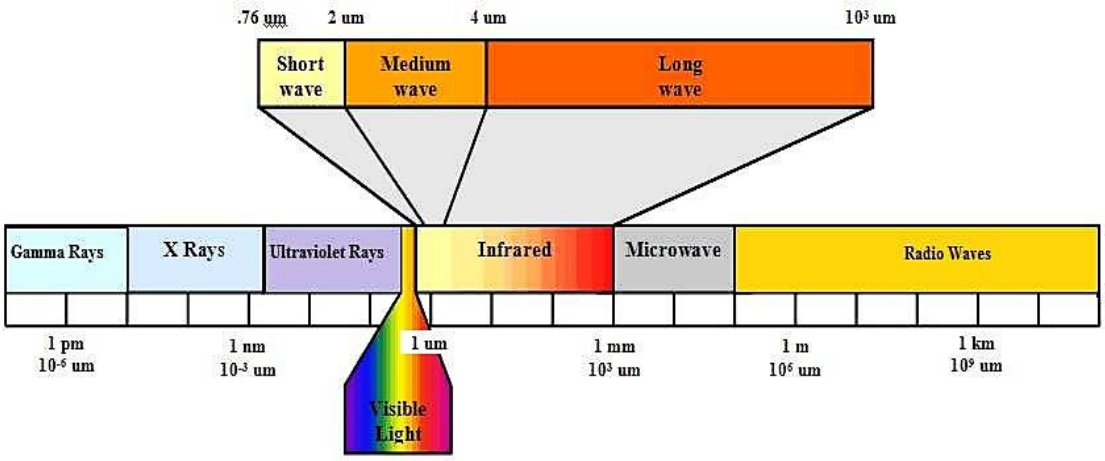

Figure 2. The wavelength range in photography

Then the captured infrared images are processed using image processing in the frequency domain, namely wavelet transform. The wavelet transform can be used as a multi-resolution analysis that can represent the time and frequency information of a signal. A signal whose frequency varies in time can be well analyzed using this transformation. In image processing, the wavelet transforms used are 2-D wavelet transforms. The image for image processing is represented as a 2-D matrix.

The decomposition process in the wavelet transform will attempt to divide the signal into two parts by the same number of sampling signals. These two parts are separated by two types of filters which have two different frequency bands, i.e. high-pass filter ($h[n]$) and lowpass filter ($g[n]$). After that the process is continued by modifying the signal based on the function of scale and time. This process repeatedly to determine the Discrete Wavelet Transform level and will affect the magnitude of the frequency band in each coefficient. The wavelet decomposition process is shown in Figure 3.

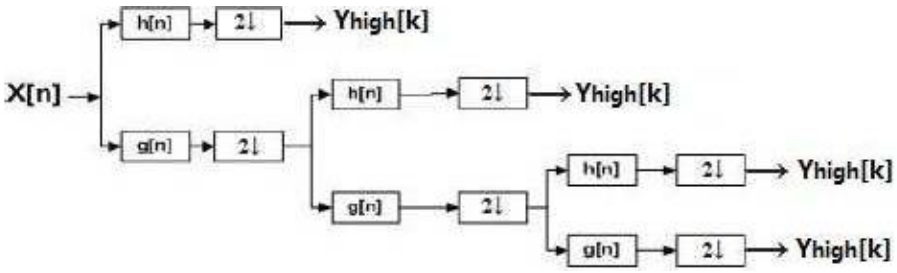

Figure 3. The wavelet decomposition

Decomposition process can be through one or more levels Mathematical, the one level decomposition is expressed by the following (1) and (2):

$$YHigh[k] = \sum_n X[n]h[2k - n] \quad (1)$$

$$YLow[k] = \sum_n X[n]g[2k - n] \quad (2)$$

Here $YHigh$ and $YLow$ are results from highpass filters and lowpass filters, $x[n]$ is origin signal, $h[n]$ is highpass filter, and $g[n]$ is lowpass filter. In the Haar wavelet, each step of the transformation always takes into account the wavelet coefficients and the

average set. The equations for calculating an average a_i and Wavelet coefficients (c_i) are (3) and (4):

$$a_i = \frac{s_i + s_{i+1}}{2} \quad (3)$$

$$c_i = \frac{s_i - s_{i+1}}{2} \quad (4)$$

here s_i is the *i-th* data, s_{i+1} is the data after *i-th* data, s_{i-1} is the data before *i-th* data, a is the data average, and c is the wavelet coefficient.

3. Results and Analysis

The captured image results are shown in Figure 4. The image size obtained from the camera is 4 MP. The image is cropped with a size of 100×200 pixels on the area to be observed (region of interest/ROI), shown in Figure 5 respectively.

