# AUTOMATED MULTI-VIEW VISUAL INSPECTION AND GRADING SYSTEM FOR SHRIMP

Yudha Prasetyawan[1] , Putu Dana Karningsih[2], Lucky Sabrina Adluna[3].

[1,2,3] Industrial Engineering Department, Institut Teknologi Sepuluh Nopember Surabaya.
Surabaya, East Java, Indonesia
E-mail : yudhaprase@ie.its.ac.id

**_ABSTRACT_**

*Automated Multiple View Inspection (AMVI) is a non-contact automated inspection that observed from two or more angle. This research is focused on designing an automated multi-view visual inspection and grading system based on digital image processing. By adopting AMVI and using Digital Image Processing, Seven Tools of Quality, also Root Cause Analysis (RCA), this system is applied to a fisheries sector, which is vanname shrimp that used as research objects. Mechanisms designed system consists of the inspection, grading, and sorting process. The system is also supported by the integrated of prototyping and AmviGS software. The making of prototype is done by designing a machine that accommodate those process, while software development is done by modifying the software AVIS7 1.0 that have been made in previous research. Machine designed in this study requires a cost of Rp 8.982.550,-. Testing the mechanism of inspection, grading, and sorting systems on the instrument was conducted on 75 vanname shrimp. Those shrimp are classified into three size, which are size 16/20, 21/25, and 26/30, as well as to the accepted or rejected products. The test result is obtained that the speed of machine in the inspection is 116 pc/hour wit a maximum capacity of 9,667 lbs/hour/machine. In addition, there are 6 of 75 pc that identified in a wrong answer, so that errors that occur at this time is still 8%.*

**Key words:** *Automated Multi-View Inspection, Grading System, Digital Image Processing, Seven Tools of Quality, RCA.*

## 1. INTRODUCTION

As Island Countries, Indonesia has a wide sea two-thirds of its land area. Its strategic location, which is located between Asia and the continent of Australia and the Pacific and the Indian Ocean, making Indonesia the trade routes and shipping because it has abundant natural resources. One potential marine resources of Indonesia belimpah shrimp. Ministry of Marine Affairs and Fisheries (MMAF) Indonesia, still putting shrimp aquaculture as commodities during 2010-2014. This is because the demand is high enough shrimp exports thus making it an important commodity (Investor Daily, 2010). The Center for Statistics and Information stated that commodity production is projected to increase by 13% each year for shrimp and 16% for shrimp vanname. Data from the Food and Agricultural Organization (FAO) in 2010 also showed that Indonesia is ranked fourth with a total world exports of 140,000 tonnes of shrimp vanname in 2007. Meanwhile, in 2008 ranked Indonesia rose to three world under China and Thailand. Indonesia's total exports reached 168,000 tons, up by 21%. (Kabarbisnis.com, 2010). However, the production of these commodities is not necessarily increased. According to the Ministry of Marine Affairs and Fisheries (MMAF), shrimp export data throughout the month of January to August 2010 decreased compared to the same period in 2009. In that period shrimp exports reached 94,867 tons, of which this volume decreased by 5.76% compared to the same period in 2009 of 100,668 tons.

From the data above, it can be said that both shrimp farmers and production company processed marine products, particularly in Indonesia, must be able to maintain and ensure the quality of the shrimp. In order for the production of marine products processing enterprises can meet the challenges above, we need a quality measurement system that is able to accommodate those needs.

One solution that can help solve the problems that happen is by visual inspection and grading system of the multi-view and automated digital image processing approaches. This approach has been used extensively in the manufacturing process for automated inspection and testing is accurate, for classification and sorting, as well as for quality control in order to improve product quality.

The objectives of this study, firstly the identification and classification requirements for each level of quality raw material to be used for the production of marine products processing company. Second, identify the causes of defects that exist in raw material using Root Cause Analysis (RCA). Third, do a visual inspection tool design and grading the multi-view and digital-based automated image processing. Fourth, to test the mechanism of digital image processing tools. Fifth, comparing the speed with the speed of the tool operator when do 100% inspection and grading on the raw material. Sixth, comparing the maximum capacity of the equipment with operators able to handle both of them for 1 hour.

