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Unique	Hence an automatic detection system for damaged container is needed	-
Unique	The achieved visual result was satisfactory as well as the computational aspect	-
Unique	Keywords—Image Processing, Ship to Shore Crane, camera, container, damage, Template Matching, object detection	-
Unique	Complaints related to container damage are still frequently occurring	-
Unique	A system to automatically detect damaged container was proposed	-
Unique	The proposed system is called Container Damage Inspection (CDI)	-
Unique	LITERATURE STUDY Image processing has been used widely in various applications	-
Unique	There are numerous algorithms developed for these purposes	-
Unique	One crucial and common part in these algorithms is noise detection and noise removal	-
Unique	It reports that system with template matching performed better [2]	-
Unique	Another application for face detection is presented by Tripathi et	-
Unique	Original template matching algorithm utilizes cross- correlation algorithm	-

17,800 results	The method is straightforward but slow	researchgate.net arxiv.org web.mit.edu ultra.usc.edu deepai.org code-examples.net patents.google.com alumni.dailyorange.com patents.google.com researchgate.net
Unique	Many modifications have been devised to improve its performance	-
Unique	Vanderbrug and Rosenfeld used only subtemplate to reduce the method’s computational cost	-
Unique	Several techniques to reduce the method’s drawbacks were compared in [8]	-
Unique	Recent methods in noise removal algorithm Kim et	-
Unique	Similar to LaseCDI, this system combines laser technology, OCR, and visual imaging application	-
Unique	RESEARCH METHOD Our input are images of container	-
Unique	3 depicts the work flow of generating a template	-
Unique	Get Noise Point Get Edge Set Group Calculate Template Template Start End Photo Fig	-
Unique	1 requires input from container which is taken from perpendicular side	-
Unique	This group will be labeled the same	-
Unique	The required resolution is at least 1200x500 pixels	-
Unique	This study only consider container whose shape is a bar or beam	-
Unique	2 The position of camera in facing the container Fig	-
Unique	3 Side view of the container Fig	-
Unique	6 shows a clean container side model	-
Unique	Start Assign to Grid Calculate Average End Get Noise Point Fig	-
Unique	This is in accordance with (1)	-
Unique	This is in accordance with (2)	-
Unique	The division of this grid is to speed up the process of noise detection	-
Unique	If it is empty then it means the point is on the edge	-
Unique	R) <= threshold and abs(current	-
Unique	G) <= threshold and abs(current	-

Unique	8 it can be seen in the logo there is a green line	-
Unique	9, where all the points in the image are edge	-
Unique	This point(s) is then pushed into the stack	-
Unique	This is done until the stack is empty	-
Unique	The step is repeated until all the points in the edge list are processed	-
Unique	A template of a container noise contains:	-
Unique	Name Contains the name of the saved template	-
Unique	List of information per angle Contain:	-
Unique	Angle At what angle this information (contains 0 - 359 degrees)	-
Unique	Total point Contains the number of edge points in this corner	-
Unique	Total distance Contains the total distance of the edge point to the midpoint	-
Unique	12 Container Images with characters (left)original image (right)result It is demonstrated in Fig	-
Unique	13 shows results of the algorithm when the input are images with company logo	-
Unique	13 Container Images with Company Sign/Logo (left)original image (right)result Images with Damages Fig	-
Unique	14 demonstrated the algorithm performance with damaged container	-
Unique	It is shown that the algorithm can successfully identified the damage	-
Unique	The damage area is marked with blue circle	-
Unique	14 Original container image with damages (top)	-
Unique	Our experiment with over 10 images yield 2.71 as the average execution time	-
1 results	The achieved visual result was satisfactory as well as the computational aspect	technav.ieee.org
Unique	The research will not stop at this point	-
Unique	Remained in our list for future work is to distinguish between the identified objects	-
Unique	Fan, "Driver fatigue detection based on eye tracking and dynamk, template matching," Taipeil, 2004	-
32 results	Rosenfeld, "Two-Stage Template Matching," IEEE Transactions on Computers, vol	dl.acm.org researchgate.net rsisinternational.org ijert.org patents.google.com link.springer.com

3 results	Poggiot, "Template Matching: Matched Spatial Filters and Beyond," Pattern Recognition, vol	sciencedirect.com sciencedirect.com academia.edu
Unique	[10] Lase, "LASE GmbH," [Online]	-
Unique	de/en/products/port-logistics/lasecdi- container-damage-inspection.html	-
Unique	fi/products/visy-automatic-container- damage-detection-system/	-
Unique	Template Matching Algorithm For Noise Detection in Cargo Container Doni Setio Pambudi Department of Informatics	-
Unique	id Abstract— A seaport terminal providing services for inbound and outbound flow of cargo container	-
Unique	In some cases, the port is sued for damaged container which in fact has	-
Unique	In this research, an algorithm to identify objects in a side-view of a cargo	-
