Study of Environmental Condition Using Wavelet Decomposition Based on Infrared Image

By Sri Ratna Sulistiyanti

2014
The 1st International Conference
on Information Technology,
Computer, and Electrical Engineering

ICITACEE

Semarang, 8-9 November 2014

PROCEEDINGS

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2014 1st International Conference on Information Technology, Computer and Electrical Engineering (ICITACEE)

GREETINGS FROM THE GENERAL CHAIR

Welcome to 2014 1st International Conference on Information Technology, Computer, And Electrical Engineering (ICITACEE) held in Semarang, the capital city of Central Java! This conference provides a forum for researchers, academicians, professionals, and students from various engineering backgrounds and also from cross-disciplinary research in the development and the design of Information Technology & Computer, Power System, Circuit & Control, and Communication Systems, as well as the Interdisciplinary topics to interact and to disseminate the latest issues and research.

The ICITACEE 2014 is held in the ICT building of Diponegoro University on November, 8. Three distinguished scholars will start the session as keynote speakers: Prof. Hiroshi Ochi as a wireless expert from Kyushu Institute of Technology Japan, Dr. Trio Adiono as an IC design expert from Bandung Institute of Technology, and Mr.Adi Rahman Adiwoso as an aeronautics expert from PT Pasific Satellite Nusantara. We are very grateful for them to share their knowledge, experience, and their motivation for always doing the best. We recently received more than 140 papers, however only of 87 high quality papers were accepted and being presented in this event. All the accepted and presented papers will be then published in the IEEE Xplore (ISBN 978-1-4799-6432-1). We will select the best papers of each categories mentioned above.

Organizing such an ambitious conference has always been incredibly challenging and would have been impossible to happen without our outstanding committee supports. I would like to thanks all staffs of Department of Electrical Engineering and Department of Computer System as well as IEEE Student Branch of Diponegoro University. They have been working very hard and been always providing me with unprecedented support, advice, and kind assistance on all aspects of the conference. Special thanks goes to the IEEE Indonesia Section, Cisco, Des Net, and PSN for all support to ICITACEE 2014. I also would like to thank all of the steering commitee, technical program commitee, reviewers, authors, session organizers and chairs, and other volunteers and participants. I expect that everyone is able to enjoy some of what Semarang City has to offer! Hopefully The ICITACEE 2014 conference would become the event of our best deeds.

Wahyul Amien Syafei
General Chair,
2014 1st International Conference of Information Technology,
Computer and Electrical Engineering (ICITACEE)

FOREWORD FROM HEAD OF DEPARTMENT OF ELECTRICAL ENGINEERING, UNIVERSITAS DIPONEGORO, SEMARANG-INDONESIA

It is pleasant to welcome all the participants in the International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE 2014) at Semarang. This is the second conference held together by Electrical Engineering Department and Computer System Department of Engineering Faculty Universitas Diponegoro. I would like to welcome several keynote speakers from Kyushu Institute of Technology Japan and Institut Teknologi Bandung.

As the Chief of Electrical Engineering Department Universitas Diponegoro, I would like to appreciate the vast work in this conference as collaborative effort among Electrical Engineering Department, Computer System Department Universitas Diponegoro, IEEE Student Branch of Universitas Diponegoro and IEEE Indonesia Section. I also wish that this conference to be a needed forum for engineers and scientist to communicate and sharing their findings and precious researches.

I would like to express hearty gratitude to Organizing Committee members, staffs, and students of Electrical Engineering and Computer System Department of Universitas Diponegoro for their efforts and supports. I do expect that this conference will give important contribution to development of Electrical Engineering and Computer Science locally and internationally.

Ir. Agung Warsito. D.H.E.T
Head, Department of Electrical Engineering – Faculty of Engineering
Universitas Diponegoro, Semarang – Indonesia
and
Vice Chairman of FORTEI (Indonesia Electrical Engineering Forum)

FOREWORD FROM DEAN OF FACULTY OF ENGINEERING
UNIVERSITAS DIPONEGORO, SEMARANG – INDONESIA

The International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE 2014) is now held in Semarang, Indonesia and being organized under the collaborative committee effort among Electrical Engineering and Computer System Department Diponegoro University and IEEE (Institute of Electrical and Electronics Engineers) Indonesia Section. This event also becomes a part of 56th Faculty of Enginering Dies Natalis and 57th Diponegoro University Dies Natalis agenda

The goals of the conference are to obtain and extend the knowledge of the recent issues, opinions, bright ideas about the development of a comprehensive green technology constructively from distinguish scholars, researchers, and academics. Furthermore, this forum is expected to bring new innovations in technology for a better future, especially in the field of information technology, computers, and electrical engineerings and also create cooperation between institutions of science at the college level, industries and government.