## 2. THEORETICAL BACKGROUND

Automated multi-view visual inspection and grading system is one of two main elements in this study. Automated multi-view visual inspection and grading system can be defined as a system of inspection and grading visually observed from multiple viewpoints and automated. In practice, this system typically uses sensor technology, high speed camera, x-ray, and more. The technology is installed in a place that has a measurable range of products so as to measure or capture the parameters of the desired product. Parameters are often captured from product inspection and grading system may be any color, physical form such as texture, scratches, fractures, length, width, depth, and thickness. The technique is known as the inspection and grading inspection technique without contact (non-contact inspection and grading technique). Some of the advantages of the application of this technique among others to avoid damage to the product, the cycle time (cycle time) for the inspection process more quickly, on a production line, in the application of this technique does not require additional treatment (additional handling) of the product, and it is possible and support the implementation of 100% automated inspection system.

The second main element in this research is the digital image processing. According Sutoyo et al (2009), which spawned discipline techniques for image processing can be referred to as Digital Image Processing (Digital Image Processing). So digital image processing is a science that studies matters relating to the improvement of the quality of the image (image enhancement), image transformation (rotation, scale, skewness), and compression or data reduction for data storage purposes. Image enhancement is the process of turning an image into a new image is done in various ways, so that the resulting new image quality is better than the original image (Sutoyo et al, 2009). Specifically for this research, image enhancement is done later is not intended to further improve or clarify display the captured object, but to interpret the object in order to obtain the information required in the process of classification quality.

The theory that is often used in quality control (quality control) is Seven Tools of Quality. According to Montgomery (2005), the notion of quality distinguished the two viewpoints. The first perspective is the traditional sense of quality and the second is the quality in the modern sense. In the traditional sense stated that "quality means fitness for use", or suitability for use. In it there are two important aspects as determinants of achieving "quality means fitness for use", the quality of design and quality of conformance. Design quality for all products and services are produced in the levels of different qualities. The difference is due to the quality level of adjustment to the wants and needs of consumers. While the quality of conformance is how well the products and services produced in accordance with the specifications that have been designed.

When found high variability of products, will allow the product to not sell. It certainly can be detrimental to the company. That is why quality improvement done. According to Montgomery (2005), a series of quality improvement activities to reduce variability, both in products and processes. Tools are often used in quality improvement is Seven Tools of Quality, which consists of: Flow Charts, Histogram, Cause and Effect Diagram, Check Sheet, Scatter Diagram, Control Chart, Pareto Chart.

Root Cause Analysis (RCA) is a scheme that is designed to be used in the investigation and categorization of the root causes of the problem (Rooney and Heuvel, 2004). Simply put, RCA can also be used as a tool designed to help identify not only what and how an event happened, but also why it happened. Therefore, when the researchers were able to determine why an event, issue, or a failure occurs, they will be able to determine the corrective action that can be implemented to prevent such events happening again in the future.

## 3. RESEARCH METHOD

The methodology in this study consists of several major steps that need to be done, the problem identification stage, the stage of system design and data processing, data analysis and interpretation phase, and the phase of the conclusions and suggestions.

Identification phase of the problem in this study begins with the identification and formulation of the problem. Problem identification is done by determining research topics. This determination is to be the first step of the study, in which the subject is taken around the grading system and automated inspection in agriculture in Indonesia. Researchers found that in Indonesia are still not many agricultural companies that do automated inspection and grading of raw material on it. This is because there are many inspection and grading is done manually by the operator. Further identification was carried formulation of the problem, ie "how to design a visual inspection and grading system that multi-view and digital-based automated image processing".

Then the design tools Automated Multi-View Visual Inspection and Grading System will be designed. Broadly speaking, the design of this system consists of two main parts, namely the design of hardware and software. The design of the hardware will be a mini prototype of the mechanism of inspection and grading system that multi-view and automated. This prototype will consist of a conveyor, a web camera, as well as inspection and sorting mechanisms. While the software design will be based on Digital Image Processing mechanism, namely 1.0 software AVIS7 previously created, modified and adapted to the object to be inspected and in-grading. Further testing is done to ensure that the tool can work effectively, both when inspecting and grading object of research. In general, this test later performed in two activities, namely test mechanism on digital image processing tools with a single camera and two cameras, and road test the system with a number of objects that much. When finished verified and tested, the tool can be allowed to work. Performance data tool is further processed with methods and approaches that have been described in this Theoritical Backgorund, so that the results can be expected to support the resolution of the issues raised in the study.

