2013 INTERNATIONAL CONFERENCE ON QiR
(QUALITY in RESEARCH)

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Yogyakarta
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WELCOME FROM THE RECTOR OF UNIVERSITAS INDONESIA

It is both a pleasure and honor for me to welcome you all to the 13th International Conference on QiR (Quality in Research) 2013. In this globalization era, mankind's competitive explorations to find new and better ways to enhance their life has often resulted in sacrificing the environment for their convenience. To preserve the environment for our future generations, steps must be made to ascertain that development and innovation of mankind must be more sustainable, balancing both mankind's' effort in enhancing their quality of life and fulfilling their needs, with its harmony with nature.

Today, scientists and experts, in particular, people in engineering, architecture and design are looking to develop new environmentally friendly technologies, or eco-technologies. Innovation in eco-based multidisciplinary knowledge and skills becomes the important key, and this central issue should be encouraged for the motivation of current and future development. Eco-technology can help protect, conserve and even restore our precious shared environment. To develop this technology, we need to combine engineering, scientific or technological approaches, with ecology, economics and the social sciences and humanities. The eco-innovation field is now wide open and offers exciting new territories to explore and develop. Creative thinking by our top technical and scientific researchers is giving us a more and more treasures of new workable ideas.

However, innovations require more than just brilliant ideas. Innovations require resources, skills, technology, knowledge, tools, techniques and so much more. But most of all, innovations require people. People are the driving force behind every need of change, changes that are aimed to improve mankind's quality of life, to enhance their living conditions or to simply make life easier and more comfortable. This conference is about learning of the fundamental aspects which can transform the world and society, thinking ahead to possible challenges facing the globe, discovering innovations related to opportunities for industry, and most importantly, this conference is about bringing together interdisciplinary people to accelerate activities in many areas simultaneously. This is what makes the conference exceptional this year in terms of potential impact from this networking.

I extend my sincere thanks to the Faculty of Engineering Universitas Indonesia, supporting parties and institutions for their participation and contributions in QiR 2013. I would also thank the people of Yogyakarta for their gracious support and hospitality. Additionally, I extend a hearty thank you to the members of the organizing committees for dedicating their valuable time so that each one of us enjoys an exceptional conference program over the next several days. May we have a successful, stimulating, fruitful and rewarding conference.

Prof. Dr. Ir. Muhammad Anis M.Met.
Rector
Universitas Indonesia

WELCOME FROM THE DEAN OF FACULTY OF ENGINEERING UNIVERSITAS INDONESIA

Welcome to the 13th International Conference on QiR (Quality in Research) 2013. The Faculty of Engineering Universitas Indonesia is thrilled that, together with our co-hosts IST-Akprind and Gadjah Mada University, we are able to present an international conference of this magnitude. This two-day conference speaks to the importance of fostering relationships among national and international front liners, thinkers, academics, executives, government and business officials, practitioners and leaders across the globe in an effort to share knowledge and best practices as part of a worldwide network.

The quest for knowledge has been from the beginning of time but knowledge only becomes valuable when it is disseminated and applied to benefit humankind. It is hoped that QiR 2013 will be a platform to gather and disseminate the latest knowledge in engineering, architectural design and community services. Academicians, scientist, researchers and practitioners of these fields will be able to share and discuss new findings and applications of their expertise. It is envisaged that the intellectual discourse will result in future collaborations between universities, research institutions and industry both locally and internationally. In particular it is expected that focus will be given to issues on innovations for the enhancement of human life and the environment.

In accordance to this year's theme, this conference will cover a wide range of sustainable design and technology issues, especially state of the art information and knowledge of new innovations, ideas, creative methods or applications which can be implemented to enhance the human life and also our environment. The itinerary of the conference over the two days has been carefully planned to ensure a lively exchange of ideas and the development of innovative strategies and there will be many opportunities for everyone in attendance to share their expertise with, and learn from, peers from around the world.