It is a great pleasure to welcome all the participants of this conference and also several keynote speakers from Kyushu Institute of Technology Japan, Bandung Institute of Technology and Pasific Satelite Nusantara.

I do hope that this conference to be a valuable forum for engineers and scientist to share their precious researches and this event will give significant contributions to the development of Electrical Engineering and Computer Science. It is hope that this conference will rise the awareness of scientific community members in bringing better life.

I hope that the conference will be stimulating and memorable for you. So, enjoy your time in Semarang.

Ir. Bambang Pudjianto, M.T.
Dean, Faculty of Engineering
Universitas Diponegoro, Semarang – Indonesia

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Bahniman Ghosh (Indian Institute of Technology Kanpur, India)

| **KEYNOTE SPEAKER 1** |
|---|
| Keynote Speech :

 Prof. Hiroshi Ochi
 (Kyushu Institute of Technology, JAPAN) |
| Keynote Title :

 Multi-User MIMO Wireless System -From Theory to Chip Design |
| **Speaker's Biography:**
 Hiroshi Ochi is a professor in Computer Science and Electronics of Kyushu Institute of Technology in Fukuoka, Japan.Dr. Ochi is a cofounder of Que-Wave.He received Ph.D. from Tokyo Metropolitan University in 1990.He has been engaged in researches and developments of digital communication systems and signal processing areas at an academic environment since 1986.He brings over 17 years of experience and knowledge of electronics engineering to Que-Wave.One of the reasons he founded QW is he has felt to need more useful and high-performance devices than ever. And then, he decided to focus on producing useful tools and services from an engineer's point of views. |

KEYNOTE SPEAKER 2

Keynote Speech :

Prof. Dr. Trio Adiono
(Institut Teknologi Bandung)

Keynote Title :

Challenges and Opportunities in Designing Internet of Things

Speaker's Biography:

Trio Adiono is faculty member of the School of Electrical Engineering and Informatics of Institut Teknologi Bandung (ITB) and the head of IC Design Laboratory of Microelectronics Center ITB. He obtained his Ph.D. degree in VLSI Design from Tokyo Institute of Technology (Titech), Japan. From 2002 to 2004 he was a research fellow of the Japan Society for the Promotion of Science (JSPS) in Titech. In 2005, he was a visiting scholar at MESA+, Twente University, Netherlands. He has developed several microchips for video processing, smart card, NFC, and WiMax Baseband Chip. He received the "Second Japan Intellectual Property (IP) Award" in 2000 from Nikkei BP for his research on "Low Bitrate Video Communication LSI Design".

KEYNOTE SPEAKER 3

Keynote Speech :

Adi Rahman Adiwoso
(Pasifik Satelit Nusantara)

Keynote Title :

Role of Telecommunication Satellite in Indonesia

Name : Adi Rahman Adiwoso
Place / Date of Birth : Yogyakarta, 26 July 1953
Status : Married With 2 Children
Education :
BSc in Aeronautical and Astronautical Engineering, Purdue University, 1974
MSc in Aeronautical and Astronautical Engineering, California Institute of Technology, 1976
Work Experience :
1974 – 1982 Hughes Aircraft Company
1982 – 1987 Rasikomp Nusantara
1987 – 1990 PT Rajasa Hazanah Perkasa as Managing Director
1987 – 1991 Board member and COO of Orion Satellite Asia Pacific in Washington DC
1991 – Current President Director of PT Pasifik Satelit Nusantara
1993 – 1995 Marketing Director of PT Satelit Palapa Indonesia
1994 – Current Chairman and CEO of ACeS
1999 – 2008 Chairman of Indonesian Institute of Corporate Governance
2005 – 2006 Expert Staff for BRR
2007 – 2012 Member of Board of Commissioner of PT Garuda Indonesia
2008 – 2012 Member of Board of Commissioner of PT Dirgantara Indonesia (Persero)
2008 – 2011 Member of Board of Commissioner of PT Perusahaan Pengelola Aset
2009 – 2010 Member of Board of Commissioner of PT Merpati Nusantara
Other :
Graduate with Honors from Purdue University
Howard Hughes Fellowship
Nominated in 1997 as The Best Satellite Executive of The Year, Washington DC
Nominated in 2001 as The Best Satellite Executive of The Year, Washington DC
Awarded in 2005 as The Best Satellite Executive of The Year in the Asia-Pacific