The next stage is the stage of data analysis and interpretation. The data that has been processed in the previous stage and interpreted to obtain information if required. Further analysis will be conducted on the performance of hardware and software that have been made, and the potential for success when applied in the field. Further analysis will also be done from the RCA, which is about what causes defects in the raw material.

The last stage is the stage of the research conclusions and suggestions. At this stage the researchers determined the overall conclusion of research settings. Later this conclusion will answer the purpose of the research that has been predetermined. It also included suggestions or recommendations for the development of further research.

## 4. RESULT AND DISCUSSION

Running the designed software is done by using 75 vanname shrimps. Please note that the sample of shrimp prior to the study have been classified according to size first and quality, namely:

- size 16/20 quality-accept = 22 shrimps
- size 16/20 quality-reject = 9 shrimps
- size 21/25 quality-accept = 11 shrimps
- size 21/25 quality-reject = 9 shrimps
- size 26/30 quality-accept = 18 shrimps
- size 26/30 quality-reject = 6 shrimps

with the
16-20 shripms/lbs, in the size of 16/20
21-25 shrimps/lbs, in the size of 21/25
26-30 shripms/lbs, in the size of 26/30
Here are the results of running the tool against 75 observed products (Figure 1)

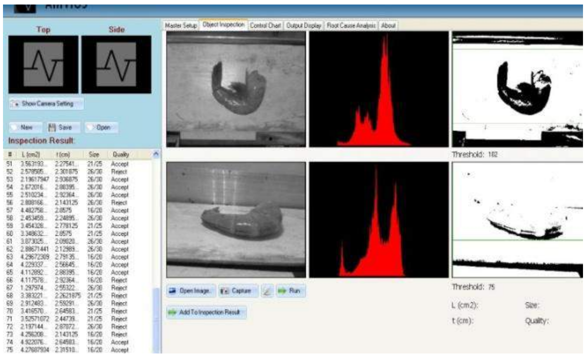

Figure 1. Result of testing for 75 shrimps

As it is known that in addition to measuring the gray level, the software is also able to measure the product size and extent of observation of thick body. The results of measurements of thickness and extent of the software will be further validated. Mechanism validation is performed by comparing the measurement results against manual measurement software. This assisted manual measurement using calipers. Manual measurement to the extent done by forming a circle like shrimp, then measured his fingers then calculated by the formula area of a circle (πr2). As for the thickness of the body is done by measuring the thickest shrimp.

From the 75 data recapitulated, it is found that the average thickness measured by the software is 2.40 cm, while the manual is 2:41 cm. And the average width is engraved with the software is 27.50 cm2, while the manual is 29.68 cm2. After a recap of the data obtained ratio between width and thickness measurements manually with the software, then performed Paired t-Test. Tests conducted to determine how big the difference between the two. Paired t-test was carried out with the help of software SPSS 15.0, with a confidence level of 95%. It is found that the Sig. (2-shrimped) respectively 0.102 and 0951, where the value is> 0.05. So it can be stated that there is no significant difference between the measurements manually with the software.

For the flow chart preview, starting from a master product captures and observations, and both converted to grayscale images, and obtained his image histogram. From the histogram will be calculated rate equation, the value of the degree of difference image, and image similarity percentage (KC). Furthermore, the percentage Kc tolerance is matched by size and quality of each raw material. From here it will be the classification process and raw material obtained according to two parameters.