1 results	The objects include but not limited to company name of the cargo container, logo,	technav.ieee.org
Unique	By utilizing template matching algorithm, an algorithm to identify objects in container images has	-
Unique	INTRODUCTION Being the second most extensive port in Indonesia, Lamong Bay terminal Surabaya serves	-
Unique	The port is also a central distribution channel to the entire eastern region of	-
Unique	As a world-class terminal, Lamong Bay Terminal always prioritizes efficient and effective service for	-
Unique	One of the problems that occurred and greatly affect the image of service in	-
Unique	Container damage happen very often so that many complaints are received by Lamong Bay	-
Unique	This complaint will subsequently be converted with the nominal loss to be paid by	-
Unique	The losses incurred by damaged container losses can reach up to 2 (two) billion	-
Unique	is not good to the quality of service and this will of course affect customer	-
Unique	the it is caused by faults of a series of container removal activities in Lamong	-
Unique	Field Officers (Tally) have been provided to manually record under the STS (Ship to	-
Unique	But because this tool is very expensive, so up until now there has been	-
Unique	In this study, the "Template Matching" method is proposed to automatically detect damage to	-
Unique	With this detection, it is expected to know the condition of existing containers arriving	-
Unique	Template Matching Algorithm is an algorithm that processes existing image input (container to be	-

Unique	These three images will be compared so that a decision will be made whether	-
Unique	Damage detection, character recognition, disease detection, heart beat counting are just a few example	-
Unique	Recent advancement in template matching applications Template matching is a scientific technique for locating	-
Unique	Penelitian dan Pengabdian Masyarakat (LPPM) UISI between system built based on template matching and another	-
Unique	where they utilized combined skin color detector in addition to the template matching method	-
Unique	Further more, in face image processing, digital capture of a driver's image is computed	-
Unique	developed a template-matching based system to automatically detect pulmonary nodules in images of helical	-
Unique	Choi and Kim proposed a method to accommodate the algorithm for rotation since the	-
Unique	Only when the subtemplate's matching score exceeds a threshold, the rest of the template	-
Unique	Their approaches includes matched reconstruction residuals, principal component projections, spatial filters, and synthetic discrimination	-
Unique	utilized a noise removal techniques based on fuzzy system to detect and remove noise	-
Unique	Recent applications in damaged container detection Specific works around seaport container's damage detection include	-
Unique	LaseCDI provides a detection solution by means of laser combined with Optical Character Recognition(OCR),	-
Unique	This system is claimed to be able to detect various kinds of damages in	-
Unique	Another commercial product in the market is a system from Visy named Visy Automatic	-
Unique	Using Template Matching Algorithm, the images will be compared with a template, in this	-
Unique	1 Flow Chart of Generating A Template Noise Removal Container image will have some	-
Unique	These objects are considered as noise that will hinder the next process hence need	-
Unique	The image will be then divided into grids and search will be performed to	-
Unique	This search is done by computing average image color compared to average color values	-
Unique	Noise which is considered similar will be grouped into one even though it is	-
Unique	A noise group resulted from the computation will be further computed to produce	-
Unique	the entire container and focuses exactly in the center of the container as illustrated by	-

1 results	In this study, only one side of the container is tested, either the right	scribd.com
Unique	As for the photographs that are used for testing, we obtained them from Lamong	-
Unique	certain base color and generally the existing noise has the opposite color of the base	-
Unique	5 Flow Chart of Obtaining Container Candidate Noise Point The designed algorithm calculates the	-
46 results	This process is done by summing all components R, G, B and then divide	docshare.tips alldokument.com ar.scribd.com archive.org mafiadoc.com archive.org docplayer.net
Unique	The base color which is called α from now onward is a unity of	-
Unique	(2) Data are divided into certain grids in the noise detection process as shown in	-
Unique	Generally a photograph of the container is divided into the same number of grids	-
Unique	Grid(s) that has the number of noise below the threshold is not processed since	-
Unique	y) compared with α exceeds the specified threshold then the pixel is considered as noise	-
Unique	replaced with the pixel value, if the pixel contains noise then it is recorded into	-
Unique	of container noise points, from which the results need to be calculated to determine the	-
Unique	This step can be replaced by using edge detection (eg canny, sobel, difference, etc)	-
Unique	This algorithm uses a simpler way of detecting whether one of its neighbors (left,	-
Unique	Edge determination serves to determine the border of the noise and also to calculate	-