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CONFERENCE PROGRAM

SATURDAY, 8 NOVEMBER 2014

7:30 - 8:00	Registration			
8:00- 8:45	Opening ceremony			
	Photo session			
8:45 - 9:00	Coffee break			
9:00 - 9:50	Invited speaker 1: Prof. Hiroshi Ochi (*Kyushu Institute of Technologi, JAPAN*) *Multi-MIMO Wireless System - from Theory to Chip Design*			
9:50 - 10:40	Invited speaker 2: Prof. Dr. Trio Adiono (Institut Teknologi Bandung) *Challenges and Opportunities in Designing Internet of Things*			
10:40 - 11:30	Invited speaker 3: Dr. Adi Rahman Adiwoso (PT. Pasifik Satelit Nusantara) *Role of Satellite Telecommunication in Indonesia*			
11:30 - 12:30	LUNCH BREAK			
12:30 - 15:00	Parallel session 1			
	ROOM A	ROOM B	ROOM C	ROOM D
15:00 - 15:15	coffee break			
15:15 - 17:30	Parallel s ession 2			
	ROOM A	ROOM B	ROOM C	ROOM D
18:30 - 20:00	GALA DINNER			

SUNDAY, 9 NOVEMBER 2014

8:00 - …	*cultural program (city tours)* *(*with additional arrangements)*

PARALLEL SESSION

TIME: 12.30 – 15.00

NO	CODE	ROOM A (HALL, 5th FLOOR) TITLE	CODE	ROOM B (5th FLOOR) TITLE	CODE	ROOM C (4th FLOOR) TITLE	CODE	ROOM D (4th FLOOR) TITLE
1	PS01	Design and Implementation of Solar Power as Battery Charger Using Incremental Conductance ent Control Method based on dsPIC30F4012	IP01	Visual Object Tracking using Particle Clustering	CC01	Enhancement of DRAMs Performance using Resonant Tunneling Diode Buffer	ITC01	The Development of 3D Educational Game to Maximize Children's Memory
2	PS02	An Adaptive Neuro Fuzzy Inference System for Fault Detection in Transformers by Analyzing solved Gases	IP02	Selective Encryption of video MPEG use RSA Algorithm	CC02	Real-time SoC Architecture and Implementation of Variable Speech PDF based Noise Cancellation System	ITC02	The Influence of Knowledge Management to Successful Collaborative Design
3	PS03	Optimal Power Flow based upon Genetic Algorithm deploying Optimum Mutation and Elitism	IP03	Analytical Hierarchy Process for Land Suitability Analysis	CC03	Application of Supervised Learning in Grain Dryer Technology Recirculation Type Cooperated with Wireless Sensor Network	ITC03	Knowledge and Protocol on Collaborative Design Selection
4	PS04	Design Analysis and Optimization of Ground Grid Mesh of Extra High Voltage Substation Using an Intelligent Software	IP04	Training Support for Pouring Task in Casting Process using Stereoscopic Video See-through Display – Presentation of Molten Metal Flow Simulation Based on Captured sk Motion -	CC04	Design of Real-Time Gas Monitoring System Based-on Wireless Sensor Networks for Merapi Volcano	ITC04	Mobile-Based Learning Design with Android Development Tools
5	PS05	Design and Simulation of Neural Network Predictive Controller Pitch-Angle Permanent Magnetic Synchronuous Generator Wind Turbine Variable Pitch System	IP05	Feature Extraction and Classification of Heart Sound based on Autoregressive Power Spectral Density	CC05	ANFIS Application for Calculating Inverse Kinematics of Programmable Universal Machine for Assembly (PUMA) Robot	ITC05	A mobile diabetes educational system for Fasting Type 2 Diabetes in Saudi Arabia
6	PS06	Inverse Clarke Transformation based Control Method of a Three-Phase Inverter for PV-Grid stems	IP06	Smart-Meter based on current transient signal signature and constructive ckpropagation method	CC06	MRC NN Controller for Arm Robot Manipulator	ITC06	Aggressive Web Application Honeypot for Exposing Attacker s Identity
7	PS07	Control of a Single Phase Boost Inverter with the Combination of Proportional Integrator and Hysteresis Controller	IP07	AUTOMATIC DOORSTOP SAFETY SYSTEM BASED ON IMAGE PROCESSING WITH WEBCAM AND SCANNER	CC07	Development of Microcontroller-based Stereoscopic Camera Rig Positioning System	ITC07	Adjustment Levels for Intelligent Tutoring System using Modified Items Response Theory
8	PS08	A Simple Three-phase Three-wire Voltage Disturbance Compensator	IP08	Palmprint identification for User Verification based on Line Detection and Local Standard viation	CC08	Design of A Digital PI Controller for Room Temperature on Wireless Sensor and ctuator Network (WSAN) System	ITC08	Smile Recognition System based on Lip Corners Identification
9	PS09	Analysis of Protection Failure Effect and Relay Coordination on Reliability Index	IP09	Cerebellar Model Articulation Controller (CMAC) for Sequential Images Coding	CC09	Display and Interface of wireless EMG measurements	ITC09	An Integrated Framework for Measuring Information System Success Considering the Impact of Culture in Indonesia
10	PS10	Extreme Learning Machine Approach to Estimate Hourly Solar Radiation On Horizontal Surface (PV) in Surabaya – East Java	IP10	A Comparative Study on Signature Recognition	CC10	Accuracy Enhancement of Pickett Tunnelling Barrier Memristor Model	ITC10	Pre-Processing Optimization on Sound Detector Application AudiTion (Android Based Supporting Media for the Deaf)