We urge you to spend the next two days in interesting discussions and exchanging ideas among yourselves. We foresee more and more challenges in our future. Challenges in how to improve our life, how can we enhance our society, how can we make our lives and the lives or our society better? These challenges should be answered together by developing collaborations for future research in various engineering and design areas. It is our hope and aim that this conference would be able to provide an international media for exchange of the knowledge, experience and research as well as the review of progress and discussion on the state of the art and future trend of prospective collaboration and networking in broad field of eco-based technology development.

My deepest appreciation to our sponsors, supported parties and various contributors for their never ending supports of this conference. I would also like to convey my humblest thankfulness to all of our distinguished speakers for making the time to share their knowledge with us. To our fellow researchers and/or practitioners from Indonesia and overseas, welcome and enjoy your stay in this amazing historical city, Yogyakarta. I would also like to invite all participants in expressing our appreciation to all members of the QiR 2013 organizing committee for their hard work in making this conference another success.

Prof. Dr. Ir. Bambang Sugiarto, M.Eng
Dean Faculty of Engineering
Universitas Indonesia

PREFACE

WELCOME FROM THE QiR 2013 ORGANIZING COMMITTEE

Welcome to the 13th International Conference on QiR (Quality in Research) 2013. It is a great pleasure for Faculty of Engineering Universitas Indonesia to be co-hosting this biennial event with IST-Akprind and Gadjah Mada University, in the spirit of strengthening of cooperation and mutual growth to be world class institution. For the first time, the QiR 2013 is held in one of the most historical city in Indonesia – Yogyakarta. It is with our utmost pleasure to hold this year's QiR 2013 in conjunction with the 2nd International Conference on Civic Space (ICCS 2013) and introducing the International Symposium on Community Development 2013 as a forum to share experience on engaging community for a better life and environment.

The aim of this International Conference with our selected theme, "Exploring Innovation for Enhancement of Human Life and Environment", is to provide an international forum for exchanging knowledge and research expertise as well as creating a prospective collaboration and networking on various fields of science, engineering and design. We hope this conference can be a kick-off for the strengthened action and partnerships on creating a platform for us; national and international thinkers, academics, government officials, business executives and practitioners, to present and discuss the pivotal role of engineers in innovative products which will reduce environmental impacts, applications in sustainable planning, manufacturing, architecture, and many more to grow and ensure the rising prosperity of our society going into the future. Under this theme, the conference focuses on the innovative contributions in science, engineering and design as well as their market perspectives to the existing and future enhancement of human life and environment quality.

Over the period of 15 years, this biennial conference has become an important place of encounter between scholars and practitioners from different countries, cultures and backgrounds discussing contemporary engineering and design issues dealt in their hometown, country or even region. Serving as a platform for an engineering and design dialogue, this conference will have 16 invited speakers and has gathered more than 500 papers from more than 20 countries all over the world:
92 papers on International Symposium on Civil and Environmental Engineering
51 papers on International Symposium on Mechanical and Maritime Engineering
97 papers on International Symposium on Electrical and Computer Engineering
111 papers on International Symposium on Materials and Metallurgy Engineering
31 papers on International Symposium on Architecture, Interior and Urban Planning
57 papers on International Symposium on Chemical and Bioprocess Engineering
71 papers on International Symposium on Industrial Engineering
25 papers on International Symposium on Community Development

My deepest gratitude to all of our speakers, participants and contributors who have given this conference their generous support. I would also like to thank all members of the Organizing Committee and our distinguished International Board of Reviewers for all of their support and advice. Our thanks to all of our sponsors, supporters, exhibitors, and professional associations for their great support and encouragement through committed funding and any other form of help and support. We also owe our success to the full support of the Rector of Universitas Indonesia and the Dean of Faculty of Engineering. Thank you to IEEE Indonesia Section that has supported QiR 2013 to be approved as IEEE Conference. Last but not least, a special thanks to our co-hosts, IST-Akprind and Gadjah Mada University for all of their immense supports in making this conference a success.

Allow me to wish all of you a meaningful and rewarding conference. We wish you a pleasant and memorable stay in Yogyakarta. Thank you and we hope to see you again at the QiR 2015.