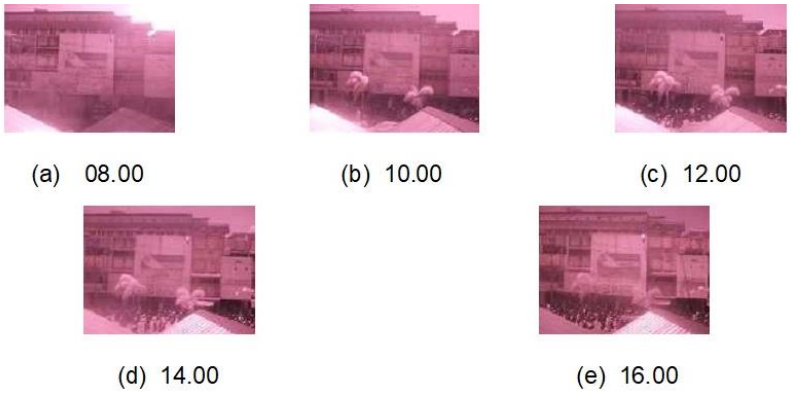

Figure 4. Results of capturing an image

Figure 5. The position of the observed area in the research (a) original image and (b) the position of cropping

In this proposed method, infrared images of a RGB mode are converted into a grayscale to find out how much noise of the object. In this conversion process, the original image has a 24 bit pixel depth become to 8 bits. The next step is the image registration process. This process is done to get the same area on the different image. This process is done because the image is taken at different times so that there may be changes a camera position due to movement.

The use of cropping which has 8-bit image format is assigned wavelet transformation process and then done the decomposition process. The result of the decomposition process is shown in Figure 6. From the decomposition result, the intensity of the four images is summed to obtain the final image, shown in Figure 7.

The image of the summing of these intensities is segmented into 4 segments, 8 segments or 16 segments. From the final image is calculated the average intensity to obtain image data that represents the presence of pollutants. Calculation of the average intensity using (5):

$$I_{average} = \frac{\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} I_{(i,j)}}{M \times N} \quad (5)$$

here M is the image width, N is the image height, and $I_{(i,j)}$ is the intensity of the(i,j) pixel.

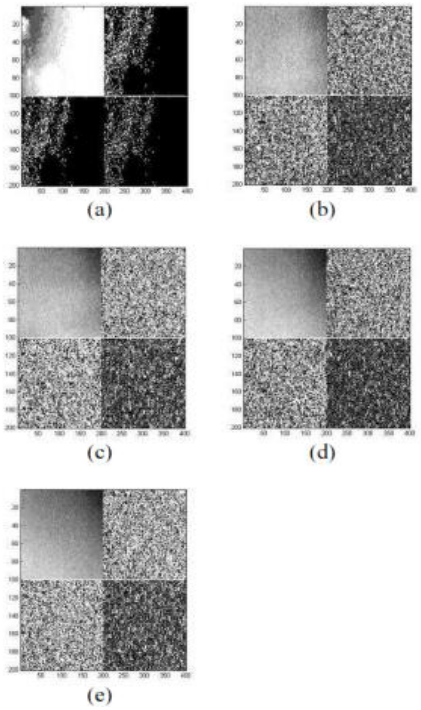

Figure. 6 The wavelet decomposition result in the image at (a) 08.00, (b) 10.00, (c) 12.00, (d) 14.00, and (e) 16.00

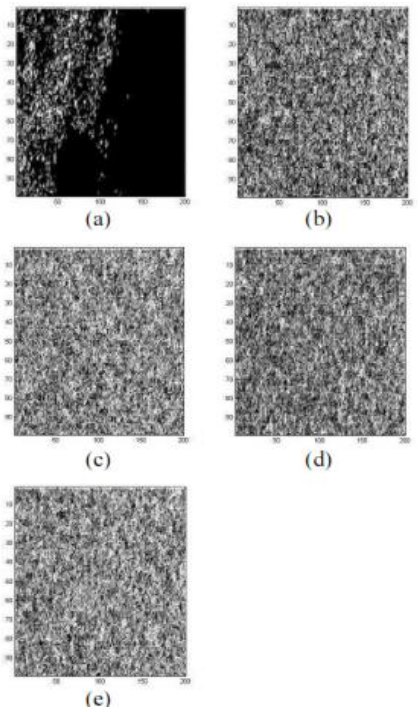

Figure 7. The summing result of the decomposition image at (a) 08.00, (b) 10.00, (c) 12.00, (d) 14.00, and (e) 16.00

The result value of the sum and average of the intensity for each segment and time is shown in Table 1. The minimal number of pollutants in the observed area occurred at 08.00 and the maximum number of pollutants occurred at 12.00. The area observed is the shopping area where the trade activity and the busiest traffic occurred in 12.00. In the observed area, the primary source of the pollutant comes from the smoke of vehicles passing through the area. At 08.00, traffic conditions in the area have not been crowded because the shops open at 09.00 so the condition of air pollution is still low. Similar pollutant detection results from the use of segmentation of 4 segments, 8 segments, and 16 segments, is shown by the graph in Figure 8.