COFFEE BREAK

TIME: 15.15 – 17.30

NO	CODE	ROOM A (HALL, 5th FLOOR) TITLE	CODE	ROOM B (5th FLOOR) TITLE	CODE	ROOM C (4th FLOOR) TITLE	CODE	ROOM D (4th FLOOR) TITLE
11	PS11	Maximum Power Point Tracking Control for Stand-Alone Photovoltaic System using Fuzzy Sliding Mode Control Maximum Power Point Tracking Control for Stand-Alone Photovoltaic System using Fuzzy Sliding Mode Control	IP11	Study of Environmental Condition Using Wavelet Decomposition Based on Infrared Image	CC11	Data Fusion and Switching Function For UAV Quadrotor Navigation System	ITC11	EVALUATION OF DISTRIBUTION NETWORK RELIABILITY INDEX USING LOOP RESTORATION SCHEME
12	PS12	Influence of Meteorological Parameters under Tropical Condition on Electricity Demand haracteristic: Indonesia Case Study	IP12	Very High Throughput WLAN System for Ultra HD 4K Video Streaming	CC12	ata Logger Management Software Design for Maintenance and Utility in note	ITC12	ficient Message Security Based Hyper Elliptic Curve Cryptosystem (HECC) for Mobile stant Messenger
13	PS13	Optimal Distribution Network Reconfiguration with Penetration of Distributed Energy Resources	IP13	Iris Recognition Analysis Using Biorthogonal Wavelets Tranform for Feature Extraction	CC13	Investigation of Electrical Properties of Nanofibre Polyaniline Synthesize as Material for Sensor	ITC13	Application of Web-Based Information System Production Process of Batik Industry Design Vision
14	PS14	Maximum Power Point Tracking Photovoltaic Using Root Finding Modified Bisection Algorithm	TE01	Data Rate of Connections Versus Packet Delivery of Wireless Mesh Network with Hybrid Wireless Mesh Protocol and Optimized Link State Routing Protocol	CC14	Reconfigurable Floating Point Adder	ITC14	Managing and Retrieval of Cultural Heritage Multimedia Collection Using Ontology
15	PS15	Design of LLC Resonant Converter for Street Lamp Based On Photovoltaic Power Source	TE02	Empirical Studies of Wireless Sensor Network Energy Consumption for Designing RF Energy Harvesting	CC15	HOVER POSITION CONTROL WITH FUZZY LOGIC	ITC15	Individual Decision Model for Urban Regional Land Planning