Prof. Dr. Ir. Bondan T. Sofyan, M.Si.
Chairman of QiR 2013 Organizing Committee

Microplate Luminescence Automated Digital Analyzer for Medicinal Plants Evaluation on Quorum Sensing Inhibition

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***Abstract*—Quorum sensing is a mechanism used by most of pathogenic bacteria to coordinate their gene expression. Through this kind of mechanism the bacteria could detect the density of their local population until at a certain level they will act together to emerge virulence which cause disease in their host organism. Thus, the inhibition ability to quorum sensing mechanism is commonly used as an indicator to evaluate the potentiality of extracts from plants as antibacterial in drugs development. The quorum sensing activity could be detected using luminescence method. When the colony of bacteria reach the quorum and express certain activity, the luminescence will be produced. Microplate is a kind of experiment media which is used to conduct such experiment. The luminescence as the experiment result were captured as a digital image. The luminescence then examined to determine the plant performance to inhibit the bacteria virulence activity. Regarding most of the researcher's experience, it is believed that manual evaluation of those luminescence images is hard to interpret due to subjectivity factor and also inefficiency in time, especially when working with a large number of experiments. Therefore, in this research we developed a computer application to run quantification of the luminescence automatically. The automation process begin with gridding algorithm followed by object recognition and segmentation algorithm based on neural network learning. In order to improve the accuracy, image enhancement module were also attached to the system. In the output section, the quantification report presented using some statistical parameter to simplify interpretation and facilitate the researcher to run additional data analysis. With this application, the potentiality of extracts from plants as antibacterial agent could be inferred quickly, easily and accurately.**

Keywords—digital image processing; artificial neural network; automation; luminescence; quorum sensing

I. Introduction

Quorum sensing is bacterial mechanisms which is regulating some specific proteins expressions by calculating population density in their environment. Genes which are regulated by quorum sensing mechanism will only express (activated) at the time the bacteria population reached certain level of density. Some examples of genes whose expression was regulated by this mechanism are genes that regulate the formation of flagella and biofilm, and genes associated with virulence properties [1]. The fact that the virulence factor is also regulated by quorum sensing mechanism raises new hope to discover many techniques and/or agents to inhibit virulency of pathogenic bacteria. In this research, extracts from some Indonesian Medicinal plants was evaluated for their performance to inhibit quorum sensing mechanism of P*seudomonas aeruginosa* (one of the pathogenic bacteria which have resistance to many antibiotics). The evaluation was done by measuring the level of luminescence which is produced by the colony of P*seudomonas aeruginosa* when they reach the quorum and express certain activity. This experiment was conducted in a microplate which is a flat plate with multiple holes/wells used as small test tubes. Both of the bacteria colony and the extracts from plants was loaded into the holes. The level of luminescence then captured and transformed into digital image [2]. Next task is comparison of the result. Brighter luminescence indicates weak inhibition to the *Pseudomonas aeruginosa* quorum sensing mechanism. Most of the researcher use manual comparison to evaluate these luminescence images. Unfortunately, this method is not the best way to get good inference of the result. Manual comparison has many weaknesses due to subjectivity of the evaluator and also inefficiency in time when run multiple experiments. Hence, we propose the application of automatic digital image processing to quantify the luminescence images in the form of software named Microplate Luminescence Automated Digital Analyzer (MILDA). Therefore, the researcher could run various statistical data processing to get accurate and fast conclusion.

The first generation of MILDA was developed using hough transform algorithm for the segmentation (separation of the luminescence and the background area) procedure. But, due to the problem of imprecise circular form of the luminescence area, this method is found to be ineffective [3].

In this research, the artificial neural network algorithm was applied to improve the segmentation result.

II. Materials and methods

Input of the software are luminescence images using microplate as experiment media. Fig. 1 is the examples of the input images. The bright round shapes are the luminescence produces by the experiment in the round shape wells. Each well was loaded with the *Pseudomonas aeruginosa colony* and extract from particular medicinal plant. The medicinal plants used in this experiment are fennel, lawang, selasih, temu ireng, temu putih, temu giring and temu lawak. When the quorum sensing mechanism was totally inhibits by the extracts, the well will not produce any luminescence and will appears as black round shape. The micro plate could contain various numbers of wells, such as 36, 96, 384 and 1536.