Unique	the edge point that has been searched in the previous stage , labelling is run	-
Unique	If the point is still connected to point(s) in different grid then it is	-
Unique	The categorization of this noise is to unify the noise so that it becomes	-
Unique	average α for y = 1 to grid height for x =	-
Unique	B) <= threshold add to list foreach point in list of noise get all neighbour	-
Unique	x is the value of x for all x coordinates in the same group, and	-
Unique	This line indicates the border of a noise group, while the red line is	-
Unique	min,min (4) max, (5) The step by step procedure of the group setting algorithm	-

Unique	In Pseudocode 3 the grouping algorithm works by obtaining a point from the edge	-
Unique	Neighbors from the popped point is pushed into the stack and set the group	-
Unique	If it has never been processed, the neighboring point is also set to the	-
Unique	Groups whose number of points is less than threshold are removed from the group	-
Unique	Calculate Template Each group of edges will be computed into a template, so if	-
Unique	List of edge points List of edge points that have angles equal to Angle	-
Unique	9 Steps of Set Group Algorithm Pseudocode 3 – Setting Group of Noise Points	-
Unique	10 Noise Template The interval from an angle within the template has been determined,	-
Unique	10 shows an evaluation point whose distance with the center and angle to the	-
Unique	11 illustrates in detail an angle in the template where all points that are	-
Unique	For now the matching process only compares each point angle and total distance from	-
Unique	than the threshold then it is considered the same angle, and if the similarity of	-
Unique	if not add to group list repeat step 2 for all points Border Line Center	-
Unique	RESULT AND DISCUSSION Images Requirement In order for the algorithm to perform at its	-
Unique	The container in the image should also in the side view and perpendicular to	-
Unique	Testing was done with several types of noise objects considered in this work namely	-
Unique	12 that the algorithm has successfully marked the noises in the container images, for	-
Unique	It can be seen in the image that the container is dented in some	-
Unique	hence next in line for the subsequent research is to be able to set threshold	-
Unique	Damages marked with circle (bottom) The execution time of this polynomial complexity algorithm is	-
Unique	Conclusion In this research, we applied Template Matching Algorithm to detect objects in the	-
Unique	Objects that are considered noise includes but not limited to company name of the	-
Unique	The ultimate goal is to create a system which can automatically detect whether	-
Unique	Chen, "A Fast Template Matching Method for Rotation Invariance Using Two- Stage Process," Kyoto,	-

6,280 results	Poggio, "Face recognition: features versus templates," IEEE Transactions on Pattern Analysis and Machine Intelligence,	dl.acm.org eem.eskisehir.edu.tr researchgate.net citeseerx.ist.psu.edu coursehero.com onlinelibrary.wiley.com scholar.google.com researchgate.net face-rec.org dl.acm.org
Unique	Sharma, "Face Detection using Combined Skin Color Detector and Template Matching Method," International Journal	-
Unique	Ishigaki, "Automated detection of pulmonary nodules in helical CT images based on an improved	-
Unique	Kim, "A novel two stage template matching method for rotation and illumination invariance," Pattern	-
Unique	Yang, "An Intelligent System for Container Image Recognition Using ART2-Based Self-organizing Supervised Learning Algorithm,"	-
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Template Matching Algorithm For Noise Detection in Cargo Container

Doni Setio Pambudi Department of Informatics Universitas Internasional Semen Indonesia Gresik, Indonesia doni.pambudi@uisi.ac.id Ruktin Handayani Department of Informatics Universitas Internasional Semen Indonesia Gresik, Indonesia ruktin.handayani@uisi.ac.id Lailatul Hidayah Department of Informatics Universitas Internasional Semen Indonesia Gresik, Indonesia lailatul.hidayah@uisi.ac.id

Abstract— A seaport terminal providing services for inbound and outbound flow of cargo container often has issues with the handling of container. In some cases, the port is sued for damaged container which in fact has not been taken care properly before arriving in the port. Hence an automatic detection system for damaged container is needed. In this research, an algorithm to identify objects in a side-view of a cargo container is proposed. The objects include but not limited to company name of the cargo container, logo, identification code, signs, labels, and damages. By utilizing template matching algorithm, an algorithm to identify objects in container images has been developed. The achieved visual result was satisfactory as well as the computational aspect. Keywords—Image Processing, Ship to Shore Crane, camera, container, damage, Template Matching, object detection. I. INTRODUCTION Being the second most extensive port in Indonesia, Lamong Bay terminal Surabaya serves a strategic role to develop the economy especially for industrial communities in East Java. The port is also a central distribution channel to the entire eastern region of the country. As a world-class terminal, Lamong Bay