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No	PS	TE	CC / ITC	ITC
16	**PS16** Power Loss Reduction Strategy of Distribution Network with Distributed Generator Integration [19]	**TE03** Modulation Performance in Wireless Avionics Intra Communications (WAIC) [1]	**CC16** METHODOLOGY OF FUZZY LOGIC WITH MAMDANI FUZZI MODELS APPLIED TO THE MICROCONTROLLER [4]	**ITC16** Enhancing Online Expert System Consultation Service with Short Message Service Interface [4]
17	**PS17** Double Dielectric Barrier Discharge Chamber for Ozone Generation [1]	**TE04** Implementation and Performance Analysis of Alamouti Algorithm for MIMO 2__2 Using Wireless Open-Access Research Platform (WARP) [4]	**CC17** Fall Detection System Using Accelerometer and Gyroscope Based on Smartphone	**ITC17** Mobile Nutrition Recommendation System For 0-2 Year Infant
18	**PS18** Leakage Current Characteristics at Different Shed of Epoxy Resin Insulator under Rain Contaminants [1]	**TE05** Period Information Deviation on the Segmental Sinusoidal Model [4]	**CC18** Design and Implementation of Sensor Fusion for Inertia Measurement on Flying Robot Case Study: Hexacopter [4]	**ITC18** Comparison of Distance and Dissimilarity Measures for Clustering Data with Mix Attribute Types [4]
19	**PS19** Transformer monitoring using harmonic current based wavelet transformation and probabilistic neural network (PNN) [15]	**TE06** A Compact Dual-band Antenna Design using Meander-line Slots for WiMAX Application in Indonesia [1]	**CC19** Triple Band Bandpass Filter With Cascade Tri Section Stepped Impedance Resonator [1]	**ITC19** Determining E-commerce Adoption Level by SMEs in Indonesia Based on Customer-Oriented Benefits [1]
20		**TE07** Design and Analysis of Dualband J-Pole Antenna with Variation in T-Shape for Transceiver Radio Communication at VHF and UHF Band [1]	**CC20** Temperature Response Analysis Based on Pulse Width Irradiation of 2.45 GHz Microwave Hyperthermia [1]	**ITC20** Providing Information Sources Domain for Information Seeking Agent From Organizing Knowledge [1]
21		**TE08** Low Cost Implementation for Synchronization in Distributed Multi Antenna Using USRP/GNU-Radio [4]	**ITC24** Visualization of Condition Irrigation Building and Canal Using Web GIS Application	**ITC21** Decision Support System For Stock Trading Using Decision Tree Technical Analysis Indicators and Its Sensitivity Profitability analysis [1]
22		**TE09** Development of the First Indonesian S-Band Radar	**ITC25** Comparison of three back-propagation architectures for interactive animal names utterance learning [4]	**ITC22** Design Web Service Academic Information System Based Multiplatform [1]
23			**ITC26** WORK IN PROGRESS - OPEN EDUCATION METRIC (OEM): DEVELOPING WEB-BASED METRIC TO MEASURE OPEN EDUCATION SERVICES QUALITY	**ITC23** Effects of VANET's Attributes on Network Performance

Study of Environmental Condition Using Wavelet Decomposition Based on Infrared Image

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Abstract—In this paper, we report our experiment about wavelet decomposition for study environmental condition based on infrared images. Infrared images acquired by consumer digital camera, after replacing the infrared stoping filter with filter SRS, and the images captured sequentially every two hours (from 06:00—16:00). The result of this research is the increasing air pollution characterized using wavelet decomposition by increasing index value from 0—3 and amount of white spots about 60% (from 5%—65%). Finally wavelet decomposition was made to estimate the environmental condition, especially air pollution, based on infrared image.

Keywords—*environmental condition, wavelet decomposition, infrared image*

I. INTRODUCTION

Air as a component of the environment is important in life needs to be maintained in order to provide support for living things in an optimal. Several researchers have been working on air quality remote monitoring system researches. An Internet and short message-based air quality monitoring was developed in [1], [2]. However, to the authors' knowledge, an air quality remote monitoring system based on thermal imaging of the surrounding environment has not been developed in Indonesia. Therefore, this study proposes an air pollution monitoring system based on infrared images using wavelet decomposition.