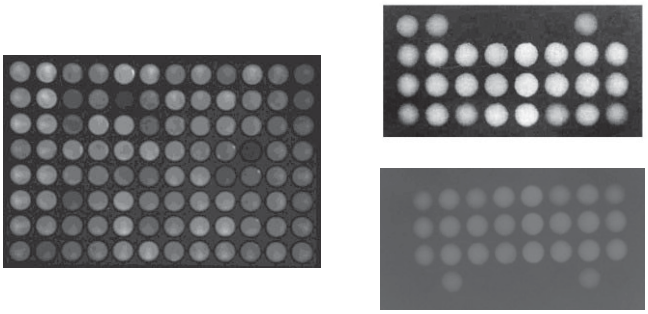

Fig. 1. Examples of the input images

The first step of the MILDA's system is preprocessing the input image to enhance its quality, the second step is run gridding procedure. In this procedure the system will automatically make a pattern of regularly spaced horizontal and vertical lines forming squares on the input image with modified fixed spot position algorithm.. At the end of the procedure, each square will only contain one round shape. Next, segmentation procedure was applied to each square. The aim of this procedure is to classify each pixel in the square as object (the luminescence) or background. Classification was done using neural network algorithm. Finally, the last step is quantification of the object pixels. In order to simplify the quantification result, MILDA was equipped with the statistical report feature. Fig. 2 depict the flowchart of the system. Details algorithm of each step will be explained in the next sections.

III. System Design

A. Preprocessing

In order to improve the accuracy of the luminescence value as the systems output, preprocessing the input image is one of the important step. Input image could have various quality due to its clarity, color intensity, color contrast or symmetricalness. Preprocessing will reduce the complexity of the algorithm in the next procedures. Some of the image enhancement algorithms was applied in preprocessing step which are noise reduction, image rotation and normalization. Noise reduction was conducted using median or wiener filtering algorithm. Median filtering reduced salt and pepper noise and wiener filtering reduced Gaussian noise [4].

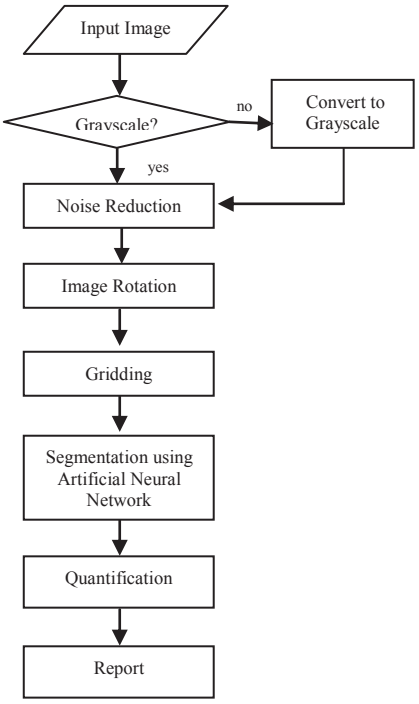

Fig. 2. Flowchart of the system

Fig. 3 depict the example of noise reduction result on the input image. Image rotation was applied due to symmetricalness problem of the input image. Asymmetric image will cause problems in the gridding procedure. Therefore radon transformation [5] algorithm used to transform asymmetric image into a symmetric one. Fig. 4 depict the example of image rotation to fix asymmetric image.