Seen in Figure 8, in the morning (08.00) qualitatively produces images that look mostly dark, this means the air condition is still relatively clear. The black color declared a state of air condition that there are no pollutants while the color other than black is a pollutant because it is due to the wavelength reflections of the pollutants. Increased white pixels that indicate the presence of pollutants in the air in the observed area looks at 10.00-16.00. Increased air pollution is due to the increasing number of vehicles that pass through or has activities in the area.

The pollution peak occurs at 12:00 because at that hour the store employees use their time for activities in the outside because that time is a rest time. At 14:00 there was a

decrease in pollution because traffic activity was not as busy as at 12:00. The increased of the pollution occurred again in 16:00 because ahead of the shops closed so that traffic vehicle activity of the buyers who leave a shop increased. CO2 measurement were carried out using a Combo IAQ meter at a location and the same hour proving that the highest levels of CO2 were at 12:00 and 16:00, shown in Figure 9.

This research proves that the more pollutant in the air, then the more noise arising in the image too, this phenomenon is shown in Figure 1. This noise appears from the reflection of the wavelength transmitted by pollutants that hitting the sensors in the camera. The wavelength of this pollutant is different from the wavelength reflected by the background object. This difference is that causes the occurrence of spots as if the noise.

Table 1. The Result Value of the Sum and Average of the Intensity

Clock	4 segment		8 segment		16 segment	
	Sum	Average	Sum	Average	Sum	Average
08:00	224592	112296	246000	12.3000	235024	117512
10:00	789156	39.4578	726477	36.3239	809631	404816
12:00	1003695	501846	898299	44.9150	912234	456117
14:00	821454	410727	742931	371466	721778	360889
16:00	927678	463839	776300	38.8150	815852	40.7946

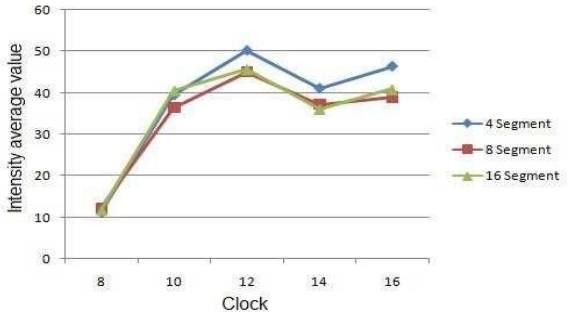

Figure 8. The average value of intensity for each segment

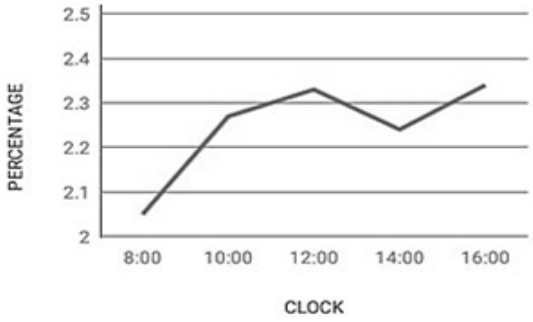

Figure 9. Trend of percentage CO_2 levels in the air using Combo IAQ meter

4. Conclusion

This paper proposes a pollutant detection technique on air pollution using Wavelet transforms. Using a wavelet transforms, the noise on the image can be well recognized so that it can be used to represent the presence of pollutants. The trends of an increase of the air pollution are obtained from the calculation data of the intensity average of the image in the observed area. This is in accordance with the condition that at 12:00 is the busiest traffic time resulting in maximum air pollution in the area.

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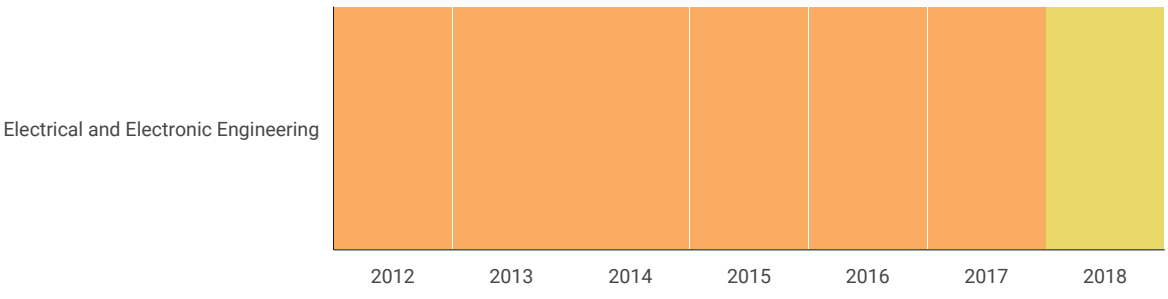