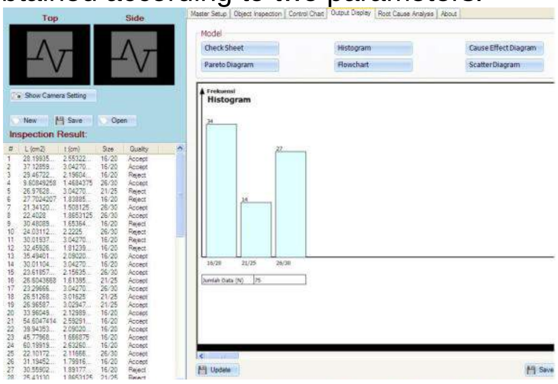

Figure 2. Running Results with Histogram Method

From Figure 2 it can be seen in the histogram of the results of running on 75 products scrutiny. Through these histograms will make it easier for readers to know the frequency or amount of data in each size. So it can be seen that there are 34 shrimp were identified as size 16/20, 14 were identified as shrimp size 21/25, and 27 were identified as shrimp size 26/30.

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From the cause and effect diagram, it is known that there are five causes that result in rejected product, namely factor man, machine, method, material, and environment. Man factors could be due to a lack of treatment operator caution in handling the material. The factors could be due to box machine coolant temperature does not fit (above 5 ˚ C). Of the method factor due to two things: do not check the temperature in the box container, and handling of raw materials which are not suitable SOP (eg soaking in the rinse water, and so on). Of material factors could be caused because the shrimp itself was not fresh, so in-reject when inspected. While the environment factors could be due to a virus that makes it not healthy shrimp, making it fit into the classification of the product reject. For the check sheet, recap sheets contains data from the inspection result columns. For example for observations to-1 product identified as shrimp size 16/20 quality accept. And so on until the 75th observation products.

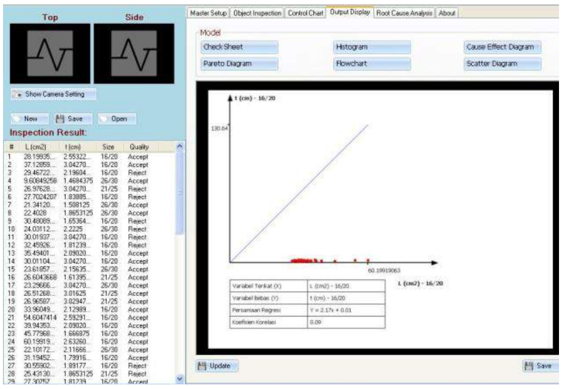
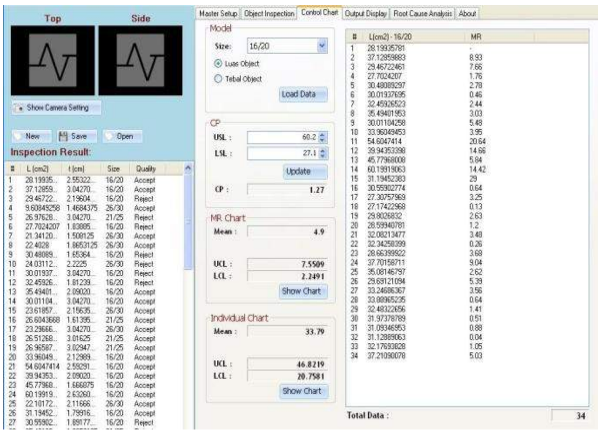


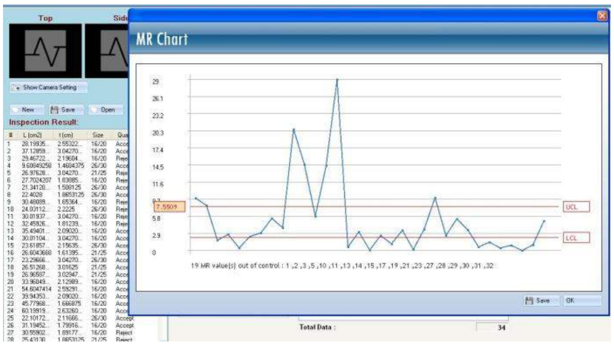
Figure 3. Scatter diagram between the Size of the Length in Size 16/20

From Figure 3 it can be seen the scatter diagram of the results of the thick area to size 16/20. Extents (L) as the independent variable while the thickness (t) as the dependent variable. It was found that the regression equation was y = 2.17 x + 0.01 and the correlation coefficient is 0.09. With the form that such a distribution point and the value of the correlation coefficient close to 0 means that there is no correlation between the two variables. The results of the scatter diagram between the extents denan thick on size 16/20 can then be stored (save) in JPEG format by pressing the save button at the bottom right.