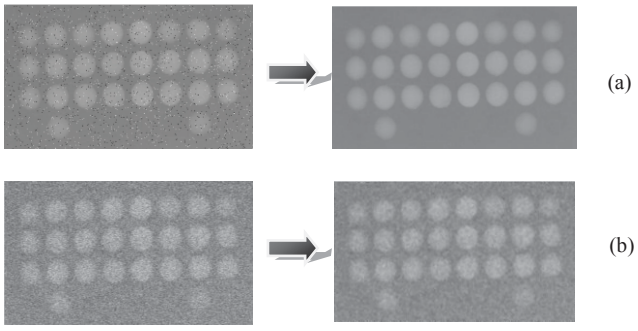

Fig. 3. Example of noise reduction, (a) Salt and Pepper, (b) Gaussian

Finally, the normalization algorithm was applied to adjust the color intensity range, such adjustment will increase the color contrast as shown in Fig. 5. Normalization was done using (1), O is intensity value before normalization and N is intensity value after normalization.

$$N_{x,y} = \frac{N_{max} - N_{min}}{O_{max} - O_{min}} \times \left(O_{x,y} - O_{min}\right) + N_{min} \quad \forall x, y \in 1, N \qquad \text{....(1)}$$

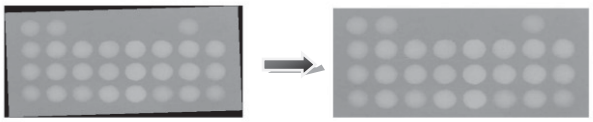

Fig. 4. Example of image rotation

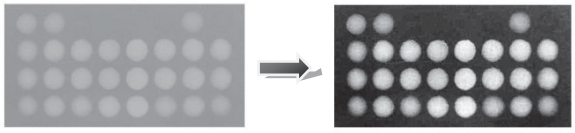

Fig. 5. Example of image normalization

B. Gridding Procedure

This procedure contain techniques to find the location of the objects (the round shape luminescence) automatically. In general, the basic concept is iteratively creates vertical and horizontal lines on the input image such that in the final step each object will be placed exactly on the center of a square. The algorithm used for this process is fixed spot position [6] with some modification. Formerly the input image should be transform into grayscale type and followed by application of particular intensity threshold value to identify each pixel as object or background. Vertical and horizontal line will divide two objects in equal distance regarding the edge pixels of both objects. Fig. 6 is the example of the gridding procedure result. Now, each square carried out one object.

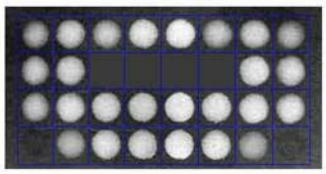

Fig. 6. Result of the gridding procedure

C. Segmentation Procedure

After gridding procedure, the system will save position of each square with the object inside. Thus, the extraction of the objects is ready to be proceeded. The first step to extract the object is finding all the object's pixels. To find those pixels, the system should have the ability to well recognize the characteristic of the color intensity of the object pixels as well as the background pixels. In order to increase this ability, neural network (NN) method was applied here. Intensity histogram was chosen as the input of the NN architecture. Therefore, 256 nodes are used in the input layer. For the hidden layer it is found that one layer with 6 node give the best output prediction. One output node represents the color intensity threshold value that will classify each pixel as object or background. Fig. 7 depict the best NN architecture implemented in the system. At the end of the process, the system will store the position of each object pixel and the corresponding intensity value in its database.

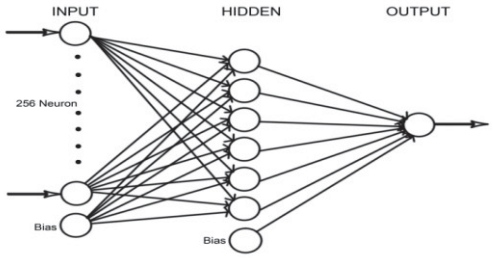

Fig. 7. Neural network architecture for segmentation process

D. Quantification

This is the step to summarize all object pixels intensity values (from the segmentation procedure) in the database and represent them in more sophisticated format. Quantification of each object luminescence should appear as single value. For this purpose, the system provide option button such that user could choose the method of summarization which is mean, median, maximal or minimal value. Fig. 8 shows example of the quantification process result using mean value.