Terminal always prioritizes efficient and effective service for smooth operation by using the latest and environmentally friendly technology. One of the problems that occurred and greatly affect the image of service in Lamong Bay Terminal is the handling of the container up to the customer's hand. Container damage happen very often so that many complaints are received by Lamong Bay Terminal. This complaint will subsequently be converted with the nominal loss to be paid by Lamong Bay Terminal to Customer. The losses incurred by damaged container losses can reach up to 2 (two) billion a year. Not only money loss, Lamong Bay Terminal also has to bear poor image that is not good to the quality of service and this will of course affect customer trust. Damage to the containers that occurred until now is not known for sure whether the it is caused by faults of a series of container removal activities in Lamong Bay Terminal, or the trouble already occurred in the previous port. Field Officers (Tally) have been provided to manually record under the STS (Ship to Shore Crane), but this is not sufficient. Complaints related to container damage are still frequently occurring. A system to automatically detect damaged container was proposed . The proposed system is called Container Damage Inspection (CDI). But because this tool is very expensive, so up until now there has been no solution to solve the problem of damaged container detection. In this study, the "Template Matching" method is proposed to automatically detect damage to containers in the lower area of the STS to improve the performance of Tally officers. With this detection, it is expected to know the condition of existing containers arriving at Lamong Bay Terminal before being touched by STS. Template Matching Algorithm is an algorithm that processes existing image input (container to be lifted) with ideal image (normal container) and image which become output parameter (damaged container). These three images will be compared so that a decision will be made whether the existing container (input image) is declared damaged or not. II. LITERATURE STUDY Image processing has been used widely in various applications. Damage detection, character recognition, disease detection, heart beat counting are just a few example from many other useful applications. There are numerous algorithms developed for these purposes. One crucial and common part in these algorithms is noise detection and noise removal. A. Recent advancement in template matching applications Template matching is a scientific technique for locating a reference image or any other object inside a larger image [1]. Brunelli and Poggio compared results of face recognition This research was funded by Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) UISI between system built based on template matching and another one based on calculation of several geometrical features. It reports that system with template matching performed better [2]. Another application for face detection is presented by Tripathi et.al. where they utilized combined skin color detector in addition to the template matching method [3]. Further more, in face image processing, digital capture of a driver's image is computed with template matching to determine whether there is any signs of fatigue. This is built by Horng et.al. for safety in driving [4]. Lee et.al. developed a template-matching based system to automatically detect pulmonary nodules in images of helical CT scan results [5]. Original template matching algorithm utilizes cross- correlation algorithm. The method is straightforward but slow. Many modifications have been devised to improve its performance. Choi and Kim proposed a method to accommodate the algorithm for rotation since the original one can't handle when the image is rotated [6]. Vanderbrug and Rosenfeld used only subtemplate to reduce the method's computational cost. Only when the subtemplate's matching score exceeds a threshold, the rest of the template is used [7]. Several techniques to reduce the method's drawbacks were compared in [8]. Their approaches includes matched reconstruction residuals, principal component projections, spatial filters, and synthetic discrimination functions. B. Recent methods in noise removal algorithm Kim et.al. utilized a noise removal techniques based on fuzzy system to detect and remove noise from container digital image in their work for recognition system of shipping container identifier [9]. C. Recent applications in damaged container detection Specific works around seaport container's damage detection include a commercially offered system called Lase Container Damage Inspection (LaseCDI) [10]. LaseCDI provides a detection solution by means of laser combined with Optical Character Recognition(OCR), and high resolution imaging system. This system is claimed to be able to detect various kinds of damages in container such as bulges, dents, tears, holes, etc. Another commercial product in the market is a system from Visy named Visy Automatic Container Damage Detection System (ADDS) [11]. Similar to LaseCDI, this system combines laser technology, OCR, and visual imaging application. III. RESEARCH METHOD Our input are images of container. Using Template Matching Algorithm, the images will be