II. THE UNDERLYING THEORY

Air pollution is harmful elements that may result in environmental damage, disruption on human health and the quality of the environment. The causes of air pollution caused by motor vehicle exhaust using gasoline and diesel as well as the disposal of the remnants of the industrial plant that could damage the environment.

Worse air environment is estimated to be the causes of fatigue during the trip. Fatigue can lead to motorists and other road users cannot control themselves. In turn, this may reduce alertness and threaten the safety of the trip. However, there is currently no practical tools to tell this condition. So far, the road superintendents (traffic police and CCTV cameras) are only able to tell the extent of traffic levels. In fact, the more dense and the longer traffic congestion, pollution levels in the jammed area also increased. This has implications for accelerated fatigue and concentration of motorists and other road users. CCTV cameras were installed to monitor the level of traffic density and the infrared camera can be used utilized as a means of monitoring air pollution. The resulting infrared image is a picture of a record object or objects in an image is usually a picture. The term image is used to express the intensity of light in a two-dimensional function f (x, y), where (x, y) coordinates of spatial states and the values of f at the point (x, y) expressed levels of brightness (gray level) image at that point [3].

A. Infrared image

Infrared image acquired from infrared photography, they have wavelength greater than 700 nm.

Investigation the characteristics of the light-absorbing filter visual and infrared light passed by the effect of variations in light intensity and SRS filter the results obtained [4]; [5] studied the physical phenomena on digital photography which in fact can be improved by using the image of near infrared (NIR), the result of a combination of NIR image with a grayscale image look more powerful than the original RGB image.

Furthermore Fredembach et al. [6] suggested that the near-infrared spectrum contains important information about the imaging light source. It is shown that a simple calculation of the ratio of the NIR and RGB, scene illuminant can be determined accurately.

Have obtained infrared image histogram characteristics are captured using a modified digital camera [7]. Furthermore

conducted a study and found that moving averages can be applied to spatial filtering towards the object to obtain thermal conditions [8]. Sulistiyanti, et. al. also found that slicing the histogram can be used to obtain information object temperature distribution thermal conditions [9]. Furthermore, by conducting research with Surface (2D) contour fittings obtained for the isothermal calorimetry catches consumer digital camera [10]. Article entitled characterization of Cutting Temperature and Ignition Phenomena of Magnesium Chip using Infrared Imaging [11] indicated that infrared thermography could be use to determine the ignition point of magnesium chips cutting temperature.

B. Wavelet Transform

The wavelet transform is processing for images, used 2-D wavelet transform. The steps of 2-D wavelet transform could be illustration in the Figure 1.
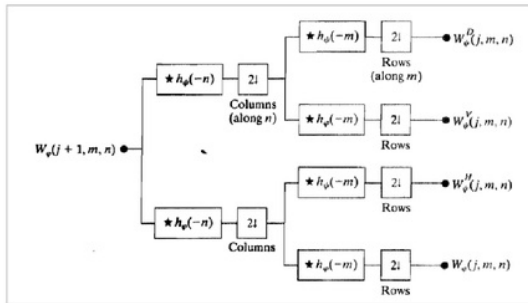
Fig. 1 The 2-D Fast Wavelet Transform, the analysis filter bank [12].

C. Wavelet Decomposition
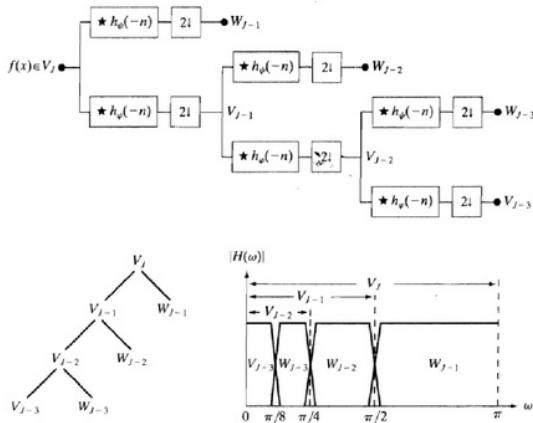
Fig. 2 A three-scale FWT filter bank: a. block diagram; b. decomposition space tree; and c. spectrum splitting characteristic [12].