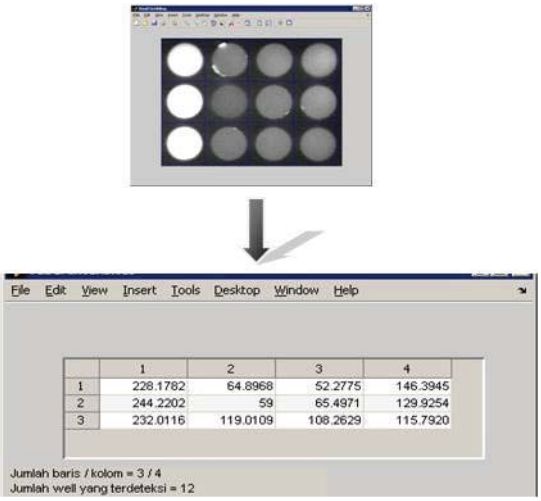

Fig. 8. Example of the quantification process result

E. Report

Report feature was attached to the system to facilitate user for advance data processing. The report will be in .xls format which is contains the position and luminescence intensity of

each object pixels. By this feature the researcher could easily prepare raw data to run various kinds of statistical data processing such as testing hypothesis, ANOVA, regression and cluster analysis.

IV. Result and Discussion

In general the performance of the system is good. The quantification performance of the intensity value is depends the input image. From all input images sample with various level of quality, the system could give reasonable quantification result for 87.5% among them. The system only fail on very low quality of input image. For this kind of input image, the systems already fail in gridding process thus no intensity value reported on the output interface. The accuracy of the system was proven too by changing the concentration of the plant extract. In theory, the increasing concentration of quorum sensing inhibitors will result on decreasing luminescence intensity [7]. The quantification result shows exactly the same tendency in almost all of the samples as shown in Table 1. In the matter of time, the run time depend on the number of the microplate wells. MILDA could run all the process less than 15 second. This result is better than previous system using circular hough transform for its segmentation process [3].

TABLE I. THE ABILITY OF PLANTS EXTRACT IN VARIOUS CONCENTRATION TO INHIBIT THE LUMINESCENCE

Plant	Concentration (mg/ml)	Luminescence Inhibition (%)
Fennel	23.8	59.2
	19.0	65.4
	14.3	53.9
Lawang	23.8	34.1
	19.0	19.2
	14.3	-3.2
Selasih	23.8	59.8
	19.2	47.9
	14.3	44
Temu Ireng	38.1	44.1
	19.0	39.7
	9.5	7.7
Temu Giring	38.1	16.3
	19.0	3.9
	9.5	7.9
Temu Putih	38.1	-0.3
	19.0	4.9
	9.5	28.8
Temulawak	38.1	16.5
	19.0	23.5
	9.5	6.3

V. Conclusion

Although this system could perform good quantification result, it is known that the quality of input image still bring major difficulties. Therefore, for the future works we propose to design a customized media to capture the luminescence directly from the microplate. This media then integrated to the MILDA software such that the quantification could run in real time.

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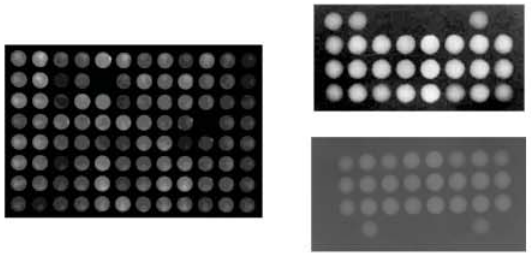

Fig. 1. Examples of the input images

The first step of the MILDA's system is preprocessing the input image to enhance its quality, the second step is run gridding procedure. In this procedure the system will automatically make a pattern of regularly spaced horizontal and vertical lines forming squares on the input image with modified fixed spot position algorithm.. At the end of the procedure, each square will only contain one round shape. Next, segmentation procedure was applied to each square. The aim of this procedure is to classify each pixel in the square as object (the luminescence) or background. Classification was done using neural network algorithm. Finally, the last step is quantification of the object pixels. In order to simplify the quantification result, MILDA was equipped with the statistical report feature. Fig. 2 depict the flowchart of the system. Details algorithm of each step will be explained in the next sections.