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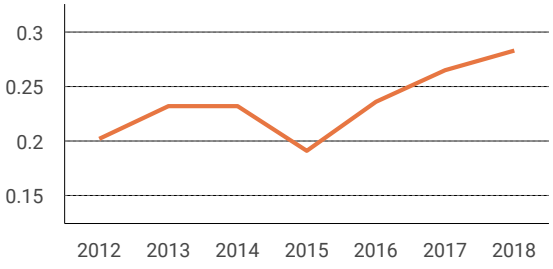

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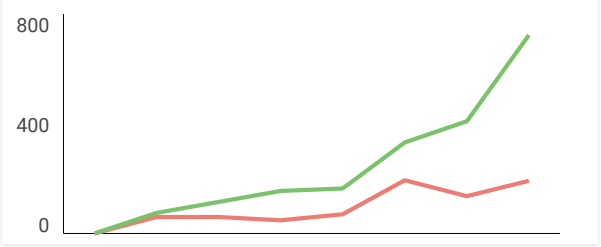

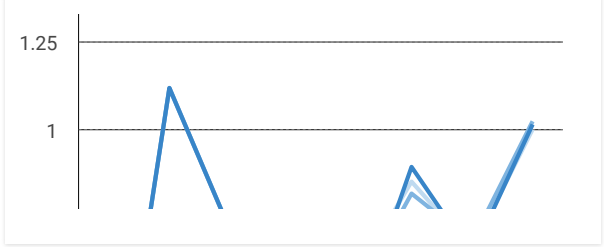

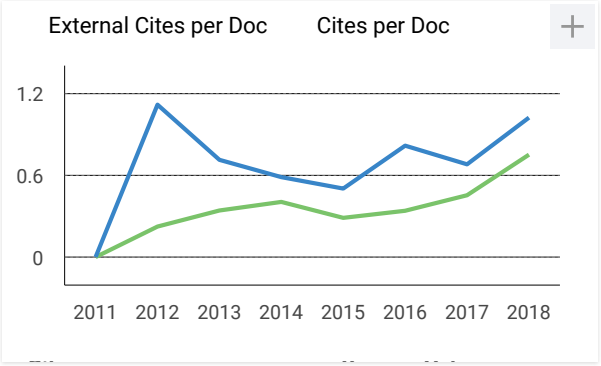

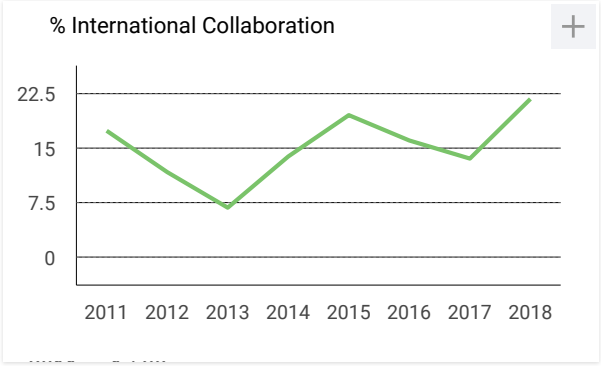

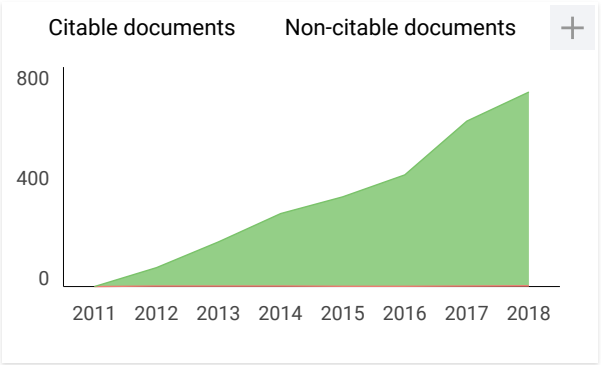

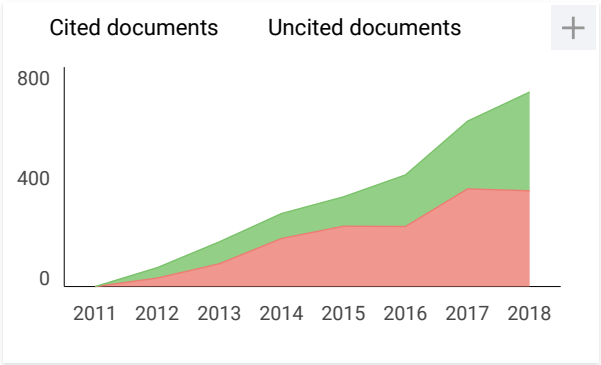

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