compared with a template, in this case is image of a non-damage container. Fig. 3 depicts the work flow of generating a template. Get Noise Point Get Edge Set Group Calculate Template Template Start End Photo Fig. 1 Flow Chart of Generating A Template Noise Removal Container image will have some labels like brands and codes. These objects are considered as noise that will hinder the next process hence need to be removed. The algorithm in Fig. 1 requires input from container which is taken from perpendicular side. The image will be then divided into grids and search will be performed to find candidate spots for noise. This search is done by computing average image color compared to average color values of the grid. Noise which is considered similar will be grouped into one even though it is from a different grid. This group will be labeled the same. A noise group resulted from the computation will be further computed to produce a data template that can be compared. Images Requirement The ideal container image that is required is a photograph that shows the entire container and focuses exactly in the center of the container as illustrated by Fig. 4. The required resolution is at least 1200x500 pixels. In this study, only one side of the container is tested, either the right or left side of the container. Example can be seen in Fig. 5. This study only consider container whose shape is a bar or beam. As for the photographs that are used for testing, we obtained them from Lamong Bay Terminal. Fig. 2 The position of camera in facing the container Fig. 3 Side view of the container Fig. 4 A side view of container model Get Noise Point Each container has a certain base color and generally the existing noise has the opposite color of the base color, so the noise is clearly visible. Fig. 6 shows a clean container side model. Start Assign to Grid Calculate Average End Get Noise Point Fig. 5 Flow Chart of Obtaining Container Candidate Noise Point The designed algorithm calculates the base color of the container by flattening the color from one side. This process is done by summing all components R, G, B and then divide it by the pixels quantity in the image. This is in accordance with (1). The base color which is called α from now onward is a unity of color consisting of components R, G, and B with the value between 0 – 255. This is in accordance with (2). ∑ ∗ (1) ∑ ∗ ∑ ∗ Average Color (α) = (R, G, B) (2) Data are divided into certain grids in the noise detection process as shown in Fig. 6. Generally a photograph of the container is divided into the same number of grids hence the grid size can be different from each other. The division of this grid is to speed up the process of noise detection. Grid(s) that has the number of noise below the threshold is not processed since amount that is too low will be considered as noise. In (3) if the average pixel color in the grid (hereinafter referred to as γ) compared with α exceeds the specified threshold then the pixel is considered as noise and added to the amount of noise in the grid. Fig. 6 Grid Built on Container Image Contain noise = abs(γ - α) < threshold (3) In Pseudocode 1 each grid checks each pixel using (3) with the value γ replaced with the pixel value, if the pixel contains noise then it is recorded into the noise list . Pseudocode 1 – Noise Scanning in Grid Get Edge Pseudocode 1 produces a list of container noise points, from which the results need to be calculated to determine the edges. This step can be replaced by using edge detection (eg canny, sobel, difference, etc) method. This algorithm uses a simpler way of detecting whether one of its neighbors (left, right, up, down, see Fig. 7) is empty (Pseudocode 2). If it is empty then it means the point is on the edge. Edge determination serves to determine the border of the noise and also to calculate the groups from the container noise points. Fig. 7 Points coordinate in the image Pseudocode 2 - Get edge Set Group From the edge point that has been searched in the previous stage , labelling is run according to the relationship between points. If the point is still connected to point(s) in different grid then it is still considered as one group. The categorization of this noise is to unify the noise so that it becomes an object that later can be recognized as one shape. average α for y = 1 to grid height for x = 1 to grid width current pixel (x, y) if abs(current.R – average.R) <= threshold and abs(current.G – average.G) <= threshold and abs(current.B – average.B) <= threshold add to list foreach point in list of noise get all neighbour from current point if one of neighbour is empty current.edge true Fig. 8 Noise Object Grouping The boundary of the noise group area is obtained by finding the lower right corner and the upper left corner using (4) and (5), where x is the value of x for all x coordinates in the same group, and y is the y coordinate value. In Fig. 8 it can be seen in the logo there is a green line. This line indicates the border of a noise group, while the red line is the vertical and horizontal center point of the noise group. min,min (4) max, (5) The step by step procedure of the group setting algorithm is depicted in Fig. 9, where all the points in the image are edge. In Pseudocode 3 the grouping algorithm