III. System Design

A. Preprocessing

In order to improve the accuracy of the luminescence value as the systems output, preprocessing the input image is one of the important step. Input image could have various quality due to its clarity, color intensity, color contrast or symmetricalness. Preprocessing will reduce the complexity of the algorithm in the next procedures. Some of the image enhancement algorithms was applied in preprocessing step which are noise reduction, image rotation and normalization. Noise reduction was conducted using median or wiener filtering algorithm. Median filtering reduced salt and pepper noise and wiener filtering reduced Gaussian noise [4].

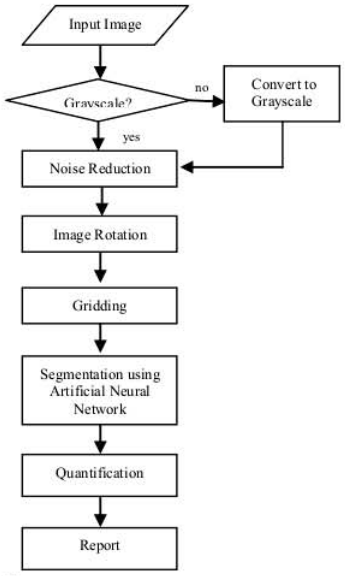

Fig. 2. Flowchart of the system

Fig. 3 depict the example of noise reduction result on the input image. Image rotation was applied due to symmetricalness problem of the input image. Asymmetric image will cause problems in the gridding procedure. Therefore radon transformation [5] algorithm used to transform asymmetric image into a symmetric one. Fig. 4 depict the example of image rotation to fix asymmetric image.

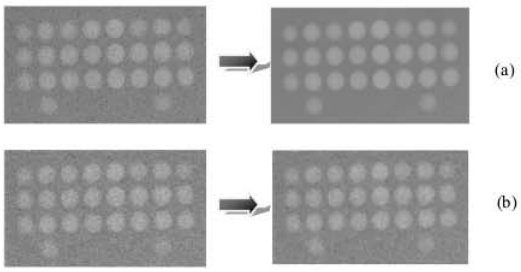

Fig. 3. Example of noise reduction, (a) Salt and Pepper, (b) Gaussian

Finally, the normalization algorithm was applied to adjust the color intensity range, such adjustment will increase the color contrast as shown in Fig. 5. Normalization was done using (1), O is intensity value before normalization and N is intensity value after normalization.

$$N_{x,y} = \frac{N_{max} - N_{min}}{O_{max} - O_{min}} \times \left(O_{x,y} - O_{min}\right) + N_{min} \quad \forall x, y \in 1, N \qquad \ldots(1)$$

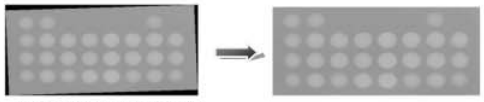

Fig. 4. Example of image rotation

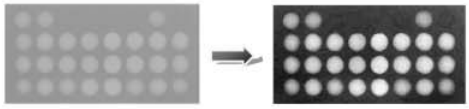

Fig. 5. Example of image normalization

B. Gridding Procedure

This procedure contain techniques to find the location of the objects (the round shape luminescence) automatically. In general, the basic concept is iteratively creates vertical and horizontal lines on the input image such that in the final step each object will be placed exactly on the center of a square. The algorithm used for this process is fixed spot position [6] with some modification. Formerly the input image should be transform into grayscale type and followed by application of particular intensity threshold value to identify each pixel as object or background. Vertical and horizontal line will divide two objects in equal distance regarding the edge pixels of both objects. Fig. 6 is the example of the gridding procedure result. Now, each square carried out one object.