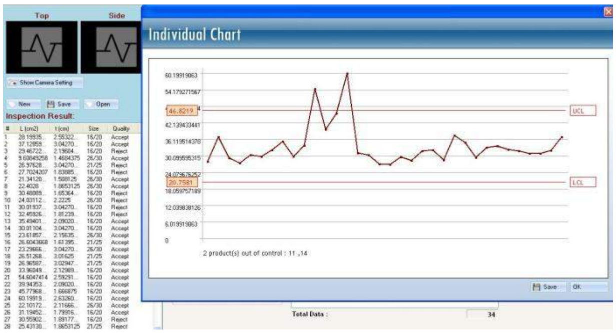
The following are the results of running by using control charts. Results returned from this method is the value of process capability or CP (Process Capability), graphics MR chart, individual charts and graphs. Eg for an attribute extents (L), the value obtained from the USL's highest L value, while the value obtained from the MSM lowest L value. So the CP value obtained from (USL-LSL) / $6\sigma$. Then in the MR chart mean values ($\overline{MR}$) is obtained by calculating the average value of all observations MR, UCL values obtained from D4 * $\overline{MR}$, and LCL values obtained from D3 * $\overline{MR}$. D4 and D3 values obtained from Appendix Table VI on the book written by Montgomery Statistical Quality Control, where D4 = D3 = 1.541 and a value of 0.459. While individual chart plotting values obtained from L itself, where its mean value is calculated from the average value of the individual, and the UCL and LCL values obtained using the same formula as mentioned above. Here are the results of running the method of control charts, MR Chart and Individual Chart:



(a)



(b)




(c)

Figure 4. The results of running Control Charts, MR Chart and Individual Chart for Size of Size 16/20

From the results (Figure 4) of running control charts for attributes extents size 16/20 in Figure 5.14, 5.15, and 5:16 get value CP = 1.27. This value can be interpreted as the ability (ability) process to process (inspecting, grading and sorting) observation products (shrimp vanname) in accordance with the specifications. The smaller the value of CP means that the narrow range of acceptance for the specification attributes. In addition, from the results obtained that the MR chart there are 19 of the 34 products that its MR value out off control. While the results of individual chart was found that there are 2 products out off control. Value out off control may indicate that there are problems in the process.

From the results of running the Pareto diagram below found that the frequency of the most widely reject products derived from shrimp size 26/30, as many as 12 heads. While the frequency of reject products derived from shrimp size 16/20 and 21/25 respectively, are as much as 6 shrimps and 5 shrimps. Indeed reject frequency of size 16/20 and 21/25 received a share of 20%, less than the reject frequency of size 26/30 which gets a share of 80% out of 100% reject frequencies that occur. However, in accordance with the principle of 80-20, 80% of the problem is actually caused by the 20% problem. Shrimp size 16/20 and 21/25 is having a greater income than the shrimp size 26/30. So when there are shrimp size 16/20 and 21/25 are handicapped or reject, costs the company incurred losses will be greater than the cost of losses to shrimp size 26/30 with disabilities. Therefore, if the company requires the improvement in process quality control, the company should give more priority to maintain the quality of shrimp size 16/20 and 21/25 first and then a size 26/30.

Further comparisons will be analyzed in terms of speed with the speed of the tool operator when do 100% inspection. It is known from the above that a human operator can inspect as many as 857 shrimp shrimps / hour. So the speed to inspect each shrimp is ± 14 fish / min. While these tools are known to be inspected shrimp were 116 head / hour. So the speed to inspect each shrimp is ± 2 shrimp / min. So it can be seen that the difference in speed between the two is 12 fish / min.