works by obtaining a point from the edge list obtained from the previous step. This point(s) is then pushed into the stack. This is done until the stack is empty. Neighbors from the popped point is pushed into the stack and set the group label. If it has never been processed, the neighboring point is also set to the group value corresponding to the group from the popped point. The step is repeated until all the points in the edge list are processed. Groups whose number of points is less than threshold are removed from the group list because the group is considered as noise (not the actual container noise). Calculate Template Each group of edges will be computed into a template, so if a container has 20 groups of noise it will have 20 noise templates. A template of a container noise contains: a. Name Contains the name of the saved template b. List of information per angle Contain: i. Angle At what angle this information (contains 0 - 359 degrees). ii. Total point Contains the number of edge points in this corner. iii. Total distance Contains the total distance of the edge point to the midpoint. iv. List of edge points List of edge points that have angles equal to Angle Fig. 9 Steps of Set Group Algorithm Pseudocode 3 – Setting Group of Noise Points . Fig. 10 Noise Template The interval from an angle within the template has been determined, for instance a 1 degree interval means the number of angle lists is 360. Fig. 10 shows an evaluation point whose distance with the center and angle to the center are calculated. Fig. 11 illustrates in detail an angle in the template where all points that are straight with that angle are recorded (dotted red line). For now the matching process only compares each point angle and total distance from all points. If the difference in the number of points and the total distance is less than the threshold then it is considered the same angle, and if the similarity of all angles exceeds the specified threshold it is considered the same object. Fig. 11 Data Example in One Angle create new group take points in the edge which has not been processed with group from step 1 set all neighboring points to be in the same group if the number of points less than threshold remove group if not add to group list repeat step 2 for all points Border Line Center Line Center Point Evaluated PointV. RESULT AND DISCUSSION Images Requirement In order for the algorithm to perform at its best, it requires input image around 1200 pixels minimum wide. The container in the image should also in the side view and perpendicular to the shooting angle. Testing was done with several types of noise objects considered in this work namely characters, stamp/company logos, and damages. Images with Characters Fig. 12 Container Images with characters (left)original image (right)result It is demonstrated in Fig. 12 that the algorithm has successfully marked the noises in the container images, for both large – shipping company name- and tiny characters – code and numbers. Images with Company Logo Fig. 13 shows results of the algorithm when the input are images with company logo. Fig. 13 Container Images with Company Sign/Logo (left)original image (right)result Images with Damages Fig. 14 demonstrated the algorithm performance with damaged container. It is shown that the algorithm can successfully identified the damage. The damage area is marked with blue circle. It can be seen in the image that the container is dented in some parts near the center of top border. Damage at this level may not be classified as serious damage by some seaports, hence next in line for the subsequent research is to be able to set threshold to conFig. minimum limit for the damage. Fig. 14 Original container image with damages (top). Damages marked with circle (bottom) The execution time of this polynomial complexity algorithm is shown to be exceptional. Our experiment with over 10 images yield 2.71 as the average execution time. VI. Conclusion In this research, we applied Template Matching Algorithm to detect objects in the side of shipping container. Objects that are considered noise includes but not limited to company name of the cargo container, logo, identification code, signs, labels, and damages. The achieved visual result was satisfactory as well as the computational aspect. The research will not stop at this point. Remained in our list for future work is to distinguish between the identified objects. The ultimate goal is to create a system which can automatically detect whether a container is damaged or not. I. REFERENCES [1] W.-C. Lee and C.-H. Chen, "A Fast Template Matching Method for Rotation Invariance Using Two- Stage Process," Kyoto, 2009. [2] R. Brunelli and T. Poggio, "Face recognition: features versus templates," IEEE Transactions on Pattern Analysis and Machine Intelligence, pp. 1042-1052, 1993. [3] S. Tripathi, V. Sharma and S. Sharma, "Face Detection using Combined Skin Color Detector and Template Matching Method," International Journal of Computer Applications, vol. 26, no. 7, 2011. [4] W.-B. Horng, C.-Y. Chen, Y. Chang and C.-H. Fan, "Driver fatigue detection based on eye tracking and dynamk, template matching," Taipeil, 2004. [5] Y. Lee, T. Hara, H. Fujita, S. Itoh and T. 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