In [13], demonstrate the advantage of this algorithm over standard soft thresholding (implemented with the same wavelet representation) on images with artificial Gaussian noise. On infrared images of land mines from our data set, this simple technique offers a significant improvement. The background noise is strongly suppressed and the presence of the object of interest is enhanced. One should note that noise suppression is achieved here by a "severe" suppression of all the coefficients that are not located in the vicinity of the edges detected from the low-pass images. This is useful for images where a uniform-intensity object needs to be distinguished from a background, but this method is not as favorable in cases where fine image details need to be preserved.

III. MATERIALS AND METHODS

The experiment used Fuji Finepix A400 digital camera is given filter infrared SRS, performed around the market Bambu Kuning Bandarlampung. Data obtained starting at 06.00 s.d. 16.00, with a time interval of 2 hours. For infrared images of environmental condition processing, the RGB images converted into gray level images. Conversion to gray level meant to be seen how much noise of the object. After that, the next step is processing using wavelet transformation and wavelet decomposition method, to compare the result of them. Wavelet and wavelet decomposition process aims to evaluate concerning this for characterize air pollutant.

IV. RESULTS OF THE RESEARCH

Figure 3 shows one of original infrared environmental image with position of cropping in RGB and grayscale format, local time is 06:00. Position of cropping assumed as air condition unlimited and could be used everywhere. If cropping in the building, the result obtained in the other place must be calibrate with the building. The images, captured every two hours from 06:00 till 16:00, changed be grayscale images. After that, the grayscale images processed use wavelet and wavelet decomposition.

Figure 4 show the result of wavelet processing, they captured every two hours from 06:00 till 16:00. On the left of each image in Figure 4 is a process wavelet, top-left and clockwise are grayscale an image, horizontal process, diagonal process, and vertical process. And on the right of each image in Figure 4 is amount of horizontal, vertical, and diagonal process of wavelet decomposition. In Figure 4, increasingly air pollution depends on the time. In the morning (06:00—08:00) qualitatively resulting images seen 'dark', these mean environmental condition relatively clear, but from 10:00—16:00 seen increasing 'white spots', these mean dirty air in other words increasing pollution air. Index value in these result of wavelet decomposition processing of images also increase from 0—3 (dark or black spots=0 and white spots=3). It could be show in Figure 4. Figure 4 also show the result of wavelet decomposition processing, they captured every two hours from 06:00 until 16:00. Like Figure 3, the left of each image in Figure 4 is a process wavelet decomposition, top-left and clockwise are grayscale an image, horizontal process, diagonal process, and vertical process. And on the right of each image in Figure 4 is amount of horizontal, vertical, and diagonal process of wavelet decomposition.

Seen in Figure 5, increasingly air pollution depends on the time. In the morning (06:00—08:00) qualitatively resulting images seen 'dark', these mean environmental condition

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relatively clear, but from 10:00—16:00 seen increasing 'white spots', these mean dirty air in other words increasing pollution air. Index value in these result of wavelet decomposition processing of images also increase from 0—3 (dark or black spots=0 and white spots=3) and amount of white spots increase about 60% (from 5% become 65%), it could be show in Figure 5.

The result of this research shows that wavelet transform could be used to see environmental condition but it is less clear than wavelet decomposition. This is as seen in Figure 4 and Figure 5.