It is known that the price of shrimp / pcs for size 16/20 is $ 3298, -, while for size 21/25 is $ 2323, - and for a size 26/30 is $ 1719, -. The average size is a size 27 are sorted, so the price of shrimp / pcs used for further calculations is USD 1719, -. As is known in advance that an error occurred in the process of sorting in PT GMCP is 5%. If the operator can sort as many as 857 shrimp shrimps / h while the effective working hours is 7 hours / day and days effective 25 days / month, then a month the operator can sort 149,975 shrimps. Assuming 5% error happens every day, then the shrimp of the sort contained 149,975 ± 7475 head / month misidentification. So when shrimp is wrong is multiplied by the price / pcs her is Rp 12,849,525, -. This value can be considered as a loss to be borne by the company each month.

The new tools are designed in this study requires the manufacturing cost of Rp 8,982,550, -. These costs consist of the cost of raw materials amounting to Rp 2.72 million, -, component cost of Rp 1,232,550, -, webcam purchase cost of Rp 830,000, -, mechanical technician cost of Rp 1.9 million, -, and software cost of Rp 2.300.000, -. So the investment for 7 this new tool will be Rp 62,877,850, -, is more expensive because it uses conveyor and software for process inspection, grading, and sortirnya. During this period there were an estimated economic life of the costs incurred each month for each tool, ie a tool maintenance costs Rp 100,000, - and the operational costs of Rp 1.000.000, -. So to 7 tools such expenses per month to Rp 7.7 million, -.

Having obtained the value of Present Worth of the investment cost and profit, it can be calculated the difference between two conditions. So from the calculation of Rp 284,693,761.50 - (170,680,709.80 62,877,850.00 + USD) = USD $ 51,135,201.70 which is revenue for the company when applying this tool.

From the above calculations can be compared to the value of the assets of the old Present Worth (sort operator) with new assets (tools designed). It was found that the longer an asset in the form of cash flow outflow of Rp 21,612,167.80, which is a fee or reward for sorting operators that will be issued by the company during the economic age. While the cash flow in the form of a new asset inflow of Rp 51,135,201.70, which is the revenue for the company when applying these tools for economic useful life. So it would be more profitable company when applying these tools.

## 5. CONCLUSION

A system has been designed to identify where raw materials belonging to accept or reject quality, and where raw materials belonging to size 16/20, 21/25 and 26/30 of shrimp. The results of identification using the RCA regarding the causes of defects in raw material influenced from Man, Machine, Method, Materials, Environment, namely the treatment less careful of the operator, the setting of the engine coolant is not appropriate, methods of handling raw materials which are not suitable SOPs, raw materials that are not fresh, and viral factors that make raw material defects.

From the analysis of the process 100% inspection found that the speed of sorting operator PT GMCP is 857 head / hour / person, while the speed of the tool is 116 head / hour / device. And the analysis of the maximum capacity that can be handled in the sorting operator PT GMCP is 71.429 lbs / hour / person, while capable handled tool is 9.667 lbs / hour / device. So to be able to reach speeds of inspection and maximum capacity as the necessary condition of existing equipment as much as ± 7 pieces.

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## AUTHOR BIOGRAPHIES

**Yudha Prasetyawan** is a lecturer in Department of Industrial Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya. He received his Master in Advanced Manufacturing Technology from Swinburne University of Technology, Australia in 2005. His research interests are in the area of Computer Integrated Manufacturing, Automated Quality Control System and Manufacturing System Design. He is a member of the Manufacturing System Laboratory in Industrial Engineering Department. His email address is <yudhaprase@ie.its.ac.id>

**Putu Dana Karningsih** is a lecturer in Department of Industrial Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya. She received his PhD in Manufacturing Engineering and Management from University of New South Wales, Australia in 2012. Her research interests are in the area of Computer Integrated Manufacturing, Risk Management and Manufacturing System Design. She is a member of the Manufacturing System Laboratory in Industrial Engineering Department and also as the secretary of this department. Her email address is <yudhaprase@ie.its.ac.id>

**Lucky Sabrina Adluna** is a former student in Department of Industrial Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya. She received her Bachelor of Industrial Engineering from this department in 2012. Her research interests are in the area of Quality Management and Manufacturing System Design. She works at a well known Indonesian Bank. Her email address is <luckyadluna@gmail.com>