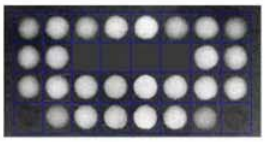

Fig. 6. Result of the gridding procedure

C. Segmentation Procedure

After gridding procedure, the system will save position of each square with the object inside. Thus, the extraction of the objects is ready to be proceeded. The first step to extract the object is finding all the object's pixels. To find those pixels, the system should have the ability to well recognize the characteristic of the color intensity of the object pixels as well as the background pixels. In order to increase this ability, neural network (NN) method was applied here. Intensity histogram was chosen as the input of the NN architecture. Therefore, 256 nodes are used in the input layer. For the hidden layer it is found that one layer with 6 node give the best output prediction. One output node represents the color intensity threshold value that will classify each pixel as object or background. Fig. 7 depict the best NN architecture implemented in the system. At the end of the process, the system will store the position of each object pixel and the corresponding intensity value in its database.

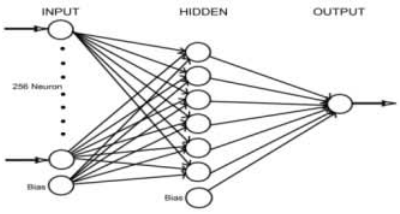

Fig. 7. Neural network architecture for segmentation process

D. Quantification

This is the step to summarize all object pixels intensity values (from the segmentation procedure) in the database and represent them in more sophisticated format. Quantification of each object luminescence should appear as single value. For this purpose, the system provide option button such that user could choose the method of summarization which is mean, median, maximal or minimal value. Fig. 8 shows example of the quantification process result using mean value.

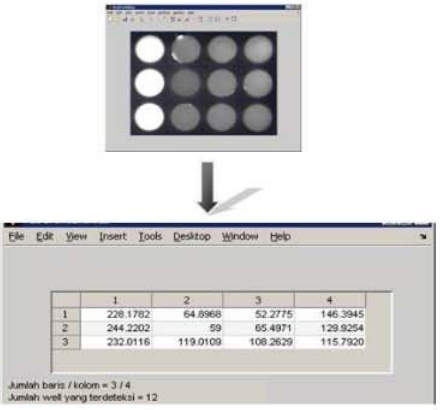

Fig. 8. Example of the quantification process result

E. Report

Report feature was attached to the system to facilitate user for advance data processing. The report will be in .xls format which is contains the position and luminescence intensity of

each object pixels. By this feature the researcher could easily prepare raw data to run various kinds of statistical data processing such as testing hypothesis, ANOVA, regression and cluster analysis.

IV. Result and Discussion

In general the performance of the system is good. The quantification performance of the intensity value is depends the input image. From all input images sample with various level of quality, the system could give reasonable quantification result for 87.5% among them. The system only fail on very low quality of input image. For this kind of input image, the systems already fail in gridding process thus no intensity value reported on the output interface. The accuracy of the system was proven too by changing the concentration of the plant extract. In theory, the increasing concentration of quorum sensing inhibitors will result on decreasing luminescence intensity [7]. The quantification result shows exactly the same tendency in almost all of the samples as shown in Table 1. In the matter of time, the run time depend on the number of the microplate wells. MILDA could run all the process less than 15 second. This result is better than previous system using circular hough transform for its segmentation process [3].

TABLE I. THE ABILITY OF PLANTS EXTRACT IN VARIOUS CONCENTRATION TO INHIBIT THE LUMINESCENCE

Plant	Concentration (mg/ml)	Luminescence Inhibition (%)
Fennel	23.8	59.2
	19.0	65.4
	14.3	53.9
Lawang	23.8	34.1
	19.0	19.2
	14.3	-3.2
Selasih	23.8	59.8
	19.2	47.9
	14.3	44
Temu Ireng	38.1	44.1
	19.0	39.7
	9.5	7.7
Temu Giring	38.1	16.3
	19.0	3.9
	9.5	7.9
Temu Putih	38.1	-0.3
	19.0	4.9
	9.5	28.8
Temulawak	38.1	16.5
	19.0	23.5
	9.5	6.3

V. Conclusion

Although this system could perform good quantification result, it is known that the quality of input image still bring major difficulties. Therefore, for the future works we propose to design a customized media to capture the luminescence directly from the microplate. This media then integrated to the MILDA software such that the quantification could run in real time.

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