RGB level

b. Grayscale level

Fig. 3 One of original image

a.   06.00

b.   08.00

c.   10.00

d.   12.00

e.   14.00

f.   16.00
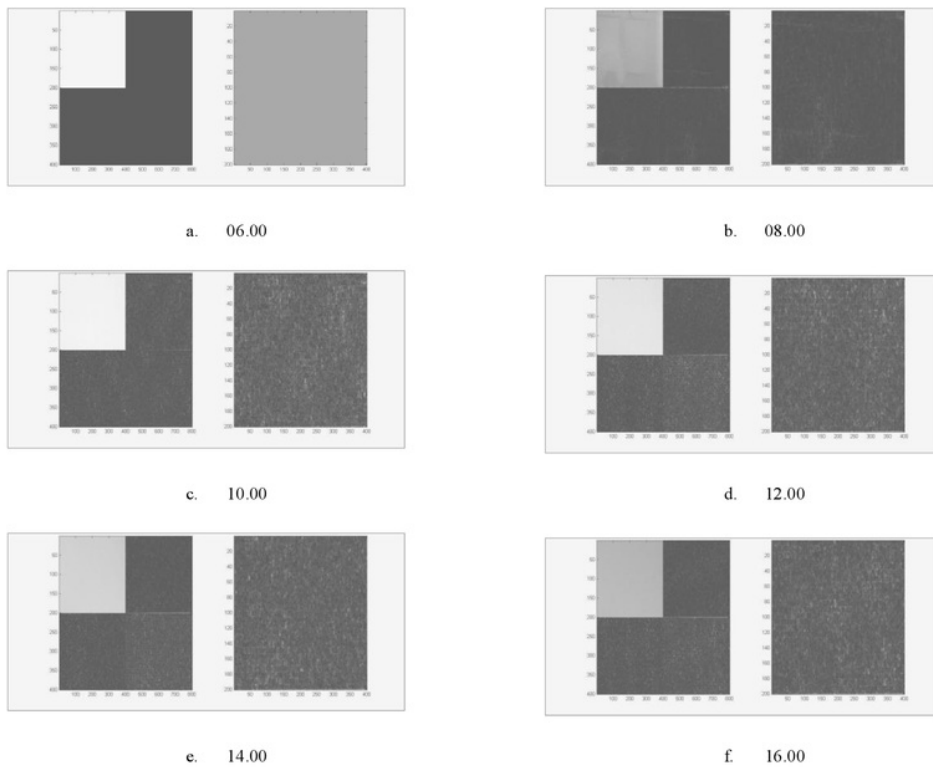
Fig. 4 Wavelet transform of infrared environmental condition images

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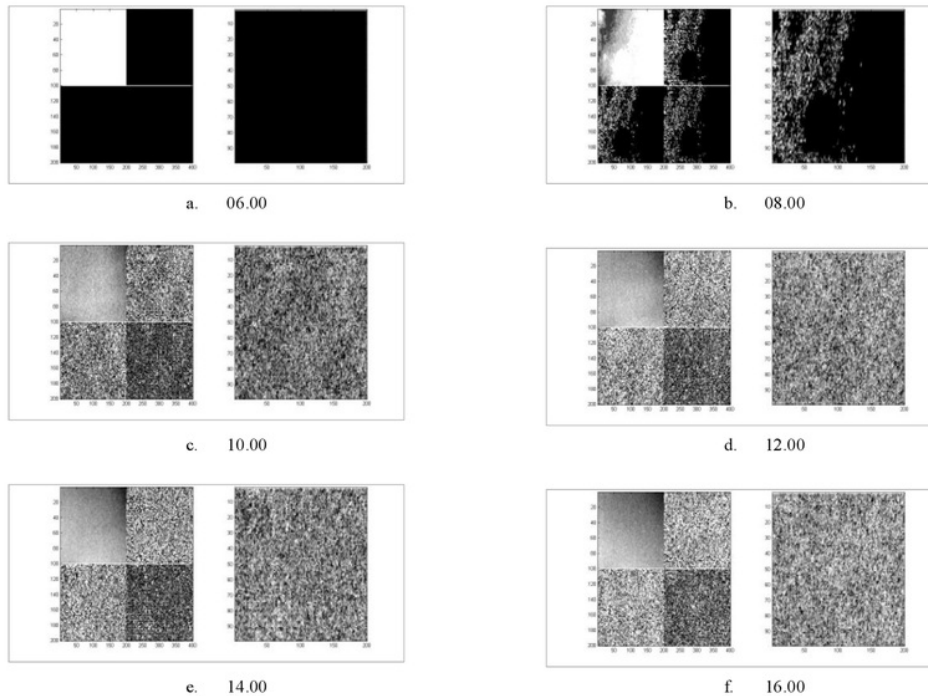
Fig. 5 Wavelet decomposition of infrared environmental condition images

V. CONCLUSIONS AND SUGGESTION

A. Conclusions

- The increasing air pollution characterized using wavelet decomposition by increasing index value from 0 (black)—3 (white) and amount of white spots about 60% (from 5% become 65%).

- Wavelet decomposition could be use to monitoring environmental condition, especially air pollution.

B. Suggestion

This research could be continuing with further research to get characteristic of air pollutant and monitoring air pollution.

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